Effect of tillage and crop establishment methods on yield and economics of cotton

ANIL KHIPPAL*, KAMINI KUMART AND JASBIR SINGH

ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana, India

ABSTRACT

In Haryana (India) cotton is generally sown with conventional tillage practices witnesses poor germination and plant establishment. Poor plant stand is attributed by burning of emerging plants due to very high temperature at the time of planting, which is further worsened by crust formation due to pre-monsoon showers. Keeping these points in view, an experiment was conducted with farmers’ participatory research mode in village Hajwana of Kaithal district. Cotton sown with zero tillage technique resulted in approximately five percent higher yield i.e. 136.3 kg ha\(^{-1}\) over conventional tillage. Mean returns over variable cost of all the three years were 10.8 percent i.e. Rs. 11794 ha\(^{-1}\) more in zero tillage over conventional tillage. Benefit: cost ratio were 3.86, 3.86 and 4.61 in conventional method of planting, bed planting and zero tillage technique, respectively. Zero tillage planting of cotton reduced fuel consumption by 93.4 % and 91.7 % compared to bed planting and conventional planting respectively.

Keywords: Bt cotton, zero tillage, bed planting and yield

INTRODUCTION

Cotton production and related businesses are among the most main sources of employment and income for different nations around the world. In India, cotton is cultivated in 7.8 million hectares in varied agro-ecological conditions across nine major states. Cotton cultivation offers employment of 200 man-days/ha annually. It employs directly and indirectly more than 60 million persons in its production, processing and marketing (Vittal et al., 2004). This is an essential raw material in textile and oil press industries in many countries. Cotton requires a growing season of more than 150 days. It not only provides fiber for the textile industry, but is also an oilseed whose cake can be fed to cattle. There are few revolutions in agriculture that occur in any one lifetime. For thousands of years tillage and agriculture were synonymous, and it was difficult to think of growing plants without tillage or without controlling weeds. However, with the introduction of modern herbicides, cultivation without tillage became a reality. Repeated intensive tillage on soils in the tropics and subtropics leads to soil loss, reduction in soil nutrients and organic matter (including soil organisms), release of soil carbon to atmosphere, undesirable changes in soil structure, and reduced water infiltration and moisture-holding capacity. Conventional cotton production practices encompass several tillage operations, including land planing, leveling, harrowing, chisel ploughing, and cultivation for weed control and maintenance of irrigation furrows. Tillage operations may lead to degradation of soil structure, oxidation of organic matter and soil loss through wind and water erosion. Zero tillage is an alternative production system that may offer several economic and environmental profits. Over time, crop residue on the soil surface may increase the infiltration of water into the soil as compared to conventional tillage production, reduce crusting and decrease the effect of wind and temperature on soil water evaporation from the soil surface. Reducing tillage operations can also enhance cotton root growth by minimizing soil compaction. These beneficial effects of conservation tillage practices related to soil and water management can enhance environmental quality and improve the natural resource base on which a large portion of agricultural economy depends. In Haryana (India) cotton is generally sown with conventional tillage practices in the month of April/May. At this time temperature is very high which lead to burning of emerging plant. Also pre - monsoon showers after sowing result in crust formation hence hampering germination. Heavy rain at early growth stage may result in stagnation of water and cotton is very sensitive to moisture at this stage. So farmers have to sow the cotton again and again.

The increases in fuel prices have renewed the interest in reduced tillage systems previously considered for conservation reasons, but now considered for economic reasons as well. De Vita et al. (2007) reported that zero tillage decreased the evaporation from the top soil. Straw of wheat is either removed from the fields or is burnt due to shortage of time between harvesting of wheat crop (mid April) and sowing of cotton crop (end of April to mid of May) that causes loss of carbon and other nutrients and development of water repellency in soil (Singh et al., 2005). As a result, productivity of cotton–wheat system has become static or started declining again and again.
the effects of different tillage systems on lint yield of Bt cotton and to increase the profitability by reducing the tillage operations.

MATERIALS AND METHODS

Site characteristics

Field experiments were conducted for three rotations of cotton–wheat system in years of 2011, 2012 and 2013 at farmer’s field in village Hajwana of Kaithal district (Haryana, India) in participatory mode. The soil of the experimental field was loamy in texture having pH 8.0, medium in organic carbon (0.45%), medium in available phosphorus (13.0 kg ha\textsuperscript{-1}) and medium in available potassium (172 kg ha\textsuperscript{-1}).

