REDUCED TILLAGE EFFECTS ON COTTON GROWTH AND YIELD IN NEW MEXICO

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Abstract

Reducing tillage in arid soils of southwestern USA is highly necessary, due to accelerated soil erosion, especially by wind and soil quality degradation prominent in conventionally tilled agricultural soils of this region. Conventional land preparation for cotton production in southern New Mexico is based on the plow-till system, which involves following practices - plowing, deep-ripping, multiple disking and shaping of soil into beds, to provide an optimum seedbed for emerging cotton seedlings. A study was conducted in Las Cruces, New Mexico, to evaluate the effects of different tillage systems on growth and yield of cotton. Tillage treatments tested included plow-till without beds (PTF) [cotton planted on flat], plow-till with beds (PTB) [cotton planted on beds] and strip-till (STP) systems. The strip tillage involved only one single pass with Orthman Manufacturing 1tRIPr strip tillage equipment, to create about 10 inches zone for seed placement. A glandless cotton cultivar (NM 13P1117) was planted in May 2017, and cotton growth, yield and fiber quality were measured. Results showed that there were no significant differences in cotton yield and fiber quality parameters except for micronaire. An economic analysis of the net returns after deducting land preparation costs showed that the strip tillage system was more profitable than both conventional tillage treatments that were tested due to much lower land preparation cost.

Introduction

Soil erosion by wind is common in the arid regions of southwestern USA (Huszar and Piper, 1986). The predominant tillage system used for growing cotton in the region involves plowing, disking, subsoiling and bed shaping of agricultural fields during the spring season each year. Unfortunately, the windiest period occurs in spring, when farmers prepare their seedbed using the conventional tillage practices, leaving the soil bare, smooth, and unprotected by surface residue. This practice predisposes such soils to wind erosion (Li et al., 2007).

Reduced tillage practices such as a strip tillage can help address the problem of wind erosion especially during the early part of the season (López et al., 2000). Strip tillage involves the tilling of a narrow portion of the soil where seeds are to be placed, leaving the spaces between the seed zones untilled and covered by standing stubble, for soil protection. Strip tillage practices can leave up to 70% of the soil untilled in a field. Other additional benefits of the strip tillage include reduced costs of land preparation due to fewer tillage passes across the field and long-term improvement in quality and moisture retention of the soil (Licht and Al-Kaisi, 2005).

The objectives of this study were

i. To evaluate the yield and fiber quality of cotton grown with strip tillage compared to conventional tillage practices; and
ii. To compare net returns from cotton, after deducting land preparation costs of different tillage treatments tested.

Materials and Methods

The experiment took place at the New Mexico State University Leyendecker Plant Science Research Center in Las Cruces, NM. Tillage treatments were established after fall planted winter wheat cover crop. Winter wheat cover crop was mowed to about 10 inches height and sprayed with roundup, after which the tillage treatments were established on plots that were 12 m x 4 m.

The first tillage treatment was plow till (PT) which involved 5 tillage passes (plowed, twice disked, subsoiled and harrowed), with the cotton planted on flat. The second tillage treatment plow till + beds (PTB) involved 6 tillage passes (plowed, twice disked, subsoiled, harrowed and bed shaping), with the cotton planted on beds. The third treatment was strip tillage (ST), involved only one pass for creation of strips 0.25 m wide as seedbed, using Orthman Manufacturing 1tRIPr strip tillage equipment, with the cotton planted on flat within the strips (Figure 1).

Figure 1. Seedbed prepared by strip tillage equipment with winter wheat stubble in-between the strips

Cultivar tested was NM 13P1117 glandless cotton specifically developed for high desert Southwest. Row spacing was 1 m between rows and 0.1 m within rows and irrigation was applied in furrows for the PTB treatments and on flat in PT and ST treatments. Cultural practices were according to those prescribed by the New Mexico State University and the same practices were applied to all the tillage treatments. Planting done May 15, 2017 and Harvest was on December 1, 2017 and the experimental design was a randomized complete block with four treatment replicates.

Twenty-five matured bolls were collected from each plot (1 boll/plant) for seed/lint ratio and the fiber quality determination. Quantitative field yield was assessed on each plot by hand-harvesting 2 rows, 10 feet long. Fiber quality was analyzed by High Volume Instrument (HVI) at Cotton, Inc., Cary, NC. Analysis of variance (ANOVA) was performed on different measurements to assess the significance of tillage treatments on yield and fiber quality measurements. Additionally, net returns from cotton harvest was calculated after deducting only the cost of tillage.

