Suppression of Foliar and Soilborne Peanut Diseases in Bahiagrass Rotations

T. B. Brenneman, D. R. Sumner, R. E. Baird, G. W. Burton, and N. A. Minton

First, second, and third authors: Department of Plant Pathology, University of Georgia, Tifton 31793; fourth and fifth authors: USDA-ARS, Coastal Plain Experiment Station, Tifton, GA 31793.
Accepted for publication 2 June 1995.

ABSTRACT

Brenneman, T. B., Sumner, D. R., Baird, R. E., Burton, G. W., and Minton, N. A. 1995. Suppression of foliar and soilborne peanut diseases in bahiagrass rotations. Phytopathology 85:948-952.

Florunner peanut was grown after 1, 2, or 3 years of Tifton 9 bahiagrass and in alternating years with bahiagrass. Continuous peanut was grown in nontreated plots and in plots treated with flutolanil (4.48 kg/ha). In continuous peanut, stem rot (*Sclerotium rolfsii*) incidence was 4, 18, 19, and 44% during 1990 to 1993, respectively, without flutolanil and 0, 4, 10, and 17% with flutolanil. In 1993, stem rot incidence was 39, 29, 17, and 23% in the third, second, first, and alternating year of peanut, respectively. Rhizoctonia limb rot severity was low to moderate and not affected by crop rotation. Leaf spot diseases caused by *Cercospora arachidicola* and *Cercosporidium personatum* were present each year and were more severe in the short-term rotations. Pod yield of peanut was 3,044, 3,616, 4,547, and 3,922 kg/ha during the third, second, first, and alternating year of peanut, respectively. Compared to continuous peanut, longer rotations or treatment with flutolanil increased peanut grades and reduced percent damaged kernels (seeds). Population densities of *Rhizoctonia solani* and *Pythium* spp. in the soil generally were low and not altered by crop rotation. Rotation had little effect on root-knot (*Meloidogyne incognita*), ring (*Criconemoides curvatum*), or lesion (*Pratylenchus brachyurus*) nematodes.

Peanut (*Arachis hypogaea* L.) is susceptible to numerous pathogens wherever the crop is grown but is a nonhost for the southern root-knot nematode *Meloidogyne incognita* (Kofoid & White) Chitwood. In the southeastern United States, both early (*Cercospora arachidicola* S. Hori) and late (*Cercosporidium personatum* (Berk. & M.A. Curtis) Deighton) leaf spot can be devastating, and five to seven fungicide sprays per year are required for control. Because foliar diseases typically are well-managed by fungicide applications, soilborne pathogens usually cause the greatest losses in peanut production in the United States.

The single most damaging pathogen, *Sclerotium rolfsii* Sacc., causes peanut stem rot. Commercially grown cultivars are susceptible to this pathogen. Until recently, available fungicides were expensive and only partially effective in controlling stem rot. This changed with the 1994 registration of tebuconazole for use on peanut. Flutolanil, another new fungicide, has excellent activity on stem rot and was used on a limited basis during 1994 according to the provisions of an experimental use permit. Both fungicides offer a level of disease control superior to that achieved with currently registered fungicides (16).

Peanut pod yields in the southeastern United States increased dramatically during the 1970s and early 1980s but have stabilized or even decreased during subsequent years. Several factors may be involved, but shorter crop rotations may contribute to reduced yields. A recent survey of county agents indicates that approximately 70% of Georgia peanuts are grown after 2 years or less of another crop (J. Baldwin, *personal communication*). A lack of other profitable crops has exacerbated the problem. Although frequent planting of corn (*Zea mays* L.) can increase population densities of stubby-root, lesion, and other nematodes (15), it is still one of the best crops to rotate with peanut. Corn production in Georgia declined from 781,000 ha in 1973 to 263,000 ha in 1993 (Georgia Agricultural Statistic Services, Athens). During the same time period, peanut production increased from 210,000 to 284,000 ha. Curl (9) indicates monoculture can be justified if the returns are sufficient to pay for the added inputs. Traditionally this has been the case with peanut, but pending changes in government policies may alter this scenario.

