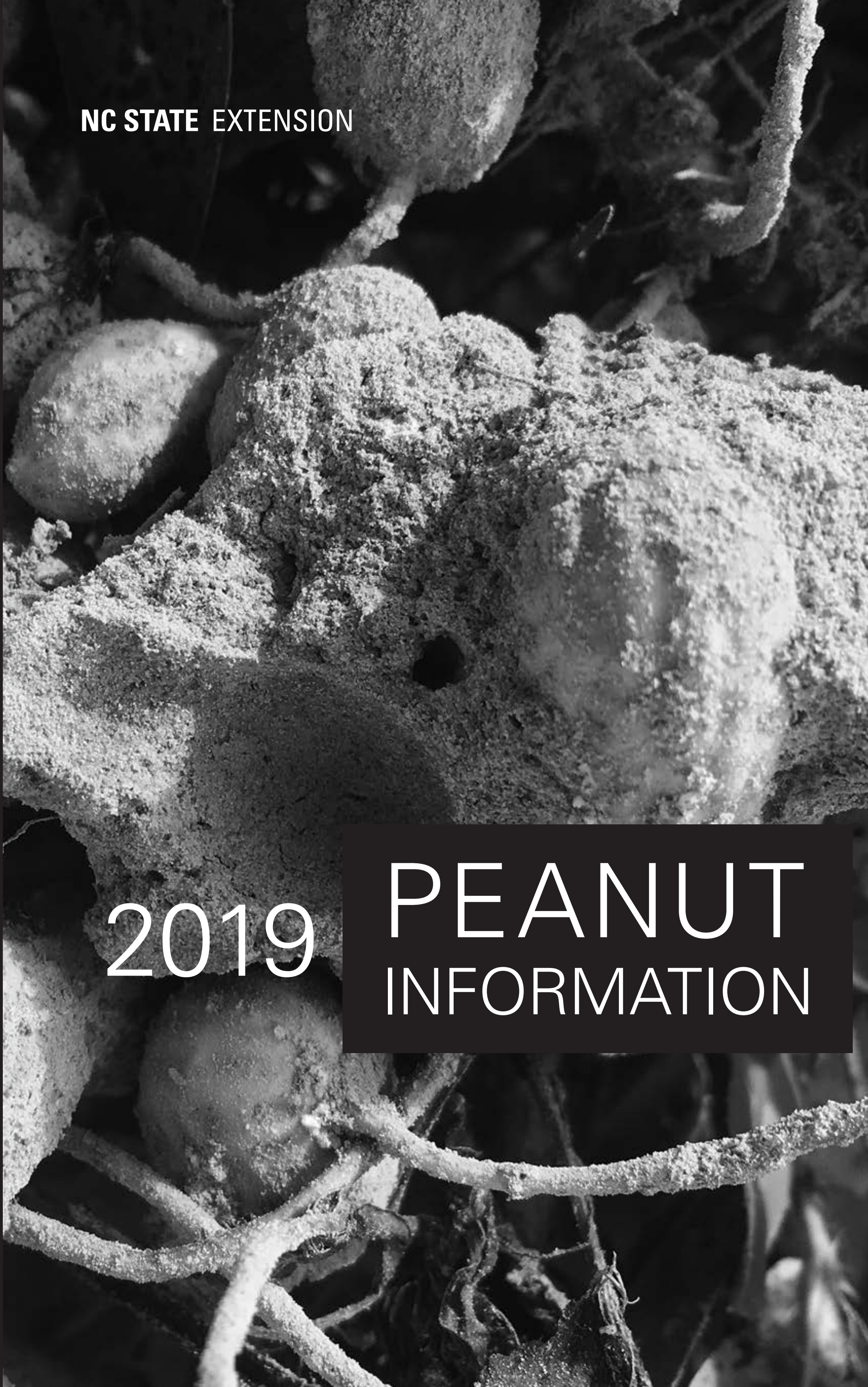
NC STATE EXTENSION

2019 PEANUT INFORMATION



2019 PEANUT INFORMATION

NC STATE EXTENSION

2019 PEANUT Information

Prepared by

David L. Jordan
Coordinating Author and Extension Specialist—Department of Crop and Soil Sciences

Rick L. Brandenburg
Extension Specialist—Department of Entomology and Plant Pathology

A. Blake Brown
Extension Economist—Department of Agricultural and Resource Economics

S. Gary Bullen
Extension Associate—Department of Agricultural and Resource Economics

Greg Buol
Research Technician—Department of Crop and Soil Sciences

Lisa Dean
Research Food Technologist—Market Quality and Handling Research Unit, United States Department of Agriculture, Southeast Area

Bill Foote
Director—North Carolina Crop Improvement Association

Andrew Hare
Research Technician—Department of Crop and Soil Sciences

Amanda Kaufman
Graduate Student—Department of Food, Bioprocessing, and Nutrition Sciences

Chris Reberg-Horton
Extension Specialist—Department of Crop and Soil Sciences

Gary T. Roberson
Extension Specialist—Department of Biological and Agricultural Engineering

Barbara Shew
Extension Specialist—Department of Entomology and Plant Pathology

Derek Washburn
NC Farm School Associate—Department of Agricultural and Resource Economics

Gail Wilkerson
Professor—Department of Crop and Soil Sciences

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Contents

EXTENSION PERSONNEL WORKING WITH PEANUTS

County Extension personnel with peanut responsibilities as of January 1, 2019:

County	Name	City	Telephone
Beaufort	Rod Gurganus	Washington	(252) 946-0111
Bertie	Billy Barrow	Windsor	(252) 794-5317
Bladen	Bruce McLean Jr.	Elizabethtown	(910) 862-4591
Chowan	Matthew Leary	Edenton	(252) 482-6585
Columbus	Lydia Miles	Whiteville	(910) 640-6605
Craven-Carteret	Mike Carroll	New Bern	(252) 633-1477
Cumberland	Anthony Growe	Fayetteville	(910) 321-6875
Duplin	Vacant	Kenansville	(910) 296-2143
Edgecombe	Art Bradley	Tarboro	(252) 641-7815
Gates	Paul Smith	Gatesville	(252) 357-1400
Greene	Grayson Wells	Snow Hill	(252) 747-5831
Halifax	Arthur Whitehead	Halifax	(252) 583-5161
Harnett	Brian Parrish	Lillington	(910) 893-7530
Hertford	Vacant	Winton	(252) 358-7822
Johnston	Tim Britton	Smithfield	(919) 989-5380
Jones	Jacob Morgan	Trenton	(252) 448-9621
Lenoir	Stephen Killette	Kinston	(252) 527-2191
Martin	Lance Grimes	Williamston	(252) 789-4370
Nash	Maryanna Bennett	Nashville	(252) 459-9810
Northampton	Craig Ellison	Jackson	(252) 534-2711
Onslow	Melissa Huffman	Jacksonville	(910) 455-5873
Pender	Mark Seitz	Burgaw	(910) 259-1235
Perquimans	Dylan Lilley	Hertford	(252) 426-5428
Pitt	Carrie Ortel	Greenville	(252) 902-1702
Robeson	Mac Malloy	Lumberton	(910) 671-3276
Sampson	Della King	Clinton	(910) 592-7161
Scotland	Randy Wood	Laurinburg	(910) 277-2422
Washington	Vacant	Plymouth	(252) 793-2163
Wayne	Daryl Anderson	Goldsboro	(919) 731-1520
Wilson	Jessica Anderson	Wilson	(252) 237-0111

NC State University Extension specialists with peanut responsibilities as of January 1, 2019:

Name and email	Specialty	Phone
Rick Brandenburg rick_brandenburg@ncsu.edu	Insects	(919) 515-8876
Blake Brown blake_brown@ncsu.edu	Economics	(919) 515-4536
Gary Bullen sgbullen@ncsu.edu	Economics	(919) 515-6095
David Jordan david_jordan@ncsu.edu	Agronomy and Weeds	(919) 515-4068
Gary Roberson gtrobers@ncsu.edu	Engineering	(919) 515-6715
Barbara Shew barbara_shew@ncsu.edu	Diseases	(919) 515-6984
Derek Washburn dawashbu@ncsu.edu	Economics	(919) 515-4614

Directors of peanut grower organizations:

Name and email	Organization	Phone
Bob Sutter sutter@aboutpeanuts.com	North Carolina Peanut Growers Association Inc.	(252) 459-5060
Dell Cotton Dcotton25@vcpeanutdma.com	Peanut Growers Cooperative Marketing Association	(757) 562-4103

1. SITUATION AND OUTLOOK

A. VIRGINIA TYPE PEANUTS: SITUATION AND OUTLOOK

A. Blake Brown
Extension Economist—Department of Agricultural and Resource Economics

United States peanut production was estimated at 5.471 billion pounds in 2018, according to the USDA October Crop Report, down from 7.115 billion pounds in 2017. Harvested acres for the U.S. decreased from 1.776 million acres in 2017 to 1.345 million acres in 2018. Yield per acre was estimated at 4,066 pounds, up from 4,007 pounds in 2017.

The North Carolina crop was adversely impacted by Hurricane Florence. The USDA November forecast was for 99,000 harvested acres, down from 103,000 harvested acres forecast in August. Production in North Carolina was forecast in August at 422.3 million pounds. After the hurricane, the forecast decreased to 386.1 million pounds. Both acreage and production were down from 2017 when North Carolina harvested acreage was 117,000 and production was 483.8 million pounds. Yields for North Carolina were forecast to be 3,900 pounds per acre. Stocks of peanuts were up substantially near the end of harvest in 2018. Stocks (in shell basis) were estimated at 2.595 billion pounds at the end of September 2018 up from 1.806 billion pounds at the same time last year. The Price Loss Coverage (PLC) provisions for peanuts under the 2014 Farm Bill were the primary drivers for increased acreage of peanuts prior to 2018. However, in 2018, legislation put in place a new cotton program that lowered incentives to plant peanut acres. Under the new provisions, generic base had to be converted to cotton and the base of other covered commodities. The base conversions to other covered commodities like peanuts were based on 2009-to-2012 acres planted.

B. PEANUT PRODUCTION BUDGETS

S. Gary Bullen
Extension Associate—Department of Agricultural and Resource Economics

Derek Washburn
NC Farm School Associate—Department of Agricultural and Resource Economics

David Jordan
Peanut Specialist—Department of Crop and Soil Sciences

The budgets in the following tables represent costs and returns that are achieved by many growers in different regions of North Carolina using strip-till or conventional production technologies. The budgets do not represent average costs and returns.

Budgets are intended to be used as guides for planning purposes only. They do not include sprays for Sclerotinia blight, fumigation for CBR, or government payments. The cost of gypsum is assumed to be $47.50 per ton; less expensive sources are available, although transportation costs can be significant.

Current information on the peanut outlook and situation, budgets, farm management, and more is available at the North Carolina State University Department of Agricultural and Resource Economics website: www.ag-econ.ncsu.edu.

Table 1-1. Estimated Costs and Returns Per Acre of RUNNER STRIP-TILL Peanuts, 2019—4,000-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost per Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS Peanuts	4000.00 lb	0.20	800.00	
Total Receipts			**800.00**	
2. VARIABLE COSTS*				
Seed	110.00 lb	0.80	88.00	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer*				
Nitrogen	0.00 lb	0.13	0.00	
Phosphate	48.00 lb	0.38	18.24	
Potash	100.00 lb	0.22	22.00	
Manganese	3.00 lb	0.35	1.05	
Boron	2.50 lb	1.35	3.38	
Lime (prorated)	0.33 ton	46.00	15.18	
Gypsum (spread)	0.30 ton	47.50	14..25	
Herbicides**	1.00 acre	62.51	62.51	
Insecticides**	1.00 acre	18.95	18.95	
Fungicides**	1.00 acre	79.77	79.77	
Prohexadione Calcium**	1.00 acre	0.00	0.00	
Scouting	1.00 acre	16.00	16.00	
Hauling	2.00 ton	12.00	23.95	
Drying & Cleaning	2.00 ton	45.00	89.82	
State Check-off Fee	2.00 ton	3.00	6.00	
National Assessment	$800.00	0.95%	7.60	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	69.95	69.95	
Labor	4.25 hours	11.46	48.71	
Interest on Operating Capital	$223.85	6.0%	13.43	
Total Variable Costs			**634.49**	
3. INCOME ABOVE VARIABLE COSTS			**165.51**	
4. FIXED COSTS				
Machinery/Overhead	1.00 acre	163.24	163.24	
Total Fixed Costs			**163.24**	
5. TOTAL COSTS			**797.73**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT***			**2.27**	

Please note: *This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation or Proline in-furrow for CBR, or land rent.*
**Fertilizer is listed as cost per lb of fertilizer.*
***Adjuvant costs are distributed evenly across pesticide and growth regulator applications.*
****To see yield and price tables for breakeven analysis, visit: https://cals.ncsu.edu/are-extension/business-planning-and-operations/enterprise-budgets/.*

Table 1-2. Estimated Costs and Returns Per Acre of RUNNER CONVENTIONAL-TILL Peanuts. 2019—4,000-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost per Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS Peanuts	4,000 lb	0.20	800.00	
Total Receipts			**800.00**	
2. VARIABLE COSTS				
Seed	110.00 lb	0.80	88.00	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer*				
Nitrogen	0.00 lb	0.13	0.00	
Phosphate	48.00 lb	0.38	18.24	
Potash	100.00 lb	0.22	22.00	
Boron	2.50 lb	1.35	3.38	
Manganese	3.00 lb	0.35	1.05	
Lime (prorated)	0.33 ton	46.00	15.18	
Gypsum (spread)	0.30 ton	47.50	14.25	
Herbicides**	1.00 acre	53.45	53.45	
Insecticides**	1.00 acre	18.80	18.80	
Fungicides**	1.00 acre	79.62	79.62	
Prohexadione Calcium**	1.00 acre	0.00	0.00	
Scouting	1.00 acre	16.00	16.00	
Hauling	2.00 ton	12.00	23.95	
Drying & Cleaning	2.00 ton	45.00	89.82	
State Check-off Fee	2.00 ton	3.00	6.00	
National Assessment	$800.00	0.95%	7.60	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	71.10	71.10	
Labor	4.59 hours	11.46	52.60	
Interest on Operating Capital	$221.84	6.0%	13.31	
Total Variable Costs			**630.35**	
3. INCOME ABOVE VARIABLE COSTS			**169.65**	
4. FIXED COSTS				
Machinery/Overhead	1.00 acre	161.72	161.72	
Total Fixed Costs			**161.72**	
5. TOTAL COSTS			**792.07**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT* **			**7.93**	

Please note: *This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation or Proline in-furrow for CBR, or land rent.*

**Fertilizer is listed as cost per lb of fertilizer.*

***Adjuvant costs are distributed evenly across pesticide and growth regulator applications.*

****To see yield and price tables for breakeven analysis, visit: https://cals.ncsu.edu/are-extension/business-planning-and-operations/enterprise-budgets/.*

Table 1-3. Estimated Costs and Returns Per Acre of VIRGINIA STRIP-TILL Peanuts, 2019—4,000-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost/ Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS				
Peanuts	4,000 lb	0.23	920.00	
Total Receipts			**920.00**	
2. VARIABLE COSTS				
Seed	125.00 lb	0.85	106.25	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer*				
Nitrogen	00.00 lb	0.13	0.00	
Phosphate	48.00 lb	0.38	18.24	
Potash	100.00 lb	0.22	22.00	
Manganese	3.00 lb	0.35	1.05	
Boron	2.50 lb	1.35	3.38	
Lime (prorated)	0.33 ton	46.00	15.18	
Gypsum (spread)	0.60 ton	47.50	28.50	
Herbicides**	1.00 acre	62.48	62.48	
Insecticides**	1.00 acre	18.92	18.92	
Fungicides**	1.00 acre	79.74	79.74	
Prohexadione Calcium**	1.00 acre	51.47	51.47	
Scouting	1.00 acre	16.00	16.00	
Hauling	2.00 ton	12.00	23.95	
Drying & Cleaning	2.00 ton	45.00	89.82	
State Check-off Fee	2.00 ton	3.00	6.00	
National Assessment	$920.00	0.95%	8.74	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	69.65	69.65	
Labor	4.25 hours	11.46	48.71	
Interest on Operating Capital	$273.79	6.0%	16.43	
Total Variable Costs			**722.51**	
3. INCOME ABOVE VARIABLE COSTS			**197.49**	
4. FIXED COSTS				
Machinery/Overhead	1.00 acre	169.41	169.41	
Total Fixed Costs			**169.41**	
5. TOTAL COSTS			**891.92**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT* **			**28.08**	

Please note: *This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation or Proline in-furrow for CBR, or land rent.*

**Fertilizer is listed as cost per lb of fertilizer.*

***Adjuvant costs are distributed evenly across pesticide and growth regulator applications.*

****To see yield and price tables for breakeven analysis, visit: https://cals.ncsu.edu/are-extension/business-planning-and-operations/enterprise-budgets/.*

Table 1-4. Estimated Costs and Returns Per Acre of VIRGINIA CONVENTIONAL-TILL Peanuts, 2019—4,000-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost per Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS				
Peanuts	4,000 lb	0.23	920.00	
Total Receipts			**920.00**	
2. VARIABLE COSTS				
Seed	125.00 lb	0.85	106.25	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer*				
Nitrogen	0.00 lb	0.13	0.00	
Phosphate	48.00 lb	0.38	18.24	
Potash	100.00 lb	0.22	22.00	
Manganese	3.00 lb	0.35	1.05	
Boron	2.50 lb	1.35	3.38	
Lime (prorated)	0.33 ton	46.00	15.18	
Gypsum (spread)	0.60 ton	47.50	28.50	
Herbicides**	1.00 acre	53.43	53.43	
Insecticides**	1.00 acre	18.77	18.77	
Fungicides**	1.00 acre	79.59	79.59	
Prohexadione Calcium**	1.00 acre	51.47	51.47	
Scouting	1.00 acre	16.00	16.00	
Hauling	2.00 ton	12.00	23.95	
Drying & Cleaning	2.00 ton	45.00	89.82	
State Check-off Fee	2.00 ton	3.00	6.00	
National Assessment	$920.00	0.95%	8.74	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	71.10	71.10	
Labor	4.59	11.46	52.60	
Interest on Operating Capital	$258.94	6.0%	15.54	
Total Variable Costs			**717.61**	
3. INCOME ABOVE VARIABLE COSTS			**202.39**	
4. FIXED COSTS				
Machinery/Overhead	1.00 acre	167.83	167.83	
Total Fixed Costs			**167.83**	
5. TOTAL COSTS			**885.44**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT* **			**34.56**	

Please note: *This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation or Proline in-furrow for CBR, or land rent.*

**Fertilizer is listed as cost per lb of fertilizer.*

***Adjuvant costs are distributed evenly across pesticide and growth regulator applications.*

****To see yield and price tables for breakeven analysis, visit: https://cals.ncsu.edu/are-extension/business-planning-and-operations/enterprise-budgets/.*

Table 1-5. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Peanut

Peanut Yield (pounds/acre)	**Net Return ($/acre) at $600/ton**					
	Total Cost of Production ($/acre)					
	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	150	100	50	0	-50	-100
3500 (1.75 tons)	300	250	200	150	100	50
4000 (2 tons)	450	400	**350**	300	250	200
4500 (2.25 tons)	600	550	500	450	400	350
5000 (2.5 tons)	750	700	650	600	550	500

Peanut Yield (pounds/acre)	**Net Return ($/acre) at $535/ton**					
	Total Cost of Production ($/acre)					
	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	53	3	-47	-97	-147	-197
3500 (1.75 tons)	186	136	86	36	-14	-64
4000 (2 tons)	320	270	**220**	170	120	70
4500 (2.25 tons)	454	404	354	304	254	204
5000 (2.5 tons)	588	538	488	438	388	338

Peanut Yield (pounds/acre)	**Net Return ($/acre) at $470/ton**					
	Total Cost of Production ($/acre)					
	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	-45	-95	-145	-195	-245	-295
3500 (1.75 tons)	73	23	-27	-77	-127	-177
4000 (2 tons)	190	140	**90**	40	-10	-60
4500 (2.25 tons)	308	258	208	158	108	58
5000 (2.5 tons)	425	375	325	275	225	175

Continued on the next page.

Table 1-5. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Peanut (continued)

	Net Return ($/acre) at $405/ton					
	Total Cost of Production ($/acre)					
Peanut Yield (pounds/acre)	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	-143	-193	-243	-293	-343	-393
3500 (1.75 tons)	-41	-91	-141	-198	-241	-291
4000 (2 tons)	60	10	**-40**	-90	-140	-190
4500 (2.25 tons)	161	111	61	11	-39	-89
5000 (2.5 tons)	263	213	163	113	63	13

	Net Return ($/acre) at $355/ton					
	Total Cost of Production ($/acre)					
Peanut Yield (pounds/acre)	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	-218	-268	-318	-368	-418	-468
3500 (1.75 tons)	-129	-179	-229	-279	-329	-379
4000 (2 tons)	-40	-90	**-140**	-190	-240	-290
4500 (2.25 tons)	49	-1	-51	-101	-151	-201
5000 (2.5 tons)	138	88	-12	-62	-112	-162

Table 1-6. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Corn

Corn Yield (bushels/acre)	Net Return ($/acre) at $3/bushel Price				
	Total Cost of Production ($/acre)				
	400	450	500	550	600
	Net Return ($/acre)				
60	-220	-270	-320	-370	-420
90	-130	-180	-230	-280	-330
120	-40	-90	**-140**	-190	-240
150	50	0	-50	-100	-150
180	140	90	40	-10	-60

Corn Yield (bushels/acre)	Net Return ($/acre) at $5/bushel Price				
	Total Cost of Production ($/acre)				
	400	450	500	550	600
	Net Return ($/acre)				
60	-100	-150	-200	-250	-300
90	50	0	-50	-100	-150
120	200	150	**100**	50	0
150	350	300	250	200	150
180	500	450	400	350	300

Corn Yield (bushels/acre)	Net Return ($/acre) at $7/bushel Price				
	Total Cost of Production ($/acre)				
	400	450	500	550	600
	Net Return ($/acre)				
60	20	-30	-80	-130	-180
90	230	180	130	80	30
120	440	390	**340**	290	240
150	650	600	550	500	450
180	860	810	760	710	660

Table 1-7. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Grain Sorghum

Grain Sorghum Yield (bushels/acre)	**Net Return ($/acre) at $2.55/bushel Price**				
	Total Cost of Production ($/acre)				
	350	400	450	500	550
	Net Return ($/acre)				
60	-197	-247	-297	-347	-397
90	-121	-171	-221	-271	-321
120	-44	-94	**-144**	-194	-244
150	33	-17	-67	-117	-167
180	309	259	209	159	109

Grain Sorghum Yield (bushels/acre)	**Net Return ($/acre) at $4.25/bushel Price**				
	Total Cost of Production ($/acre)				
	350	400	450	500	550
	Net Return ($/acre)				
60	-95	-145	-195	-215	-265
90	33	-17	-67	-117	-167
120	160	110	**60**	10	-40
150	288	238	188	138	88
180	415	365	315	265	215

Grain Sorghum Yield (bushels/acre)	**Net Return ($/acre) at $6.15/bushel Price**				
	Total Cost of Production ($/acre)				
	350	400	450	500	550
	Net Return ($/acre)				
60	19	-31	-81	-131	-181
90	204	154	104	54	4
120	388	338	**288**	238	188
150	573	523	473	423	373
180	757	707	657	607	557

Table 1-8. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Cotton

	Net Return ($/acre) at $0.60/pound Price				
	Total Cost of Production ($/acre)				
Cotton Yield (pounds lint/acre)	500	550	600	650	700
	Net Return ($/acre)				
300	-320	-370	-420	-470	-520
600	-140	-190	-240	-290	-340
900	40	-10	**-60**	-110	-160
1200	220	170	120	70	20
1500	400	350	300	250	200

	Net Return ($/acre) at $0.80/pound Price				
	Total Cost of Production ($/acre)				
Cotton Yield (pounds lint/acre)	500	550	600	650	700
	Net Return ($/acre)				
300	-260	-310	-360	-410	-460
600	-20	-70	-120	-170	-220
900	220	170	**120**	70	20
1200	460	410	360	310	260
1500	700	650	600	550	500

	Net Return ($/acre) at $1.00/pound Price				
	Total Cost of Production ($/acre)				
Cotton Yield (pounds lint/acre)	500	550	600	650	700
	Net Return ($/acre)				
300	-200	-250	-300	-350	-400
600	100	50	0	-50	-100
900	400	350	**300**	250	200
1200	700	650	600	550	500
1500	1000	950	900	850	800

Table 1-9. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Soybean

Soybean Yield (bushels/acre)	Net Return ($/acre) at $6/bushel Price				
	Total Cost of Production ($/acre)				
	160	190	220	250	280
	Net Return ($/acre)				
20	-40	-70	-100	-130	-160
30	20	-10	-40	-70	-100
40	80	50	**20**	-10	-40
50	140	110	80	50	20
60	200	170	140	110	80

Soybean Yield (bushels/acre)	Net Return ($/acre) at $10/bushel Price				
	Total Cost of Production ($/acre)				
	160	190	220	250	280
	Net Return ($/acre)				
20	40	10	-20	-50	-80
30	140	110	80	50	20
40	240	210	**180**	150	120
50	340	310	280	250	220
60	440	410	380	350	320

Soybean Yield (bushels/acre)	Net Return ($/acre) at $14/bushel Price				
	Total Cost of Production ($/acre)				
	160	190	220	250	280
	Net Return ($/acre)				
20	120	90	60	30	0
30	260	230	200	170	140
40	400	370	**340**	310	280
50	540	510	480	450	420
60	680	650	620	590	560

Table 1-10. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Wheat

Wheat Yield (bushels/acre)	Net Return ($/acre) at $3/bushel Price				
	Total Cost of Production ($/acre)				
	250	300	350	400	450
	Net Return ($/acre)				
50	-100	-150	-200	-250	-300
65	-55	-105	-155	-205	-255
80	-10	-60	**-110**	-160	-210
95	35	-15	-65	-115	-165
110	80	30	-20	-70	-120

Wheat Yield (bushels/acre)	Net Return ($/acre) at $5/bushel Price				
	Total Cost of Production ($/acre)				
	250	300	350	400	450
	Net Return ($/acre)				
50	0	-50	-100	-150	-200
65	75	25	-25	-75	-125
80	150	100	**50**	0	-50
95	225	175	125	75	25
110	300	250	200	150	100

Wheat Yield (bushels/acre)	Net Return ($/acre) at $7/bushel Price				
	Total Cost of Production ($/acre)				
	250	300	350	400	450
	Net Return ($/acre)				
50	100	50	0	-50	-100
65	205	155	105	55	5
80	310	260	**210**	160	110
95	415	365	315	265	215
110	520	470	420	370	320

Table 1-11. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Sweetpotato

Sweetpotato Yield (bushels/acre)	Net Return ($/acre) at $5.4/pound Price Assuming 70% No. 1, 20% Jumbo, and 10% Canner				
	Total Cost of Production ($/acre)				
	2,000	2,300	2,600	2,900	3,200
	Net Return ($/acre)				
400	160	-140	-440	-740	-1,040
450	430	130	-170	-470	-770
500	700	400	**100**	-200	-500
550	970	670	370	70	-230
600	1,240	940	640	340	40

Sweetpotato Yield (bushels/acre)	Net Return ($/acre) at $6.4/pound Price Assuming 70% No. 1, 20% Jumbo, and 10% Canner				
	Total Cost of Production ($/acre)				
	2,000	2,300	2,600	2,900	3,200
	Net Return ($/acre)				
400	560	260	40	-260	-560
450	880	580	280	-20	-320
500	1,200	900	**600**	300	0
550	1,520	1,220	920	620	320
600	1,840	1,540	1,240	940	640

Sweetpotato Yield (bushels/acre)	Net Return ($/acre) at $7.4/pound Price Assuming 70% No. 1, 20% Jumbo, and 10% Canner				
	Total Cost of Production ($/acre)				
	2,000	2,300	2,600	2,900	3,200
	Net Return ($/acre)				
400	960	660	360	60	-240
450	1,330	1,030	730	430	130
500	1,700	1,400	**1,100**	800	500
550	2,070	1,770	1,470	1,170	870
600	2,440	2,140	1,840	1,540	1,240

Table 1-12. Return to Land, Overhead, and Management at Various Yields and Costs of Production for Tobacco

Tobacco Yield (pounds/acre)	Net Return ($/acre) at $1.50/pound Price				
	Total Cost of Production ($/acre)				
	2,400	2,700	3,000	3,300	3,600
	Net Return ($/acre)				
1,800	300	0	-300	-600	-900
2,200	900	600	300	0	-300
2,600	1,500	1,200	**900**	600	300
3,000	2,100	1,800	1,600	1,300	1,000
3,400	2,700	2,400	2,100	1,800	1,500

Tobacco Yield (pounds/acre)	Net Return ($/acre) at $1.80/pound Price				
	Total Cost of Production ($/acre)				
	2,400	2,700	3,000	3,300	3,600
	Net Return ($/acre)				
1,800	840	540	240	-60	-360
2,200	1,560	1,260	960	660	360
2,600	2,280	1,980	**1,680**	1,380	1,080
3,000	3,000	2,700	2,400	2,100	1,800
3,400	3,720	3,420	3,120	2,820	2,520

Tobacco Yield (pounds/acre)	Net Return ($/acre) at $2.00/pound Price				
	Total Cost of Production ($/acre)				
	2,400	2,700	3,000	3,300	3,600
	Net Return ($/acre)				
1,800	1,200	900	600	300	0
2,200	2,000	1,700	1,400	1,100	800
2,600	2,800	2,500	**2,100**	1,800	1,500
3,000	3,600	3,300	3,000	2,700	2,400
3,400	4,400	4,100	3,800	3,500	3,200

2. PEANUT SEED

David Jordan
Extension Specialist—Department of Crop and Soil Sciences

Bill Foote
Director—North Carolina Crop Improvement Association

A uniform stand of healthy, vigorous plants is essential if growers are to achieve the yields and quality needed for profitable peanut production. It is important for growers to plant high-quality seed of varieties adapted to their farm situations, management styles, and intended market uses.

WHAT'S IN A BAG OF PEANUT SEED?

A bag of seed peanuts contains thousands of potential plants. To grow a uniform stand of healthy plants, you need genetically pure seed that has been produced under a management system that maximizes seed health, germination, and vigor. The genetic composition of a peanut variety dictates maturity date, disease and insect resistance, peanut quality, grade, and many other characteristics. The best assurance of obtaining genetically pure seed is to purchase certified seed.

Seed health is related to seedborne pathogens present on or in peanut seeds. Pathogens can reduce germination potential and can in some cases transmit peanut diseases. Professional seed producers take specific measures to reduce the level of seedborne pathogens. The extra steps they take minimize the chance for the spread of unwanted diseases. Seed lots high in germination and vigor potential will germinate more rapidly and produce more robust seedlings. These seedlings are more likely to survive moderate stress during the weeks following planting.

Always purchase seed from a reputable, professional seed dealer. Bargain seed from a stranger, or even a neighbor, may not be such a bargain. Along with their seed, you could be buying weed seed or mixed varieties. You could even introduce diseases onto your farm.

PEANUT SEED PRODUCTION

The key component to producing high-quality peanut seed is to make the seed crop your highest farm priority. Attention to details is essential, and critical steps include the following:

- field selection
- seed selection

- cleaning and tuning up planting equipment
- applying gypsum and boron at the right time
- digging the crop when a majority of the pods are close to maturity
- adjusting harvesting equipment to minimize mechanical damage
- curing the peanuts slowly
- storing the seeds in a cool, dry environment

SAVING SEED

In years when profits are low, some growers may decide that saving their own seed will help reduce production costs. Cleaning, treating, and bagging seed, however, can be expensive, and a grower may not save more than a few cents per acre. In fact, a loss may occur if the seeds they planted were of poor quality. Seed germination and vigor of saved seed can be an issue, and growers are urged to have germination tests run on saved seed immediately after harvest and again about six weeks before planting. Checking the quality of the seed early will tell the grower if the seed is worth saving. The second test will tell the grower if the seed is worth planting. Seed production is a specialized process; varietal purity, seed quality, and seed health are carefully monitored throughout the growing season and during the digging, combining, curing, cleaning, storage, and treating operations. Saving seed should not be an afterthought, but rather a process that begins well before the seed crop is planted.

Growers who decide to save seed should be aware that they might be in violation of the North Carolina State Seed Law, the Plant Variety Protection Act (PVPA), and Title V of the Federal Seed Act if they sell that saved seed.

According to regulations, growers may save enough seed of a PVPA-protected variety to plant back on their own holdings (land owned, leased, or rented). If the variety is protected under PVPA-Title V, a farmer may not sell or transfer ownership of any seed without the permission of the variety owner and the seed must only be sold as a Certified Class of Seed. Very few varieties currently grown in the mid-Atlantic states are not protected by PVPA-Title V. Growers who are considering selling saved seed are encouraged to consult with their department of agriculture seed sections or the North Carolina Crop Improvement Association (919-515-2851) to be sure of the variety protection level. See Table 2-1 for a list of popular Virginia market type varieties and their level of protection.

North Carolina Seed Regulations require variety labeling on all peanut seed sold in the state, regardless of whether the seed is certified or farmer stock. No peanut seed can be sold as *variety not stated*, even if the variety is not known or the seed is a mixture of varieties.

Table 2-1. List of Varieties and Requirements for Sale

Variety	Can you save seed?	Can you sell that saved seed?	Must the saved seed be sold as a class of certified seed?
Bailey	Yes	Only with permission	Yes
Bailey II	Yes	Only with permission	Yes
Brantley	Yes	Only with permission	Yes
Emery	Yes	Only with permission	Yes
CHAMPS	Yes	Only with permission	Yes
Gregory	Yes	Only with permission	Yes
Perry	Yes	Only with permission	Yes
Phillips	Yes	Only with permission	Yes
NC-V 11	Yes	Only with permission	Yes
Sugg	Yes	Only with permission	Yes
Sullivan	Yes	Only with permission	Yes
Wynne	Yes	Only with permission	Yes

CO-OP SEED DISTRIBUTION

Some growers are members of a co-op, and questions have been raised about co-op distribution of seed to growers. A farmer may bring saved seed into the co-op to be shelled, cleaned, treated, and bagged. But the entire quantity of saved seed must be returned to the farmer who produced it. The seed may not be commingled with seed from any other grower, and the seed may not be sold, traded, or given to any other grower. These actions are a violation of PVPA and the Federal Seed Act. The amount of peanuts shelled, cleaned, treated, and bagged must not exceed the amount the grower may legally save.

A co-op may become a licensed seed dealer, allowing co-op members to produce their own seed as a group with seed from several growers combined and distributed among the membership. If so, steps must be taken before planting to ensure proper certification and state seed law requirements have been met. Certified seed must be grown from foundation or registered seed, fields must be inspected, and the seed must meet minimum germination standards. The co-op must be licensed under the North Carolina State Seed Law. Contact the North Carolina Crop Improvement Association (919-515-2851) for details on how to certify peanut seed and the North Carolina Department of Agriculture and Consumer Services Seed Section (919-733 3930) for details about becoming a licensed seed dealer.

The percentage of acres of a variety that is certified can reflect planted acreage. The percentage of certified acres from 2015 through 2018 is presented in Table 2-2.

Table 2-2. Percentage of Acres of Varieties Certified in North Carolina during 2015 – 2018

Variety	2015	2016	2017	2018
Bailey	64.7	47.4	40.5	36.6
Gregory	2.1	0	0.4	2.7
Sugg	9.7	1.9	0.1	0
Sullivan	4.8	28.7	40.2	46.1
Wynne	5.3	13.5	7.5	5.2
Emery	0	0	-0.1	0.2
Bailey II	0	0	0	0.3
Florida 07	1.4	1.8	0.7	0
FloRun 107	1.1	0.2	0	0
Georgia 09B	9.9	6.2	10.5	5.0

MAINTAINING PURITY OF HIGH OLEIC VARIETIES

Releases of Virginia market types from the Virginia-Carolina region will possess the high oleic trait. This trait has been shown to improve shelf life of peanuts in general but specifically for in-shell products. Maintaining uniform expression of this trait can be influenced by management both in the field and following harvest. Digging peanuts at optimum maturity will help ensure adequate expression of the trait in commercial products. Handling and storing peanuts in a manner that prevents commingling with peanuts that do not express the high oleic fatty acid profile is essential and needs to be a focus of both seed producers and shellers. All Virginia market types grown in the Virginia-Carolina region eventually will express the high oleic trait. Runner market types grown in North Carolina and Virginia currently express this trait.

3. PEANUT PRODUCTION PRACTICES

David L. Jordan
Extension Specialist—Department of Crop and Soil Sciences

Andrew Hare
Research Technician—Department of Crop and Soil Sciences

Successful production of quality peanuts requires growers to plan an effective production and marketing program and to implement that program on a timely basis during the season. Each cultural practice and marketing decision must be effectively integrated into the total farm management plan to produce optimum profits from the whole farm. In recent years, yields have increased significantly with several records set since 2011. Several factors have contributed to high yields and include improved genetics, production of peanut on soils that are adapted to peanut production, long rotations that minimize impact of disease, availability of plant protection products for virtually all pests, equipment and technology, and skills of farmers and their support staff who manage peanut extremely well. In North Carolina, weather conditions can have a major impact on yield, given only 15 percent of acreage is irrigated. But given good weather conditions, two tons per acre is the new average yield, and yields of 5,000 pounds per acre are not uncommon in North Carolina.

STAND ESTABLISHMENT

Soil temperatures need to be above 65°F for germination to proceed at an acceptable rate. Large-seeded Virginia market type peanuts planted under favorable moisture and temperature conditions will show beginning radicle (root) growth in about 60 hours. If conditions are ideal, sprouting young seedlings should be visible in seven days for smaller-seeded varieties like Bailey and in 10 days for larger-seeded varieties like Wynne.

Peanuts should not be planted until the soil temperature at a 4-inch depth is 65°F or above at noon for three days. Favorable weather for peanut germination should also be forecast for the next 72 hours after planting. The soil should be moist enough for rapid water absorption by the seed. The planter should firm the seedbed so there is good soil-to-seed contact. Growers should establish at least four plants per foot of row regardless of variety. This goal generally means setting the planter to deliver five seeds per foot of row. Peanuts can emerge from depths as low as 3 inches.

VARIETY SELECTION

Yield and quality are two major factors that influence variety selection. Growers with significant disease history may need to choose a variety with disease tolerance or resistance. Planting at least three varieties with differing maturity dates will permit efficient use of limited harvesting and curing capacities. Planting varieties with different genetic pedigrees reduces the risk of crop failure because of adverse weather or unexpected disease epidemics. In recent years, the variety Bailey has become the dominant variety in North Carolina because of its high yield potential and disease resistance. There is concern that heavy reliance on this variety will increase risk that is often minimized by planting a group of varieties on each farm.

The selection of a variety should be based on more than one year's data. Performance of our most popular peanut varieties from reports prepared by Dr. Maria Balota's PVQE (Peanut Variety and Quality Evaluation) program is presented in Table 3-1. Varietal characteristics are listed in Table 3-2. Disease reaction of varieties can be found in chapter 6, "Peanut Disease Management."

Table 3-1. Percentages of FP, ELK, SMK, and Total Kernels and Pod Yield for the Major Virginia Market Type Varieties

Variety	% FP	% ELK	% SMK	Total Kernels (%)	Yield (lb/acre)
Bailey	83	32	63	67	4,631
Bailey II	85	35	64	68	5,045
Emery	90	33	64	67	4,527
Sullivan	85	30	62	65	4,615
Wynne	90	30	61	65	4,420

*Data are from Balota et al. (PVQE director) from eight trials during 2014 to 2016.

Table 3-2. Varietal Characteristics

Factors	Bailey	Emery	Sullivan	Wynne
Growth habit (R = runner; SR = semi-runner)	SR	SR	R	SR
Heat unit requirement	2,590	2,600	2,630	2,700
Comparative days to optimum maturity	0	+2	+2	+4
Seed per pound	600	535	575	450
Need for calcium (M = moderate; H = high)	M	H	M	H

Heat unit requirement = degree day accumulation (56°F base and a 95°F ceiling) required to reach optimum maturity, assuming adequate soil moisture for sustained growth and development.
In comparative days to optimum maturity, **–** = optimum maturity for the variety occurs prior to 0; **+** = optimum maturity for variety occurs after 0.

VARIETY CHARACTERISTICS

Bailey and **Bailey II** are large-seeded Virginia market type peanut with resistance to several key peanut diseases. These varieties offer tolerance to CBR, Sclerotinia blight, tomato spotted wilt, and stem rot. Seed size for Bailey is small compared with all other Virginia market types. Bailey II was released in 2017 and is the high oleic version of Bailey. Seed for this variety will not be available until after the 2021 growing season.

Emery is a large-seeded, high oleic variety that offers resistance to several key diseases in peanut. Vine growth is intermediate between Bailey and Sullivan. Pods and kernels for this variety are larger than those for Bailey but smaller than those for Wynne.

Sullivan is a large-seeded Virginia market type that possesses the high-oleic trait and offers some resistance to some of the key diseases found in peanut in North Carolina. This variety does not have excessive vine growth like Bailey and has yielded well in many trials. Pod size is larger than Bailey but not as large as Gregory or Wynne.

Wynne is a large-seeded Virginia market type possessing the high-oleic trait like Sullivan and offers resistance to some of the key diseases. Pod size is larger than all Virginia market types except Gregory.

SELECTING AND MANAGING SOIL RESOURCES

Peanuts are best adapted to well-drained, sandy loam soils, such as Norfolk, Orangeburg, and Goldsboro sandy loam soils. These soils are loose, friable, and easily tilled with a moderately deep rooting zone for easy penetration by air, water, and roots. A balanced supply of nutrients is needed. Soil pH should be in the range of 5.8 to 6.2. Peanuts grown in favorable soil conditions are healthier and more able to withstand climatic and biotic stresses.

Crop Rotation

A long crop rotation program is essential for efficient peanut production. The peanut plant responds to both the harmful and beneficial effects of other crops grown in the same field. Research shows that long rotations are best for maintaining peanut yields and quality. Benefits and potential problems associated with crops typically found within peanut-based cropping systems can be found in chapter 6, "Peanut Disease Management." Research conducted at the Peanut Belt Research Station demonstrates the benefits of long rotations with corn and cotton.

In recent years, there has been interest in crop yields, especially grains, when transitioning out of traditional peanut rotations. Results indicate that corn, cotton, soybeans, and wheat are not affected by rotation to the extent that peanuts are affected. Sweetpotato is a good rotation crop for peanut, while some decreases in peanut yield have been observed when peanut follows sage. Growers should plant corn, cotton, or grain sorghum for at least one year following sage before planting peanut.

FERTILIZING PEANUTS

Lime

Peanuts grow best on soils limed to a pH of 5.8 to 6.2, provided other essential elements are in balance and available to the plant. Yields of peanuts planted in soil with four differing pH regimens are provided in Figure 3-1.

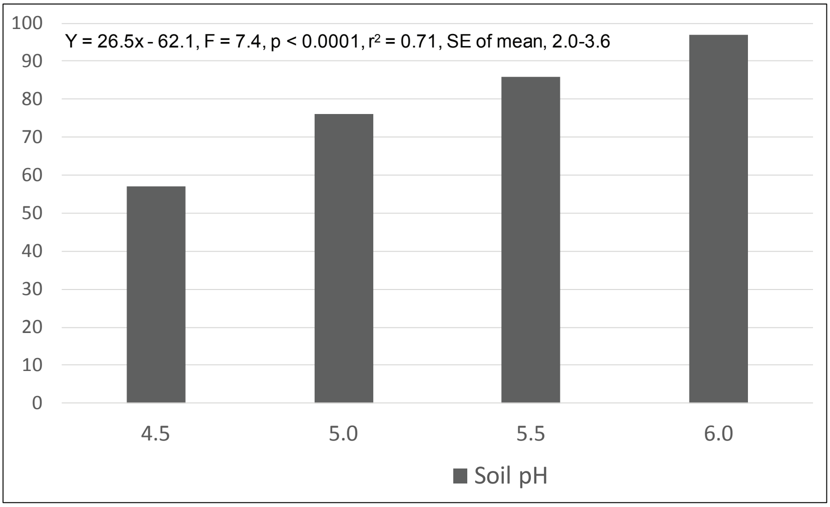


Figure 3-1. Influence of soil pH on peanut yield presented as percentage of maximum yield. Data are pooled over six years.

Dolomitic limestone is the desired liming material because it provides both calcium and magnesium. Strongly acidic soils reduce the efficient uptake and use of most nutrients and may enhance the uptake of zinc to potentially toxic levels. The efficiency of nitrogen fixation is reduced in acid soils. Molybdenum is an essential element in biological nitrogen fixation, and it can be limiting at low soil pH. Soils too high in pH are not desirable because some elements are less available to the peanut plant, and incidence of Sclerotinia blight may be greater. Manganese deficiency is often observed in fields that are overlimed. Some research has demonstrated that higher rates of calcium sulfate (gypsum or land plaster) can reduce peanut yield when soil pH in the pegging zone is relatively low (Table 3-3).

These results remind us that soil pH should be maintained around 6.0 and that gypsum should be applied at rates not exceeding those currently recommended for Virginia market type peanuts. Increased broiler production in North Carolina and use of manure as a fertilizer source has increased concern over micronutrient toxicity.

Several peanut fields have exhibited severe and yield-limiting zinc toxicities. These toxicities are increased in fields with low pH because zinc is more available at a lower pH. Maintaining soil pH around 6.0 is important in minimizing the adverse effects of zinc, and growers are cautioned not to overload fields with high levels of waste products. Micronutrient levels can build up quickly. Peanuts generally are able to tolerate zinc indices of 250. However, zinc toxicity can occur with lower index values if soil pH is low.

Table 3-3. Peanut Response to Gypsum Rate at Three Soil pH Values

Relative Gypsum Rate	Soil pH		
	5.0	**5.5**	**6.0**
0	1,920	2,720	2,900
0.5X	1,930	2,690	3,320
1.0X	2,110	2,190	3,250

Data are pooled over three years.

Nitrogen

Roots of peanuts can be infected by *Bradyrhizobia* bacteria. Nodules form on the roots at the infection sites. Within these nodules, the bacteria can convert atmospheric nitrogen into a nitrogen form that can be used by plants through a process called biological nitrogen fixation. This symbiotic relationship provides sufficient nitrogen for peanut production if the roots are properly nodulated. Growers should inoculate their peanut seed or fields to ensure that adequate levels of *Bradyrhizobia* are present in each field. The data in Table 3-4 are from multiple locations and years and give an indication of the possible response of peanuts to inoculant applied as a liquid or granular in the seed furrow.

Table 3-4. Peanut Yield Response and Economic Return at a Price of $535 per ton in Fields without a History of Peanuts versus Fields with Frequent Plantings of Peanuts (1999 – 2017). Trials were conducted in North Carolina, South Carolina, and Virginia with Virginia market type varieties.

Inoculant Use	New Peanut Fields		Fields with a Recent History of Peanuts	
	Yield (lb per acre)	**Economic return ($ per acre)**	**Yield (lb per acre)**	**Economic return ($ per acre)**
No inoculant	3,460	5	4,280	227
Inoculant	4,660	323	4,450	268
Difference	1,200	318	170	41
Number of Trials	52	52	43	43
Years	1999 – 2017		1999 – 2017	

While peanut response to rotation is often predictable, response to inoculant and rotation combinations is less predictable. Therefore, peanuts should be inoculated in all years regardless of previous rotation history to minimize risk and maintain yield. The economic value of inoculation is demonstrated in these trials (Table 3-4). Assuming a commercial inoculant cost of $8 per acre, economic return in new peanut fields at $535 per ton was 51 times higher than the cost of the inoculant. A five-fold increase in economic return over inoculant cost was noted in fields with a recent history of peanut production.

Generally, a peanut plant with 15 nodules on the tap root by 40 days after emergence has adequate nodulation. Oftentimes foliar symptoms of nitrogen deficiency will be apparent by this time if nodulation is not effective. Later in the season the plant will need many more nodules, more than 100, for optimum growth, development, and yield. If fewer than 15 nodules are noted 40 days after emergence, especially if peanut foliage is yellow, growers should consider application of ammonium sulfate.

