Fluazinam: A New Fungicide for Control of Sclerotinia Blight and Other Soilborne Pathogens of Peanut[1]

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ABSTRACT

Fluazinam provided effective control of Sclerotinia blight (*Sclerotinia minor* Jagger) of peanut in six field trials during a 4-yr period. Applications of fluazinam (0.56 kg/ha) at the onset of Sclerotinia blight and 4 wk later provided an average of 69% suppression of disease incidence and increased yields by 1598 kg/ha compared to untreated plots. Performance of fluazinam was significantly better than iprodione, the material currently used for control of Sclerotinia blight. Two applications of iprodione at 1.12 kg/ha provided only 31% suppression of disease incidence and increased yield by 718 kg/ha. Fungicides were also evaluated in 1990 as tank-mixes with chlorothalonil (1.26 kg/ha) that were applied in foliar sprays according to the Virginia peanut leafspot advisory program. Treatments consisted of no fungicide, chlorothalonil alone, and tank-mixes of chlorothalonil plus either dicloran at 2.10 kg/ha, fluazinam at 0.56 kg/ha, or iprodione at 0.84 kg/ha. Sclerotinia blight at harvest in untreated plots and plots treated with chlorothalonil alone averaged 27.8 and 35.8 disease foci per plot, whereas yields averaged 3624 and 2251 kg/ha, respectively. Compared to plots treated with chlorothalonil alone, Sclerotinia blight was suppressed by 92, 25, and 25%, and yield was increased by 4020, 1925, and 1684 kg/ha in plots treated with chlorothalonil plus either fluazinam, iprodione, or dicloran, respectively. Applications of tank-mixes containing fluazinam plus chlorothalonil in 1991 provided additional evidence that this approach was a highly effective means of controlling both Sclerotinia blight and early leafspot, a previously unattainable goal. Fluazinam did not control early leafspot (*Cercospora arachidicola* S. Hori) in field trials; however, the fungicide was fungitoxic *in vitro* to *Sclerotium rolfsii* Sacc. and *Rhizoctonia solani* Kühn.

Key Words: *Arachis hypogaea,* fungicides, groundnut, *Sclerotinia minor.*

Sclerotinia blight, caused by *Sclerotinia minor* Jagger (7,8), is the most destructive disease of peanut in Virginia. Losses of yield attributed to *S. minor* from 1988 to 1991 averaged 6% annually, in spite of the increased use of iprodione [3-(3,5-dichlorophenyl)-N-(methylethyl)-2,4-dioxo-1-imidazolidine carboxamide], a dicarboximide fungicide registered for use on peanut in 1985. Control of Sclerotinia blight with iprodione commonly averages 45-55% (3), and there remains a need for a more efficacious control strategy. Losses occur as the disease attacks lateral vines of plants at the soil surface. Lesions on stems and pegs weaken the plant and often result in a large loss of peanut pods at harvest.

In addition to Sclerotinia blight, control of early leafspot of peanut, caused by *Cercospora arachidicola* S. Hori, is required to produce a profitable yield in southeast Virginia. In spite of the widespread implementation of recommended control measures (13), early leafspot still reduces peanut yield in Virginia by approximately 4% each year. Chlorothalonil [2,4,5,6-tetrachloroisophthalonitrile] is an effective fungicide for control of early leafspot, but its use has been demonstrated to increase the severity of Sclerotinia blight (17). To avoid this problem in fields with a history of severe Sclerotinia blight, growers have risked the potential for more leafspot by reducing the use of chlorothalonil through the use of less effective fungicides for control of early leafspot, or alternating sprays between chlorothalonil and other fungicides (13).

A reduction in the total number of fungicide applications required for effective control of leafspot resulted when the Virginia peanut leafspot advisory program was established in 1981 (15). Advisories to spray for leafspot control are issued to growers whenever plants are vulnerable to infection. Growers that use the advisory program have reduced the number of spray applications by an average of 3.5 per season (12). The incidence of Sclerotinia blight in plots treated with chlorothalonil according to the advisory program has been significantly less than in plots treated six or seven times at 2-wk intervals (10). Unfortunately, the advisory program often calls for sprays late in the season when applications of chlorothalonil may trigger increases in severity of Sclerotinia blight. A dense peanut canopy has been implicated as a factor favoring Sclerotinia blight (5). However, in peanut plots lacking significant differences in defoliation, plots sprayed more frequently with chlorothalonil still had higher incidence of Sclerotinia blight (11), which suggests a direct role for chlorothalonil in triggering an increased severity of the disease.

[1]This investigation was part of the senior author's doctoral research program. Use of trade or common names does not imply endorsement or criticism of the products by Virginia Polytechnic Institute and State University, judgment of similar ones not mentioned, or registration under FIFRA.

