New fungicide options for managing Sclerotinia blight of peanut.

Mychele Batista da Silva[1] and David B. Langston[2, †]

[1,2] Plant Pathology Department, Virginia Polytechnical Institute and University, Tidewater Research and Extension Center, Suffolk, VA, 23437

[†]Corresponding Author: David B. Langston, vegpath@vt.edu

Keywords: disease management, pydiflumetofen, benzovindiflupyr, leaf spot, Sclerotinia

Funding: National Peanut Board

Abstract

Late leaf spot (LLS), caused by *Nothopassalora personata,* and Sclerotinia blight (SB), caused by *Sclerotinia minor,* are significant diseases affecting peanut production in Virginia. Field trials were conducted in 2020 - 2022 at two locations per year to identify fungicide programs that manage both diseases. In 2020, pydiflumetofen applied independently, as well as in combination with a premix of azoxystrobin + benzovindiflupyr, provided effective protection against both LLS and SB. This combination demonstrated potential as a cost-effective alternative to fluazinam. Years 2021 and 2022 focused on the most effective timing of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr. Results demonstrated that the combination of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr applied 60 and 90 days after planting was most consistent in providing the greatest efficacy against both diseases while improving yield. The tank-mix/premix combination of pydiflumetofen and azoxystrobin + benzovindiflupyr offers effective and economical management of both LLS and SB compared to fungicide programs where fluazinam is added for SB management only.

The U.S. is the world's fifth largest peanut (*Arachis hypogea* L.) producer behind India, Nigeria, Senegal, and Chad. U.S. peanut farm gate value is over $1.5 billion with over 1 million acres planted (USDA-NASS 2023). In 2022, the cultivated area dedicated to peanut farming in Virginia reached 11,736 ha with a total estimated value of $35 million (USDA-NASS 2023). Of all of the peanut growing states, Virginia often has the highest average yields compared to other states with an average of 5,040 kg/ha. Losses due to fungal diseases are comorbidities that can reduce peanut yields annually in every region peanuts are grown (Kokalis-Burelle et al. 1997). The most common diseases in Virginia are late leaf spot (LLS) caused by *Nothopassalora personata*

[(Berk. & M.A. Curtis) U. Braun, C. Nakash, Videira & Crous (syn. *Cercosporidium personatum* (Berk & M.A. Curtis) Deighton)] and Sclerotinia blight (SB) caused by *Sclerotinia minor* Jagger. The primary control strategies for managing these diseases are long rotations and planting resistant varieties; however, there are no peanut varieties completely resistant to both diseases. Therefore, growers rely on preventive fungicide applications to reduce the risk of losses to both diseases. Timing of fungicide applications is critical to successful disease management in peanuts, and prescriptive programs based on DAP (days after planting) have been developed to manage peanut diseases while reducing the risk of fungicide resistance development (Dafny Yelin et al. 2022; Langston Jr et al. 2002; Woodward et al. 2015). Each fungicide program utilizes different fungicides and MOAs (modes of action) to target both leaf spot and soilborne diseases.

Virginia peanut growers experience leaf spot diseases similar to those in other peanut growing regions. Yet, losses to southern stem rot (SSR) are lower in Virginia compared to those observed in more southern states due to the cooler climate and the optimum temperature range for SSR being 25 to 35ºC (Aycock 1966). Nevertheless, the cooler climate prevalent in the area provides favorable conditions for infection of SB due to its preferred temperature range of 15 to 20 ºC (Matheron and Porchas 2005). Fluazinam (FRAC Group 29) has been the standard fungicide for many years for control of SB and is often included in leaf spot fungicide programs (Langston, personal communication). The addition of fluazinam significantly increases production costs as it is the most expensive fungicide labeled on peanuts at $16.2 to $24.3/ha based on 0.2 and 0.3 L/ha, respectively (Langston, personal communication). Optimally, a fungicide or fungicide program that controls both LLS and SB would be beneficial to growers if the cost of control was not compounded. Recently, pydiflumetofen (FRAC Group 7) was labeled for use on peanut and is particularly effective against leaf spot diseases (Duan et al. 2019; Wei et al. 2018, 2019a, 2019b). Azoxystrobin (FRAC Group 11) and benzovindiflupyr (FRAC Group 7) are labeled as a premix fungicide combination for suppression of peanut LLS and SSR. None of these fungicides have been specifically applied to manage SB. The objective of these studies was to identify fungicides and fungicide programs to control LLS and SB in Virginia peanuts utilizing the tank-mix combination of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr.