Commercial inoculants can be added to the seed or put into the furrow with the seed at planting. In-furrow inoculants are available in either granular or liquid form. When inoculants are applied directly in the seed furrow, either as a spray or granular, it is essential that the product reach the bottom of the seed furrow so that infection occurs as the root system develops. Some growers have had difficulty in obtaining nodulation because soil moved in the seed furrow after seed drop but before inoculant spray or granules entered the seed furrow. Delivering granular or in-furrow sprays above seed placement also will compromise effectiveness of systemic insecticides and fungicides.

In addition, shallow planting along with in-furrow spray inoculants have performed poorly under hot and dry soil conditions. Peanuts are capable of emerging from depths of at least 3 inches; therefore, it is advisable to plant deep to protect sprayed inoculant from breakdown caused by high temperatures. Direct applications of nitrogen to peanuts are not generally needed. However, application of nitrogen fertilizers can increase yield, but only when peanuts are not nodulating and nitrogen deficiency is obvious. Research indicates that 90 to 120 pounds actual nitrogen per acre as a single application may be needed to obtain yields similar to adequately nodulating peanuts when a true nitrogen deficiency exists. Economic return on investment of inoculant and various rates of ammonium sulfate are also compared in Table 3-5 at a peanut price of $560/ton and fertilizer cost of $0.29/pound ammonium sulfate. While a rate of 90 pounds of nitrogen is the most economically effective, in some trials 120 pounds of nitrogen were needed when late-season rainfall was excessive. Lower rates also may be effective but perform inconsistently. Research also suggests that ammonium sulfate is a more effective source than ammonium nitrate. Split applications may be more efficient than a single application. Best results are obtained when applications are made early in the season. Peanuts grown on deep, sandy soils often respond to nitrogen fertilization and may lap middles more quickly, even when inoculation is adequate. Rapid canopy closure results in cooler soil temperatures in the pegging zone. When soils have high temperatures, pegs cannot survive.

Table 3-5. Peanut Response from 14 Trials to Inoculation and Ammonium Sulfate at 571 lb/acre (120 lb actual N/acre) Applied when Nitrogen Deficiency Is First Visible.

Inoculant	Ammonium Sulfate	Pod Yield (lb/acre)	Net Return ($/acre)
No	No	3,530 c	20 c
Yes	No	4,850 a	353 a
No	Yes	4,550 b	271 b

Means followed by the same letter are not significantly different at $p < 0.05$.

Potassium and Phosphorus

The most efficient and easiest way to apply potassium is to apply it to the crop preceding peanuts. This practice usually increases the yield of the preceding crop and allows the potassium to leach into the area where the peanut root system obtains most of its nutrients. However, if NC Department of Agriculture and Consumer Services soil test recommendations indicate that potassium and phosphorus are needed, then the appropriate levels of these nutrients should be applied.

Many growers and researchers feel that high levels of soil potassium in the fruiting zone (the upper 2 or 3 inches of soil) result in more pod rot and interfere with the uptake of calcium by pegs and pods, which results in a higher percentage of "pops" and calcium deficiency in the seeds. If the potassium level is high in the fruiting zone, a higher rate of gypsum may be needed.

Most of the peanut soils in North Carolina have adequate levels of phosphorus for good peanut production. Once a medium or higher level of phosphorus is achieved, it remains quite stable over a number of years. The addition of phosphorus-containing fertilizer to peanuts is generally not needed if it is applied to other crops in the rotation. However, soil testing is the only way to be sure.

Calcium

Perhaps the most critical element in the production of large-seeded Virginia market type peanuts is calcium. Lack of calcium uptake by peanuts causes "pops" and is often reflected as darkened plumules in the seed. Seeds with dark plumules usually fail to germinate.

Calcium must be available for both vegetative growth and pod growth. Calcium moves upward in the peanut plant but does not move downward. Thus, calcium does not move to the peg and pod and developing kernels. The peg and developing pod absorb calcium directly from soil, so it must be readily available in the soil.

Adequate soil calcium is usually available for good plant growth but not for pod development for good quality peanuts. It is important to provide calcium in the fruiting zone through gypsum applications. Gypsum should be applied to all Virginia market types, regardless of the soil characteristics or soil nutrient levels. The calcium supplied through gypsum application is relatively water soluble (compared to other calcium sources) and more readily available for uptake by peanut pegs and pods. Each pod must absorb adequate calcium to develop normally.

Gypsum product materials vary in elemental calcium content. Studies show that all forms of gypsum effectively supply needed calcium when used at rates that provide equivalent calcium levels uniformly in the fruiting zone. General recommendations for application rates are given in Table 3-6.

Table 3-6. Gypsum Sources and Application Rates

		Application Rate (lb/acre)	
Source	**% $CaSO_4$***	**Band (16 – 18 in)**	**Broadcast**
USG Ben Franklin	85	600	—
USG 420 Granular	83	—	1,215
USG 500	70	—	1,300
Super Gyp 85	85	—	1,200
TG Phosphogypsum	50	—	2,000
Agri Gypsum	60	—	1,800
Gyp Soil	85	—	1,200

*Guaranteed analysis percentage in registration with North Carolina Department of Agriculture and Consumer Services.

The use of gypsum on large-seeded peanuts is very effective in improving peanut seed quality and grades. Some research data indicate that high rates of gypsum may control or reduce the pod rot disease complex. Gypsum should not be broadcast before land preparation or before planting because too much rain may leach the calcium below the fruiting zone.

Best results are obtained when gypsum is applied in late June or early July. The availability of calcium supplied by gypsum application is also influenced by the amount of rainfall. Moisture is needed to make gypsum soluble and calcium available to the peanut fruit. In unusually dry years, peanuts may show symptoms of calcium deficiency, even when recommended rates of gypsum are applied.

Increasingly, there are questions concerning the need to apply gypsum as supplemental calcium to peanuts. Sometimes peanuts do not respond to supplemental calcium. Sometimes peanuts respond well to half the amount given in Table 3-6. The interactions of environmental conditions, seed size, soil series, native fertility, and soil moisture are unpredictable. However, for a consistent response over a wide range of soil characteristics and weather conditions, the full rate of gypsum is recommended for Virginia market types. Growers are encouraged to evaluate peanut response to gypsum on their own farms before leaving off this input or reducing rates below those presented in Table 3-6. Data from twelve trials (Table 3-7) indicate that gypsum at rates below those recommended in Table 3-6 can, in some cases, be effective.

Table 3-7. Pod Yield Following Application of Gypsum at 0.5 and 1 Times (X) the Recommended Use Rate for Virginia Market Types.

		Pod Yield (lb/acre)		
Pod Yield (lb/acre)	**No. of Trials**	**No Gypsum**	**0.5X Gypsum**	**1.0X Gypsum**
Actual yield	12	3,970	4,510	4,590
Increase in yield over no-gypsum control	—	—	540	620

Excessive rainfall can occur during June and July after gypsum has been applied. If rainfall exceeding 5 inches occurs over a short period of time within a few weeks after gypsum is applied, growers should consider applying a rate of 0.5 times the normal use rate to make sure sufficient calcium is in soil during the entire period of reproductive growth. Likewise, if growers cannot get into fields to apply gypsum on time due to wet soils, gypsum still needs to be applied even if application is delayed until early to mid-August. While liquid calcium products are available, they are not a substitute for gypsum.

There is also a question of whether or not the gypsum rate needs to be increased for extremely large-seeded Virginia market type varieties, such as Wynne. Results from previous research indicated that a rate of gypsum 1.5 times the recommended rate did not increase pod yield over the normal use rate in most experiments. While the data did indicate that a large-seeded variety was more responsive to gypsum than a smaller-seeded variety, there was no advantage to applying gypsum at rates exceeding those rates listed in Table 3-6.

In recent years, runner market type varieties referred to as "jumbo runners" have become more popular. Growers should apply at least half the rate recommended for Virginia market types (Table 3-6).

Manganese and Boron

Two other elements often found to be deficient in peanuts are manganese and boron. Manganese deficiency usually occurs when soil is overlimed. Increasing the soil pH reduces the plant's uptake of manganese. The symptom of manganese deficiency is interveinal chlorosis. This symptom can be confused with carryover of atrazine (from corn) or Cotoran/Meturon (from cotton). A deficiency can be corrected by a foliar application of manganese sulfate. The usual practice is to apply 3.5 to 4 pounds per acre of dry material when the deficiency is observed.

Boron plays an important role in kernel quality and flavor. Boron deficiency may occur in peanuts produced on deep, sandy soils. Deficient kernels are referred to as having "hollow hearts." The inner surfaces of the cotyledons are depressed and darkened, so they are graded as damaged kernels. A general recommendation is to apply 0.5 pound of actual boron per acre as a foliar spray in early July. Several formulations of boron are available. Some growers apply boron with their preplant incorporated herbicides, and others have boron added to their fertilizers.

Growers are advised to make sure boron and manganese sources provide sufficient elemental boron. Several liquid boron and manganese formulations are available. Although liquid sources are more convenient to use than some dry products, some of the liquid products contain only a fraction of the needed boron or manganese. The amount of formulated product needed to supply 0.5 pound elemental boron per acre is provided in Table 3-8. Similarly, the amount of formulated manganese product needed to supply 1.0 pound of manganese per acre or two applications of 0.5 pounds of manganese spaced 10 to 14 days apart is provided in Table 3-9. Lower rates of boron or manganese are often applied for "maintenance." Growers should make sure the product they purchase supplies the amount of boron or manganese the plant needs.

Table 3-8. Amount of Formulated Product Needed to Provide Equivalent Amounts of Elemental Boron per Acre

Source	Amount Needed to Supply 0.5 lb Boron per Acre
Boric acid	3.0 lb
Disodium octaborate (Solubor, 17.5% boron)	2.8 lb
Liquid (9.0% boron)	2.2 qt

Table 3-9. Amount of Formulated Manganese Products Needed to Provide Equivalent Amounts of Elemental Manganese per Acre

Source	Amount Needed to Supply 1.0 lb Manganese per Acre
Manganese sulfate (Techmangum, 27% manganese)	3.7 lb
Manganese sulfate (8% manganese)	1.2 gal

The percentage of element (in this case, manganese or boron) or the weight of the element per unit volume of product can be used to determine the amount of liquid product needed to correct a nutrient deficiency. For example, if 1 pound of manganese is needed per acre, the following formulas can be used to determine the amount of 8 percent water-soluble manganese product needed per acre.

Step 1. Figure the weight of manganese per gallon by multiplying the percentage of manganese in product in pounds by the weight of product in pounds per gallon:

% manganese in product × lb product per gal = lb manganese per gal

Step 2. Figure the gallons of manganese product per acre by dividing the desired amount of manganese in pounds per acre by the weight of the manganese per gallon:

$$\frac{\textbf{desired lb manganese per acre}}{\textbf{lb manganese per gal}} = \textbf{gal manganese product per acre}$$

Example:

Step 1.

0.08 × 10.5 lb manganese sulfate per gal = 0.84 lb manganese sulfate per gal

Step 2.

$$\frac{\textbf{1 lb manganese per acre desired}}{\textbf{0.84 lb manganese per gal}} = \textbf{1.2 gal 8\% manganese product per acre}$$

LAND PREPARATION

Historically, peanut growers have planted into conventionally prepared seedbeds to obtain a smooth, uniform, residue-free seedbed for planting. The effectiveness of burial of old crop residue and weed seed in the long-term suppression of soilborne diseases and short-term suppression of some weed problems was noted when the moldboard plow was used. However, only 5 percent of acres were treated this way, based on a 2014 survey in North Carolina (Table 3-10), in part because newer plant protection products are very effective. There is also a growing trend toward reduced-tillage crop production in North Carolina, and some growers are successfully using these practices for peanut. There has also been a significant decrease in the number of growers using secondary tillage. Changes in tillage systems over the past decade are presented in Table 3-10.

Table 3-10. Percentage of Farmers Using Certain Tillage Practices on at Least a Portion of Their Farms

Tillage	1998	2004	2009	2014
Disk	90	78	71	75
Chisel	25	23	27	12
Moldboard plow	58	17	7	5
Field cultivate	75	55	42	44
Rip and bed	49	39	40	55
Bed	44	35	32	25
Reduced tillage	10	23	41	20

There is concern about stratification of nutrients in reduced-tillage systems. For example, repeated applications of potassium in reduced-tillage cotton may result in excessive amounts of this nutrient in the pegging zone when peanuts are planted in a reduced-tillage system. Growers are encouraged to test soils for excessive potassium levels and incorporate this nutrient with tillage, if needed.

Many peanut growers bed their peanut fields either in the fall or the spring. Many growers prefer planting on raised beds rather than flat planting. The beds often give faster germination and early growth, provide drainage, and may reduce pod losses during digging. While reduced-tillage systems can be as successful as conventional-tillage systems, reduced-tillage systems often have less consistent yields than conventional-tillage systems. However, most peanut production has shifted to sandy soils that respond more favorably to reduced-tillage systems. A summary of peanut response to tillage is presented in Table 3-11.

Table 3-11. Peanut Yield Response to Tillage Practices in North Carolina, 1999 to 2013. A positive value indicates that yield of peanut in conventional tillage exceeded yield of peanut in reduced tillage.

No. of Trials	Years	Actual Yield Difference (lb/acre)	Yield Difference (%)	Range of Yield Difference (%)
65	1997 – 2013	+132	+3.4	-16.1 to +27.5

Because of concern about digging losses on finer-textured soils, it is recommended that beds be established in the fall with a grass cover crop with peanuts strip-tilled into previously prepared beds. Research during 2005 and 2006 demonstrated that wheat, cereal (cover crop), rye, oats, and triticale can serve equally well as wheat when used as a cover crop grown the winter and spring prior to planting peanuts. A risk advisory index has been developed to assist growers in deciding the risk of peanut yield in reduced-tillage systems being lower than yield in conventional-tillage systems (Table 3-12). Research also suggests that prior cropping history generally does not affect peanut response to tillage. However, peanuts are often more responsive to tillage systems, primarily because of the digging requirement. The risk advisory index has been modified from the initial version. A positive value indicates that yield was higher in conventional tillage than in reduced tillage.

Table 3-12. Advisory Index for Determining the Risk of Peanut Yield in Reduced-Tillage Systems Being Lower Than Yield in Conventional-Tillage Systems

Soil series Roanoke and Craven…40 points Goldsboro and Lynchburg…20 points Norfolk…10 points Conetoe and Wanda…0 points Pod loss on finer-textured soils, such as those on the Roanoke and Craven series, is often greater than on coarser-textured soils, such as Conetoe and Wanda series, regardless of tillage system. Difficulty in digging can increase when these soils become hard in the fall if rainfall is limited.	**Soil series** **Your score:**
Tillage intensity No tillage into flat ground…35 points Strip tillage into flat ground…10 points Strip tillage into stale seedbeds…0 points Peanut response to reduced-tillage systems is invariably correlated with the degree of tillage. Efficient digging can be difficult when peanuts are planted in flat ground in reduced-tillage systems. Although fields may appear to be flat and uniformly level, often fields are more rugged than they appear, and setting up the digger to match unforeseen contours in the field can be difficult. Strip tillage into flat ground is a better alternative than no tillage into flat ground, although digging peanuts planted on flat ground can be more challenging regardless of the tillage system. Strip tillage into preformed beds often results in yields approaching those of conventional tillage.	**Tillage intensity** **Your score:**
Risk of yield being lower in reduced tillage than in conventional tillage: 35 or Less—Low Risk 40 to 50—Moderate Risk 55 or more—High risk	**Total index value** **Your score:**

PLANTING

Varieties grown in North Carolina can require as many as 160 days for full pod maturity, depending upon soil moisture and temperature. Along with yield and market grades, planting date can affect disease and insect development (see chapters 5 and 6). Less damage from thrips and lower incidence of tomato spotted wilt virus have been associated with later plantings. Peanut yields are often the highest when peanuts are planted in mid-May. However, in some years peanuts planted later can yield quite well. Conditions in the fall, especially night temperatures, can have a great impact on yield when they prevent peanut pods from reaching optimum maturity.

Data for the variety Bailey during 2013 to 2017 exposed to three planting dates when peanut was dug at optimum maturity based on pod mesocarp color are provided in Table 3-13. Yield differences among planting dates were noted in all years. In most years planting in mid-May resulted in the highest yields. When peanut was planted in mid-June following wheat, yield was substantially lower compared with planting in May (Table 3-14).

Table 3-13. Yield (lb/acre) of the Variety Bailey as Influenced by Planting Dates at Lewiston-Woodville from 2013 to 2017

Planting Date	2013	2014	2015	2016	2017
May 3 – 4	4,955	5,114	4,816	3,848	5,868
May 16 – 19	6,123	4,524	6,337	5,009	5,417
May 28	6,352	3,898	4,001	4,481	5,198

Table 3-14. Yield (lb/acre) of the Variety Bailey Planted in Early and Late May and Following Wheat Harvest in Mid-June at Lewiston-Woodville from 2013 to 2017.

Planting Date	2013	2014	2015	2016	2017
May 2	3,340	3,660	5,590	3,640	4,173
May 22	3,470	3,690	3,840	5,016	6,312
June 20	3,070	2,930	2,030	3,045	3,273

Seeding Rates and Twin Rows

Table 3-15 provides the conversion of seed per foot of row to pounds per acre in order to establish the desired plant population for a given variety. Germination percentage is not considered in this conversion, but it should be considered when planning planting.

In the Southeast, less tomato spotted wilt virus has been associated with twin row plantings than with single rows. Similar results have been observed in North

Carolina. Higher plant populations and closer row spacings often result in fewer symptoms of virus. Pod yield of peanut in twin rows was higher than yield of single rows by 235 pounds per acre (Table 3-17). Seeding peanuts in narrow rows or at extremely high seeding rates has not increased yield over twin row plantings that establish a plant population of five plants per foot of row (sum of both twin rows). Although higher seeding rates are needed, and higher rates of in-furrow insecticide and inoculant are required, twin rows tend to produce a greater taproot crop rather than a limb crop. This tendency can improve uniformity of harvested peanuts, and in a dry season when peanut vines do not lap, this can result in higher yields. One of the detriments of twin row plantings, especially with the higher plant populations, is excessive vine growth, which can make digging more difficult.

Table 3-15. Approximate Pounds of Peanut Seed Required per Acre to Provide 3, 4, and 5 Seeds per Foot of Row on 36-inch Rows

		Pounds per Acre (36-inch rows)		
Variety	**Seed/lb**	**3 Seeds/ft**	**4 Seeds/ft**	**5 Seeds/ft**
Bailey	600	72	95	120
Emery	535	76	102	135
Florida 07*	650	64	87	110
Georgia 06G*	650	64	87	110
Georgia 09B*	650	64	87	110
Sullivan	575	76	101	126
Wynne	500	87	116	145

*Denotes runner market types. All other varieties are Virginia market types.

Table 3-16. Relationship Between In-row Plant Density (Seed per Linear Foot of Row) and Total Number of Seed per Acre on 30-inch and 36-inch Rows.

Seed per Linear Foot	30 inch rows	36-inch rows
4	69,696	58,080
5	87,120	72,150
6	104,544	87,126

Table 3-17. Peanut Yield Response to Twin Row Planting

Planting Pattern	Pod Yield (pounds/acre)
Single Rows	3,760
Twin Rows	3,995
Difference	235
Number of Trials	20

IRRIGATION

Having adequate water available throughout the peanut life cycle is important for optimal plant growth and development. Drought or flood can have tremendously negative impacts on peanut yields and quality. Likewise, pest infestation and severity of damage from these pests is influenced by available water, either in the form of rainfall or irrigation. Understanding how environmental conditions, and in particular irrigation, affect pest complexes is important in developing appropriate management strategies. Although less than 20 percent of North Carolina peanut acreage is irrigated, irrigation is a powerful production tool. Irrigation minimizes risk and enhances consistency of yield. In addition, irrigation improves consistency of pesticide performance and in many ways the predictability of pest complexes. The major production and pest management practices employed in North Carolina peanut production are listed in Table 3-18, with brief comments on how irrigation or ample rainfall affects efforts to manage pests or supply peanuts with adequate nutrition. Research supported by the North Carolina Peanut Growers Association has been conducted to determine the feasibility of subsurface drip irrigation. While there are many logistical issues associated with this approach, data collected at Lewiston-Woodville in corn, cotton, and peanut indicate that this approach to irrigation is feasible. As expected, corn yield was affected more than cotton or peanut yield by irrigation. Peanut yield was maintained more effectively than cotton in dry years without irrigation. These data give a good indication of yield under growing conditions where water is not limiting relative to dry-land production for these crops.

DETERMINING MATURITY

Maturity affects flavor, grade, milling quality, and shelf life. Not only do mature peanuts have the quality characteristics that the consumer desires; they are also worth more to the producer. However, the indeterminate fruiting pattern of peanuts makes it difficult to determine when optimum maturity occurs. The fruiting pattern can vary considerably from year to year, mostly because of the weather. Therefore, each field should be checked before digging begins.

The hull-scrape method, currently the most objective method, requires the use of a peanut profile board that is available at county Extension centers. A version of the peanut profile board was developed for Virginia market types grown in the Virginia-Carolina region (Figure 3-2). It is important to follow a specific maturity prediction method to achieve maximum dollar value for peanuts. Also, expression of the high oleic trait is lower in immature kernels compared to kernels that are older and more fully developed. To ensure the benefits and uniformity of high oleic expression in the cultivars Emery, Sullivan, and Wynne, digging peanut as close as possible to optimum maturity is advised.

Table 3-18. Impact of Irrigation on Production and Pest Management Strategies

Production or Pest Management Practice	Benefits of Irrigation or Optimum Rainfall
Land preparation	Helps in establishment of seedbeds, either conventional or reduced tillage.
Seed germination	Ensures germination of seed when existing soil moisture is marginal for complete stand establishment.
Weed management	Irrigation or adequate rainfall activates preemergence herbicides and minimizes plant stress. Less moisture stress often enhances control by postemergence herbicides and enables peanut to recover more rapidly from herbicide damage.
Insect management	Important for activation of in-furrow insecticides. Improves plant growth and root establishment, which is important in absorption of in-furrow insecticides. Improves peanut recovery from early season insect damage and insecticide phytotoxicity. Increases likelihood of southern corn rootworm survival and subsequent damage to pods but can protect against damage from lesser cornstalk borer. Minimizes potential damage from corn earworms and armyworms by establishment of a dense canopy that can withstand damage from feeding. Reduces the likelihood of spider mite damage by keeping spider mite populations low.
Disease management	Wet conditions early in the season can favor infection of peanut by CBR, but can minimize potential for crown rot. Irrigation increases likelihood of having a favorable microclimate for development of many foliar and soilborne diseases. A dense canopy that is supplemented by irrigation increases humidity within the canopy and minimizes airflow, all of which favor pathogen and disease development. Symptoms associated with tomato spotted wilt of peanut are often more pronounced when peanuts are growing under dry and especially hot conditions. Timely irrigation will reduce plant stress and possibly enable plants to withstand tomato spotted wilt, Diplodia collar rot, and charcoal rot more effectively than nonirrigated, water-stressed plants.
Pod maturation	Irrigation buffers against extremes in moisture and reduces stress (heat and drought), which allows normal flower production and kernel development. Maturation is more predictable and generally earlier. Limited rainfall during reproductive growth often causes delays in maturation and establishment of “multiple crops” or “split crops” on the same plant. Sufficient rainfall is critical for complete kernel development and pod fill. Limited soil moisture during flowering can reduce pegging. Irrigation modeling programs often include soil temperature as a trigger for irrigation during pegging.
Supplemental calcium	Kernels need adequate calcium to become mature and completely developed. Irrigation buffers against drought, which reduces calcium concentration in soil water and mass flow movement into developing pegs.
Digging	Ability to supply soil water to improve digging conditions (reduces hardness of soil), improves digging efficiency, and minimizes pod loss during the digging process.

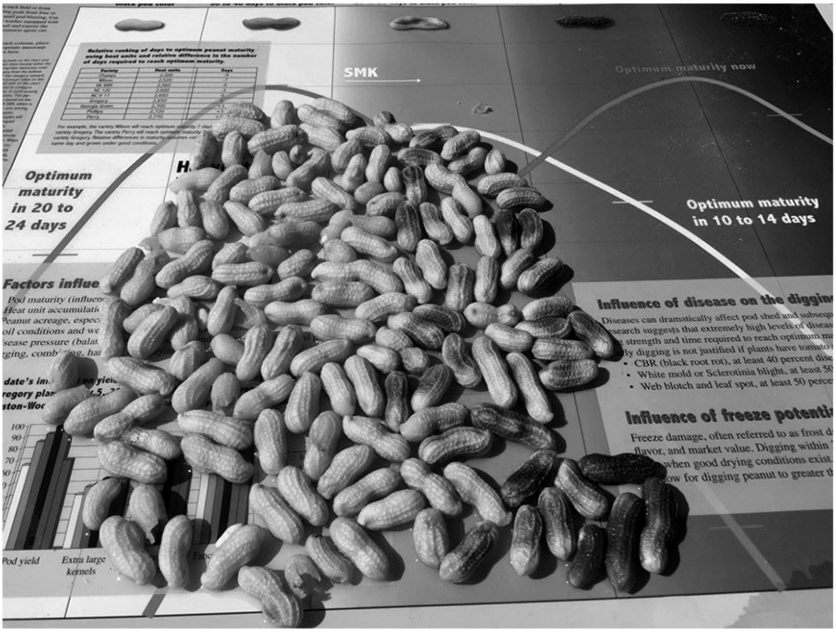


Figure 3-2. The peanut profile board shown above was developed for Virginia market types.

Heat units, or growing degree days (DD), can be a means of determining maturity. One growing degree day (base 56°F) accumulates when the average daily high and low temperature is 57°F. A ceiling of 95°F is used as temperatures above 95°F can cause plant stress. If the average daily high and low temperatures were 76°F, then 20 growing degree days accumulate for that day. Research has shown that 2,520 to 2,770 growing degree days are needed for Virginia market types to mature if soil moisture is not limiting. Average heat unit accumulation for 2009 to 2018 is presented in Figure 3-3 compared with data from 2018 only. Peanut planted in early to mid-June in 2018 were able to yield relatively well, in part due to the higher than normal accumulation of heat units from August 16 through October 15. Pod maturation generally ceases in the fall when night temperatures are in the mid- to high 40s for two nights in a row. Even though day temperatures may increase considerably, the plant seldom recovers from these cooler night temperatures. I

Research during 2016 and 2017 compared yield of Bailey, Wynne, and Sullivan planted in mid-May and dug September 10 and 20, and October 1 and 10. Maturity of these varieties varied little when comparing pod mesocarp color, and there was no interaction of variety and digging date (Figure 3-4). When averaged over varieties, delaying digging from September 10 to September 20 resulted in a substantial yield increase. A slight decrease was noted when peanuts were dug October 1, with a

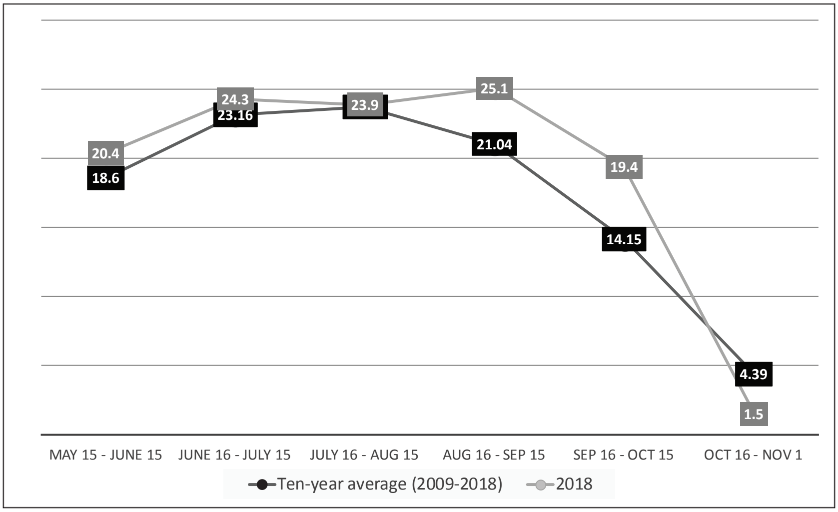


Figure 3-3. Average heat unit accumulation from 2009 to 2018, Lewiston-Woodville, NC.

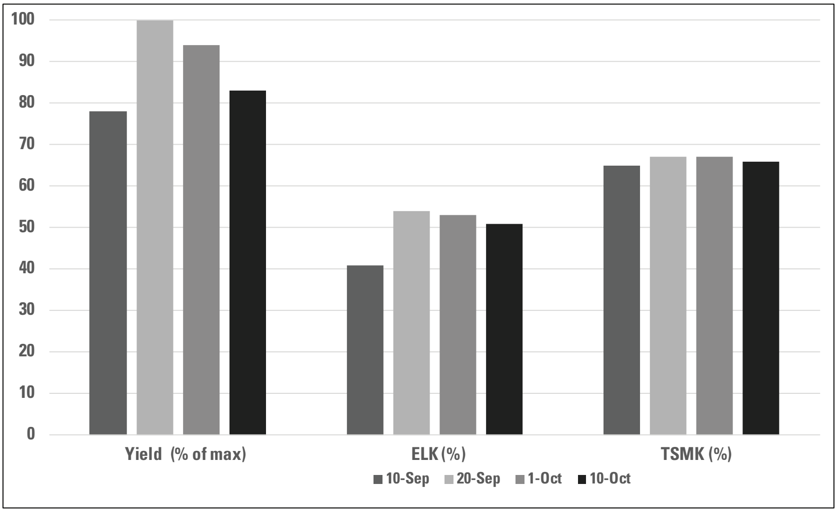


Figure 3-4. Influence of digging date on peanut yield and percentages of extra large kernels (ELK) and total sound mature kernels (TSMK). Data are pooled over three varieties and two years.

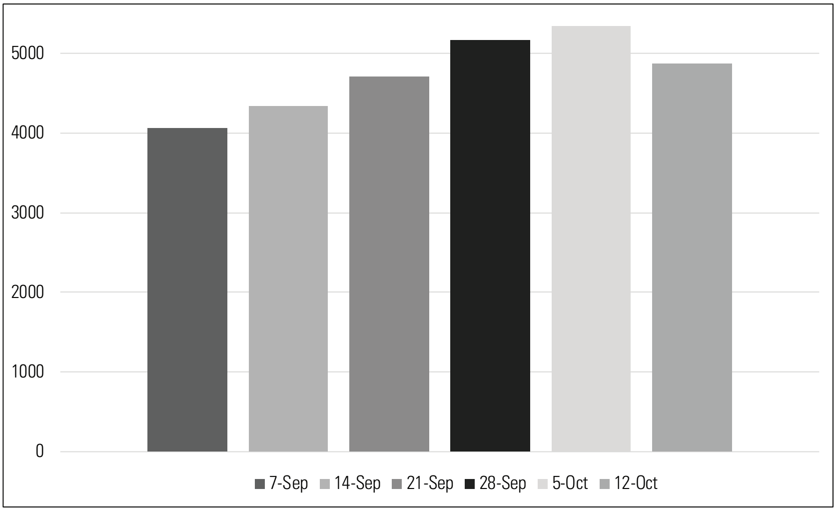


Figure 3-5. Influence of digging date on peanut yield (lb/acre) at Lewiston-Woodville from 2013 – 2018 for the variety Bailey.

more substantial loss observed for October 10. Percentages of extra large kernels and total sound mature kernels increased when peanuts were dug September 20 or later compared with digging September 10. Data from six years of research at Lewiston-Woodville with the variety Bailey also demonstrate the value of waiting until peanut are at optimum pod maturity before digging (Figure 3-5). Yield increased from 4,070 pounds per acre to 5,345 pounds per acre over a 28-day period from September 7 to October 5. At a selling price of $500 a ton or $0.25 a pound, each day digging is delayed until optimum maturity results in an increase in economic value of $11 per acre (increase in yield of 45 pounds per acre per day.)

At harvest, growers should follow the weather forecast closely and not dig peanuts when freezing temperatures are expected. It is also important to have adequate harvesting and curing equipment so that the peanut crop can be handled within a reasonable period of time. At least three days (72 hours), and in many cases more than three days, are needed between the time of digging and frost to allow sufficient drying to prevent freeze damage.

Digging and harvest capacity for growers are important to consider. The speed at which growers can plant peanuts is not the same as the time and labor it takes to dig, combine, dry, and haul peanuts. Most crops require a one-step process to harvest, while peanuts require two stages. Soil conditions during digging must be ideal to effectively remove peanuts from the soil and invert vines. Growers need to realistically determine the amount of time these operations will require.

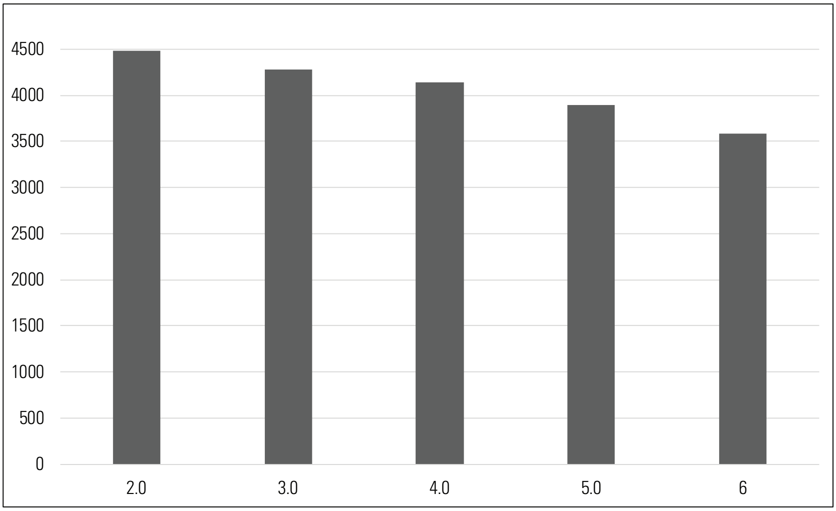


Figure 3-6. Influence of digging speed (mph) on peanut yield (lb/acre) for the variety Bailey at Lewiston-Woodville during 2018.

With respect to digging, it is estimated that with four-row equipment and six-row equipment, 30 and 40 acres can be dug per day if growers dig for 10 hours a day driving at 3 mph with no interruptions. A six-row self-propelled combine can harvest 20 acres in a day driving at 1.5 mph, while four-row and six-row pull-type combines can harvest 15 to 20 acres in a day, respectively. Weather conditions can have a tremendous impact on the number of hours peanut can be dug and combined in a given day, and the estimates provided here relative to time represent a best-case scenario.

Data presented in Figure 3-6 indicate how important it is to dig at a relatively slow speed. Based on research conducted at Lewiston-Woodville during 2018, for each increase in ground speed of 1 mph above 2 mph resulted in a loss of approximately 225 pounds per acre. Growers can determine if a higher loss from digging more rapidly is acceptable if that allows greater acreage to be covered, especially if poor weather conditions are expected or a frost is in the forecast.

The decision between digging prior to optimum pod maturity and experiencing greater disease while peanut continue to mature can be stressful. When diseases are controlled well during the season, there is greater flexibility in deciding when to dig. The threshold for early digging is high and is discussed in more detail in chapter 6. Peanut should be dug when 40 to 50 percent leaf defoliation occurs, regardless of pod maturity.

RUNNER MARKET TYPES

There is some demand for runner market type peanut production in North Carolina. Part of this interest is related to market demand and sheller operations in the region. Runner production is also appealing to some growers because of potential savings in production of runners compared with Virginia market type peanuts (approximately 110 pounds of seed for runners versus 125 to 160 pounds of seed for Virginia market types and lower requirements for supplemental calcium by runner market types). Yield response to Virginia, Runner, Spanish, and Valencia market types planted in early June during 2017 and 2018 are provided in Table 3-19. Each variety was dug at optimum maturity.

Table 3-19. Yield of Virginia, Runner, Spanish, and Valencia Market Types Grown in North Carolina During 2017 and 2018 when Planted June 5 and Dug at Optimum Maturity

Variety	Market Type	Fatty Acid Profile	Breeding Program and State	Yield (lb/acre)	
				2017	2018
Bailey	Virginia	Normal	NC State, North Carolina	3811 ab	4380 ab
Sullivan	Virginia	High oleic	NC State, North Carolina	4636 a	4623 a
Emery	Virginia	High oleic	NC State, North Carolina	4538 a	4395 ab
VENUS	Virginia	High oleic	USDA–ARS, Oklahoma	3642 ab	4005 ab
Florida 07	Runner	High oleic	University of Florida, Florida	3896 ab	4041 ab
Florunner 331	Runner	High oleic	University of Florida, Florida	3651 ab	4591 a
Lariat	Runner	High oleic	USDA–ARS, Oklahoma	4008 ab	4595 a
OLé	Spanish	High oleic	USDA–ARS, Oklahoma	3890 ab	3883 b
NuMex-01	Valencia	High Oleic	New Mexico State University, New Mexico	3242 bc	3041 c

Means within a year followed by the same letter are not significantly different at $p < 0.05$ based on Fisher's Protected LSD test.

PLANT GROWTH REGULATORS

Apogee and Kudos (prohexadione calcium) are registered for use in peanuts. Research has demonstrated that prohexadione calcium improves row definition, which can lead to increased efficiency in the digging and inversion process. Prohexadione calcium should be applied when 50 percent of vines from adjacent rows are touching (Figure 3-5). Sequential applications (7.2 ounces per acre followed by 7.2 ounces per acre) spaced two to three weeks apart are generally needed.

Include crop oil concentrate and nitrogen solution (UAN) or ammonium sulfate with prohexadione calcium. Depending upon growing conditions, soil fertility, frequency of rainfall and irrigation, and variety selection, row visibility obtained in mid-August may not be sufficient through digging. Research suggests that in addition to increased row visibility, prohexadione calcium minimizes pod shed and pod loss during digging and harvesting operations. While prohexadione calcium always improves row visibility, this characteristic has not always translated into yield increases with prohexadione calcium. Many growers use GPS tracking during the digging operation, and this can decrease pod loss substantially. Improved pod retention has been associated with yield increases following prohexadione calcium.

The peanut industry is transitioning to varieties expressing the high oleic trait (Emery, Sullivan, and Wynne). Sullivan may become a widely used variety in the coming years. The morphological or growth habit of Sullivan is different from that of Bailey in that its foliage is less robust than Bailey's growth habit. This characteristic may minimize the need for prohexadione calcium in terms of row visibility. However, in 2017 and 2018 many growers applied prohexadione calcium to Sullivan because growing conditions resulted in robust growth for this variety.

4. PEANUT WEED MANAGEMENT

David L. Jordan
Extension Specialist—Department of Crop and Soil Sciences

Effective weed management is essential for profitable peanut production. Peanuts are not very competitive with weeds and thus require higher levels of weed control than most other agronomic crops to avoid yield losses. Weeds may also decrease digging efficiency, so effective late-season weed control can minimize losses during harvest. A weed management program in peanuts consists of good weed control in rotational crops; cultivation, if needed; establishment of a satisfactory stand and growing a competitive crop; and proper selection and use of herbicides. Finally, weeds interfere with fungicide movement into the peanut canopy, often referred to as deposition, and this can negatively affect disease control.

CROP ROTATION

Rotate peanuts with corn, cotton, or grain sorghum to help manage various pests, including weeds. Crop rotation allows the use of different herbicides on the same field in different years. Crop and herbicide rotation, along with good weed control in the rotational crops, helps prevent the buildup of problem weeds and helps keep the overall weed population at lower levels. Crop rotation will also help reduce the chance of developing populations of weeds that are resistant to herbicides.

CULTIVATION

Cultivation can supplement chemical weed control. However, cultivation can damage the crop and reduce yield if not done properly. Moving soil onto the lower branches and around the base of the plants causes physical damage and enhances development of stem and pod diseases. Deep cultivation also destroys residual herbicide barriers and brings up additional weed seeds. Cultivate when peanuts are small. Set sweeps to run flat and shallow to avoid throwing soil onto the peanut plants. Generally, in-season cultivation of peanuts is not recommended.

WEED SCOUTING

All fields, regardless of the crop being grown, should be surveyed for weeds between mid-August and the first killing frost. Record the weed species present and note the general level of infestation of each species (light, moderate, or heavy). Weeds present in the fall will be the ones most likely to be problems the following year. Knowing what problems to expect allows you to better plan a weed management program for the following crop.

Scout peanut fields weekly from planting through mid-July to determine if or when postemergence herbicide treatment is needed. Proper weed identification is necessary because species respond differently to various herbicides. Contact your county Extension center for aid in weed identification. Timely application of postemergence herbicides is critical for effective control. Cultivation may be more appropriate if herbicide-resistant biotypes increase in prevalence.

WebHADSS (Herbicide Application Decision Support System), a computer-based program designed to assist in making decisions pertaining to postemergence herbicide applications, is available online through NC State Extension (www.webhadss.ncsu.edu). Weed density, predicted crop value, predicted weed-free crop yield, herbicide and application costs, and herbicide efficacy are used to develop a ranking of the economics of herbicide options for a specific weed complex. This approach does not consider the long-term effect of weed seed production if weeds are not controlled. More importantly, allowing herbicide-resistant biotypes to reproduce, especially when they are first appearing in fields, can result in a tremendous long-term problem. The patchiness of weeds in each field and the time needed to scout fields are limitations to this approach. However, this decision support system is beneficial in explaining herbicide options. Listed below are the competitive index values assigned to weeds typically found in North Carolina peanut fields (Table 4-1). Cocklebur, with a ranking of 10, is considered the most competitive weed in peanut.

Table 4-1. Competitive Indices for Weeds in Peanut*

Weed	Rank	Weed	Rank
Common cocklebur	10.0	Fall panicum	1.8
Jimsonweed	5.8	Florida pusley	1.5
Common lambsquarters	5.2	Tropic croton	1.2
Smartweed	4.7	Dayflower	1.2
Redroot pigweed	4.0	Common purslane	1.2
Common ragweed	3.8	Prickly sida	1.2
Sicklepod	3.6	Horsenettle	1.1
Pitted morningglory	3.6	Yellow nutsedge	0.3
Entireleaf morningglory	3.2	Purple nutsedge	0.2
Velvetleaf	3.0	Goosegrass	0.2
Broadleaf signalgrass	1.8	Crabgrass	0.2
Eclipta	1.8		

*10 = most competitive weed

The combined effect of interference by the weed complex is used to predict yield loss in the WebHADSS program. For example, a weed complex containing one Palmer amaranth, five yellow nutsedge, four broadleaf signalgrass, and one sicklepod per 100 square feet (33 feet of row with rows spaced 3 feet apart) would reduce peanut yield by 16 percent, based on a projected weed-free yield of 4,500 pounds per acre (Table 4-2). Using WebHADSS and given a crop value of $535 per ton, adequate growing conditions (good soil moisture for satisfactory herbicide performance), and large size weeds (at least 4 inches tall), WebHADSS would provide the suggestions in Table 4-3 with various economic returns. In this example, peanuts were planted May 6 and emerged May 14. The field was scouted June 4 and herbicide sprayed soon thereafter. Although issues relative to accuracy and time required for weed scouting do exist, the WebHADSS program does allow a relatively quick and clear comparison of herbicide options while taking herbicide efficacy, herbicide cost, and economic return from that investment into account.

Table 4-2. Potential Yield and Economic Losses if Weeds Are Not Controlled as Compared to Weed-free Peanuts*

Weed Species	**Population**	**Yield Loss (lb per acre)**	**Yield Loss (% of weed-free yield)**	**Economic Loss ($ per acre)**
Palmer amaranth	1	180	4.0	48
Sicklepod	1	162	3.6	43
Signalgrass	4	324	7.2	87
Yellow nutsedge	5	66	1.5	18
Total Estimated Loss		734	16.3	196

*Anticipated yield of 4,500 pounds per acre and crop value of $535 per ton farmer stock peanuts.

Table 4-3. Ranking of Selected Herbicide Options Considering Efficacy and Economics*

Herbicide	**Gain by Applying Herbicide ($ per acre)**	**Cost of Weed Control ($ per acre)**
Paraquat	170	5.1
Cadre + 2,4-DB	144	29
Clethodim then Storm + 2,4-DB	121	33

*Herbicide options other than these were listed. Includes adjuvant and application costs. Follow up applications of herbicides would be needed in most fields to obtain season-long weed control.

COMMENTS ON PEANUT HERBICIDES

Preplant Burndown Herbicides

Glyphosate (various formulations) and Gramoxone SL (other formulations are available) are relatively nonselective herbicides that control many of the winter weeds present in reduced tillage fields (Table 4-4). Harmony Extra and 2,4-D (various formulations) can also be applied. Harmony Extra can be applied no closer to planting than 45 days before planting. 2,4-D should be applied at least 30 days before planting.

Preplant Incorporated, Preemergence, and Postemergence Herbicides

Numerous herbicides are labeled for use in peanuts (Tables 4-5, 4-6, 4-7). Timely application of the appropriate herbicide at the correct rate is essential for successful weed control in peanuts. Additional information on feeding restrictions of peanut hay (Table 4-8), suggested rain-free period to maintain control (Table 4-9), and rotation restrictions on herbicide use (Table 4-10) are provided.

Reduced Rates of Herbicides

When crop prices are low, producers are looking for ways to reduce production costs. One possibility is to reduce the application rate of herbicides. Under certain environmental conditions and with certain weed species or weed complexes, specific herbicides can be applied below the manufacturer's suggested use rate without sacrificing weed control. However, growers are cautioned that herbicides applied at reduced rates often do not control weeds adequately when environmental conditions (soil moisture in particular) do not favor herbicide activity. Applying herbicides at reduced rates to large weeds or weeds that are "hardened" often results in poor control as well. Weeds can also be more difficult to control if they were injured by herbicide with previous treatment. Using reduced rates will require that growers apply herbicides in a more timely manner and when weeds are not stressed. Regardless of the previously mentioned factors relative to reduced rates, manufacturers of herbicides will not back up their products when they are applied below the suggested use rate. Liability falls exclusively to the grower.

COMPATIBILITY OF AGROCHEMICALS

Compatibility is an important consideration when applying two or more products in the same tank. See chapter 9 for more information on agrochemical compatibility. Consult product labels, chapter 9, and your county Extension agent for more information on agricultural chemical compatibility.

Table 4-4. Weed Responses to Herbicides Applied Prior to Peanut Planting in Reduced Tillage Systems[1,3]

Species	**Gramoxone SL**	**Glyphosate**	**2,4-D**	**Glyphosate + Harmony Extra**	**Glyphosate + 2,4-D**	**Glyphosate + Valor SX[2]**
Bluegrass	GE	E	N	E	E	E
Buttercup	E	E	G	E	E	E
Chickweed	E	E	P	E	E	E
Curly dock	NP	E	F	E	FG	G
Geranium	GE	PF	PF	GE	F	GE
Henbit	E	E	FG	E	E	E
Horseweed	PF	GE	GE	E	E	E
Mustard	FG	FG	GE	GE	E	E
Primrose	PF	F	E	FG	E	G
Ryegrass	G	E	N	E	E	E
Small grains	GE	E	N	E	E	E
Swinecress	P	FG	F	GE	G	E

[1] Gramoxone SL can be applied after peanut emergence; see notes in Table 4-7. Glyphosate (various formations) can be applied at or before ground cracking. 2,4-D (various formulations) should be applied 3 or more weeks before planting. Harmony Extra cannot be applied closer than 45 days prior to planting. See specific product labels for tank mixtures with these herbicides.

[2] Valor SX can be applied prior to planting up to 2 days after planting. See product label for information on sprayer cleanout.

[3] E = excellent control, 90% or better; G = good control, 80 to 90%; F = fair control, 50 to 80%; P = poor control, 25 to 50%; N = no control, less than 25%.

CHEMICAL WEED CONTROL IN PEANUTS

Control of witchweed is part of the State/Federal Quarantine Program. Contact the N.C. Department of Agriculture, Plant Industry Division, at 1-800-206-9333.