Treatments

The experiment was conducted with three treatments and seven replications in randomised block design.

- Farmers’ Practice (Conventional tillage) : (3 harrowing + 2 cultivator + 2 planking)
- Bed Planting : (3 harrowing + 2 cultivator + 2 planking)
- Zero tillage: (no harrowing and no cultivator)

Crop management

Field was prepared for sowing of cotton crop by applying a pre-sowing irrigation of 7 cm. The recommended doses of fertilizers @ 175 kg N ha\textsuperscript{-1}, 60 kg P\textsubscript{2}O\textsubscript{5} ha\textsuperscript{-1} and 60 kg K\textsubscript{2}O ha\textsuperscript{-1} were applied as per recommendation. In conventional sowing and zero tillage, sowing of Bioseed 6488 BG II was done with the cotton planter on 2\textsuperscript{nd} May, 28\textsuperscript{th} May and 6\textsuperscript{th} May during 2011, 2012 and 2013 respectively. The seed rate was 2.25 kg ha\textsuperscript{-1}. The spacing was 100 cm row to row x 45 cm plant to plant. In bed planting method a slight modification was made so as to prepare bed of 80 cm width and sowing was done on the bed with bed planter maintaining row to row spacing of 100 cm. Weeds were controlled with pre-emergence application of Stomp 30 EC (pendimethalin) @ 2.5 L ha\textsuperscript{-1} and two manual hoeings at 40 and 65 days after sowing of the crop. Protected spray of 0.5% glyphosate was done to control weeds in zero tillage planting. Insects and sucking pests were controlled by adopting the recommended schedule as per Haryana Agricultural University, Hisar. Thinning/gap filling was done before first irrigation so as to maintain the recommended spacing and only single plant was left at one place.

Irrigations were applied to the crop depending on the requirements and rainfall during the crop season. The data on number of monopods, sympods and bolls/plant were recorded from randomly selected (tagged) five plants in each treatment when the boll formation was completed and seed cotton yield was recorded from the whole plot excluding borderer rows. The crop was picked three times in each treatment. The crop was harvested on 2\textsuperscript{nd} week of December in both the years. Fuel consumption was obtained using full tank method for both seed bed preparation and planting operations. Total time required for seed bed preparation and planting operations in each treatment was measured by adding time spent in each operation.

Statistical analysis

The data was analyzed using OPSTAT. Online Statistical Analysis was available on CCSHAU, Hisar website.

RESULTS AND DISCUSSION

Seed cotton yield

The data presented in Table 1 clearly reveals that there was no significant difference in seed cotton yield and yield contributing characters during all the three years, although maximum seed cotton yield was realized under zero tillage sowing of cotton. Mean data on seed cotton yield of all the three years presented in Fig. 1 reveal that cotton sown with zero tillage technique resulted in approximately five percent higher yield i.e. 136.3 kg ha\textsuperscript{-1} over conventional tillage. The higher yield achieved may be due to reduction of some weather risks such as burning of young seedling due to higher temperature, crust formation due to rain, avoidance from heavy rain due to increase in infiltration rate, better moisture retention and reduced rainfall runoff. Kennedy and Hutchinson (2001) reported that no-tillage had a five and 16 percent higher yield than the conventional till and reduced till systems, respectively. Boquet et al. (2004) also showed a five and a nine percent higher lint yield in a no-tillage system than in a conventional tillage system, respectively.

Table 1: Effect of different planting methods on yield and yield attributing characters of Bt Cotton

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Sympods / plant</th>
<th>Bolls / plant</th>
<th>Seed cotton Yield (kg ha\textsuperscript{-1})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed Planting</td>
<td>31.00</td>
<td>29.17</td>
<td>32.00</td>
</tr>
<tr>
<td>Zero Tillage</td>
<td>32.15</td>
<td>30.00</td>
<td>33.2</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>32.00</td>
<td>30.20</td>
<td>33.6</td>
</tr>
</tbody>
</table>
Monitory benefit

Data presented in Table 2 reflect that highest returns over variable cost were achieved under zero tillage planting method of cotton. Returns were more in 2011 because the rate of seed cotton was Rs. 6500 qt⁻¹ whereas, in 2012 and 2013 rate was Rs. 4000 qt⁻¹. Seed cotton yield was also more in 2011 and 2013 as compared to 2012.