Material and methods

Field experiments were conducted at the Virginia Tech Tidewater Agricultural Research and Extension Center's fields (Trial 1) or the Hare Rd. Farm (Trial 2) in 2020, 2021, and 2022. Fields at both locations had histories of severe losses to both LLS and SB and followed a cotton (*Gossypium hirsutum*), corn (*Zea maize*), and peanut rotation. Cultivars used were Sullivan (2020 and 2021) and Bailey II (2022). Peanuts were planted on the following dates for trials 1 and 2: May 16 and 15, 2020; May 11 and 12, 2021; and May 16 and June 3, 2022, respectively. Seeding rate was ca. 13 seed/m row and a 0.91 m row spacing was used for all three experiments. Plots were 2-rows, 10-m long and were bordered on both sides by untreated buffer rows. A 2.44-m bare-ground buffer separated plot ends within the row. Experiments utilized a randomized complete block arrangement with four replications per treatment. Treatment applications were made with a tractor-mounted, multi-boom sprayer calibrated to deliver 187 L/ha at 262 kPa through Twinjet 8002VS nozzles (Tee Jet Technologies, Springfield, IL, U.S.A.) spaced 45.7-cm apart.

In 2020, imidacloprid plus prothioconazole was applied in-furrow at planting. Untreated controls did not receive any treatments for SB or LLS. Treatment programs designed for managing only LLS rotated chlorothalonil with a premix of prothioconazole + tebuconazole. Application timing each year and products applied are listed in Tables 1 to 4. All other inputs (fertilizer, weed control, insect control) were used according to standard Virginia Cooperative Extension recommendations (Balota et al. 2023).

Disease assessments were conducted at approximately two-week intervals until harvest. LLS was assessed using the Florida 1-10 scale where 1=no disease and 10=complete defoliation and complete plant death (Chiteka et al. 1988), and percentage of defoliation was calculated as previously reported (Jordan et al. 2017; Li et al. 2012):

% Defoliation = 100/1+exp(-(Florida 1-10 scale – 6.0672)/ 0.7975)

SB incidence was recorded as infection foci exhibiting symptoms and/or signs of SB in increments of 30.5 cm of row length for both treatment rows per plot (22.86 m). LLS and SB assessments were used to calculate the area under the disease progress curve (AUDPC) described by Shaner and Finney (1977). Peanut yield was determined by digging and harvesting the two center rows of each plot. Yield of peanuts used a 7% (wt/wt) moisture content conversion. Disease and yield data were analyzed using Fisher's protected LSD test ($P \leq 0.05$) PROC GLIMMIX of SAS (SAS Institute, Cary, NC).

