COMPARISON OF BT AND NON-BT COTTON (GOSSYPIUM HIRSUTUM L.) CULTIVARS FOR EARLINESS INDICATORS AT DIFFERENT SOWING DATES AND NITROGEN LEVELS

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ABSTRACT

Bt and non-Bt cotton (Gossypium hirsutum L.) cultivars were compared for different earliness indicators in the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during the year 2010. In this study two cotton cultivars MNH-786 (non-Bt) and IR-1524 (Bt), three nitrogen levels (115, 145 and 175 kg/ha) and two sowing dates (mid March and mid May) were included. Layout system was RCBD with split split plot arrangement in a plot measuring 6.0 x 4.5 m. Nitrogen levels and sowing dates showed significant effect on earliness related parameters. Nitrogen level of 115 kg per hectare showed more earliness index (59.2) than 145 kg (51.1) and 175 kg N (48.5). Nitrogen level of 115 kg also took less number of days for floral bud initiation (30.5), flowering (50.1), first boll splition (93.1) and also less number of days to node above white flower (95.9). With regards to sowing date, May sowing produced more earliness index (57.5) and less number of days for floral bud initiation (30.5), flowering (49.6), first boll splition (91.1) and less number of days to node above white flower (99.4) than mid March sowing. Both cultivars showed non-significant differences in earliness related parameters with relatively more earliness in non-Bt cultivar than Bt cultivar. The study concludes that 115 kg N per hectare and mid May sowing produced early maturity in cotton.

KEYWORDS: Gossypium hirsutum; Bt varieties; sowing; timing; nitrogen fertilizer; agronomic characters; Pakistan.

INTRODUCTION

After initiation of flowering in cotton (Gossypium hirsutum L.), vegetative growth continues due to its indeterminate and perennial habit but cotton is grown as an annual crop. Cotton plant has ability to overcome the fruit abscission and fruit damaging due to its growth and fruit pattern without yield reduction. However, it may increase the risk of insect attack and may also

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delay the crop harvest. It indicates that yield recovery is only possible when the plant is young (23).

Cotton growth and maturity are altered by cultivars, seasonal management and environmental conditions (11). Early maturity of cotton cultivars allows timely removal from the field, helps the crop to fit in double cropping system and can overcome the problem of water shortage (8, 24).

Nitrogen is the integral part of chlorophyll, protein, nucleic acids, biomolecules, chromosomes and phytochromes (21, 22). Nutrients affect the photosynthesis, leaf area of the crop (6) and supply of carbohydrates to sink of the crop. To prevent the bolls and squares from abscission, nitrogen is important controlling factor (6, 27). Khan (20) observed that a mineral nutrient such as nitrogen is essential to attain higher yield of agricultural crops and exploit the crop potential. Ahmad (1) reports that nitrogen is important nutrient for cotton yield in irrigated areas. In some other studies (3, 33) earliness reduced with increasing levels of nitrogen. High nitrogen availability caused excessive vegetative growth thus delaying crop maturity and reducing yield by shifting the balance between vegetative and reproductive growth (14).

In early sown cotton, there is a serious reduction in yield because reproductive stages of the crop come in hottest months of the year. Crop sown in too early season has shown lower crop yield and lower crop stand, while crop sown in too late season of year resulted in excessive vegetative growth and reduction in yield. So for better crop management proper sowing time is the key factor in any region (34). The primary factor affecting crop development is temperature and initiation of first square and its development was temperature and cultivar dependant (13). Plant development rate is much increased at high temperature (15, 28, 29) shortening plant life period.

Cotton earliness, a quantitative trait, is mainly affected by environment and crop genotype (18). Therefore, in any cropping system cultivar selection is the key factor (25). Keeping in view the importance of earliness in cotton crop response of cotton crop to nitrogenous fertilizers and sowing dates, the present study was conducted to identify the cultivar that can fit well in our cotton-wheat cropping system.

**MATERIALS AND METHODS**

This study was conducted in the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during kharif 2010. The soil of experimental site was sandy clay loam with alkaline pH (7.4), 0.65 percent organic matter,
0.039 percent N, 7.85 ppm available phosphorus and 220 ppm available potassium. Layout-system was RCBD with split split arrangement replicated thrice. Plot size was 6x 4.5 m. Experimental treatments comprised three nitrogen levels viz. 115 kg (N1 = recommended for non-Bt), 145 kg (N2 = medium dose) and 175 kg per hectare (N3 = recommended for Bt cotton), two sowing dates viz. mid March (S1 = recommended for Bt) and mid May (S2 = recommended for non-Bt) and two cotton cultivars viz. MNH-786 (V1 = non-Bt) and IR-1524 (V2 = Bt).