Corresponding author: T. B. Brenneman
E-mail address: arachis@tifton.cpes.peachnet.edu

Although some crops can be grown successfully with monoculture (32), rotations usually enhance yield and quality of subsequent crops by several mechanisms, including reducing diseases and pests (9). Monocultures may reduce yields even when no identifiable primary pathogen is present (31). Crop rotation is also an important practice for general soil and resource conservation programs. This is particularly true of sod-based rotations with various grasses (37). However, the 1993 Georgia Peanut Production Survey indicated that only 2 to 4% of peanuts in Georgia were planted following a grass sod. Grass crops are also more effective in reducing stem rot than other crops (12). For example, stem rot incidence was lower in a wheat-peanut rotation than in a fallow-peanut rotation (25). *S. rolfsii*, however, is not readily managed by crop rotation due to its extremely wide host range and ability to survive saprophytically in soil (1,36).

Pensacola bahiagrass (*Paspalum notatum* Flüggé) is an improved perennial grass that is widely grown in the southeastern United States (6). It is an excellent rotational crop to increase yield of peanut by reducing nematode damage (10,27,29), stem rot (37), or limb rot (*Rhizoctonia solani* Kühn AG-4) (3). Additional benefits to field soils where bahiagrass has been grown include increased organic matter and nitrogen (2), reduced soil and water losses (37), and improved soil conditioning from the deep, penetrating root system (5,11). There is evidence that crop-pasture rotations are more beneficial than permanent pastures (24). Norden et al. (27) found that the largest increase in peanut yields occurred after 1 year in bahiagrass. As many as four additional years in sod provided only slight increases, and in all cases, subsequent crops of peanut yielded less than the first crop following bahiagrass. However, the site used in that study did not have damaging levels of stem rot, limb rot, or root-knot nematode (*M. arenaria* (Neal) Chitwood).

Tifton 9 is an improved cultivar of Pensacola bahiagrass with more seedling vigor than the Pensacola variety from which it was bred (7). It also produces more seed and has yielded up to 47% more forage.

In this experiment, we evaluated the effects of 0, 1, 2, or 3 years or alternating years of Tifton 9 bahiagrass sod on subsequent peanut crops with emphasis on the role of diseases. A continuous peanut program treated with a high rate of flutolanil to control soilborne pathogens was included as a baseline to separate the disease suppressive effects of bahiagrass from its other agronomic benefits to subsequent peanut crops.

MATERIALS AND METHODS

The study was initiated in 1990 at the Coastal Plain Experiment Station Blackshank Farm, Tifton, GA. Lupine (*Lupinus* sp.) and pearl millet (*Pennisetum glaucum* (L.) R. Br.) were the crops primarily grown in previous years, but peanut was grown in 1989. The soil was a Tifton loamy sand (fine-loamy, siliceous, thermic Plinthic Kandiudults, pH 6.2). Crop rotations were bahiagrass (B)-peanut (P)-P-P, B-B-P-P, B-B-B-P, P-P-P-P untreated, B-P-B-P, and P-P-P-P treated with flutolanil. Flutolanil (2.24 kg/ha) was applied as a broadcast foliar spray each year 60 and 90 days after planting. These were applied with a CO_2 belt-pack sprayer with three evenly spaced D2-23 (Spraying Systems Co., Wheaton, IL) nozzles per row delivering 189 liters of water per ha at 312 kPa.

The experimental design was a randomized complete block with five replicates. Plots were 7.6 × 5.5 m and consisted of three beds with two rows per bed. Disease evaluations and yields were recorded from the center bed. Fallow alleys (4.3 m) separated blocks of plots. Florunner peanut was seeded each year (100 to 112 kg/ha) during the second week of May in single rows 0.91 m apart. Each year soil was deep-turned with a moldboard plow prior to peanut planting. All other management practices, including biweekly chlorothalonil sprays (1.25 kg/ha), were according to standard practices for the crop, except no treatments were applied for soilborne diseases (21). Leaf spot was evaluated using the Florida 1 to 10 rating scale based on both disease incidence and defoliation, in which 1 = no disease and 10 = plants killed by leaf spot (8). The peanut crop was dug and inverted during the last week of September each year. Stem rot incidence (percentage of 30.5-cm sections of linear row per plot with at least one disease locus) and limb rot severity (percentage of vines colonized by *R. solani* in six 0.6-m sections of linear row per plot) were rated immediately after digging. Roots, pods, and pegs of 10 randomly selected plants from each plot also were rated for nematode-induced galling on the same day plants were dug and inverted. Pods were inspected for damage from lesion nematode (*Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven) and rated using a 1 to 5 scale, in which 1 = no damage, 2 = 1 to 25, 3 = 26 to 50, 4 = 51 to 75, and 5 = 76 to 100% of pods with lesions. Pods were mechanically harvested 1 to 2 weeks after inverting and drying to approximately 10% (wt/wt) moisture. One 500-g pod sample was collected per plot and graded according to official Federal-State Inspection Service methods.