Results

2020 field experiments. The incidence of both LLS and SB was high in 2020. Both locations contained 17 treatments per trial, but only treatments relevant to SB control are shown in Table 2 with the exception of the program where a rotation of prothioconazole and chlorothalonil was used as a leaf spot control only. Results demonstrated that all fungicide programs significantly reduced LLS AUDPC values compared to the untreated control in both trials. Trial 1 had higher disease pressure from SB than Trial 2 in 2020 based on AUDPC values (Table 2). All fungicide programs in Trial 1 containing pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr alone or as a tank-mix or when pydiflumetofen was rotated with fluazinam significantly reduced SB AUDPC values compared to the untreated and leaf spot only controls. Pydiflumetofen rotated with fluazinam showed a significant advantage in reducing SB AUDPC values compared to all other treatments except the treatment where the tank-mix of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr were applied early at 63 and 91 DAP. Lower disease pressure in Trial 2 resulted in only two fungicide programs significantly reducing SB AUDPC values compared to the untreated plots. These treatments included a tank-mix of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr at 63 and 91 DAP or where pydiflumetofen was rotated with fluazinam. In Trial 1, significant yield improvement above the untreated control was observed with programs containing pydiflumetofen alone, pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr tank-mix, and pydiflumetofen rotated with fluazinam. No significant difference in yield was observed between treatments in Trial 2. Additionally, two applications of fluazinam rotated with pydiflumetofen did not provide additional SB suppression compared to the tank-mix of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr applied at 63 and 91 DAP in Trial 1, and all treatments containing pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr alone or as a tank-mix in Trial 2 in 2020. The fungicide program alternating pydiflumetofen and fluazinam did not improve yield compared to both pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr tank-mix programs in Trial 1.

2021 field experiments. Fungicide trials in 2021 focused on timing of the pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr tank-mix. In Trial 1, none of the fungicide program significantly reduced LLS compared to the untreated controls (Table 3). However, SB control was only observed when pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr were applied at 60 and 90 DAP and prothioconazole tank-mixed with fluazinam at 125 DAP. All fungicide programs improved yield compared to the untreated control, and the tank-mix of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr applied at 60 and 90 DAP without fluazinam significantly improved yield compared to the leaf spot program only (premix of prothioconazole + tebuconazole rotated with chlorothalonil).

In Trial 2, all fungicide programs were effective in reducing the AUDPC values of SB and LLS and improving yield compared to untreated control. Plots receiving the latest initial applications of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr at 90 DAP and the leaf spot only program demonstrated the highest SB AUDPC values which indicates the importance of earlier applications of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr for reducing damage caused by SB (Table 3).

2022 field experiments. Weather was abnormally dry during the latter part of the 2022 growing season and only one location developed SB (Trial 2). The same fungicide programs utilized in 2021 were included in the 2022 programs (Table 4). Yields were lower compared to those observed in 2020 and 2021, with no statistical differences among fungicide programs. All fungicide programs in Trial 1 and Trial 2 significantly reduced LLS. In Trial 2, the combination of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr applied at 60 and 90 DAP, followed by the premix of prothioconazole + tebuconazole with or without fluazinam at 120 DAP was effective in reducing SB progression. Two additional fungicide programs were effective in reducing SB: the premix of azoxystrobin + benzovindiflupyr applied at 90 and 120 DAP; and the leaf spot program only (premix of prothioconazole + tebuconazole rotated with chlorothalonil).

Discussion

The results obtained in 2020 are the first to demonstrate that pydiflumetofen applied alone and pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr tank-mix can provide acceptable protection against both LLS and SB and improve yields in peanuts. Fluazinam has historically been the most consistently effective fungicide used by peanut growers to control SB; however, fluazinam does not provide acceptable control of leaf spot pathogens (Smith et al. 1992). Therefore, fluazinam applications were included in LLS fungicide programs when SB is a threat, which adds additional cost. In these trials, the highest levels of SB suppression were observed when pydiflumetofen was rotated with fluazinam and when the tank-mix of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr were applied earlier at the company-recommended 60-90 DAP schedule. Pydiflumetofen is a versatile foliar fungicide that is effective against a wide range of fungal pathogens (Stierli et al. 2021). This active ingredient was developed to manage diseases affecting plant leaves and molds (Budde-Rodriguez et al. 2021; Stierli et al. 2021). Its efficacy has been demonstrated in effectively controlling Sclerotinia stem rot or white mold (Duan et al. 2019; Ge et al. 2019), Cercospora leaf spot (Pethybridge et al. 2020), and Fusarium head blight (Hou et al. 2017). The premix fungicide combination of azoxystrobin and benzovindiflupyr has been labeled primarily for suppression of peanut foliar diseases and SSR in peanuts, but is not labeled against SB. In vitro studies showed the premix of azoxystrobin + benzovindiflupyr had some of the lowest EC50 values for inhibiting *S. minor* compared to other SDHIs labeled on peanut (Cannon 2017, 21-43). Additional in vitro work demonstrated that the pyrazole-4-carboxamides of SDHIs (which includes benzovindiflupyr and pydiflumetofen) had the highest activity against a similar pathogen, *S. sclerotiorum* (Gao et al. 2020). These previous findings suggest that combining pydiflumetofen with benzovindiflupyr has additive or inhibitory effects on SB in the field, which was demonstrated in this study.