Mean returns over variable cost of all the years were 10.8 percent i.e. Rs. 11794 ha⁻¹ more in zero tillage planting over conventional tillage practices. Benefit: cost ratio were 3.86, 3.86 and 4.61 in conventional method of sowing, bed planting and zero tillage technique, respectively. Increase in profit may be due to reduced energy needs, savings in labor and lower fuel use in field preparation and planting.

Sullivan et al. (2008) also reported that no-till management can reduce costs and improve performance compared to conventional tillage. Dangolani and Narob (2013) also reported the similar results. Atwell et al. (2001) reported that no tillage had a $104 (Rs. 6672) ha⁻¹ and $180 (Rs.11548) ha⁻¹ higher profit than a strip tillage and conventional tillage system, respectively, in the first three years of a study. Smart et al. (2001) found that conservation till had a $121 (Rs. 7763) ha⁻¹ lower input cost and equal or greater economic returns than a conventional moldboard plow tillage system.

Table 2: Economics of different planting methods

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Returns over variable cost (Rs. ha⁻¹)</th>
<th>B:C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>2012</td>
</tr>
<tr>
<td>Conventional Tillage</td>
<td>168236</td>
<td>63965</td>
</tr>
<tr>
<td>Bed Planting</td>
<td>170699</td>
<td>65928</td>
</tr>
<tr>
<td>Zero Tillage</td>
<td>180373</td>
<td>79619</td>
</tr>
</tbody>
</table>

Time requirement

In bed planting method, 425 minutes were required for seed bed preparation and planting operations in one hectare while, these times were 312.5 and 37.5 minutes for conventional and zero tillage methods, respectively (Fig. 2). Since there was no seed bed preparation operation in the zero tillage method, time saving in this method was 88% as compared to farmers’ practice i.e. conventional tillage. Afzalinia et al. (2011) also reported that zero tillage planting saved 73.9 % time as compare to conventional tillage.

Fuel consumption

The effect of tillage methods on fuel consumption during seed bed preparation and planting process is shown in Fig 3. Bed planting consumed the highest amount of fuel (56.5 L ha⁻¹) i.e. 52.75 L ha⁻¹ more than zero tillage planting as no operation was done for seed bed preparation in zero tillage planting. Results reveal that zero tillage planting of cotton reduced fuel consumption by 93.4 % and 91.7 % as compared to bed planting and conventional planting respectively.

Rusu (2005) reported that minimum tillage reduced fuel consumption by 12.4 to 25.3 liter per hectare and power requirement by 23.6 to 42.8 % compared to conventional tillage. Afzalinia et al. (2011) also reported that fuel consumption saving was 77.3 % when using zero tillage method.

Table 3: Cost comparisons in seedbed preparation and planting (Rs. ha⁻¹) among different treatments

<table>
<thead>
<tr>
<th>Name of operation</th>
<th>Conventional sowing (Rs. ha⁻¹)</th>
<th>Bed Planting (Rs. ha⁻¹)</th>
<th>Zero Tillage (Rs. ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2011</td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>Harrowing</td>
<td>3000</td>
<td>3375</td>
<td>3750</td>
</tr>
<tr>
<td>Cultivator</td>
<td>2000</td>
<td>2500</td>
<td>2500</td>
</tr>
<tr>
<td>Planking</td>
<td>500</td>
<td>750</td>
<td>750</td>
</tr>
<tr>
<td>Sowing</td>
<td>1000</td>
<td>1000</td>
<td>1250</td>
</tr>
<tr>
<td>Total</td>
<td>6500</td>
<td>7625</td>
<td>8250</td>
</tr>
</tbody>
</table>

Cost comparison

Net monitory saving in seed bed preparation and planting under zero tillage over conventional tillage and bed planting in cotton is Rs 6375 and Rs 7625 respectively (Table 3). Jalota et al. (2008) also reported that net monitory saving under optimum tillage over conventional tillage was 31.0 US$ in cotton.
REFERENCES

CONCLUSIONS
The studies suggested that cotton sowing under no-till systems not only help to avoid injury to cotton plant due to higher temperature and crust formation, but also avoided residue burning and environmental pollution.

Sowing of the crop was also advanced by a week in zero tillage technique which in turn helps in timely maturity of the crops. No–till technique planting of cotton also resulted in increase in cotton yield, higher returns over variable cost, more B: C ratio and less fuel consumption.

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Citation: