Survey of Herbicide and Fungicide Use in Peanut in North Carolina and Virginia in the United States

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Abbreviations: FRAC, Fungicide Resistance Action Committee; HRAC, Herbicide Resistance Action Committee.

Summary

Diseases and weeds can reduce yield of peanut if effective control measures including fungicides and herbicides are not used. A survey of 76 farmers in North Carolina and Virginia at Cooperative Extension Service meetings was completed relative to fungicide and herbicide use in 2021. Eighty-two percent of farmers made between three and five herbicide applications while sixty-eight percent of farmers made between four and five fungicide applications. 2,4-DB was the herbicide applied most frequently. The fungicide chlorothalonil was applied most often. Pydiflumetofen was applied by 61% of farmers. Results from this survey can be used to inform regulatory agencies on pesticide use patterns by defining the relative importance of individual or

groups of pesticides currently used to suppress pests and prevent or mitigate associated economic losses.

Pathogens causing diseases as well as weeds can reduce yield of peanut (*Arachis hypogaea* L.) if effective control measures are not implemented (Anco, 2023; Anco et al., 2020a 2020b 2020c; Jordan, 2023; Jordan et al., 2020; Leon et al., 2019; Shew, 2023). Late leaf spot disease [caused by *Nothopassalora personata* (Berk. & M.A. Curtis) U. Braun, C. Nakash., Videira & Crous], southern stem rot (caused by *Athelia rolfsii* Sacc.), and Sclerotinia blight (caused by *Sclerotinia minor* Jagger) are the most prominent diseases in peanut production in North Carolina and Virginia in the U.S. (Langston, 2023; Shew, 2023). Establishing effective crop rotation sequences, planting cultivars with partial resistance to pathogens, and applying effective fungicides in a timely manner to control pathogens causing these diseases are practices used in concert to optimize peanut yield (Anco, 2023; Langston, 2023; Shew, 2023). Multiple fungicide applications are made during the cropping cycle and are initiated no later than beginning pod or R-3 stage of peanut development (Boote, 1982). Fungicides used in peanut are primarily protective with minimal curative activity against disease (Anco, 2023; Langston, 2023; Shew, 2023). In most cases, fungicides are applied every 14 days during the latter portion of the cropping cycle depending on weather patterns (e. g., humidity in the peanut canopy and temperature) and field history of disease (Anco, 2023; Langston, 2023; Shew, 2023).

Weed management in the U.S. in the Virginia-Carolina region is achieved primarily through use of herbicides (Jordan, 2023; Jordan et al., 2020; Leon et al., 2019). Herbicides can be applied prior to planting to control winter vegetation and emerged summer weeds in conservation tillage systems or incorporated into soil in conventional tillage systems. Herbicides are also applied preemergence after planting and throughout the cropping cycle to control emerged weeds. Season-long weed control is needed because peanut has a short canopy with a runner-type posture making this crop a poor competitor with weeds. Peanut pods are first dug and vines inverted before combines pick the crop. Weeds present in fields during this process can reduce yield not only through interference with peanut for light and other resources but also through pod loss in the digging process (Leon et al., 2019).

Information on use patterns for fungicides and herbicides is limited in the Virginia-Carolina region of the U.S. In this Brief, we discuss results from a survey in North Carolina and Virginia of peanut farmers at annual Cooperative Extension service meetings in these states related to applications of fungicides and herbicides.

Survey Methodology

Response of 76 farmers in North Carolina and Virginia relative to fungicide and herbicide use in 2021 was determined at Cooperative Extension service meetings in 2022 (Table 1). In North Carolina, twelve peanut production meetings were held in February at county or multi-county levels. One statewide meeting on peanut production was held in Virginia during February. Approximately 27,450 acres in the region corresponding to approximately 24% of harvested acreage in 2021 were represented for these states (NASS, 2023). Growers provided estimates of their yield and acreage. Growers also provided a list of fungicides applied on a bi-weekly basis and herbicides applied prior to planting to control emerged weeds, preplant incorporated in conventional tillage systems, preemergence, and at the time of peanut emergence. Growers were asked to provide a list of herbicides applied within the first 30 days after peanut emergence (DAE), 31 to 60 DAE, and greater than 60 DAE. Percentages of specific herbicides used for these methods and timings were calculated based on the total number of applications within a method or timing of herbicide application. The percentage of specific fungicides applied during the cropping cycle was calculated based on the total number of fungicides applied. No distinction was made between states. Numbers associated with herbicide and fungicide sites of action (FRAC, 2023; HRAC, 2023) are also provided.