Each plot contained six rows of cotton crop. Seedbed was prepared by cultivating the field one time with rotavator and two times with tractor-mounted cultivator each followed by planking. The crop was sown on March 14 and May 15, 2010 with help of dibbler by maintaining 0.75 m row to row and 0.30 m plant to plant spacings. Full dose of phosphorus was applied at sowing while nitrogen was applied in three equal splits viz. at sowing, 35 days after sowing (squaring stage) and 65 days after sowing (flowering stage). Crop was given nine irrigations throughout its growth period. Weeds were controlled by two hoeings viz. 35 and 65 days after planting while insects were controlled with insecticides. All other agronomic practices were kept normal and uniform for all treatments. When seedlings were established, ten true representative plants were selected randomly from each plot. These plants were monitored and tagged to record the following data:

**Days from planting to first floral bud initiation**

Data on number of days from planting to first floral bud initiation [the days when subtending leaf unfolded (7)] were recorded from ten selected plants of each plot, when bud beam became visible with the naked eye having a pin head size of about 3 mm. The data were recorded from the selected plants when 50 percent selected plants showed squaring.

**Days from planting to appearance of first flower**

Number of days from planting to appearance of first flower were noted when 50 percent of selected plants showed flowering with creamy white or yellowish colour of flower.

**Days to node above white flower**

Data on this trait were recorded from selected plants after one week of flowering and continued till appearance of five nodes above white flowers. Data were noted weekly in days and average of selected plants was calculated.
Days from planting to first boll splitition

This parameter was noted when lint was seen within the boll with squares around (cracked boll) and took average of selected plants.

Earliness index (%)

Earliness index (%) was calculated with following formula (35).

\[
\text{Earliness index (\%)} = \frac{\text{Weight of seed cotton from first pick}}{\text{Total seed cotton weight from all picks}} \times 100
\]

Growing degree days (DD 60°F)

Minimum or base temperature for cotton growth is 60°F. Daily heat units or degree days (DD60s) as given in Table 1 were calculated as defined by Bendnarz and Burmester (5).

\[
\text{DD60 °F} = \frac{\text{Day time high °F + Night time low °F-60}}{2}
\]

Table 1. Growing degree days (DD 60°F) during cotton growing period.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>March</th>
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<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
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<td>16.25</td>
<td>10.0</td>
<td>11.75</td>
<td>2.5</td>
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</tbody>
</table>

Table 1 contd....
Data collected on different parameters were analyzed statistically by using MSTAT-C (4) for analysis of variance. Means were separated using Fisher’s protected least significant difference (LSD) test at 5 percent probability level (36).

RESULTS AND DISCUSSION

Days to first floral bud initiation

The data (Table 2) indicated that this trait was significantly influenced by sowing dates and nitrogen levels while cultivars and all first order and second order interactions showed non-significant effects. Relatively less days to squaring were noted in non-Bt cultivar MNH-786 (32.9) than Bt cultivar IR-1524 (33.6) (Table 2). Mid March sowing took more days for floral bud initiation (36.0) than mid May sowing (30.5). These higher days to squaring in mid March sowing were due to low degree days accumulation in the months of March and April than mid May sowing. The primary factor affecting crop development is temperature as described by Hodges et al. (13). They also observed that initiation of first square and its development was temperature and cultivar dependant. They alongwith Reddy et al. (28, 29) further argued that plant development rate is much increased at high temperature shortening plant life period. Floral bud initiation and growth is affected by photoperiod (2). Initiation of squaring was used by Godoy (10) for the selection of early genotypes as against findings of Saleem et al. (32) which revealed that appearance of first floral bud cannot be used as an indicator to estimate earliness of cotton cultivars. Higher nitrogen level i.e 175 kg took more number of days for floral bud initiation (35.0) and was statistically
Table 2. Effect of sowing date and nitrogen rates on earliness related traits of cotton cultivars.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>DFS</th>
<th>DFF</th>
<th>NAWF</th>
<th>DFOB</th>
<th>EI</th>
</tr>
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<td><strong>Sowing dates</strong></td>
<td></td>
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<tr>
<td>Mid March (S1)</td>
<td>36.0a</td>
<td>63.7a</td>
<td>108.3</td>
<td>110.4a</td>
<td>48.3</td>
</tr>
<tr>
<td>Mid May (S2)</td>
<td>30.5b</td>
<td>49.6b</td>
<td>99.4</td>
<td>91.1b</td>
<td>57.5</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td>3.49</td>
<td>4.59</td>
<td>NS</td>
<td>14.24</td>
<td>NS</td>
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<td><strong>Varieties</strong></td>
<td></td>
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</tr>
<tr>
<td>MNH-786 (non-Bt)</td>
<td>32.9</td>
<td>55.5</td>
<td>102.7</td>
<td>99.6</td>
<td>55.0</td>
</tr>
<tr>
<td>IR-1524 (Bt)</td>
<td>33.6</td>
<td>57.8</td>
<td>105.0</td>
<td>101.9</td>
<td>50.9</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td><strong>N rates (kg/ha)</strong></td>
<td></td>
<td></td>
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<tr>
<td>115</td>
<td>30.5b</td>
<td>50.1b</td>
<td>95.9b</td>
<td>93.1b</td>
<td>59.2a</td>
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<tr>
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<td>34.2a</td>
<td>57.8a</td>
<td>106.8a</td>
<td>103.1a</td>
<td>51.1b</td>
</tr>
<tr>
<td>175</td>
<td>35.0a</td>
<td>62.1a</td>
<td>108.9a</td>
<td>106.0a</td>
<td>48.5b</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td>2.92</td>
<td>6.02</td>
<td>9.60</td>
<td>6.57</td>
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</table>

