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Effect of Age of Bahiagrass Sod on Succeeding Peanut Crops[1]

A.J. Norden, V.G. Perry, F.G. Martin and J. NeSmith[2]

ABSTRACT

This study was designed to determine effects, unconfounded by seasons, of 0 to 5 year-old bahiagrass (*Paspalum notatum* Flugge) sod on yield and quality of subsequent peanut (*Arachis hypogaea* L.) crops; and to provide information as to factors responsible for the observed beneficial effects.

Essentially the experiment was a 6 x 4 x 2 factorial in a randomized complete block arrangement. Previously designated plots were seeded each year to bahiagrass while the remaining plots were maintained in a cultivated crop rotation of corn and peanuts. Duplicate soil samples, taken annually, were analyzed for major plant nutrients and for nematodes. After 5 to 7 years all the plots were planted to peanuts and corn for successive years. A total of 21 responses, associated with yield and quality of peanuts, nematode counts, and soil characteristics, were measured. Not all nematode responses were analyzed because of a high percentage of zero values.

Twelve of the 15 responses were affected by the length of time the land was in sod. Peanut yield and quality increased with years in sod, with the greatest improvement occurring after one year. The percent shriveled seed and concealed damage decreased with years in sod and again the reductions were most pronounced between the 0 and 1 year-old sod treatments. In every case the first crop of peanuts following sod was better than the second. However, as the number of years in sod increased differences between the first and second peanut crop diminished. Years in sod had an effect on the level of major soil nutrients but no regular trends were evident. Numbers of lance nematodes were significantly reduced by age of sod while ring nematodes were not. Eleven of the 15 responses showed significant interactions between the length of time in sod and season and/or crop order.

Additional index words: Crop rotation, Sod-based rotation, Nematodes.

It has been observed that some crops give higher yields and a more uniform and higher quality product when following an old established grass sod (7, 8). Senterfitt and Van Arsdale (7) reported a farmer obtained from 448 to 896 kg/ha increases in peanut (*Arachis hypogaea* L.) yields in central Florida by following a bahiagrass (*Paspalum notatum* Flugge) sod. Weber (8) described farmer experiences with growing bright leaf tobacco (*Nicotianna tabacum*) following bahiagrass sod in which the farmers were convinced that the sod was one of the important factors in their high yields. They found that weeds were not a problem and that the common insect pests were no more numerous than ordinary.

There is some evidence that permanent pastures of grasses are less productive than pastures plowed and seeded periodically. L'Hote (5) concluded that pastures in a crop-and-pasture rotation are usually more productive than permanent pastures. De Vane et al. (2) reported higher soil nitrogen and organic matter levels under bermuda and bahiagrass sod than in adjacent cultivated fields.

White et al. (9) obtained 523 kg/ha higher yields of Spanish peanuts at Tifton, Georgia in 1958-59 from a sod-based rotation than from a corn (*Zea mays* L) - peanut rotation. They suggested that the higher peanut yields might be due to the reduced incidence of white mold (*Sclerotium rolfsii*) in the sod-based rotation plots.

'Pensacola' bahiagrass is an improved perennial grass with good forage quality and a wide tolerance to soil fertility, moisture, temperature and soil acidity (3). It has a very vigorous root system and is widely grown in the southeastern United States, including over 0.6 million hectares in Florida. Burton et al. (1) found that Pensacola bahia produced 10,360 kgs of oven dry roots per hectare, a total of 46 percent more than any other grass in the test which included five commonly grown forage pasture species.

The reasons for the observed beneficial effects of sod on subsequent cultivated crops are not well understood. In most cases the observations have been confounded by seasons. The amount of increase that can be expected is not outlined very clearly nor the number of years that land must remain in sod before these benefits can be derived. Growers want to know if it would be economical for them to incorporate a grass sod into their cultivated crop rotation. This long-range study was designed in 1959 to remove the seasonal influence while determining the effect of age of bahiagrass sod on the yield and quality of subsequent crops of corn and peanuts. This paper concerns the effects of 0 to 5 year-old Pensacola bahiagrass sod on the yield and quality of subsequent peanut crops.