Herbicide Use Patterns

Seventy-two percent of growers made between three and five herbicide applications per season (Table 1). When considering all herbicide applications, the highest percentage of herbicide applications were made at the preemergence timing (Table 2). When combining applications made when peanut was emerging and within the first 30 days after peanut emergence, 37% of all herbicides were applied. These findings are consistent with recommendations on use of herbicides within the cropping cycle. Controlling weeds by applying herbicides at planting and within the first 30 days after planting often results in less weed interference with peanut compared with applications later in the cropping cycle (Everman et al., 2008; Jordan, 2023; Leon et al., 2019). Preplant burndown herbicides and preplant incorporated herbicides also contribute to early season suppression of weeds in peanut with 14% and 6% of herbicide applications made at these respective timings (Table 2).

Glyphosate and 2,4-D were the most frequently applied herbicides used to control emerged summer weeds and winter vegetation prior to planting; pendimethalin was the most popular herbicide applied preplant incorporated (Table 3). Flumioxazin was the herbicide applied most frequently preemergence followed by metolachlor and *S*-metolachlor (Table 4).

Paraquat was applied the most frequently as peanut emerged followed by metolachlor or *S*-metolachlor (Table 5). These results were expected given that a mixture of paraquat plus metolachlor or *S*-metolachlor is recommended for early season weed control in peanut (Jordan, 2023). However, the percentage of applications of bentazon and acifluorfen plus bentazon was lower than expected given the frequency of paraquat use. Bentazon reduces injury caused by paraquat (Jordan, 2023).

Acifluorfen plus bentazon and 2,4-DB were the most frequently applied herbicides within the first 60 DAE (Tables 6 and 7). While these herbicides can be applied alone, they are often applied in mixture for broadleaf weed control (Jordan, 2023). Imazapic, bentazon, and paraquat were also applied frequently within the first 30 DAE. Clethodim became a more popular herbicide at 31 to 60 DAE and when herbicides were applied after 60 DAE compared with applications within the first 30 days after planting (Tables 7 and 8). 2,4-DB remained popular after 60 days. One reason clethodim and 2,4-DB were applied frequently later in the season is the preharvest interval for these herbicides relative to other herbicides (Marshall, 2022). Clethodim is applied to control annual grasses that have escaped previous herbicides at these timings to minimize weed interference but primarily to facilitate digging and vine inversion (Jordan, 2023). When considering all methods and timings of application, the most frequently applied herbicide was 2,4-DB (25%) followed by paraquat (17%). Acifluorfen plus bentazon, bentazon, clethodim, and imazapic constituted 10 to 13% of all herbicide applications (Table 9).

Fungicide Use Patterns

Sixty-eight percent of growers made four or five fungicide applications (Table 10). Chlorothalonil was the most frequently applied fungicide (29%) with commercial formulation of prothioconazole plus tebuconazole, pydiflumetofen, tebuconazole, and the commercial formulation of azoxystrobin plus benzovindiflupyr constituting between 10 to 18% of fungicide sprays (Table 11). The high frequency of chlorothalonil use is explained by how this fungicide is recommended for use in peanut combined with its comparatively economical price point (Anco et al. 2020a). This fungicide does not protect peanut from southern stem rot disease but does offer protection from leaf spot disease (Anco, 2023; Langston, 2023; Shew, 2023). Protection from leaf spot disease is needed throughout the cropping cycle after peanut reaches the R3 stage of development (Boote, 1982) up to harvest (Shew, 2023). *Athelia rolfsii*, the causal agent of southern stem rot and is characteristically active during a narrower timeframe within the cropping cycles when peanut also needs protection from leaf spot disease. Therefore, chlorothalonil (or other fungicide active ingredients with efficacy primarily against foliar pathogens) can be applied as the first and last sprays to protect peanut from leaf spot disease. Southern stem rot is often not active when the first and last sprays of the season are applied for leaf spot disease. Chlorothalonil affects the pathogen causing leaf spot disease at multiple sites and is therefore an effective resistance management option and one for which development of resistance has not been reported in the more than 50 years of its use in peanut (Grichar et al. 2000; Munir et al. 2020). Fifty-four percent of chlorothalonil applications were made at both the beginning and end of the season (Table 12). When only one spray was made at either the first spray timing or the final spray timing, 62% and 75% of chlorothalonil sprays were made at these respective timings.