Designated plots of Tifton 9 bahiagrass were seeded at 22.4 kg/ha during late winter or early spring. Plots were hand-weeded the first year to ensure establishment of weed-free bahiagrass. Bahiagrass plots received 56 to 140 kg/ha of N during March and 112 to 140 kg/ha again during June with adequate P and K applied as needed. Bahiagrass hay was cut, dried to approximately 16% moisture, and weighed during early June prior to seed set, mid-to-late July, and September each year. All bahiagrass plots were burned during late winter prior to the initiation of new growth. Irrigation from solid-set sprinklers was applied uniformly to both crops but was scheduled according to recommendations for peanut (21).

Soil samples were collected each spring prior to planting and each fall prior to peanut harvest to assay population densities of soilborne pathogens. Five cores (2.5 cm diameter × 15 cm deep)

TABLE 1. Influence of bahiagrass rotations and fungicide treatments on peanut yield and value, 1990–1993

	Pod yield (kg/ha)				Dollars/ha[b]			
Rotation[a]	1990	1991	1992	1993	1990	1991	1992	1993
B-P-P-P	...	4,443	4,572	3,044	...	...[c]	3,745	2,330
B-B-P-P	...	...	4,792	3,616	...	...	4,036	2,821
B-B-B-P	...	...	...	4,547	...	...	...	3,518
P-P-P-P (N)[d]	4,218	3,877	4,058	3,077	3,214	...	3,245	2,400
B-P-B-P	...	4,775	...	3,922	...	...	...	3,152
P-P-P-P (T)[d]	4,837	4,775	4,213	4,144	4,052	...	3,562	3,302
LSD ($P \leq 0.05$)	NS	485	NS	693	NS	...	NS	605

[a] B = bahiagrass; P = peanut.
[b] Values were calculated from a 500-g pod sample per plot graded according to official Federal-State Inspection Service methods.
[c] Not determined in 1991.
[d] N = continuous peanut with no flutolanil treatment; T = treated continuous peanut. Treatment was flutolanil (Moncut 50W), two applications of 2.24 kg/ha.

TABLE 2. Influence of bahiagrass rotations and fungicide treatment on stem rot and Rhizoctonia limb rot of peanut, 1990–1993

	Stem rot[b]				Rhizoctonia limb rot[c]			
Rotation[a]	1990	1991	1992	1993	1990	1991	1992	1993
B-P-P-P	...	15.6	22.0	38.8	...	31.2	9.6	23.5
B-B-P-P	...	...	10.4	28.8	...	...	10.3	25.0
B-B-B-P	...	...	...	16.8	...	...	...	17.5
P-P-P-P (N)[d]	4.0	18.4	19.2	44.0	19.2	33.8	7.4	22.5
B-P-B-P	...	12.4	...	23.2	...	31.4	...	25.5
P-P-P-P (T)[d]	0.0	3.6	9.6	17.2	11.5	25.8	6.2	16.5
LSD ($P \leq 0.05$)	1.7	7.0	NS	13.3	5.2	6.1	4.0	7.7

[a] B = bahiagrass; P = peanut.
[b] Percent 30.5-cm sections of linear row per plot with at least one disease locus.
[c] Visual estimate of the percentage of vines colonized by *Rhizoctonia solani* in six 0.6-m sections of linear row per plot.
[d] N = continuous peanut with no flutolanil treatment; T = treated continuous peanut. Treatment was flutolanil (Moncut 50W), two applications of 2.24 kg/ha.

were collected 0.6 m apart from the middle 4.6 m of the inside row of both the left and right beds. The 10 cores were mixed thoroughly, and a 300-cm^3 subsample was assayed for *Rhizoctonia* and *Pythium* spp. Soil was assayed on tannic acid-benomyl agar (33) with a multiple-pellet soil sampler (17) for *R. solani* and on pimaricin-ampicillin-rifampicin-pentachloronitrobenzene agar (22) for *Pythium* spp. Additional soil samples consisting of 10 cores per plot (2.5 cm diameter × 20 cm deep) were collected from each plot before planting and from the peanut root zone prior to digging. Nematodes were extracted from a 150-cm^3 subsample by the centrifuge-flotation method (20), identified, and counted.