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A possible solution to the dilemma facing growers seeking to control both Sclerotinia blight and early leafspot would be the development and use of a fungicide capable of controlling both diseases. Because the two pathogens are unrelated taxonomically and possess marked differences in disease etiology, it may be difficult to find a single fungicide with a high level of activity against both pathogens. Current fungicides used in management of Sclerotinia blight and early leafspot have different chemistry and lack efficacy against both pathogens. Applications of iprodione have not limited the severity of early leafspot nor has chlorothalonil limited Sclerotinia blight (9). Chlorothalonil was also relatively ineffective in limiting mycelial growth of *S. minor* in culture (18). Tank-mixes of fungicides, such as chlorothalonil with iprodione or other compounds, may provide an effective combination for economical control of both diseases.

Other dicarboximide fungicides with a higher level of activity than iprodione have been identified for control of Sclerotinia blight, but toxicology and residue problems have discouraged their development. Procymidone was reported to provide almost complete control of Sclerotinia blight (16). Myclozolin was also effective in suppressing Sclerotinia blight when either applied alone or as a tank-mix with chlorothalonil (4). Research on these two compounds has been discontinued in the United States. Due to the good performance of vinclozolin and lack of other effective materials, vinclozolin was granted an emergency-use label for Virginia in 1984 by the Virginia Department of Agriculture and the EPA. However, efforts to obtain a peanut label for vinclozolin have continued without success since 1984. Dicloran [2,6-dichloro-4-nitroaniline], an aromatic hydrocarbon fungicide, was also used in Virginia for suppression of Sclerotinia blight from 1977 to 1984, based on emergency-use permits. It has a mode of action similar to the dicarboximides (6).

Fluazinam [3-chloro-N-(3-chloro-5-trifluoromethyl-2-pyridyl)-2,2,2-trifluoro-2,6-dinitro-p-toluidine], is one of the few fungicides that is unrelated to the dicarboximides and possesses a high level of activity against Sclerotinia blight. This fungicide has resulted in excellent control of Sclerotinia blight in field trials and suppressed mycelial growth of iprodione-resistant isolates *in vitro* (20). Its activity in several laboratory assays was distinctly different from the dicarboximide fungicides.

The objectives of this study were to obtain additional efficacy data in the field for fluazinam against Sclerotinia blight of peanut and to evaluate tank-mixes of fungicides containing chlorothalonil for control of both Sclerotinia blight and early leafspot of peanut. As a result of the outstanding yield response of peanuts treated with fluazinam, its fungicidal activity against other peanut pathogens was determined. Included were early leafspot (*C. arachidicola*), Rhizoctonia limb rot (*Rhizoctonia solani* Kühn), and southern stem rot (*Sclerotium rolfsii* Sacc.).

Materials and Methods

Design of Field Trials and Data Analysis

Field trials were done on farms in southeast Virginia near or at the Tidewater Agricultural Experiment Station in Suffolk. All sites had a history of severe Sclerotinia blight. Peanut seed, cultivar NC 9, were planted in May of each year and managed according to standard practices for peanut production in Virginia. Included were applications of chlorothalonil (Bravo 720®, ISK-Biotech, Mentor, OH) for control of early leafspot according to the Virginia peanut leafspot advisory program (15). Recommended research procedures (14) were used in all field tests and consisted of a randomized block design with four replications. Plots consisted of four 12.2-m rows spaced 0.9 m apart. Fungicide sprays were applied to the two center rows of the four-row plots. The adjacent outer rows of each plot functioned as guard rows. Disease incidence was monitored monthly beginning at the end of July and recorded as the number of disease foci in the two center rows of each plot. A disease focus represented an area of active growth by *S. minor* and included up to 30 cm of row length. Peanuts were dug and harvested in early October. Yield was based on weight of harvested peanuts from the two center rows of plots, and weights were adjusted to reflect a moisture content of 7% (w/w). Statistical analyses of disease incidence and yield were determined by Duncan's multiple range test using a probability of 0.05 (SAS Institute, Inc., Cary, NC).

Demand Applications of Fungicides for Control of Sclerotinia Blight.

Fluazinam was obtained in 1988 as RH-3486 50WP from Rohm and Haas Co., Philadelphia, PA and from 1989 and 1991 as ASC-66825 50WP from ISK-Biotech. Iprodione, Rovral® 50WP in 1988 and Rovral® 4F from 1989 to 1991, was obtained from Rhône-Poulenc, Inc., Research Triangle Park, NC. Applications of fluazinam or iprodione alone were applied with one 8008LP nozzle in 1988 and 1989 or one 8010LP nozzle in 1990 and 1991 (TeeJet Spraying Systems Co., Wheaton, IL) centered over each row at a level to provide complete coverage of plants. During 1988 and 1989, nozzles were calibrated to deliver 335 L/ha at 165 kPa with a ground speed of 4.35 km/hr using a CO_2-pressurized sprayer. During 1990 and 1991, nozzles were calibrated to deliver 374 L/ha at 172 kPa with a ground speed of 6.28 km/hr. The slightly higher spray volume and larger droplet size obtained with 8010LP nozzles allowed for better penetration of spray droplets through the peanut canopy to the site of Sclerotinia blight activity at the soil-plant interface. Fungicides were applied on 3 Aug and 1 Sep 1988, 19 Jul and 16 Aug 1989, 26 Jul and 22 Aug 1990, and 17 Jul and 16 Aug 1991. The first spray each year was made on demand, at the initial appearance of Sclerotinia blight, and then repeated approximately 4 wk later.

Advisory Sprays of Tank-Mixes of Fungicides.

In 1990 and 1991, field trials were conducted at the Tidewater station using an experimental design as described previously. Tank-mixes of soil fungicides with chlorothalonil at 1.26 kg/ha were applied five times in 1990 according to the leafspot advisory program (26 Jun, 16 Jul, 6 Aug, 28 Aug, and 17 Sep) using D2-23 nozzles for control of both Sclerotinia blight and early leafspot (Table 1). Advisory treatments in 1990 consisted of no fungicide, chlorothalonil alone, and tank-mixes of chlorothalonil plus either dicloran (Botran® 75WP, Nor-Am Chemcial Co., Wilmington, DE) at 2.10 kg/ha, fluazinam at 0.56 kg/ha, or iprodione at 0.84 kg/ha. In addition, demand treatments using 8010LP nozzles included the previously tested soil fungicides applied alone, starting at the initial onset of Sclerotinia blight and again 4 wk later (25 Jul, 20 Aug). For leafspot control, chlorothalonil was applied separately five times according to the leafspot advisory program using D2-23 nozzles.

Field trials in 1991 focused on the use of fluazinam. Fluazinam was either tank-mixed with chlorothalonil and applied according to the leafspot advisory program, or applied alone on demand. Three advisory sprays of chlorothalonil at 1.26 kg/ha with and without fluazinam at 0.56, 0.28, 0.14 or 0.07 kg/ha were applied (25 Jun, 22 Jul, and 21 Aug). Demand treatments with fluazinam alone were applied twice (22 Jul and 19 Aug). Separate sprays of chlorothalonil were applied to these plots three times according to the leafspot advisory program.

Treatments containing chlorothalonil with and without soil fungicides

Table 1. Specifications for applications of soil fungicides in sprays to control Sclerotinia blight of peanut.

Year and treatment[1]	No. nozzles/row and type	No. of applications[2]	Spray volumes (L/ha)	Spray pressure (kPa)
1990				
Advisory	3, D2-23	5	140	345
Demand	1, 8010LP	2	374	172
1991				
Advisory	3, D2-23	3	140	345
Demand	1, 8010LP	2	374	172

[1]Advisory treatments were tank-mixed with chlorothalonil and applied according to the Virginia peanut leafspot advisory program. Demand treatments were applied when Sclerotinia blight became active and 4 wk later. For control of early leafspot in the demand plots, applications of chlorothalonil were made according to the leafspot advisory program using D2-23 nozzles.

[2]All sprays were applied at 6.28 km/hr.

were applied with D2-23 nozzles which produce small spray droplets with uniform distribution of fungicides on the foliar surface. This application method also resulted in some redistribution of soil fungicides through the canopy for control of Sclerotinia blight. When soil fungicides were applied alone, one high-volume 8010LP nozzle per row was used to produce large spray droplets to penetrate through the canopy to the site of Sclerotinia blight activity.

Evaluation of Fluazinam Against Other Pathogens.

To evaluate the activity of fluazinam against early leafspot of peanut, field trials were conducted with Florigiant peanut, a cultivar highly susceptible to early leafspot. Treatments consisted of chlorothalonil at 1.26 kg/ha, fluazinam of 0.56 kg/ha, and no treatment. Fungicides were applied three times in 1991 (24 Jun, 18 Jul, and 19 Aug) according to the advisory program using D2-23 nozzles as previously described in table 1. Plots were rated monthly for percentage of leaflets with spots and defoliation. Analyses of leafspot incidence and defoliation were conducted after arcsine transformation of data.

The fungicidal activity of fluazinam against *S. minor*, *S. rolfsii*, and *R. solani* was determined by measuring mycelial growth on glucose-yeast extract agar (GYEA) amended with various concentrations of the fungicide (3). Suspensions of fluazinam were prepared in sterile distilled water and added to the agar medium at 70 C to yield concentrations of 0.0005, 0.002, 0.01, 0.05, 0.2, 1, 5, 20, and 100 μg/mL. Four replicate GYEA plates of each concentration were prepared for testing activity against each pathogen, and the test was repeated to confirm results. After the medium solidified, plates were inoculated with 6-mm-diam agar plugs of unamended GYEA with mycelium from the periphery of 3-day, 4-day, and 5-day-old colonies of *S. minor*, *R. solani*, and *S. rolfsii*, respectively. These agar plugs were placed with the surface mycelium face-down on GYEA at the edge of the 9-cm-diam petri plate. Plates containing *S. minor* or *R. solani* were incubated at 20 C; those containing *S. rolfsii* were incubated at 25 C. Mycelial growth (mm) across the agar surface was measured at 24-hr intervals. After 5-days growth, the percent inhibition of growth was transformed into probability units (probits) and fungicide dosage was converted to logarithms (1). Linear regression analyses were used to determine ED_{50} values (estimated dose for 50% inhibition of mycelial growth) for fluazinam against each pathogen.

Table 2. Comparison of fluazinam and iprodione for control of Sclerotinia blight of peanut in field trials over a 4-yr period.

Year and treatment[1]	Rate[2] (kg/ha)	Disease incidence[3]	Yield[4] (kg/ha)
1988			
Fluazinam	0.56	15.0 c	4107 a
Fluazinam	1.12	9.0 c	4160 a
Iprodione	1.12	27.5 b	3202 b
Untreated check	--	47.8 a	1914 c
1989			
Fluazinam	0.28	13.0 b	4811 a
Fluazinam	0.56	9.8 b	4532 a
Iprodione	1.12	20.3 ab	3920 ab
Untreated check	--	29.8 a	3452 b
1990-Site A			
Fluazinam	0.28	18.8 bc	5383 a
Fluazinam	0.56	12.3 c	5730 a
Fluazinam	0.84	16.0 bc	5914 a
Iprodione	1.12	25.0 ab	5229 a
Untreated check	--	25.7 a	4912 a
1990-Site B			
Fluazinam	0.56	7.5 c	4363 a
Iprodione	1.12	16.8 b	3026 b
Untreated check	--	35.0 a	1847 c
1991-Site A			
Fluazinam	0.56	3.8 b	4507 a
Iprodione	1.12	14.8 a	4348 a
Untreated check	--	15.8 a	3813 b
1991-Site B			
Fluazinam	0.56	7.3 c	5940 a
Iprodione	1.12	19.3 b	4172 b
Untreated check	--	26.0 a	3651 b
Six-Trial Average			
Fluazinam	0.56	9.3 c	4863 a
Iprodione	1.12	20.6 b	3983 b
Untreated check	--	30.0 a	3265 c

[1]Means followed by the same letter(s) in a column for a given year grouping are not significantly different at $P \leq 0.05$ according to Duncan's multiple range test.

[2]Two applications were made each year. The first application was made when disease was first detected followed by a second application 4 wk later. Sprays were applied using one high-volume nozzle (8008LP or 8010LP) centered over each row.

[3]Disease incidence represents the number of disease foci in two 12.2-m rows at harvest. A disease foci was a point of active growth by *Sclerotinia minor* and included 15 cm of row length on either side of that point.

[4]Yield based on weight of peanuts adjusted to 7% moisture (w/w).

Results

Comparison of Demand Sprays of Fluazinam and Iprodione.

In all six field trials, treatments with either fluazinam or iprodione provided some control of Sclerotinia blight. Significant suppression of disease incidence at harvest was obtained by applications of fluazinam at 0.56 kg/ha in all six fields, but in only two fields treated with iprodione at 1.12 kg/ha (Table 2). In fields with heavy disease pressure, applications of fluazinam at 0.56 kg/ha provided 69% and 79% disease suppression, whereas iprodione provided 42% and 52% disease suppression as reflected by results in 1988 and 1990-site B, respectively. Treatments of fluazinam at 0.56 kg/ha or iprodione at 1.12 kg/ha applied to all six fields averaged 69% and 31% disease suppression, respectively. Fluazinam treatments appeared to be approximately twice as effective as iprodione in suppressing Sclerotinia blight. Diseases other than Sclerotinia blight were detected at trace levels in all six trials and were not believed to affect results.

Fluazinam significantly increased yield of peanut in five of six trials, whereas iprodione significantly increased yield in only three of six trials. Yield from untreated plots in 1990-site A was unusually high as late-season disease had little impact. No significant yield differences between treatments were observed in this trial. Yield increases attributed to fungicide applications were highest in 1988, 1990-site B, and 1991-site B, as treatments of fluazinam (0.56 kg/ha) increased yields by 2193, 2516 and 2289 kg/ha; treatments of iprodione (1.12 kg/ha) increased yields by 1288, 1179, and 521 kg/ha, respectively. Treatments of fluazinam at 0.56 kg/ha or iprodione at 1.12 kg/ha applied to plots in all six fields resulted in an average yield increase of 1598 kg/ha and 718 kg/ha, respectively. These yields represented a 49% and 22% increase over yield from untreated plots. Fluazinam resulted in a yield increase that was twice as high as that obtained with iprodione.

Effectiveness of Tank-mixes of Fungicides for Control of Sclerotinia Blight and Early Leafspot.

The incidence of Sclerotinia blight in 1990 at harvest in untreated plots and plots treated on an advisory schedule with chlorothalonil alone averaged 27.8 and 35.8 disease foci per plot, respectively (Fig. 1A). The 29% increase in incidence of Sclerotinia blight in plots treated with chlorothalonil was characteristic of disease enhancement previously observed in chlorothalonil-treated fields. Chlorothalonil alone was selected as the reference standard for evaluating the performance of tank-mixes since a failure to control early leafspot makes the crop vulnerable to yield losses of up to 50% or greater. The percentage of leaflets showing symptoms of early leafspot averaged 0.1% in all plots treated with chlorothalonil, indicating excellent control of leafspot. Plots not treated averaged 51.3% incidence of leafspot at harvest. The addition of other fungicides for control of Sclerotinia blight had no detectable antagonistic effect on foliar disease control with chlorothalonil.

Compared to plots treated five times with chlorothalonil alone according to the advisory program, the incidence of Sclerotinia blight was suppressed by 92, 25 and 25% by five applications of a tank-mix of chlorothalonil plus either fluazinam, iprodione, or dicloran, respectively (Fig. 1A). All three tank-mix treatments provided significant suppression of Sclerotinia blight. Demand sprays of either fluazinam, iprodione, or dicloran alone using 8010LP nozzles provided 85, 29, and 20% disease suppression, respectively. These plots also received five applications of chlorothalonil using D2-23 nozzles according to the leafspot advisory program for control of early leafspot. Compared to the chlorothalonil-alone treatment, demand applications of either fluazinam or iprodione alone provided significant disease suppression. Tank-mixes containing fluazinam were the only treatments to suppress significantly disease incidence over that of no fungicide treatment.

Without chlorothalonil for leafspot control, untreated plots averaged 3624 kg/ha (Fig. 1B). Yield in plots treated with chlorothalonil alone was significantly lower, averaging only 2251 kg/ha because heavy Sclerotinia blight pressure destroyed much of the potential peanut crop. Yields were increased by 4020, 1925, and 1684 kg/ha in plots treated five times on an advisory schedule with tank-mixes of chlorothalonil plus fluazinam, iprodione or dicloran, respectively, compared to plots receiving only chlorothalonil. In plots sprayed twice on demand for Sclerotinia blight control and five times with chlorothalonil alone for control of early leafspot, yield was increased by 4106, 1670, and 1401 kg/ha with fluazinam, iprodione and dicloran, respectively. All fungicide treatments for control of Sclerotinia blight resulted in a significantly higher yield of peanuts compared to chlorothalonil alone. Sprays with fluazinam were the only treatments to improve yield significantly over that of no fungicide treatment.

Disease was light in 1991 compared to 1990 as the incidence of Sclerotinia blight in plots treated with chlorothalonil alone averaged 15.8 disease foci per plot (Fig. 2A). Disease incidence was suppressed by 70, 34, 53, and 13% in plots treated three times according to the advisory program with tank-mixes of chlorothalonil plus fluazinam at 0.56, 0.28, 0.14, or 0.07 kg/ha, respectively. Tank-mixes containing fluazinam at 0.56 or 0.14 kg/ha provided significant disease suppression. Applications of fluazinam at 0.56, 0.28, 0.14, and 0.07 kg/ha applied on demand and again 4 wk later with 8010LP nozzles, suppressed disease incidence by 76, 59, 57, and 63%, respectively. All of these treatments provided disease control that was significantly better than that of chlorothalonil alone.

Although disease was light in 1991, yield was significantly increased by 997 kg/ha in plots treated with a tank-mix of chlorothalonil plus fluazinam at 0.56 kg/ha according to the advisory program (Fig. 2B). Applications of fluazinam alone at 0.56 or 0.28 kg/ha with 8010LP nozzles on demand and 4 wk later increased yield by 694 and 1040 kg/ha, respectively. Reduced rates of fluazinam alone or in tank-mixes with chlorothalonil also increased yields, but the response was not significant.

Fungitoxicity of Fluazinam to Other Pathogens.

In field trials to evaluate performance of fungicides for control of early leafspot, treatments with fluazinam at 0.56 kg/ha showed no evidence of activity against *C. arachidicola* (Table 3). Leaflets in plots treated with fluazinam alone exhibited levels of disease incidence and defoliation that were similar to that in untreated check plots. Yield was 597 kg/ha higher in fluazinam-treated plots than in untreated plots, but this difference was not significant at P≤0.05 and

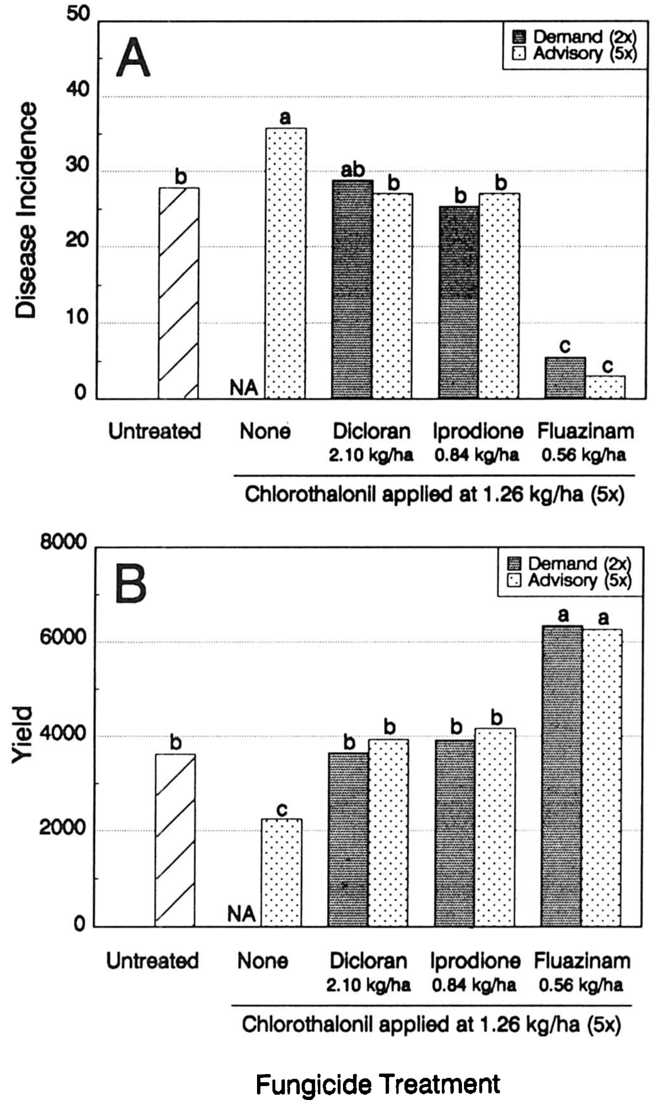

Fig. 1. Effect of applications strategies on performance of fungicides for control of Sclerotinia blight in 1990. A) Incidence of Sclerotinia blight (disease strikes per plot), and B) yield (kg/ha). Treatments for control of Sclerotinia blight were either applied separately from chlorothalonil sprays when Sclerotinia first became active and again 4 wk later (Demand), or tank-mixed with chlorothalonil and sprayed according to the leafspot advisory program (Advisory). Demand treatments for Sclerotinia blight control were applied twice using 8010LP nozzles, and chlorothalonil was applied five times for control of early leafspot. Advisory treatments of tank-mixes were applied five times using $D_2$23 nozzles. NA = not applicable.

could not be attributed to control of early leafspot. Only trace levels of other diseases were observed in these plots.

Axenic growth of *S. minor* was most sensitive to fluazinam, followed by *S. rolfsii* and *R. solani* in laboratory tests. The ED_{50} values for fluazinam against *S. minor*, *S. rolfsii* and *R. solani* were 0.0025, 0.035, and 0.19 µg/mL, respectively (Table 4). These ED_{50} values reflect a high level of *in vitro* activity by fluazinam against *S. minor* and *S. rolfsii*, and a moderate level of activity against *R. solani*. Coefficient of determination (r^2) ranged from 0.77 to 0.93, indicating that changes in percent inhibition of mycelial growth could be explained to a high degree of confidence by changes in

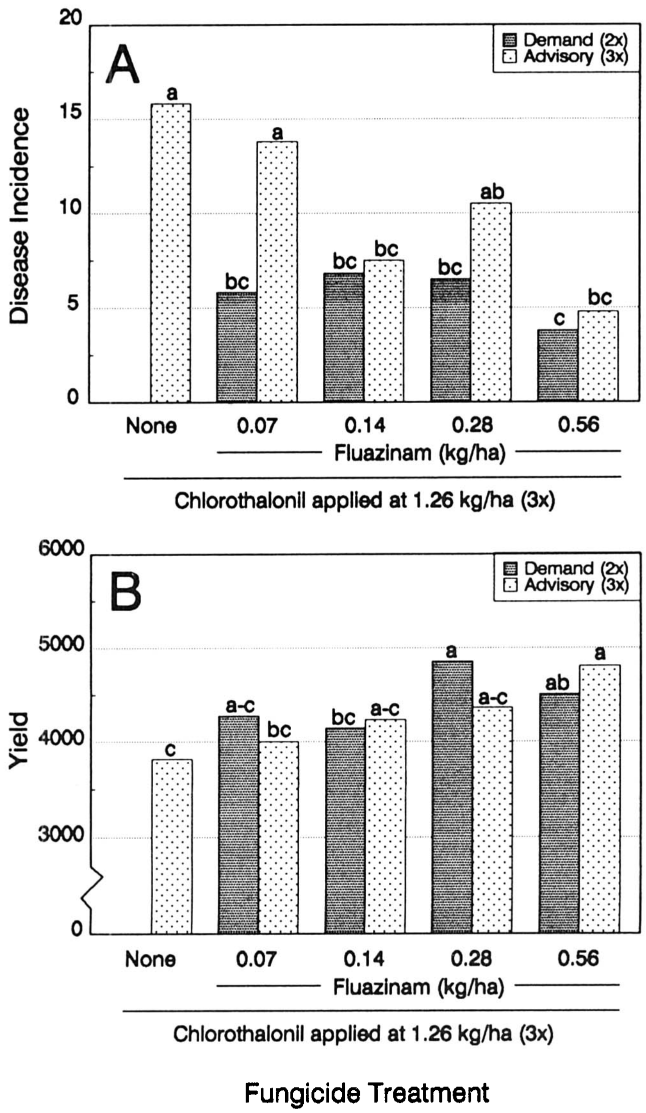

Fig. 2. Effect of applications strategies on performance of fluazinam for control of Sclerotinia blight in 1991. A) Incidence of Sclerotinia blight (disease strikes per plot), and B) yield (kg/ha). Treatments for Sclerotinia blight were either applied separately from chlorothalonil sprays when Sclerotinia blight first became active and again 4 wk later (Demand), or tank-mixed with chlorothalonil and sprayed according to the leafspot advisory program (Advisory). Demand treatments were applied twice using 8010LP nozzles, and chlorothalonil was applied three times for control of early leafspot. Advisory treatments of tank-mixes were applied three times using $D_2$23 nozzles.

fungicide concentration after data were transformed to a probit-logarithm scale. Field evaluations for control of southern stem rot and Rhizoctonia limb rot in Virginia have been inconclusive due to low levels of disease.

Discussion

Fluazinam gave excellent control of Sclerotinia blight of peanut, even under severe levels of disease. This fungicide was approximately twice as effective in suppressing disease and increasing yield as iprodione, even at rates that were half that of iprodione. The high level of field activity demonstrated by fluazinam was sufficient to provide significant disease control in all six trials under different weather conditions

Table 3. Efficacy of fluazinam for control of early leafspot of peanut in 1991[1].

Treatment[2]	Rate[2] (kg/ha)	% leafspot[3]	% defoliation[4]	Yield[5] (kg/ha)
Chlorothalonil	1.26	48.3 b	12.7 b	4469 a
Fluazinam	0.56	96.0 a	68.3 a	2735 b
Untreated check	–	98.0 a	76.7 a	2138 b

[1]Means followed by the same letter in a column are not significantly different at $P \leq 0.05$ according to Duncan's multiple range test. Arcsine transformation of percentage data was made in analyses to determine statistical significance.
[2]Three sprays were applied according to the Virginia peanut leafspot advisory program (24 Jun, 18 Jul, and 19 Aug) using three low-volume, D3-23 nozzles per row. Chlorothalonil was used as the reference standard for leafspot control.
[3]Rating scale: 0 = no spots, 100 = spots on all leaflets.
[4]Rating scale: 0 = no loss of leaflets, 100 = defoliation of all leaflets.
[5]Yield based on weight of peanuts adjusted to 7% moisture (w/w).

Table 4. *In vitro* sensitivity of *Sclerotinia minor*, *Sclerotium rolfsii* and *Rhizoctonia solani* to fluazinam[1].