Materials and Methods

The experiment was initiated in 1959 with the collection of surface and subsurface soil samples from each of the experimental plots. Dolomitic lime was broadcast over the experimental area at 2.24 metric tons/hectare on October 1, 1959 and disked in prior to seeding a winter cover crop. The experimental design, essentially a 6 x 4 x 2 factorial in a randomized complete block arrangement, required that previously designated plots be seeded annually to bahiagrass beginning in 1960. The remaining plots were to be maintained in a two-year rotation of corn in the even-numbered years (1960, 1962, etc.), and peanuts in the odd-numbered years (1961, 1963, etc.), with a winter cover crop (generally rye-*Secale cereale* L) planted each fall. Each plot, 12.2 x 15.2 m, was surrounded by bahiagrass borders 7.6 m wide running east to west and 3.0 m wide running north to south.

The number of plots in the cultivated crops decreased each year and the numbers in bahiagrass increased each year until 1966 through 1968 when the designated grass plots were plowed and divided in half (six rows, 15.2 m long of peanuts and six rows of corn) to provide simultaneous information on the effects of 0, 1, 2, 3, 4 and 5 year-old sod on the subsequent crops of corn and

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[2]Professors, Departments of Agronomy and Entomology-Nematology; Associate Professor, Statistics; and Associate Professor (Deceased), Soil Science; Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida 32611.

peanuts.

Soil test results from duplicate composite samples, obtained annually from each plot during July, were used as a guide in determining the kinds and rates of plant nutrients to apply in order to lessen soil heterogeneity. The analyses of variance of the corn yield data in 1960 and 1962 and peanut yield data in 1961 showed that the plot means involved in the "years in bahiagrass" variable were not statistically different at the .05 level, indicating that no systematic differences existed among the plots which might bias the test for treatment effects.

The duplicate soil samples taken from each plot in July were also analyzed to determine the species and numbers of plant parasitic namatodes present. Thus, the annual level of major soil nutrients and the status of the nematode populations in the bahiagrass and in the corn-peanut rotation were available and provided information annually on changes that were taking place. The procedures used in obtaining and analyzing the soil samples for species and numbers of nematodes, and the effects of the cropping sequence on the nematode populations in the experimental plots during the first four years of the study, were reported by Perry and Norden in 1963 (6).

Generally recommended production practices were followed throughout the course of the experiment (1959-1968) in regard to plant nutrient applications and chemicals for pest control, except that no nematicides were used at any time. Mechanically scarified Pensacola bahiagrass seed was drilled in the pre-assigned plots in rows spaced 25 cm apart with tractor-mounted Planet Jr. planters set to distribute 11.2 to 13.4 kgs of seed per hectare. The grass received two topdressings of 56 kg/ha of nitrogen approximately two and four months after seeding. Grass yield samples, three per plot, were taken annually in June, July, August, and September. Dry weight yields of grass were obtained and a composite grass sample was taken from each plot at each cutting for nitrogen determination data, which was used to calculate the recovery of the applied nitrogen and provide an index of the quality of the grass removed. The remnant grass was cut and removed from the plots after each sampling.

'Early Runner' peanut yield samples, 5.9 m^2 in size were obtained from the center of each of the four center rows of each plot. Entire plants, including vines, nuts, and roots were hand harvested and placed in cloth bags for artificial drying. After drying, the samples were weighed and the pods hand picked from the vines to obtain the dry weight of the unshelled fruit. Grade component data were obtained from two, 200-gram pod samples from each plot using standard Federal-State Inspection Service equipment and procedures. The remnant peanuts, including vines, were mechanically harvested and removed from each plot.