In 2018, pydiflumetofen received registration in peanut and has been promoted as a fungicide that can provide up to 30 days of protection from leaf spot disease; however, the length of protection is debated among the public and private sector, especially relative to environments consisting of elevated leaf spot disease pressure (Anonymous, 2018; Kemerait et al., 2023). The current survey was used to determine the frequency of pydiflumetofen use and what fungicides are co-applied with pydiflumetofen. How often pydiflumetofen was applied sequentially and fungicides applied following pydiflumetofen for resistance management were also of interest. Sixty-one percent of growers applied pydiflumetofen (46 growers out of 76 growers). The site of action (SOA) of pydiflumetofen (SDHI, FRAC group 7) and the extended interval recommended by the manufacturer have created concern over selection for resistance to this fungicide (FRAC, 2023). Pydiflumetofen does not control *Athelia rolfsii* or *Rhizoctonia solani*, requiring co-application with another fungicide for protection from these pathogens (Shew, 2023). The highest frequency use pattern, based on the percentage of applications including pydiflumetofen, was pydiflumetofen plus the commercial formulation of azoxystrobin (HDMI, FRAC group 11) plus benzovindiflupyr (SDHI, FRAC group 7) (21%) followed by pydiflumetofen alone (14%) when pydiflumetofen was applied only once during the season (Table 13). When applied sequentially, pydiflumetofen plus azoxystrobin plus benzovindiflupyr constituted 9% of sprays that included pydiflumetofen. All other approaches to applying pydiflumetofen were 2% of pydiflumetofen applications. In the survey, chlorothalonil was the fungicide applied most frequently following pydiflumetofen applications (67%) followed by prothioconazole plus tebuconazole (13%) (Table 14). Ten percent of pydiflumetofen sprays were followed by a wide range of fungicides at much lower frequencies than chlorothalonil or prothioconazole plus tebuconazole. Additionally, ten percent of applications of pydiflumetofen did not have a follow up fungicide applied. There is concern that selection for resistance could occur more rapidly in fields where pydiflumetofen is the last fungicide applied or when it is applied in response to established leaf spot infections. However, a high percentage of pydiflumetofen was applied with the commercial formulation of azoxystrobin plus benzovindiflupyr which includes two SOA. Co-application of fungicides with different SOA is recommended for fungicide resistance management (FRAC, 2023; Munir et al., 2020; Shew, 2023). Concern over selection for resistance to the combination of azoxystrobin (FRAC group 11) plus benzovindiflupyr (FRAC group 7), and pydiflumetofen (FRAC group 7) exists. Following this combination with chlorothalonil, a fungicide with multiple sites of action (FRAC, 2023), is an important tool for management of leaf spot resistance (Shew, 2023).

Summary

Results from this survey provide information on fungicide and herbicide use patterns in peanut. This information can be used to inform regulatory agencies on use pesticide patterns by defining the relative importance of individual or groups of pesticides currently using to suppress pests and prevent or mitigate associated economic losses. Information provided in this paper on how pydiflumetofen is used can assist practitioners in managing resistance in leaf spot to this fungicide. However, two caveats should be considered when interpreting these data. First, fungicide and herbicide use patterns represent a single growing season. Pest outbreaks and pesticides used to minimize impacts of pests often differ from year to year based on weather patterns that affect pest complexes. A second caveat is that the sample pool did not represent all farmers but was focused on farmers attending Cooperative Extension service meetings. This group may be more likely to implement Cooperative Extension service recommendations or invest greater resources into growing peanut. For example, growers at Cooperative Extension service meetings in NC from 2014 to 2022 reported yields that were on average 518 pounds/acre greater than the state average (Jordan and Collins, 2023). None-the-less, in absence of information in the peer-reviewed literature on pesticide use in peanut, results from this survey provide a useful benchmark on selection of herbicides and fungicides by a significant number of farmers.

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Conflicts of Interest

The authors express no conflicts of interest.

