Cotton Yield and Yield Components as Influenced by Chiseling and Irrigation Intervals in Sandy Loam Soil

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Abstract: Cotton (Gossypium hirsutum) plant has unique type qualities in various ways regarding its growth and development, vegetative and reproductive as well as yield components and field management. Establishment of indeterminate growth parameters and reproductive aspects is of crucial importance during field conditions. Although it is perennial in its nature, it is much responsive to climate, environment, field, soil and field preparatory practices adopted at field level for maximum potential yield. Two year field study was designed to carry out at the research area of CCRI, Multan to investigate the effect of soil preparatory technique i.e. chiseling and crop irrigation intervals in cotton field for soil moisture holding capacity, yield of seed cotton and its components. Cotton cultivar CIM-496 was manually dibbled on silt loam soil in the second week of May with bed and furrow planting method during both cropping years. Split plot design was applied comprising inter culturing chiseling and interculturing no chiseling were in main plots and irrigation intervals (8 and 12 days) treatments were kept in sub plots. Results indicated that inter culturing + chiseling produced the highest significant seed cotton production (18%) more bolls plant\(^{-1}\) (14.7%) and water intake (17.7%) than no chiseling with inter culturing. However, irrigation interval after eight days produced the maximum yield of seed cotton (14.7%), more 14.0% bolls plant\(^{-1}\) and water retention (36.2%) than 12 days irrigation interval.

Key words: Bed and furrow planting technique • Chiseling • Cotton • Inter- culturing • Irrigation intervals • Seed cotton yield

INTRODUCTION

Water and its application intervals play a vital role for healthy cotton plant growth and development in many ways. Water itself is a source of plant nutrients, namely, hydrogen and oxygen [1]. All plant nutrients derived from the breakdown of soil minerals and organic matter present in the soil are obtained from applied fertilizers and manures which are first dissolved in soil water. These nutrients are absorbed by plant roots and transported to different parts of the plant in solution.

Thus water acts as a carrier of crop nutrients into complex organic substances like starch, sugars, proteins, fats and soils, vitamins etc takes place in the presence of water. Moreover water keeps plants turgid and thus moderates the effects of temperature differences drought, frost, etc [2]. Unlike most other crops, root growth in cotton is more sensitive to oxygen in the soil rather than to the CO\(_2\) level. Standing water in cotton fields due to rain or over irrigation lowers the oxygen content in the soil thus suffocating the root system and causing the plants to wilt, if the effect is prolonged plants die [3].

Without sufficient amount of water given either through rainfall or where this is not sufficient through supplemental irrigation, the above biological processes will not take place to desired extent. This will result in poor plant growth and reduced crop yields. Meeting the water requirement of cotton by irrigation is a major management consideration and production cost in the arid and semi-arid regions of the country. Increasing demand for water, decline water table in the tracts with sweet aquifer and increasing energy costs for pumping emphasize the need for conserving water in irrigated agriculture. Irrigation for maximum cultivars of cotton could potentially decrease water requirements. However
to produce acceptable yields in a shorter time the plants
must fruit early and rapidly. Delays and interruptions in
boll productions would either reduce yields or lengthen
the item required to produce the crop [4, 5].

The objective of irrigation is to keep the soil supplied
with readily available moisture for plant growth and
development. In areas where the total rainfall normally
exceeds the amount necessary for optimum crop
production the purpose of irrigation can be limited to
correcting differences in soil moisture caused by poor
distribution of rainfall, excessively high temperatures and
poor moisture intake and storage condition within the soil.

The water requirement of cotton depends on the
variety of cotton, type of soil, the length of the growing
season, temperature, hours of sunshine, the amount and
distribution soil [2]. During the early growth stages
(seedling) less amount of water is consumed by the
cotton plants and by transportation and evaporation a lot
of amount is lost. As plants grown the need of water
increases, as soon as it reached to its peak and cotton
crop plant have many bolls, while decline in water
consumption started. The irrigation schedule should be
such that it supplied these needs. Proper timing is
that in row chiseling increased plant height, rooting depth
and cotton lint yields as compared to non-chisel treatment.

El-Aewad [7] and Ahmad et al. [8] reported
significant decrease in cotton yields after two, three and
four week intervals of irrigation. While yield differences
produced by two and three week irrigation intervals were
not significant statistically. Mirjat et al. [9], Onder et al.
[5] and Schomberg et al. [10] compared different tillage
types and frequencies for cotton and noted 15-20% greater lint yields with annual in row chisel than with
conventional disk tillage.