Beyond the basic activity of fungicides against fungal pathogens, timing of fungicide applications during the season is critical for maximizing fungicide efficacy. Previous studies have shown the effectiveness in spray timing against LSS and SSR in Georgia (Tsai and Brenneman 2018). Similar research has demonstrated that managing SB is more effective when fungicides are applied preventively rather than after symptoms are observed (Woodward et al. 2015). In these studies, pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr was generally more effective controlling both LLS and SB, with or without fluazinam, if initiated ca. 60 DAP compared to initial applications beginning 75 DAP or later.

Conclusions and significance

Since 1997, Virginia peanut growers have used online, weather-based disease advisories to time fungicide applications to manage LLS and SB (Phipps et al. 1997). The advisory system for SB utilizes an algorithm, developed by Langston Jr. et al. (2002), which focused on timing fluazinam applications. SB was managed more successfully using versions of the algorithm that timed fluazinam sprays just prior to disease onset. Longer rotations and more disease-tolerant peanut cultivars have greatly reduced the frequency and severity of SB in grower fields which led to the recommendation for growers to scout for SB once the advisory indicated that SB risk was high and apply fluazinam only if found through scouting. Fluazinam efficacy is greater if applied preventively, but can have good curative activity if applied subsequent to disease onset (Langston Jr. et al. 2002). On-demand sprays like with fluazinam are only effective with fungicides having curative activity. While greenhouse bioassays have shown significant curative activity of pydiflumetofen and benzovindiflupyr against certain fungal pathogens, these studies also demonstrate that preventive activity is often significantly greater than curative activity (Duan et al. 2019; Huang et al. 2019). Also, fluazinam is specifically used against SB only and has little to no efficacy against other peanut diseases. The combination of pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr has activity against foliar diseases and SSR, for which they were primarily labeled. Therefore, it is more appropriate to apply that tank-mix combination on a preventive spray schedule since the onset of two or more diseases occurs across a large part of the peanut growing season, and the tank-mix partners exhibit greater preventive than curative activity. Overall, utilizing the pydiflumetofen and the premix of azoxystrobin + benzovindiflupyr ($17/ha) eliminates cost associated with historically expensive fluazinam ($16.2-$24.3/ha) and by controlling more diseases with fewer fungicide applications.

Acknowledgments

We would like to thank Linda Byrd-Masters and Matthew Wilkins for their assistance with field and data collection, and the National Peanut Board for funding this research project.

Literature cited

Aycock, R. 1966. Stem rot and other diseases caused by *Sclerotium rolfsii:* or the status of Rolfs' fungus after 70 years. N. C. Agri. Exp. Stn. Tech. Bull. 174.

Balota, M., Jordan D., Langston D., Shortridge J., and Taylor S. V. 2023. 2023 Virginia peanut production guide. (*Publication* SPES-367NP (SPES-451NP). Virginia Cooperative Extension, Virginia Tech. Retrieved from https://www.sites.ext.vt.edu/newsletter-archive/peanut-production/2023.pdf

Budde-Rodriguez, S., Celoy, R. M., Mallik, I., Pasche, J. S., and Gudmestad, N. C. 2021. Impact of SDH mutations in *Alternaria solani* on recently developed SDHI fungicides adepidyn and solatenol. Plant Dis. 105: 3015-3024.

Cannon, M. D. Sensitivity of *Sclerotinia minor* to Common Peanut Fungicides. (master's thesis, North Carolina University, 2017). https://repository.lib.ncsu.edu/server/api/core/bitstreams/fba2fb86-2b50-432b-b9de-7073a2452e87/content

Chiteka, Z. A, Gorbet, D. W., Shokes, F. M., Kucharek, T. A., and Knauft, D. A. 1988. Components of resistance to late leafspot in peanut. I. Levels and variability-implications for selection. Peanut Science 15: 25-30.

Dafny Yelin, M., Moy, J. C., Rabinovitz, O., and Hovav, R. 2022. Reduction of *Sclerotium rolfsii* damage in Virginia-type peanuts using a combination of tolerant varieties and fungicide. Phytoparasitica 50: 769-773.

Duan, Y., Xiu, Q., Li, H., Li, T., Wang, J., and Zhou, M. 2019. Pharmacological characteristics and control efficacy of a novel SDHI fungicide pydiflumetofen against *Sclerotinia sclerotiorum*. Plant Dis. 103: 77-82.

Gao, Y., He, L., Zhu, J., Cheng, J., Li, B., Liu, F., and Mu, W. 2020. The relationship between features enabling SDHI fungicide binding to the Sc-Sdh complex and its inhibitory activity against *Sclerotinia sclerotiorum.* Pest Management Science 76: 2799-2808.

Ge, T., Ekbataniamiri, F., Liu, Q., Giggie, E., and Hao, J. J. 2019. Evaluation of Miravis Prime for controlling white mold and grey mold on potato, Presque Isle, ME, 2018. Plant Dis. Manag. Rep 13 : V114. https://doi.org/10.1094/PDMR13

Hou, Y-P., Mao, X-W., Wang, J-X., Zhan, S-W., and Zhou, M-G. 2017. Sensitivity of *Fusarium asiaticum* to a novel succinate dehydrogenase inhibitor fungicide pydiflumetofen. Crop Protection 96: 237-244.

Huang, X-P., Luo, J., Li, B-X., Song, Y-F., Mu, W., and Liu, F. 2019. Bioactivity, physiological characteristics and efficacy of the SDHI fungicide pydiflumetofen against *Sclerotinia sclerotiorum*. Pesticide biochemistry and physiology 160: 70-78.

Jordan, B. S., Culbreath, A. K., Brenneman, T. B., Kemerait Jr, R. C. and Branch, W. D., 2017. Late leaf spot severity and yield of new peanut breeding lines and cultivars grown without fungicides. Plant Dis. 101:1843-1850.

Kokalis-Burelle, N., Porter, D. M., Rodriguez-Kabana, R., Smith, D.H., and Subrahmanyam, P. 1997. Compendium of peanut diseases. Vol. 2. American Phytopathological Society.

Langston Jr., D. B., and Mehl, H. L. 2021. Applied Research on Field Crop Disease & Nematode Management 2020. Virginia Cooperative Extension. SPES-296NP. Available at http://hdl.handle.net/10919/105561

Langston Jr., D. B., Phipps, P. M., and Stipes, R. J. 2002. An algorithm for predicting outbreaks of Sclerotinia blight of peanut and improving the timing of fungicide sprays. Plant Dis. 86: 118-126.

Li, Y., Culbreath, A. K., Chen, C. Y., Knapp, S. J. C., Holbrook, C., and Guo, B. 2012. Variability in field response of peanut genotypes from the US and China to tomato spotted wilt virus and leaf spots. Peanut Science 39 (1) : 30-37.

Matheron, M. E, and Porchas, M. 2005. Influence of soil temperature and moisture on eruptive germination and viability of sclerotia of *Sclerotinia minor* and *S. sclerotiorum*. Plant Dis. 89: 50-54.

Pethybridge, S. J., Sharma, S., Hansen, Z., Kikkert, J. R., Olmstead, D. L, and Hanson, L. E. 2020. Optimizing Cercospora leaf spot control in table beet using action thresholds and disease forecasting. Plant Dis. 104: 1831-1840.

