Strip-Till Cotton Yield in Six Double Cropping Systems

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ABSTRACT

The objective of this research was to determine adaptability and yield of strip-till cotton (*Gossypium hirsutum* L.) in combination with six winter crops in double cropping systems. Six winter crops were planted in a randomized complete block design in the fall of 2000. Winter crops were wheat (*Triticum aestivum* L.) cv. 'Flemming', rye (*Secale cereale* L.) cv. 'Wrens 96', oat (*Avena sativa* L.) cv. 'Chapman', lupin (*Lupinus angustifolius* L.) cv. ' Tiftblue 78', vetch, (*Vicia villosa* roth.) cv. 'Common Hairy', and crimson clover (*Trifolium incarnatum* L.) cv 'Dixie Resseding'. The small grain seed harvest was in mid May 2001 followed by bailing the small grain straw. The three legumes were left undisturbed. Six varieties of cotton were randomized and strip-tilled on 31 May 2001 into the winter crop plots as sub plot treatments, allowing the testing of the varieties in six double cropping systems. Varieties included 'Delta Pine 5690', 'Delta Pine 5690 RR', 'Delta Pine 655 BG/RR', 'Delta Pine 5415', 'Delta Pine 5415 RR', and 'Delta Pine 458 BG/RR'. Crops were irrigated, fertilized according to soil test, and pests were controlled using best management practices. Cotton was hand harvested and samples were ginned to determine lint yield. Data collected included seed cotton and lint yield, plant height, and final plant population. Cotton data was analyzed as a split-plot with winter crops as main treatments and cotton varieties as sub treatments with six replications. The average of the six varieties showed that all double cropping systems were equal in seed-cotton (lint + seed) yield and cotton seed (delinted seed) yield except for double cropping with crimson clover (lowest yield). Lint yield averaged across all cropping systems showed that Delta Pine 458 BG/RR had the greatest yield (1270 pounds/acre) and the lowest yield was for Delta Pine 655 BG/RR (1102 pounds/acre). The highest lint yield was obtained with cotton double cropped after oat for Delta Pine 458 BG/RR (1415 pounds/acre) and after rye for Delta Pine 5415 RR (1420 pounds/acre). Final plant populations were significantly higher in double cropping systems with the three small grains compared to double cropping systems after the three legumes. Based on these results the best double cropping system was oat or rye followed by Delta Pine 458 BG/RR.

KEYWORDS

Gossypium hirsutum L., winter cover crops, small grains, winter legumes, cultivars

INTRODUCTION

Increased global competition requires US farmers to become more efficient in their farming practices. The best way to improve a grower's financial condition is through research that will lead to improved competitiveness for U.S. growers by learning ways to reduce or improve effectiveness of inputs and/or increase yield (Baldwin, 1998). Upland cotton is a source of oil and fiber for humans and protein for livestock (Lee, 1984; Cassman, 1993). It is valued in the billions of dollars to the U.S. economy (Goodell, 1993). This crop is steadily increasing in importance in the Southeast and in recent times especially in Florida (Gallaher and Brecke, 1999).

Conservation tillage is increasingly becoming conventional due to savings to farmers in fuel, labor, equipment, time, etc. and at the same time improves the environment. Because of the huge decreases in soil erosion, soil water and nutrients are also conserved which results in improved plant growth. Approximately 300 million acres of cropland is now under conservation tillage management in the U.S., of which a significant portion is strip-till cotton (Mitchell, 1996). Refinement of conservation tillage management is important in order to maximize crop growth and productivity.

Past research on strip-till cotton in Florida has resulted in the refinement of N fertility management. Gallaher's (unpublished data) research for the past four years has concluded that nitrogen fertilizer should be applied in three splits in sandy soils to ensure crop utilization and avoidance of leaching from heavy rainfall events. During dry years 90 lbs N acre^{-1} (with irrigation) and 120 lbs N acre^{-1} during years of heavy rainfall events were needed to maximize lint yield. Research at Quincy, Florida has shown cotton yields to respond to 120 lbs N acre^{-1} (Wiatrak *et al*., 1999). We have also tested several cotton varieties (Gallaher, 1999) and weed control strategies (Edenfield *et al*., 1999) under

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strip-till management. Some studies pointed to high yielding varieties adapted to Florida like Delta Pine 5415 RR (RR = Roundup Ready gene variety) (Gallaher, 1999). Selecting the proper variety, using the proper research supported nitrogen management, and knowing the best crop rotation for pest management (Edenfield, *et al*., 1999; McSorley and Gallaher, 1993; 1999; Munro, 1987) can result in significant yield increases. The objective of this research was to determine adaptability and yield of strip-till cotton in combination with six winter crops in double cropping systems.