Analysis of variance of the data was determined by the general linear model procedure (30), and Fisher's protected LSD test ($P < 0.05$) was used to separate means. Regression analysis was used to determine the relationship between the number of years in bahiagrass and disease intensity.

RESULTS

The effect of rotation on peanut yield was cumulative with additional years in bahiagrass (Table 1). In the first year peanuts were grown following bahiagrass, yields were increased 566, 734, and 1,470 kg/ha by 1, 2, or 3 years of bahiagrass, respectively, compared to a peanut monoculture nontreated with flutolanil. This increase from 1 year of bahiagrass lasted 2 years, after which pod yields were similar to those plots in continuous peanut production.

Although 1990 was a very hot, dry year, supplemental irrigation was adequate to ensure a good stand of bahiagrass and moderate peanut yields (Table 1). Incidence of stem rot was very low in nontreated plots and was not detected in the flutolanil-treated plots (Table 2). Environmental conditions during 1991 were more favorable for disease development than those during 1990. One year of bahiagrass did not lower stem rot incidence, although yields increased compared to the nontreated continuous peanut plots (Table 1). Less stem rot occurred in flutolanil-treated plots than in plots with any rotation, but yields were equivalent to those in the rotated plots.

Wet conditions during 1992 again were favorable for stem rot development and also contributed to the occurrence of Cylindrocladium black rot (CBR) caused by *Cylindrocladium parasiticum* Crous, Wingfield, & Alfenas. Exact counts of plants with CBR were not obtained due to the presence of tomato spotted wilt virus (TSWV), which has very similar symptoms. However, both CBR and TSWV contributed to increased experimental error, and neither rotation nor flutolanil treatment significantly affected yield. Although 1993 was a dry year, rainfall and irrigation were adequate for a severe stem rot epidemic. Incidence of stem rot in all rotations was approximately twice those during the previous season (Table 2). Stem rot incidence during the final year of the study was negatively correlated ($r = -0.986$) with the number of years in bahiagrass (Fig. 1).

Rhizoctonia limb rot severity was low to moderate and varied from year to year in all rotations (Table 2). This disease requires more specific environmental conditions than stem rot, which occurs more consistently. Rotation had little effect on limb rot

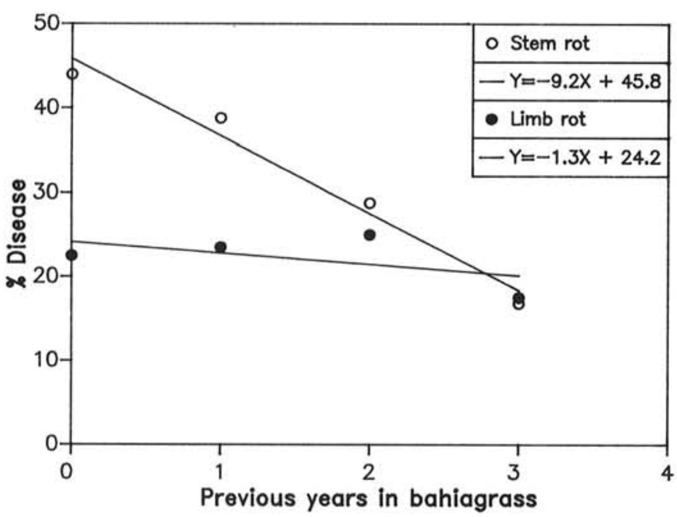

Fig. 1. Relationship between the number of years plots were in bahiagrass prior to peanut and the incidence of stem rot and severity of Rhizoctonia limb rot in 1993 (mean ratings of all plots at harvest; stem rot, $r = -0.986$; limb rot, $r = -0.534$).