Means not sharing a common letter within a column differ significantly at 5% probability level. NS= Non-significant, DFS= Days to first square, DFF= Days to first flower, NAWF= Node above white flower, DFOB= Days to first open boll, El=Earliness index (%),

similar to 145 kg N (34.2) (Table 2). Nitrogen level of 115 kg took minimum number of days to floral bud initiation (30.5). The regression analysis indicated that relationship between number of days to first floral bud initiation and node above white flower was strong and positive ($R^2 = 0.79$) (Fig. 1a). Similarly, linear regression coefficient (90 %) for number of days to first floral bud initiation vs earliness index was even more higher indicating strong but negative relationship (Fig 1b).
Days to first flower

The results (Table 2) further indicated that number of days to first flower were also affected by sowing dates and nitrogen levels significantly and by cultivars non-significantly. Relatively less days to first flower were taken by non-Bt cultivar MNH-786 (55.5) than Bt cultivar IR-1524 (57.8). Contrarily, Rehana et al. (30) observed significant difference in cultivars for number of days taken to open first flower. A cultivar taking less number of days to flowering and first boll splition may be classified as earlier (9). Appearance of first flower can be used as an indicator of early maturing cultivar (19). With regard to sowing dates, mid March sowing took more days to appearance of first flower (63.7) than mid May sowing (49.6). These higher days to flowering in mid March sowing were due to low degree days accumulation in the months of March and April than mid May sowing (Table 1). The primary factor affecting crop development is temperature (13). Appearance of first flower was photoperiod dependent (17) and plant growth rates are highly correlated with temperature (38). The number of days from squaring to flowering, as well as the days from flowering to boll opening were influenced by temperature (12). Among N levels, 175 kg N took more number of days to appearance of first flower (62.1) and was statistically at par with 145 kg N (57.8). Relationship between number of days to appearance of first flower and node above white flower was strong and positive ($R^2 = 0.75$) (Fig 2a). Similarly its relation with earliness index was also strong and negative ($R^2 = 0.80$) (Fig. 2b).
Days to node above white flower

This trait was significantly affected by nitrogen levels (Table 2) while sowing dates and cultivars had non-significant effect. Relatively less days to node above white flower were noted in mid May sowing (99.4) than in mid March sowing (108.4). Similar non-Bt cultivar MNH-786 showed relatively less days to node above white flower (102.7) than Bt cultivar IR-1524 (105.0) (Table 2). Waddle (37) was the first to use node above white flower as an indicator of maturity in cotton. He reported that varieties that attain five NAWF were the early maturing varieties. Nitrogen level of 175 kg took more days to node above white flower (108.9) and was statistically at par with 145 kg N (106.8). Nitrogen application after 175 kg did not respond indicating that high doses of nitrogen did not increase the flowering period, days to node above white flower and also seed cotton yield (16). Regression coefficient indicated that
Comparison of Bt and non-Bt cotton cultivars for earliness indicators

Dependence of earliness index on days to node above white flower was 77 percent which was strong and negative (Fig 3).

Days to first boll split

Cultivars showed non-significant difference with respect to number of days from planting to first boll split (Table 2). Panhwar et al. (26) observed that early maturing varieties opened their bolls earlier than late maturing varieties. Days to open first boll was used for selecting the early genotypes by Godoy (10). In contrast, Rehana et al. (30) observed significant difference in cultivars for number of days taken to open first boll. Mid March sowing took more days to first boll split (110.4) than mid May sowing (91.1). These higher days in mid March sowing were due to low degree days accumulation in the months of March and April than mid May sowing. Nitrogen rate of 175 kg resulted in more number of days to first boll split (106.0) and was
statistically similar to 145 kg N (103.1). Relationship between number of days from planting to first boll spliton and node above white flower was strong and positive ($R^2 = 0.69$) (Fig. 4a). $R^2$ for number of days from planting to first boll spliton vs earliness index was even higher (87 %) but negative (Fig. 4b).

**Earliness index (%)**

Earliness index was affected by nitrogen levels while sowing dates, cultivars and all interactions showed non-significant effect (Table 2). Nitrogen level of 115 kg showed significantly higher earliness index (59.2%) than 145 kg (51.1%) and 175 kg N (48.5%). It indicated that increased N level increased vegetative growth and delayed earliness. Similar results have also been reported by earlier scientists (3, 33). Percentage of first picking in the multiple harvests is a poor estimate of earliness (31).

**CONCLUSION**

It is concluded that mid May sowing and 115 kg nitrogen per hectare resulted in more earliness. Cultivars showed non-significant effect on earliness related parameters with relatively more earliness in non-Bt cultivar.

**REFERENCES**


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