PEANUT YIELD RESPONSE TO BAHIAGRASS KILL TIME AND TILLAGE METHOD IN THE SOUTHEAST

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ABSTRACT

Experiments were conducted in 2006 at two locations (Marianna and Quincy) of the North Florida Research and Education Center, FL to investigate effects of bahiagrass (*Paspalum notatum*) kill time and tillage practices on peanut yield and market grade. The experiments included two bahiagrass kill times (fall kill and spring kill) and six tillage methods [(1) strip till, (2) disk+turned, (3) disk+chisel, (4) paratill+strip till at planting, (5) disk+strip till, and (6) strip till+40 lbs N acre^{-1}] within each kill time. Peanut (cv. AP 3) was seeded on 15-16 May 2006 with a row space of 3 feet and six seeds per foot row. During the growing season, insects and diseases were controlled and irrigation was scheduled based on peanut production practices in the region. Pod yield and market pod grade characteristics were determined. Neither kill time of bahiagrass nor tillage methods affected peanut yield at both locations ($P > 0.05$). There was no interactive effect of the bahiagrass kill time and tillage type on peanut yield. In the strip till, peanut yield did not respond the N application. Averaged across the locations and tillage methods/bahiagrass kill times, peanut yields of the fall kill and spring kill were 4077 and 4173 lbs acre^{-1}, respectively; and the yields of the six tillage methods were 4199, 4201, 4281, 4072, 4162, and 3843 lbs acre^{-1}, respectively. These results indicate that (i) in the sod-based rotation systems in Florida, farmers may have a wide window of time period to kill bahiagrass and to prepare seedbed for following peanut crop; (ii) N nutrient may not be a factor of limiting peanut yield or make a difference in crop residue decomposition in the strip till system of peanut following bahiagrass in the region; (iii) there is potential to make the sod-based crop rotation system more profitable by reducing energy input and tillage requirements; and (iv) high yields of peanuts may be expected when planting peanuts after bahiagrass.

INTRODUCTION

Studies have shown that sod-based rotation of peanut (*Arachis hypogea* L.) and cotton (*Gossypium hirsutum* L.) in the Southeast US can significantly reduce disease pressure (Dickson and Hewlett, 1989; Johnson et al., 1999; Marois and Wright, 2003a; Wright et al., 2004a), improve crop growth and development, and increase crop yield and profitability (Norden et al., 1980; Brenneman et al., 1995; Katsvairo et al., 2006) compared with conventional cropping systems. The value of bahiagrass (*Paspalum notatum*) in rotation with peanuts is clear in many field experiments (Brenneman et al., 1995; Marois and Wright, 2003b; Wright et al., 2004a; Wright et al., 2004b). However, most growers have not see the system as being out of crop production for a year or more and the cost of breaking up the land to get it back to peanut production. With rising fuel prices as well as input cost, it has become more important to find ways of reducing costs and increasing profitability while increasing peanut yields. Studies suggest that there are considerable differences among tillage methods in input cost, soil impact or crop yields (Jordan et al., 2002). In order to make the sod-based crop rotation system more profitable by reducing energy input and tillage requirements, we conducted this research at three states of Florida, Alabama, and Georgia in 2006 and 2007. The specific objectives of this study were to investigate effects of bahiagrass kill time and tillage practices on peanut yield, market grade, and net return and to test if fungicide application has different effects on peanut yield. In this report, we summarize the results of peanut yield responses to bahiagrass kill time, tillage, and fungicide application in 2006 at two locations (Marianna and Quincy) of the North Florida Research and Education Center.

MATERIALS AND METHODS

Marianna location

The experiment included two levels of bahiagrass kill time (fall kill and spring kill) and six tillage treatments within each kill time. The dates of bahiagrass fall kill and spring kill were 26 October 2005 and 20 March 2006, respectively with 3 qts. of Rundup Weather Max per acre. The six tillage treatments were: (1) Strip till, (2) Disk+turned, (3) Dick+chisel, (4) Paratill+strip till at planting, (5) Disk+strip till, and (6) Strip till+40 lbs N acre^{-1}. A rate of 40 lbs N fertilizer of Ammonium N per ace was forecasted on April 15 for the strip till+40 lbs N treated plots.