Abdelatif et al. [11] and Rodriguez et al. [2] reported
that no clear differences in yield and quality between the
two shorter watering intervals, 7 and (4 days However,
larger irrigation interval of 21 days decreased the yield
by 16 % and 22% for Barac (67) B and Barakat cultivars,
respectively. Chisel plough is an ideal implement to
increases soil fertility as more enough sunlight, moisture
and air circulation is provided by the deep tillage. It is also
helps in maintaining the soil moisture content for longer
period in the soil. Cotton plant vegetative growth and
development is regulated by water. Seed cotton yield is
adversely affected by the both more irrigation than
required and deficient water stress [4, 5, 12]. In crop
production, water is a significant and vital input.

Therefore, the present studies were carried out
consecutively during the crop seasons of 2012-2013 to
investigate the effect of irrigation intervals and chiseling
effect on seed cotton yield under Southern Punjab
climatic conditions.

MATERIALS AND METHODS

Chiseling and irrigation interval effects on cotton
plant yield and yield components were studied, at Central
Cotton Research Institute Multan during 2012 and 2013
on silt loam soil. The treatments consisted of (a) [3 inter-
culturing plus chiseling, 3 inter-culturing plus no
chiseling] (b) [8-day and 12-day irrigation intervals]. Field
trail was carried out in a split plot design with four
replicates having chiseling in main plot and irrigation
interval in the sub plot. CIM-499 cultivar was sown in the
fourth week of May. The bed furrow were made on well
prepared soil with 75 cm apart rows from each other by
tractor driven implement followed by bed shaping and
spray of Pendimethalin 33% @ 2.5 lit. The seeds were
planted manually by dibbling method at 22.5cm plant to
plant distance within the rows. Thinning was done 20
days after sowing by making single plant per hill.

Irrigation water was applied in measured quantity by
installing a Cut Throat Flume (CTF) in water channel and
irrigation water discharge was measured by reading the
height of water passing through Cut Throat Flume from
the inlet side. The height column then was read from a
given chart of specified Cut Throat Flume measurement
into cusecs. Then it was converted into the required unit
(mm). Soil samples for soil moisture content up to a depth
of 90 cm were taken from field area before all the
irrigations. Soil samples were oven dried at 120 °C for 24
hours. The difference of the wet and dry soil measured in
percentage. The cotton crop was protected from the
attack of insect pests with insecticidal sprays as and
when required. Standard crop production practices were
followed during the season. The data for the seed cotton
yield and its components were recorded at crop maturity.

The significant differences and analysis of variance
among the treatments was analyzed by the LSD at 5 %
level [13].

RESULTS AND DISCUSSION

The results on seed cotton yield and its components,
irrigation water addition and soil moisture content are
shown in Tables 1-6. Chiseling and irrigation interval
treatments indicated significant results for seed cotton
yield.
Table 1: Chiseling and irrigation interval effect on irrigation water ha\(^{-1}\) (mm) applied in soil

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Irrigation interval</th>
<th>Total water applied</th>
<th>Water applied before chiseling</th>
<th>Water applied after chiseling</th>
<th>Average soil moisture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-culturing + Chiseling</td>
<td>8-day</td>
<td>833.3</td>
<td>298.1</td>
<td>535.2</td>
<td>15.0</td>
</tr>
<tr>
<td>Chiseling</td>
<td>12-day</td>
<td>693.0</td>
<td>298.1</td>
<td>394.9</td>
<td>13.9</td>
</tr>
<tr>
<td>Inter-culturing + No Chiseling</td>
<td>8-day</td>
<td>752.9</td>
<td>298.1</td>
<td>454.8</td>
<td>12.4</td>
</tr>
<tr>
<td>+ No Chiseling</td>
<td>12-day</td>
<td>630.1</td>
<td>298.1</td>
<td>332.0</td>
<td>11.2</td>
</tr>
</tbody>
</table>

Table 2: Chiseling, inter-culturing and irrigation interval effect plant height, seed cotton yield (kg ha\(^{-1}\)), bolls plant\(^{-1}\) and cotton boll weight (g)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Irrigation intervals</th>
<th>Plant height (cm)</th>
<th>Seed cotton yield</th>
<th>Bolls plant(^{-1})</th>
<th>Cotton boll weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-culturing + Chiseling</td>
<td>8-day</td>
<td>116.0</td>
<td>1960</td>
<td>25</td>
<td>2.76</td>
</tr>
<tr>
<td>+ Chiseling</td>
<td>12-day</td>
<td>110.2</td>
<td>1758</td>
<td>22</td>
<td>2.60</td>
</tr>
<tr>
<td>Inter-culturing + No Chiseling</td>
<td>8-day</td>
<td>106.9</td>
<td>1705</td>
<td>22</td>
<td>2.56</td>
</tr>
<tr>
<td>+ No Chiseling</td>
<td>12-day</td>
<td>104.5</td>
<td>1451</td>
<td>19</td>
<td>2.46</td>
</tr>
</tbody>
</table>

Table 3: Effect of irrigation interval on plant height, seed cotton yield (kg ha\(^{-1}\)), bolls plant\(^{-1}\) and boll weight