References

Anco, D. (2023). Peanut disease management. In Peanut Money-Maker 2023 Production Guide (*Clemson University Circular 588*, pp. 44-55). Clemson University. https://blogs.clemson.edu/sccrops/peanut-money-maker-2023-production-guide/

Anco, D. J., Hiers, J. B., and Thomas, J. S. (2020a). Improved management efficacy of late leaf spot on peanut through combined application of prothioconazole with fluxapyroxad and pyraclostrobin. *Agronomy (Basel), 10,*298. https://www.mdpi.com/2073-4395/10/2/298

Anco, D. J., Thomas, J. S., Jordan, D. L., Shew, B. B., Monfort, W. S., Mehl, H. L., Small, I. M., Wright, D. L., Tillman, B. L., Dufault, N. S., Hagan, A. K., and Campbell, H. L. (2020b). Peanut yield loss in the presence of defoliation caused by late or early leaf spot. *Plant Disease, 104,*1390-1399. https://doi.org/10.1094/PDIS-11-19-2286-RE

Anco, D. J., Thomas, J. S., and Monfort, W. S. (2020c). Efficacy and profitability of insecticide treatments for tomato spotted wilt management on peanut in South Carolina. *Plant Disease, 104,*1096-1104. https://doi.org/10.1094/PDIS-09-19-1829-RE

Anonymous. (2018). New products. *The Peanut Grower*. https://peanutgrower.com/new-products/new-products-19-6/

Boote, K. (1982). Growth stages of peanut. *Peanut Science, 9,* 35-40.

Everman, W. J., S. B. Clewis, W. E. Thomas, I. C. Burke, and J. W. Wilcut. (2008). Critical period of weed interference in peanut. *Weed Technology, 22,*63-67.

FRAC [Fungicide Resistance Action Committee]. (2023). Fungicide resistance management. https://www.frac.info/fungicide-resistance-management

Grichar, W., Besler, B., and Jaks, A. (2000). Use of azoxystrobin for disease control in Texas peanut. *Peanut Science, 27,*83-87.

HRAC [Herbicide Resistance Action Committee]. (2023). Herbicide resistance management. https://hracglobal.com/herbicide-resistance

Jordan, D. L. (2023). Weed management. In 2023 Peanut Information (*North Carolina Cooperative Extension Service Publication AG-331*, pp. 48-82). North Carolina State University. https://content.ces.ncsu.edu/peanut-information/peanut-weed-management

Jordan, D. L., and Collins, A. (2023). Guidelines for the North Carolina peanut production contest, 5,000 pound club, and group of sixty. In 2023 Peanut Information (*North Carolina Cooperative Extension Service Publication AG-331*, pp. 166-172). North Carolina State University. https://content.ces.ncsu.edu/peanut-information/guidelines-for-the-north-carolina-peanut-production-contest

Jordan, D. L., Dunne, J., Stalker, H. T., Shew, B. B., Brandenburg, R. L., Anco, D., Mehl, H., Taylor, S., and Balota, M. (2020). Risk to sustainability of pest management tools in peanut. *Agricultural and Environmental Letters, 5,* https://acsess.onlinelibrary.wiley.com/doi/full/10.1002/ael2.20018

Kemerait, R., Culbreath, A., Brenneman, T., Tubbs, S., Srinivasan, R., Abney, M., Monfort, S., Pilon, C., Bag, S., Brown, N., LaForest, J., Prostko, E., Tillman, B., Dufault, N., Small, I., Chen, C., Jacobson, A., Balkom, K., Strayer-Scherer, A., Graham, S., Zerweller, B., Anco, D. (2023). The 2023 Version of the Peanut Disease Risk Index: Minimizing diseases of peanut in the Southern United States (*University of Georgia Extension*). University of Georgia. https://peanutrx.org/

Langston, D. (2023). Peanut diseases. In 2023 Virginia Peanut Production Guide (*Virginia Cooperative Extension Publication SPES-451NP*, pp. 95-110). https://www.pubs.ext.vt.edu/SPES/SPES-367/SPES-367.html

Leon R. G., D. L. Jordan, G. Bolfrey-Arku, and I. Dzomeku. (2019). Sustainable weed management in peanut. In *Weed Control: Sustainability, Hazards and Risks in Cropping Systems Worldwide*, pp. 345-366. CRC Press/Taylor and Francis Group, Boca Raton, Florida.

Marshall, M. 2023. Weed control. In Peanut Money-Maker 2023 Production Guide (*Clemson University Circular 588*, pp. 26-42). Clemson University. https://blogs.clemson.edu/sccrops/peanut-money-maker-2023-production-guide/

Munir, M., Wang, H., Agudelo, P., and Anco, D. J. (2020). Rapid detection of fungicide resistance phenotypes among populations of *Nothopassalora personata* in South Carolina peanut fields. *Plant Health Progress*, *21*, 123-132. https://apsjournals.apsnet.org/doi/10.1094/PHP-12-19-0087-RS

NASS [National Agricultural Statistics Service]. (2023). Statistics by state. https://quickstats.nass.usda.gov.