Peanut (cv. AP 3) was seeded with a 2-row planter on 15 May 2006 with a row space of 3 feet and six seeds per foot row. During the growing season, insects and diseases were controlled and irrigation was scheduled based on peanut production practices in the region. When crop reached maturity stage on 4 October 2006, the two middle rows in each plot were mechanically dogged and reversed and harvested on 9 October. Pod samples were placed a forced-air dryer at 113°F for 72 hours to ensure for a constant weight. Pod yield and market pod grading characteristics, including percentages of sound mature kernels (SMK), sound split kernels (SSK), other kernels (OK), Hulls, and TSWV were determined.

Quincy location

Similar to the Marianna experiment, the experiment at Quincy was also composed with two levels of bahiagrass kill time (fall kill and spring kill) and six tillage treatments. The fall kill date was 26 October 2005 with 3 qts. of Rundup Weather Max per acre and the spring kill was two times of applying Glyphomax Plus on 29 March and 10 April 2006 with the rate of 3 qts. acre^{-1} each time. The six tillage treatments were the same as that in Marianna and they were: (1) Strip till, (2) Disk+turned, (3) Dick+chisel, (4) Paratill+strip till at planting, (5) Disk+strip till, and (6) Strip till+40 lbs N acre^{-1}. Seeds of peanut cultivar AP 3 were planted on 16 May 2006. Measurements of Soil mechanical resistance were taken in all plots using a CP20 Cone Penetrometer on 18 May, 5 June, 25 July, and 15 August. Except for the kill time and tillage treatments, other field management practices, such as irrigation and herbicide and insecticide application, were scheduled for all plots based on peanut production practice recommendations in the region during the growing season. At maturity, the two middle rows in each plot were mechanically harvested. Pod samples were dried to determine yield and market pod grading parameters using the similar methods described above.

Experimental design and data analysis

The experiments were a split plot design with four replications. The bahiagrass kill times were main plots and tillage treatments were sub-plots. The sub-plot size was 50 feet long and 18 feet wide. Analysis of variance (ANOVA) was carried out using SAS procedures of GLM to determine the main and interactive effects of bahiagrass kill time and tillage type. The least significant difference (LSD) tests were used to distinguish the treatment difference at $P = 0.05$ level.

RESULTS AND DISCUSSION

Soil mechanical resistance

Studies have confirmed that soil compaction directly affects crop root growth and limits use of deep soil water and nutrients, resulting in a reduced crop growth and low yields (Atwell, 1990; Alakukku and Elonen, 1995). Measurements of soil mechanical resistance in Quincy indicated that the fall kill treatment had less soil resistance from 20 to 30 cm of soil depth than the spring kill treatment (Figure 1A). Less resistance in soil compaction layer for the fall killed than the spring killed bahiagrass is not surprised because fall kill treatment had more time to decompose bahiagrass biomass, especially roots. When roots decay, they leave root channels which can improve soil penetration (Katsvairo et al., 2006) and field infiltration (Katsvairo et al., 2007). However, this soil penetration advantage from fall kill of bahiagrass did not result in yield benefit of the following peanut in the present study (Tables 1 and 2). Reduced soil mechanical resistance in the fall killed treatment may save horse power for seedbed preparation although peanut yield did not respond soil resistance. Types of tillage greatly affected soil mechanical resistance. Averaged across measurement dates and the bahiagrass killed times, the Disk+strip till treatment had the greatest and the Paratill+strip till had lowest soil resistance (Figure 1B).