Phipps, P. M., Deck, S. H., and Walker, D. R. 1997. Weather-based crop and disease advisories for peanuts in Virginia. Plant Dis. 81: 236-244.

Shaner, G., and Finney, R. E. 1977. The effect of nitrogen fertilization on the expression of slow-mildewing resistance in Knox wheat. Phytopathology 67: 1051-1056.

Smith, F. D., Phipps P. M., and Stipes, R. J. 1992. Fluazinam: a new fungicide for control of Sclerotinia blight and other soilborne pathogens of peanut. Peanut Science 19: 115-120.

Stierli, D., Haas, H. U., Rajan, R., Bartlett, D., Sierotzki, H., Cederbaum, F., Walter, H., and Lamberth, C. 2021. ADEPIDYN—the first N-methoxy-substituted carboxamide among the succinate dehydrogenase inhibitors. In Recent Highlights in the Discovery and Optimization of Crop Protection Products, 357-366. Elsevier.

Tsai, Y. C., and Brenneman, T. B. 2018. Early-season fungicide programs for peanut disease management. Plant Health Prog. 19: 103-106.

USDA-NASS. 2023. Crop Production 2022 Summary. ISSN:1057-7823.

Wei, X., Byrd-Masters, L., and Mehl, H. 2018. Comparison of foliar fungicide programs for leaf spot and soilborne disease control in peanut in Virginia, 2017. Plant Dis. Manag. Rep 12:CF041. https://doi.org/10.1094/PDMR12

Wei, X., Byrd-Masters, L., and Mehl, H. 2019a. Comparison of in-furrow and foliar applications of fungicides for leaf spot and soilborne disease control in peanut in Virginia, 2018. Plant Dis. Manag. Rep 14:CF165. https://doi.org/10.1094/PDMR14

Wei, X., Byrd-Masters, L., and Mehl, H. 2019b. Evaluation of in-furrow and foliar applications of fungicides to control leaf spot and soilborne diseases in peanut in Virginia, 2019. Plant Dis. Manag. Rep 14:CF166. https://doi.org/10.1094/PDMR14

Woodward, J. E., Russell, S. A., Baring, M. R., Cason, J. M., and Baughman, T. A. 2015. Effects of fungicides, time of application, and application method on control of Sclerotinia blight in peanut. International Journal of Agronomy 2015: 1-8. https://doi.org/10.1155/2015/323465

Table 1. Fungicide products used in programs for the control of Sclerotinia blight and Late leaf spot in peanut.

Trade name	Active ingredient	Rate/ha	Manufacturer
Admire Pro 4.6 SC	Imidacloprid	0.62 L	Bayer CropScience LP, St. Louis, MO
Proline 480 SC	Prothioconazole	0.41 L	
Provost Silver 3.52 SC	Prothioconazole and Tebuconazole	0.95 L	
Elatus 45 WG	Azoxystrobin and Benzovindiflupyr	0.66 kg	Syngenta Crop Protection, Greensboro, NC
Miravis 1.67 SC	Pydiflumetofen (adepidyn)	0.25 L	
Omega 500 F	Fluazinam	1.75 L	
Bravo Weather Stik 6.0 SC	Chlorothalonil	1.75 L	ADAMA Agricultural Solutions Ltd., Ashdod, Israel

Table 2. Effect of select fungicide programs on Sclerotinia blight and late leaf spot disease severity (AUDPC) and the yield of peanut in 2020.