The following 21 responses associated with the yield and quality of peanuts, soil characteristics, and nematode counts were measured: peanut-yield, percent shriveled seed, percent seed damage (visible, concealed, and total), shelling percent, seed weight, and percent sound mature kernels; soil-pH, CaO, MgO, P_2O_5, and K_2O; nematodes-ring (*Criconemoides curvatum* Raski), sting (*Belonolaimus longicaudatus* Rau), dagger (*Xiphinema americanum* Cobb), root lesion (*Pratylenchus brachyurus* Goodey), lance (*Hoplolaimus coronatus* Cobb), stubby root (*Trichodorus christiei* Allen), root-knot (*Meloidogyne incognita*), and spiral (*Helicotylenchus mannus* Steiner). The data were statistically analyzed with the exception of the counts for sting, dagger, root lesion, stubby root, root knot, and spiral nematodes, all of which showed a high percentage of zero values.

Results and Discussion

The results of the analyses of variance for 12 of the 21 responses measured are summarized in Table 1. Due to the high percentage of zero values, the data on numbers of nematodes for six of the eight species were not analyzed. The analysis of variance of the seed damage data is not given in Table 1 because the total seed damage was generally less than 1%. The main effect means for all twenty-one responses are presented in Tables 2 to 4. All but three of the 15 responses analyzed were affected by the length of time the land was in sod.

Table 1. Mean squares and levels of significance from the analysis of variance.

Source of variation	Df	Peanut yield and quality factors				
		Yield	Shelling	Shrivels	Wt./seed	SMK
		kg/ha	%	%	g	%
Blocks	1	70959	0.1667	1.7604	2.0417	27.0938
Years in Sod (Y)	5	1345670**	6.4917*	12.7104**	52.4417**	37.9604**
Plot type (PT) †	3	2679955**	12.5278**	101.2604**	125.4028**	174.0382**
Y x PT	15	325432**	1.3861	4.3771	8.6694	9.5049
Crop Order (C) ‡	1	9450150**	1.0417	49.5938**	450.6667**	68.3438**
Y x C	5	381568*	13.9167**	50.6938**	1.4167	100.7938**
PT x C	3	1823076**	25.7361**	185.3160**	27.4722**	323.1215**
Y x PT x C	15	182234	2.4111	5.1493*	3.0889	11.7049
Error	47	128816	2.6560	2.7391	5.2757	7.9235

Source of Variation	Df	Soil Characteristics				
		pH	Ca O	Mg O	K_2O	P_2O_5
			Available kg/ha			
Blocks	1	0.24000	2481	10500	1183	128.344
Years in Sod (Y)	5	0.26792*	571444**	39058**	6982**	132.610
Plot Type (PT) †	3	0.68375**	482191**	54024**	16232**	429.427
Y x PT	15	0.24225**	302158**	17161**	2620	149.144
Crop Order (C) ‡	1	0.24000	479685**	57526**	30211**	1.760
Y x C	5	0.02850	15102	1305	2860	101.910
PT x C	3	0.22500	131869	28150*	1538	487.760*
Y x PT x C	15	0.03250	33671	4274	2006	85.710
Error	47	0.08468	51577	6941	1948	131.365

Source of variation	Df	Nematodes	
		Ring	Lance
Blocks	1	90590**	7.042
Years in Sod (Y)	5	5625	166.017*
Plot Type (PT) †	3	232078**	15.486
Y x PT	15	32859**	132.994*
Crop Order (C) ‡	1	191978**	442.042*
Y x C	5	11811	119.167
PT x C	3	276684**	17.819
Y x PT x C	15	34371**	69.011
Error	47	12147	67.340

*,** Significant at the 0.05 and 0.01 levels, respectively.
† The seasonal effects for 1966, 1967 and 1968 including the first and second crops after the sod was plowed under. e.g. Plot type (1) is the first crop in 1966, (2) the first crop in 1967, (3) the second crop in 1967, and (4) second crop in 1968.
‡ Crop order 1 is the response the first year after the sod was plowed under and crop order 2 is the response the second year after plowing.

Table 2. Mean influence of years in bahiagrass sod, plot type (Season + crop order), and crop order on the yield and grade components of peanuts.