<table>
<thead>
<tr>
<th>Irrigation Interval</th>
<th>Plant height (cm)</th>
<th>Seed Cotton yield</th>
<th>Bolls plant(^{-1})</th>
<th>Cotton boll weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-Day</td>
<td>111.5</td>
<td>1833</td>
<td>24</td>
<td>2.66</td>
</tr>
<tr>
<td>12-Day</td>
<td>107.4</td>
<td>1605</td>
<td>21</td>
<td>2.53</td>
</tr>
</tbody>
</table>

Table 4: Chiseling effect on water applied and on soil moisture content

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Total water applied ha(^{-1}) (mm)</th>
<th>Water applied before chiseling ha(^{-1}) (mm)</th>
<th>Water applied after chiseling ha(^{-1}) (mm)</th>
<th>Average soil moisture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiseling</td>
<td>763.2</td>
<td>298.1</td>
<td>465.1</td>
<td>14.5</td>
</tr>
<tr>
<td>No Chiseling</td>
<td>691.5</td>
<td>298.1</td>
<td>393.4</td>
<td>11.8</td>
</tr>
<tr>
<td>8-Day Irrigation Interval</td>
<td>793.1</td>
<td>298.1</td>
<td>495.0</td>
<td>13.7</td>
</tr>
<tr>
<td>12-Day Irrigation Interval</td>
<td>661.6</td>
<td>298.1</td>
<td>363.5</td>
<td>12.6</td>
</tr>
</tbody>
</table>

Table 5: Economic analysis hec\(^{-1}\) (chiseling v/s zero chiseling)

<table>
<thead>
<tr>
<th>Increased yield over zero chiseling (kg ha(^{-1}))</th>
<th>More Water applied (Hr ha(^{-1}))</th>
<th>Total cost ha(^{-1})</th>
<th>Increased income ha(^{-1})</th>
<th>Net income ha(^{-1})</th>
<th>Cost benefit ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>281</td>
<td>2.99</td>
<td>2730</td>
<td>8170</td>
<td>5440</td>
<td>1:1.99</td>
</tr>
</tbody>
</table>

Table 6: Basis of calculation

<table>
<thead>
<tr>
<th>a</th>
<th>Seed cotton</th>
<th>1163 rupees /40Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>Cotton Picking Dues</td>
<td>2.25 rupees kg(^{-1})</td>
</tr>
<tr>
<td>c</td>
<td>Water charges (Tube well)</td>
<td>200 rupees hrs</td>
</tr>
<tr>
<td>d</td>
<td>Cost of chiseling (3times)</td>
<td>500 rupees / ha / chiseling</td>
</tr>
<tr>
<td>e</td>
<td>Irrigation applications</td>
<td>150 rupees, Man/day (3 irrigations)</td>
</tr>
</tbody>
</table>

yield and cotton boll weight (g). These results are supported by Heilman [6] and Schomberg et al. [10], who reported an increase in cotton lint yields with in row chiseling application. Inter culturing plus chiseling with 8-day irrigation interval with irrigation water of 833 mm/ha produced the highest seed cotton yield of 1960 kg ha\(^{-1}\).

These results are in accordance with that of Abdelatif et al. [11], Ahmad et al. [8] and Mirjat et al. [9] reported that larger irrigation intervals result decrease in seed cotton yield. Averaged across the irrigation interval, inter-culturing plus chiseling gave 281 kg ha\(^{-1}\) higher seed cotton yield than inter culturing plus no chiseling.
Averaged across the chiseling, 8-day irrigation gave 228 kg ha⁻¹ seed cotton yield than 12-day irrigation interval. Seed cotton yield was increased by increasing cotton bolls plant⁻¹ and average boll weight (g). (Tables 1-4) there were 10.4% more irrigation water addition in furrow followed by three times chiseling than no chiseling. Similarly the 8-day irrigation interval had 20% more irrigation water addition in soil than 12 day irrigation interval [1, 10, 14].

These results are supported by those of Bhatti and Soomro [12], Steel and Torrie [13] and Yang et al. [15] that also reported that cotton crop needs more irrigation water for better crop yields. On the basis of average, the soil moisture in chiseling treatment per 30 cm depth remained high (14.5%) through the crop season as compared no chiseling treatment (11.8%) (Tables 5 and 6). The analysis of cost benefit ratio of irrigation interval 1:2.57 and chiseling was 1:1.99 (Tables 5 and 6).

CONCLUSIONS

Inter-culturing plus chiseling with 8-day irrigation interval is useful in maintaining soil moisture content in the soil and obtaining better seed cotton yields. Inter culturing plus chiseling treatment produced increased (17.81% seed cotton yield) against zero chiseling treatment. The 8-day irrigation interval gave 14.21% more seed cotton production than irrigation interval of 12-days. Soil moisture content in chiseling treatment remained high 2.70% as compared no chiseling treatment.

REFERENCES