Fungicide programs	Spray DAP[v]	LS AUDPC[w]		SB AUDPC[x]		YIELD (kg/ha)[y]	
2020		**Trial 1**	**Trial 2**	**Trial 1**	**Trial 2**	**Trial 1**	**Trial 2**
Untreated control	-	408.3 a[z]	301.8 a	1191.6 ab	213.9 a-d	952.6 d-f	3368.4
Imidacloprid + Prothioconazole Azoxystrobin + Benzovindiflupyr + Pydiflumetofen Chlorothalonil	at planting 90, 125 119	17.1 b	7.1 b	490.1 hi	33.1 ef	2143.1 ab	4901.1
Imidacloprid + Prothioconazole Azoxystrobin + Benzovindiflupyr + Pydiflumetofen Chlorothalonil	at planting 77, 105 119	10.7 b	6.3 b	611.1 gh	83.5 c-f	2276.7 a	4492.9
Imidacloprid + Prothioconazole Pydiflumetofen + Tebuconazole Chlorothalonil	at planting 63, 91 119	18.8 b	9.9 b	752.1 fg	58.5 d-f	1594.3 bc	4323.8
Imidacloprid + Prothioconazole Pydiflumetofen Fluazinam Chlorothalonil	at planting 63, 91 77, 105 119	9.3 b	7.1 b	343.8 i	15.4 f	2369.7 a	4310.3
Imidacloprid + Prothioconazole Azoxystrobin + Benzovindiflupyr Chlotothalonil + Tebuconazole Chlorothalonil	at planting 63, 91 77, 105 119	20.5 b	6.3 b	824.0 e-g	153.8 b-f	1505.7 cd	3825.7

Imidacloprid + Prothioconazole	at planting	9.8 b	8.2 b	1158.4 ab	181.6 a-e	954.0 d-f	3719.9
Prothioconazole + Tebuconazole	63, 91						
Chlorothalonil + Tebuconazole	77, 105						
Chlorothalonil	119						
P(f)		<0.0001	<0.0001	<0.0001	0.01	<0.0001	0.09

[v]Spray timing in days after planting.

[w]LS AUDPC = area under disease progress curve for late leaf spot. Disease onset: 26 and 25 August for Trial 1 and Trial 2, respectively.

[x]SB AUDPC = area under disease progress curve for Sclerotinia blight. Disease onset: 13 September and 28 August for Trial 1 and Trial 2, respectively.

[y]Yields are weight of peanuts with moisture content adjusted to 7%. Peanuts were dug on 19 and 20 October and harvested on 4 and 5 November on Trial 1 and 2 respectively.

[z]Means in a column followed by the same letter(s) are not significantly different according to Fisher's Protected LSD (P>0.05).

Table 3. Effect of select fungicide programs on Sclerotinia blight and late leaf spot disease severity (AUDPC) and the yield of peanut in 2021.

Fungicide programs	Spray DAP[v]	LS AUDPC[w]		SB AUDPC[x]		YIELD (kg/ha)[y]	
		Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
2021							
Untreated control	--	2233.1	1256.6 a[z]	569.1 ab	630 a	3446.1 d	2168.7 c
Pydiflumetofen + Azoxystrobin + Benzovindiflupyr Prothioconazole + Tebuconazole Chlorothalonil	60, 90 125 132	473.9	129.6 b	281.0 bc	161.5 c	6530.8 a	6167.3 ab
Pydiflumetofen + Azoxystrobin + Benzovindiflupyr Prothioconazole + Tebuconazole + Fluazinam Chlorothalonil	60, 90 125 132	1043.2	139.1 b	127.8 c	175.4 c	6458.6 ab	6525.7 a
Chlorothalonil Prothioconazole + Tebuconazole Pydiflumetofen + Azoxystrobin + Benzovindiflupyr Fluazinam	60, 132 75, 125 90 125	975.4	230.8 b	775.5 a	231.0 c	5605.5 a-c	5822.9 ab
Chlorothalonil Prothioconazole + Tebuconazole Pydiflumetofen + Azoxystrobin + Benzovindiflupyr	60, 132 75 90, 125	1312.3	95.3 b	729.9 a	418.5 b	6089.0 ab	5631.1 ab
Chlorothalonil Pydiflumetofen + Azoxystrobin + Benzovindiflupyr	60, 132 75, 104	1398.1	80.7 b	478.4 a-c	124.1 c	6116.8 ab	5564.5 ab