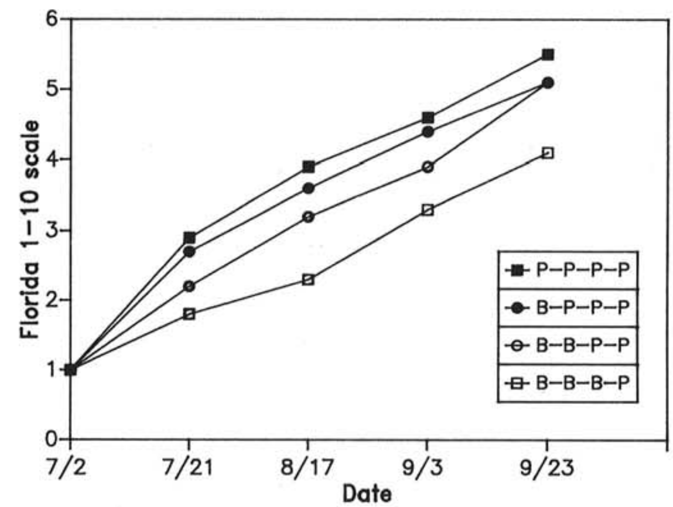

Fig. 2. Effect of bahiagrass rotations on peanut leaf spot intensity in 1993 (Florida 1–10 scale, in which 1 = no disease and 10 = plant death). The LSD's ($P \leq 0.05$) were 0.6, 0.6, 0.5, and 0.4 for 21 July (7/21), 17 August (8/17), 3 September (9/3), and 23 September (9/23), respectively. P = peanut, B = bahiagrass crops grown from 1990 to 1993.

TABLE 3. Influence of bahiagrass rotations and fungicide treatment on peanut grade and damaged kernels, 1990–1993

	Damaged kernels (%)				Grade (SMK + SS)[b]			
Rotation[a]	1990	1991	1992	1993	1990	1991	1992	1993
B-P-P-P	…	…[c]	4.1	4.3	…	…[c]	70.6	64.9
B-B-P-P	…	…	3.6	4.6	…	…	71.3	67.1
B-B-B-P	…	…	…	5.6	…	…	…	67.4
P-P-P-P (N)[d]	6.1	…	4.8	6.2	66.3	…	69.3	64.3
B-P-B-P	…	…	…	4.2	…	…	…	68.3
P-P-P-P (T)[d]	3.3	…	3.6	3.8	70.6	…	71.5	67.4
LSD ($P \leq 0.05$)	2.6	…	1.5	1.7	6.7	…	1.5	3.0

[a] B = bahiagrass; P = peanut.
[b] Grade equals the percent sound mature kernels plus sound splits (SMK + SS).
[c] Not determined in 1991.
[d] N = continuous peanut with no flutolanil treatment; T = treated continuous peanut. Treatment was flutolanil (Moncut 50W); two applications of 2.24 kg/ha.

severity (Fig. 1). Flutolanil suppressed limb rot in some years, but the response was less than that observed with stem rot.

Although all plots were sprayed with chlorothalonil (1.25 kg/ha) on a calendar schedule (approximately every 14 days), significant levels of leaf spot developed during 1992 and 1993. The primary pathogen was *Cercospora arachidicola*, but *Cercosporidium personatum* also was present by the end of the season. Disease was most severe during 1992 when plots in continuous peanut rated 6.5 at digging. This rating indicates defoliation of more than 60%. Plots in their second year of peanut had similar ratings, but plots in their first year of peanut rated only 5.2, indicating approximately 25% defoliation. The same effect was evident throughout the season during 1993 when leaf spot severity was directly related to the number of years in peanut production (Fig. 2). Flutolanil did not affect leaf spot severity.

Peanuts from nonrotated plots treated with flutolanil usually graded higher with fewer damaged kernels than those not treated. Peanuts from the first crop following bahiagrass also graded higher than continuously cropped peanuts during 1992 and 1993 (Table 3). This effect was not significant for the second or third crop of peanuts following bahiagrass. The influence of rotation on damaged kernels was less evident, but nontreated, continuously cropped peanuts consistently had the highest amount of damaged kernels (Table 3).

Crop value is determined primarily by yield, grade, and the percentage of damaged kernels. Due to large experimental error, differences in crop value among rotations were significant only in 1993 (Table 1). The use of flutolanil increased crop value by \$902/ha in 1993. The first year's peanut crop following bahiagrass was worth an average of \$955/ha more than peanuts from continuously cropped plots in 1992 and 1993. The 1993 peanut crop in the B-P-B-P rotation also had significantly higher value, reflecting both an increased grade and fewer damaged kernels.