Pathogen	Regression equation[2] (probits-logarithm)	Coefficient of determination (r^2)	ED_{50} value[3] (μg/mL)
S. minor	Y = 0.507x + 1.444	0.77	0.0025
S. rolfsii	Y = 0.688x + 0.999	0.93	0.035
R. solani	Y = 0.676x + 0.494	0.86	0.19

[1]Assays were performed on fungicide-amended glucose yeast extract agar using four replications of plates containing nine fungicide concentrations ranging from 0.0005 to 100 μg/mL.
[2]Data were transformed to a logarithmic scale on the X-axis for fungicide concentration and a probit scale on the Y-axis for growth inhibition where 50% inhibition was defined as zero on the probit scale.
[3]ED_{50} values (estimated dose required for 50% inhibition of mycelial growth) was determined after 5 days growth at 20 C for *S. minor* and *R. solani* and 25 C for *S. rolfsii*.

and levels of disease. To date, this level of superior performance is not approached by any currently available material. Fluazinam appears to be the most active and promising material for control of Sclerotinia blight, exceeding the potential benefits of other previously tested fungicides. No fungicide possessing an ED_{50} value lower than 0.0025 µg/mL, as observed for fluazinam against *S. minor*, has been identified in laboratory screenings of numerous experimental fungicides (F.D. Smith and P. M. Phipps, unpublished).

The task of successfully controlling both Sclerotinia blight and early leafspot of peanut has been a difficult problem for peanut growers in Virginia. Fluazinam functioned well in a tank-mix with chlorothalonil, providing much better control of Sclerotinia blight than either iprodione or dicloran, even when total applications of these latter two fungicides exceeded approved or label rates. Iprodione and dicloran lacked sufficient efficacy for suppressing Sclerotinia blight to acceptably low levels in plots treated with chlorothalonil. Applications of fluazinam to plots treated with chlorothalonil prevented the enhancement of Sclerotinia blight that has been associated with use of chlorothalonil for early leafspot control. When fields are treated with fluazinam, growers may be able to use full-season applications of chlorothalonil for superior control of several foliar diseases without any increase in Sclerotinia blight. This would eliminate the need to use less effective treatments which increase the risk for yield losses from uncontrolled foliar diseases. At the present time, full-season use of chlorothalonil is the only effective means of limiting severe early leafspot and late-season vine breakdown. Combinations of early leafspot, web blotch (*Phoma arachidicola* Marasas, G.D. Pauer, & Boerema) and pepper spot (*Leptosphaerulina crassiasca* (Sechet) C.R. Jackson & D.K. Bell) are thought to be the cause of late-season vine breakdown, which poses an annual threat to peanuts in Virginia (P.M. Phipps, unpublished data).

Total reliance on tank-mixes of fungicides sprayed according to the leafspot advisory program would be somewhat risky. Protective fungicides, such as fluazinam and iprodione, need to be present when initial outbreaks of Sclerotinia blight are first detected or at least soon thereafter. This may necessitate a separate application of fungicide for control of Sclerotinia blight, when leafspot sprays are not needed. Whenever sprays are needed for control of early leafspot and Sclerotinia blight, then application of a tank-mix of chlorothalonil and fluazinam with D2-23 nozzles may be appropriate. A total of 1.12 kg/ha of fluazinam per season should provide adequate control of Sclerotinia blight when two applications are made with 8010LP nozzles. When applied strictly with chlorothalonil in leafspot sprays using D2-23 nozzles, 1.68 to 2.80 kg/ha of fluazinam per season may be required for adequate control of Sclerotinia blight according to two years of tests in this study.

Limiting the number of spray applications to a minimum is desirable as tractor tires can injure the peanut plants and predispose them to infection by *S. minor* (19). Unneeded sprays also cost a grower time and operation expenses. The good performance of only two sprays using 8010LP nozzles, suggests that these low-pressure nozzles may be somewhat more effective in delivering fungicide to the soil-plant interface where Sclerotinia blight is found. However, the option to utilize tank-mixes for control of both leafspot and Sclerotinia blight is a valuable alternative application method that minimizes spraying cost and vine damage at times when fungicides are needed to control both diseases.

Fluazinam is classified as a broad-spectrum fungicide by its manufacturer, in spite of its inability to control early leafspot. Besides its strong activity against *Sclerotinia* spp., it is reported to be active against *Alternaria, Botrytis, Phytophthora, Plasmopara* and *Venturia* (21). The low ED_{50} value of fluazinam against the pathogens tested herein suggests that the fungicide may be effective in the field against southern stem rot and to a lesser extent Rhizoctonia limb rot. The fungicide, PCNB, is used for suppression of southern stem rot and Rhizoctonia limb rot in Georgia and other southern states. The ED_{50} values for PCNB against *S. rolfsii* and *R. solani* were reported to be 2.96 and 6.91 μg/mL, respectively (2). Fluazinam was approximately 85 and 36 times more active than PCNB *in vitro* against these respective pathogens. Fluazinam has been reported to be 45 times more active against *S. minor* than iprodione (20), the currently registered fungicide for control of Sclerotinia blight. Future registration of fluazinam may benefit peanut growers nationwide if it is capable of suppressing all three major soilborne diseases of peanut: Sclerotinia blight, southern stem rot and Rhizoctonia limb rot.

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