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preplant Incorporated, Annual grasses and small-seeded broadleaf weeds		
alachlor, MOA 15 (Intrro 4 EC)	2 to 3 (2 to 3 qt)	Incorporate no deeper than 2 inches; see label for specific instructions. Unless shallowly incorporated, Intrro is more consistently effective when applied preemergence. Weak on Texas panicum. Do not apply more than 3 qt of Intrro per acre per season. Before using Intrro, check with buyers to determine if there are marketing restrictions on Intrro-treated peanuts.
acetochlor, MOA 15 (Warrant 3 ME)	0.94 to 1.5 (1.25 to 2 qt)	Apply and incorporate in top 2 inches of soil. Do not apply more than 4 qt of Warrant per acre per year.
ethalfluralin, MOA 3 (Sonalan 3 EC)	0.56 to 0.75 (1.5 to 2 pt)	Controls common annual grasses including Texas panicum. Use 3 pt Prowl or 2 pt ethalfluralin for control of broadleaf signalgrass, Texas panicum, and fall panicum. Incorporate 3 inches deep for Texas panicum; otherwise, incorporate 2 to 3 inches deep. See labels for maximum waiting period between application and incorporation. Immediate incorporation is best. Dual Magnum, Outlook, or Warrant may be tank mixed with Prowl or Sonalanto suppress yellow nutsedge.
pendimethalin, MOA 3 (Prowl H2O 3.8 EC) (Prowl 3.3 EC)	0.71 to 1.43 (1.5 to 3 pt) (1.7 to 3.5 pt)	
Preplant Incorporated, Annual grasses, small-seeded broadleaf weeds, and nutsedge		
dimethenamid, MOA 15 (Outlook 6.0 L)	0.75 to 1 (16 to 21 fl oz)	Apply and incorporate in top 2 inches of soil within 14 days of planting. Use high rate of Dual Magnum, Dual, or Outlook for yellow nutsedge and broadleaf signalgrass. Not effective on purple nutsedge. Weak on Texas panicum. May be tank mixed with Prowl or Sonalan.
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt)	

(continued)

Table 4-5. Chemical Weed Control in Peanuts		
Herbicide and Formulation	**Pounds Active Ingredient Per Acre**	**Precautions and Remarks**
Preplant Incorporated, Broadleaf weeds and suppression of nutsedge		
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 (0.45 oz)	Effective on common cocklebur, morningglory, common ragweed, eclipta, and common lambsquarters. Suppresses yellow and purple nutsedge. Does not control sicklepod. More effective when applied in combination with Dual, Outlook, Warrant, Prowl, or Sonalan. See label for rotation restrictions, especially corn and grain sorghum. Growers are cautioned that Strongarm can occasionally injure cotton the following year on soils with a shallow hardpan (less than 10 inches) and/or loam soils. Cotton grown under early season stress resulting from conditions such as excessively cool, wet, dry, or crusted soils may be particularly susceptible to carryover of Strongarm. The rotation interval between applying Strongarm to peanut and then planting cotton is 18 months in Camden, Currituck, Pasquotank, and Perquimans counties. Some weed species have developed resistance to Strongarm including common ragweed and Palmer amaranth.
Preplant Incorporated, Annual grasses, broadleaf weeds, and suppression of nutsedge		
diclosulam, MOA 2 Strongarm + pendimethalin, MOA 3 (Prowl H2O 3.8 EC) (Prowl 3.3 EC) or ethalfluralin, MOA 3 (Sonalan 3 EC) or metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC) or dimethenamid (Outlook 6.0 L) or acetochlor (Warrant 3 ME)	0.024 (0.45 oz) + 0.71 to 1.43 (1.5 to 3 pt) (1.7 to 3.5 pt) or 0.56 to 0.75 (1.5 to 2 pt) or 0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt) or 0.75 to 1 (16 to 21 fl oz) or 0.95 to 1.5 (1.24 to 2 qt)	Effective on annual grasses, common cocklebur, common ragweed, eclipta, morningglory, and common lambsquarters. Suppresses purple and yellow nutsedge. Does not control sicklepod. See Strongarm label for rotation restrictions.

(continued)

Table 4-5. Chemical Weed Control in Peanuts		
Herbicide and Formulation	**Pounds Active Ingredient Per Acre**	**Precautions and Remarks**
PPI followed by PRE, Annual grasses, broadleaf weeds, and suppression of nutsedge		
pendimethalin, MOA 3 (Prowl H2O 3.8 EC) (Prowl 3.3 EC) or ethalfluralin, MOA 3 (Sonalan 3 EC) or metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC) or dimethenamid, MOA 15 (Outlook 6.0L) or acetochlor, MOA 15 (Warrant 3 ME) followed by diclosulam, MOA 2 (Strongarm 84 WDG) or flumioxazin, MOA 14 (Valor SX 51 WDG)	0.71 to 1.43 (1.5 to 3 pt) (1.7 to 3.5 pt) or 0.56 to 0.75 (1.5 to 2 pt) or 0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt) or 0.75 to 1 (16 to 21 oz) or 0.95 to 1.5 (1.24 to 2 qt) 0.024 0.45 oz or 0.063 (2 oz)	Controls most broadleaf weeds. Will not control sicklepod and is marginal on certain large-seeded broadleaf weeds. Do not incorporate Valor SX. Valor SX should be applied to the soil surface immediately after planting. Significant injury can occur if flumioxazin is incorporated or applied 3 or more days after planting. Significant injury from Valor SX has been noted in some years even when applied according to label recommendations. However, injury is generally transient and does not affect yield. See previous comments about cotton response to Strongarm applied the previous year on some soils. Up to 3 oz per acre of Valor SX can be applied to peanut but injury potential increases. See product label for sprayer cleanup before other uses.
Split application (PPI + POST), Most broadleaf weeds and nutsedge		
imazethapyr, MOA 2 (Pursuit 2 AS)	0.031 + 0.031 (2 + 2 oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control eclipta, lambsquarters, ragweed, or croton. Pursuit will usually control seedling johnsongrass and foxtails. For control of other annual grasses, Pursuit may be tank mixed with Dual Magnum, Dual, Outlook, Prowl H2O, Prowl, or Sonalan and incorporated. See label for incorporation directions and rotational restrictions. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence.

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	**Pounds Active Ingredient Per Acre**	**Precautions and Remarks**
Preemergence, Annual grasses and small-seeded broadleaf weeds		
alachlor, MOA 15 (Intrro 4 EC)	2 to 3 (2 to 3 qt)	Apply as soon after planting as possible. All four herbicides are weak on Texas panicum. Before using Inntro, check with buyers to determine if there are marketing restrictions on Intrro-treated peanuts.
dimethenamid, MOA 15 (Outlook 6.0 L)	0.75 to 1 (16 to 21 fl oz)	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 to 1.27 (1 to 1.33 pt) (1.5 to 2 pt)	
acetochlor (Warrant 3 ME)	0.95 to 1.5 (1.25 to 2 qt)	
Preemergence, Broadleaf weeds		
flumioxazin, MOA 14 (Valor SX 51 WDG)	0.063 2 oz	Apply within 2 days after planting. Significant injury can occur if Valor SX is incorporated or applied 3 or more days after seeding. Controls carpetweed, common lambsquarters, Florida pusley, nightshade, pigweeds, prickly sida, and spotted spurge. Does not control sicklepod, yellow and purple nutsedge, or annual grasses. Morningglory control is marginal where Valor SX is applied at 2 oz per acre. Significant injury from Valor SX has been noted in some years even when applied according to label recommendations. However, injury is generally transient and does not affect yield. Injury may occur if excessive and forceful rainfall occurs when peanut is emerging. Peanut recovers from injury by midseason in most instances. Up to 3 oz per acre of Valor SX can be applied to peanut, but injury potential increases. See product label for comments on sprayer cleanup before other uses.

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preemergence, Annual grasses, broadleaf weeds, and suppression of nutsedge		
flumioxazin, MOA 14 (Valor SX 51 WDG) + metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC) or dimethenamid, MOA 15 (Outlook 6.0L) or acetlochlor, MOA 15 (Warrant 3 ME)	0.063 (2 oz) + 0.95 to 1.27 (1 to 1.33 pt) 1.5 to 2 pt) or 0.75 to 1 (16 to 21 fl oz) or 0.94 to 1.5 (1.25 to 2 qt)	Apply within 2 days after planting. Significant injury can occur if applied 3 or more days after planting. The combination of Valor SX and Dual, Dual Magnum, Warrant, or Outlook does not control sicklepod but will control annual grasses (except Texas panicum) and will suppress yellow nutsedge. Valor SX and Warrant will not suppress yellow nutsedge. Significant injury from Valor SX has been noted in some years even when applied according to label recommendations. However, injury is generally transient and does not affect yield. Injury may occur if excessive and forceful rainfall occurs when peanut is emerging. Peanut recovers from injury by midseason in most instances. Up to 3 oz per acre of Valor SX can be applied to peanut but injury potential increases. See product label for comments on sprayer cleanup before other uses.
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 (0.45 oz)	Effective on common cocklebur, morningglory, common ragweed, eclipta, and common lambsquarters. Suppresses yellow and purple nutsedge. Does not control sicklepod. More effective when applied in combination with Dual, Dual Magnum, Outlook, Prowl, Sonalan, or Warrant. See label for rotation restrictions, especially corn and grain sorghum. See previous comments on possible cotton injury from Strongarm applied the previous year on some soils.
sulfentrazone, MOA 14 + carfentrazone, MOA 14 (Spartan Charge (0.35 + 3.15 F)	0.07 to 0.12 (3 to 5 fl oz)	Do not apply Spartan Charge after peanuts crack soil. Application immediately after planting is advised. See label for specific rates based on soil texture and organic matter content. See product label for comments on application with other herbicides. Rotation restriction for planting cotton following Spartan Charge at recommended rates for peanut is 12 months.

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Preemergence, Annual grasses, broadleaf weeds, and suppression of nutsedge (continued)		
diclosulam, MOA 2 (Strongarm 84 WDG) + metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC) or dimethenamid, MOA 15 (Outlook 6.0 L) or acetolchlor, MOA 15 (Warrant 3 ME)	0.024 (0.45 oz) + 0.95 to 1.27 (1 to 1.33 pt) 1.5 to 2 pt) or 0.75 to 1 (16 to 21 oz) or 0.94 to 1.5 (1.25 to 2 qt)	Effective on annual grasses, common cocklebur, common ragweed, eclipta, morningglory, and common lambsquarters. Suppresses purple and yellow nutsedge. Does not control sicklepod. See label for rotation restrictions. Some weed species have developed resistance to Strongarm. See previous comments on carryover potential to cotton on some soils and restrictions on planting corn or grain sorghum after use in peanut.
Preemergence, Most annual broadleaf weeds and nutsedge		
imazethapyr, MOA 2 (Pursuit 2 AS)	0.063 (4 fl oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control ragweed, eclipta, lambsquarters, or croton. Pursuit may be tank mixed with Dual, Dual Magnum, Warrant, or Outlook for annual grass control. See label for **rotational restrictions**. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence.
Cracking stage, Emerged annual grasses and broadleaf weeds		
paraquat, MOA 22 (Gramoxone 2.5 SL) (Parazone 3 SL)	0.13 (8 oz) (5.4 oz)	Apply at ground cracking for control of small emerged annual grasses and broadleaf weeds. May be tank mixed with Dual, Dual Magnum, Outlook, or Warrant for residual control. Tank mix may increase injury to emerged peanuts. Add 1 pint nonionic surfactant per 100 gallons spray solution. Follow all safety precautions on label. Applying Basagran at 0.5 pt per acre will reduce injury.

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Cracking stage and Postemergence, Additional residual control of annual grasses and certain small-seeded broadleaf weeds		
alachlor, MOA 15 (Intrro 4 EC)	2 to 3 (2 to 3 qt)	Use as a supplement to preplant or preemergence herbicides to provide additional residual control of annual grasses and certain small-seeded broadleaf weeds such as pigweed and eclipta. This treatment will not control emerged grasses or broadleaf weeds. See product labels for recommended tank mixtures with contact and systemic herbicides with foliar activity on weeds.
dimethenamid, MOA 15 (Outlook 6.0L)	0.75 to 1 (16 to 21 oz)	
metolachlor, MOA 15 (Dual Magnum 7.62 EC) (Dual 8 EC)	0.95 1 pt 1.5 pt	
acetochlor, MOA 15 (Warrant 3 ME)	0.95 to 1.5 (1.25 to 2 qt)	
pyroxasulfone, MOA 15 (Zidua 85 WG) (Zidua 4.25 SC)	0.08 to 0.11 (1.5 to 2.1 oz) (2.4 to 3.3 oz)	
Cracking stage, Most annual broadleaf weeds and nutsedge		
imazethapyr, MOA 2 (Pursuit 2 AS)	0.063 (4 oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control ragweed, eclipta, lambsquarters, or croton. If weeds are emerged, add surfactant or crop oil according to label directions. See label for rotational restrictions. Pursuit may be tank mixed with paraquat. Some weed species have developed resistance to Pursuit.
Cracking stage, Some emerged broadleaf weeds and suppression of eclipta and yellow nutsedge		
diclosulam, MOA 2 (Strongarm 84 WDG)	0.024 (0.45 oz)	Strongarm can be applied through the cracking stage. Add 1 quart nonionic surfactant per 100 gallons. The spectrum of weeds controlled is much narrower when applied to emerged weeds. Strongarm will not control emerged common lambsquarters or pigweeds but will control common ragweed and morningglories and will suppress yellow nutsedge and eclipta. See product labels for information on mixing Strongarm with other herbicides. Some weed species have developed resistance to Strongarm. See product label for carryover potential to cotton, corn, and grain sorghum. Strongarm suppresses emerged marestail and dogfennel more effectively than other postemergence broadleaf herbicides when applied to small weeds.

(continued)

Table 4-5. Chemical Weed Control in Peanuts		
Herbicide and Formulation	**Pounds Active Ingredient Per Acre**	**Precautions and Remarks**
Postemergence, Annual broadleaf weeds		
acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.25 to 0.38 (1 to 1.5 pt)	Apply when weeds are small and actively growing. Use minimum of 20 GPA and high pressure (40 to 60 psi). See label for species controlled, maximum weed size to treat, and addition of surfactant. Do not apply more than 2 pints per acre per season. May make sequential applications of 0.25 pound followed by 0.25 pound per acre. Allow at least 15 days between sequential applications. Can be applied with residual herbicides for improved control.
acifluorfen, MOA 14 (Ultra Blazer 2 L) + 2,4-DB, MOA 4 (Butyrac 200 2 L)	0.25 to 0.38 (1 to 1.5 pt) + 0.25 (16 fl oz)	Addition of 2,4-DB to Ultra Blazer improves control of certain weeds when weed size exceeds that specified on the Ultra Blazer label. See label suggestions on use of surfactant or crop oil. Apply when peanuts are at least 2 weeks old and before pod filling begins. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 (Basagran 4 L)	0.75 to 1 (1.5 to 2 pt)	Apply when weeds are small and actively growing. Use minimum of 20 GPA and high pressure (40 to 60 psi). See label for addition of oil concentrate, species controlled, and maximum weed size to treat. Basagran may also be applied at 1 pint per acre for control of cocklebur, jimsonweed, and smartweed 4 inches or less. Do not apply more than 4 pints of bentazon per acre per season. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 (Basagran 4 L) + acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.5 to 1 (1 to 2 pt) + 0.25 to 0.38 (1 to 1.5 pt)	See above comments for Ultra Blazer and Basagran. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Can be applied as a tank mixture or as Storm 4L. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 + acifluorfen, MOA 14 (Storm 4L)	0.5 + 0.25 (1.5 pt)	These rates of bentazon and acifluorfen (Ultra Blazer and Basagran) may not provide consistent control of lambsquarters, prickly sida, spurred anoda, and morningglory. Can be applied with residual herbicides for improved control.

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual broadleaf weeds (continued)		
bentazon, MOA 6 (Basagran 4 L) + acifluorfen, MOA 14 (Ultra Blazer 2 L) + 2,4-DB, MOA 4 (Butyrac 200 2 L)	0.5 (1 pt) + 0.25 (1 pt) + 0.125 to 0.25 (8 to 16 fl oz)	Adding 2,4-DB will improve control of larger morningglory, cocklebur, common ragweed, pigweed, jimsonweed, and citron. Add surfactant or crop oil according to label directions. Apply when peanuts are at least 2 weeks old. Do not apply after pod filling begins. See comments for Ultra Blazer and Basagran alone. Can be applied with residual herbicides for improved control.
bentazon, MOA 6 (Basagran 4 L) + 2,4-DB, MOA 4 (Butyrac 200 2 L)	0.75 to 1 1.5 to 2 pt) + 0.125 (8 fl oz)	Addition of 2,4-DB to Basagran improves control of morningglories. See above comments for Basagran. Add surfactant or crop oil according to label directions. Do not make more than two applications per year. Apply when peanuts are at least 2 weeks old and not within 45 days of harvest. Can be applied with residual herbicides for improved control.
imazapic, MOA 2 (Cadre 2 AS) (Impose 2 AS)	0.063 (4 fl oz)	Controls most broadleaf weeds except ragweed, croton, lambsquarters, and eclipta. Apply before weeds exceed 2 to 4 inches; see label for specific weed sizes to treat. Add nonionic surfactant at 1 quart per 100 gallons or crop oil concentrate at 1 quart per acre. A soil-applied grass control herbicide should be used. However, Cadre will usually control escaped broadleaf signalgrass, large crabgrass, fall panicum, and Texas panicum but not goosegrass. Cadre can be mixed with Cobra, Ultra Blazer, and 2,4-DB. See label for rotational restrictions. Some weed species have developed resistance to Cadre. Can be applied with residual herbicides for improved control.
imazethapyr, MOA 2 (Pursuit 2 L)	0.063 (4 fl oz)	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control eclipta, lambsquarters, ragweed, or croton. Apply when weeds are 3 inches tall or less. Add surfactant or crop oil according to label directions. See label for rotational restrictions. Pursuit rmay be tank mixed with Basagran, Ultra Blazer, Gramoxone, and 2,4-DB. Some weed species have developed resistance to Pursuit.

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual broadleaf weeds (continued)		
2,4-DB, MOA 4 (Buryrac 200 2 L)	0.2 to 0.25 (12 to 16 fl oz)	Effective on cocklebur and morningglory; pitted morningglory may be only partially controlled. Best results achieved when applied to small weeds. May use two applications per year. Do not apply within 45 days before harvest.
lactofen, MOA 14 (Cobra 2 EC)	0.2 (12.5 fl oz)	Apply after peanuts have at least six true leaves. Apply to actively growing peanut. Controls most annual broadleaf weeds. See label for species controlled and maximum weed size to treat. Add nonionic surfactant at 1 quart per 100 gallons or crop oil concentrate or methylated seed oil at 1 to 2 pints per acre. See label on when to use various adjuvants. Allow at least 14 days between applications. Can be tank mixed with Basagran, Pursuit, Cadre, 2,4-DB, and/or Select. Can be applied with residual herbicides for improved control.
lactofen, MOA 14 (Cobra 2 EC) + bentazon, MOA 6 (Basagran 4 L)	0.2 (12.5 fl oz) + 0.75 to 1 (1.5 to 2 pt)	See above comments for Basagran and Lactofen alone. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Can be applied with residual herbicides for improved control.
lactofen, MOA 14 (Cobra 2 EC) + bentazon, MOA 6 (Basagran 4 L) + 2.4-DB, MOA 4 (Butyrac 200 2 L)	0.2 (12.5 fl oz) + 0.75 to 1 (1.5 to 2 pt) + 0.125 to 0.25 (8-16 fl oz)	Adding 2,4-DB will improve control of larger morningglory, cocklebur, common ragweed, jimsonweed, and citron. See above comments for bentazon, lactofen, and 2,4-DB. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Can be applied with residual herbicides for improved control.
lactofen, MOA 14 (Cobra 2 EC) + imazapic, MOA 2 (Cadre 2 AS) (Impose 2 AS)	0.2 (12.5 fl oz) + 0.063 (4 fl oz)	See above comments for imazapic and lactofen. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Some weed species have developed resistance to Cadre. Can be applied with residual herbicides for improved control.
lactofen, MOA 14 (Cobra 2 EC) + imazethapyr, MOA 2 (Pursuit 2 AS)	0.2 (12.5 fl oz) + 0.063 (4 fl oz)	See above comments for imazethapyr and lactofen. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Some weed species have developed resistance to Pursuit.

(continued)

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual broadleaf weeds (continued)		
paraquat, MOA 22 (Gramoxone 2 SL) (Parazone 3 SL)	0.13 (8 fl oz) (5.4 fl oz)	See label for weeds controlled and maximum weed size to treat; best results if weeds 1 inches or less. A postemergence application may be made following an at-crack application. Do not make more than two applications per season, do not apply later than 28 days after ground cracking, and do not apply if peanuts are under stress or have significant injury from thrips feeding. Gramoxone is more effective when applied within 2 weeks after peanut emergence. Add 1 pint of nonionic surfactant per 100 gallons of spray solution. Will cause foliar burn on peanuts, but peanuts recover, and yield is not affected. Follow all safety precautions on label. Can be applied with residual herbicides for improved control.
paraquat, MOA 22 (Gramoxone 2 SL) (Parazone 3 SL) + bentazon, MOA 6 (Basagran 4 L)	0.13 (8 oz) (5.4 oz) + 0.25 to 0.75 (0.5 to 1.5 pt)	See previous comments for paraquat alone. Adding Basagran improves control of common ragweed, prickly sida, smartweed, lambsquarters, and cocklebur and reduces injury to peanuts from paraquat. May be applied any time from ground cracking up to 28 days after ground cracking. Add 1 pint of nonionic surfactant per 100 gallons of spray solution. Can be applied with residual herbicides for improved control.
paraquat, MOA 22 (Gramoxone 2 SL) (Parazone 3 SL) + bentazon, MOA 6 + acifluorfen, MOA 14 (Storm 4 L)	0.13 (8 fl oz) (5.4 fl oz) + 0.5 + 0.25 1 pt	See previous comments for paraquat alone. Storm improves control of common ragweed, smartweed, lambsquarters, common cocklebur, tropic croton, and spurred anoda. May be applied anytime from ground cracking up to 28 days after ground cracking. Add 0.5 pint of nonionic surfactant per 100 gallons of spray solution. The mixture of Gramoxone SL and Storm is more injurious than these herbicides applied alone. Can be applied with residual herbicides for improved control.

Table 4-5. Chemical Weed Control in Peanuts

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Florida beggarweed		
chlorimuron, MOA 2 (Classic 0.25 DF)	0.008 (0.5 oz)	Use only for control of Florida beggarweed. Apply from 60 days after crop emergence to within 45 days of harvest. Application to peanuts less than 60 days old will result in crop injury and yield reduction. Apply before Florida beggarweed has begun to bloom and before it has reached 10 inches tall. Larger beggarweed may only be suppressed. Add 1 quart of nonionic surfactant per 100 gallons spray solution; do not add crop oil. May be tank mixed with 2,4-DB; see label for rates and precautions. Recommended as a salvage treatment only.
Postemergence, Yellow nutsedge		
bentazon, MOA 6 (Basagran 4 L)	0.75 to 1 (1.5 to 2 pt)	Apply when nutsedge is 6 to 8 inches tall. A repeat application 7 to 10 days later may be needed. Adding crop oil concentrate at 1 quart per acre will increase control. Do not apply more than 2 pints of Basagran per season. Not effective on purple nutsedge.
Postemergence, Yellow and purple nutsedge		
imazapic, MOA 2 (Cadre 2 AS) (Impose 2 AS)	0.063 (4 fl oz)	Apply postemergence when nutsedge is 4 inches or less. Add nonionic surfactant at 1 quart per 100 gallons or crop oil concentrate at 1 quart per acre. See label for rotational restrictions.
imazethapyr, MOA 2 (Pursuit 2 AS)	0.063 (4 fl oz)	Apply before nutsedge is larger than 3 inches tall. Add surfactant at 1 quart per 100 gallons or crop oil concentrate at 1 quart per acre. Do not mix with Basagran for nutsedge control. See label for rotational restrictions. A split application with half of the Pursuit applied preplant incorporated and half applied early postemergence may be more effective than applying all of the Pursuit at one time.

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Annual grasses		
clethodim, MOA 1 (Select Max 0.97 EC) (Various "2 EC" formulations)	0.094 to 0.125 (9 to 16 fl oz) (6 to 8 fl oz)	Apply Select and Poast to actively growing grass not under drought stress. Consult labels for maximum grass size to treat. Apply in 5 to 20 GPA at 40 to 60 psi. Do not cultivate within 7 days before or after application. Add 2 pints crop oil to Poast. See label for adjuvant use with Select or Select Max. Some broadleaf/ sedge herbicides and fungicides can reduce the efficacy of Select and Poast when applied in tank mixtures. See product labels for specific instructions concerning compatibility with other chemicals. See 2017 Peanut Information AG-331 for specific pesticides that reduce control by these herbicides.
sethoxydim, MOA 1 (Poast 1 EC) (Poast Plus 1.5 EC)	0.19 (1.5 pt) (1 pt)	
Postemergence, Bermudagrass		
clethodim, MOA 1 (Select Max 0.97 EC) (Various "2 EC" formulations)	0.125 to 0.25 (12 to 32 fl oz) (8 to 16 fl oz)	Apply to actively growing bermudagrass before runners exceed 6 inches In most cases, a second application will be needed. Make second application if regrowth occurs. See comments under annual grasses for adjuvant selection and tank mixing for these herbicides.
sethoxydim, MOA 1 (Poast 1 EC) (Poast Plus 1.5 EC)	0.28 (2.25 pt) (1.5 pt)	
Postemergence, Rhizome johnsongrass		
clethodim, MOA 1 (Select Max 0.97 EC) (Various "2 EC" formulations)	0.125 to 0.25 (12 to 32 fl oz) (8 to 16 fl oz)	Apply to actively growing johnsongrass before it exceeds 25 inches tall. Add 2 pints per acre of crop oil concentrate. A second application of the same rates can be made if needed before new plants or regrowth exceeds 12 inches.
sethoxydim, MOA 1 (Poast 1 EC) (Poast Plus 1.5 EC)	0.28 (2.25 pt) (1.5 pt)	

(continued)

Table 4-5. Chemical Weed Control in Peanuts

Herbicide and Formulation	Pounds Active Ingredient Per Acre	Precautions and Remarks
Postemergence, Suppression of large Palmer amaranth and other pigweed species that are resistant to the ALS inhibiting herbicides imazapic, chlorimuron, imazethapyr, and diclosulam		
2,4-DB, MOA 4 (Buryrc 200 2 SL) + lactofen, MOA 14 (Cobra 2 EC) or acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.25 (16 fl oz) + 0.20 (12.5 fl oz) or 0.38 (1.5 pt)	Suppresses and does not completely control Palmer amaranth and other pigweed species that exceed 8 inches. Suppression of weeds exceeding 12 inches will be less than suppression of smaller weeds. Do not expect suppression to exceed 60%. Applying 2,4-DB 3 to 4 days prior to Ultra Blazer or Cobra may be more effective than tank mixtures of 2,4-DB with Ultra Blazer or Cobra. Cobra is generally more effective on larger Palmer amaranth and other pigweed species than Ultra Blazer. Apply crop oil concentrate at 1 gallon per 100 gallons water with acifluorfen or lactofen. See product labels for comments on spray volume and effects on peanut especially during pod set and pod fill. Higher spray volumes are more effective by increasing spray coverage of the contact herbicides Ultra Blazer and Cobra. Two applications of 2,4-DB spaced 10 to 14 days apart will suppress Palmer amaranth and other pigweed species. Although suppression by 2,4-DB is lower than sequential or tank mix application of 2,4-DB and acifluorfen or lactofen within two weeks after application, suppression by sequential applications of 2,4-DB 4 to 5 weeks after initial application is only slightly lower than suppression by sequential or tank mix application of 2,4-DB and Ultra Blazer or Cobra.
2,4-DB, MOA 4 (Butyrac 200 2 SL) then lactofen, MOA 14 (Cobra 2 EC) or acifluorfen, MOA 14 (Ultra Blazer 2 L)	0.25 (16 fl oz) then 0.20 (12.5 fl oz) or 0.38 (1.5 pt)	
2,4-DB, MOA 4 (Butyrac 200 2 L) then 2,4-DB, MOA 4 (Butyrac 200 2 L)	0.25 (16 oz) then 0.25 (16 oz)	
paraquat, MOA 22 (Gramoxone SL)	See comments	Apply in a roller/wiper implement. Best control achieved when at least 60% coverage of weed foliage occurs. Do not allow paraquat to contact peanut foliage. Mix 1 part Gramoxone SL (other formulations may not be labeled) with 1 to 1.5 parts water to prepare 40 to 50% solution. Add nonionic surfactant at 1 quart per 100 gallons. Adjust equipment to apply up to 2 pints per acre of the herbicide-water mixture.

(continued)

Table 4-5. Chemical Weed Control in Peanuts		
Herbicide and Formulation	**Pounds Active Ingredient Per Acre**	**Precautions and Remarks**
Postemergence, Late-season residual control of annual grasses and certain small-seeded weeds		
dimethenamid, MOA 15 (Outlook 6.0 L)	0.75 to 1 (16 to 21 fl oz)	Will not control emerged grasses or weeds; apply following a cultivation or appropriate postemergence herbicide if emerged grasses or broadleaf weeds are present. Benefit likely only on very sandy fields heavily infested with annual grasses that receive above normal rainfall during the first 4 to 5 weeks of the growing season. Lay-by of Dual Magnum, Outlook, or Warrant may also be of value in fields with a history of eclipta problems; the application must be made before eclipta emerges. Rates are on a broadcast basis; apply in an 18-inch band to row middles. See labels for preharvest intervals.
metolachlor, MOA 15 (Dual Magnum 7.62 EC)	0.64 to 0.84 (0.67 to 0.88 pt)	
acetochlor, MOA 15 (Warrant 3 ME)	0.95 to 1.5 (1.25 to 2 qt)	
Postemergence, Harvest Aide for morningglory control		
Carfentrazone, MOA 14 (Aim 2 EC)	0.016 to 0.031 (1.0 to 2.0 oz)	Aim desiccates annual morningglory. Apply with nonionic surfactant at 1 quart per 100 gal or crop oil concentrate at 1 gal per 100 gal within 7 days of optimum pod maturity and digging and vine inversion. Do not apply earlier in the season. Yield reductions occur when applied prior to 7 days before optimum pod maturity.

Table 4-6. Weed Response to Preplant Incorporated, Preemergence, At-Cracking, and Postemergence Herbicides in Peanuts

Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC= At-Cracking; POST = Postemergence

	Prowl or Sonalan PPI	Prowl or Sonalan + Dual Magnum or Dual PPI	Prowl or Sonalan + Outlook PPI	Dual Magnum or Dual PPI	Warrant PPI	Outlook PPI	Strongarm PPI or PRE	Prowl or Sonalan + Strongarm PPI	Dual Magnum, Dual or Outlook PPI or PRE	Pursuit PPI + POST	Dual Magnum or Dual PRE	Intro PRE	Warrant PRE	Outlook PRE	Valor SX PRE	Prowl or Sonalan PPI + Valor SX PRE	Dual Magnum, Dual, Outlook or Warrant + Valor SX PRE	Dual Magnum or Dual AC[1]	Intro AC[1]	Outlook AC[1]	Gramoxone SL AC or POST	Strongarm AC [2]	Gramoxone + Strongarm AC [2]	Zidua, AC[2], or POST[1]
Bermudagrass	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P	N
Black nightshade	N	F	F	F	F	F	N	N	F	G	F	FG	FG	F	E	E	E	F	FG	F	PF	N	G	F
Broadleaf signalgrass	G	E	E	G	FG	FG	P	G	G	G	G	FG	FG	FG	P	G	FG	G	FG	FG	E	N	GE	FG
Carpetweed	G	G	G	FG	FG	FG	G	G	G	FG	FG	FG	FG	G	—	G	G	FG	FG	G	FG	—	G	G
Cocklebur	N	N	N	N	N	N	G	G	G	GE	N	N	N	N	PF	PF	PF	N	N	N	E	E	E	N
Common ragweed	N	P	PF	PF	PF	F	G	G	GE	P	PF	PF	PF	F	FG	G	GE	PF	PF	F	F	E	E	FG
Crabgrass	E	E	E	E	E	E	P	E	E	F	E	E	E	E	PF	E	E	E	E	E	G	N	G	E
Crowfootgrass	E	E	E	E	E	E	—	—	—	—	E	E	E	E	PF	G	G	E	E	E	E	N	GE	E
Dayflower	P	GE	—	GE	—	—	G	G	GE	—	GE	—	—	—	F	F	GE	GE	—	—	—	—	G	—
Eclipta	N	G	G	G	FG	G	GE	GE	GE	P	FG	FG	FG	FG	G	G	GE	FG	FG	FG	FG	NP	FG	FG
Fall panicum	G	E	E	E	E	E	P	E	E	PF	E	E	E	E	PF	FG	GE	E	E	E	E	N	GE	E
Florida beggarweed	N	PF	PF	F	F	F	F	F	F	P	F	F	F	F	G	GE	E	F	F	F	E	FG	G	F

Table 4-6. Weed Response to Preplant Incorporated, Preemergence, At-Cracking, and Postemergence Herbicides in Peanuts *(continued)*

Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC= At-Cracking; POST = Postemergence

	Prowl or Sonalan PPI	Prowl or Sonalan + Dual Magnum or Dual PPI	Prowl or Sonalan + Outlook PP!	Dual Magnum or Dual PPI	Warrant PPI	Outlook PPI	Strongarm PPI or PRE	Prowl or Sonalan + Strongarm PPI	Dual Magnum, Dual or Outlook PPI or PRE	Pursuit PPI + POST	Dual Magnum or Dual PRE	Intro PRE	Warrant PRE	Outlook PRE	Valor SX PRE	Prowl or Sonalan PPI + Valor SX PRE	Dual Magnum, Dual, Outlook or Warrant + Valor SX PRE	Dual Magnum or Dual AC[1]	Intro AC[1]	Outlook AC[1]	Gramoxone SL AC or POST	Strongarm AC [2]	Gramoxone + Strongarm AC [2]	Zidua, AC[2], or POST[1]
Foxtails	E	E	E	E	E	E	P	E	E	G	E	E	E	E	PF	E	E	E	E	E	E	N	GE	E
Goosegrass	E	E	E	E	E	E	P	E	E	PF	E	E	E	E	PF	GE	E	E	E	E	E	N	GE	E
Jimsonweed	N	N	N	N	N	N	GE	GE	GE	G	N	N	N	N	G	G	GE	N	N	N	E	—	E	N
Johnsongrass, Seedling	G	G	G	PF	PF	PF	N	G	PF	GE	PF	PF	PF	PF	N	FG	PF	PF	PF	PF	E	N	GE	PF
Johnsongrass, Rhizome	P	PF	PF	N	N	N	N	P	N	FG	N	N	N	N	N	N	N	N	N	N	P	N	P	N
Lambsquarters	G	NG	G	F	F	FG	FG	GE	GE	FG	F	F	F	FG	GE	GE	GE	F	F	FG	F	N	G	FG
Morningglory	P	P	P	N	N	N	G	G	G	G	N	N	N	N	FG	G	G	N	N	N	F	GE	E	N
Nutsedge, Yellow Nutsedge, Purple	N N	G N	FG N	G N	N N	FG N	FG FG	FG FG	G FG	FG FG	FG N	P N	N —	F N	P P	PF P	FG P	FG N	P N	F N	PF PF	PF NP	G PF	F N
Palmer amaranth and other pigweed	G	E	E	G	G	G	G	E	E	E	G	GE	G	GE	E	E	E	G	GE	GE	E	NP	E	GE
Prickly sida	N	P	P	P	P	P	FG	FG	FG	G	P	P	P	P	FG	G	G	P	P	P	F	—	G	P
Purslane	G	GE	GE	G	FG	G	—	G	G	—	G	G	FG	G	G	GE	GE	GE	P	P	—	—	—	G

(continued)

Table 4-6. Weed Response to Preplant Incorporated, Preemergence, At-Cracking, and Postemergence Herbicides in Peanuts *(continued)*

Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC= At-Cracking; POST = Postemergence

	Prowl or Sonalan PPI	Prowl or Sonalan + Dual Magnum or Dual PPI	Prowl or Sonalan + Outlook PP!	Dual Magnum or Dual PPI	Warrant PPI	Outlook PPI	Strongarm PPI or PRE	Prowl or Sonalan + Strongarm PPI	Dual Magnum, Dual or Outlook PPI or PRE	Pursuit PPI + POST	Dual Magnum or Dual PRE	Intro PRE	Warrant PRE	Outlook PRE	Valor SX PRE	Prowl or Sonalan PPI + Valor SX PRE	Dual Magnum, Dual, Outlook or Warrant + Valor SX PRE	Dual Magnum or Dual AC[1]	Intro AC[1]	Outlook AC[1]	Gramoxone SL AC or POST	Strongarm AC [2]	Gramoxone + Strongarm AC [2]	Zidua, AC[2], or POST[1]
Sicklepod	N	NP	NP	NP	NP	NP	P	P	P	P	NP	PF	NP	NP	P	PF	PF	NP	PF	NP	G	N	G	NP
Smartweed	N	N	N	N	N	N	G	G	G	G	N	N	N	N	—	—	—	N	N	N	G	—	E	N
Spurge spp.	P	F	F	PF	P	PF	—	—	—	P	F	P	P	F	G	G	G	N	N	N	F 2	—	F 2	N
Spurred anoda	N	N	N	N	N	N	FG	FG	FG	G	N	N	N	N	F	FG	FG	N	N	N	P	—	G	N
Texas panicum	G	G	G	PF	PF	PF	P	G	PF	PF	PF	PF	PF	PF	PF	G	F	PF	PF	PF	E	N	GE	F
Tropic croton	N	N	N	N	N	N	PF	PF	PF	P	N	N	N	N	—	—	—	N	N	N	F	—	F	N
Velvetleaf	N	N	N	N	N	N	GE	GE	GE	FG	N	N	N	N	F	FG	FG	N	N	N	F	—	FG	N

[1] Residual control only.
[2] Assumes weeds are 1- to 2-inches tall or smaller.

Key:
E = excellent control, 90% or better   G = good control, 80% to 90%   F = fair control, 50% to 80% P = poor control, 25% to 50%   N = no control, less than 25%

Table 4-7. Weed Response to Postemergence Herbicides — Peanuts

Species	Butyrac 200	Gramoxone [1]	Gramoxone + Basagran	Gramoxone + Storm	Basagran	Basagran + buryrac 200	Ultra Blazer	Ultra Blazer + Butyrac 200	Ultra Blazer + Basagran[2]	Storm	Storm + Butyrac 200	Pursuit + Butyac 200	Cadre or Impose	Cobra	Cobra + Basagran	Cobra + Basagran + Butyrac 200	Cobra + Cadre or Impose	Cobra + Pursuit	Poast or Poast Plus	Clethodim products
	Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC = At-Cracking; POST = Postemergence																			
Bermudagrass	N	P	P	P	N	N	N	N	P	N	N	N	N	N	N	N	N	N	FG	G
Black nightshade	N	PF	PF	G	P	P	G[1]	G[1]	G[1]	G[1]	G[1]	G	G	G[1]	G[1]	G[1]	G	G	N	N
Broadleaf signalgrass	N	GE	E	GE	N	N	NP	NP	P	NP	NP	G	G	N	N	N	G	G	E	E
Carpetweed	P	FG	FG	G	P	P	GE	E	E	G	G	FG	FG	G	G	G	G	G	N	N
Cocklebur	E	G	E	E	E	E	G	E	E	E	E	E	E	G	G	E	E	E	N	N
Common ragweed	PF	F	G	E	G[4]	G[4]	E[1]	E[1]	E[1]	E[1]	E[1]	P	PF	E	E	E	E	E	N	N
Crabgrass	N	G	G	G	N	N	N	N	N	N	N	FG	FG	N	N	N	FG	FG	GE	GE
Crowfootgrass	N	GE	G	GE	N	N	P	P	P	P	P	P	G	N	N	N	G	P	F	G
Dayflower	—	G	G	FG	G	G	—	—	G	FG	FG	—	G	—	G	G	G	—	N	N
Eclipta	P	F	F	FG	FG	FG	G	G	G	FG	FG	P	F	G	G	G	G	G	N	N
Fall panicum	N	GE	G	GE	N	N	PF	PF	P	PF	PF	PF	G	N	N	N	G	PF	E	E
Florida beggarweed	P	G	GE	G	N	P	PF	F	F	P	P	P	F	F	F	F	F	F	N	N
Foxtails	N	GE	G	GE	N	N	PF	PF	P	PF	PF	G	G	N	N	N	G	G	E	E
Goosegrass	N	GE	G	GE	N	N	N	N	N	N	N	N	F	N	N	N	F	N	GE	GE
Jimsonweed	P	G	E	E	E	E	E	E	E	E	E	G	E	E	E	E	E	E	N	N
Johnsongrass, Seedling	N	GE	GE	GE	N	N	P	P	P	P	P	GE	E	N	N	N	E	GE	E	E
Johnsongrass, Rhizome	N	P	P	P	N	N	N	N	N	N	N	F	FG	N	N	N	FG	F	G	GE
Lambsquarters	PF	F	G	G	FG	G[4]	G	G	GE	G	G	P	PF	P	FG	G	PF	P	N	N
Morningglory, Pitted	FG	F	FG	E	P	G	E	E	E	E	E	G	GE	G	G	G	GE	G	N	N
Morningglory, Others	E	F	FG	E	P	E	GE	E	E	GE	E	E	G	G	G	E	G	E	N	N

(continued)

Table 4-7. Weed Response to Postemergence Herbicides — Peanuts (continued)

Species	Butyrac 200	Gramoxone [1]	Gramoxone + Basagran	Gramoxone + Storm	Basagran	Basagran + buryrac 200	Ultra Blazer	Ultra Blazer + Butyrac 200	Ultra Blazer + Basagran [2]	Storm	Storm + Butyrac 200	Pursuit + Butyac 200	Cadre or Impose	Cobra	Cobra + Basagran	Cobra + Basagran + Butyrac 200	Cobra + Cadre or Impose	Cobra + Pursuit	Poast or Poast Plus	Clethodim products
	Herbicides Key: PPI = Preplant Incorporated; PRE = Preemergence; AC = At-Cracking; POST = Postemergence																			
Nutsedge, Yellow	N	PF	FG	G	G[3]	G	N	N	G	F	F	F	G	N	G[3]	G[3]	G	F	N	N
Nutsedge, Purple	N	PF	PF	PF	NP	P	N	N	P	N	N	FG	G	N	P	P	G	FG	N	N
Palmer amaranth and other pigweeds	PF	G	G	E	N	P	E	E	E	E	E	E	E	E	E	E	E	E	N	N
Prickly sida	F	F	G	G	G	G	N	F	G	FG	G	P	G	G	G	G	G	G	N	N
Purslane	FG	—	G	G	G	G	E	E	E	GE	GE	FG	—	E	E	E	E	E	N	N
Sicklepod	G[3]	G	G	G	N	G[6]	NP	G[6]	NP	NP	G[6]	G[6]	E	P	P	G[6]	E	F	N	N
Smartweed	PF	G	E	E	E	E	GE	E	E	E	E	G	F	F	E	E	F	G	N	N
Spurge spp.	P	F[1]	F[1]	F[1]	P	P	F[1]	F[1]	F[1]	PF[1]	PF[1]	PF[1]	—	F[1]	F [1]	F[1]	F[1]	—	N	N
Spurred anoda	P	P	FG	G	G	GE	P	P	G	F	F	F	G	F	G	GE	G	F	N	N
Texas panicum	N	GE	G	GE	N	N	NP	NP	NP	NP	NP	NP	G	N	N	N	G	NP	E	E
Tropic croton	PF	F	F	G	F	F	G	G	G	G	G	P	P	G	G	G	G	G	N	N
Velvetleaf	P	F	G	FG	G	G	PF	PF	FG	FG	FG	FG	G	G	G	G	G	G	N	N

[1] Assumes weeds are 1 to 2 inches tall or smaller.
[2] Assumes optimum rates and ratios of Basagran and Blazer; see labels.
[3] Two applications, 10 to 14 days apart.
[4] Assumes optimum conditions and addition of crop oil concentrate.
[5] Ratings assume weeds in one- to two-leaf stage.
[6] Assumes follow-up treatment with 2,4-DB.

Key: E = excellent control, 90% or better G = good control, 80% to 90% F = fair control, 50% to 80% P = poor control, 25% to 50% N = no control, less than 25%

Table 4-8. Restriction on Feeding Peanut Hay to Livestock Following Treatment with Herbicides

Feeding Restricted (Do not feed treated hay to livestock.)	No Feeding Restrictions or Defined Feeding Restrictions*
2,4-DB, Aim, Cadre, clethodim-containing products, Cobra, Impose, Poast, Poast Plus, Pursuit, Sonalan, Storm, Ultra Blazer	Basagran, Dual Magnum, Gramoxone SL, Outlook, Prowl, Zidua

* See product labels for specific information.

Table 4-9. Suggested Rain-free Periods After Application of Postemergence Herbicides

Herbicide	Rain-free Period (hours)	Herbicide	Rain-free Period (hours)
2,4-DB	NR**	Paraquat	0.5
Arrow	1	Poast	1
Basagran	NR*	Poast Plus	1
Ultra Blazer	NR*	Pursuit	1
Cadre, Impose	3	Select, Select MAX	1
Classic	1	Storm	NR*
Cobra	1		

* No restriction listed on label. Suggest 4 to 6 hours for best results.

** No restriction listed on label. Suggest at least 1 hour for best results.

Table 4-10. Restrictions on Crop Rotation of Herbicides with Significant Residual Activity Applied to Peanuts

Herbicide	Corn	Cotton	Soybean	Tobacco	Wheat	Grain Sorghum
Cadre, Impose	9 months	18 months	9 months	9 months	4 months	18 months
Pursuit	NR/8.5 months*	9.5 months/ 18 months*	NR	9.5 months	4 months	18 months
Strongarm	18 months**	9 months	NR	> 18 months	4 months	18 months
Valor	NR	NR	NR	NR	4 months	NR
Prowl	Following year	NR	NR	NR	4 months	NR
Outlook	NR	Following year	NR	NR	4 months	NR
Dual Magnum	NR	NR	NR	NR	4.5 months	NR
Warrant	NR	NR	NR	NR	4 months	NR
Zidua	NR	NR	NR	18 months	4 – 6 months ***	6 – 12 months ***

NR = no restriction.
*No restriction and 9.5 months if applied postemergence; 8.5 and 18 months if applied preplant incorporated. See label on rainfall and temperature requirements.
**No restriction if appropriate IMI-tolerant corn hybrid is planted. See label for specific instructions.
***See label for Zidua rates.

PREVENTING AND MANAGING HERBICIDE-RESISTANT WEEDS

In recent years, populations of weeds that were once controlled by specific herbicides have developed resistance to these herbicides. Historically, the resistance of individual weeds within a population of a species has rarely occurred. However, increased selection pressure and the occurrence of cross and multiple resistance have resulted in increased frequency of herbicide resistance in some peanut fields. Two steps are critical to prevent yield loss from weed interference and preserve herbicide effectiveness: (1) determine whether weed escapes are herbicide resistant, and (2) develop an appropriate management strategy for herbicide-resistant weeds. While most weed escapes are the result of an application error or weather conditions, herbicide resistance is a real threat. Indicators of herbicide resistance, approaches to managing herbicide-resistant weed populations, and classification of resistance potential by mode of action are listed in Tables 4-11 and 4-12. Note that herbicides that are generally not prone to having resistance populations develop can become ineffective if they are used repeatedly without implementation of other weed management practices. The intensity of selection pressure (frequency of application) and likelihood of resistance to develop for a particular herbicide are the two essential elements in determining occurrence of herbicide resistant biotypes. Contact your local Cooperative Extension agent if herbicide resistance is suspected.

In North Carolina, populations of Palmer amaranth and common ragweed resistant to acetolactate synthase (ALS) inhibiting herbicides have been confirmed. The effectiveness of the herbicides Cadre, Pursuit, and Strongarm will be less in fields where resistant populations exist. Common ragweed resistance to ALS-inhibiting herbicides also has been confirmed. To manage weeds in these fields, growers must use herbicides with a different mode of action from the ALS-inhibiting herbicides. This goal can be accomplished in a variety of ways, including application of herbicide mixtures to broaden the spectrum of control.