Shew, B. B. 2023. Peanut disease management. In 2023 Peanut Information (*North Carolina Cooperative Extension Service Publication AG-331*, pp. 101-145). https://content.ces.ncsu.edu/peanut-information/peanut-disease-management

Table 1. Relative number of herbicide applications over the cropping cycle in 2021.[a]

Number of herbicide applications	Percent of total herbicide applications for the cropping cycle
	% of total sprays
One	0
Two	4
Three	24
Four	29
Five	29
Six	11
Seven	3

[a]Surveys were provided by 76 farmers representing 27,450 acres.

Table 2. Percentage of total herbicide applications based and method of application and timing during the cropping cycle in 2021.[a]

Method or timing of application	Percent of total herbicide applications for the cropping cycle
	% of total sprays
Preplant burndown	14
Preplant incorporated	6
Preemergence	25
Emergence of peanut	16
First 30 days after peanut emergence	21
31 to 60 days after peanut emergence	11
More than 60 days after peanut emergence	7

[a]Surveys were provided by 76 farmers representing 27,450 acres.

Table 3. Percentage of preplant and preplant incorporated herbicide applications for specific herbicides in 2021.[a]

Method or timing of application	HRAC[b] number	Percent of herbicides applied for a method or time of application
Herbicides applied prior to planting but not incorporated in soil		%
Glyphosate	9	48
2,4-D	4	17
Rimsulfuron plus thifensulfuron-methyl	2	3
Dicamba	4	1
Herbicides incorporated in soil prior to planting		
Pendimethalin	3	30
Ethafluralin	3	1

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 107 herbicide applications.

[b]Abbreviation: HRAC, Herbicide Resistance Action Committee.

Table 4. Percentage of herbicide preemergence applications for specific herbicides in 2021.[a]

Herbicide applied preemergence	HRAC[b] number	Percent of total number of herbicides applied preemergence
		%
Flumioxazin	14	45
Metolachlor or *S*-metolachlor	15	39
Pendimethalin	3	9
Acetachlor	15	6
Dimethenamid-*P*	15	1

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 124 herbicide applications.

[b]Abbreviation: HRAC, Herbicide Resistance Action Committee.

Table 5. Percentage of herbicide applied when peanut was emerging for specific herbicides in 2021.[a]

Herbicide applied when peanut was emerging	HRAC[b] number	Percent of total number of herbicides applied when peanut was emerging
		%
Paraquat	22	35
Metolachlor or *S*-metolachlor	15	20
Bentazon	6	18
Acifuorfen plus bentazon	14 + 6	7
Pyroxasulfone	15	4
Acetachlor	15	4
Imazapic	2	4
Diclosulam	2	3
Clethodim	1	2
2,4-DB	4	2
Pendimethalin	3	1

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 79 herbicide applications.

[b]Abbreviation: HRAC, Herbicide Resistance Action Committee.

Table 6. Percentage of herbicide applied within the first 30 days after peanut emerged for specific herbicides in 2021.[a]

Herbicide applied 1 to 30 days after peanut emerged	HRAC[b] number	Percent of total number of herbicides applied from 1 to 30 days after peanut emergence
		%
2,4-DB	4	21
Acifuorfen plus bentazon	14 + 6	16
Imazapic	2	13
Bentazon	6	12
Paraquat	22	12
Metolachlor or *S*-metolachlor	15	8
Clethodim	1	5
Lactofen	14	5
Acifluorfen	14	2
Pyroxasulfone	15	2
Pyroxasulfone plus carfentrazone	15 + 14	2
Dimethenamid-*P*	15	2

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 106 herbicide applications.

[b]Abbreviation: HRAC, Herbicide Resistance Action Committee.

Table 7. Percentage of herbicide applied 31 to 60 days after peanut emerged for specific herbicides in 2021.[a]

Herbicide applied 31 to 60 days after peanut emerged	HRAC[b] number	Percent of total number of herbicides applied from 1 to 30 days after peanut emergence
		%
2,4-DB	4	44
Acifuorfen plus bentazon	14 + 6	20
Clethodim	1	10
Imazapic	2	5
Pyroxasulfone	15	5
Metolachlor or *S*-metolachlor	15	4
Lactofen	14	4
Acetachlor	15	2
Acifluorfen	14	2
Bentazon	6	2
Paraquat	22	2

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 55 herbicide applications.