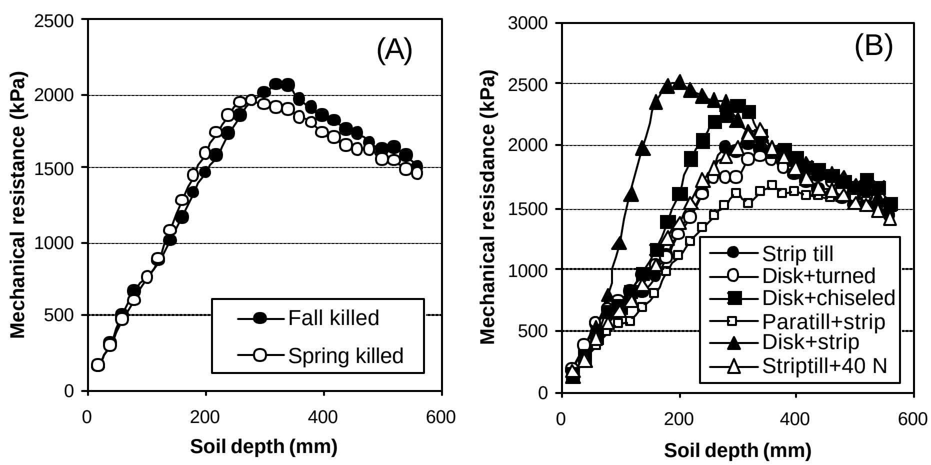

Figure 1. Soil mechanical resistance for (A) plots of fall kill vs. spring kill bahiagrass and (B) the six tillage types. Data are means of four times of measurements in Quincy, Florida.

Peanut yield responses to bahiagrass kill time and tillage

Peanut yields in Marianna and Quincy were 4273 and 3978 lbs acre^{-1}, respectively, averaged across the bahiagrass kill time and tillage treatments. Overall, the peanut yield in the present study is 60 to 70% higher than State average yield (about 2500 lbs acre^{-1}) of peanut in the Southeast. The good yields are attributable to being after 2 years of bahiagrass (Brenneman et al., 1995; Marois and Wright, 2003b; Wright et al., 2004a; Wright et al., 2004b). Statistical analysis indicated that there was significant difference ($P < 0.05$) in peanut yield between the two experimental locations. Therefore, yield data were analyzed independently for each location. In Marianna, neither the kill time nor tillage statistically affected pod yield. The interaction between replication and the kill time was significant ($P < 0.05$, Table 1). In Quincy, the kill time did not, but the tillage did affect peanut yield ($P < 0.10$). There was no any interaction of the kill time and tillage in yield at the experimental location of Quincy (Table 1).

Table 1. Analysis of variance (ANOVA) for peanut yield responses to the kill time of bahiagrass and tillage at Marianna and Quincy, Florida in 2006.

Source	DF	*P* value	
		Marianna	Quincy
Replication	3	0.1458	0.5663
Kill time	1	0.9122	0.3616
Rep × Kill time	3	0.0274	0.6685
Tillage	5	0.4843	0.0910
Rep × tillage	15	0.2323	0.4061
Kill time × tillage	5	0.7473	0.2334

Peanut yields from bahiagrass kill date and tillage treatments at two locations are given in Table 2. Averaged across the tillage treatments, peanut yields of the fall kill and spring kill of bahiagrass were 4264 and 4280 lbs acre^{-1}, respectively in Marianna and 3890 and 4066 lbs acre^{-1}, respectively in Quincy. Peanut yield did not differ between the fall kill and the spring kill of bahiagrass at the both locations. Our unpublished data in a corn following bahiagrass experiment also indicate that there are no differences in corn growth and physiological parameters between the fall kill and the spring kill of bahiagrass. Thus, farms have a great time window or flexibility from fall to spring to kill bahiagrass for the following row crops without any yield reduction. In Marianna, tillage did not affect peanut yield in the fall kill, but the strip till had higher yield than the disk+chiseled treatment in the spring kill of bahiagrass ($P < 0.05$). Although yield did not differ between the fall kill and spring kill treatments when averaging yield across tillage treatments at Quincy, yield of the strip + 40 lb N/acre treatment was significantly lower than that of the disk+turned treatment in the fall kill of bahiagrass and that of the disk+chiseled treatment in the spring kill of bahiagrass. The yield of the paratill+strip till at planting time was also lower than that of the disk+chiseled (Table 2).