While not confirmed, it is speculated that populations of Palmer amaranth resistant to PPO-inhibiting herbicides (Valor SX, Cobra, Ultra Blazer, and Storm) are present in North Carolina. Prevent weeds escaping PPO-inhibiting herbicides from reproducing when these weed escapes are first observed. Experiences with development of Palmer amaranth resistance to glyphosate and ALS-inhibiting herbicides reminds us that recognizing and addressing resistant populations when they first develop is critical.

Table 4-11. Identification and Management of Herbicide-Resistant Weeds

Possible reasons why herbicides do not control weeds that are NOT associated with herbicide resistance:
Improper herbicide choice or rate. Poor or improper application of herbicide. Poor timing of herbicide application. Weather conditions were not favorable when herbicide was applied. Weeds emerged after the postemergence herbicide was applied. Other chemicals antagonized the herbicide.
Indicators suggesting that weeds are resistant to herbicides:
Herbicide normally controls the weed in question. Performance poor on one species while other species are controlled well. Poor control is confined to spots in the field. Some plants of the weed in question are controlled well while other plants of that species are controlled poorly. Field history of heavy use of herbicides with the same mechanism of action.
Steps to take to prevent or manage herbicide resistance:
Rotate herbicides having different mechanisms of action. Use tank mixes or sequential applications of herbicides having different mechanisms of action. Be especially vigilant when using herbicides with higher risk of resistance development. Integrate nonchemical controls when possible. Avoid allowing weeds to produce seeds when herbicide resistance is suspected.
Additional key points:
Although some herbicides inherently are at low risk for resistance development, selection pressure (the frequency of herbicide applications with the same mode of action) can overcome the low or moderate theoretical possibility of resistance developing. Spraying weeds that are large and beyond the recommendation on the herbicide label is equivalent to applying herbicides at rates lower than the recommended labeled rates applied to small weeds. This approach increases the decreases the length of time (number of generations) required for weed populations to become resistant.

Table 4-12. Herbicide Categories Prone to Have Weeds Develop Resistance

Trade Name	Common Name	Family	MOA
ALS* Inhibitors—Weeds highly susceptible to developing resistance			
Cadre, Impose, Pursuit	Imazapic, Imazethapyr	Imidazolinone	2
Strongarm	Diclosulam	Triazolopyrimidine	2
Classic	Chlorimuron	Sulfonyl urea	2
ACCase* Inhibitor—Weeds moderately to highly susceptible to developing resistance			
Arrow, Clethodim, Cleanse, Select, Select MAX, Tapout, Volunteer	Clethodim	Cyclohexanedione	1
Poast, Poast Plus	Sethoxydim	Cyclohexanedione	1
Microtubule Assembly Inhibition—Weeds moderately susceptible to developing resistance			
Prowl	Pendimethalin	Dinitroaniline	3
Sonalan	Ethafluralin	Dinitroaniline	3
Herbicides at low to moderate risk for resistance development			
Aim	Carfentrazone ethyl	Aryltriazinone	14
Basagran	Bentazon	Benzothiadiazole	6
Cobra	Lactofen	Diphenylether	14
Gramoxone SL	Paraquat	Bipyridilium	22
Dual Magnum	Metolachlor	Chloroacetamide	15
Intrro	Alachlor	Chloroacetamide	15
Outlook	Dimethenamid	Chloroacetamide	15
Spartan Charge	Carfentrazone + Sulfentrazone	Triazolinone + Triazolinone	14
Storm	Acifluorfen + Bentazon	Diphenylether + Benzothiadiazole	14 + 6
Ultra Blazer	Acifluorfen	Diphenylether	14
Valor SX (various formulations)	Flumioxazin	*N*-phenylphtalimide derivative	14
Warrant	Acetochlor	Chloroacetamide	15
Zidua	Pyroxasulfone	Pyrazole	15
2,4-DB (various formulations)	2,4-DB	Phenoxy	4

*ALS = acetolactate synthase; ACCase = acetyl CoA carboxylase; MOA, mode of action.

MANAGING PALMER AMARANTH IN PEANUTS

Palmer amaranth has become one of the most difficult weeds to control in peanuts and other crops throughout North Carolina. This weed is very competitive with crops and produces an abundant amount of seed if left uncontrolled. Development of herbicide-resistant biotypes including those resistant to glyphosate and ALS inhibitors (Cadre, Impose, Pursuit, Strongarm, Classic) has contributed to the challenge in controlling Palmer amaranth. A comprehensive strategy is necessary to control this weed and includes intensive preplant incorporated and preemergence herbicide applications and multiple and timely postemergence herbicide applications. Specific herbicide programs and limitations of these programs are listed in Table 4-13.
The importance of timely application of all postemergence herbicides cannot be emphasized enough. A general recommendation for weed control is provided in Table 4-14.

Table 4-13. Herbicide Programs for Palmer Amaranth Control in Peanuts[1]

Preplant incorporated	Preemergence	Cracking or early postemergence[2] (Palmer < 2 in.)	Postemergence[3, 4] (Palmer < 3 in.)	Postemergence[5] (Palmer >10 in.)
Prowl[6] or Sonalan + Dual Magnum[7] or Outlook or Warrant		Paraquat, Paraquat + Basagran, or Paraquat + Storm	Cobra, Storm, or Ultra Blazer + 2,4-DB	2,4-DB followed by 2,4-DB or Gramoxone SL applied using a roller/wiper system
Prowl[6] or Sonalan		Dual Magnum[7] + Paraquat + Basagran or Outlook + Paraquat + Basagran or Warrant + Paraquat + Basagran or Zidua + Paraquat + Basagran		
Prowl[6] or Sonalan	Valor SX			
Prowl[6] or Sonalan	Strongarm[8]			
	Valor SX + Dual Magnum[7] or Valor SX+ Outlook or Valor SX+ Warrant			
	Strongarm[8] + Dual Magnum[7] or Strongarm + Outlook or Valor SX+ Warrant			

[1] Glyphosate- and ALS-resistant Palmer amaranth are very serious concerns. An aggressive management program is necessary to slow the spread of the resistant biotypes and to reduce selection pressure in areas currently not infested with resistant biotypes. Good control in peanuts rotated with cotton will aid control in cotton.

[2] Apply cracking or early postemergence treatment only if weeds are emerged.

[3] Timing of application is critical. Cobra, Storm, or Ultra Blazer plus 2,4-DB will control Palmer amaranth 3 inches tall or less. Weeds taller than 3 inches will only be suppressed.

(continued)

Table 4-13. Herbicide Programs for Palmer Amaranth Control in Peanuts[1] (continued)

[4] Cadre or Pursuit may be included with Cobra, Storm, or Ultra Blazer. Cadre and Pursuit are ALS inhibitors. Because of concerns with weed resistance to ALS inhibitors, a mixture of Cobra, Storm, or Ultra Blazer with Cadre or Pursuit would be preferred over Cadre or Pursuit alone. However, Cadre and Pursuit have rotational restrictions for cotton.

[5] Sequential applications of 2,4-DB will suppress Palmer amaranth approximately 50%. Gramoxone applied using a roller/wiper applicator will control large Palmer amaranth if 65% or more of the Palmer amaranth plant is wiped. Do not allow Gramoxone to contact peanut foliage.

[6] Generic brands of pendimethalin (Prowl) are available and perform similarly.

[7] Generic brands of metolachlor are available. However, these products may not provide the same length of residual control as Dual Magnum (which contains *S*-metolachlor).

[8] Strongarm is an ALS inhibitor. Because of concerns with weed resistance to ALS inhibitors, Strongarm is suggested only when other non-ALS options are not adequate for the weeds expected.

Table 4-14. General Recommendations on Herbicides to Use in a Comprehensive Weed Management Program for Peanuts

Herbicide	Timing	Should these herbicides be used?
Prowl or Sonalan	Preplant incorporated	**Yes.** These herbicides are relatively inexpensive and provide early season control of grasses and small-seeded broadleaf weeds. Although Prowl can be applied preemergence, it is generally more effective incorporated. Sonalan always needs to be incorporated. These herbicides are an important part of a comprehensive weed management strategy and should always be applied.
Dual Magnum (various formulations), Outlook, or Warrant	Preplant incorporated or preemergence	**Yes.** These herbicides are important in suppressing yellow nutsedge, especially Dual Magnum, and provide control of small-seeded broadleaf weeds including pigweeds. While these herbicides do not control weeds for the entire season, they provide good early-season control and are an important foundation of a comprehensive weed management strategy for peanuts.
Valor SX (various formulations) or Strongarm	Preemergence	**Yes.** Under current situations with increased prevalence of Palmer amaranth and traditional broadleaf weeds such as eclipta, common ragweed, and common lambsquarters, one of these two herbicides is needed in a comprehensive weed management strategy for peanuts. Valor SX provides excellent rotation options for crops grown the following season, while Strongarm will carry over to corn and grain sorghum, and there is some concern about carryover to cotton on some soils. Weeds present, especially Palmer amaranth, that express resistance to Strongarm keep this herbicide from being a complete answer in some fields. Although Valor SX is effective early in the season, the rate used in peanut (2 oz/acre) generally does not control morningglories and will not control other weeds season-long every year.
Paraquat plus Basagran plus Dual Magnum (various formulations), Outlook, Warrant, or Zidua	At cracking or early postemergence	**Yes.** Given that Palmer amaranth is present in many fields and that preplant incorporated and preemergence herbicides often are incomplete in control due to weather conditions or poor incorporation, this treatment (paraquat, with Gramoxone SL being the most prevalent commercial product) can often clean up fields when applied on time, taking pressure off of other postemergence options. Basagaran reduces injury from paraquat. In fields with known histories of Palmer amaranth and other problematic weeds, applying Dual Magnum, Outlook, Warrant or Zidua with paraquat plus Basagran will improve early-season weed control. Apply paraquat early in the season, no later than 28 days after peanuts emerge, but preferably within the first three weeks.

(continued)

Table 4-14. General Recommendations on Herbicides to Use in a Comprehensive Weed Management Program for Peanuts (continued)

Herbicide	Timing	Should these herbicides be used?
Cobra, Ultra Blazer, Storm, Basagran	Postemergence	**Most likely.** These herbicides should be applied as needed. In fact, many if not most peanut fields will need at least one application of these herbicides. Weed size has a major impact on the degree of control obtained with these herbicides. If weeds exceed 3 inches, control is often incomplete. When preplant incorporated or preemergence herbicides are not applied or are marginally effective, growers often have to apply repeat applications of these herbicides (Cobra, Storm, Ultra Blazer). Multiple applications in some cases can negatively affect peanut yield. For this reason growers are encouraged to have a comprehensive program of preplant incorporated and preemergence herbicides and apply paraquat plus Basagran to take the pressure off of Cobra, Storm, and Ultra Blazer. Note that Storm does not contain sufficient Ultra Blazer to control Palmer amaranth and other weeds in most cases, so adding additional Ultra Blazer to Storm is recommended in some circumstances. Residual herbicides can be added to improve control.
Postemergence grass herbicides (clethodim and sethoxydim are active ingredients in these herbicides)	Postemergence	**Most likely.** Preplant incorporated and preemergence herbicides often control annual grasses through midseason and sometimes late into the season. However, many fields need a postemergence application of sethoxydim (several formulations) or clethodim (several formulations). These herbicides should be applied as needed because grasses often cause peanut pod loss during the digging process.
Cadre, Pursuit	Postemergence	**In many cases.** Pursuit is used much less often now than in previous years. Cadre (also formulated as Impose) is a very good herbicide that controls yellow and purple nutsedge, annual grasses in many cases, and a range of broadleaf weeds. The challenge with Cadre is presence of resistant Palmer amaranth and carryover potential to cotton and grain sorghum. Cadre continues to be a good option for peanut growers as long as they realize carryover potential and know whether or not resistance to this herbicide is present in certain fields. Residual herbicides can be added to improve control.
2,4-DB	Postemergence	**Yes.** The broadleaf herbicides mentioned above, with the exception of paraquat, benefit from the addition of 2,4-DB. For example, when Palmer amaranth is slightly larger than the size recommended for complete control by Cobra, Ultra Blazer, or Storm, the inclusion of 2,4-DB can help obtain complete control. 2,4-DB is often effective when applied alone, but this is very species dependent. For example, common cocklebur can be controlled completely by 2,4-DB. 2,4-DB is also a viable option for suppression of escapes of sicklepod and Palmer amaranth when applied sequentially.

5. PEANUT INSECT AND MITE MANAGEMENT

Rick L. Brandenburg
Extension Specialist—Department of Entomology and Plant Pathology

We know that 2018 had its share of challenges, but all in all, it was a good year for peanuts. There were some big swings in the weather from wet to dry and back to wet again. Thrips populations were average, and tomato spotted wilt virus (TSWV) was out there, and a few fields had high levels of incidence. We had a few caterpillars, and some of them proved hard to control. As always, it is important to look at lessons we can learn from the past year.

2018 IN REVIEW

Thrips occurred as usual in peanut fields this year, so TSWV was present throughout the areas of production and appeared to be higher than last year but not a big threat to yield. The continued presence of TSWV in peanuts reminds us to keep using the practices that limit TSWV. Thrips migration into peanut fields was normal and resulted in the typical stunted plants early in the season. Corn earworms and other caterpillars were a problem, with some reports of poor insecticide performance and pyrethroid resistance. These appear to be issues we will need to address. We did see a number of fields infested with tobacco budworm, which caused control problems. This subject is discussed in the next section, "Foliar Insects." Spider mites were not a serious problem except in a few isolated areas that missed the rains in July, August, and September across the peanut production areas. We had some rootworm-damaged peanuts as rains kept the soil moisture high in late summer and then there was Florence.

FOLIAR INSECTS

Thrips and leafhoppers are usually found in peanut fields. An in-furrow systemic insecticide applied at planting is the most common approach used to reduce seedling damage from thrips and leafhopper damage. A number of caterpillars (usually corn earworm) will also attack peanuts during August and September.

Thrips and TSWV

TSWV incidence was higher in 2018 but remained lower than the serious levels we had in 2002. I believe it is safe to assume that this disease is still a threat and can also make a comeback. The incidence of the disease is influenced by the winter and spring weather and the summer growing conditions. The virus is found in many weeds and even in winter annuals, such as chickweed and henbit, providing an opportunity for the thrips to pick up the virus each spring.

The future of TSWV in North Carolina cannot be predicted. Dr. David Jordan helped coordinate an effort initiated in 2001 and concluded in 2006 to develop management recommendations based upon field research. Our approach was based upon successful efforts in Georgia. One important point to understand is that TSWV does not justify a foliar treatment at midseason. Research in Georgia indicates that follow-up treatments to reduce the virus once it is established in the field are like throwing money away. Studies conducted from 2003 through 2006 confirm this management issue for North Carolina. Our research revealed the following trends for managing TSWV. We saw less virus in VA 98R, NC-V11, and Gregory. More recently, we view Gregory, Georgia Green, Bailey, Wynne, and Sullivan as the best for reducing the incidence of TWSV. Less virus also occurred in twin-row production and in plots planted at higher seeding rates. At-plant, in-furrow insecticides do help reduce the virus, and Thimet (phorate) appeared to be the most effective insecticide for reducing virus, but all thrips control approaches provide some benefit. Reduced tillage or strip till production also appears to help minimize the level of virus.

Our 2003 through 2006 trials indicate that in most years the earliest-planted and latest-planted peanuts are probably at greatest risk from the virus. We have found that varieties like Perry, which are a little more susceptible to the TSWV, can still be planted with confidence if the grower follows the other practices for reducing virus. Our findings are consistent with the results of testing in Georgia. I am quick to point out, however, that recommended practices help reduce the incidence of virus; they do not eliminate it. Managing TSWV, which outlines a virus index and provides guidance on its management, is found later in this chapter.

Use of Systemic Insecticides

Systemic insecticides are an effective production tool. Over 90 percent of the North Carolina peanut acreage has been treated annually with phorate (Thimet), imidacloprid (Admire), or acephate (Orthene). This treatment eliminates the need for most foliar insecticides unless worms or mites become a problem in August or September. Systemic insecticides are applied in-furrow at planting as a granular formulation. Aldicarb (Temik) was discontinued in 2011, and farmers have used alternatives since then. A new generic formulation of aldicarb (AgLogic 15G) is now available for use at plant. We are always evaluating products and revising the products recommended for at-plant protection. These recommendations include listings of Cruiser (suppression only) and Admire. Cruiser has given us inconsistent results in numerous trials, but Admire has performed quite well in recent studies.

Acephate (Orthene) 97, a spray formulation, allows the use of acephate as an in-furrow spray. This approach has proven successful and offers an additional option for at-plant thrips management. While we observed some delayed emergence in 2011 in fields using acephate in furrow, I am not convinced that other factors didn’t play a major role in this delay. We did not observe this delay as a problem in 2012 to 2017, but some concern remains among growers. There has been increasing interest in the use of acephate (Orthene) as an additional foliar spray at about three weeks after planting. Our data show a favorable yield response from those applications in most fields.

When foliar insecticides are used in addition to fungicides, spider mite outbreaks often occur if hot, dry weather persists. The use of systemic insecticides at planting eliminates the need for foliar insecticide treatments for thrips early in the season, and this practice may decrease the likelihood of mite buildup. Systemic insecticides are not effective against worms; if peanuts are attacked by worms in August and September, foliar sprays may be needed.

On-demand treatments. Integrated pest management focuses on treating only when necessary. At-planting treatments are contrary to that idea. However, the convenience and effectiveness of these in-furrow treatments make most other options less attractive. At-planting treatments provide some peace of mind because growers know that they suppress any potential early-season pests (thrips and leafhoppers). However, such treatments assume that these insect pests will be present in economically damaging numbers. Foliar treatments seem to have less of an impact in reducing the levels of TSWV than at-plant treatments do.

On the other hand, on-demand foliar insecticides are used only when insect populations reach or exceed an economic threshold. While insect populations are below this level, there is no need to treat; when they exceed the threshold, treatments can be applied to prevent economic damage. Such an approach requires a commitment to an effective scouting program.

Foliar Insecticides

A number of insecticides are labeled for use on peanuts as foliar sprays. Often, only one insecticide is needed for season-long control of foliar peanut insect pests in North Carolina. Growers should check their fields, know the pest situation, and treat only as needed.

Thrips can be serious pests early in the season if at-planting systemic insecticides were not used, but foliar sprays can be effective. The economic threshold for thrips is 25 percent leaf damage. It is very important to follow this guideline closely. Delaying thrips treatment will still provide control but may not provide any real benefits in plant response.

Potato leafhoppers can also damage peanuts; however, research indicates the economic threshold should be somewhere below 50 percent leaf damage. Such levels are not commonly seen, but leafhoppers have been more of a problem in recent years, particularly in fields not treated for rootworms. We did see more leafhopper damage in 2018, but it is difficult to scout for and predict this damage and treat it in a timely manner.

Several types of caterpillars or "worms" may attack the crop later in the season. The most common is the corn earworm. The threshold for treatment varies with the time of year, and I am slightly increasing them for 2019. Generally, earworms occur in August, and the threshold for treatment is as soon as the worms reach six to eight per row foot. In early September, at least eight to ten worms per row foot are necessary to cause economic loss, and by mid-September no treatment is justified unless at least 12 or more worms per row foot are seen. There are several other products to use than the traditional pyrethroids, but they typically cost more. Review the range of products that are available in the various sections for caterpillars. Danitol, an insecticide for corn earworms and spider mites, showed good effectiveness against fall armyworms as well as earworms, spider mites, and leafhoppers in one test. In recent years we have seen more variety in the worm complex that attacks peanuts, such as budworms, and more beet and fall armyworms. These are more difficult to control, and it is important to get species identification and to select the proper product. Fall armyworms have been very common in recent years, but their damage is less than that of corn earworms. Fall armyworms damage the leaves with what I call an "onion skin" appearance. In 2018 we saw tobacco budworms in peanuts, usually in fields that had been sprayed for earworms and the grower noticed poor control. Budworms are harder and more expensive to control than earworms. This fact has caused some growers to think we are having insecticide resistance problems. While corn earworms are showing more resistance to pyrethroid insecticide use in peanuts, there is more going on than just resistance to pyrethroids. There are two options to caterpillar control. One is to use the "cheaper" pyrethroid insecticides and hope you have few resistant corn earworms and few budworms. If that is the case, you will get good control for a reasonable price. The other option is to use the more expensive "caterpillar" insecticides (such as Steward, Intrepid Edge, Prevathon, Danitol, and Exirel), which will control more species of caterpillars, including pyrethroid-resistant corn earworms, but you will spend more money. So the decision comes down to which risk you are most comfortable accepting. We simply cannot determine the level of resistance in a specific field before you spray (although it has been running as high as 40 percent), and identifying the budworms from the corn earworm is difficult in the field. In 2018 more farmers appeared to choose the option of treating with the more expensive "caterpillar" insecticides, and I cannot argue with that choice.

Application of Foliar Sprays

Calibrate the sprayer accurately to ensure application of the recommended amounts of insecticides. Check the calibration periodically during the season.

Spray for thrips, leafhoppers, corn earworms, fall armyworms, and other foliar-feeding insects on peanuts with hollow-cone or solid-cone nozzles at a minimum of 40 psi and a total of 10 to 15 gallons per acre. Low-volume sprays are ineffective for spider mite control. Apply a minimum of 25 gallons of spray per acre for spider mites, with adequate pressure for the nozzle setup on the sprayers. Many growers combine spider mite or caterpillar treatments with their leafspot fungicide application. Spray volume commonly used for fungicide application (12 to 14 gallons per acre) may not be sufficient for good mite control. Change nozzles or slow down if past experience has given poor results.

Use flat fan nozzles to apply a minimum of 20 to 40 gallons of spray per acre directed at the base of the plant for lesser cornstalk borer control. Low gallonage applications for lesser cornstalk borer are an absolute waste of time!

Spider Mites

Spider mites were a not a common problem for peanut farmers except in areas that experience hot and dry weather throughout the peanut growing areas. While problems with spider mites usually worsen when certain fungicides and insecticides are used, the overwhelming effect of hot and dry weather caused spider mite problems—despite our best efforts to minimize their populations. The use of a leafspot advisory system rather than a calendar approach to fungicide sprays has been documented to help reduce mites in peanuts. Suggestions for reducing the threat of spider mites are listed in the control recommendations at the end of this chapter. The use of Lorsban can also increase the likelihood of spider mite outbreaks. Check peanut fields frequently when it's hot and dry for spider mites during late July and August, especially if they are next to cornfields.

Options for control of spider mites are limited to three products at this time: Comite, and Danitol, with Brigade being more of a suppressant than a control. Therefore, it is important to scout fields and use a spray only when necessary. Spider mites have a great ability to develop resistance, and until new materials are available, we run the risk of resistance developing to our only available miticides. It is important to remember that like peanut disease problems, spider mites are very much regulated by the weather, as we observed this past year. Therefore, it is important to look at management of this pest in much the same way one looks at managing a disease. Unlike caterpillars, for example—which, once treated, are generally gone for the year—spider mites have the ability to bounce back in hot, dry weather.

It is important to note, however, that controlling mites usually requires two applications. Treating one time often will not stop a spider mite problem because these products do not do a good job of killing the eggs. If you find the infestation very early, one application may be effective, but usually we don't see the mites until damage and populations are high. Unless it rains, mites almost certainly will come back with a vengeance in a couple of weeks. Using one spray and taking a wait-and-see approach is often not best unless the problem is caught very early in the season before a lot of eggs are present. With the two-spray technique, the first spray gets the mites already present, and the second gets all the mites that have hatched from the eggs present during the first spray. It is also important to note that using your leafspot spray set-up may not provide good enough coverage to get a high level of mite control. Higher pressure and higher volumes are often required. Keep the practices that reduce mite outbreaks at the forefront because they have served us well over the past 10 to 20 years.

Some formulations of bifenthrin, such as Brigade, have a label for spider mite control in peanuts. They can be used, but my experience is that the mites are more likely to “bounce back” from this treatment because bifenthrin is very active against beneficial insects. While this insecticide will do a good job on mites, it does have a tendency, under continuing hot and dry weather, to allow for a more rapid resurgence of the mites. I don’t like to see it used before late summer. Bifenthrin, in my opinion, is best suited as a cleanup spray later in the season, when there is less chance of a resurgence of the mites.

SOIL INSECTS

The southern corn rootworm is one of the most troublesome insects for peanut producers. Pests like caterpillars, thrips, and spider mites can cause severe damage that is often quite obvious above the ground. Rootworms, however, feed below the soil surface.

Beginning in late July and continuing through August, beetles lay eggs in the peanut field. Egg-laying and the survival of these eggs depend on the soil being moist. If the soil is hot and dry, many eggs will not hatch. Rootworm beetles lay most of their eggs in the soil near the base of the plant. The soil stays wetter there than in the row middles. Adequate rainfall in late July and early August can result in rootworm infestation, and most areas had good rains in late summer. In 2018 we had a lot of rain in late July, all of August, and early September. Rootworms often damage irrigated fields. Heavier soils also are more likely to have rootworm problems. The heavier the soil, the better its water-holding ability, so this soil is more likely to have the moisture rootworms need for survival. However, this fact does not mean that sandy soils can’t have rootworm problems. If the soil moisture is adequate, rootworms can occur in almost any field.

Management Decisions

The standard management approach for rootworms is an at-pegging granular insecticide application in a band over the row. Dr. Ames Herbert (now retired from Virginia Tech) and I developed a southern corn rootworm advisory, which is shown later in this chapter. This index relies on soil type to help make a good decision about treatment. Heavier soils are more of a risk, for reasons already discussed. Any soils referred to as “stiff land” probably should be treated. Fields under irrigation run a greater risk from rootworms because higher soil moisture favors egg laying, egg hatch, and rootworm survival. Early maturing varieties can sometimes escape the damage. David Jordan and I also made a couple of new categories in the index based upon irrigation.

Monitoring the soil moisture doesn't offer much help for decision making. The critical time for adequate soil moisture to ensure rootworm survival is early August. But treatments need to be applied before the grower knows if soil moisture is going to be adequate. Even if an at-pegging preventive treatment is applied and the conditions that follow do not encourage a rootworm outbreak, some benefits are still derived from the application. These insecticides protect the crop from leafhoppers, offer some white mold suppression, and give some protection should any cornstalk borers and cutworms be present.

Remember, however, that this is not a blanket recommendation to treat every acre of peanuts with a rootworm insecticide. Treat those fields that are high risk or those in which problems have occurred in the past. The use of rootworm insecticides can increase the likelihood of spider mite outbreaks, which is another good reason to avoid the unnecessary use of such products. As production has moved to the more southern counties, the soil types found there have made problems with rootworms in peanut much less than 20 years ago.

Treatment and Application Options

Rootworm treatments are usually applied after July 4 with ground equipment using properly calibrated hopper boxes to place the insecticide in a 16-inch to 18-inch band over the row. This band provides an important zone of protection around the developing pods. Check the height of the bander over the row, and make sure that the granules are striking the top of the foliage in at least an 8-inch to 10-inch band. Granules falling down through the plant should be distributed in a 16-inch to 18-inch band. Research has shown that light incorporation of the insecticide improves its performance. However, this incorporation is often difficult, as the row middles may be closed when the materials are applied.

Insecticides can be applied any time from mid-June to the first of August. Treatments applied after August 5 may not prevent some of the early-hatching larvae from feeding on pods. Once the larvae hatch and begin feeding, an insecticide treatment is not effective. If growers wait until the end of the first week in August to determine if there was adequate soil moisture to allow a rootworm infestation, it may be too late for the treatment to achieve sufficient control. NC State University studies have shown that treatments after the first week of August do very little to protect pods from rootworm damage (see section titled "Application after August 1"). Thimet (phorate), and its generic equivalents, is also an option but should NOT be applied as an early treatment, only as an at-pegging July application.

Early Application

Many growers have considered the early application of their rootworm insecticides. This early application would be at flowering, or approximately mid-June, rather than at pegging (mid-July). There are several possible advantages to this early application. First, growers begin gaining the benefits of leafhopper control much earlier. In addition, some products offer white mold suppression. Earlier application would also mean the middles are more open, and fewer vines would be run over with the standard four-row equipment used for granular application. One final benefit would be that some products might offer some lesser cornstalk borer protection should conditions be extremely dry in late June and July.

Application after August 1

The option for rootworm control other than the standard pegging-time treatment is a delayed treatment. This delayed treatment is often not intentional but rather the result of wet weather in July that delayed the ground application. If the application of rootworm insecticides is delayed until after August 1, there are risks involved. First, the middles will be more closed, so the use of ground equipment will crush more vines. Most importantly, the insecticide must be applied by August 5. Any delay beyond this date may allow rootworms to begin feeding on pods and do significant damage. Although you wouldn't plan this delay, it can often happen if we get substantial rainfall in the first week in August and the soil is too wet to run ground equipment across the field. The rains in 2018 in August created a great environment for rootworms and kept many growers out of the field and unable to treat. As a general rule, I do not recommend planning to treat for rootworms after August 1 simply because I've seen too many situations where it rained and treatment was delayed beyond the date for which it would have still provided an economic benefit.

PREVENTING INSECT AND MITE PROBLEMS

Many things can be done to help prevent damaging insect and mite infestations. Where possible, consider the following suggestions:

1. Do not treat on a schedule or because a neighbor is spraying.
2. Scout fields and treat only as needed around fields in fall or early spring.
3. Maintain an area clear of weeds and briars around fields during the early growing season. Do not mow weeds around fields from late June through early September.
4. To reduce the probability of spider mite buildup, avoid using foliar insecticides in July and August unless needed to control damaging insect infestations. The fewer insecticide applications used, the lower the probability of creating a pesticide-induced outbreak of mites. Using the leafspot advisory for leafspot applications will help reduce the likelihood of spider mite outbreaks. Avoid unnecessary applications for rootworms. Rootworms treatments often cause spider mite outbreaks.
5. Avoid moving workers and equipment from mite-infested areas to noninfested areas.
6. Avoid planting peanuts immediately adjacent to fields of sweet corn. Spider mite populations often disperse into peanuts as the corn matures.

Safe Use

Phorate (Thimet) and methomyl (Lannate) are extremely toxic to people, animals, and fish. Some other products are toxic to fish. Always carefully read and observe all safety precautions on the label when handling or applying these materials. Use only insecticides labeled and recommended for peanuts. Follow suggestions on dosage and time of application to avoid residues. See NC State Extension publication AG-463-5, *Pesticides and Wildlife—Peanuts*, for additional information on minimizing pesticide impact on wildlife.

INSECT CONTROL ON PEANUTS

Table 5-1. Insect Control on Peanuts

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
SEASONAL CONTROL OF THRIPS AND LEAFHOPPERS		
Thrips at Planting		
acephate (Orthene 97) (generics available)	0.75 to 1 lb	Apply as in-furrow spray in 3 to 5 gallons of water per acre. State (24c) label must be in possession at time of application.
phorate (Thimet) (generics available)	5.0 lb of 20% granules	
fluopyram + imidacloprid (Velum Total)	14 to 18 fl oz	Application rate appropriate for in-furrow spray during planting directed on or below seed, or chemigation into root-zone through low-pressure drip or trickle irrigation.
imidacloprid (Admire Pro)	7.0 to 10.5 fl oz	In furrow spray during planting, directed on or below seed.
thiamethoxam + mefenoxam + fludioxonil + azoxystrobin (Cruiser Maxx Peanuts)	treated peanut seed	Suppression only
aldicarb (AgLogic 15GG & AgLogic 15G)	7.0 lb	Apply granules in the seed furrow and cover with 1-inch or more of soil. May provide suppression of nematodes when applied according to specific label directions.
Thrips Foliar Postemergence		
acephate (Orthene) 97 (generics available)	0.375 to 0.75 lb	Do not feed or graze livestock on treated vines. Apply 10 to 50 gallons spray solution per acre to foliage. Do not apply more than 4.125 pounds per acre (4 pounds a.i. per acre) per season.

(continued)

Table 5-1. Insect Control on Peanuts

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Thrips Foliar Postemergence (continued)		
beta-cyfluthrin (Baythroid XL)	2.8 oz	
bifenthrin (Brigade)	2.1 to 6.4 fl oz	Pre-harvest interval of 14 days.
spinetoram (Radiant SC)	1.5 to 3.0 fl oz	Suppression only. See 2(ee) recommendation.
CONTROL OF SPECIFIC PESTS		
Beet Armyworm		
Bacillus thuringiensis (Xentari)	0.5 to 2 lb	Apply to small caterpillars. Use highest rate for larger worms or high populations; 0 day harvest restriction.
methomyl (Lannate LV)	1.25 to 3 pt	Apply broadcast in sufficient water for good coverage when worms are small. Do not apply within 21 days of harvest. See fall armyworm for additional restrictions.
methoxyfenozide + spinetoram (Intrepid Edge)	4-8 fl oz	Application rate varies with timing. Lower rates appropriate for light infestations, smaller larvae and/or small plants.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14-day preharvest interval.
spinosad (Blackhawk)	1.7 to 3.3 fl oz	Do not apply more than 12.4 fluid ounces per season or make more than three applications. 3-day preharvest interval.
bifenthrin (Brigade)	2.1 to 6.4 fl oz	Pre-harvest interval of 14 days.
chlorantraniliprole (Prevathon)	14.0 to 20.0 fl oz/A	Make no more than 4 applications per crop per year.
Corn Earworm, Southern Armyworm, Green Cloverworm, Velvetbean Caterpillar		
acephate (Orthene) 97 (generics available)	0.75 to 1 lb	Do not feed or graze livestock on acephate-treated vines. Do not apply within 14 days of harvest (digging).
Bacillus thuringiensis (Dipel DF) (Dipel ES) (Xentari)	 0.5 to 2 lb 1 to 2 pt 0.5 to 2 lb	For velvetbean caterpillar control only. Apply to small caterpillars and use highest rate for larger worms and/or high populations; 0-day harvest restriction. Xentari also controls southern armyworm.
esfenvalerate (Asana XL)	2.9 to 5.8 oz	Do not feed Asana-treated vines or graze livestock on treated plants.

(continued)

Table 5-1. Insect Control on Peanuts

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Corn Earworm, Southern Armyworm, Green Cloverworm, Velvetbean Caterpillar (continued)		
fenpropathrin (Danitol) 2.4 EC	10.67 to 16 fl oz	Do not exceed 2.67 pints per acre per season. Use 10 to 50 gallons per acre by ground and 5 to 10 gallons per acre by air. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14 day preharvest interval. For corn earworm.
lambda-cyhalothrin (Karate Z)	1.28 to 1.92 oz	Do not feed or graze livestock on Karate-treated plants.
methomyl (Lannate LV)	0.75 to 3 pt	Apply to foliage when four or more worms are present per foot of row and preferably when worms are small. Do not apply methomyl within 21 days of harvest. Do not feed methomyl-treated vines to livestock. Use minimum of 3 gallons of water for aerial application.
methoxyfenozide + spinetoram (Intrepid Edge)	4 to 8 fl oz	Application rate varies with timing. Lower rates appropriate for light infestations, smaller larvae and/or small plants.
spinosad (Blackhawk)	2 to 3 fl oz	Do not apply more than 9 fluid ounces per season or make more than three applications. 3-day preharvest interval.
bifenthrin (Brigade)	2.1 to 6.4 fl oz	Pre-harvest interval of 14 days.
chlorantraniliprole+ lambda-cyhalothrin (Besiege)	6.0 to 10.0 fl oz/A	Pre-harvest interval 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year.
chlorantraniliprole (Prevathon)	14.0 to 20.0 fl oz/A	Make no more than 4 applications per crop per year.
cyantraniliprole (Exirel)	10.0 to 20.5 fl oz/A	Pre-harvest interval of 14 days.
Budworm, Tobacco		
cyantraniliprole (Exirel)	10.0 to 20.5 fl oz/A	Pre-harvest interval of 14 days.

(continued)

Table 5-1. Insect Control on Peanuts

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Cutworm		
chlorpyrifos (Lorsban) 15 G	1.33 lb	Apply in 16- to 18-inch band over row when infestation is first seen. May be applied by air. Do not graze or feed immature crop to livestock.
esfenvalerate (Asana XL)	5.8 to 9.6 oz	Do not feed treated vines to livestock.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14 day preharvest interval.
lambda-cyhalothrin (Karate Z)	0.96 to 1.6 oz	Do not use treated vines or hay for animal feed.
methomyl (Lannate LV)	1.5 to 3 pt	Do not apply within 21 days of harvest. Do not feed treated vines to livestock.
bifenthrin (Brigade)	2.1 to 6.4 fl oz	Pre-harvest interval of 14 days.
chlorantraniliprole + lambda-cyhalothrin (Besiege)	5.0 to 8.0 fl oz/A	Pre-harvest interval 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year.
cyantraniliprole (Exirel)	10.0 to 20.5 fl oz/A	Pre-harvest interval of 14 days.
Fall Armyworm		
acephate (Orthene) 97 (generics available)	0.75 to 1 lb	Do not apply within 14 days of harvest (digging). Do not feed or graze livestock on vines treated with acephate. Apply 10 to 50 gallons spray solution per acre. Do not apply more than 4.13 pounds per acre (4 pounds a.i. per acre per season).
fenpropathrin (Danitol) 2.4 EC	10 2/3 to 16 fl oz	Do not exceed 2.67 pints per acre per season. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14 day preharvest interval.
lambda-cyhalothrin (Karate Z)	1.28 to 1.92 oz	
methomyl (Lannate LV)	0.75 to 1.5 pt	Effective against all sizes of worms. Use minimum of 3 gallons of water for aerial application. Do not apply within 21 days of harvest. Do not feed methomyl-treated vines to livestock.

(continued)

Table 5-1. Insect Control on Peanuts

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Fall Armyworm (continued)		
methoxyfenozide + spinetoram (Intrepid Edge)	4 to 8 fl oz	Application rate varies with timing. Lower rates appropriate for light infestations, smaller larvae and/or small plants.
spinosad (Blackhawk)	1.7 to 3.3 fl oz	Do not apply more than 12.4 fluid ounces per season or make more than three applications. 3-day preharvest interval.
bifenthrin (Brigade)	2.1 to 6.4 fl oz	Pre-harvest interval of 14 days.
chlorantraniliprole+lambda-cyhalothrin (Besiege)	6.0 to 10.0 fl oz/A	Pre-harvest interval of 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year.
chlorantraniliprole (Prevathon)	14.0 to 20.0 fl oz/A	Make no more than 4 applications per crop per year.
cyantraniliprole (Exirel)	10.0 to 20.5 fl oz/A	Pre-harvest interval of 14 days.
Leafhoppers		
acephate (Orthene) 97 (generics available)	0.75 to 1 lb	See remarks under Thrips.
esfenvalerate (Asana XL)	2.9 to 5.8 oz	Do not feed livestock Asana-treated vines or graze livestock on treated plants.
fenpropathrin (Danitol) 2.4 EC	6 to 10.67 fl oz	Do not exceed 2 2/3 pints per acre per season. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application.
chlorantraniliprole+lambda-cyhalothrin (Besiege)	6.0 to 10.0 fl oz/A	
lambda-cyhalothrin (Karate Z)	0.96 to 1.6 oz	Do not use treated vines or hay for animal feed.
methomyl (Lannate LV) bifenthrin (Brigade)	0.75 to 3 pt 2.1 to 6.4 fl oz	Do not apply within 21 days of harvest. Do not use treated vines as feed. Pre-harvest interval of 14 days.
Lesser Cornstalk Borer		
chlorpyrifos (Lorsban, Pilot) 15 G (generics available)	7 to 14 lb	
chlorantraniliprole+lambda-cyhalothrin (Besiege)	10.0 fl oz/A	Pre-harvest interval 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year.

(continued)

Table 5-1. Insect Control on Peanuts

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Lesser Cornstalk Borer (continued)		
chlorantraniliprole (Prevathon)	14 to 20.0 fl oz/A	See 2 (ee) Label recommendation.
cyantraniliprole (Exirel)	13.5 to 20.5 fl oz/A	Pre-harvest interval of 14 days.
Southern Corn Rootworm		
chlorpyrifos (Lorsban, Pilot) 15 G (generics available)	13.3 lb	Apply in a 16- to 18-inch band over the row just before pegging.
Spider Mite		
propargite (Comite) 73 L	2 pt	Apply in at least 25 gallons of water per acre. Spider mite outbreaks are less likely to develop if foliar insecticides are not used during July and August and copper fungicides are used for Cercospora leafspot. Do not apply propargite within 14 days of harvest.
fenpropathrin (Danitol) 2.4 EC	10.67 to 16 fl oz	Do not exceed 2.67 pints (42 2/3 fluid ounces) per acre per season. Use 10 to 50 gallons per acre by ground and 5 to 10 gallons per acre by air. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application. Pre-harvest interval of 14 days.
bifenthrin (Brigade)	5.1 to 6.4 fl oz.	

MANAGING TOMATO SPOTTED WILT VIRUS IN PEANUTS IN NORTH CAROLINA AND VIRGINIA

Thrips transmit TSWV when they feed on peanut plants. Although most of the virus is transmitted early in the season when thrips are most abundant, thrips can transmit the virus throughout the season. Even though very little damage from thrips might be noticed because insecticides kill thrips, the virus is transmitted to the peanut plant rapidly before the thrips are killed with systemic insecticide.

A wide range of plants, both crops and weeds, are hosts for the virus and for the thrips that transmit it. Thrips must acquire the virus by feeding on infected host plants. Thrips feed and overwinter in and among many plants. During the spring while peanut plants are emerging, the thrips move into fields, feeding on peanut plants and transmitting disease.

Even though it seems logical that killing many of the plants that harbor thrips and virus in areas adjacent to peanut fields will reduce levels of virus in peanut, thrips can enter fields from great distances. Depending on wind currents and weather patterns, thrips from many miles away can land and feed on peanuts and subsequently transmit the virus. Efforts to kill all of the vegetation adjacent to peanut fields most likely will not reduce virus in peanuts.

There are no control practices that can be implemented to reduce the virus after peanuts are planted. The major factors that influence the level of virus in peanut—including variety selection, planting date, plant population, in-furrow insecticide, row pattern, and tillage system—are considered and implemented prior to planting. Poor and inconsistent emergence of peanuts and establishment of spotty peanut stands increase incidence of TSWV regardless of variety selection, planting date, insecticide choice, and tillage system. Establishing optimum plant stands is critical in managing this pest.

An insect management program that effectively controls thrips will lower the amount of TSWV. Unlike many of the other pests found in peanuts, considerable variation in response to management strategies occurs and should be expected. Weather conditions that influence populations of thrips, the vector for this virus, and their subsequent arrival in fields can vary considerably from year to year. Variation in strains of the virus and the ability of the virus to adapt also contribute to variations in response.

Some production practices can be implemented with no additional equipment investment. These variables include planting date, variety selection, seeding rate, and insecticide selection. Planting peanuts in twin rows or in reduced tillage systems may require equipment purchase. The strengths and weaknesses of each input must be considered when developing a TSWV management program. Contact your county Cooperative Extension agent for additional information on developing pest management and production systems for peanuts grown in North Carolina.

Table 5-2. Advisory Index for Managing TSWV in North Carolina Peanuts

Peanut Variety	Points	Score
Sugg, CHAMPS Bailey, Emery, Florida 07, Georgia 07W, Gregory, Sullivan, Wynne	30 20	
While not shown here, other runner market type varieties as well as Virginia market types developed in the southeastern U.S., where TSWV is more common, often express elevated resistance to TSWV but have not been thoroughly evaluated In North Carolina. Seed for large-seeded varieties require more pounds to achieve optimum plant stands, resulting in greater expense compared with small-seeded varieties. Growers are tempted to reduce seeding rates below recommended levels. Low planting rates may negate any benefits of partial resistance to TSWV.		
Planting Date	**Points**	**Score**
Prior to May 6 May 6 – 15 After May 15	20 10 15	
In absence of spotted wilt, higher yields are often obtained when peanuts are planted prior to May 15. Crop maturity can be affected by many factors. Planting a late-maturing variety end of May to avoid spotted wilt may result in lower yields and market grades because pods do not have sufficient time and heat units to adequately mature.		
Plant Population (actual, not projected, stand)	**Points**	**Score**
2 or fewer plants per row foot 3 to 4 plants per row foot 5 or more plants per linear foot of row	25 15 5	
Seed size and count per pound should always be considered when planting Virginia market type peanuts. The varieties and seeding rates in pounds per acre (listed in parentheses) needed to establish a plant population of 4 plants per row foot assuming 80% germination (planting 5 seeds per row foot to get 4 plants per row foot): Florida 07 and Georgia 07W (110 lb/acre); CHAMPS, Bailey, Emery, Sugg, and Sullivan (126 lb/acre), and Wynne (150 lb/acre). Actual seed count and germination can vary by year and lot. Consider the characteristics of the peanut seed you have purchased when setting your planter. For twin rows, the final plant population per linear foot of row is the sum of individual twin rows.		

(continued)

Table 5-2. Advisory Index for Managing TSWV in North Carolina Peanuts

Insecticide/Nematicide	Points	Score
None Acephate early postemergence Admire Pro, or Acephate in-furrow or Velum Total in-furrow Thimet 20G or Phorate 20G in-furrow	25 20 10 5	
The influence of insecticide on TSWV should not be the overriding consideration for selection. Also consider effectiveness against thrips, injury potential from insecticides, cost of treatment, and possible interactions of insecticides with herbicides.		
Tillage	**Points**	**Score**
Conventional tillage Strip tillage into killed cover crop or previous crop residue	10 5	
Research in North Carolina and Virginia has shown lower yields on average when peanuts are seeded into stubble from the previous crop. Establishing beds in the fall, seeding a cover crop, and then strip tilling peanuts into the killed cover crop has been the most effective reduced tillage system, with yields from this approach similar to yields in conventional tillage systems. Yield potential has been more difficult to maintain on finer-textured soils when peanuts are strip tilled into the stubble from the previous crop and little or no bed is present. Using reduced tillage exclusively to manage TSWV is not recommended.		
Total Score		
Less than 60, low risk; 65-85, moderate risk; greater than 90, high risk		

Examples of the Advisory Index

All management options designed to minimize TSWV:

Plant the variety Bailey (20 points) after May 5 but before May 16 (10 points) in strip tillage (5 points) at a plant population of 5 plants per row foot (5 points) using Thimet 20G in-furrow (5 points).

Advisory index = 45 (low risk)

No management options designed to minimize TSWV:

Plant the variety CHAMPS (30) before May 5 (25) in conventional tillage (10) at a plant population of 2 plants per row foot (25) using no in-furrow insecticide (25).

Advisory index = 115 (high risk)

Compromise situation—Finer-textured soil with history of Sclerotinia blight and CBR:

Plant the variety Sugg (30) between May 6 and 15 (10) in conventional tillage (15) at a plant population of 5 plants per foot of row (5) using Phorate 20G in-furrow (5).

Advisory index = 65 (moderate risk)

Compromise situation—Coarse-textured soil with history of Sclerotinia blight:

Plant the variety Sullivan (20) prior to May 5 (25) in strip tillage (5) at a plant population of 5 plants per foot of row (5) using Orthene in-furrow (10).

Advisory index = 65 (moderate risk)

MANAGING PEANUT ROOTWORM

Peanut Rootworm Advisory: What's the risk of SCR in your fields?

Table 5-3. One-Minute SCR Field Index Score

Soil texture	Points	Score
Loamy sand	5	
Fine sandy loam	10	
Loam	15	
Drainage class	**Points**	**Score**
Well drained	5	
Moderately well drained	10	
Somewhat poorly drained	15	
Poorly drained	20	
Field history of rootworm damage	**Points**	**Score**
None	0	
Low	5	
Moderate	10	
High	15	
Planting date	**Points**	**Score**
Before May 1	5	
May 2 – May 15	10	
After May 15	15	
Cultivar resistance	**Points**	**Score**
CHAMPS, Lower scored based on early maturity	10	
Bailey, Emery, Florida 07, GA 06G, Sugg, Sullivan, Wynne	20	
Irrigation	**Points**	**Score**
No irrigation	0	
Periodic irrigation or frequent rainfall	20	
Intensive Irrigation	45	
Total score		

70 or above High risk Treatment needed

Treat high-risk fields with rootworm insecticides from about June 20 to July 10. All irrigated fields should be treated.

55 to 65 Moderate risk May not need treatment

Treatment decisions for moderate-score fields depend on additional factors, such as weather and land-lease requirements. In many moderate-score fields, especially those at the low end of the range, rootworm damage does not reach economically damaging levels. In most years, pod damage in moderate-risk fields is not likely, so treatment may not provide an economic return and may, in fact, help create a spider mite problem. All irrigated fields should be treated.