Main effect	Yield	Shelling	Shrivels	Damaged seed			Wt./seed	SMK
				Visible	Concealed	Total		
	kg/ha	%	%	%	%	%	g	%
Years in sod								
0	1873	73	8	.5	.3	.8	.48	64
1	2557	74	6	.6	.2	.8	.52	67
2	2503	75	6	.5	.2	.7	.53	68
3	2664	74	6	.4	.1	.5	.52	68
4	2697	74	6	.4	.2	.6	.52	67
5	2754	74	6	.4	.1	.5	.51	68
Plot type †								
1	2368	73	8	.1	.1	.2	.53	65
2	2737	74	5	.5	.2	.7	.51	69
3	2878	75	4	.6	.2	.8	.52	70
4	2048	74	9	.7	.3	1.0	.48	64
Crop order ‡								
1	2859	74	6	.4	.2	.6	.53	68
2	2157	74	7	.5	.2	.7	.49	66

† Plot type (1) = 1st crop in 1966, (2) = 1st crop in 1967, (3) = 2nd crop in 1967, (4) = 2nd crop in 1968.
‡ Crop order (1) = The first crop after the bahiagrass sod was plowed under, crop order (2) is the peanut crop the 2nd year after the grass sod was plowed.

Peanut yield and quality, as shown in Table 2, on the average increased with years in sod, with the greatest improvement, a 684 kg/ha yield increase, occuring after one year. Allowing the sod to remain four additionalyears resulted in a total yield increase of 881 kg/ha over the corn-peanut (0 years in sod) rotation plots. Although the differences were significant, it is clear from the means that the length of time in sod does not greatly alter the shelling percent or percent shrivels.

The main effect of the Plot Type variable, which includes the 1966, 1967 and 1968 seasonal effects, had a highly significant influence on all but the following three of the 15 responses analyzed: percent visible seed damage, numbers of lance nematodes, and the available P_2O_5 (Table 1).

Table 3. Mean influence of years in bahiagrass sod, plot type (season + crop order), and crop order on soil pH and available macronutrients from duplicate soil samples collected in each plot in July of 1966, 1967, and 1968.

Main effect	pH	kg/ha available nutrients Ca O	Mg O	P_2O_5	K_2O
Years in sod					
0	6.1	1440	270	74	190
1	6.0	1052	233	72	155
2	6.1	1172	279	70	148
3	6.1	1555	395	76	184
4	6.1	1240	274	69	155
5	5.8	1028	269	68	126
Plot type †					
1	5.8	1067	239	67	123
2	6.1	1391	314	78	171
3	6.1	1163	246	71	153
4	6.2	1371	348	70	191
Crop order ‡					
1	6.0	1169	260	72	140
2	6.1	1327	315	71	179

† Plot type (1) = 1st crop in 1966, (2) = 1st crop in 1967, (3) = 2nd crop in 1967, (4) = 2nd crop in 1968.
‡ Crop order (1) = The first peanut crop after the bahiagrass sod was plowed under, crop order (2) is the peanut crop the 2nd year after the grass sod was plowed.

Table 4. Mean influence of years in bahiagrass sod, plot type (season + crop order), and crop order on the numbers of 8 species of nematodes found in the peanut plots in July of 1966, 1967, and 1968.

Main effect	Species of nematodes - mean numbers per plot sample Sting	Dagger	Root lesion	Lance	Stubby root	Root knot	Spiral	Ring
Years in sod								
0	1.7	0.0	0.0	7.1	0.0	0.1	0.0	147.2
1	2.3	0.6	0.0	6.4	0.2	0.4	0.4	129.4
2	0.8	1.3	0.2	3.9	0.0	1.8	0.0	163.2
3	0.2	0.0	0.0	0.4	0.2	1.5	0.0	186.0
4	0.2	0.6	0.2	0.2	0.0	0.6	0.2	152.6
5	1.0	0.4	0.0	0.2	0.4	0.4	1.0	158.9
Plot type †								
1	0.7	0.4	0.1	3.2	0.4	1.5	0.1	123.8
2	2.3	0.8	0.0	3.4	0.1	0.4	0.9	95.5
3	0.7	0.4	0.1	3.6	0.0	0.7	0.0	103.0
4	0.4	0.3	0.0	1.8	0.0	0.7	0.1	302.6
Crop order ‡								
1	1.2	0.4	0.0	0.9	0.3	0.6	0.3	111.5
2	0.8	0.5	0.1	5.2	0.0	1.1	0.3	200.9