[b]Abbreviation: HRAC, Herbicide Resistance Action Committee.

Table 8. Percentage of herbicide applied more than 60 days after peanut emerged for specific herbicides in 2021.[a]

Herbicide applied more than 60 days after peanut emerged	HRAC[b] number	Percent of total number of herbicides applied more than 60 days after peanut emergence
		%
Clethodim	1	40
2,4-DB	4	33
Acifuorfen	14	10
Bentazon	6	7
Imazapic	2	6
Lactofen	14	4

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 31 applications.

[b]Abbreviation: HRAC, Herbicide Resistance Action Committee.

Table 9. Percentage of applications for all herbicides applied after peanut emergence in 2021.[a]

Herbicides applied postemergence	HRAC[b] number	Percent of total number of herbicides applied after peanut emergence
		%
2,4-DB	4	25
Paraquat	22	17
Acifluorfen plus bentazon	14 + 6	15
Bentazon	6	13
Imazapic	2	10
Clethodim	1	10
Lactofen	14	4
Pyrozasulfone	15	3
Acifluorfen	14	3

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 271 herbicide applications.

[b]Abbreviation: HRAC, Herbicide Resistance Action Committee.

Table 10. Relative number of fungicides applied for leaf spot and southern stem rot control over the cropping cycle in 2021.[a]

Number of fungicide applications	Percent of total fungicide applications for the cropping cycle
	% of total sprays
Two	3
Three	14
Four	37
Five	31
Six	15

[a]Surveys were provided by 76 farmers representing 27,450 acres with 408 total sprays.

Table 11. Percentage of applications of total fungicides applied for protection from leaf spot and southern stem rot disease for specific fungicides in 2021.[a]

Fungicides	FRAC[b] number	Percent of total number of fungicides applied
		%
Chlorothalonil	M5	29
Prothioconazole plus tebuconazole	3 + 3	18
Pydiflumetofen	7	15
Tebuconazole	3	14
Azoxystrobin plus benzovindiflupyr	11 + 7	10
Bixafin plus flutriafol	7 + 3	4
All others	-	10

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 408 fungicide applications.

[b]Abbreviation: FRAC, Fungicide Resistance Action Committee.

Table 12. Distribution of chlorothalonil sprays for protection from leaf spot disease in 2021.[a]

Chlorothalonil use pattern	Percent of chlorothalonil applications
	%
First spray only	8
Last spray only	21
First and last spray	54
Sprays other than first and last sprays	17
Total of all first sprays	62
Total of all last sprays	75

[a]Surveys were provided by 76 farmers representing 27,450 acres with a total of 408 fungicide applications.

Table 13. Percentage of pydiflumetofen sprays with respect to co-application with other fungicides in 2021.[a]

Fungicides	FRAC[b] number	Percent of total number of fungicides applied after peanut emergence[c]
		%
Pydiflumetofen	7	14
Pydiflumetofen then pydiflumetofen	7 then 7	2
Pydiflumetofen plus azoxystrobin plus benzovindiflupyr	7 + 11 + 7	21
Pydiflumetofen plus azoxystrobin plus benzovindiflupyr then pydiflumetofen plus azoxystrobin plus benzovindiflupyr	7 + 11 + 7 then 7 + 11+ 7	9
Pydiflumetofen plus tebuconazole	7 + 3	1
Pydiflumetofen plus tebuconazole then pydiflumetofen plus tebuconazole	7 + 3 then 7 + 3	2
Pydiflumetofen plus flutolanil	7 + 7	2
Pydiflumetofen plus flutolanil then pydiflumetofen plus flutolanil	7 + 7 then 7 + 7	2

[a]Data are from 46 farmers (61% of all farmers surveyed) who applied pydiflumetofen alone or with other fungicides.

[b]Abbreviation: FRAC, Fungicide Resistance Action Committee.

[c]Percentages will not total 100% because the calculation is not based on applications with pydiflumetofen but is based on applications of all fungicides during the cropping cycle.

Table 14. Percentage of pydiflumetofen sprays receiving a fungicide after pydiflumetofen was applied in 2021.[a]

Fungicides	FRAC[b] number	Percent of total number of pydiflumetofen sprays
		%
Chlorothalonil	M5	67
Prothioconazole plus tebuconazole	3 + 3	13
Other fungicides	-	10
No fungicide	-	10

[a]Data are from 46 farmers who applied pydiflumetofen.

[b]Abbreviation: FRAC, Fungicide Resistance Action Committee.