50 or less	**Low risk**	**No treatment needed**

Irrigation or wet weather may make rootworm problems worse. Always treat irrigated fields. Rainfall patterns are unpredictable, and growing seasons can occasionally experience rainfall throughout the entire season that equals and in some cases exceeds intensive irrigation, with 2014 being a prime example. The decision to apply insecticide for SCR is made in late June and throughout early to mid-July to be most effective. When rainfall patterns are similar to those in 2014, fields that register low to moderate risk of SCR can actually be at greater risk because of the excessive and uniform moisture in soil. The SCR index during the vast majority of years is reliable because rainfall tends to be more sporadic and dry weather occurs periodically throughout the growing season in absence of irrigation.

Can You Count on the SCR Advisory?

The SCR advisory was tested on 436 commercial peanut fields in Virginia and North Carolina from 1989 to 2002. Farmers who followed the advisory recommendations were protected 96.5 percent of the time; 3.5 percent of the fields examined had damage above the SCR threshold.

Was the SCR Advisory Index Tested Near You?

The SCR Index was tested on farmer fields in these North Carolina counties: Bertie, Bladen, Chowan, Edgecombe, Gates, Halifax, Martin, Northampton, Perquimans, and Pitt. It was also tested in the following Virginia locations: Dinwiddie, Greensville, Isle of Wight, Prince George, Southampton, Suffolk, Surry, and Sussex.

What Are the Keys to Fields with Low Scores?

- Resistant cultivars. The early-maturing pods of CHAMPS are not as susceptible to rootworm attack during the peak pest pressure in late July and early August.
- Good drainage and sandy soils. SCR larvae prefer moist soils. Irrigation, high loam content, and poor drainage increase the risk of damage. Always treat irrigated fields.
- Early planting. Early planting reduces risk because pods tend to mature before rootworm feeding.
- Known history. Base your estimate on experience in previous years with damage levels in areas of the field not treated with insecticide. If fields have always been treated, estimate a moderate level of damage.

For more information about the SCR Advisory, contact your county Extension agent.

6. PEANUT DISEASE MANAGEMENT

Barbara Shew
Extension Specialist—Department of Entomology and Plant Pathology

This chapter provides details about how to use integrated methods to manage major peanut diseases. Selecting and integrating appropriate rotations, cultivars, cultural methods, and chemical controls can help growers maintain a healthy crop and attain high yield potential while minimizing expensive inputs.

FIELD HISTORY AND RISK ASSESSMENT

Know the disease and rotation history of each field so that you can select appropriate management tactics and crop protection products (Table 6-1). Some of the most effective disease management tactics, such as rotation and cultivar resistance, must be selected before planting. The Peanut Risk Management website (see chapter 11: **agroclimatenc.ncsu.edu/peanut/riskmgmt/**) can help you see how different field histories and management decisions affect overall risks of disease in peanut production. During the season, keep detailed records of the specific diseases observed, when they appeared, where they were found, and the products used to manage them. Save these records as guides for future pest management decisions.

ROTATION

Rotations of three to four years or more are the most effective way to avoid disease problems. The fungi, bacteria, nematodes, and viruses that cause peanut diseases (pathogens) need to survive during times when peanuts or other host plants are not growing. The longer a pathogen goes without a host, the more likely it is to die, thus lowering the population of surviving pathogens. Rotation is most effective against pathogens that are not very mobile, like soilborne pathogens, and those that have no host other than peanut, like leaf spots. Not all rotation crops are equally effective in reducing disease risk (Table 6-2).

In general, rotations with crops in the grass family, including corn, small grains, and sorghum, are the most effective because these plants are not hosts to most peanut pathogens. Rotations with cotton are beneficial for both crops.

Soybeans and peanuts have many diseases in common, so peanut-soybean rotations increase disease risk in both crops and should be avoided. When it is necessary to include soybeans in the rotation scheme, plant them AFTER peanut and extend rotations as long as possible. Double cropping with a small grain also will reduce risk. Be aware that adding a new crop to your usual rotation has the potential to change the risk of disease problems.

Because peanut pathogens can infect and reproduce on volunteer peanuts, it is very important to control volunteers in rotation crops. Otherwise, large numbers of volunteers can erase the benefits of rotation. Weed control in rotation crops is important because weed species may support survival and reproduction of some pathogens, reducing the benefits of rotation.

RESISTANCE

Peanut cultivars range in resistance from highly susceptible to moderately resistant, depending on the disease (Figure 6-1; Table 6-3). Avoid highly susceptible cultivars in fields with a history of disease problems. Using a resistant cultivar is very cost-effective: it costs little or nothing extra while reducing inputs and preserving yield. The cultivars Bailey, Sullivan, and Wynne have moderate resistance to several diseases relative to older cultivars. In general, runner cultivars are less susceptible to most diseases than Virginia types, but there are exceptions with certain diseases and cultivars (Figure 6-1).

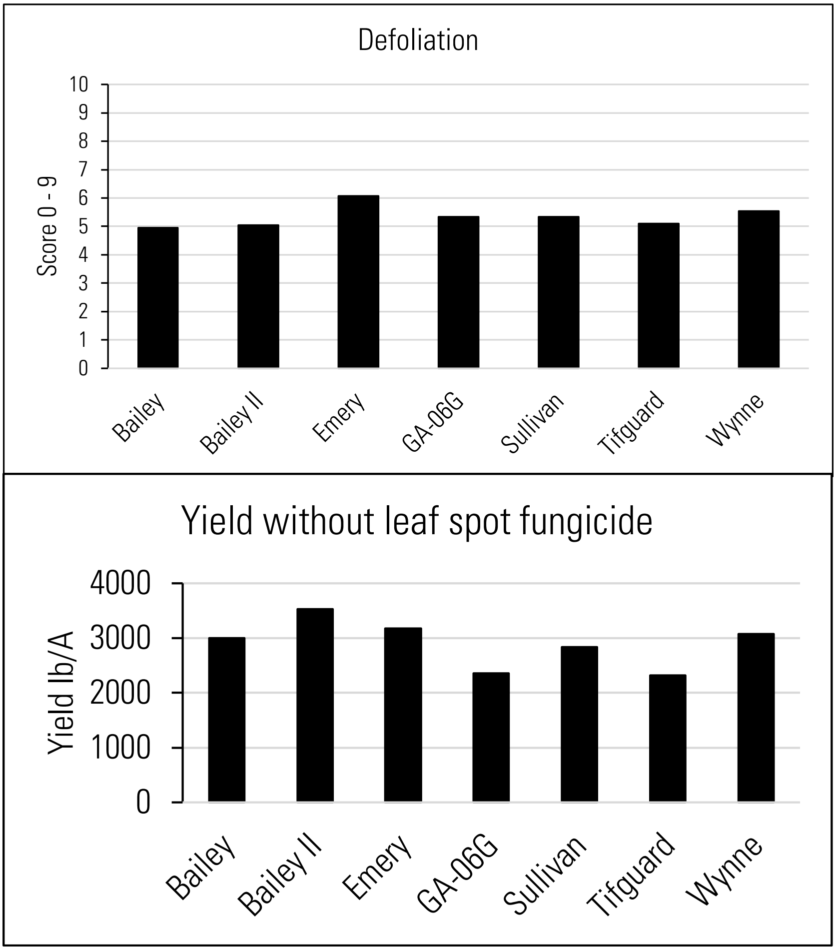
CULTURAL PRACTICES

In addition to rotation, cultural practices such as planting date, cultivation, sanitation, field selection, fertility management, weed management (see "Rotation" above) and irrigation can affect disease severity and yield loss due to disease. In general, practices that minimize plant stress reduce the risk of disease and related yield loss. However, irrigation and lush growth can favor development of leaf spots, stem rot, and Sclerotinia blight and make them more difficult to control. Extra vigilance is needed under these conditions.

CHEMICAL CONTROL

Pesticides should be used only when host resistance, rotation, and cultural practices are not sufficient to reduce disease to levels below economic thresholds. Choose the appropriate pesticide to control the particular disease or diseases of concern (Table 6-4). Keep in mind that inexpensive fungicides can be just as effective as more expensive products (Table 6-5), and that mixing or rotating fungicides with different group numbers is necessary to prevent fungicide resistance and loss of control (Table 6-6). Apply all pesticides according to label directions and understand all safety precautions. Check the label for formulation changes that may require larger or smaller amounts of a pesticide than you have applied in the past. Calibrate sprayers and other applicators at the start of the season, and check calibration from time to time during the season.

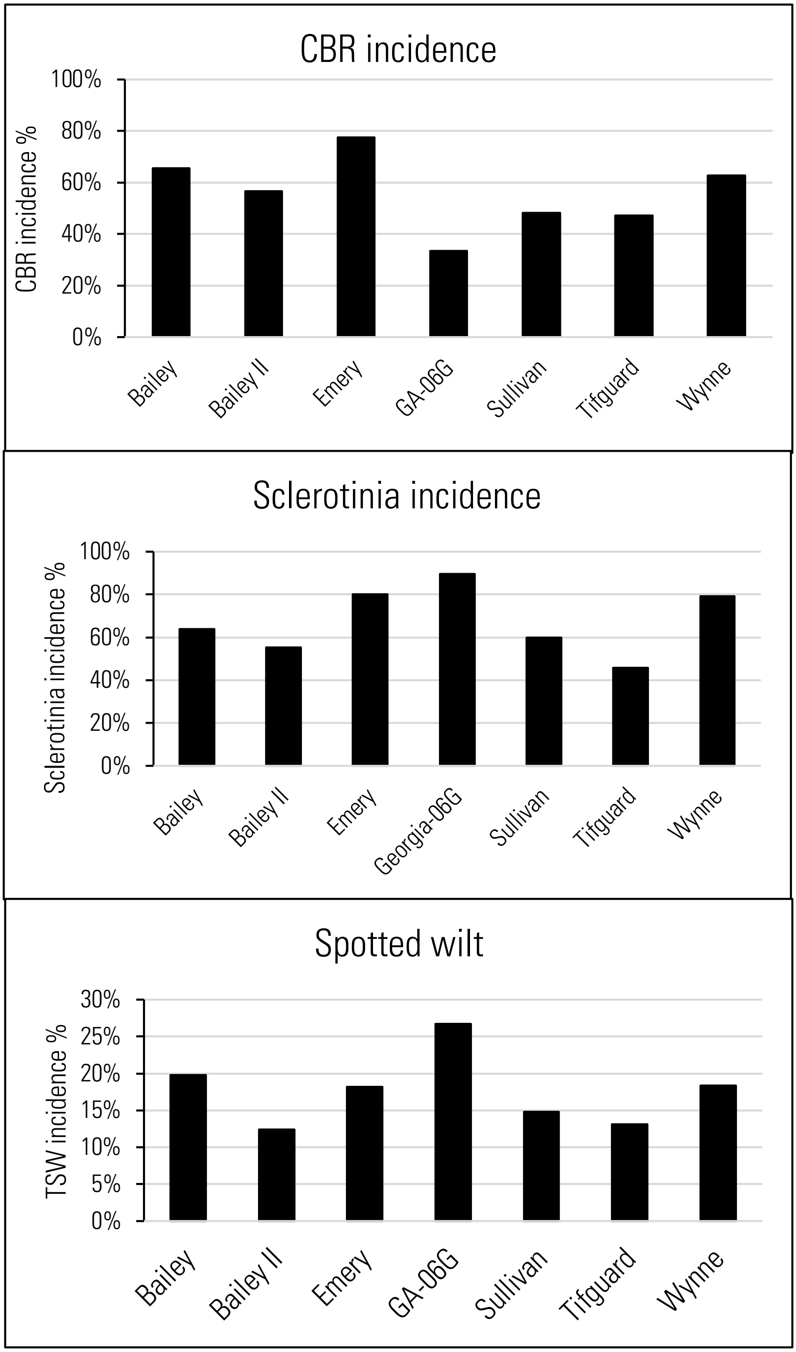
Figure 6-1. Disease Responses of Peanut Cultivars in North Carolina Breeding Trials[1]



[1] Data from Dr. Tom Isleib and Jeff Dunne. Cultivars were evaluated in plots managed to create conditions highly favorable for each disease. Results are means across all years of testing. Ratings for runner cultivars may be less reliable than for others due to low trial numbers.

(continued)

Figure 6-1. Disease Responses of Peanut Cultivars in North Carolina Breeding Trials[1]



SCOUTING, WEATHER, AND WEATHER-BASED ADVISORIES

Because fungicides have very limited ability to stop established infections or cure diseases, effective management often depends on anticipating disease outbreaks even before symptoms are apparent. This fact means that most diseases must be controlled preventively.

Careful scouting can help you find disease, insect, or weed problems when they are easiest to control and before they become serious. Scouting also can alert you to any pesticide application errors and other cultural problems that need to be corrected. Begin scouting for disease no later than early pegging and continue weekly until digging.

Weather has a profound effect on disease problems. Risk of most (but not all) diseases is highest during warm humid weather. Following disease advisories can minimize unnecessary pesticide use during unfavorable weather while identifying periods when risk of disease is high and sprays are necessary. Contact your county Extension agent to receive daily leaf spot and Sclerotinia advisories by email.

IDENTIFYING DISEASES

Successful disease management depends on correct diagnosis of the problem or disease observed. Symptoms caused by cultural problems can be mistaken for disease, but will not respond to fungicide applications and other disease control practices. Likewise, management tactics that work for one disease may not work for another (Table 6-1).

Observe the time and pattern of symptom appearance. Diseases typically build slowly and are found in clusters or hot spots during early stages of development. In contrast, symptoms of cultural problems, such as of nutritional problems, excess moisture, drought stress, and chemical injury, may appear suddenly and usually are found in regular patterns or are widespread across a field.

Many peanut diseases can be diagnosed from their characteristic symptoms. Photos of common diseases can be found online at **peanut.ces.ncsu.edu/peanut-disease-photos/**. If you need additional help, contact your county Extension agent, or submit samples to the NC State Plant Disease and Insect Clinic. Be sure to submit entire plants (not just foliage) and include about a pint of soil (bagged separately) with all samples. See **www.ncsu.edu/pdic** for additional information about submitting clinic samples.

The rest of this chapter describes the management and characteristic symptoms of peanut diseases commonly found in North Carolina.

FOLIAR DISEASES

Leaf spots

Leaf spots are caused by two different fungi: *Nothopassalora personata* (late leaf spot pathogen) and *Cercospora arachidicola* (early leaf spot pathogen). Other diseases cause spots on leaves, but they are not referred to as “leaf spot” (see other diseases listed below). Leaf spots usually appear first on lower leaves, with symptoms progressing up the plant over time. As the disease continues to increase, the lower leaves defoliate first, followed by the middle and upper leaves. The plant may become completely defoliated and die, causing severe yield loss.

Late leaf spot is by far the predominant leaf spot in North Carolina. The primary symptoms are dark-brown to black leaf spots that may (or may not) be surrounded by a yellow halo. In humid weather, late leaf spots produce dark-brown spores. The mass of spores gives the spot a velvety appearance, which can be seen without magnification on the underside of the leaf. As the name implies, symptoms of late leaf spot may not be evident until after the first of August. Once established, late leaf spot increases very rapidly. Aggressive disease control is needed to prevent yield loss.

Early leaf spot causes brown lesions (spots) that are lighter in color than late leaf spots. The difference in color is most evident on the underside of the leaf. A yellow halo usually is present around early leaf spots, but this is NOT diagnostic since halos may also be present with late leaf spot. In humid weather, early leaf spots produce tufts of silvery, hair-like spores on the top of the leaf. If present, these spores can be seen with the help of a good magnifying glass. Although early leaf spot can be found as soon as 30 days after planting, it is usually not observed until mid-July or later if good rotations are used.

Weather: Warm, humid weather favors infection, spore production, and rapid disease increase. Infection and spore production usually occur overnight and during humid mornings. Risk of leaf spot is high when dew points are high (upper 60s or higher) or during prolonged rainy periods. However, weather can be favorable for leaf spots even during dry spells if humidity and dew points are high. Favorable weather can occur anytime from late June to early October but is most common from mid-July to mid-September.

Rotation, history and risk: Because peanuts are the only known hosts of leaf spot fungi, rotations (Table 6-2) are very effective in reducing disease. Fields with short rotations and a history of high leaf spot pressure are at high risk for leaf spot, whereas fields with long rotations (four years or more between peanut crops) have reduced the risk of leaf spot problems.

Cultivar selection: Peanut cultivars vary in susceptibility to leaf spots (Figure 6-1); follow a strict control program on highly susceptible cultivars. Sullivan, Bailey, and

Wynne are less susceptible to leaf spots compared to the cultivars grown 10 years ago, but leaf spot severity has increased on these cultivars in the past two to three seasons, possibly indicating adaptation of leaf spot fungi to these cultivars.

Cultural practices: Irrigation favors leaf spot (high risk). Stay on a 14-day spray schedule in irrigated fields (see below).

Fungicides: Fungicide application is required for leaf spot control. DO NOT wait until leaf spot is apparent before starting a spray program. Instead, apply fungicides:

- on a set 14-day calendar schedule OR
- according to a weather-based leaf spot advisory.

In fields that have been rotated at least three years, the first fungicide spray (calendar spray or advisory) should be applied at the very early pod stage (R3), which usually occurs in the first week of July. In the lowest risk fields, the first spray can be delayed by 7 to 10 days on most cultivars (Figure 6-1). After the first spray, reapply fungicides every 14 days or according to advisory. Sprays should continue until 14 to 21 days before harvest.

Some products may retain efficacy over more than 14 days, allowing longer intervals between sprays (Table 6-4). If considering spraying at intervals longer than 14 days, BE SURE the product label supports extended intervals and check the label to see if a higher rate is needed for extended interval applications. Use extended intervals with caution. Conditions that affect leaf spot can change considerably over a 28-day interval.

Because disease develops only in favorable weather, weather-based advisories can be used to delay or eliminate sprays during unfavorable periods. Eliminating unnecessary fungicide sprays during dry spells helps to prevent spider mite flare-ups (chapter 5) and can reduce tractor damage to vines, making them less prone to Rhizoctonia limb rot and Botrytis blight. For more information on advisories in your area or to receive leaf spot advisories by email, contact your county Extension agent.

Many fungicides control early and late leaf spot (Tables 6-4 and 6-5), and most also control minor foliar diseases. In addition, some "leaf spot" fungicides also control or suppress stem rot, CBR, and Rhizoctonia limb and pod rot (Table 6-5).

CAUTION: Leaf spot advisories are intended to be used on dry-land peanuts. Irrigated peanuts should be sprayed on a calendar schedule.

CAUTION: DO NOT assume that conditions are unfavorable for leaf spots during dry spells. High humidity and dew points can be present even when rainfall is low. Check disease advisories to determine if fungicide sprays are needed.

Leaf Spot Fungicide Resistance and Resistance Management

IMPORTANT NOTICE: Strobilurin fungicides (group 11) appear to be have lost efficacy against some leaf spot populations (Table 6-8). Use of unmixed strobilurins for leaf spot control is NOT recommended. Moreover, several fungicide pre-mixes include a group 11 component, which could make these products more vulnerable to resistance problems in the future. FOLLOW RESISTANCE MANAGEMENT GUIDELINES to prevent further erosion in fungicide performance. Read the information below and check with your county Extension agent for updates about possible fungicide resistance issues and recommendations for leaf spot control. Many common peanut fungicides belong to resistance groups 3, 7, or 11 (Figure 6-2).

Figure 6-2. Example of a fungicide resistance group label

GROUP **11** FUNGICIDES

The resistance group is prominently displayed on the fungicide label (Table 6-8). Continued use of fungicides from the same group (even if they have different active ingredients) may select for resistant strains of a fungus, causing the fungicide to lose effectiveness over time. To prevent fungicide resistance, use fungicides from different groups during the season (Table 6-6). To maintain fungicide efficacy:

- MIX or ALTERNATE fungicides with different group numbers or with a group M fungicide (such as chlorothalonil) during the growing season.
- DO NOT use fungicides at less than the recommended rates.
- STAY on a 14-day spray schedule unless the label or leaf spot advisories specifically indicate that it is safe to spray at longer intervals.
- DO NOT exceed the total number of sprays recommended under resistance management guidelines a particular fungicide or group number.
- USE chlorothalonil or another group M fungicide AT LEAST TWICE per season. Make one application (alone or mixed with another product) during the season and one application as the last spray of the season. Group M fungicides are not vulnerable to resistance problems.
- Maintain a good foliar disease control program throughout the growing season.
- NEVER rely on “rescue” treatments to clean up foliar disease problems. Rescue treatments increase risk of fungicide resistance and often are ineffective.

Fungicide labels provide additional resistance management information and recommendations.

NOTE: Some commonly used fungicides are now off-patent. Check the group number(s) on the label and follow resistance management guidelines when using generic products. Note that some premix products contain less active ingredient than the traditional single a.i. product.

CAUTION: Do not use tebuconazole (group 3, "Folicur") without mixing it with another leaf spot fungicide. Resistance to tebuconazole and loss of leaf spot control is common in North Carolina. ALWAYS mix tebuconazole with a product from another group for leaf spot control.

Rainfastness

Most peanut fungicides persist on foliage for about 14 days, but there is surprisingly little information about the rainfastness of peanut fungicides under field conditions. Frequent thunderstorms in summer mean that rain often falls soon after a fungicide is applied, which could wash it off. As a rule of thumb, reapply the fungicide, or an inexpensive protectant, if heavy rain falls within two hours of application. If rain falls within several more hours, consider shortening the interval to the next spray to 10 days. Remember that a systemic fungicide that is taken up by the plant is more likely to persist in rainy weather than a protectant that remains on the plant surface.

Leaf scorch and pepper spot are caused by the same fungus (*Leptosphaerulina crassiasca*). In early to mid-season, large v-shaped areas appear at the tips of the leaves, resulting in a scorch symptom similar in appearance to leafhopper damage. Later in the season, leaves can be covered with numerous small dark spots (pepper spot).

Weather: The pepper spot fungus has been associated with severe vine decline that sometimes occurs after heavy late-season rains.

Control: These diseases usually are not a problem when fungicides have been applied for leaf spot control. Differences in cultivar resistance have not been observed.

Botrytis blight (caused by the fungus *Botrytis cinerea*) usually causes a dark, water-soaked blight on leaves and stems. The fungus produces massive numbers of gray to brown spores on leaves and stems, covering them with gray fuzz. *Botrytis* can also cause a leaf spot. Symptoms begin as numerous small, light tan, irregular spots without obvious spores. Later, spots may increase to large, irregular tan blotches with characteristic fuzzy gray spore masses.

Weather: The blight phase of this disease usually occurs in cool, wet weather late in the season. Injured vines or leaves, or plants suffering from frost or freeze damage, are most likely to be affected. The leaf spot phase of the disease appears somewhat earlier in the year, and most commonly after unusually cool, wet weather.

Control: Although Botrytis blight usually does not cause serious losses, it can be alarming. Timely harvesting and avoiding plant injury will reduce incidence and severity. Fungicide sprays for leaf spot control will usually control the leaf spot phase of the Botrytis blight. Differences in cultivar resistance have not been observed, but it is likely that cultivars that produce heavy vine growth are prone to be infected.

Web blotch (caused by the fungus *Phoma arachidicola*) produces large (half-inch) dark patches or blotches with faint or irregular margins on the upper surface of the leaf. Lesions may have a grayish cast at first and turn dark brown as they age. Infected leaves may dry and crack with age. Web blotch has become very uncommon in the past several years.

Weather: Historically, web blotch has been most serious in wet years, but even in the very wet falls of 2015, 2016, and 2018, little to no web blotch was observed.

Control: To control web blotch, use long rotations (Table 6-2) with any crop other than peanut. Many fungicides used to control early and late leaf spot also control web blotch (Tables 6-4 and 6-5). We have little information about the efficacy of recently labeled fungicides or susceptibility in the most commonly grown cultivars due to lack of disease in North Carolina. However, Priaxor and Miravis have shown good activity against web blotch in Oklahoma.

Irregular (or physiological) leaf spot can be almost impossible to distinguish from early leaf spot unless spots are checked under a microscope. Irregular leaf spot is diagnosed if the fungal structures and spores typical of early or late leaf spot are absent even after incubation at high humidity. Symptoms usually appear within 45 days of planting. Symptoms usually are widespread across a field and tend to be distributed on leaves of similar age. Some defoliation may occur, but yield losses have not been demonstrated. While the cause of irregular leaf spot is unknown, the uniform age and distribution of affected plants suggests that the problem is not caused by a fungus or other pathogen. Leaf-spot-like symptoms seen within 45 days of planting are probably due to irregular leaf spot or phytotoxicity.

Control: Fungicides will not control irregular leaf spot. If spots are present within 45 days after planting, do not apply a leaf spot fungicide unless the spots have been positively diagnosed as early or late leaf spot.

Phytotoxicity (chemical toxicity) caused by insecticides and herbicides can be confused with leaf spots. Spots caused by phytotoxicity usually are found around the leaflet margins and generally are found before mid-June. The location on the plant (lower, middle or upper leaves) can point to the product or products involved based on time of application. Pesticides can also cause spots by burning areas contacted by spray droplets. Affected areas lack fungal structures or spores, and spray residues may be visible with slight magnification from a hand lens or in digital image.

Phytotoxicity symptoms tend to appear suddenly and to be distributed regularly (such as at the ends of rows or in streaks) or uniformly over the field.

Control: Be aware of products and application practices that can lead to plant injury (see chapter 9). The hazard of plant injury increases as the number of products in a tank mix increases. Plants usually will grow out of minor injuries.

SPOTTED WILT

Spotted wilt (caused by *tomato spotted wilt virus, TSWV*) symptoms vary, but twisted petioles and purplish brown-to-bronze spots or blotches on the undersides of leaves are the most diagnostic. Other symptoms can include stunting, dead terminal buds, pale-yellow or white ring patterns on leaves, and stunted pods bearing seeds with dark-red coats. Sometimes entire plants may wilt and turn yellow. Affected "yellows" plants may have root rot, which can be confused with Cylindrocladium black rot (CBR). A simple test (dipstick ELISA) can be performed by the NC State University Plant Disease and Insect Clinic to confirm the diagnosis. TSWV is spread by thrips. These insects obtain the virus by feeding on infected plants and then transmit it to healthy ones.

Weather: The virus and thrips survive on winter annual weeds and other annual and perennial hosts. Thus, weather in winter and early spring can affect the likelihood of spotted wilt outbreaks by affecting the survival and movement of thrips from weeds and other hosts to peanut.

Rotation: Rotation is not very effective in managing spotted wilt because TSWV and the thrips that carry the virus have hundreds of cultivated and wild plant hosts.

Spotted wilt index: Spotted wilt outbreaks are unpredictable and cannot be stopped once symptoms appear. Managing spotted wilt depends on risk reduction. As discussed below, cultivar choice, plant stand, and planting date have the greatest effect on spotted wilt risk. Each of these choices presents costs and benefits to overall crop productivity. Use the Tomato Spotted Wilt Risk Index (chapter 5 or online) to assess options for minimizing the spotted wilt risk in a given field.

Cultivar selection: Bailey, Sullivan, and Wynne have high levels of spotted wilt resistance compared to older Virginia types. Many runner cultivars also have good resistance to spotted wilt.

Cultural practices: Planting between May 5 and 15 in a stand of five or more plants per foot of row will minimize risk. Twin rows and minimum tillage reduce the risk of spotted wilt slightly.

Chemical control: There are no pesticides that can prevent or treat virus infections. However, using an insecticide (acephate, phorate, or imidacloprid) in-furrow or post-emergence (acephate) to control thrips reduces the risk of virus transmission and spotted wilt.

DISEASES CAUSED BY SOILBORNE PATHOGENS

Soilborne plant pathogens attack parts of the plant that grow in or near the soil. Affected plant parts include roots, stems, pegs, pods, and seeds. The entire plant may become symptomatic or die in advanced stages of disease. Soilborne pathogens are very difficult to control because they can survive in soil for years once established. Prevent the buildup of disease problems by rotating to nonhost crops (Table 6-2). Keep in mind that the same disease can have a different name in other crops. It is equally important to avoid introducing soilborne pathogens into uninfested areas. Use high quality treated seed and clean equipment frequently, particularly when moving from one field to another. Blow loose soil and debris from diggers and combines after they are used in heavily infested fields. Once heavy infestations occur, only very long rotations can reduce pathogen numbers below economic thresholds.

Soilborne pathogens have limited mobility, so mapping the location and intensity of the diseases they cause is a useful tool for choosing disease management tactics the next time peanuts are grown (Table 6-7).

Seed and seedling rots are caused by many species of fungi that are widespread in most soils and seeds. Seeds that become infected may fail to germinate (seed rot), germinate but not emerge from the soil (preemergence damping off), or die shortly after emergence (postemergence damping off). Sunken brown lesions may be present on the hypocotyls or primary roots of affected seedlings.

Weather: Rots often develop after seeds and seedlings are weakened by environmental problems or poor seedbed conditions. Cold soils slow down germination and increase the risk of rots. Poor drainage can cause waterlogging, a major factor in seed and seedling rots.

Control: Soil temperature should be at least 65°F at a 4-inch depth for three consecutive days before planting. Avoid planting if heavy rain is forecast. Bedding promotes soil warmth and drainage and reduces the risk of seedling diseases. Always use high-quality seed coated with a good chemical seed treatment fungicide. Replanting is the only remedy for severe stand loss due to seedling disease. See chapter 3 for information about effects of late planting dates on yield before deciding whether to replant peanut or switch to another crop.

Aspergillus crown rot (caused by *Aspergillus niger*) causes preemergence and postemergence damping off and can kill plants up to five weeks after planting. Seedlings rapidly collapse and die. Dark-brown discoloration is common on decayed roots and hypocotyls. Later, these areas often are covered with moldy looking masses of black spores.

Control: Aspergillus crown rot is of minor importance when high-quality, fungicide-treated seed are planted in well-rotated fields; rotation and seed treatments control this disease. In-furrow fungicide applications can also prevent losses (Table 6-4).

Southern stem rot (caused by *Sclerotium rolfsii)* is very common and can be found in most peanut fields in North Carolina. Damage ranges from mild to severe. Symptoms include stem lesions and wilted stems, shredded pegs, rotted pods, pod loss, crown rot, and plant death. Affected tissues are similar in color to a brown paper bag. Coarse, white, fan-shaped patterns of fungus growth may be present near the base of the plant on stems, leaf litter, or soil. Later, round tan to brown sclerotia that look like mustard seed may be present. The white fungus growth and sclerotia are diagnostic of southern stem rot, but damage can occur even when aboveground signs of the fungus are absent.

Weather: Southern stem rot is most active during the hottest part of the season. Soils at temperatures greater than 82°F and with adequate moisture are highly favorable for disease. The risk of disease increases after canopies close. In dry seasons, the fungus can be active underground, causing stem and pod damage that may not be noticeable until digging.

Rotation: *Sclerotium rolfsii* has an extremely broad host range, making rotation for disease control difficult. It does not attack small grains, corn, and many other grass species (Table 6-2), which are excellent rotation crops. When planning rotations, be aware that the disease is also known as stem rot or white mold on peanut and as southern blight on vegetables. Avoid rotations with soybeans, tobacco, melons, and vegetables.

Cultivar selection: Good resistance to southern stem rot is well-documented in Bailey. Less data are available for Sullivan and Wynne, but they appear to be similar to Bailey (Table 6-3). However, all these cultivars perform much better than older Virginia-type cultivars, which are susceptible or highly susceptible.

Cultural control: Avoid excess vine growth and excess irrigation.

Fungicides: Using a fungicide to control stem rot and other soilborne diseases is beneficial in most fields. Many fungicides that control leaf spots also control stem rot (Tables 6-4 and 6-5), but higher rates than those needed for leaf spot control alone may be necessary. Other fungicides (flutolanil, tebuconazole) control southern stem rot but are weak or ineffective against foliar diseases and must be mixed with a foliar fungicide for leaf spot control. Fungicides work best when applied just before disease onset. Make at least one (Bailey and Sullivan) to three (susceptible cultivars) applications of a fungicide active against stem rot between July 15 and the end of August. High spray volumes (20 gal water/acre) and spraying when leaves are folded (before dawn) can improve stem rot control by increasing fungicide deposition on stems but may make foliar disease control less effective. In-furrow fungicide application may help to reduce stem rot and CBR problems in susceptible cultivars but is not necessary with more resistant cultivars.

Rhizoctonia limb and pod rot (caused by *Rhizoctonia* spp.) is sometimes confused with southern stem rot. While both pathogens infect the stems, Rhizoctonia produces dark-brown or grayish-brown lesions that are usually found where the undersides of stems touch the soil. The stem lesions usually have a dark border and a target-like pattern. Rhizoctonia sometimes causes a water-soaked black foliar blight, particularly on thick growth or on injured vines. Rhizoctonia is most destructive when it causes a dark pod rot alone or in association with other fungi.

Weather: Disease is most serious in wet or irrigated fields, or where vine growth is thick.

Control: Management practices and fungicides are the same as for southern stem rot (see above). Avoid vine injury.

Sclerotinia blight (caused by *Sclerotinia minor*) infections usually start on individual limbs, but the tips of infected limbs may remain green and look healthy for several days before wilting is evident. Careful scouting is required to find symptoms and signs when they first appear. Scout by parting the vines to reveal bleached stems and the white cottony growth of the *Sclerotinia minor* fungus. Signs and symptoms are most visible on humid mornings or after a rain. Eventually, the light-colored stems shred and die. Small, black, irregularly shaped sclerotia that resemble mouse or insect droppings may be found on and in infected stems and pods. These sclerotia survive in soil for many years and can spread the fungus to other fields if moved on equipment.

Weather: Sclerotinia blight is strongly influenced by weather. Cool air or soil temperatures in combination with rain (0.5 inches or more in the last five days) or long periods of high humidity are highly favorable for disease. These conditions are most likely to happen from mid-August onward. However, infections can occur during any cool, rainy spell if rows are within 6 inches of touching.

Rotation: To prevent buildup of damaging levels of Sclerotinia blight, rotate as long as possible with cotton, corn, or other grains (Table 6-2). Sclerotinia infects canola, sunflowers, cole crops, lettuce, and snap beans, which should not be used in rotations. In addition, many common winter annual weeds are hosts. They support reproduction of the fungus during winter fallow, potentially reducing the benefits of rotation. Planting a small grain cover crop may help to reduce populations of the weeds that harbor Sclerotinia.

Cultivar choice: Avoid susceptible cultivars in fields with a history of disease. Bailey has more resistance to Sclerotinia blight than many other cultivars (Figure 6-1) but still requires fungicide applications under heavy disease pressure.

Cultural practices: Frequent application of chlorothalonil (Bravo; various generic brands) can make Sclerotinia blight more difficult to control and should be avoided in infested fields. Sclerotinia blight becomes more severe as soil pH increases above 6.0. Carefully weigh all plant health factors when applying lime to fields where Sclerotinia blight is a problem (see chapter 3).

Fungicides: The fungicides fluazinam (Omega) and boscalid (Endura) are effective against Sclerotinia blight when applied preventively (Table 6-4). Timing of the first spray is critical for season-long control. Fields with a history of serious problems should be scouted carefully, beginning when vines are within 6 inches of touching, or around July 4. A weather-based Sclerotinia blight advisory can be used to focus scouting efforts, time applications, and prevent unnecessary fungicide applications. Treat when Sclerotinia blight is first observed (on demand) or according to a Sclerotinia blight advisory. Preventive (calendar) programs can start at about 60 days after planting, but this approach usually is not as cost effective as using an advisory and scouting. If the disease continues to increase, one or two more applications may be made at three-week to four-week intervals, or according to the Sclerotinia advisory. Sclerotinia advisories are available by email every day during the growing season.

CBR (Cylindrocladium black rot or black root rot, caused by *Cylindrocladium parasiticum*) is a devastating disease on peanut. Infected plants turn light-green or yellow, wilt, and die. Symptoms usually become evident in midsummer to late summer. Roots and pods are blackened, brittle, and rotten. Typically, a CBR-infected plant will pull up or break off when tugged due to extensive rotting of the crown and taproot. The fungus produces numerous brick-red, pinhead-sized structures on crowns, lower stems, and pods, especially following moist weather. However, CBR may be present even when fungus structures are not evident. If no fungus structures are visible, late-season wilting and root rot symptoms of CBR can be confused with spotted wilt.

Weather: Most infections occur in spring when soil is cool and wet.

Rotation: CBR is strongly affected by rotation. Long rotations with nonhosts such as cotton, corn, sorghum, and small grains help to reduce losses from CBR (Table 6-2). Longer rotations in recent years probably explain why CBR problems have decreased, but growers need to remain vigilant against this disease. Short rotations with peanut or soybean will quickly lead to heavy losses. CBR can be a problem even in a field where peanuts have never been planted if it has a history of soybean production. Symptoms of CBR in soybean (red crown rot) are not dramatic, so you may not be aware of a problem until peanuts are grown. If in doubt about a field's history, select a CBR-resistant cultivar the first time you plant peanuts in a field with a history of soybean production.

Cultivar choice: Together with rotation, host resistance is the foundation of CBR control (Figure 6-1). Planting a CBR-resistant cultivar usually is all that is necessary in a well-rotated field with a history of less than 10 percent disease (Table 6-7). Highly susceptible cultivars should not be planted in fields with a history of CBR.

Cultural practices: Avoid planting in cold, wet soils. Bedding promotes soil warmth and drainage, as does delaying planting until mid-May. Always use high-quality fungicide-treated seed to prevent problems with CBR and other diseases. Root knot and ring nematode feeding (see section on nematodes) can make CBR problems worse. In a field with a history of CBR, submit a nematode sample the fall before peanuts are to be planted. Use a CBR-resistant cultivar and treat nematodes as recommended in the sample report.

Chemical control: Some fungicides may suppress CBR when applied in-furrow, banded in early season, or as part of a leaf spot control program (Table 6-4). Suppression is most helpful when used in combination with a CBR-resistant cultivar. Fungicides will not correct a CBR problem once symptoms appear nor will they substitute for fumigation in high-risk situations.

Soil fumigation with metam sodium (Table 6-4) may be necessary to control CBR in fields with 10 percent or greater disease the last time peanuts were grown. Even if previous CBR incidence was less than 10 percent, fumigation may still be necessary with poor rotations.

Important Information about Fumigant Labels

Users of metam sodium and other fumigants must follow strict application requirements. Labels require respiratory protection (respirators) for handlers, a fumigant management plan, buffer zones, and the annual communication of mandatory safety information to workers. In addition, many good agricultural practices (see below) are label requirements. Check with your fumigant supplier for the latest label information. Comprehensive information on soil fumigant regulations may be found at **www2.epa.gov/soil-fumigants.**

Good Management Practices (see the label for additional requirements)

Fumigants must be injected 8 to 10 inches below seed placement at least two weeks prior to planting. The chisel trace must be closed with a press wheel or similar device. Prevent all drips or leaks with proper application equipment as described on the fumigant label. Apply after soil temperatures reach 60°F at a 4-inch depth and temperatures of 60°F or higher are forecast for the next five days as reported by weather stations or www.nc-climate.ncsu.edu. Soil moisture at the start of application must be at 60 percent to 80 percent field capacity in the top 6 inches of soil as determined by measuring equipment or the USDA feel method. Delay fumigation if an inch or more of rain is forecast within three days. Cool or wet conditions after fumigation can slow the dispersion of the fumigant, resulting in poor control or damage to young plants. Minimize disturbance of fumigated soil; herbicides can be incorporated prior to bedding and injecting.

CBR Seed Transmission

Seed can transmit CBR. Plant certified seed that is coated with commercially applied seed treatments to minimize transmission of CBR and other seed borne pathogens.

Methods to Reduce or Eliminate CBR in Peanut Grown for Seed Production

- Maintain accurate records of field history.
- Adopt a minimum of three-year rotations of peanut with nonhosts of *Cylindrocladium parasiticum* (Table 6-2).
- Select fields with no history of CBR or Sclerotinia blight for seed production.
- Fumigate fields with metam sodium and follow label requirements.
- Inspect fields at the end of the season.
- Selectively harvest seed peanuts from disease-free areas only.

Wilt diseases are sometimes observed in North Carolina. Diplodia collar rot is caused by *Diplodia gossypina*, Fusarium wilt is caused by *Fusarium spp.*, charcoal rot is caused by *Macrophomina phaseolina*.

Diplodia collar rot causes individual stems on the lower plant to wilt suddenly and then collapse. Often one side of the plant is affected at first; later the entire plant may die. Splitting the root may reveal a dark border surrounding an oblong tan lesion that turns slate-gray in advanced stages of disease. Stems and pods typically are covered with dark-gray fungal structures about the size of a sand grain. Later these structures become quite prominent and turn coal-black. Often the dead plants nearly disintegrate, leaving only a few blackened leaves and stems.

Symptoms of **charcoal rot** include leaf-scorch, black streaking inside taproots and crowns, wilting, and death. In advanced stages of disease, small black dots form on and in stems, crowns, and taproots. **Fusarium wilt** is difficult to diagnose in the field. Taproots and crowns of wilted plants may be brown inside, but distinctive symptoms are lacking.

Weather: Diplodia collar rot is strongly associated with heat and water stress. Fusarium wilt and charcoal rot likewise appear to occur more frequently under heat and drought stress.

Control: Diplodia collar rot is seed-transmitted and usually can be prevented by planting high-quality treated seed. If available, irrigation can help to reduce the risk of these stress-associated diseases. Encouraging rapid canopy development may help to shade stems and prevent heat injury.

Pod rot can be difficult to control because the causes are so diverse. Rotted pods may be infected singly or in combination with *Pythium, Rhizoctonia, Fusarium,* and several other species of soilborne fungi. Symptoms include spotted, dark, or rotted pods.

All of the diseases caused by soilborne pathogens can have a pod rot phase. Brown, paper-thin pods, shredded pegs, and white fungus growth are typical pod symptoms caused by southern stem rot. Rhizoctonia pod rot causes brown lesions that may have well-defined dark margins, or the entire pod and its contents may become rotted and brown. Pod rots from CBR or Sclerotinia blight generally are found in association with other symptoms and the brick-red (CBR) or black (Sclerotinia) fungal structures described above. Pinkish-brown to purple-brown pods usually are infected with *Fusarium spp*. Pod rot caused by *Pythium spp.* can turn the entire pod black and soft.

Occasionally, outbreaks of pod rot occur in fields with little or no history of disease. Tops of plants look healthy, or even greener than normal, but pod rot is found upon digging, along with one or more of the common pod-rot fungi, especially Pythium.

Weather: The reasons for Pythium pod rot outbreaks are not known but probably are related to weather during pod filling. Other types of pod rot are associated with conditions that favor the individual soilborne pathogens that cause them.

Rotation: Severe pod rot is usually the result of very short rotations or poor choice of rotational or cover crops. Long rotations with most grains reduce the numbers of pod-rotting organisms in soil (Table 6-2).

Cultural practices: Poorly drained or heavy soils favor the development of Pythium pod rot and should be avoided. Practices that suppress CBR, southern stem rot, Rhizoctonia, and Sclerotinia blight help to reduce the risk of pod rots caused by these pathogens. Sometimes pod rot symptoms result from poor calcium nutrition or excessive magnesium or potash levels, which weaken the hull and allow various soil fungi to grow into and rot the pod. Calcium deficiency is characterized by "pops" and brown plumules within the seed. Follow recommendations for land plaster application (chapter 3) to reduce the likelihood of this problem.

Fungicides: Fungicides used to control soilborne diseases (Table 6-4) will help to prevent pod rot by preventing infections before they can reach the pods.

NEMATODES

The nematodes that attack peanut are microscopic to barely visible roundworms that survive in the soil and feed on or inside roots. Nematodes can move very short distances in the spaces between soil particles. For this reason, nematode problems tend to be greatest in sandy soils, which have larger pore spaces than other soil types.

Nematodes cause stunting, wilting, and yellowing of aboveground portions of the plant. Damage is often seen in clusters within a field. The northern root-knot (*Meloidogyne hapla*) and lesion nematodes (*Pratylenchus brachyurus*) are the most common species attacking peanut in North Carolina. The peanut root knot nematode (*Meloidogyne arenaria* race 1) is uncommon in North Carolina but can be very damaging when present. Sting (*Belonolaimus longicaudatus*) nematodes can severely damage peanut, but problems are very rare in North Carolina and may be limited to certain populations. Ring nematode (*Criconemella ornata*) is fairly common but its impact on peanut is uncertain.

The **northern root-knot nematode** causes small galls on roots, pegs, and pods. Galls on roots can be confused with beneficial nitrogen-fixing root nodules. Galls appear as irregular thickenings along the root itself, whereas nodules are round and found attached to the sides of the root. Infected root systems may look bushy, and pods may have dark spots about the size of a pinhead.

The **peanut root knot nematode** causes large swellings and severe galling on roots, pegs, and pods. Check pods and roots for galls immediately after digging, particularly in areas of yellow or stunted plants (Table 6-7).

Lesion nematodes cause small brown areas (lesions) on peanut roots and pods. The most distinctive symptoms are small tan-to-brown spots on the pods that look like pin-pricks. These spots may expand over time. Likewise, affected areas on the roots may expand so that the entire root system becomes brown and damaged. Wounds from nematode feeding can make roots and pods more susceptible to damage by other fungi and bacteria that live in the soil, resulting in root and pod rot.

Nematode Control

Rotation: The nematodes that infect peanut do not survive long periods of time without a suitable host, so rotation is a very effective means of control (Table 6-2). Rotation to peanut also can be useful for minimizing nematode problems in rotation crops. Peanut generally is a nonhost for most cotton nematodes; rotation with peanut can alleviate problems in cotton with southern root-knot nematode, Columbia lance nematode, and reniform nematode. Similarly, these nematodes will not affect peanut, so a cotton-peanut rotation is a win-win situation.

Chemical control: To identify nematode problems and to plan treatments for spring planting, sample for nematodes in the fall (September through November) if possible. Take samples in a zigzag pattern across the field. Take 20 probes (1 inch in diameter to an 8-inch depth in the row) for each sample, with one sample to each 4 or 5 acres. Samples will be more representative of the field if the soil is mixed by disking before samples are collected.

Divide large or nonuniform fields according to the row direction so that you can target infested areas for treatment if necessary. To prevent decomposition, keep nematode samples cool (50°F to 60°F) and give them to your county Extension agent or send to the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) Nematode Advisory Service as soon as possible. See the NCDA&CS website for further information: www.ncagr.gov/agronomi/nemhome.htm.

Fields that are below NCDA&CS threshold levels (A category) need no control procedures. Fields that are B category are borderline cases; treatment may give a return on control investment but probably will not. C-category fields are above threshold levels and should be treated.

Fumigating with metam sodium will help reduce nematode populations, but this fumigation may not be adequate in C-category fields (Table 6-4). These fields may require treatment with a fumigant containing 1,3 dichloropropene (e.g., Telone II). Be aware that labels for fumigants containing chloropicrin have stricter requirements than those for metam sodium (see above).

Velum Total is a mixture of the insecticide imidacloprid and the fungicide/nematicide fluopyram that can be applied as an in-furrow liquid (Table 6-4). We have tested this product over several years and have found it reduces thrips damage (see chapter 5) and nematode populations. However, we have not had the opportunity to observe performance against damaging levels of nematodes. Aldicarb (Temik), which was used for decades to control thrips and suppress nematodes in peanut, has not been available for several years. A new aldicarb product is now sold as AgLogic 15G. Aldicarb is most effective for nematode control when applied in-furrow, followed by a banded application postemergence. In general, nonfumigant nematicides can help to reduce nematode damage, but may not provide adequate control when nematode populations are high. Fumigation generally is the most cost-effective option in these cases.

GENERAL INFORMATION

Zinc Toxicity

Peanuts are very sensitive to excess zinc. Symptoms include yellowing, stunting, and characteristic split stems. Typically, patches of poor growth may be found in areas where tin-roofed sheds stood for years. This poor growth is due to the leaching of zinc from the metal. Old hog pen areas may be contaminated with zinc due to the use of zinc supplements in hog feed.

Zinc is also added to chicken feed and is found in abundance in chicken litter. Repeated applications of chicken litter to soil can cause zinc to build up to levels that are toxic to peanuts. Avoid poultry litter applications to peanut fields, and have soil tested if litter has been applied in the past.