Strip till was the most simple tillage method among the six tillage treatments, but its peanut yield was equivalent to that of other tillage treatments. This indicates that in sod-based peanut-cotton rotation systems in the southeast, the conservation tillage of strip till can reduce input and increase profitability. Theoretically, row crops may face N limitation when they follow bahiagrass because decomposition of bahiagrass roots and residues requires a period of time. Our results revealed that N nutrient was a factor of limiting peanut yield in the sod based rotation system with strip till in both the fall kill and the spring kill of bahiagrass (Table 2).

Table 2. Effects of bahiagrass kill time and tillage on peanut yield (lbs acre^{-1}) at Marianna and Quincy, Florida in 2006.

Tillage	Marianna			Quincy[†]		
	Fall kill	Spring kill	Mean	Fall kill	Spring kill	Mean
Strip till	4078 a[†]	4499 a	4289 a	3776 ab	4441 ab	4109 ab
Disk+turned	4115 a	3806 b	3960 a	4516 a	4369 ab	4442 a
Disk+chiseled	4331 a	4364 ab	4348 a	3731 ab	4697 a	4214 ab
Paratill+strip till	4353 a	4442 ab	4398 a	3983 ab	3508 b	3746 bc
Disk	4521 a	4316 ab	4420 a	4049 ab	3759 ab	3904 abc
Strip till+40 lb N	4187 a	4253 ab	4220 a	3285 b	3634 b	3465 c
$LSD_{0.05}$	1114	648	622	875	1023	650

[†] Means within a column followed by the same letter are not significantly different at the level of P = 0.05.

Peanut market grade characteristics

Bahiagrass kill time and tillage method did not affect any grading parameters of percent sound mature kernels (SMK), percent sound split kernels (SSK), percent other kernels (OK), percent hulls, or percent kernels with tobacco spot wilt virus (TSWV) infection (data not shown). There were no statistical differences between the two locations in SMS, SSK, OK, and percent hulls (Table 3). However, peanut kernels at Quincy had significantly higher TSWV compared to peanuts at Marianna in all tillage methods (Table 3). Averaged across kill times of bahiagrass and tillage types, the TSWV was 0.53% at Marianna and 0.81% at Quincy.

Table 3. Percentages (%) of sound mature kernels (SMK), sound split kernels (SSK), other kernels (OK), hulls, and TSWV of peanuts at Marianna and Quincy, Florida in 2006.

System	Marianna					Quincy				
	SMK	SSK	OK	Hull	TSWV	SMK	SSK	OK	Hull	TSWV
Strip till	60.0	6.82	4.25	28.6	0.48	59.7	7.39	4.18	28.0	0.83
Disk+turned	60.0	6.71	4.18	28.5	0.61	59.0	7.69	4.54	28.1	0.86
Disk+chiseled	60.4	6.22	4.84	28.3	0.51	59.3	7.06	4.46	28.4	0.85
Paratill+strip till	59.8	5.70	4.80	29.0	0.34	61.0	6.08	4.66	28.0	0.73
Disk	59.3	7.19	4.68	28.3	0.63	59.4	6.89	4.52	28.5	0.86
Strip till+40 lb N	59.9	6.03	5.14	28.9	0.64	60.0	6.16	5.10	28.0	0.71
Mean	59.9	6.44	4.65	28.6	0.53	59.7	6.88	4.57	28.2	0.81

[†] Data are means of the fall kill and spring kill of bahiagrass.

CONCLUSIONS

Preliminary results of this study at the two locations (Marianna and Quincy) of the North Florida Research and Education Center in 2006 indicated that:

1. Peanut yield and grading variables did not differ between the bahiagrass fall kill and spring kill treatments at both locations although soil penetration was improved by the fall kill bahiagrass compared to the spring kill bahiagrass. Therefore, in the sod-based rotation systems in the southeast, farmers may have a wide window to kill bahiagrass and to prepare seedbed for following peanut crop. Bahiagrass may be killed at anytime from the fall until 4-5 weeks prior to planting. However, soil compaction is higher if bahiagrass is killed in the spring as compared to the fall and may require more horse power to pull tillage implements due to more compacted soil.