Chlorothalonil Pydiflumetofen + Azoxystrobin + Benzovindiflupyr Prothioconazole + Tebuconazole + Fluazinam Prothioconazole + Tebuconazole	60, 132 75 104 125	535.6	89.1 b	323.4 bc	177.5 c	6177.9 ab	5089.6 b
Chlorothalonil Prothioconazole + Tebuconazole	60, 90, 132 75, 104, 125	1335.4	192.8 b	599.0 ab	442.1 b	5438.7 bc	5350.6 ab
P (F)		0.06	<0.0001	0.047	<0.0001	<0.0001	<0.0001

[v]Spray timing in days after planting.

[w]LS AUDPC = area under disease progress curve for late leaf spot. Disease onset: 21 and 28 August for Trial 1 and Trial 2, respectively.

[x]SB AUDPC = area under disease progress curve for Sclerotinia blight. Disease onset: 2 and 11 August for Trial 1 and Trial 2, respectively.

[y]Yields are weight of peanuts with moisture content adjusted to 7%. Peanuts were dug 6 October on both Trials and harvested on 28 and 21 October on Trial 1 and 2 respectively.

[z]Means in a column followed by the same letter(s) are not significantly different according to Fisher's Protected LSD (P>0.05).

Table 4. Effect of select fungicide programs on Sclerotinia blight and late leaf spot disease severity (AUDPC) and the yield of peanut in 2022.

Fungicide programs	Spray DAP[v]	LS AUDPC[w]		SB AUDPC[x]	YIELD (kg/ha)[y]	
2022		**Trial 1**	**Trial 2**	**Trial 2**	**Trial 1**	**Trial 2**
Untreated control	--	1592.1 a[z]	339.9 a	933.1 a	2475.0	1429.5
Pydiflumetofen + Azoxystrobin + Benzovindiflupyr Prothioconazole + Tebuconazole	60, 90 120	358.7 bc	58.2 b	316.9 ef	2315.3	2946.7
Pydiflumetofen + Azoxystrobin + Benzovindiflupyr Prothioconazole + Tebuconazole + Fluazinam	60, 90 120	232.9 bc	53.3 b	163.3 f	2954.0	2611.1
Chlorothalonil Prothioconazole + Tebuconazole Pydiflumetofen + Azoxystrobin + Benzovindiflupyr Fluazinam	60 75, 120 90 120	532.8 b	54.2 b	764.6 a-d	2628.5	2606.0
Chlorothalonil Prothioconazole + Tebuconazole Pydiflumetofen + Azoxystrobin + Benzovindiflupyr	60 75 90, 120	259.4 bc	53.3 b	563.1 b-e	2510.8	1753.7
Chlorothalonil Pydiflumetofen + Azoxystrobin + Benzovindiflupyr	60 75, 105	149.0 bc	141.1 b	823.1 a-c	2906.1	1770.2
Chlorothalonil Pydiflumetofen + Azoxystrobin + Benzovindiflupyr	60 75	180.4 bc	121.0 b	658.8 a-d	2884.8	2127.2

Prothioconazole + Tebuconazole + Fluazinam	105					
Prothioconazole + Tebuconazole	120					
Chlorothalonil	60, 90	123.8 bc	73.4 b	489.3 de	2757.0	2193.5
Prothioconazole + Tebuconazole	75, 105, 120					
P(f)		<0.0001	0.0004	0.001	0.97	0.13

[v]Spray timing in days after planting.

[w]LS AUDPC = area under disease progress curve for late leaf spot. Disease onset: 15 August and 7 September for Trial 1 and Trial 2, respectively.

[x]SB AUDPC = area under disease progress curve for Sclerotinia blight. Disease onset: 23 August for Trial 2.

[y]Yields are weight of peanuts with moisture content adjusted to 7%. Peanuts were dug on 24 and 27 October and harvested on 31 October and 7 November on Trial 1 and 2 respectively.

[z]Means in a column followed by the same letter(s) are not significantly different according to Fisher's Protected LSD (P>0.05).