MATERIALS AND METHODS

The experimental site was located at the University of Florida, IFAS Plant Science Research and Education Center near Citra, FL. Six double cropping systems with strip-till cotton were established in 2001 at this site and consisted of wheat, rye, oat, lupin, vetch, and crimson clover followed by cotton. Winter crops were planted at recommended rates into a minimum tillage seedbed on 20 November 2000. Seed of six varieties of cotton were obtained for succession planting which involved two families of genetically altered cotton. The first family of varieties consisted of Delta Pine 5690, Delta Pine 5690 RR, and Delta Pine 655 BG/RR (BG = *Bacillus thuringiensis* –Bt gene variety). The second family of varieties consisted of Delta Pine 5415, Delta Pine 5415RR, and Delta Pine 458 BG/RR. In mid May 2001 the three small grain crops were harvested for seed and the straw was baled. Legume crops were dying and were left undisturbed in the plots. Cotton was strip-tilled into the stubble of the small grains and the cover of the legumes on 30 May 2001. Crops were irrigated as needed. Fertilization was applied based on soil test recommendations and included 60 pounds lbs N acre^{-1} at planting of cotton. Cotton following the small grain crops received an extra 30 lbs N acre^{-1} sidedressed when the cotton was 12 inches tall. A 50 square foot section of each of the 175 square foot plots was harvested by hand. Seed-cotton (lint + seed), lint, and seed (delinted seed) yields were determined. Percent lint was determined using a 0.5 pound subsample from each of the 216 plots by use of a small laboratory tabletop gin. Statistical analyses were conducted on the split plot experiment with winter cover crops as main effects and the six varieties of cotton as sub effects. A bale of lint cotton was assumed to weigh 480 pounds. The experiment was replicated six times.

Table 1. Cropping system and cotton cultivar response for seed cotton yield (lint plus seed) and lint yield of strip-till cotton at Citra, FL, 2001.

Cotton Variety	Winter Crop System						
	Wheat	Rye	Oat	Lupin	Vetch	Crimson	Average
	Seed cotton yield, lbs acre^{-1}						
DP 5690	3099	3062	3126	2819	2726	2542	2896 A[†]
DP 5690 RR	2800	3208	3316	2533	2417	2549	2804 AB
DP 655 BG/RR	3113	3138	3165	2321	1955	2045	2623 B
DP 5415	2963	3268	3314	2590	2903	2167	2868 AB
DP 5415 RR	2449	3452	2974	2946	2631	2432	2814 AB
DP 458 BG/RR	3086	3203	3389	2887	3039	2669	3046 A
Average	2918 XY[‡]	3222 X	3214 X	2683 XY	2611 XY	2400 Y	
	Lint yield, lbs acre^{-1}						
DP 5690	1317	1254	1292	1185	1131	1083	1210 AB
DP 5690 RR	1175	1323	1381	1057	995	1090	1170 AB
DP 655 BG/RR	1350	1305	1327	964	810	856	1102 B
DP 5415	1252	1352	1408	1082	1222	916	1205 AB
DP 5415 RR	1044	1420	1213	1242	1105	1027	1175 AB
DP 458 BG/RR	1267	1330	1415	1185	1276	1148	1270 A
Average	1234 XYZ	1330 XY	1339 X	1119 XYZ	1089 YZ	1020 Z	

[†] Cotton cultivar averages not followed by the same letter (ABC) are significantly different at $P = 0.05$, based Duncan's Multiple Range Test.

[‡] Winter crop system averages not followed by the same letter (XYZ) are significantly different $P = 0.05$, based Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Seed cotton yields were equal for all double cropping systems except for cotton following crimson clover (Table 1). Yield of seed cotton tended to be best following rye and oat and lowest following crimson clover. All varieties gave equal yield with the exception of DP 5690 and DP 458 BG/RR, which gave higher seed cotton yield compared to DP 655 BG/RR (Table 1). No differences were found among winter cropping systems or varieties of cotton for percent lint. Lint yield was similar among the systems that included wheat, rye, oat, and lupin, all of which were greater than lint yield following crimson clover (Table 1). There appeared to be a trend for lint yield to be higher following the small grains compared to the legumes. Delta Pine 458 BG/RR had greater lint yield compared to DP 655 BG/RR. Seed yield (data not shown) tended to follow the same pattern as that of seed cotton yields with yield following crimson clover being the lowest compared to following rye and oat. Delta Pine 5690 and Delta Pine 458 BG/RR had greater seed yield compared to Delta Pine 655 BG/RR. Delta Pine 5690 and Delta Pine 458 BG/RR were taller varieties (data not shown) compared to Delta Pine 655 BG/RR and Delta Pine 5415 RR. Final plant population at harvest time (data not shown) was greater following the small grain crops compared to double cropping following the three legume crops. Final plant populations tended to be greater for Delta Pine 5690, Delta Pine 5415 RR, and Delta Pine 458 BG/RR. The variety with the lowest population at harvest time was Delta Pine 5415 RR.

CONCLUSIONS

All winter crops grew well and five of the six were easily established where they had never been grown before. First year establishment of crimson clover was more difficult compared to the other legumes.

1. These six double cropping systems worked well in north Florida where they had never been established before. The big question is the sustainability of each without some type of summer crop rotation to disrupt weeds and diseases including nematodes that may become established.
2. The six varieties of cotton in this study are all adaptable to north Florida.
3. Lint yields among varieties ranged from 1100 to 1270 lbs acre^{-1} and represents 2.3 to 2.6 bales acre^{-1} (480 pound bales) when averaged over all the six double cropping systems. However, yields close to three bales per acre were observed for some varieties following rye or oat. Lint yield tended to be lower following the legumes compared to the small grain crops and yield following crimson clover tended to be the lowest. This was likely due to poor establishment and growth of crimson clover in some replications and thus a limitation in N production that would be available to the cotton.
4. There were differences in final plant populations among varieties, but this does not readily explain why Delta Pine 655 BG/RR tended to have the lowest yield. Further experimentation is needed to attempt to explain this. However, plant populations were significantly lower following the three winter legumes compared to the three small grains. This may be due to the differences in crop residue management and possibly the difference in seed placement for germination. However, this too will need further investigation.
5. Based on these results the best double cropping system was oat or rye followed by Delta Pine 458 BG/RR.

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