Population densities of *R. solani* AG-4 were low throughout the study (<6 propagules per 100 g of soil). Plots grown continuously to peanut had low (2 to 4 propagules per 100 g of soil) but significantly higher populations than other rotations in 1990 and 1991. Populations in subsequent years were extremely low (<2 propagules per 100 g of soil). Populations of *Pythium* spp. were higher (up to 266 propagules per g of soil) but also were not affected by crop rotation.

Nematode assays indicated that *M. incognita* (southern root-knot nematode) second-stage juveniles were present at a low level when the study was initiated. Soil population densities of *M. incognita* juveniles were not increased by any of the rotations but remained stable throughout the experiment. No galls were found on peanut roots, pods, or pegs. Ring nematode (*Criconemoides curvatum* Raski) also was present at populations of up to 800/150 cm^3 of soil. These population densities fluctuated from year to year but generally were not affected by crop rotation. Norden et al. (27) also observed no effect of bahiagrass on ring nematode population densities. Significant pod damage from lesion nematode was observed during 1993. There was no effect ($P \leq 0.05$) of crop rotation on severity of lesion nematode injury to peanut pods, which rated 2.6 across all plots.

Bahiagrass was cut for hay the first year of establishment and yielded approximately 4,400 kg of dry matter per ha in 1990. In subsequent years, the mean yields were 3,389, 3,796, and 2,044 kg of dry matter ha in the first, second, and third cuttings, respectively. Calculated at 16% moisture, this equals approximately 10,700 kg of hay per ha per season.

DISCUSSION

This study was conducted in a field in which initial stem rot levels were low. When damaging levels of stem rot were already present, even 2 years of bahiagrass was inadequate for control (19). Also, when population densities of *M. arenaria* are high initially, Dickson and Hewlett (10) indicate that more than 2 years in a nonhost would be needed to prevent serious peanut yield losses. These findings reinforce the statement by Fry (13) that "Because rates of population increase for many pathogens are potentially much greater than mortality rates, fallow and crop rotation are most effective in preventing the development of a large population rather than reducing large populations to small ones." Populations of sclerotia of *S. rolfsii* were not quantified in this research, but previous studies have shown increased sclerotial populations with monoculture of host plants (38).

Although crop rotation has reduced foliar diseases of peanut (23), the primary disease control benefits of rotation are thought to be for soilborne pathogens (9,14,36). Our study documents the cumulative effects of multiple-year rotations for management of peanut leaf spot. Such reductions in inoculum may become even more critical as foliar fungicide spray programs become less calendar-based and more prescription-based in the future (28).

Rotation had little effect on the severity of Rhizoctonia limb rot (Fig. 1), although results of a previous study (19) showed a 2-year bahiagrass rotation could effectively reduce this disease. Bell and Sumner (3) found that even 1 year of bahiagrass reduced damage from *R. solani*, and additional years were more effective. Soil population densities of *R. solani* AG-4 remained low throughout the study, although Sumner et al. (34) found severe limb rot where population densities of the pathogen were low (<7 propagules per 100 g of soil). They suggested that factors such as irrigation frequency, temperature, relative humidity, and competitors or antagonists in the soil may be more directly related to disease intensity than inoculum density. Deep-turning the soil each year probably served to reduce populations of *Rhizoctonia* (35).

The effect of burning on any of the factors evaluated is not known since it was done uniformly to all bahiagrass plots. All bahiagrass plots were deep-turned with a moldboard plow prior to planting peanut; therefore, *S. rolfsii* inoculum from previous peanut crops would have been buried at the time of burning and probably would not have been adversely affected. Although the mechanisms may not be fully understood, the benefits of a sod-based rotation with bahiagrass were clearly demonstrated in this study, particularly for reducing stem rot and leaf spot of peanut. The fact that treatment with flutolanil resulted in yields nearly as high as those in longer rotations indicates that the primary benefit of rotation, at least in this test, was the reduction in diseases from soilborne pathogens. Flutolanil, a toluanilide, inhibits the succinate dehydrogenase complex and is highly specific for basidiomycetes (26). No plant growth-regulator traits have been reported that may serve to enhance yield apart from effects on stem rot and Rhizoctonia limb rot.