Because zinc is not mobile in soil, high levels (zinc availability index greater than 250) are likely to persist and damage peanuts for many years. Zinc toxicity is more severe in acid (low pH) soils, so maintain soil pH at 6 or greater.

Digging Dates and Estimating Percentage Disease

In general, early digging to minimize disease losses is a mistake. Measurable yield loss from leaf spots begins at about 25 to 30 percent defoliation. Once this level of disease has been reached, yield differences are not consistent between peanuts dug early (within 10 days of optimum maturity) or at optimum maturity. Early digging

(digging before the crop is mature) is advised when 40 to 50 percent of leaves are defoliated.

For other diseases, harvesting early is a losing proposition until there is at least 50 percent disease (one out of every two plants diseased). Keep in mind that even half this much disease will look alarming, so count affected plants to determine the percentage of diseased plants. Divide the field into 1-acre blocks, select the worst block, and step off a 100-foot section of row. Count the number of feet of row within this section that are diseased. Repeat in two more 100-foot sections within the block. Average the percentages from the three samples. Five feet of diseased row out of 100 is 5 percent disease. If more than 50 percent of the plants are diseased, early digging may be advisable. Most diseases caused by soilborne pathogens are not evenly distributed across the field. Therefore, if you decide to dig early, dig the most diseased portion of a field early and the remainder at maturity (chapter 3). Be sure to clean equipment thoroughly before moving it to healthy areas.

Adjuvants

Many adjuvants, additives, and nonpesticides are marketed as plant health boosters, pesticide performance enhancers, or both. Except as noted in Table 6-4, fungicides for peanut disease control do not need to be mixed with other products to enhance their performance. The added cost of these products generally will not be offset by increases in yield. Further, certain product combinations may cause injury or even reduce fungicide efficacy. Check the fungicide label before mixing anything with a fungicide. See chapter 9 for more information about pesticide mixtures.

Table 6-1. Effects of Cultural and Disease Management Practices on Peanut Diseases

Practice	Diseases Controlled or Suppressed	Remarks
Crop rotation	ELS, LLS, web blotch, CBR, pod rot, seedling diseases, Aspergillus crown rot, nematodes, southern stem rot, Sclerotinia blight, Rhizoctonia limb and pod rot	Rotation length and favorable rotation crops vary with the disease (Table 6-2).
Resistant cultivars	ELS, LLS, spotted wilt, CBR, southern stem rot, Sclerotinia blight; probably web blotch	See Figure 6-1.
Seedbed preparation and drainage	Seedling diseases, CBR	Planting on raised beds promotes emergence and plant health.
High-quality treated seed	Seedling diseases, Aspergillus crown rot, Diplodia collar rot, CBR, Sclerotinia blight	Highly recommended at all times. See chapter 2.
Fumigation (metam sodium)	Cylindrocladium black rot, nematodes (suppression)	Be aware of restrictions on fumigant use.
Planting date	Spotted wilt, CBR	May 6-15 optimal.
High seeding rate	Spotted wilt	Increases risk of southern stem rot, Sclerotinia blight, Rhizoctonia limb and pod rot.
In-furrow fungicide	Aspergillus crown rot, seedling diseases, ELS, LLS, Southern stem rot, CBR (suppression)	Susceptible cultivars are the most likely to benefit from treatment.
In-furrow nematicide	Suppresses nematodes	Not a substitute for fumigation for severe infestations. Some products may also suppress insects or other diseases. See Table 6-4.
Foliar fungicide	ELS, LLS, web blotch, pepper spot, Phyllosticta leaf spot	Start at R3; Many foliar fungicides also control soilborne diseases.
Soil fungicide	Southern stem rot, Rhizoctonia limb and pod rot, Sclerotinia blight	Use in mid-season; Many soil fungicides also control foliar diseases.
Irrigation	Reduces risk of Diplodia pod rot, Aspergillus crown rot	Increases risk of ELS, LLS, southern stem rot, Sclerotinia blight, Rhizoctonia limb and pod rot.

ELS = Early leaf spot; LLS = Late leaf spot; CBR = Cylindrocladium black rot

***Table 6-2. Rotational Crops for Peanut Disease Management*[1]**

Disease	Rotational Crop							Years of Rotation for Suppression[3]
	Cotton	Corn	Sorghum	Soybean[2]	Tobacco	Small Grains	Vegetables or Melons	
Leaf spots (early and late)	G	G	G	G	G	G	G	3
Sclerotinia	G	G	G	P	N	G	P	4+
Southern stem rot (white mold)	G	G	G	P	P	G	P	3 to 4+
Pod rot[4]	N/P	G	G	P	P	G	N	3 to 4
CBR	G	G	G	P	P	G	G	3 to 4
Rhizoctonia	N	G	G	N	N/P	G	N	3 to 4
TSWV	N	N	N	N	N/P	N	N/P	—
Northern[5] root-knot nematode	G	G	G	P	P	G	P	3
Peanut root-knot nematode	G	P	P	P	G	G	P	3

[1] Poor, makes disease worse (P); good, is favorable for plant health (G); neutral or variable effect (N). Heavy weed infestations can reduce effectiveness of rotation for disease management.

[2] Rotation with soybean increases problems with root knot nematodes, CBR, southern stem rot, and Sclerotinia blight. Problems are worse if soybeans are grown in the year proceeding peanuts. Soybeans double-cropped with a small grain cause fewer problems than full-season soybeans planted in the spring.

[3] Number of years between peanut crops (for example, 3 means peanut is planted every third year)

[4] Cotton rotation may increase pod rot if soils are overfertilized with potash. Rye cover crops may increase pod rot problems.

[5] Most common root-knot species

Table 6-3. Incidence of Southern Stem Rot in Selected Peanut Cultivars, 2014 – 2018

Cultivar[1]	**2018**	**2017**	**2016**	**2015**	**2014**
Bailey	ND	ND	15.61 c[2]	1.4 ab	1.5 c
CHAMPS (2016) or Spain (2014, 2015)	ND	ND	41.7 a	3.0 a	7.0 a
Sugg	ND	ND	9.9 c	0.4 b	2.6 bc
Sullivan	10.2 a	3.6 a	13.8 c	0.6 b	5.0 ab
Wynne	8.1 a	3.0 a	29.5 b	1.9 ab	2.8 bc

[1] Data collected at Lewiston-Woodville, NC
[2] Means followed by the same letter are not different (based on 5% probability of error)

Note: certain products labeled on peanut in the U.S. contain active ingredients (propiconazole, phosphites, or phosphorous acid) that were not acceptable to export markets in 2019. Products containing these ingredients are not listed in the tables below. Check with county NC Cooperative Extension personnel and your buyer for the latest information on the current status of these ingredients and products.

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Aspergillus Crown Rot (Aspergillus); see also seedling diseases				
azoxystrobin (Abound, various brands) [1] 2.08 F (11)	0.4 to 0.8 fl oz/1,000 ft of row	At planting	NA	Apply as in-furrow spray with 3 to 5 gallons water.
Black Root Rot (CBR) (Cylindrocladium); see also seedling diseases				
metam sodium 42% (various brands) 4.25 F	7.5 gal (36-inch rows) or 6.61 fl oz/100 ft of row	At least 2 weeks before planting or longer if cool and/or wet	NA	Inject 8 to 10 inches below seed placement. Apply only when soil temperature at 3-inch depth is between 60 and 90°F. If wet and/or cold weather occurs following fumigation, the waiting period should be extended. Soil aeration helps reduce residual chemical. When in doubt use a bioassay such as the lettuce seed germination test to determine if safe to plant. Buffer zones, fumigant management plans, and other restrictions on metam sodium must be followed. See your county Extension center for details.
prothioconazole (Proline) 480 SC (3)	5.7 oz per acre (36-inch rows) or 0.4 fl oz/1,000 ft of row	At planting or at full emergence	NA	Apply as in-furrow spray or banded at full emergence for suppression of CBR. Not a substitute for fumigation in fields with a history of more than 10% CBR and rotations of less than 4 years. Use with a CBR-resistant cultivar.
prothioconazole + fluopyram (Propulse) 3.3 SC (3 + 7)	13.7 fl oz	At planting	NA	Apply as in-furrow spray for suppression of CBR and nematodes. Not a substitute for fumigation in fields with a history of more than 10% CBR and rotations of less than 4 years. Use with a CBR resistant cultivar.
Early Leafspot (Cercospora)				
cupric hydroxide (Kocide, various brands and formulations) [2] (M1)	Various; see label	Begin applications at very early pod (R3). Repeat applications every 7 to 14 days.	0	Use nozzles that give a cone-shaped spray pattern. Use 12 to 24 gallons of water for spray materials applied by ground sprayers. Use at least 5 gallons of water for materials applied by air. Calendar program: Five or six applications suggested. Begin applications at very early pod (R3). Repeat applications at 7- to 14-day intervals. Not suitable for use with the leaf spot advisory.

(continued)

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Early Leafspot (Cercospora) *(continued)*				
basic copper sulfate (various brands and formulations) [2] (M1)	Various; see label	See above	0	See above
mancozeb and copper hydroxide (Mankocide) [2] 61.1 DF (M3)	2 to 2.6 lb	See above	14	See above
mancozeb (Manzate, Koverall, various brands and formulations) [2] (M3) M45 F45 75 WDG 80 WP	 1 to 2 lb .8 to 1.6 qt 1 to 2 lb 1 to 2 lb	See above	14	See above
Sulfur (various brands and formulations) [2] (M2)	Various; see label	See above	0	See above
Early Leafspot (Cercospora); Late Leafspot (Cercosporidium); Web Blotch (Ascochyta)				
chlorothalonil (Bravo, Echo, various brands) (M5) 720, 6 F 82.5 WDG 90 DF 500	 1 to 1.5 pt .9 to 1.36 lb .875 to 1.25 lb 1.5 to 2.25 pt	Begin applications at very early pod (R3). Repeat applications every 14 days or according to daily weather based advisories. Begin 14-day program if web blotch is found.	14	Use nozzles that give a cone-shaped spray pattern. Use 12 to 24 gallons of water for spray materials applied by ground sprayers. Use at least 5 gallons of water for materials applied by air. 14-day program: Five or six applications suggested. Begin applications at very early pod (R3). Repeat applications at 10- to 14-day intervals. Advisory: Begin applications at very early pod (R3). Repeat applications when weather conditions become favorable as determined by peanut leaf spot advisories. This schedule requires strict adherence to the program guidelines and usually results in fewer fungicide applications than the 14-day schedule. Contact your county Extension center for details. Leafspot advisories are most effective if used with long rotations, resistant varieties, and high rates of effective fungicides. Repeated applications of chlorothalonil can make spider mites and Sclerotinia blight more difficult to control.

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Early Leafspot (Cercospora); Late Leafspot (Cercosporidium); Web Blotch (Ascochyta) *(continued)*				
boscalid (Endura) [2,3] 70 WDG (7)	10 oz	Make up to 2 or 3 applications in mid-season as part of a full-season, 14-day, or advisory program	14	See above. Primarily controls web blotch. Alternate with another fungicide or mix with 0.75 to 1 pint chlorothalonil to improve leaf spot control. Also controls Sclerotinia blight; see below.
thiophanate methyl (Topsin, TopsinM) (1) 4.5 F 70 WSB	 10 fl oz .5 lb	14 day or advisory beginning at R3	14	See above. Do not apply alone. Always mix with another leaf spot fungicide.
dodine (Elast) 400 F (U12)	1.5 pt	Make no more than 3 applications as part of a full-season, 14-day, or advisory program	14	See above
cyproconazole (Alto) 100 SL (3)	5.5 fl oz	Apply up to 2 times in a 14-day or advisory program beginning at R3	30	See above. Mixing with chlorothalonil is recommended.
flutriafol (Topguard) 1.04 SC (3)	7 to 14 fl oz	14-day or advisory beginning at R3	14	See above. Mix or alternate with another fungicide to reduce the risk of fungicide resistance
ttetraconazole (Eminent VP, Domark) (3) 125 SL 230ME	 6 to 13 fl oz 5.25 to 6.9 fl oz	Apply up to 2 times in a 14-day or advisory program beginning at R3	14	See above. Mix or alternate with another fungicide to reduce the risk of fungicide resistance
pydiflumetofen (Miravis) 3 SC (7)	 3.4 fl oz	Apply up to 2 times in a 14-day or advisory program beginning at R3	14	See above. Can be effective up against leaf spots for up to 28 days; if using an extended interval, apply a fungicide that is effective against stem rot after 14 days or tank mix with a stem rot fungicide. Do not make more than 2 applications of an unmixed group 7 fungicide.
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia)				
tebuconazole + trifloxystrobin (Absolute) 500 SC (3 + 11)	3.5 to 7 fl oz	14 day or advisory beginning at R3	14	See above. Use highest rate for soilborne pathogens. No more than 3 applications per season. Resistance management: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of fungus resistance development.

(continued)

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia); Stem Rot (Sclerotium rolfsii); Pod Rot (Sclerotium rolfsii, Rhizoctonia)				
prothioconazole + tebuconazole (Provost Opti)[4] 433 SC (3+3)	7 to 10.7 fl oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program.	14	See Early Leaf Spot, Late Leaf Spot, and Web Blotch above. For best control of limb and pod rot, do not use a surfactant. Do not apply more than 3 times in a 5-spray program or after the first week in September. Resistance management: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of fungus resistance development.
metconazole (Quash) 50 WDG (3)	2.5 to 4 oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program.	14	See above
prothioconazole + fluopyram (Propulse) 3.3 SC (3 + 7)	13.7 fl oz	Make up to 2 applications per season as part of a full-season, 14-day or advisory program.	14	See Early Leaf Spot, Late Leaf Spot, and Web Blotch above. Application for leaf spot control requires a FIFRA Section 2(ee) label.
penthiopyrad (Fontelis)[3] 1.67 SC (7)	16 to 24 fl oz	Make up to 3 applications per season as part of a full-season, 14-day, or advisory program	14	See Early Leaf Spot, Late Leaf Spot, and Web Blotch above. FRAC guidelines recommend no more than 2 applications of an unmixed group 7 fungicide in a 5-spray program. Use higher rates for web blotch control. Also suppresses Sclerotinia blight; see below.
azoxystrobin (Abound; various brands)[1,4] 2.08 F (11)	12.0 to 24.6 fl oz	Make up to 2 applications per season as part of a full-season, 14-day, or advisory program. Use higher rates for limb rot and stem rot control.	14	See above. Use in mid-season for best control of soil-borne pathogens. Use no more than 2 applications in a 5 spray program. Resistance management: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of developing fungal resistance. . Some populations of leaf spot fungi are not controlled by group 11 fungicides.
chlorothalonil + tebuconazole (Muscle ADV)	32 fl oz	Make up to 3 applications per season as a part of a full-season, 14-day, or advisory program.	14	See above. Use in mid-season for best control of soil-borne pathogens. Chlorothalonil rate is equivalent to 1 pt/A of a 720 formulation.

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia); Stem Rot (Sclerotium rolfsii); Pod Rot (Sclerotium rolfsii, Rhizoctonia) (continued)				
pyraclostrobin (Headline)[1] 2.09 EC, 2.08 SC (11)	6 to 15 fl oz	Make up to 2 applications per season as part of a full-season, 14-day, or advisory program. Use higher rates for limb rot and stem rot control.	14	See above Resistance management: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of developing fungal resistance. Some populations of leaf spot fungi are not controlled by group 11 fungicides.
fluoxastrobin (Evito, Aftershock)[1] 480 SC (11)	5.7 fl oz	Make up to 2 applications per season as part of a full-season, 14-day, or advisory program.	14	See above Resistance management: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of developing fungal resistance. Some populations of leaf spot fungi are not controlled by group 11 fungicides.
azoxystrobin + tebuconazole (various generic) (11 + 3)	15.5 fl oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program.	14	See above. CAUTION: Check labels. Most products contain 1.0 lb/A azoxystrobin per gallon, which is about one-half the amount found in 2.08 F formulations of azoxystrobin. Consider mixing with another fungicide to improve leaf spot control.
fluoxastrobin + tebuconazole (Evito T) (11+3)	11.2 fl oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program.	14	See above
azoxystrobin + benzovindiflupyr .45 DF (Elatus) (11 + 7)	7.3 to 9.5 fl oz	Make up to 2 or 3 applications per season as part of a full-season, 14-day, or advisory program. Use higher rates for limb rot and stem rot control.		See above. Extended spray intervals (up to 21 days) may be possible at the highest rate. Resistance management: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of developing fungal resistance.
fluxapyroxad + pyraclostrobin 4.17 SC (Priaxor) (7+11)	4 to 8 fl oz	Use 1 to 3 times per season as part of a full-season, 14-day, or advisory program. Use higher rates for limb rot and stem rot control.	14	See above

(continued)

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia); Stem Rot (Sclerotium rolfsii); Pod Rot (Sclerotium rolfsii, Rhizoctonia) (continued)				
flutriafol + azoxystrobin (Topguard EQ) 2 4.3 SC (3+11)	5 to 7 fl oz	Use up to 2 times per season as part of a full-season, 14-day, or advisory program. Use higher rates for limb rot and stem rot control.	14	See above. Mix or alternate with another fungicide to reduce the risk of fungicide resistance. Mix or alternate with another leaf spot fungicide to improve leaf spot control.
Stem Rot (white mold, Southern blight, Sclerotium rolfsii); Limb Rot (Rhizoctonia); Pod Rot (Sclerotium rolfsii, Rhizoctonia)				
tebuconazole (various brands) (3) 3.6F 20AQ 75DF	 7.2 fl oz 15.4 fl oz 4.3 oz	Following leafspot advisories, make 1 to 3 applications in mid-season. May provide some control of foliar diseases.	14	Effective against stem rot. Not effective against many populations of leaf spot fungi. Always mix with chlorothalonil or another fungicide (other than group 3) that is effective against leaf spots.
flutolanil (Convoy)[3] 3.8 SC (7)	10 to 16 fl oz or 20 -32 fl oz (see remarks)	Following leafspot advisories, make 1 to 3 applications in mid-season. Does not control foliar diseases.	40	Apply up to 16 fluid ounces per acre at 2-week intervals or up to 32 fluid ounces per acre at 3- to 4-week intervals. Do not apply more than a combined total of 64 fluid ounces in a single growing season. See label for detailed information on rates. Wheat may be planted 30 days after last application; do not plant other small grains within 5 months of last application. See label for other plant-back restrictions.
Nematodes—Fumigants				
1-3 dichloropropene 97.5% (Telone II) 93.6% (Telone EC)	Depends on application method; see label for details	At least 2 weeks before planting	NA	Inject 8 to 10 inches below the soil surface. Very effective against all nematodes. Does not control soilborne fungi. Regulations require handler training and impose buffer zones and other restrictions on fumigant use. See the label and your county Extension center for details.
1-3 dichloropropene + chloropicrin 81.2% + 16.5% (Telone C-17) 63.4% + 34.7% (Telone C-35) 60.8% + 33.3% (InLine)	Depends on application method; see label for details	At least 2 weeks before planting	NA	Inject 8 to 10 inches below the soil surface. Very effective against all nematodes. Regulations require handler training and impose buffer zones and other restrictions on fumigant use. See the label your county Extension center for details.

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Nematodes—Fumigants (continued)				
metam sodium 42% (various brands) [5] 4.25 F	7.5 gal	At least 2 weeks before planting	NA	Inject 8 to 10 inches below the soil surface. If wet and/or cold weather occurs following fumigation, the waiting period should be extended. Soil aeration helps reduce residual chemical. When in doubt use a bioassay such as the lettuce seed germination test to determine if safe to plant. Moderately effective against Northern root knot nematode (M. hapla). Not very effective on peanut root knot nematode (M. arenaria). Buffer zones and other restrictions on metam sodium use are required. See your county Extension center for details.
Nematodes—Nonfumigant				
fluopyram + imidacloprid (Velum Total) 3.67 SC (7 + insecticide group 4A)	18 fl oz	At planting	30	Apply in-furrow at planting, directed on or below the seed. Also controls thrips, leaf hoppers, and aphids (see chapter 5). May provide early season control of leaf spots and stem rot. Do not exceed 0.5 pound a.i./a imidacloprid for all seed, in-furrow, and foliar applications. See label for plant-back restrictions.
prothioconazole + fluopyram (Propulse SC) 3.3 SC (3 + 7)	13.7 fl oz	Apply approx. 45 days after planting.	NA	Apply in a minimum of 15 gal of water per acre and follow with 0.1 to 0.25 inches of irrigation. Use after application of a nematicide at planting. Application requires possession of a FIFRA Section 2(ee) label.
Seed and Seedling Rot; Pythium Pod Rot				
mefenoxam + azoxystrobin (Uniform) 390 SE (4 + 11)	.34 fl oz/1,000 ft of row	At planting	75	Apply as an in-furrow spray at planting. Only one application per season
azoxystrobin[1] (Abound 2.08 F; various brands) (11)	.4 to .8 fl oz/1,000 ft of row	At planting	14	Apply as an in-furrow spray at planting; counts as a group 11 application for resistance management purposes
mefenoxam (Ridomil Gold GR; various brands) (4) (Ridomil Gold SL; various brands) (4)	Per 1,000 ft of row: 6.5 oz .25 pt	At planting	75	Apply in-furrow or as a 7-inch band over row at planting

(continued)

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Seed and Seedling Rot; Pythium Pod Rot (continued)				
mefenoxam (Ridomil Gold 2.5 GR; various brands) (4) (Ridomil Gold SL; various brands) (4)	Per 1,000 ft of row (GR): 13 oz SL per Acre: .5 to 1 pt	Early pegging	75	Apply in an 8- to 12-inch band. Do not apply to wet foliage as foliar toxicity may result. Use with other fungicides for late-season control of stem rot (Sclerotium rolfsii) and Rhizoctonia stem and pod rot (Rhizoctonia spp.).
Seedling Diseases—Seed Treatments				
azoxystrobin + fludioxonil + mefenoxam (Dynasty PD) [4] (11 + 12 + 4)	4 oz/100 lb seed	Seedling diseases: Apply to conditioned, untreated seed. Commercial application strongly recommended.	NA	Peanuts can be replanted immediately. Do not plant other crops within 45 days of planting treated seed.
thiamethoxam + mefenoxam +fludioxonil + azoxystrobin (CruiserMaxx Peanuts) [4] (MOA 4A + 11 + 12 + 4)	3 to 4 oz/100 lb seed	See above	NA	Peanuts can be replanted immediately. See label for additional information about plant-back restrictions. Do not make any soil or foliar application of products containing thiamethoxam to crops grown from seed treated with CruiserMaxx Peanuts. Also controls some early season insects; see chapter 5 for more information.
carboxin + ipconazole + metalaxyl (Rancona V PD) (3 + 4 + 7)	4 oz/100 lb seed	See above	NA	Dust formulation.
Sclerotinia Blight				
fluazinam (Omega) 500 F (29)	1 to 1.5 pt	1 to 3 applications according to weather-based advisory, field history, and scouting.	30	If favorable conditions persist, reapply at 21 to 30 day intervals. Do not apply more than a combined total of 4 pints in a single growing season. Contact your county Extension center for details on weather-based Sclerotinia advisories.
boscalid (Endura) [2,3] 70 WG (7)	8 to 10 oz	See above	14	If favorable conditions persist, reapply at 14- to 21-day intervals. Make no more than 2 consecutive applications per season. Contact your county Extension center for details on weather-based Sclerotinia advisories. Also controls or suppresses leaf spots and web blotch.

Table 6-4. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Sclerotinia Blight *(continued)*				
penthiopyrad (Fontelis) [3] 1.67 SC (7)	24 fl oz	See above	14	Suppression only. Apply at 2-week intervals or according to advisory. FRAC guidelines recommend no more than 2 applications of an unmixed group 7 fungicide in a 5-spray foliar disease control program. Do not apply more than 72 oz per season. Use on cultivars that have some Sclerotinia blight resistance, for example, Bailey. Also controls or suppresses leaf spots, web blotch, southern stem rot, and Rhizoctonia limb and pod rot; see above.
fluopyram + prothioconazole (Propulse) (7 + 3)	13.7 fl oz	See above	14	Suppression only. Apply at 2-week intervals or according to advisory. Use on cultivars that have some Sclerotinia blight resistance, for example, Bailey. Also controls southern stem rot and Rhizoctonia limb rot; see above.
Iprodione 4F (Rovral, various brands) (2)	32 fl oz	See above	10	Suppression only. Apply at 2 to 3 week intervals or according to advisory. Apply at low pressure for a spray volume of at least 40 gal per acre. Do not apply more than 72 oz per season. Use on cultivars that have some Sclerotinia blight resistance, for example, Bailey.

1 QOI (group 11) fungicide. Do not apply group 11 fungicides more than 2 times in sequence or more than 3 times per season. Some populations of leaf spot fungi are not controlled by group 11 fungicides. See www.FRAC.org for information on fungicide resistance management.

2 Less effective against leaf spot than many other fungicides; more frequent application may be necessary. If using advisories, alternate or mix with more effective fungicides.

3 Do not apply unmixed group 7 fungicides more than 2 times in sequence. FRAC guidelines: no more than 2 applications of a group 7 fungicide per 5-spray program; no more than 3 applications per ≥6-spray program. May be alternated with group 11 or group 3 fungicides. See www.FRAC.org for information on fungicide resistance management.

4 Also suppresses CBR. See label for details.

5 Probably not as effective as the other fumigants against nematodes.

Further Information: *2019 Peanut Information* and peanut disease control information are available at your county Cooperative Extension center.

Table 6-5. Characteristics of Selected Fungicides Labeled for Peanut Disease Control

Brand	Active Ingredient (group number)	Rate per Acre [1]	Controls [2]	Uses
Abound, various generic	azoxystrobin (11)	12.3 to 24.6 fl oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially where soilborne pathogens are a problem; no more than 2 applications of an unmixed group 11 fungicide in a 5-spray program. CAUTION: Some NC populations of leaf spot may be resistant to azoxystrobin and other group 11 fungicides.
Bravo, various generic	chlorothalonil (M)	1.5 pt	ELS, LLS, web blotch, pepper spot	Inexpensive, resistance management. Repeated application can flare spider mites and Sclerotinia blight.
Convoy	flutolanil (7)	10 to 32 fl oz	stem rot, Rhizoctonia limb and pod rot	Mid-season; does not control foliar pathogens
Elatus	azoxystrobin (11) + benzovindiflupyr (7)	7.3 to 9.5 oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb rot	Mid-season, especially where soilborne pathogens are a problem; apply 7.3 oz/acre every 14 days or 9.5 oz/acre every 21 to 28 days.
Endura	boscalid (7)	8 to 10 oz	Sclerotinia blight; ELS, LLS, web blotch	At row closing or according to Sclerotinia advisory
Fontelis	penthiopyrad (7)	12 to 24 fl oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially where soilborne pathogens are a problem; has some activity against Sclerotinia blight. No more than 2 applications in a 5-spray program; alternate with a good leaf spot fungicide.
Headline	pyraclostrobin (11)	6 to 15 fl oz	ELS, LLS, web blotch (all rates); stem rot, Rhizoctonia limb and pod rot (high rates)	Mid-to late season. CAUTION: Some NC populations of leaf spot may be resistant to group 11 fungicides.
Omega	fluazinam (29)	1 to 1.5 pt	Sclerotinia blight, suppresses stem rot	At row closing or according to Sclerotinia advisory.
Priaxor	pyraclostrobin (11) + fluxapyroxad (7)	4 to 8 fl oz	ELS, LLS, web blotch, pepper spot (all rates); stem rot, Rhizoctonia limb and pod rot (high rates)	Mid-to late season; no more than 2 applications in a 5-spray program.
Proline	prothioconazole (3)	5.7 fl oz	CBR, Stem rot	Apply in furrow for suppression of CBR and stem rot.

Table 6-5. Characteristics of Selected Fungicides Labeled for Peanut Disease Control

Brand	Active Ingredient (group number)	Rate per Acre [1]	Controls [2]	Uses
Propulse	Fluopyram + prothioconazole (7 + 3)	13.7 fl oz	Stem rot, Rhizoctonia limb rot; suppresses Sclerotinia blight	Apply during periods that favor stem rot, limb rot, or Sclerotinia blight development.
Provost	tebuconazole + prothioconazole (3 + 3)	7 to 10.7 fl oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially where soilborne pathogens are a problem; no more than 3 applications per season (2 is preferred).
Various generic	tebuconazole (3)	7.2 oz	Stem rot, Rhizoctonia limb and pod rot. Not effective against some populations of ELS and LLS	Mid-season, especially where soilborne pathogens are a problem; always mix with chlorothalonil or other leaf spot fungicide for foliar disease control. Inexpensive.

[1]Rate listed is for most common formulation. Check label.
[2]ELS=Early leaf spot; LLS=Late leaf spot.

Table 6-6. Managing the Risk of Fungicide Resistance in Fungicides Commonly Used for Peanut Disease Control

Group	Type	Fungicide	Resistance risk	Alternate With:
M	Multi-site	copper-containing and EBDC fungicides (Kocide, Mancozeb, various) Chlorothalonil (Bravo, various)	Very low	All
3	DMI	Tebuconazole (various), Tebuconazole + prothioconazole (Provost), Prothioconazole (Proline), Metconazole (Quash)	Moderate; some populations of leaf spot pathogens are not controlled by tebuconazole	Coppers, EBDCs, chlorothalonil, azoxystrobin, pyraclostrobin, fluoxastrobin, boscalid, flutalonil, penthiopyrad, fluxapyroxad
3 + 11	DMI + QOI (strobilurin)	Tebuconazole + Trifloxystrobin (Absolute), Tebuconazole + Azoxystrobin (Custodia)	Low when used as a mix[1]	Coppers, EBDCs, chlorothalonil, boscalid, flutalonil, penthiopyrad, fluxapyroxad
3 + 7	DMI + SDHI	Fluopyram + prothioconazole (Propulse)	Low when used as a mix[1]	Coppers, EBDCs, chlorothalonil, azoxystrobin, pyraclostrobin, fluoxastrobin, fluxapyroxad
7	SDHI	Flutalonil (Convoy), Boscalid (Endura), Penthiopyrad (Fontelis)	Moderate	Coppers, EBDCs, chlorothalonil, tebuconazole, tebuconazole + prothioconazole, prothioconazole, azoxystrobin, pyraclostrobin, fluoxastrobin
7+11	SDHI + QOI	Fluxapyroxad + pyraclostrobin (Priaxor) (7+11), Azoxystrobin + benzovindiflupyr (Elatus) (11 + 7)	Low when used as a mix[1]	Coppers, EBDCs, chlorothalonil , tebuconazole, tebuconazole + prothioconazole, prothioconazole, metconazole
11	QOI (strobilurin)	Azoxystrobin (Abound), Pyraclostrobin (Headline), Fluoxastrobin (Evito)	High; resistance to group 11 fungicides may be present in some populations of leaf spot fungi	Coppers, EBDCs, chlorothalonil, tebuconazole, tebuconazole + prothioconazole, boscalid, fultalonil, penthiopyrad, fluopyram + prothioconazole

[1]Resistance risk with premixes may be higher than previously indicated.

Table 6-7. Peanut Disease Management Calendar

TIME OF YEAR		
Disease	**Threshold**	**Management Tactics**
SPRING (APRIL – JUNE)		
Spotted wilt virus (TSWV)	See TSWV risk index	Plant a resistant cultivar (Bailey, Georgia 07W, Sullivan or Wynne); use a high seeding rate or twin rows; plant after May 5 and before May 15; apply an insecticide in furrow. Consider an additional postemergence insecticide application.
CBR (Cylindrocladium black rot)	1% to 10% disease in this field last time peanuts were grown (assumes good rotation; see Table 6-2)	Rotate 3 to 4 years; avoid soybeans in rotations. Plant a resistant cultivar (Bailey or Sullivan). Consider an in-furrow fungicide application.
	More than 10% disease in this field last time peanuts were grown OR 1% to 10% disease if inadequate rotation (see Table 6-2)	Rotate 4 to 5 years; avoid soybeans in rotations. Plant a resistant cultivar (Bailey) and fumigate before planting. Extend rotation if not fumigating.
JULY – HARVEST		
Leaf spots, Web blotch, Pepper spot	R3 (beginning pods) R3+7 to 10 days (Sullivan, Wynne)	Rotate at least 3 years to any crop other than peanuts. Longer rotations are preferred. Plant a partially resistant cultivar (Bailey, Sullivan, or Wynne). Use nozzles that give a cone-shaped spray pattern. Use 12 to 24 gal of water for ground sprayers or at least 5 gal of water for air application. **14-day program:** Four to six applications suggested. Begin applications at R3 (very early pod). The first application can be delayed 7 to 10 days on Sullivan, Wynne, or Bailey. Repeat applications at 14-day intervals. **Advisory:** Begin applications at very early pod (R3) or at R3+7 to 10 days on Sullivan, Wynne, or Bailey. Repeat applications unless weather conditions become unfavorable as determined by peanut leaf spot advisories. This schedule requires strict adherence to the program guidelines and usually results in fewer fungicide applications than the 14-day schedule. Contact your County Extension center for details. Scout fields: If 20% or more leaflets in any part of the field have spots, begin a 10- to 14-day spray program. Caution: Conditions may be favorable for disease even during dry spells. Always check advisories before skipping sprays.

(continued)

Table 6-7. Peanut Disease Management Calendar

TIME OF YEAR		
Disease	**Threshold**	**Management Tactics**
JULY – HARVEST (continued)		
Leaf spots, Web blotch, Pepper spot (continued)	20% leaflets in any part of the field with spots	Reduce intervals to 10 days between sprays when over threshold. Switch to a more effective fungicide if late leaf spot, web blotch, or pepper spot becomes predominant. If using advisory, switch to a 10- to 14-day spray schedule.
Southern stem rot	Mid-July; rows within 6 inches of touching	Plant a partially resistant cultivar (Bailey or Sullivan). Avoid highly susceptible cultivars (e.g., CHAMPS). Rotate 3 to 5 years to nonhost crops. Use a soil fungicide or a foliar fungicide with efficacy against stem rot at least once from mid-July to mid-August, or up to three times on a susceptible cultivar. See leaf spots above for application information. Higher volumes of water (15 to 25 gal/a) or spraying at night may improve control.
Sclerotinia blight	In fields with a history of disease: begin CAREFUL scouting when rows are within 6 inches of touching, in early July, or according to advisory, whichever is earliest. Apply fungicide if disease is observed.	Plant a partially resistant cultivar (Bailey). Avoid highly susceptible cultivars (CHAMPS). Rotate 4+ years with nonhost crops. Continue scouting every two weeks or according to advisory and reapply fungicide if necessary.
SEPTEMBER – OCTOBER		
CBR, Sclerotinia blight, Southern stem rot	At digging	Inspect inverted roots and pods for disease symptoms and keep a map of problem areas. Use the map to plan rotations, cultivar selection, and control treatments for future peanut crops.
OCTOBER – NOVEMBER		
Nematodes	Sample fields to be planted in spring as indicated by the NCDA nematode-testing lab report	Plan rotation, nematicide applications, or fumigation use based on recommendations.

Table 6-8. Percent Defoliation and Yield of Bailey Peanut Treated with Leaf Spot Fungicides or Their Component Active Ingredients at Lewiston In 2018

Fungicide and active ingredient[1]	**Group**	**% Defoliation**	**Yield lb/A Field Wt**
Provost 10.7 oz (prothioconazole + tebuconazole premix)	3+3	14 d	5650 a
Tebuzol 7.2 oz + Bravo 24 oz (tebuconazole + chlorothalonil)	3+M	18 d	5574 a
Fontelis 16 oz (penthiopyrad)	7	19 d	5786 a
Bravo 24 oz (chlorothalonil)	M	19 d	5285 ab
Absolute 3.5 oz (tebuconazole + trifloxystrobin premix)	11+3	22 c	4819 bcd
Priaxor 8 oz (pyraclostrobin + fluxapyroxad premix)	11+7	25 c	5517 a
Sercadis 4.5 oz (fluxapyroxad)[2]	7	26 c	5641 a
Aprovia 10.5 oz (benzonvindiflupyr)[3]	7	28 c	5497 a
Flint (trifloxystrobin)[4]	11	34 c	4607 cd
Elatus 7.3 oz (azoxystrobin + benzonvindiflupyr premix)	11+7	34 c	4917 bc
Tebuzol 7.2 oz (tebuconazole)	3	69 b	4640 cd
Headline 10.6 oz (pyraclostrobin)	11	79 b	4275 d
Evito 5.7 oz (fluxastrobin)	11	80 b	3620 c
Abound 12 oz (azoxystrobin)	11	95 a	3212 c
Untreated	—	99 a	1839 f

[1] An application of Bravo (24 oz) to all treatments on July 17 was followed by applications of the treatment fungicides on July 31, August 14, and August 28, 2018.
[2] Not labeled on peanut; fluxapyroxad is a component of Priaxor.
[3] Not labeled on peanut; benzonvindiflupyr is a component of Elatus.
[4] Not labeled on peanut; trifloxystrobin is a component of Absolute.

7. PLANTING, HARVESTING, AND CURING PEANUTS

Gary T. Roberson

Extension Specialist—Department of Biological and Agricultural Engineering

PLANTING

Land preparation, variety selection, and a host of other factors have a direct impact on the planting operation. The planter should be selected and prepared to match the production practices used on the farm.

Planters are designed to perform five major functions: open a furrow, meter the seed, place the seed, cover the seed, and firm the soil around the seed. No-till planters, in addition to the five functions listed above, must also manage crop residue and prepare the row for planting. Peanuts are a fragile seed compared to corn, soybeans, or cotton. Seed damaged in planting may not germinate. A peanut planter must not only meter and place the seed accurately, it must handle the seed gently to avoid damage.

Planter Types

Two types of planters are available for peanuts: the plate planter and the air planter. Plate planters are divided into two groups based on the design of the plate: horizontal plate or inclined plate. Air planters used for peanuts also fall into two groups: pressure disk and vacuum disk. Air planters that use a seed drum are not recommended for peanuts.

Horizontal plate planters typically have a plate mounted in the bottom of the seed hopper. The plate for peanuts is modified to allow gentle handling of the seed as well as accurate metering. Usually the plate mechanism is an attachment that must be added in the seed hopper. Inclined plate planters may have one or two seed plates per row. The seed plate cells are sized and selected for peanuts and usually do not require modifications or attachments. Planters that have two seed plates per row have a lower plate speed, which provides gentle treatment. Plate planters, horizontal plate or inclined plate, are accurate and effective if properly set up and operated within the manufacturer's recommended ground speed range.

Air planters use a seed disk to meter the seed. The seed disk is usually mounted vertically in the metering chamber. Cells are cut or formed in the edge of the disk to meter the seed. Air pressure is used to hold the seed in the cells. Pressure disk planters use a fan to blow air into the metering chamber. Vacuum disk planters have a fan designed to remove air from a chamber behind the seed disk. The vacuum created holds seeds from the metering chamber in the disk's cells much like the pressure disk system. The key to accurate planting with an air planter is controlling air pressure or vacuum. If the pressure or vacuum is too strong, too many seeds may be held in the cell. Likewise, if the pressure or vacuum is too weak, the cells may not be properly filled. Brushes remove extra seeds from each cell. As with the plate planters, gentle treatment is important. Seed disks usually have more cells than seed plates, allowing the disk to turn slower. Air planters can maintain metering accuracy at higher ground speeds than plate planters and tolerate a broader range of seed sizes. However, care must be taken to avoid excessive planting speeds. Refer to the operator's manual for information on setup, operation, and speeds.

Preparing To Plant

Before the planting season, take time to give planting equipment a thorough examination. Look for signs of worn or damaged parts, drive chains, gears, and seed plates or disks. On air planters, look for cracks or leaks in the air tubes. Also check the air delivery on each fan. Make sure the drives are turning freely and lubricated, if required, according to the manufacturer's specifications. Seed plates are usually driven by a press wheel, gauge wheel, or transport wheel. This wheel provides power to turn the plates or disks, and often fertilizer or pesticide applicators as well. If the wheel is inflatable, check the air pressure. An overinflated or underinflated tire can seriously affect planting accuracy. You should also make sure the correct size wheel or tire is mounted on the planter. Incorrect size will lead to inaccurate metering of the seed.

Be sure to calibrate fertilizer, pesticide, and planting equipment to ensure accuracy. Refer to the operator's manual to find the proper drive setup for your needs. Table 7-1 gives the necessary seed spacing for selected seed populations and row widths. Once the planter is set up, check its performance in the field to ensure continued accuracy.

***Table 7-1. Seed Spacing for Various Seed Populations and Row Widths*[1]**

Row Spacing (Inches)	**Seed Population** (Seeds per Acre)				
	40,000	**45,000**	**50,000**	**55,000**	**60,000**
	Seed Spacing (Inches per Seed)				
34	4.6	4.1	3.7	3.4	3.1
36	4.4	3.9	3.5	3.2	2.9
38	4.1	3.7	3.3	3.0	2.8

[1] For twin rows on 36-inch beds, multiply the seed spacing for a single row by 2 to get the spacing in each of the twin rows.

HARVESTING

Preparing for Harvest

Successful harvesting begins with proper preseason maintenance of harvesting equipment. Peanut diggers and combines have many key parts that require service for good performance.

On diggers, start with the blades. The edge should be sharp, and the blade should not be worn away. As the blade wears it gets narrower and shorter, which means it may not do a good job of cutting the tap root and lifting the peanuts so the shaker can catch them. The shaker chain or shaker wheels are driven by either PTO or hydraulic power. For PTO-driven units, inspect the driveline carefully for wear or damage. Replace any missing safety shields! Repair any worn bearings or other parts in the driveline. For hydraulic powered diggers, inspect the hydraulic hoses for wear or signs of leakage. Replace any damaged hose. Check the hydraulic control valve and the quick connects as well. Hydraulic quick connects, if not properly cleaned, maintained, and stored can introduce damaging grit or dirt to the hydraulic system. Grit or dirt can damage not only digger components but the tractor hydraulic system as well.

Check the shaker chain, shaker belt, or wheels for signs of wear. Replace any worn or damaged chain links, belts, rattler bars, or kicker wheels. Also inspect the shafts and bearings for wear and replace where necessary. Finally, check the inverter arms. Be sure they are bent to the proper shape. If you have new shaker bars on the chain or belt, you may want to polish them to remove any burrs or rough edges on the teeth. Rough edges can prevent the vines from releasing as they flow off the conveyor. This snag could lead to vines wrapping around the shaker chain or plugging the inverters. Smooth edges on the shaker bars will allow the vines to release smoothly, improving the inversion into the windrow. Once your inspection is complete, hook up the digger and run the shaker. Once again, check for any signs of wear or damage in the system.

For peanut combines, start by checking the input driveline for wear in the universal joints and wear or damage to the telescoping tube and the coupler. Don't forget to check the safety shield and repair or replace it if necessary! Check the lubricant in the gearboxes and service as recommended by the manufacturer. Check chain drives for wear and proper tension. Replace any chain or sprocket that does not measure up to specifications. Check belts for wear and proper tension. Replace worn belts and pulleys as necessary. Look closely at the belts and pulleys to make sure the belt is not bottoming out in the pulley. Bottoming out will cause excessive slippage and loss of power in the combine. Bear in mind the main or master belt drive on the combine will supply power to everything else behind it in the power train. Slippage in this drive will impact performance for the whole machine.

Check the condition of shafts and bearings to be sure they are acceptable. Bad bearings will typically start to overheat during use. To check the bearing, shut off all power to the combine and use an infrared thermometer or a temperature stick to check the bearing housing. Compare the temperature of the suspected bearing to others on the combine. If a bearing is much hotter, it may be going bad.

Look inside the combine and check the condition of stripper bars on the cylinders and on the concaves. Replace any broken stripper teeth. Look for clogged or blocked holes in the concaves. If the openings are blocked, peanuts cannot fall through into the cleaning pan. Check shaker pans or cylinders throughout the combine for proper movement or timing. Inspect the stemmer saws for proper alignment. Replace any blades that are broken or badly worn. Check the condition of the shaker pans, lip screens, or other cleaning elements, and be sure they are set properly for the type and variety of peanut you are harvesting. Inspect fan blades for wear and fan housings and conveyor tubes for air leaks. Air leaks can prevent proper cleaning or handling of the peanuts. Look inside the elevator tubes for obstructions. Peanuts will crack if they hit obstructions, resulting in a lower grade. Finally, check the hopper and dump cylinders to be sure they are working. Replace or repair any leaking hydraulic cylinders.

Refer to the operator's manual for recommended adjustments and settings. In addition to the recommendations above, give the machine a general inspection to find and repair loose or broken parts. A little time spent in preseason maintenance can save many hours during the harvest season. Above all, observe all safety precautions while servicing or operating the digger or combine!

Digging

Peanuts should be dug when maximum yield and quality can be obtained. The hull-scrape test can help predict the best time to dig. Contact the county Extension center for more information. Pay close attention to the weather when planning digging. If digging and combining are staggered, peanuts won't be left too long in the windrow.

Once digging begins, keep digging losses to a minimum. Most harvesting losses occur in the digging operation and can be enormous if not carefully managed. Heavy digging losses are unavoidable when pegs are weakened due to over maturity or premature defoliation caused by disease, or when the soil is very dry and hard. Under normal conditions, a yield loss of 5 percent or less should be possible if the digger is adjusted and operated properly.

Reducing Digging Losses. Digging losses can occur below ground or above ground. Losses below ground level occur when peanuts are cut off due to the blades running too shallow. Peanuts are also lost as the soil is pushed up the blades and fingers onto the shaker and are being lifted out of the soil. Try to maintain a smooth transition up the blades and onto the lift fingers.

Losses also may occur as the plants are being elevated and shaken to remove dirt, and as the peanuts are placed in windrows. These losses are usually seen on top of the ground. Adjusting the digger for optimum performance requires considerable operator skill. The following guidelines should help with the adjustment process.

Blades should be sharp and should penetrate to the same depth from side to side. A slight forward pitch of the blades (the back edge slightly higher that the cutting edge) will loosen the soil around the pods, making their removal from the soil less likely to break the pegs. Refer to the operator manual for your blade manufacturer's recommendation. Ideally, the blades should cut the taproot of the plant just below the pods. In some fields, however, the blades may have to be run deeper in the heavier spots. Pay close attention to the operator's manual for the digger for guidance on setting the depth of the plow. Most digger blades are designed to run with the bevel facing up or facing down. Install the blades with the bevel up for conditions where the soil is dry or difficult to penetrate. Adequate but not excessive soil moisture improves digger operations. Changes in soil type or moisture within a field can cause the digger to run deeper or shallower. If the digger runs shallow, peanuts will be lost when the blade cuts them off. Pay close attention to the windrow and look for signs of inadequate depth.

Ground speed of the digger is a critical operator adjustment. A 2018 study at Peanut Belt Research Station (http://go.ncsu.edu/readext?561394) indicates that for every 1 mph increase in ground speed above 2 mph, an average loss of 225 pounds may be realized. (See Figure 3-6 in chapter 3 of this guide.)

Proper synchronization of ground speed and shaker speed is essential to keep from dragging the plants forward, on the one hand, or snatching them backward out of the soil on the other. Optimum shaker speed is slightly faster than ground speed. The plant should rise vertically and fall back to the ground close to where it was growing. If the shaker is PTO-driven, there is a fixed ratio between ground speed and PTO speed in each tractor gear for most tractors. Thus, speed must be synchronized by selecting the proper gear to operate in. Most modern tractors have a sufficient selection of gears to allow synchronization. Some tractors may offer a PTO that is internally synchronized to ground speed. Hydrostatic drive tractors provide infinitely variable ground speed at any given engine speed, making it easier to achieve synchronization.

Hydraulically driven diggers can provide a constant shaker speed at any engine speed that provides adequate oil flow in the hydraulic system. Hydraulic diggers can be synchronized more accurately by adjusting the tractor hydraulic control valve. The operator can choose the best gear for the tractor and then synchronize the digger to match it. Most diggers now come with a speed readout for the shaker chain to assist in proper synchronization. The readout can be added to many older diggers as well. Even with proper synchronization, ground speeds in excess of 4 miles per hour will tend to jerk the plants from the soil and cause heavy pod losses.