Results and Discussion

ANOVA results show that the tillage effect was not significant for seedcotton, lint and cottonseed yields (Figure 2). Lint percentage was also not significantly different between the tillage treatments (Table 1). Although not significantly different, the quantitatively amounts of seedcotton and lint produced were highest in the PT treatment, followed by ST treatment, while the lowest were in the PTB treatment. During the mid-season field assessments, the PTB treatments showed indicator of earlier maturity compared to the PT and ST treatments, by reaching cutout earlier. Fiber quality assessed included the micronaire, fiber length, fiber uniformity, fiber strength, fiber elongation and the short fiber content. From of all the fiber quality measurements assessed, only micronaire gave significant tillage effect. While the micronaire of the PT and PTB were in the base range, the micronaire of the ST treatment was already in the discount range (Table 1).

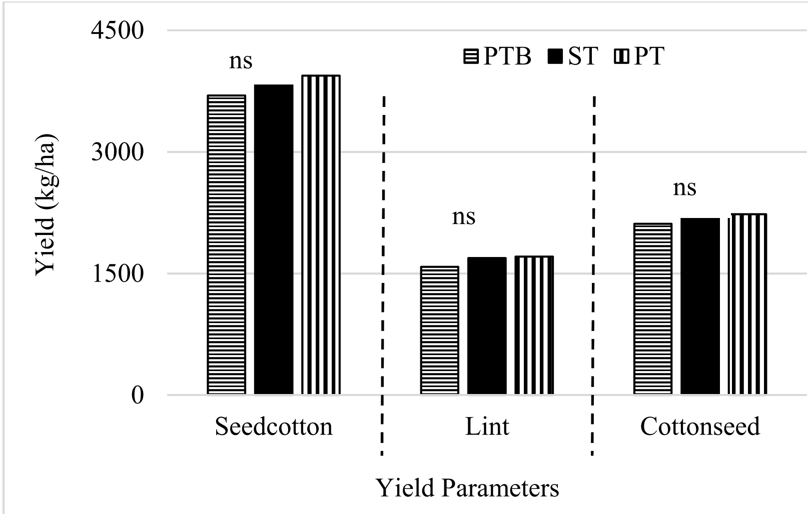

Figure 1. Seedcotton, lint and cottonseed yields under different tillage treatments (ST: Strip Tillage; PT: Plow Till; PTB: Plow Till + Beds; ns: not significant).

Table 1. Lint percentage and fiber quality measurements under the different tillage treatments.

	Tillage treatments			
Measurements	ST	PT	PTB	LS
Lint percentage (%)	43.3	42.3	43.5	ns
Micronaire	5.0 a	4.9 ab	4.7 b	5%
Fiber length (in)	1.14	1.18	1.21	ns
Fiber uniformity (%)	85.1	85.2	85.9	ns
Fiber strength (g/tex)	27.8	28.3	28.3	ns
Fiber elongation (%)	7.23	7.36	7.27	ns
Short fiber content (%)	7.97	7.83	7.40	ns

ST: Strip Tillage; PT: Plow Till; PTB: Plow Till + Beds; LS: Level of significance; ns: not significant

An economic analysis was performed to assess the relative net return from cotton yields after deducting only the cost of tillage. After subtracting the tillage costs, the income generated from lint and cottonseed was the highest in the strip tillage treatment. This was due to a significant reduction in tillage passes between ST and the other treatments (PT and PTB). The income from ST was $127/ha more than PT and $362/ha more than the PTB treatment (Table 2).

Table 2. Income generated from cotton harvest at $1.76/kg lint and $0.29/kg cottonseed.

Tillage treatment	Income from Lint ($/ha)	Income from Seed ($/ha)	Total Income ($/ha)	Cost of Tillage ($/ha)	Income minus tillage Cost ($/ha)
Plow tillage with beds	2,786	613	3,399	226	3,173
Strip tillage	2,974	642	3,616	31	**3,585**
Plow tillage	3,006	647	3,653	195	3,458

Summary

This study showed that there were no significant differences in the yield components of cotton when strip tillage was compared to the two conventional tillage treatments (Plow till on flat and Plow till on beds) which involved plowing, disking, subsoiling and bed shaping. There were also no significant differences in most of the fiber quality parameters. Conventional tillage involved multiple operations and passes over the field, leading to higher land preparation costs compared to strip tillage that involved only a single pass. Net returns after deducting land preparation costs show that the strip tillage system was more profitable than both conventional tillage treatments that were tested. This study will continue for more seasons, to assess the impact of reduced tillage on cotton production in the arid southwest.

References

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