Reduced kernel damage and improved grades with flutolanil also have been observed when tebuconazole was applied (4,18). The authors speculated that the cause is directly related to the excellent control of stem rot offered by these fungicides. Preventing losses of the pods closest to the tap root, which are the most mature, would serve to increase grades. Apparently the reduced stem rot severity attributable to rotation also can produce this effect. Bahiagrass rotations have decreased concealed damage to peanut (27).

Although the economics of establishment may be cost prohibitive, the B-P-B-P cropping system performed well in terms of disease reductions and yield increases. This confirms previous results with permanent versus rotated pastures (24), although first-year sods lose more soil and water from runoff (37). The overall utility of a bahiagrass rotation will depend on the individual grower's production program. Perhaps the best fit is achieved when cattle can be grazed, although the upright growth of Tifton 9 makes it a good choice for hay production. Some growers also are receiving excellent returns from seed production of Tifton 9.

This study clearly shows that soilborne and foliar peanut diseases can intensify with poor rotations in 4 years. Stem rot increased more than 10-fold in the continuous peanut program. Although use of flutolanil effectively prevented much of the lost yield in the continuous peanuts, this should not be considered a sustainable management program. Factors such as peanut root-knot nematode and CBR are definitely more severe in short rotations, and control options for these pests are limited. This was illustrated by the unusually low yield in the flutolanil-treated plots in 1992 due to CBR. Ideally, the registration of products such as tebuconazole and flutolanil will allow peanut farmers to produce higher yields on less land area, thus permitting more effective crop rotation.