The final stage of the digging operation—windrowing—can also lead to harvest losses. As the peanut vines flow off the shaker, they fall onto a kicker wheel assembly and slide across the inverter guide rods. Check the kicker wheel drive to be sure the kicker wheels are turning with the shaker chain. Carefully inspect the guide rod section of the implement to ensure the guide rods are properly spaced and positioned. If the rods are bent out of position, the peanuts will not flow with the rods but will push across them causing peanuts to be raked off the vine and lost. Make sure the rods are smooth and free of rust. Corroded or damaged rods can also impede the flow of vines and cause harvest loss. The damaged or corroded rods should be repaired or replaced.

In some cases, heavy vine growth makes it difficult to see the furrows during digging. Using a high accuracy GNSS receiver and a light bar as a guidance tool can make the digger operation much smoother. The light bar can help the operator stay properly positioned on the row and thus reduce potential losses. Automatic steering systems can improve field performance during digging. The automatic steering system can keep the tractor and digger on the row very effectively. However, automatic steering at digging requires a guideline created at planting to insure proper alignment.

Keep Windrows Loose. Windrows should be loose and fluffy for good drying and should be placed on level ground, or preferably, on a slight ridge for drainage. If flat cultivation was practiced, this will not present a problem. Otherwise, mount a device like a drag bar or leveler under the shaker to tear down the row beds and form a slight ridge under the windrow.

Inverters should be adjusted to turn the plants completely upside down so that the peanuts are fully exposed to air and sunlight for fast drying. Peanuts in contact with the ground do not dry as rapidly under normal conditions as those supported off the ground, and they will be much more susceptible to damage during adverse weather conditions. On hot, sunny days, peanuts very close to or in contact with the soil may get too hot and develop off-flavors or poor milling quality.

Lifting Windrows

Reshaking or lifting windows often helps with drying, particularly if the soil was wet at digging or if rain soon after digging stuck the vines to the soil. Two types of lifters are available: chain and finger. The chain lifter functions much like the shaker chain on the digger-shaker-inverter. Careful synchronization of the lifter conveyor with ground speed is necessary to avoid excessive harvest loss. The shaker chain here is much shorter than the chain on the digger-shaker-inverter so it does not lift the peanut as much or drop it as far. The finger lifter has a digger style blade that runs just below the soil surface to break the vines free and elongated fingers to lift the vines and allow some dirt to separate. Breaking the soil crust with the blades may help speed field drying in some cases. Avoid lifting or reshaking when the vines have become very dry and brittle, otherwise heavy losses will likely occur.

Combining

Combining is the culmination of a year's peanut production efforts. As such, it deserves careful assessment to ensure the maximum yield and best quality. Modern combines will get peanuts off the vines under almost any circumstances. Field losses, mechanical injury, germination, and even flavor, however, may be influenced by the feeding rate into the combine, the cylinder speeds and clearances, the cleaning and conveying fan speeds, and the moisture content of both peanuts and vines at picking.

Tests by various researchers have indicated that hull damage, loose shelled kernels, and shelling damage (splitting and skinning) are less for peanuts combined at moisture contents of 25 percent to 35 percent. However, combining at 20 percent moisture will reduce curing time and costs. During periods of good drying weather, combining can safely be delayed to take advantage of additional infield drying. Vines should be dry enough to break and tear apart readily.

Picking action should be just aggressive enough to remove all the peanuts from the vine with a minimum of vine breakage. Excessive picking action takes more power and breaks the vines into short pieces so that instead of passing out over the vine racks, they fall through with the peanuts and overload the cleaning screens.

Stripper fingers or bars should be adjusted as moisture conditions change during the day. The front strippers are usually set to be more aggressive than those in the rear. Long, clean hay should be discharged from the machine with a minimum of short, broken vines in the hopper.

Cylinder speed should be kept to the manufacturer's recommendation or below and never more than is required to get the peanuts off the vines. Slow cylinder speeds are especially important when combining seed peanuts. On some combines, cylinder speeds are adjustable independently of tractor engine rpm; on others, the speed is regulated by the tractor throttle and is generally correct when the tractor PTO is operating at rated PTO speed or the PTO speed recommended by the combine manufacturer.

Keep tractor engine speed near the recommended level in order for the cleaning and conveying components of the combine to work properly.

Watch Air Velocity. Air conveyors on the combine can cause considerable hull cracking if the fans are operated too fast or the dampers are not adjusted properly. Use only enough air velocity to lift the peanuts into the bin. The air velocity for the cleaning screens also requires frequent checking and adjustment. Sufficient air should be supplied to blow sticks, trash, and "pops"—but not marketable peanuts—out of the machine. If the screens become heavily loaded with trash, it may not be possible to get good separation. Consequently, either good peanuts will be blown out or trash will go into the bin. Overloading of the screens may indicate that picking action is too aggressive. Tail board adjustment also affects what is blown out of the back for any given fan setting.

Proper synchronization of the combine pickup with forward speed is important to minimize field loss of peanuts. The windrow should flow evenly and smoothly into the combine, without being pulled apart by a ground speed that is too slow or pushed ahead by a ground speed that is too fast. Either situation will cause peanuts to be lost off the vines before getting into the combine. Some combines have an adjustment to quickly change pickup reel speed; on others, a sprocket must be changed. In either case, changing gears on the tractor will affect synchronization and reel speed should be adjusted. The pickup tires should run just above the ground surface. If they are allowed to dig into the ground, they will pick up dirt and carry it in with the peanuts.

Combine pickup and cleaning losses (peanuts picked but blown out) can be appreciable. However, proper adjustment and operation of the equipment can virtually eliminate these losses.

Estimating Harvest Losses

The level of harvest loss in the field can be used to check digger or combine performance. Excessive losses may indicate problems with equipment adjustment or operation. Harvest losses can be estimated based on the number of pods left on or in the ground after digging or combining.

Measure a sample area behind your digger or combine. For example, if your row spacing is 36 inches, and you have two rows per windrow, you are working with a sample width of 72 inches or 6 feet. If you measure 20 inches (1.667 feet) along the row, you will have a sample area equivalent to 10 square feet. Any peanuts you pick up in that 10-square-foot sample can be used to estimate losses using Table 7-2. You can use any size area you want, but bear in mind that the larger the area, the more accurate your estimate will be. An alternative would be to use an area of 0.001 acres, 6 feet by 7.26 feet, or 43.56 square feet. Again, the number of pods picked up in the sample area is used to estimate yield loss as shown in Table 7-2.

Table 7-2. Harvest Loss Table

Cultivar	Loss (lb/a) for 1 Pod per Square Foot	Loss (lb/a) for 1 Pod per 10 Square Feet	Loss (lb/a) for 1 Pod per 0.001 Acre
Sullivan[1]	231	23.1	5.3
Bailey[1]	230	23	5.28
Gregory[1]	240	24.0	5.51
GA 09B	165	16.5	3.79
Florida 07	170	17	3.91
FCIC-Virginia Type Average[2]	187	18.7	4.29
FCIC-Runner Type Average[2]	116	11.6	2.67

[1] Based on pod weights from NC State University variety test data.

[2] Based on data from the Peanut Standards Loss Adjustment Handbook, Federal Crop Insurance Corp, USDA.

To use the table, first measure your sample area and calculate its size. Then count the number of pods found in the sample area. Harvest loss is determined by converting the number of pods found in a given area into a pound per acre estimate. Say for example that you planted the Gregory cultivar. After combining, you marked off a 10-square-foot area and counted 20 pods on the ground. For the Gregory cultivar, the table tells us each pod in a 10-square-foot area is equivalent to 24 pounds per acre.

Therefore, harvest losses would be 24 × 20, or 480 pounds per acre. If you used the 0.001-acre sample size, each pod collected in the sample for the Gregory cultivar would be equal to 5.51 pounds-per-acre yield loss. If 60 pods were collected, the yield loss would be 60 × 5.51, or 331 pounds per acre.

When estimating yield losses, particularly behind the digger, bear in mind some of the loss is due to overly mature pods, or "shedding" loss. There may be little you can do to the equipment to reduce this loss component. Closely examine the pods to determine if they were shed prior to digging or were pulled from the vine during the digging process. If you check the pods right after digging, you will see the fresh mark where each pod pulled away from the tendril.

Machinery Management

Typically, during planting and harvest seasons, there is a narrow window or number of days available for getting a field operation done. It is important that the farmer assess their field equipment and make sure the capacity is adequate. The first step is to determine the Required Field Capacity. Required field capacity is an estimate of the time you expect to have available for the job.

$$\text{Required Field Capacity, } \frac{AC}{HR} = \frac{\text{Total Acres}}{\text{Days Available for Work} \times \text{Hours Per Day Available}}$$

The next step is to estimate the capacity of your equipment in acres per hour. This is called the "Effective Field Capacity."

$$\text{Effective Field Capacity} = \frac{\text{Ground Speed, mph} \times \text{Swath, ft} \times \text{Field Efficiency}}{8.25}$$

Ground speed is the true working speed on the ground while working in the field. Swath is the effective working width of the implement. For example, a four-row digger in 36 inch rows has a swath of 12 feet. Field efficiency is the ratio of the productivity of a machine working in field conditions to the theoretical maximum productivity. Field efficiency accounts for not using full working width, turning around at the end of rows, operator capability, and field characteristics. Table 7-3 gives some field efficiency and field speed values for selected implements. These are general values and may not be correct for peanut in all cases. The values for the peanut digger-shaker-inverter are estimated from similar implements in the standard.

For example, using Table 7-3 and assuming the typical values for field efficiency and field speed, an eight-row planter (3-inch row spacing) with 65 percent field efficiency and a speed of 5.0 mph would cover 9.4 acres per hour. If you have 400 acres to plant and expect 15 days suitable for planting while working 8 hours per day, you need a required field capacity of 3.3 acres per hour. In this example, your equipment capacity is more than adequate since it exceeds the required capacity.

For best results, farmers should keep records of the time it takes to perform each operation. Farmers could then come up with estimates that are tailored to each farm.

Table 7-3. Typical Speed Range and Field Efficiency Values

Source: American Society of Agricultural and Biological Engineers. 2011 March. Agricultural machinery management data (ASAE D497.7). St. Joseph, MI: ASAE.

Implement	Field Efficiency		Field Speed	
	Range %	**Typical, %**	**Range %**	**Typical %**
Row Crop Planter	50 – 75	65	4.0 – 7.0	5.5
Peanut Digger Shaker Inverter (Estimated)[1]	70 – 90	85	2.0 – 4.0	2.5
Pull Type Combine	60 – 75	65	2.0 – 5.0	3.0
Self Propelled Combine	65 – 80	70	2.0 – 5.0	3.0

[1]Implement not in standard; values estimated from similar implements.

Harvest Safely

Always remember: tractors, diggers, and combines are potentially dangerous pieces of equipment. There are many moving parts, not all of which can be completely shielded. Always disengage power before making adjustments. Never allow bystanders or riders near the tractor or digger and combine when it is in operation. Keep all protective shields and guards in place. Above all, be alert and on the lookout for hazardous situations. Read the operator's manual and observe all safety precautions. Learn to recognize and avoid hazards. Contact the county Extension center for recommendations on improving safety in farm operations.

CURING PEANUTS

Efficient operation of the peanut curing system involves: (1) cleaning and repairing the equipment before harvest, (2) windrow curing the peanuts as long as practical, and (3) operating the equipment properly.

Preseason Operation

The preseason cleaning and repairing of the curing trailer, plenums and canvas connectors, and the fan and heater can pay big dividends. Dirt and old crop residue under the trailer curing floor and in the trailer plenum chamber can block air flow and contaminate the new peanuts with aflatoxin. The best way to clean the curing trailers is to remove the floor assembly and flush out the trailer with a stream of high-pressure water.

Clean leaves or trash from the fan and plenum. These can be a fire hazard when the burner is operating. Cut any grass and weeds that could restrict the air inlet to the fan. Remove all trash that could restrict air flow to the fan screen. Clean the dirt and trash off the fan blades to reduce drag.

Make sure that the LP gas line from the tank to the burner is in good condition and not damaged. Most peanut fans have a ring-type heater with many holes for gas-air mixture. Clean these burner holes to ensure good ignition and an even flame all the way around the burner. If some of the holes are plugged or partially closed, too little gas-air mixture may exit for good ignition or proper burning, which will waste fuel.

Check all electrical wiring, fuses, breakers, and controls. Make sure they are properly installed and functional. Have a qualified electrician make upgrades or repairs.

For conventional peanut drying trailers, check the main air plenum, canvas connections, and the trailer air plenum for holes and leaks. Be sure to repair all leaks to conserve energy. Air leaks waste energy and increase the curing time. A crack or hole measuring only 1 inch by 24 inches will leak approximately 350 cubic feet per minute on a typical curing system. An extra gallon of LP gas will be required to heat the air leaking from this crack every 11 hours when the burner is raising the temperature 20°F, and the leak will also slightly lengthen the curing time. Before you begin harvesting peanuts, operate the fan and heater for about 30 minutes to make sure they are functioning properly. Also, while the fan and heater are operating, turn the thermostat and humidistat up and down to make sure that they are functioning properly.

For the larger semi-trailer peanut drying systems, an individual fan and burner system is used for each semi-trailer. These units do not have a common air plenum, but still have a canvas transition going into the semitrailer. Inspect the entire unit for leaks and proper operation.

Refer to the owner's manual for further recommendations on adjustments and maintenance of the curing equipment.

Windrow Drying

The cost of curing peanuts is greatly influenced by the time they remain in the windrow. The longer they remain in the windrow, the more the peanuts cure (dry), and the lower the curing fuel cost; however, windrow losses may begin to increase three to five days after digging and inverting the peanuts. Even though windrow losses may increase when the peanuts remain in the windrow too long, especially in bad weather, curing costs will decrease as the peanuts continue to dry in the windrow. The most economical time to combine the peanuts is when the curing cost savings from windrow drying equals the lost value of the additional peanut losses from windrow drying. As the cost of curing fuel increases, the time in the windrow must increase to achieve the maximum profit.

Curing Operations

Air Flow. To properly cure peanuts, maintain sufficient air flow and proper temperature. If air flow rates are too low, the peanuts will mold. If the air flow is excessive, the energy costs will be high. The recommended air flow rates were established to prevent mold development during curing; however, they have also proven to be the most economical. The general recommended air flow of 50 cubic feet per minute per square foot of curing floor (cfm/sq ft) at 0.75-inch static pressure is sufficient to cure up to 25 percent moisture peanuts 5 feet deep. The air flow provides 10 cubic feet per minute per cubic foot of peanuts at a depth of 5 feet. Semitrailers cure peanuts at greater depths, but minimum airflow requirements must be maintained.

Once the fan is selected, air flow adjustments must be made by varying the curing depth or by not using all of the trailers for the system. For example, filling all the trailers half full will result in a higher air flow than completely filling half the trailers. When filling the trailer, be sure to level the peanuts to ensure uniform air flow. Avoid overfilling the trailer. The minimum or desired air flow rates along with the maximum curing depth using the recommended curing fan is shown in Table 7-4 for conventional trailer systems.

Table 7-4. Recommended Air Flow Rates

Initial Moisture Content (%)	Minimum Air Flow Rate (CFM/cu ft)*	Maximum Curing Depth* (ft)
15	5	8
20	6	6
25	10	5
30	12	4
35	15	3

*Based on a system air flow rate of 50 cfm/sq. ft At 0.75 in. S.P.

Heat. To maintain good flavor and milling quality in the peanuts, maintain the proper curing temperature. If the curing temperature is too high, the peanuts will split when shelled and may also develop a bad flavor. Never allow temperature to exceed 95°F. If you are drying seed peanuts, you may want to consider a lower maximum. You should also limit the temperature rise to no more than 15°F above ambient temperature. If the ambient temperature is below 55°F, you may use a 20°F rise above ambient temperature. The recommended temperatures can be controlled by manually adjusting the heat or using a modulating thermostat, or by using a humidistat and an on-off thermostat. When using manual heat control, adjust the LP gas pressure to achieve the desired temperature rise or curing temperature. Most fan and burner units have a gas pressure versus heat chart. This chart usually shows the British Thermal Units

(Btu) output for various gas pressures. If your burner has a “high” and “low” pressure heat value, be sure to use the low position for peanuts. The following formula is a useful aid in adjusting the heat input: Btu/hr = 1.1 × fan cfm × temperature rise.

When using an on-off thermostat and a humidistat, adjust the temperature rise to approximately 15°F to 20°F, as noted above, to reduce the cycling of the burner flame early in the season when the weather is warm. The temperature rise can be increased late in the season when the nights get cold as shown in Table 7-5.

Table 7-5. Temperature Adjustments

	Outside Relative Humidity (%)					
	90	60	30	90	60	30
Outside Temperature (°F)	Desired Temperature Rise (Added Heat, °F)			Desired Curing Temperature (°F)		
40	20	20	15	60	60	55
50	20	15	10	70	65	60
60	15	10	5	75	70	65
70	10	5	–	80	75	–
80	5	–	–	85	–	–

The best temperature controller is a modulating thermostat, which varies the temperature by raising and lowering the firing rate (flame size) without cycling when the weather changes. A modulating thermostat should be set on approximately 75°F if a constant temperature is desired; however, adjusting the setting for the weather conditions as shown in Table 7-4 is preferred.

Steps to Increase Curing Efficiency. When the hulls are wet, drying efficiency is very high. After hulls are dry, especially during the last half of the curing cycle, the drying efficiency decreases. Therefore, you need a higher air flow for the first half of curing than during the second half of the curing cycle. Air flow can be reduced during the last part of the curing cycle on a multiple trailer plenum system by partially closing the air gates of the trailers during the last half of the curing period. Generally, having the air gate half open keeps the curing efficiency high during the final curing stage. By reducing the air flow to some trailers in the final curing stages, the other trailers in the first curing stages containing peanuts with wet hulls will receive an increased air flow. Do not partially close enough air gates to restrict the fan or to cause the heater to malfunction.

On many multiple trailer curing systems, the trailer nearest the fan receives the least air. On these systems, the adjustments can be made by starting the newly filled trailers on the furthest end from the fan until the hulls are dry, and then moving this trailer to the other end of the plenum nearest the fan.

Another way to adjust air flow is to fill the peanut trailers only half full for the first half of the curing cycle to dry the hulls, then dump and mix two trailers into one trailer for the final half of the curing cycle. This method is more desirable than adjusting the air gates if dumping and handling facilities are available. The dumping and reloading of the peanuts will remove some dirt and mix the bottom layer of peanuts with the top layer resulting in a more uniform final moisture content.

Another way to save on heat energy cost and possibly improve curing quality is to recirculate part of the curing air to maintain an ideal curing temperature and relative humidity. This will require equipment changes or a specially designed curing building for the trailer and fans. Research indicates that 40 percent to 50 percent savings in energy consumption can be obtained using the recirculating systems compared to the conventional systems. A key advantage of the recirculating systems is that if the wagons leak air, the air goes back into the building and is recirculated—not lost to the outside. The economics of converting to a recirculating system will depend on the cost of the changes required and current energy cost.

PRECISION AGRICULTURE TECHNOLOGY FOR PEANUT PRODUCTION

Precision agriculture is a combination of information resources, technology, and management practices designed to work together to improve productivity. Some of the technology that can be applied to peanut production includes GNSS, GIS, guidance systems, variable rate controls, applicator controls, yield monitors, and automatic curing controls. Some of the more common technology resources and their possible application in peanut production are explained in this section.

Global Navigation Satellite System (GNSS)

GNSS receivers are designed to give the user accurate and precise position data—latitude and longitude—wherever the receiver is located, provided it can receive the satellite signal. GNSS receivers are capable of using one or more of the available constellations of positioning satellites that are maintained by various international entities. These constellations include the familiar Global Positioning System or GPS (United States), GLONASS (Russian Federation), Galileo (European Union), and Beidou (China). GNSS makes many other technologies in precision agriculture possible.

Farmers have a wide range of choices in GNSS receivers. The most common point of discussion is "How accurate is it?" GNSS accuracy can be evaluated on the basis of static accuracy, the ability to return to an exact point after a long period of time. Pass-to-pass accuracy usually refers to the system's ability to track positions within a few minutes of each swath.

GNSS accuracy is based on the type of augmentation or correction used. Differential GNSS (DGNSS) systems include beacon correction (Coast Guard and DOT towers; Coast Guard and DOT correction signals are being phased out starting in 2018 and will no longer be available after 2020), the Wide Area Augmentation System (WAAS), and commercial satellite subscription systems. These systems typically provide meter-level static accuracy and can provide accuracy of several inches in pass-to-pass. Dual frequency GNSS receivers are more accurate, providing accuracy of about 1-foot static and a few inches pass-to-pass. Some satellite correction services offer a precise point positioning (PPP) service that is accurate to a few inches or less. The most accurate GNSS correction currently available is real-time kinematic (RTK), which can deliver static and pass-to-pass accuracy of about an inch. RTK systems require a higher level of correction to achieve this accuracy. Farmers can either set up their own base station or take advantage of a dealer or cooperative RTK networks that can be shared by many users. In North Carolina, farmers can also access the North Carolina Real Time Network (NCRTN) maintained by the North Carolina Geodetic Survey as a RTK correction source.

Geographic Information Systems (GIS)

Geographic information systems is the term used to describe a family of computer software products used to manage data and information that can be georeferenced or tied to a map position. Many manufacturers offer a version of GIS software called a Farm Management Information System (FMIS) that is customized for farmers. These packages are often very user friendly and include the tools a farmer is likely to need. These include the ability to create field boundary maps, import maps from other sources, record field data, record scouting reports, assign crop enterprises, generate prescription application plans, and analyze yield maps. Some programs are available in both office and mobile versions. Office versions run on desktop or laptop computers, and mobile versions run on laptop or hand-held computers. Mobile software is extremely useful for field scouting and mapping boundaries. Some programs integrate well with other farm management software or programs to give the farmer a complete management package.

Guidance Systems

A guidance system is an electronic control system that aids the operator in steering or guiding a vehicle over a course or swath. Systems used in agriculture are based on the global navigation satellite systems (GNSS). GNSS data are used to determine accurate machine position, travel speed, and travel direction. Once position, speed, and direction are determined, the control program can monitor and provide correction information to keep the vehicles on the desired path. GNSS can be used for guidance at any level of correction: WAAS, beacon, satellite subscription, and RTK. However, the higher the accuracy of the GNSS service, the more precise the steering control will be. This control will be a key factor for both planting and digging operations.

Current guidance systems fall into two categories: steering aids and automatic steering. Steering aids include light bars and navigation screens. Light bars use a series of lights to indicate to the operator how much steering correction is needed to keep the vehicle on track. Each light left or right of the center can be programmed to represent whatever level of correction the operator wants to see. Navigation screens use a visual representation of the vehicle on a map. The guideline is projected on the map screen, and the operator uses the vehicle image on the map to keep the vehicle on the swath in the field. Some steering aids use both light bar and map screen layouts.

Automatic steering systems interface with the tractor steering system and provide steering control while the vehicle is on the swath. The operator may still take over steering control for turnarounds. Some systems can handle the turnaround automatically in some setups and field situations. In the event of a problem, the operator can override the automatic steering at any time. Automatic steering systems use guidelines established in the field to steer the vehicle. Like steering aids, the guidelines can be straight lines or curves, depending on the type of system. Once a set of guidelines are created, they can be used repeatedly in that field. Automatic steering systems fall into two types: steering wheel interface (universal) and electrohydraulic interface (integrated). A steering wheel interface can be adapted to a wide range of vehicles. As its name suggests, it is attached to the steering column and engages the steering wheel much like an operator's hand. Precision motors are used to move the wheel to keep the vehicle on the swath. Electrohydraulic interface systems use an electronically controlled hydraulic valve that is installed in the vehicle's hydraulic steering circuit. These systems must be matched to the specific vehicles they are designed for. Installation will require mounting the valve and its controls and sensors, as well as adding hydraulic hoses to tie into the hydraulic steering circuit.

Guidance systems can be used to advantage in almost any field operation in peanut production. The best uses, however, would be planting, cultivation, chemical application, and digging. Guidelines can be created at any time; however, the best advantage is obtained when the guideline is created early and used to help control other operations throughout the season. For example, a guideline file can be created during bedding or planting and used to guide cultivation, chemical application, and digging. In a test conducted at the Peanut Belt Research Station in 2009, plots that were dug using a wheel-interface automatic steering system showed an increase in yield of 363 pounds per acre over plots dug with manual steering. In this test, the peanuts were planted using the automatic steering system and the planting guideline was used for digging. Based on a system cost of $23,500 for the automatic steering components and $0.25 per pound for peanuts, payback can be achieved in 256 acres. Individual results may vary, but automatic steering will be advantageous.

Guidance systems used in crop production can provide many advantages:

- More uniform broadcast applications due to reduced skips and less overlap.
- Increased field capacity due if higher operating speeds are possible.

- Controlled traffic to reduce soil compaction.
- Ability to stay on swath in rank vine growth during late season spraying and digging.

Variable Rate and Applicator Controls

Variable rate control systems are available for a wide range of crop inputs: fungicides, insecticides, herbicides, lime, fertilizer, and others. If you can determine, through soil sampling, scouting, or other analysis, areas of a field that do not need as much of a particular input as others, then you may have a situation where variable rate control can be beneficial. Variable rate application may not reduce the total amount of an input, but will certainly allow you to use the input more efficiently by making sure you have the correct amount applied for any given area of the field.

Most variable rate control systems rely on georeferenced prescription maps. Systems are being developed to apply products based on real-time sensor data. The variable rate controller reads position data from a GNSS receiver. The controller then determines the rate of input for that location stored on the prescription map. The rate information is converted into a control signal for the valve or motor that drives the applicator. Finally, a feedback signal is picked up and sent back to the rate controller to fine-tune the output. The result is an accurate application of the product based on the prescription recorded on the map. As an added advantage, the controller can also generate a record map of the exact rate applied by the system. This record can prove to be valuable documentation.

Applicator controls are also available to help the farmer control the system's operation in the field, even if a variable rate approach is not used. Many controls are available now that allow the farmer to automatically manage individual sections or rows of a sprayer or a planter. These controls can be particularly useful to avoid areas of double application around headlands in oddly shaped fields. Section control at planting can be used in peanut production, but you should consider digger size and performance before staggering rows with section control.

Crop Monitoring

There are many applications under development for collecting crop health or status data during the growing season. Satellites, airplanes, and unmanned aerial vehicles (UAV) are among the options available. Data in the form of visual images, multispectral images, hyperspectral images, and others are currently available. Applications of these sensor platforms and the data they generate for peanut are under development and may prove to be valuable management tools.

Yield Monitors

Yield monitoring provides a check to see if management and production practices throughout the season have paid off. Yield maps and the detailed analysis of yield response to inputs can help the farmer fine-tune production practices and enhance efficiency. At this point, there are no widely used commercial yield monitors available for peanuts. Researchers in several peanut producing states have worked on developing a peanut yield monitor. Several studies have been conducted to adapt the cotton yield monitor to peanuts. Although this adaptation has been effective in some cases, it has not been adopted on a wide scale. Development of a reliable yield monitor for peanuts will complete the precision agriculture package.

A Comprehensive Approach

Precision agriculture, like most management systems, has some limitations and problems that must be overcome. When considering using precision agriculture technology for peanut production or for other crops, the farmer should consider the entire production system. Focus on technologies that are applicable to a particular problem, and also explore how these technologies can be used in other areas. Some applications are well developed, while others need further research to determine the best way to use the technology for crops such as peanuts. Multiple uses of equipment help spread the cost over several operations or even several crops. For example, a GNSS-based guidance system selected to help guide a planter can also guide a sprayer and a digger. Rate controllers used for sprayers may also be able to control a planter. It may not be necessary to purchase every available technology on the market. Before launching into a system, compare the options and alternatives carefully. Start out with the most applicable technologies first, and then add to them as needed.

8. GUIDELINES FOR THE NORTH CAROLINA PEANUT PRODUCTION CONTEST AND 5,000 POUND CLUB

David L. Jordan
Extension Specialist—Department of Crop and Soil Sciences

Bob Sutter
Chief Executive Officer—North Carolina Peanut Growers Association Inc.

BACKGROUND AND CRITERIA

For many years the North Carolina Peanut Growers Association, in cooperation with NC State Extension, has supported a peanut production contest at county and state levels and a luncheon to recognize farmers producing an average of at least 5,000 pounds per acre on all of their production. Information in Table 8-1 shows the average yield of the 5,000-pound club members from 2014 to 2017 in contrast with state averages and growers attending county production meetings. Entries should be sent to Bob Sutter (sutter@aboutpeanuts.com) and David Jordan (david_jordan@ncsu.edu) by January 20 to be eligible. Growers with a point total of 60 or more will also be recognized as a member of *The Group of Sixty*. Achieving 60 points, as outlined in the next section, is truly remarkable.

Table 8-1. Peanut yield (pounds/acre) from 2014 to 2017

Year	State Average	Grower Meetings Participants	5,000 Pound Club
2014	4,320	4,860 (3,600 to 6,400)	5,660
2015	3,400	4,080 (0 to 5,700)	5,700
2016	3,450	3,840 (0 to 5,740)	5,540
2017	4,030	4,650 (2,300 to 6,530)	5,500

The peanut production contest involves a combination of yield per acre and additional points based on total acreage. The following criteria are currently being used and include an example calculation.

1. *Eligibility*: Must produce at least 25 acres of peanuts.

2. *Requirements*:

   A. Variety—Any variety can be grown.
   B. Acreage—The entire peanut acreage under production by an individual will be used to determine official yields. The applicant enters the county in which he/she is a resident, regardless of the percentage of peanuts they produce in

that county. The county of residence for the entrant must have at least 1,000 acres.

C. Entry requirement—Official yields will be determined by the county Cooperative Extension agent. The contest will require trust that the applicant is accurately providing yield and acreage information.

3. *Point System*: An example of point calculations is provided below. The official entry will be from the contestant's county of residence (Figure 1).

Step 1. Yield—Average yield per acre (net weight) divided by 100.
Step 2. Acreage—Points will be accumulated for acreage as follows:

A.	0 – 100 acres	0 points
B.	101 – 200 acres	1 additional point or fraction thereof
C.	201 – 300 acres	1 additional point or fraction thereof
D.	301 – 400 acres	1 additional point or fraction thereof
E.	401 – 500 acres	1 additional point or fraction thereof
F.	501 – 600 acres	1 additional point or fraction thereof
G.	601 or higher	No additional points

Sample calculation:

Farmer produces 2,397,407 pounds on 420.2 acres
Average yield = 2,397,407 divided by 420.2 = 5,705.4 pounds per acre

Step 1. 5,705.4/100 = 57.054

Step 2. Acreage

0 – 100 acres	=	0 point
101 – 200 acres	=	1 point
201 – 300 acres	=	1 point
301 – 400 acres	=	1 point
401 – 500 acres	=	0.202 point
Total Points	**=**	**60.256**

GROWER SURVEY

Applicants also must complete a survey of production and pest management practices (Figure 8-2). Results from surveys often are incorporated into recommendations for North Carolina peanut producers.

Figure 8-1. Sample Certification Form

CERTIFICATION OF POINTS IN PEANUT PRODUCTION CONTEST

Date ______________________

Applicant ______________________ County ______________________

Address ______________________ Total Points ______________________

____

Official Yield __________ ON ALL ACRES PRODUCED BY THE APPLICANT

THE APPLICANT CERTIFIES THAT __________ POUNDS OF PEANUTS WERE HARVESTED FROM ____________ ACRES. THE UNDERSIGNED PARTICIPANT GUARANTEES, IN GOOD FAITH, THAT THE PRODUCTION FOR THE GIVEN CROP YIELD AND THE ACRES ON WHICH PRODUCTION OCCURRED ARE ACCURATE.

Average Yield/Acre = ______________________ points

Acreage

A.	0 – 100 acres	________
B.	101 – 200 acres	________
C.	201 – 300 acres	________
D.	301 – 400 acres	________
E.	401 – 500 acres	________
F.	501 – 600 acres	________
G.	601 or higher	________
Total		________
Grand Total		________

Signatures ______________________

County Agent ______________________

Applicant ______________________

Figure 8-2. Sample Production Practices Survey

MANAGEMENT PRACTICES FOR PRODUCTION CHAMPION AND 5000 POUND CLUB—2018 SEASON

Applicants must complete this form to be eligible for the contest.

Name ______________________________ County ____________________

Address ____

Date _________________________

1. Planting date: ________________

2. Seeding rate: ________________

3. Row spacing: Twin or single rows: _________________
   Please provide approximate percentage of acres for each.

4. Varieties (please indicate approximate percentage of acres for each variety):

____

5. Rotation Crops:

2017 ________________ (if more than one, please include percentage of acres)

2016 ________________ (if more than one, please include percentage of acres)

2015 ________________ (if more than one, please include percentage of acres)

2014 ________________ (if more than one, please include percentage of acres)

2013 ________________ (if more than one, please include percentage of acres)

2012 ________________ (if more than one, please include percentage of acres)

6. Lime applied and rate:
   2018 ______________________ 2017 ______________________

7. Fertilizer used: ________________ (provide percentage of acres)

8. Land plaster (please list trade name): ______________________

9. Broadcast or Banded ____________________

10. Bagged, Bulk, or Granular ________________

11. Rate and application date ______________________

Figure 8-2. Sample Production Practices Survey (continued)

12. Herbicides:

Burndown	__________	__________	__________
Preplant	__________	__________	__________
Preemergence	__________	__________	__________
At cracking	__________	__________	__________
Postemergence	__________	__________	__________

13. Leaf spot program: (list fungicide for each timing)

A.	__________	E.	__________
B.	__________	F.	__________
C.	__________	G.	__________
D.	__________	H.	__________

14. What percentage of your acreage was treated for Sclerotinia blight? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

15. What percentage of your acreage was fumigated for CBR? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

16. What percentage of your acreage was treated with an in-furrow insecticide? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

17. What percentage of your acreage was treated for foliar insects? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

18. What percentage of your acreage was treated for southern corn rootworm? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

19. What percentage of your acreage was treated for spider mites? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

20. What percentage of your acreage was irrigated? (circle the percentage)

0 20 40 60 80 100

21. Did you apply boron? ______ How much and what brand?____________________

22. Did you apply manganese? ______ How much and what brand? ____________________

Figure 8-2. Sample Production Practices Survey (continued)

23. Did you inoculate? ________ What product and what percentage of acres?

____

24. What percent of your acreage received the following tillage practices?

Disk	0	20	40	60	80	100
Chisel	0	20	40	60	80	100
Moldboard plow	0	20	40	60	80	100
Field cultivate	0	20	40	60	80	100
Bed	0	20	40	60	80	100
Rip and bed	0	20	40	60	80	100
Strip till	0	20	40	60	80	100
No till	0	20	40	60	80	100

25. Did you apply Apogee or Kudos on your peanuts? If so, what percentage and to what varieties?

26. Place a number for each piece of equipment in a size category.
________ 2-row digger
________ 4-row digger
________ 6-row digger
________ 2-row pull type combine
________ 4-row pull type combine
________ 6-row pull type combine
________ 6-row self-propelled combine
________ 8-row self-propelled combine

27. How many days did it take to dig and harvest your entire peanut crop?
_______dig
_______ harvest

28. What caused your greatest delay in harvesting?

29. What decisions and/or practices contributed most to your success?

9. COMPATIBILITY OF AGROCHEMICALS APPLIED TO PEANUT

David L. Jordan
Extension Specialist—Department of Crop and Soil Sciences

Barbara B. Shew
Extension Specialist—Department of Entomology and Plant Pathology

Rick L. Brandenburg
Extension Specialist—Department of Entomology and Plant Pathology

Numerous pests impact peanut growth and development as well as yield and quality (Table 9-1). In addition, growers apply fertilizers and plant growth regulators to improve or manage peanuts (Table 9-1). Growers often apply more than one pesticide, foliar fertilizer, plant growth regulator, and adjuvant at the same time in order to save time and because a single application is more convenient. In many cases, applying agrochemicals at the same time as tank mixtures is successful in controlling pests and improving plant health. However, on occasion there can be problems associated with poor control and greater injury to peanut than normally expected. Also, in some cases precipitates form that can prevent delivery of spray solutions when products are tank mixed.

Defining interactions of agrochemicals before growers prepare spray solutions with multiple components in the mixture is one goal of research and extension efforts at NC State University. This goal can be challenging, especially given that several thousand possible combinations can be applied because of the diversity of products registered for weed, insect, and disease control and plant growth regulation. The following comments on agrochemical interactions were developed to provide a general sense of interactions that might occur. Product labels do not always provide adequate information on how products will interact in all instances, especially in regions where water quality and other factors differ. Also, the label for one product will in many cases refer the user to other product labels. Although it is clear that the most restrictive label is to be followed, there are challenges in understanding the intent of label recommendations. However, state and federal labels are the law, and users are required to follow the specifics of the product labels.

WHY TANK MIX?

Growers have limited time to complete all of their tasks in the field, and although sequential applications often are more effective, they require a greater investment in time and labor. Extra trips across the field also decrease the life of equipment and increase transportation of equipment and water to and from fields. Even though

Table 9-1. Schedule for management of biotic and abiotic stresses in peanut. *Shaded months indicate a time when a stress is often addressed in peanut.*

STRESSES	APRIL	MAY	JUNE	JULY	AUG	SEPT
Weeds						
Broadleaf	■	■	■	■	■	
Sedge	■	■	■	■		
Grass	■	■	■	■	■	
Insects						
Thrips	■	■	■			
Corn rootworm				■	■	
Corn earworm				■	■	■
Fall armyworm				■	■	■
Beet armyworm				■	■	■
Spider mites			■	■	■	■
Diseases						
Botrytis					■	■
Cylindrocladium black rot (CBR)	■	■				
Pythium	■	■				
Aspergillus crown rot	■	■				
Early leaf spot				■	■	■
Late leaf spot				■	■	■
Rhizoctonia limb rot				■	■	
Sclerotinia blight				■	■	■
Spotted wilt virus	■	■				
Stem rot	■	■		■	■	
Web blotch				■	■	■
Nematodes	■	■	■			
Nutrient and Vine Management						
Boron			■	■		
Bradyrhizobia	■	■				
Calcium			■	■		
Manganese			■	■		
Prohexadione calcium				■	■	

tank mixing can result in control of one species that is less than ideal, the value in making a single application of several agrochemicals can outweigh the partial control obtained. This approach will depend on the pest in question and the degree of reduction in control, either through incompatibility or suboptimal timing of application for individual components of the mixture. For all pests, there is generally an optimum timing for control when considering pest size, stress status, and deposition of spray solutions in the peanut canopy. In some operations, especially large operations during the busiest times of the year, making a tank-mix application that controls most of the pests in a given field at the desired level is the goal. These growers can then go back to some of their acres with a second application to control the pest completely. For these growers this approach is often more feasible than spending time developing numerous programs for individual fields or groups of fields. Certainly the most informed decision and implementation of that decision on a field-by-field basis is desired, reflecting sound principles of integrated pest management. However, in practice this goal can be difficult in large operations. The impact of tank mixing on crop response and pest control is very important. But even before the sprayer reaches the field, growers need to make sure the combination of products does not settle and create a load of water and agrochemical precipitates that has to be cleaned and disposed of in some manner.

SPECIFIC QUESTIONS TO CONSIDER

There are several specific questions that need to be addressed, either based on local conditions or recommendations and comments on labels of products. First, is the formulation more important than active ingredient in terms of impact on the tank mixture? Some formulations of chlorothalonil, for example, can affect control by grass herbicides more than others. Second, how does the adjuvant recommended for each component differ? For example, if you are trying to control annual grasses with a clethodim product or a sethoxydim product and want to add fungicides to control stem rot, how will the adjuvant recommendations for both products influence control of both weeds and disease? Clethodim and sethoxydim require crop oil concentrate, whereas fungicides designed to control stem rot generally do not require adjuvant. In fact, a crop oil concentrate most likely will retain much of the fungicide on peanut leaves, with an insufficient amount of fungicide reaching the base of the plant where it is needed for complete control of stem rot. A second example is mixtures of Omega 500 with clethodim or sethoxydim. These herbicides require crop oil, and Omega 500 needs to reach the base of the plant. The key is to make sure pesticide performance is optimized or at least considered when mixing, and the adjuvant required for both products should be considered. As mentioned previously, growers may need to balance the need to cover significant acres in a timely manner, which tank mixtures often facilitate, with obtaining adequate but not complete control of all pests in the equation.

Another question relates to water hardness and softness as well as the effects of spray solution pH. Some products can be adversely affected by positively charged compounds (referred to as cations) in the spray solution, with clethodim and sethoxydim being good examples. When control is compromised by presence of cations, other products that are added to the tank that generally affect control only slightly can have a much greater negative impact. Fortunately, many of the products used in peanut are not affected to a great extent by hard or soft water.

Stress and pest size can affect control achieved by tank mixtures compared with applying agrochemicals independently. If weeds are large or drought stressed, reductions in control that can occur are often greater in magnitude. When applying products together it is important to be timely in applications, as this can minimize adverse effects when extremes in stress or pest size exist. Also, when tank mixtures are applied, all of the target pests are generally not at the optimum size or stage of development. Mixtures are often applied at a time that hits a happy medium. While this timing is often not a big issue, in some cases poor control of one pest may occur because one pest gets larger and more difficult to control as application is delayed.

GENERAL OBSERVATIONS ABOUT TANK MIXING

It is important to remember that the product label is the most important reference on using pesticides. However, in many cases product labels are incomplete in terms of mixing products. The following are general comments about tank mixtures that have resulted from observations or reports and from detailed research projects at NC State University. These comments are to be used as a guide for products that can be applied legally based on the most recent product label for a particular agrochemical.

In-Furrow Products

When considering applying products in the seed furrow at planting, keep in mind that seed cost is the highest single investment, replanting is very expensive, the planting date window is very narrow in North Carolina, and spotty or low plant populations are more prone to having tomato spotted wilt. Typically, seed is pretreated with fungicide, and there are no reports of interactions with other agrochemicals with respect to fungicide seed treatments.

Many growers are applying inoculant in the seed furrow as a spray or granular material. It is important to keep in mind that inoculants contain bradyrhizobia, a living bacteria that infects peanut roots and is responsible for biological nitrogen fixation. It is important to treat inoculants properly to ensure that bacteria are alive and able to function adequately. The in-furrow insecticides currently used in peanut to control thrips—including acephate, Admire Pro, Thimet, and Ag-Logic—are compatible with inoculants.

In recent years, companies have pursued labels for fungicides generally used later in the season for in-furrow application. For example, Folicur was labeled but often resulted in delayed peanut emergence; however, this delay did not negatively affect inoculant performance. More recently, Proline has been used to suppress CBR and improve stem rot control. Currently, Proline appears to be compatible with in-furrow inoculants and insecticides.

Several distributors have in-furrow products that serve as growth stimulants and enhancers, and some growers have used these products and feel that they affect peanuts positively. From a research standpoint, it is impossible to compare all products available on the market. While growth stimulants and enhancers may in some instances affect peanuts positively, in general these products will not improve emergence or early-season growth all of the time. In fact, they probably affect peanuts—both positively and negatively—only on occasion and under conditions that are unique and hard to repeat. Given the expense of peanut seed and the fact that many growers are already applying inoculant and insecticide (and in some cases fungicide) in the seed furrow, our general recommendation is to think carefully about the possible benefits and detriments of adding unproven products in the seed furrow.

Some growers apply relatively low rates of fertilizer either in the seed furrow or to the side and below the seed furrow. Generally, research has shown little benefit from startup fertilizers for peanuts. Corn certainly responds to these applications, especially phosphorus in some cases, but peanuts seldom respond to fertilizers at planting. In some instances, growers have lost stands or had peanut stands decrease considerably due to fertilizers applied in the seed furrow. With the expense of seed, our recommendation is not to apply fertilizer in the seed furrow or as a band close to the seed furrow.

Weed Control with Paraquat

To minimize peanut injury from paraquat (various formulations) we recommend that growers always add Basagran at least 0.5 pt/acre to paraquat. This practice will reduce symptoms significantly, especially when paraquat is applied with residual herbicides such as metolachor or *S*–metolachlor (Dual Magnum and other products), dimethenamid–*P* (Outlook), acetochlor (Warrant), or pyroxasulfone (Zidua). Injury following application of paraquat with residual herbicides will always be higher than injury when these are not included, irrespective of Basagran treatment. In some cases less grass control occurs when Basagran is included, but other weeds such as yellow nutsedge and our typical complex of broadleaf weeds are controlled more effectively with the mixture of paraquat and Basagran compared with these herbicides applied alone. In fact, if considerable yellow nutsedge is present, a higher rate of Basagran is recommended when applied with paraquat. Paraquat is compatible with acephate as an early postemergence spray. However, if thrips damage is significant, application of paraquat should be avoided. Some research indicates that peanut injury following

Basagran is greater when Thimet or Phorate is applied in the seed furrow. This injury is infrequent and occurs when Basagran is applied at a higher rate for nutsedge control and when peanuts are planted on coarse-textured soils and are already suffering from injury caused by insecticides. Applications of Basagran later in the season, after peanuts have outgrown thrips damage and insecticide injury, are generally okay.

Weed Control with Grass and Broadleaf/Sedge Herbicides

Grass control by clethodim (various formulated products) and Poast is often reduced by Cobra, Storm, and Ultra Blazer (ranging from 10 percent to 40 percent, depending on many factors), is reduced less by Cadre and Pursuit (0 percent to 30 percent), and is reduced even less by 2,4-DB or residual herbicides (metolachlor or *S*–metolachlor products and Outlook) (10 percent or less). Broadleaf weed control by Cadre, Pursuit, Ultra Blazer, Cobra, Storm, and 2,4-DB is generally not affected by fungicides, insecticides, or other herbicides (up or down 10 percent). In some cases Basagran reduces control by Pursuit, but this mixture is seldom used in peanuts.

Grass control is generally lower when clethodim (various products) or Poast are applied with chlorothalonil products, Headline, and Abound more so than application with Provost, tebuconazole (various products), and Omega 500. Control reductions of as much as 60 percent can occur when these grass herbicides are applied with chlorothalonil, Headline, or Abound, but reductions in control most often fall in the range of 0 percent to 20 percent compared with the grass herbicide alone. Pyrethroid insecticides do not adversely affect grass control by clethodim products or Poast. Research suggests that acephate can reduce grass control by these herbicides, but the reduction is minor. Compatibility of many of the newer fungicides with herbicides has not been evaluated in recent years. Additional research in this area of study is planned.

Applying herbicides and other products sequentially eliminates the compatibility issue, especially when the grass herbicide is applied prior to the broadleaf/sedge herbicides. In some instances, increasing the grass herbicide rate in the mixture by 25 percent to 50 percent can reduce the antagonism. However, this approach is product specific and is not always reflected on the label.

Disease Control

Disease control generally is not affected by insecticides or herbicides. Also, insect control is generally not affected by fungicides or herbicides. However, keep in mind that specific adjuvant recommendations need to be followed in order to optimize pesticide performance. Adjuvants are almost always recommended for use with herbicides, whereas adjuvants are only used on occasion with fungicides or insecticides, especially the products used in peanut. Fungicide mixtures often increase disease control and are an important tool in resistance management. Although the issue of compatibility is not related to interactions in the spray solution, mixtures of chlorothalonil with fungicides to control Sclerotinia blight can result in greater incidence of this disease.

Insect Control

Fungicides and herbicides generally do not affect insect control by insecticides. As was noted for fungicides, there are differences in recommendations relative to adjuvant selection and insecticide performance. While interactions with insecticides and other pesticides are often not noted in tank mixtures, use of insecticides can change the balance of beneficial and problematic insects, resulting in the need to address secondary outbreaks of insects. This need is particularly important when considering populations of spider mites.

Plant Growth Regulators

Performance of the plant growth regulators Apogee and Kudos (both contain the active ingredient prohexadione calcium) have not been affected by agrochemicals in trials conducted at NC State University. However, Apogee and Kudos are expensive and require both crop oil or nonionic surfactant and, most important, nitrogen to perform at the highest level. Nitrogen is absolutely critical, and growers are encouraged to look closely at product labels to determine whether and how Apogee or Kudos should be applied with other products. Based on research conducted at NC State University, there appears to be no increase in injury or poor performance when other products are applied with Apogee with respect to row visibility (the primary role of Apogee and Kudos). Much less is known about the effect of Apogee or Kudos and the adjuvant system needed for these products on performance of fungicides or insecticides. Apogee and Kudos do not appear to negatively impact weed control by postemergence herbicides.