2. Peanut yield response to tillage treatments depends upon the experimental location. At Marianna, the six tillage treatments did not affect peanut yield in the fall kill of bahiagrass, but in the spring kill, yield of the strip till was significantly higher than the disk+turned treatment. At Quincy, the disk+turned treatment had significant higher yield than the strip till+40 lb N treatment in fall kill of bahiagrass. In the spring kill of bahiagrass, the treatment of disk+chiseled had the highest, but the disk+strip till at planting and the strip till+40 lb N treatments had the lowest yield. More studies are required for further investigating tillage effect on peanut yield.

3. Application of N fertilizer did not improve peanut yield, when peanut followed bahiagrass in strip till system at both locations in this study. Therefore, N nutrient may not be a factor of limiting peanut yield or make a difference in cover crop decomposition in the strip till system of peanut following bahiagrass in Florida.

4. High yields of peanuts can be expected when planting peanuts after bahiagrass in conservation tillage.

REFERENCES

Alakukku, L., and Elonen, P. 1995. Long-term effects of a single compaction by heavy field traffic on yield and nitrogen uptake of annual crops. Soil Tillage Res, 36: 141-152.

Atwell, B.J. 1990. The effect of soil compact on wheat during early tillering. I: Growth, development and root structure. New Phytol., 115: 29-35.

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.

Dickson, D.W., and Hewlett, T.F. 1989. Effects of bahiagrass, and nematicides on Meloidogyne arenaria on peanut. Suppl. J. Nematol. 21, 4S:671–676.

Johnson, A.W., Milton, N.A., Brenneman, T.B., Burton, G.W., Culbreath, A.K., Gascho, G.J., and Baker, S.H. 1999. Bahiagrass, corn, cotton rotations, and pesticides for managing nematodes diseases, and insects in peanuts. J. Nematol. 31:191–200.

Jordan, D.L., Bailey, J.E., Barnes, J.S., Bogle, C.R., Bullen, S.G., Brown, A.B., Edmisten, K.L., Dnphy, E.J., and Johnson, P.D. 2002. Yield and economic return of ten peanut-based cropping systems. Agron. J., 94: 1289-1294.

Katsvairo, T.W., Wright, D.L., Marois, J.J., Hartzog, D.L., Rich, J.R., and Wiatrak, P.J. 2006. Sod–livestock integration into the peanut–cotton rotation: A systems farming approach. Agron. J. 98: 1156-1171.

Katsvairo, T.W., Wright, D.L., Marois, J.J., Hartzog, D.L., Balkcom, K.B., Wiatrak, P.P., and Rich, J.R. 2007. Cotton roots, earthworms, and infiltration characteristics in sod–peanut–cotton cropping systems. Agron. J. 99:390-398.

Marois, J.J., and Wright, D.L. 2003a. Effect of tillage system, phorate, and cltivar on tomato spotted wilt of peanut. Agron. J. 95: 386-389.

Marois, J.J., and Wright, D.L. 2003b. A working business model for cattle/peanuts/cotton. Proc. Sod Based Cropping Syst. Conf., North Florida Research and Education Center-Quincy, University of Florida, Feb. 20-21, 2003, pp. 180-186.

Norden, A.J., Perry, V.G., Martin, F.G., and NeSmith, J. 1980. Effect of age of bahiagrass sod on succeeding peanut crops. Peanut Sci. 4:71–74.

Wright, D.L., Katsvairo, T.W., Marois, J.J., and Wiatrak, P.J. 2004a. Introducing bahiagrass in peanut/cotton cropping systems-effects on soil physical characteristics. In Annual Meeting Abstracts of ASA, CSSA, and SSSA. Madison, WI.

Wright, D., Marois, J., Katsvairo, T., Wiatrak, P., and Rich, J. 2004b. Value of perennial grasses in conservation cropping systems. Proc. 26th Southern Conserv. Tillage Conf. Sustain. Agric., Raleigh, NC, 8-9 June 2004. p. 135-142.