LITERATURE CITED

1. Aycock, R. 1966. Stem rot and other diseases caused by *Sclerotium rolfsii*. N.C. Agric. Exp. Stn. Tech. Bull. 174.
2. Beaty, E. R., and Tan, K. H. 1972. Organic matter, N, and base accumulation under Pensacola bahiagrass. J. Range Manage. 25:38-40.
3. Bell, D. K., and Sumner, D. R. 1993. Beneficial effect of bahiagrass on the yield of Florunner peanut grown in soil infested with *Rhizoctonia solani* AG-4. (Abstr.) Proc. Am. Peanut Res. Educ. Soc. 25:61.
4. Brenneman, T. B., and Culbreath, A. K. 1994. Utilizing a sterol demethylation inhibiting fungicide in an advisory program to manage foliar and soilborne pathogens of peanut. Plant Dis. 78:866-872.
5. Burton, G. W. 1954. Root penetration, distribution and activity in southern grasses measured by yields, drought symptoms and P^{32} uptake. Agron. J. 46:229-233.
6. Burton, G. W. 1967. A search for the origin of Pensacola bahiagrass. Econ. Bot. 21:379-382.
7. Burton, G. W. 1989. Registration of Tifton 9 Pensacola bahiagrass. Crop Sci. 29:1326.
8. Chiteka, Z. A., Gorbet, D. W., Shokes, F. M., Kucharek, T. A., and Knauft, D. A. 1988. Components of resistance to late leaf spot in peanut. I. Levels and variability—Implications for selection. Peanut Sci. 15:25-30.
9. Curl, E. A. 1963. Control of plant diseases by crop rotation. Bot. Rev. 29:413-479.
10. Dickson, D. W., and Hewlett, T. E. 1989. Effects of bahiagrass and nematicides on *Meloidogyne arenaria* on peanut. J. Nematol. (Suppl.) 21: 671-676.
11. Elkins, C. B. 1985. Plant roots as tillage tools. Pages 519-523 in: Tillage Machinery Systems as Related to Cropping Systems. Proc. Int. Conf. Soil Dynamics, vol. 3. Auburn University, Auburn, AL.
12. Flowers, R. A. 1976. Influence of various crop rotation sequences on peanut yields and incidence of white mold caused by *Sclerotium rolfsii* in Georgia. (Abstr.) Proc. Am. Peanut Res. Educ. Soc. 8:104.
13. Fry, W. E. 1982. Principles of Plant Disease Management. Academic Press, New York.
14. Garren, K. H. 1961. Control of *Sclerotium rolfsii* through cultural practices. Phytopathology 51:120-124.
15. Good, J. M. 1972. Management of plant parasitic nematode populations. Pages 109-127 in: Proc. 4th Tall Timbers Conf. Ecol. Anim. Control Habitat Manage. Tall Timbers Research Station, Tallahassee, FL.
16. Hagan, A. K., Weeks, J. R., and Bowen, K. 1991. Effects of application timing and method on control of southern stem rot of peanut. Peanut Sci. 18:47-50.
17. Henis, Y., Ghaffar, A., Baker, R., and Gillespie, S. L. 1978. A new pellet soil-sampler and its use for the study of population dynamics of *Rhizoctonia solani* in soil. Phytopathology 68:371-376.
18. Jacobi, J. C., and Backman, P. A. 1991. Effects of tebuconazole on seed quality and fungal colonization on two cultivars of peanuts. (Abstr.) Phytopathology 81:812.
19. Jacobi, J. C., Backman, P. A., Rodriguez-Kabana, R., and Robertson, D. G. 1991. Bahiagrass in rotations shows promise for boosting peanut yields. Highlights Agric. Res., Ala. Agric. Exp. Stn. 38:7.
20. Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Rep. 48:692.
21. Johnson, W. C., Beasley, J. P., Thompson, S. S., Womack, H., Swann, C. W., and Samples, L. E. 1987. Georgia Peanut Production Guide. Univ. Ga. Coll. Agric. Coop. Ext. Serv. Bull.
22. Kannwischer, M. E., and Mitchell, D. J. 1981. Relationship of numbers of spores of *Phytophthora parasiticum* var. *nicotianae* to infection and mortality of tobacco. Phytopathology 71:69-73.
23. Kucharek, T. A. 1975. Reduction of Cercospora leafspots of peanut with crop rotation. Plant Dis. Rep. 59:822-823.
24. L'Hote, H. J. 1942. Measuring the productive value of pastures. Mo. Agric. Exp. Stn. Bull. 443.
25. Minton, N. A., Csinos, A. S., Lynch, R. E., and Brenneman, T. B. 1991. Effects of two cropping and two tillage systems and pesticides on peanut pest management. Peanut Sci. 18:41-46.
26. Motoba, K., Uchida, M., and Tada, E. 1988. Mode of antifungal action and selectivity of flutolanil. Agric. Biol. Chem. 52:1445-1449.
27. Norden, A. J., Perry, V. G., Martin, F. G., and Nesmith, J. 1980. Effect of age of bahiagrass sod on succeeding peanut crop. Peanut Sci. 4:71-74.
28. Phipps, P. M. 1993. IPM in peanuts: Developing and delivering working IPM systems. Plant Dis. 77:307-309.
29. Rodriguez-Kabana, R., Weaver, C. F., Robertson, D. G., and Ivey, H. 1988. Bahiagrass for the management of *Meloidogyne arenaria* in peanut. Ann. Appl. Nematol. 2:110-114.
30. SAS Institute. 1985. SAS User's Guide: Statistics. Version 5 ed. SAS Institute, Cary, NC.
31. Schippers, B., Bakker, A. W., and Bakker, P. A. H. M. 1987. Interactions of deleterious and beneficial microorganisms and the effect of cropping practices. Annu. Rev. Phytopathol. 25:339-358.
32. Shipton, P. J. 1977. Monoculture and soilborne plant pathogens. Annu. Rev. Phytopathol. 15:387-407.
33. Sumner, D. R., and Bell, D. K. 1982. Root diseases of corn induced by *Rhizoctonia solani* and *Rhizoctonia zeae*. Phytopathology 72:86-91.
34. Sumner, D. R., Brenneman, T. B., and Harrison, G. W. 1991. Populations of fungi in soil after chemigation with chlorothalonil and tebuconazole via center-pivot irrigation. Plant Dis. 75:999-1004.
35. Sumner, D. R., Doupnik, B., Jr., and Boosalis, M. G. 1981. Effects of reduced tillage and multiple-cropping on plant diseases. Annu. Rev. Phytopathol. 19:167-187.
36. Umaerus, V. 1992. Crop rotation in relation to crop protection. Neth. J. Plant Pathol. (Suppl.) 98(2):241-249.
37. White, A. W., Jr., Sparrow, G. N., and Carter, R. L. 1962. Peanuts and corn in sod-based rotations. Ga. Agric. Res. 4(2):5-6.
38. Wokocha, R. C. 1988. Relationship between the population of viable sclerotia of *Sclerotium rolfsii* in soil to cropping sequence in the Nigerian savanna. Plant Soil 106:146-148.