Micronutrients

Boron and manganese products generally do not affect pest control, but pesticide and adjuvant can affect absorption of micronutrients. There is little concern about increased burn from manganese products, but there is some concern relative to boron toxicity. When using dry materials, make sure the products go into solution before preparing the entire mixture. While aggravating to prepare, creating slurries of dry manganese products and water often can prevent settling in the tank and clogging spray nozzles and associated delivery components. Cleaning a sprayer that has a spray solution that has settled is time consuming and can be expensive,

SUMMARY

Compatibility of agrochemicals is important to know but can be difficult to define, especially when three or more components are included in the mixture. A considerable amount of research has been conducted at NC State University and other universities in the peanut belt, but defining all possible combinations is not possible. A wide range of new pesticides or new formulations of older pesticides are currently available, and formulation is known to affect compatibility as much as the active ingredient for some pesticides. Distributors also market a wide range of growth enhancers and stimulants as well as formulations of micronutrients. Very little research is available on compatibility of more recently marketed materials with agrochemicals historically applied in peanut. Growers are encouraged to read product labels thoroughly, follow product label recommendations, and contact Cooperative Extension personnel, consultants, distributors, and manufacturers to get information on possible agrochemical interactions before mixing products. Several new fungicides, herbicides, and insecticides have received labels for peanut. A portion of our research plans include determining compatibility of new active ingredients and formulations.

10. PEANUT GROWTH AND DEVELOPMENT AND PEANUT INDUSTRY TERMINOLOGY

David Jordan
Peanut Specialist—Department of Crop and Soil Sciences

INTRODUCTION

With the exception of Table 10-2, the information is this section is adapted from *Agronomic Recommendations and Procedures* by Dr. Maria Balota in *2016 Virginia Peanut Production Guide*, Virginia Cooperative Extension Service, Publication AREC-117NP.

GROWTH AND DEVELOPMENT

Optimal temperature for peanut growth is between 77°F and 86°F. Plant growth is significantly slower at temperatures below 60°F and above 95°F. Leaf and stem weights increase up to a maximum value, which occurs at about 90 to 100 days after planting (DAP). Good vine production is necessary for a good pod yield. Drought and heat can reduce vine production and therefore yield, even though peanut is an indeterminate plant. As such, peanut can resume growth after a drought episode even during the reproductive period, re-bloom, and produce another crop of pegs. However, optimal temperatures are minimized during the critical 60 to 100 DAP interval.

Optimum temperature for peanut flowering and fruit-setting is between 83°F and 91°F. Drought and heat stress reduces flower production and pollination, and extreme soil surface temperatures cause peg abortion. Peanut pollination and seed set hold up well under low weather as long as daily maximum temperatures do not exceed 97°F. Even under the most ideal conditions, maximum peanut pollen viability is about 90 percent and maximum seed set is about 75 percent. Above 97°F maximum temperature there is decline in both pollination and seed set. If the daily high temperature reaches 104°F, pollen viability can drop to around 70 percent and seed set to around 50 percent. Although standard weather station temperatures seldom reach 104°F, peanut canopy may be greater than that measured in weather station shelters in sensitive varieties, and may be lower in tolerant ones. Therefore, development and use of tolerant varieties is critical in dry and hot years.

Approximate days from planting until a specific growth stage and a description of growth stages are presented in Table 10-1. Examples of when key growth stages most likely would be reached based on planting date are provided in Table 10-2. Note that in any given year heat unit accumulation could differ and subsequently affect actual number of days when peanuts would reach a particular growth stage,

Table 10-1. Peanut Growth Stages and Descriptions

Approximate Number of Days After Planting*	Growth Stage	Description
7	Emergence	Seedling “cracking” the ground and cotyledons visible
45	Flower (R1)	One-half of the plants with a bloom
55	Beginning Peg (R2)	First visible peg
70	Beginning Pod (R3)	Peg tip swollen to twice the peg diameter
75	Full Pod (R4)	Fully-expanded pod, to dimensions characteristic of the variety
80	Beginning Pod-Fill (R5)	Pod in which seed is visible in cross-section
90	Full Size Seed (R6)	Seed is filling the pod cavity
130	Beginning Maturity (R7)	Pods having interior hull color and orange to brown mesocarp
150 – 160	Harvest Maturity (R8)	70% of harvestable pods have an orange, brown, or black mesocarp (scrape pod saddle with knife) and interior hull color (crack pod open)
165 – 170	Over-mature (R9)	Kernels in oldest pod develop tan-brown seed coat and pegs may have deteriorated; over-mature pods have coal-black mesocarp color.

*Based on average of 30 Virginia market type peanut varieties planted on May 1 at Tidewater AREC. The numbers of days after planting increase for earlier and decrease for later plantings. If June is dry, these numbers are bigger from R1 through R4 and smaller afterwards.

Table 10-2. Approximate Number of Days Between Planting and Various Stages of Peanut Development

Development Stage	Calendar Date or Days after Planting			
	May 1	**May 15**	**June 1**	**June 15**
Emergence	May 10 (10)	May 22 (7)	June 6 (5)	June 20 (5)
Flower (R1)	June 15 (45)	June 25 (40)	July 13 (38)	July 23 (38)
Peg (R2)	June 25 (55)	July 5 (50)	July 23 (48)	Aug 3 (48)
Full pod (R4)	July 15 (75)	July 25 (70)	Aug 10 (65)	Aug 20 (65)
65% brown/black mesocarp development	Sep 25 (145)	Oct 5 (140)	Oct 20 (140)	Nov 15 (150)

Assumes adequate moisture and temperature throughout the season. Estimates are from timing of planting to 65% flowering, pegging, full pod, and brown/black mesocarp color. Cool night temperatures after October 5 could decrease the rate of maturation and negatively impact yield. Peanut planted after June 1 will be in the process of maturing after October 1, and this creates substantial risk. If temperatures are in the high 40°F for two nights in a row, maturity will most likely cease for the remainder of the season and yield will be lower than yield of peanut planted earlier in the season. The predictions of maturity presented here are no substitute for pod blasting (assessing pod mesocarp color) two or three times in September to determine actual maturity in the field.

PEANUT GRADING DEFINITIONS AND ECONOMIC SIGNIFICANCE

The following definitions are intended to assist growers in understanding the economic significance of peanut grading technology.

Farmers' Stock Peanuts: Peanuts the grower brings to the buying point.

FM (foreign material): Everything other than loose peanut kernels and in-shell peanuts in the farmers' stock sample. Foreign materials include dirt, peanut vines, sticks, stones, insect parts, peanut hulls, and "raisins" or "twisters." Raisins or twisters are very immature, shriveled pods that cannot be commercially shelled. Foreign material is the first component to be separated from the grade sample of farmers' stock peanuts. There is no penalty for foreign material up to 4 percent.

LSK (loose shelled kernels): Kernels and parts of kernels that are free from the hull in a load of a farmers' stock peanuts. LSKs are the second component separated out in grading. LSKs are undesirable because they spoil more rapidly and are more likely to be contaminated with aflatoxin. LSKs are checked for *Aspergillus flavus* mold by the grader. At this point the grade sample has had the foreign material and LSKs removed. The remaining intact pods are then run down a set of sizing rollers to pre-size them for the proper shelling and to determine the percent of "fancy pods" for Virginia types.

Fancy Pods: The percentage of fancy (larger) pods is determined (Virginia type only) by the percentage that rides a 34/64-inch roller spacing. The grower is not rewarded for fancy pods other than that they must meet the 40 percent fancy pod minimum to qualify for Virginia type market. At this point the sample is shelled and the kernels will be mechanically shaken on screens.

ELK (extra large kernels): An ELK screen is used only for Virginia type. ELK is the percentage by weight of kernels from the shelled sample that rides a 21.5/64-inch by 1-inch screen. There is a premium for each percent ELK.

SMK (sound mature kernels): the percentage by weight of kernels from the shelled sample that rides a 15/16-inch by 1-inch (Virginia type) or a 16/16-inch by 3/4-inch (runner type) screen.

SS (sound splits): The percentage by weight of kernels from the shelled sample that consists of undamaged split kernels or broken kernels (undamaged ¼- to ¾-kernel pieces); pieces less than ¼ kernel remain on OK (other kernel category); pieces larger than ¾-kernel are considered SMKs. There is no sound split penalty up to 4 percent and for each percent above 4.

TSMK (total sound mature kernels): TSMK is the total SMK (sound mature kernels) + SS (sound splits). ELKs (extra large kernels) are also included in TSMK for Virginia types.

OK (other kernels): The percentage by weight of kernels from the shelled sample that falls through the SMK screen. Other kernels are mostly smaller, less mature kernels. Pieces of broken kernels less than ¼ kernel size are also included in other kernels. Other kernels are worth less than sound mature kernels.

DK (damaged kernels): The percentage by weight of kernels from the shelled sample that are judged to be inedible due to decay, mold, insect damage sprouting (> 1/8 inch), discoloration or pitting darker than light yellow, freeze damaged, or skin-discoloration (< 25 percent). Although graders do have picture and definition guidelines, the determination of damaged kernels is somewhat subjective. Minor pitting, discoloration, or other damage to the kernel skin or flesh does not constitute a damaged kernel. Notice that broken kernels are also not included in damaged kernels; instead they are classified as sound splits and thus contribute to TSMK. Damaged kernels are the major component of total damage penalties as described in the following sections.

Freeze Damage: The percentage by weight of kernels from the shelled sample that have characteristics of freeze damage such as hard, translucent, or discolored flesh. This damage is included in damaged kernels (DK) and thus contributes to total damage.

Concealed Damage (RMD): Concealed damage—rancid, moldy, or decayed, is damage detected after the kernel sample is put through a kernel splitter and examined on a belt. This damage is added to DK to determine total damage.

Total Damage: The sum of damaged kernels (DK), including freeze damage and concealed RMD. Once total damaged kernels reach 2.5 percent by weight, the penalty can be catastrophic. At damage levels slightly above 2.5 percent, the peanuts can sometimes be cleaned. If they can't be cleaned below 2.5 percent damage, the load is classified as segregation II and is consigned to the oil market, with a potential value as low as 35 percent of loan value.

Hulls: The percentage by weight of hulls from the shelled sample. Although no grade premiums or penalties are based on hull weight, the lower the percentage hull weight, the higher the grade. Hull weights in the lower twenties indicate excellent grades because they indicate that the total kernel weight is the high seventies.

***Aspergillus flavus* mold**: This is mold that produces aflatoxin. Only three grade components are examined for the presence of *A. flavus* mold (LSKs, OKs, and DKs) because these components have the greatest risk. The grader indicates on the grade sheet that *A. flavus* either was or was not detected.

Detection of *A. flavus*. Detection results in the lot being cleaned and re-examined. If the contamination is not adequately removed by cleaning, the peanuts are consigned to segregation III for the oil market, with a potential market value as low as 35 percent of loan value.

11. RISK OF PESTS IN PEANUT, INTEGRATED PEST MANAGEMENT, AND PESTICIDE STEWARDSHIP

David L. Jordan
Extension Specialist—Department of Crop and Soil Sciences

Barbara B. Shew
Extension Specialist—Department of Plant Pathology and Entomology

Rick L. Brandenburg
Extension Specialist—Department of Plant Pathology and Entomology

Greg Buol
Research Technician—Department of Crop and Soil Sciences

Gail Wilkerson
Professor—Department of Crop and Soil Sciences

RISK MANAGEMENT

Managing pest risk in peanut can be complicated and is very important to maintaining a successful and sustainable peanut production system. A pest risk management tool has been developed at North Carolina State University to help peanut farmers and those who advise them. This tool allows users to determine if the production plan they have developed is effective across all pest disciplines. A plan designed to control a pathogen and prevent disease might increase incidence of another disease-causing pathogen or insect. Farmers, Extension agents, consultants, and others in the agricultural sector are encouraged to try the peanut risk tool as they develop management strategies for the 2019 peanut crop.

Step 1. Access the risk tool at the following website:
agroclimatenc.ncsu.edu/peanut/riskmgmt/

Step 2. Select North Carolina and then “Go” if you want to use the tool without having an account (Figure 11-1). If you want the ability to save field plans and make changes during future visits, create an account and use the login option.

Step 3. Input data in all sections on the left side of the screen (Figure 11-2).

Step 4. The number of red, yellow, or green dots on the right side of the screen indicates the risk level to yield you are taking with the pest management practices you have decided to use.

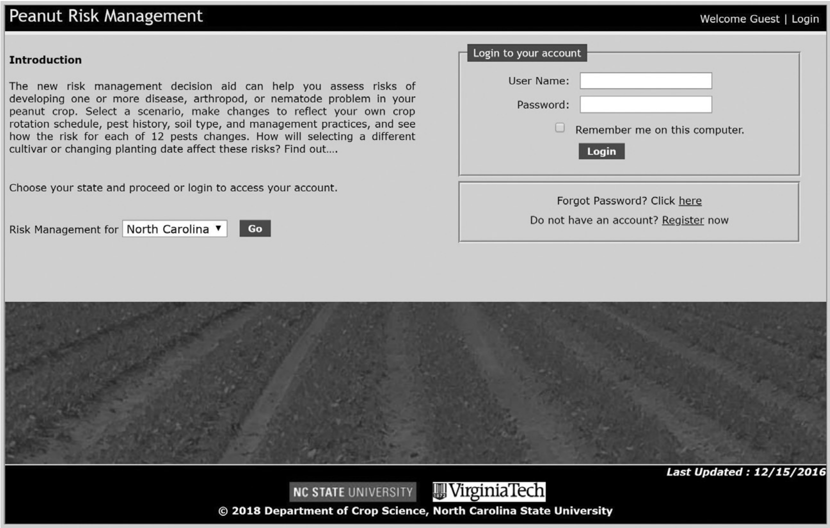


Figure 11-1. Peanut risk management tool access screen.

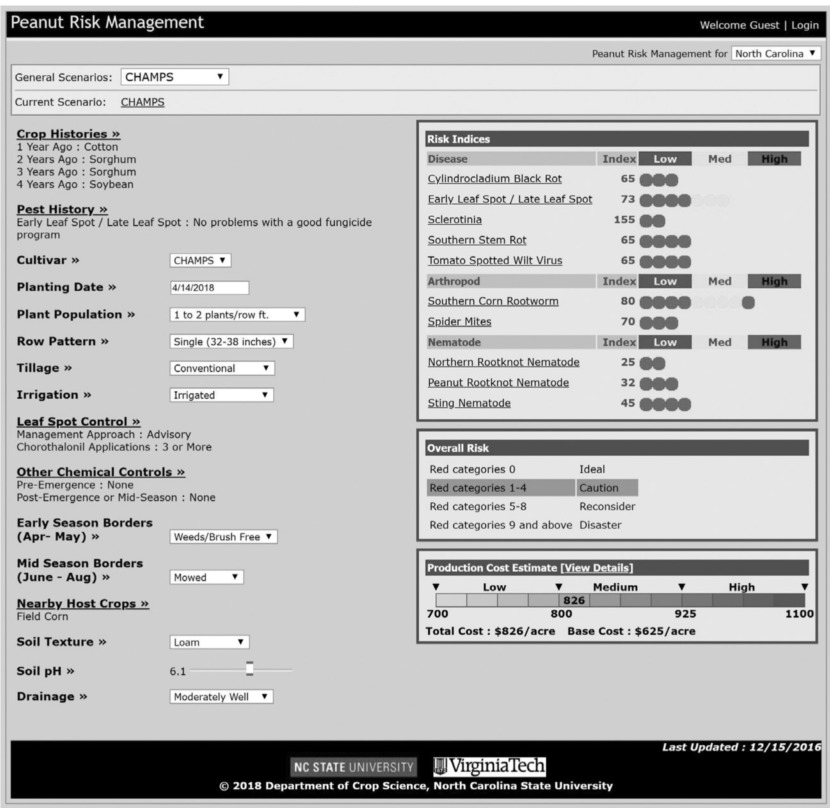


Figure 11-2. Data entry screen.

Step 5. If needed, change practices to minimize risk, but keep in mind that risk of other pests can be affected and that production costs will also change.

Step 6. Remember the risk tool is for planning prior to the season. Almost all farmers start with a plan but need to make adjustments based on weather, pest outbreaks, and economic constraints. This risk tool was created to help farmers start the season by selecting practices that minimize pest risk and identify pests that might impact peanut yield during the season. The risk tool is currently being updated to reflect new varieties, production and pest management practices, and to include a weed management category. Please contact your local county Extension agent or specialists if you have questions.

INTEGRATED PEST MANAGEMENT (IPM)

Integrating pest management strategies is important in protecting yield from pests. The Southern IPM Center (http://www.sripmc.org/) defines IPM in the following manner:

> *Integrated pest management (IPM) is socially acceptable, environmentally responsible, and economically practical crop protection. Traditionally, a pest is defined as any organism that interferes with the production of the crop. We generally think of pests as insects, diseases, and weeds, but there are many other types, including nematodes, arthropods other than insects, and vertebrates. We now also deal with pests in many non-crop situations, such as human health and comfort.*

The Southern IPM Center also suggests the following approach to protecting peanut and other crops from pest injury by using the PAMS approach (Prevention, Avoidance, Monitoring, Suppression):

> *Adoption of integrated pest management (IPM) systems normally occurs along a continuum from largely reliant on prophylactic control measures and pesticides to multiple-strategy biologically intensive approaches and is not usually an either/or situation. It is important to note that the practice of IPM is site-specific in nature, with individual tactics determined by the particular crop/pest/environment scenario. Where appropriate, each site should have in place a management strategy for Prevention, Avoidance, Monitoring, and Suppression of pest populations (the PAMS approach). In order to qualify as IPM practitioners, growers should be utilizing tactics in at least three of the four PAMS components. The rationale for requiring only three of the four strategies is that success in prevention strategies will often make either avoidance or suppression strategies unnecessary.*
>
> ***Prevention** is the practice of keeping a pest population from infesting a field or site and should be the first line of defense. It includes such tactics as using pest-free seeds and transplants, preventing weeds from reproducing, irrigation*

scheduling to avoid situations conducive to disease development, cleaning tillage and harvesting equipment between fields or operations, using field sanitation procedures, and eliminating alternate hosts or sites for insect pests and disease organisms.

Avoidance *may be practiced when pest populations exist in a field or site but the impact of the pest on the crop can be avoided through some cultural practice. Examples of avoidance tactics include crop rotation such that the crop of choice is not a host for the pest, choosing cultivars with genetic resistance to pests, using trap crops or pheromone traps, choosing cultivars with maturity dates that may allow harvest before pest populations develop, fertilization programs to promote rapid crop development, and simply not planting certain areas of fields where pest populations are likely to cause crop failure. Some tactics for prevention and avoidance strategies may overlap in most systems.*

Monitoring *and proper identification of pests through surveys or scouting programs, including trapping, weather monitoring and soil testing where appropriate, should be performed as the basis for suppression activities. Records should be kept of pest incidence and distribution for each field or site. Such records form the basis for crop rotation selection, economic thresholds, and suppressive actions.*

Suppression *of pest populations may become necessary to avoid economic loss if prevention and avoidance tactics are not successful. Suppressive tactics may include cultural practices such as narrow row spacing or optimized in-row plant populations, alternative tillage approaches such as no-till or strip till systems, cover crops or mulches, or using crops with allelopathic potential in the rotation. Physical suppression tactics may include cultivation or mowing for weed control, baited or pheromone traps for certain insects, and temperature management or exclusion devices for insect and disease management. Biological controls, including mating disruption for insects, should be considered as alternatives to conventional pesticides, especially where long-term control of an especially troublesome pest species can be obtained. Where naturally occurring biological controls exist, effort should be made to conserve these valuable tools. Chemical pesticides are important in IPM programs, and some use will remain necessary. However, pesticides should be applied as a last resort in suppression systems using the following sound management approach:*

1. *The cost benefit should be confirmed prior to use (using economic thresholds where available);*
2. *Pesticides should be selected based on least negative effects on environment and human health in addition to efficacy and economics;*
3. *Where economically and technically feasible, precision agriculture or other appropriate new technology should be utilized to limit pesticide use to areas where pests actually exist or are reasonably expected;*

4. *Sprayers or other application devices should be calibrated prior to use and occasionally during the use season;*
5. *Chemicals with the same mode of action should not be used continuously on the same field in order to avoid resistance development; and*
6. *Vegetative buffers should be used to minimize chemical movement to surface water.*

PESTICIDE STEWARDSHIP

Avoiding Spray Drift

Integrated pest management does not exclude pesticide use, but it does encourage a holistic approach and careful consideration of whether a pesticide is the best approach and the most economical approach. In most cases, pesticides deliver a much greater economic return than the costs of the pesticide when an economically-important pest is present or when there is a high likelihood that a pest will be present in the crop.

Pesticide stewardship is very important in peanut production systems. Farmers make as many as 15 applications in a year to suppress pests and protect peanut yield and quality. Adhering to worker protection standards and being well informed on when to apply pesticides at the appropriate rate and timing are essential in protecting people, animals, and plants from injury and maximizing yield and profit. Recent challenges with stewardship with auxin technology in cotton and soybean remind us of how difficult it can be to make sure pesticides go only where they are needed. While most pesticides applied in peanut are not volatile and will not move from fields due to vapor drift, particle drift remains a major concern. The principles discussed in the auxin-training program administered jointly by the NC Cooperative Extension service (Alan York) and the NCDA&CS (Patrick Jones) and designed to reduce particle drift should be used in peanut.

Physical spray drift can be minimized by paying close attention to the following factors:

Nozzle type. Nozzles that deliver coarser droplets that move toward the ground more quickly than finer droplets will reduce physical drift of spray solution. Most peanut farmers apply pesticides with either regular flat-fan nozzles or hollow-cone nozzles. These nozzles are often very effective in delivering spray solution of fungicides, herbicides, and insecticides onto and through the canopy. However, the fines, or small droplets associated with these nozzles, are particularly sensitive to physical drift. When possible, use coarser-textured nozzles. Research is underway at NC State to determine efficacy of commonly used pesticides used in peanut when applied with nozzles that deliver droplets that are larger and less prone to physical drift than regular flat-fan or hollow-cone nozzles. Pesticides with systemic activity do not require as much coverage of peanut foliage (control of insects and fungal pathogens) or weeds to be effective. However, contact herbicides (Gramoxone and other formulations, PPO-inhibiting herbicides, and Basagran) and fungicides that are not absorbed and translocated throughout leaf tissue are generally more effective when applied in higher spray volumes and when spray droplets are smaller and distributed uniformly throughout the canopy. Until more information is available, these pesticides should be applied using flat-fan or hollow-cone nozzles that deliver smaller droplets and ensure effective distribution throughout most of the peanut canopy or weed.

Wind speed and direction. The higher the wind speed is, the further spray droplets will travel before they reach the ground, top of peanut canopy, or weeds. Avoid spraying when wind speed is high. The maximum wind speed for auxin herbicides applied in cotton and soybean is 10 miles per hour. This would be a good maximum, although sprays delivered through regular flat-fan or hollow-cone nozzles will travel further in lower speed winds than the spray delivered through very coarse nozzles required for Enlist and Xtend crops. Applying pesticides when wind speed is less than 3 miles per hour increases the likelihood of thermal inversions and makes it difficult to know which direction the wind is blowing. Be keenly aware of the ramifications of off-site movement with respect to the areas around peanut fields.

Spray pressure. The relationship between spray pressure and nozzle type is clearly established. Higher pressure creates a higher percentage of fine droplets that can remain suspended in the air and subsequently move with the wind. Some pesticides do not require high pressure, but often late-season fungicides require high pressure to get the spray solution into the middle and bottom of the canopy to protect peanut from leaf spot disease or to get solution to the base of the plant to control stem rot and Sclerotinia blight.

Spray volume. Using higher spray volumes often allows use of coarser droplets without sacrificing coverage. Coarser droplets create a lower percentage of fines, which reduces off-site movement. However, applying pesticides in higher volumes decreases efficiency of spraying operations, although contact herbicides and fungicides can be more effective because coverage increases when applied in a higher spray volume.

Sprayer speed. Higher sprayer speeds increase off-site movement of pesticides. At higher speeds, the boom height is less predictable depending on the roughness and contour of the field, and greater turbulence can occur behind the sprayer when traveling at higher speeds. Greater turbulence results in a longer period when spray droplets are suspended. This longer suspension time can increase the likelihood of off-site movement of pesticides.

Boom height. The higher the boom and spray nozzles are above the target pest or crop, the longer the time that spray droplets are suspended. This longer suspension time increases the risk of particle drift. The contour of a field can result in the boom height being too high or too low.

Co-application of pesticides and adjuvants. Spray solution characteristics can vary depending on how products interact in the tank, and these changes can result in greater likelihood of physical drift or volatility, depending upon the mixture components.

Pesticides as Resources

Pesticides are important resources used in peanut and are essential to maintaining yield and quality and generating economic return by farmers. Preventing injury to workers and the public, keeping pesticides within field boundaries, and using them in a coordinated effort with cultural practices to suppress pests will increase the sustainability of pesticides in peanut production systems. It is also important to practice resistance management for all groups of pesticides: fungicides, herbicides, and insecticides. Resistance of more than one species within a pest discipline (entomology, plant pathology, weed science) exists in North Carolina, and there are concerns that the number of cases is increasing. Maintaining the availability of pesticide tools will require proactive management, persistent monitoring, and changing specific pesticides when needed. There are many sources of information relative to pesticide modes of action and managing resistance. Refer to chapters in *Peanut Information* related to management of disease, insects, and weeds for specific details on developing a comprehensive management strategy for pests in peanut.

12. ORGANIC PEANUT PRODUCTION

David L. Jordan
Extension Specialist—Department of Crop and Soil Sciences

Barbara B. Shew
Extension Specialist— Department of Plant Pathology and Entomology

Rick L. Brandenburg
Extension Specialist— Department of Plant Pathology and Entomology

Chris Reberg-Horton
Extension Specialist— Department of Crop and Soil Sciences

S. Gary Bullen
Extension Economist—Department of Agricultural and Resource Economics

Derek Washburn
NC Farm School Associate—Department of Agricultural and Resource Economics

Amanda Kaufman
Graduate Student—Department of Food, Bioprocessing, and Nutrition Sciences

Lisa Dean
Research Food Technologist—Market Quality and Handling Research Unit, United States Department of Agriculture, Southeast Area

Bob Sutter
Chief Executive Officer —North Carolina Peanut Growers Association Inc.

INTRODUCTION

Producing peanuts that meet certified organic criteria set by the USDA with restrictions set by the Organic Materials Review Institute (OMRI) can be challenging compared with peanut produced using conventional technologies (synthetic pesticides and fertilizers). However, demand for organically-produced peanut is strong, and markets are available. The two major production-oriented challenges with the organic approach to production are obtaining adequate plant stands and effectively controlling weeds. While disease, insect and nematode control can be difficult to achieve, in most instances impacts of insects and nematodes, and in some cases in-season diseases, are not catastrophic but can reduce yield substantially. In contrast, the need to plant seed that is not treated with effective fungicides and the difficultly in controlling grassy weeds can result in complete crop failure. Growers interested in producing peanut using organic principles should plant when soil conditions favor rapid emergence of seedlings. Fields with low infestations of weeds should be selected.

Challenges also exist from a post-harvest perspective. The certification process does not end in the field but carries through all processing steps. This can be a major constraint to organic adoption because current shellers in the Virginia-Carolina region are too large to invest in transitioning their plants to a relatively small volume of peanut for organic certification. For example, Hampton Farms markets several products that are certified organic, but all production is in New Mexico because of shelling and processing logistics and certification requirements at the post-harvest level.

The North Carolina Agricultural Foundation has provided funding to develop elements of an organic peanut value chain in North Carolina. This project includes efforts to increase efficiency of production, determine consumer demand and potential farmer involvement, and establish a pilot project with selected certified organic growers in the state. The current goal is to assist growers in producing certified organic peanut for the in-shell trade. Depending on success in this approach, a cooperative among producers of certified organic peanut could lead to shelling of peanut for additional markets.

Our goal in this chapter is to provide information on requirements for certified organic production, basic agronomic practices required for certified organic production of peanut, challenges with pest management in certified organic production, and estimated cost of certified organic production.

TERMS AND REQUIREMENTS FOR CERTIFIED ORGANIC PRODUCTION

The following indicates requirements for certification as organic production by the USDA:

> The National Organic Program (NOP) develops the rules and regulations for the production, handling, labeling, and enforcement of all USDA organic products. This process, referred to as rulemaking, involves input from the National Organic Standards Board (a Federal Advisory Committee made up of fifteen members of the public) and the public. The NOP also maintains a Handbook that includes guidance, instructions, policy memos, and other documents that communicate the organic standards.
> **www.ams.usda.gov/rules-regulations/organic**
>
> USDA organic products have strict production and labeling requirements. Organic products must meet the following requirements: produced without excluded

methods, (e.g., genetic engineering, ionizing radiation, or sewage sludge); produced using allowed substances; and overseen by a USDA National Organic Program-authorized certifying agent, following all USDA organic regulations. **www.ams.usda.gov/rules-regulations/organic/labeling**

To be considered organic all inputs used must be in compliance with the Organic Materials Review Institute (OMRI). Your local Cooperative Extension agent can also assist you with questions on certification and benefits and challenges of organic peanut production.
www.ams.usda.gov/grades-standards/organic-standards
www.omri.org/omri-lists

GENERAL AGRONOMIC PRACTICES

Variety Selection

Variety selection most likely will vary little in organic and conventional production systems. One of the major focal points of the breeding program at North Carolina State University is development and release of varieties that express field tolerance or resistance to pathogens and tomato spotted wilt. The strengths and weakness of varieties to diseases are provided in chapter 6, "Peanut Disease Management." These characteristics are important to consider in both conventional and organic systems. It is important to note that growers might plant Spanish, Valencia, or runner market types, and possibly Virginia market type varieties not commonly grown in North Carolina, in their organic production systems. If that is the case, make a strong effort to know the susceptibility of these varieties to pathogens commonly found in North Carolina.

Crop Rotation and Sequence

Crop rotation serves as the foundation of successful peanut production in North Carolina for conventional production systems (see chapter 3, "Peanut Production Practices," and chapter 6, "Disease Management," for more details). Principles of good rotation for peanut also hold true for organic production. Rotations to non-hosts reduce populations of disease-causing fungi and nematodes and can minimize the negative impact of these pathogens on peanut health and productivity. This practice is especially critical in organic production due to the absence or limited efficacy of fungicides, nematicides, and seed treatments that are OMRI-approved for disease control. Long rotations are necessary to suppress diseases, especially those caused by soilborne plant pathogens. Corn, cotton, small grains, and other grasses typically are the best rotation crops for reducing pathogen infestations. However, some grain and grass species are not good rotations for nematode suppression. Soils should be assayed before planting for potential nematode problems, and infested areas should be avoided.

Crop rotation does not have a major impact on most insects that affect peanut. However, crop diversity can impact insect pests on farms and subsequent movement from crop to crop. See chapter 5, "Peanut Insect and Mite Management," for discussions of spider mites and other arthropods that are mobile.

Weed control in previous crops can have a major impact on weeds in both organic and conventional production systems (see chapter 4, "Peanut Weed Management"). However, there are no salvage treatments in organic production systems for weeds, and farmers should avoid fields with moderate to heavy weed pressure. It is necessary to ensure weeds that were controlled relatively well in previous crops do not grow and reproduce after these crops are harvested. Fields should be tilled as needed after harvest to keep weeds from reproducing late in the summer or early in the fall. Managing the soil seedbank is a critical component of organic crop production.

Tillage System

Reduced tillage systems are used by approximately 20 percent of peanut growers in North Carolina. While conservation tillage has been adopted more widely in other row crops, the requirement of digging pods and vine inversion is often more challenging in reduced tillage systems. In these systems peanuts are often grown in seedbeds with residue from the previous crop or in a desiccated cover crop. Pod loss is often greater when peanuts are dug in fields that are flat and not tilled without new rows prepared in spring. This is also the case for organic production systems. A second major challenge in reduced tillage in organic systems is controlling weeds prior to planting but before peanuts emerge. There is simply no way to control winter vegetation and emerged summer weeds without synthetic herbicides. Although reduced tillage often results in fewer weeds emerging with the crop, and high residue cover crops such as cereal rye can suppress weeds to a great degree, these approaches are generally not completely effective and would interfere with the multiple cultivations with a tine weeder that are needed during the first month of the season (see the next section on weed management). Soils in reduced tillage, especially if seedbeds are flat, often warm more slowly in spring. These soils often hold more soil water, resulting in cooler soils that impact stand establishment, especially when pathogens are present that affect seed and seedlings. Higher seeding rates are required to obtain adequate stands. While cover crops can suppress weeds, timing of planting peanut in late May often decreases biomass available for weed suppression. Leaf spot, stem rot, and tomato spotted wilt can be suppressed in reduced tillage, but challenges with stand establishment and early season weed control far outweigh potential benefits.

Soil Fertility and Plant Nutrition

Soil fertility in conventional production systems is often addressed in the crop preceding peanut, although growers are encouraged to sample soils frequently for nutrients to obtain timely recommendations and to adjust soil pH to optimum levels (see chapter 3, "Peanut Production Practices"). However, more and more growers in conventional production systems are applying remedial amounts of fertilizer to make sure peanut do not lack essential nutrients. Addressing fertility in organic production systems can be more challenging than in traditional production systems. This challenge is due to sources of fertilizer that are OMRI approved and the rate of mineralization of these fertilizers in some cases. For this reason, farmers should consider applying adequate amounts of fertilizer in the previous crop to meet the demands of the following peanut crop.

OMRI-approved inoculants that contain *Bradyrhizobia* bacteria essential for biological nitrogen fixation (BNF) are available for peanut. It is very important to apply adequate amounts of inoculant to seed or in the seed furrow at planting to ensure adequate infection of roots for BNF (see chapter 3 on peanut production for more details). This is especially the case if organic peanuts are planted in fields without a history of peanut production. In these fields there is no backup in the form of native *Bradyrhizobia* species. Synthetic nitrogen fertilizer can be applied quickly if inoculant fails in conventional production systems, and much of the yield potential can be realized when ammonium sulfate is applied after an inoculant failure. This fertilization effect is not the case in organic production systems.

Supplemental calcium as calcium sulfate or gypsum is applied to Virginia market types to ensure adequate kernel development. OMRI-approved gypsum sources are available and should be applied at pegging. OMRI-approved formulations of manganese and boron are also available. These micronutrients are often needed to optimize peanut yield. Growers are also cautioned that use of poultry or swine litter, even from many years ago, can result in levels of zinc that are yield limiting. Fields should be avoided if zinc levels exceed NCDA&CS indices of 250.

Digging Pods and Inverting Vines

Digging peanut and inverting vines will be similar in organic production systems compared with traditional production systems in most instances. However, more weeds, especially annual grasses, are likely to be present in organic systems than in conventional systems, and this can increase pod loss during digging and vine inversion. Weeds above the canopy can be mowed within two weeks of digging, but it is important to track rows precisely so that peanut rows can be clearly seen for effective digging. Rapid and haphazard mowing can make tracking rows extremely difficult. To prevent pod loss in the digging process, the implement must be positioned within just a few inches of optimum tracking.

Farmers might experience greater pod shed due to less effective fungicides for leaf spot in organic systems compared with conventional systems. In some fields peanut will need to be dug prior to optimum pod maturity to prevent excessive yield loss. The balance between pod loss from defoliation caused by leaf spot disease and not allowing enough time for peanut to reach full maturity is discussed in more detail in chapter 3, “Peanut Production Practices,” and chapter 6, “Peanut Disease Management.”

WEED MANAGEMENT

DO NOT attempt to grow peanuts in fields with moderate to high levels of weeds, especially if annual or perennial grasses, common ragweed, nutsedge, and Palmer amaranth are present. Grasses are particularly hard to manage because of their fibrous root system, which makes them difficult to remove by hand or by hoeing and causes greater pod shed during digging and vine inversion.

While heavy residue cover crops, in particular cereal rye, can suppress weeds, conventional tillage systems that allow frequent cultivation within the first month of the season have proven to be the most effective approach to organic peanut production. In these systems fields are weed-free at the time of planting peanut at a depth of 3 inches. Cultivation with a tine weeder should begin no later than three days after planting even though peanuts have not emerged. This operation will kill young seedlings below the soil surface, especially grasses. At least five more cultivations at weekly intervals are recommended using a spring-loaded tine weeder. The root system of peanuts planted at a depth of 3 inches will be anchored relatively well, and while some damage of foliage will occur and some plants will be occasionally removed from soil by tines, intensive cultivation in this manner is the only way to minimize weed interference and prevent a weed-control failure. Cultivators with sweeps can also be used as peanut plants grow larger. Soil from these cultivators can be deposited around the base of each plant to bury and suppress weeds in the peanut drill. This approach to weed control is the direct opposite of what is recommended in conventional production systems with respect to cultivation. In conventional systems, in-season cultivation is discouraged because of movement of soil that may contain pathogens onto peanut plants. Cultivation also brings soil to the surface that has not been treated with herbicide. Nonetheless, an aggressive approach to in-season cultivation with a tine weeder that covers the entire row is absolutely critical for success in organic peanut production. The value of weed control from these operations outweighs the negative impact of increased infection by pathogens.

Some weeds will need to be removed by hand in organic production systems. This practice is also true of conventional production systems when herbicides are not completely effective, especially when herbicide-resistant biotypes are present. In organic production, however, timeliness of weed removal by hand is needed not only to avoid interference with yield by weeds but also to minimize damage to peanut plants when physically removing weeds by hand or with implements.

There are currently no OMRI-approved chemicals that control weeds effectively in peanut.

INSECT MANAGEMENT

Thrips, southern corn rootworm, caterpillars, leaf hoppers, and spider mites can be suppressed in conventional tillage systems with insecticides. There are a few OMRI-approved insecticide options to control foliar feeding insects on an "as needed" basis, but there are no preventive, at-plant products. Products that contain spinosads, neem extract (azadirachtin), *Bacillus thuringiensis*, insecticidal soaps, and pyrethrins are available as nontraditional products for insect management. Growers should adjust cultural practices to a certain degree to minimize the likelihood of an infestation and the impact of insects (see chapter 5, "Peanut Insect and Mite Management"). However, sometimes a practice that minimizes the impact of one insect on peanut can increase the potential for another insect to damage peanut. For example, planting as late as possible in May minimizes injury potential from thrips in some years and can lower incidence of tomato spotted wilt compared with earlier plantings. Planting later in May increases potential from southern corn rootworm. In light, sandy soils, however, which pose a low risk from rootworms, this later planting may be a viable option to suppress early season thrips damage.

Unlike the catastrophic nature of a failure in stand establishment and early season weed control in organic peanut, yield loss from insects is often more incremental and generally will not result in complete yield loss. However, the presence of numerous arthropods that affect yield individually can ultimately result in yield losses that approach 15 to 20 percent. Maintaining good plant health will always make the plants more tolerant of insect feeding and less likely to suffer yield loss.

Unfortunately, the search for host plant resistance to insects in peanuts has not been productive, and varieties currently grown in North Carolina do not offer adequate resistance to insects to be considered a control strategy. While thrips vector tomato spotted wilt virus and variety selection can have a major impact on expression of tomato spotted wilt in peanut, resistance is not associated with impacts on thrips but is related to physiological effects of the virus within the peanut plant. Likewise, variety selection can impact damage from southern corn rootworm but is not related directly to resistance to feeding by the insect. Less pod scarring from southern corn rootworm occurs with some varieties because the resistant variety requires less time to reach optimum maturity and possesses hulls that are more fully developed when larvae begin feeding on pods. See both the Southern Corn Rootworm index and the Tomato Spotted Wilt Virus index in chapter 5, "Insect and Mite Management," for more information on management of these pests.

Several OMRI-approved insecticides are available that are effective in controlling leaf hoppers, thrips, and caterpillars. Although insecticidal soaps can suppress spider mites, they require excellent coverage. And under the hot, dry conditions that create spider mite outbreaks, these products may cause severe phytotoxicity. However, while any and all of these insect pests can injure peanut, they often do not occur at populations that result in serious yield reductions, and an overall organic production program can help preserve beneficial organisms that help limit pest populations.

DISEASE AND NEMATODE MANAGEMENT

Seedling diseases may be the greatest threat to organic peanut production because they can result in almost complete stand failure depending on weather and soil conditions at planting. This threat is the case even in conventional production systems when seed is not treated with fungicides. Several OMRI-approved products are available to suppress seedling pathogens, but these products are often less effective than the synthetic seed treatments in conventional production systems that are described in chapter 6, "Peanut Disease Management."

As stated in the introduction to this chapter, failure to establish an adequate stand and ineffective weed control are considered the most yield-limiting challenges in organic peanut production. For this reason, farmers are encouraged to plant peanut as late as possible within the effective planting window (late May) and increase the seeding rate by 50 to 75 percent compared with seeding rates used in conventional production systems where synthetic fungicides are applied to seed before planting. Soil is warmer in late May compared with early and mid-May, and this warmth most often results in more rapid emergence of peanut. The longer peanut seed and seedlings remain in soil prior to emergence, the more likely it is that soil-borne pathogens will cause seeds to rot. Pathogens also cause seedlings to die before and after emergence.

With the exception of systemic insecticides that suppress thrips, cultural practices that are effective in reducing tomato spotted wilt are the same for conventional and organic production. Planting at a seeding rate that ensures four to five plants per foot and in May can reduce incidence of tomato spotted wilt.

Most Virginia market type peanut varieties grown in North Carolina express resistance to one or more diseases typically found in peanut fields. Varieties available for both conventional and organic producers are much more effective at withstanding disease than varieties grown a decade or more ago. However, current varieties are not immune to disease. And in conventional production systems, there is concern that these varieties are less effective in withstanding disease now than when they were first adopted by growers.

Several OMRI-approved fungicides (usually copper and sulfur compounds) are available that can be used in peanut. These fungicides are not as effective as synthetic fungicides used to control leaf spot and require more frequent applications at shorter intervals. These products are strictly surface protectants and must be applied in advance of infection. Good coverage is essential. There are no OMRI-approved fungicides for control of diseases caused by soilborne pathogens (stem rot and Sclerotinia blight). Biological control products are only marginally effective against soil-borne pathogens and nematodes. As mentioned above, rotation is critical for maximizing the potential benefits of other disease control tactics. Yield most likely will be lower in organic production systems than in conventional production systems due to less effective management options for economically important diseases.

CURRENT RESEARCH IN NORTH CAROLINA

Research supported through the North Carolina Agricultural Foundation is currently underway. Trials on research stations that simulate organic production have demonstrated differences in yield between peanut grown at higher seeding rates without synthetic fungicide applied to seed, without insecticides, and with copper fungicide to control leaf spot compared with traditional production systems that include planting at normal seeding rates with fungicide-treated seed, acephate applied within three weeks after emergence to control thrips, insecticide applied at pegging to control southern corn rootworm, and synthetic fungicides designed to control leaf spot and stem rot. These experiments are being conducted in fields where weeds are controlled with synthetic herbicides and fertilizers used in conventional production systems are applied. Yield in the simulated organic system was approximately 20 percent lower than yield in the conventional system. Yield most likely would be even lower due to weed interference and possible fertility issues in the organic system. These studies will shed light on yield potential in organic peanut compared with conventional peanut with respect to disease and insect control.

The project also includes participation with two organic growers who are trying to incorporate peanut into their established organic production systems. Both growers are experienced organic producers. One of these growers has a substantial amount of organically-produced tobacco and sweetpotato. Unfortunately, this grower was unable to produce an organic peanut crop despite a dedicated effort to do so. In 2017, a field was prepared in a manner that would have created the best opportunity for success for organic production. However, the night after planting, a 4-inch rainfall event occurred. Although this did not result in a stand failure, it did prevent cultivation for several weeks, especially when a second significant rainfall event occurred within the next 10 days. This situation underscores the challenges with weed control and how unavoidable weather conditions can result in complete weed control failures in organic systems. In conventional systems, weeds could have been easily controlled with synthetic herbicides. In 2018, a second weed-control failure occurred with the same farmer. However, the failure was not due to weather conditions after planting but rainfall after seedbed preparation but before planting. This allowed weeds to escape and required re-establishment of seedbeds. By the time the field dried out adequately for primary tillage, planting would have occurred well into June. Yield potential for peanut in North Carolina decreases substantially after May. A third attempt will be made in 2019 with this grower to produce organic peanut. The limitation in tools that allow weeds to be controlled quickly without tillage pose a major challenge to organic peanut production, and as growers consider this approach and marketing opportunities, they will need to be aware that a higher frequency of failure will occur compared with traditional production systems, at least with weed management tools currently available in peanut. There is an old adage among farmers that, "a dry year will scare you to death, but a wet year will kill you." That phrase was coined during a time when few herbicides were available and most weed control in peanut was achieved through cultivation and hoeing. Researchers involved with organic peanut in Georgia indicated that they have had more success in dry years than during years with average or above-average rainfall. In fact, most organic peanuts are grown in New Mexico under arid conditions with irrigation. In that system, water can be managed in a way that does not interfere with weed control operations. Likewise, dry conditions and low humidity strongly suppress the activity of many plant pathogens. In North Carolina, the challenge of timely weed control with cultivation and hoeing will exist for organically-produced peanut because rain can be unpredictable and abundant in May and June.

The graduate student involved in this project is also conducting consumer surveys and surveys of organic growers without experience with peanut, traditional peanut growers who might be interested in expanding their operation to include organic peanut, and small, specialty shops that cater to consumers who prefer organically-certified food. Results from these surveys will help determine the feasibility of further development of a value chain for organic peanut in North Carolina.

The actual price the market is willing to pay for organic peanut is unknown. A complete and precise budget is also unknown. However, the budget found in Table 1 is most likely an accurate estimate. One major assumption in the budget is price for farmer stock peanut ($0.46 per pound). This price is roughly twice the price of conventionally-produced Virginia market type peanut.

Table 12-1. Estimated Enterprise Budget for Certified Organic Peanut Production

Item	Quantity or Unit	Price per Unit	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS[1]	2,500 lb	0.46	1,150.00	
Total receipts			1,150.00	
2. VARIABLE COSTS				
Seed	200 lb	0.85	170.00	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer (prorated)[2]	1.00 acre	40.00	40.00	
Lime (prorated)	0.33 ton	46.00	15.18	
Gypsum (spread)	0.60 ton	47.50	28.50	
Hand weeding[3]	1.00 acre	22.92	22.92	
Insecticides	1.00 acre	74.71	74.71	
Fungicides[4]	1.00 acre	180.00	180.00	
Scouting	1.00 acre	16.00	16.00	
Organic certification fee[5]	1.00 acre	32.00	32.00	
Hauling	1.25 ton	12.00 ton	14.97	
Drying	1.25 ton	45.00 ton	56.14	
State Check-off Fee	1.25 ton	3.00 ton	3.75	
National Assessment	1,150.00 acre	0.095%	10.93	
Crop insurance	1.00 acre	30.00	30.00	
Tractor/Machinery[6]	1.00 acre	103.44	103.44	
Labor[7]	9.02	11.27	103.37	
Interest on Operating Capital	376.60	6.0%	22.60	
Total Net Variable Costs			930.51	
3. INCOME ABOVE VARIABLE COSTS			**219.49**	
4. FIXED COSTS				
Machinery	1.00 acre	147.59	147.59	
Total Fixed Costs			**147.59**	
5. TOTAL COSTS			**1,078.10**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT			**71.90**	

(continued)

Please note: This budget is for planning purposes only. It does not include land rent.

[1]Peanut price was set at twice the price for conventionally produced peanut.

[2]No nitrogen application is considered, but we assume that P and K levels are maintained with a previous crop for which the cost is estimated to be $40.00 an acre.

[3]Hand weeding is hand labor paid at $11.46 an hour for two hours an acre.

[4]Fungicide cost includes eight passes with a copper-containing, OMRI-approved product.

[5]The organic certification fee includes the cost of maintaining records as well as the annual assessment to stay certified.

[6]Equipment cost assumes eight passes with a cultivator at a total equipment cost of $66.96 and two hours of equipment operator labor and could also be included in the cost of weed control.

[7]This is labor that is operating equipment in the field.

A PRECAUTIONARY STATEMENT ON PESTICIDES

Pesticides must be used carefully to protect against human injury and harm to the environment. Diagnose your pest problem, and select the proper pesticide if one is needed. Follow label use directions, and obey all federal, state, and local pesticide laws and regulations.

This publication is also available at **content.ces.ncsu.edu/peanut-information**.

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