† Plot type (1) = 1st crop in 1966, (2) = 1st crop in 1967, (3) = 2nd crop in 1967, (4) = 2nd crop in 1968.
‡ Crop order (1) = The first peanut crop after the bahiagrass sod was plowed under, crop order (2) is the peanut crop the 2nd year after the grass sod was plowed.

Table 5. Differential peanut response (kg/ha) of first and second year peanut crops following 0 to 5 year-old bahiagrass sod.

Years in sod	Crop order* First**	Second
0	2559	1185
1	2912	2203
2	2737	2268
3	3005	2324
4	2966	2488
5	2977	2531
Mean	2859	2157

* Differences between first and second crops are statistically significant.
** The regression equation for the yield of the first crop with length of time the land was in sod = 2607 + 72 T (where T = years in sod + 1).

Significant Years in Sod x Plot Type, and Crop Order x Plot Type interactions were found for the latter two responses. The soil K_2O was the only response for which the effect of Plot Type was independent of the effects of the other factors. While the effect of the Plot Type factor on the K_2O response can be determined from the means presented in Table 3, additional information is available through the use of Duncan's multiple range test. The results of this test were as follows; K_2O 4 2 3 1, indicating that the soil K_2O was significantly less with Plot Type 1 than with any other Plot Type.

The numbers of ring nematodes were by far the most predominant species associated with peanuts in this experiment, and averaged over the other factors, the years in bahiagrass variable did not significantly alter their numbers (Tables 1 and 4). Kinlock and Lutrick (4) monitored annual population changes of nematodes associated with crops grown in short term rotations for four years at Jay, Florida and found that ring nematodes (*Criconemoides ornatus* Raski) were also the most predominant species associated with peanuts in their experiment. Lance nematodes were the next most commonly found species in this experiment, although in much fewer numbers than for ring. However, the years in bahiagrass sod reduced the numbers of lance nematodes in a highly significant linear manner, which probably accounts to some degree for the increased peanut yields following bahiagrass sod. The data in Table 4 indicate that there is a rapid buildup of lance nematodes on the cultivated crops after the bahiagrass is turned, from 0.9 to 5.2 lance nematodes per plot sample for the first and second peanut crops, respectively. Peanut yields were apparently reduced in the corn-peanut rotation plots during the early stages of this study (1961 and 1963) by populations of lance nematodes (6). The annual monitoring of nematode species in the corn-peanut rotation plots during the period of this study, 1959-1968, showed that the populations of various species of nematodes change rapidly from year to year.

The yield and quality of the peanut crop following plowing of the bahiagrass sod were significantly better in the first than in the second year (Tables 1 and 2). The mean percent sound mature kernels (SMK) was 2% more, the weight per seed .04 g heavier, and the pod yield 702 kg/ha higher the first year after the sod was plowed than the second year. A significant (.05 level) interaction was obtained for Years in Sod x Crop Order for yield, shelling %, % shrivels, and % SMK. Table 5 presents the interaction means for yeild, along with the linear regression equation for the first crop with time (years in sod). The yield response tended to increase with time. In every case the yield response of the first crop was significantly higher than for the second. The interaction was primarily one of magnitude since only the magnitude of the difference varied from year to year. In general, as the number of years in sod increased the difference between the first and second peanut crop diminished.

One would have to conclude, from these results, that farmers could profit by utilizing bahiagrass in rotations with peanuts, even if the grass is plowed after the first year.

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