Effect of High Density Planting and Weed Management Practices on Weed Drymatter, Weed Indices and Yield of Bt Cotton

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Abstract

An experiment was conducted during kharif, 2015 at College Farm, College of Agriculture, Rajendranagar, Hyderabad to find out the growth and yield of Bt cotton as influenced by high density planting system and different weed control management practices. The treatments comprised of four planting densities and four weed management practices. Among the plant densities, the plant density of 1,11,111 plants ha\(^{-1}\) normal planting (60 cm x 15 cm) produced significantly more kapas yield (3134 kg ha\(^{-1}\)), reduced weed drymatter with higher weed control efficiency (61.88\%) as against high plant density of 1, 11,111 plants ha\(^{-1}\) paired row planting and 1, 48,148 plants ha\(^{-1}\). Among the weed management practices, pre emergence application of pendimethalin 1.0 kg ha\(^{-1}\) fbPoE tank mix application of pyrithiobac sodium 62.5 g ha\(^{-1}\) + quizalofop-p-ethyl 50 g ha\(^{-1}\) at 20, 40 and 60 DAS recorded more kapas yield (3119 kg ha\(^{-1}\)), with higher weed control efficiency (73.24\%) with reduced weed drymatter.

Key words: Bt cotton, HDPS, Weed control efficiency, Weed index, Yield.

Introduction

Cotton is an important cash crop of India owing to its pivotal role in agriculture, industrial development and employment generation. Almost 95 per cent Indian cotton farmers cultivated the genetically modified Bt cotton. But the farmers are facing a problem of stagnating yields from Bt cotton hybrids due to increased labour demand, increased labour costs, increased seed costs and increased costs for cotton picking and nutrient requirements. All these facts point to the dire need for sustainable practices. So, to sustain the productivity, high density planting systems, with narrow and ultra-narrow spacing for rainfed soils and developing suitable management options for improving yields and also to improve input use efficiency is the need of the hour. The concept on high density cotton planting, more popularly called Ultra Narrow Row (UNR) cotton was initiated by Briggs et. al.\(^2\).
In general, lower plant densities produce high values of growth and yield attributes per plant, but yield per unit area was higher with higher plant densities. However, moderate increase in plant densities may not increase the yield but decrease due to competition between plants for nutrients, water, space and light. It is sensitive to weed competition during initial growth stages due to slow growth and wider spacing. Weeds compete for nutrients, water, light and thus reduce cotton yield substantially. Optimum cotton yield and quality for high-density planting requires good weed control throughout the growing season. The weeds can severely decrease cotton productivity. In view of the above, present research work is carried out with the objective to find out the effect of High Density Planting System (HDPS) and weed management practices on Weed Drymatter, Weed Indices and Yield of Bt cotton.

MATERIALS AND METHODS
An experiment was conducted during kharif, 2015 at College Farm, College of Agriculture, Rajendranagar, Hyderabad. The farm is geographically situated an altitude of 542.6 m above mean sea level on 18’ 50” N latitude and 77.53” E longitude. The soil of the experimental field was sandy loam in texture, pH(8.7) and EC(0.225 ds m⁻¹), low in available N (250 kg ha⁻¹), medium in available phosphorus (21.68 kg P₂O₅ ha⁻¹) and high in available potassium (685.6 kg K₂O ha⁻¹). The treatments comprised of four planting densities 55,555 plants ha⁻¹ (D₁), 1,11,111 plants ha⁻¹ (normal planting (D₂), 1,11,111 plants ha⁻¹ (D₃) paired row planting, 1,48,148 plants ha⁻¹ (D₄) and weed management practices (pendimethalin 1.0 kg ha⁻¹ as pre emergence fb pyrithiobac sodium 62.5 g ha⁻¹+quizalofop-p-ethyl 50 g ha⁻¹ at 20, 40 and 60, DAS (W₁), pyrithiobac sodium 62.5 g ha⁻¹+quizalofop-p-ethyl 50 g ha⁻¹ at 15 DAS as early post emergence fb glyphosate ammonium salt 2.13 kg ha⁻¹ at 45 DAS (W₂), pendimethalin 1.0 kg ha⁻¹ as pre emergence fb HW at 20 and 45 DAS (W₃) and unweeded control (W₄). The experiment was laid out in randomized block design (with factorial concept) and replicated thrice. The weed control efficiency and weed index was calculated by the following formula:

\[
WCE(\%) = \frac{DM_C - DM_T}{DM_C} \times 100
\]

Where,

\[DM_C\] : Dry weight of weeds in unweeded check
\[DM_T\] : Dry weight of weeds in treated plot

\[
\text{Weed Index (\%) = } \frac{X - Y}{X} \times 100
\]

Where,

\[X\] : Yield from minimum weed competition plot
\[Y\] : Yield from treatment plot

RESULTS AND DISCUSSION
Weed indices
Total weeds Dry matter
Data obtained on total weed drymatter during crop growing season was analysed statistically and was presented in the Table 1. Plant densities did not influence drymatter of total weeds up to 90 DAS, but there after significant effect was observed on weed drymatter. At 120 DAS, significantly less dry matter of total
Weeds was noticed with plant density of 1,11,111 plants ha⁻¹ (D₃) normal planting and it was on par with 1,11,111 plants ha⁻¹ (D₁) paired row planting. In turn this was on par with 1,48,148 plants ha⁻¹ (D₂) and 55,555 plants ha⁻¹ (D₄). At harvest stage the significant difference in weed drymatter production was not observed due to different planting methods. However, the highest weed dry matter was recorded in 55,555 plants ha⁻¹ (D₄) and the lowest drymatter production was observed in 1,11,111 plants ha⁻¹ (D₁) paired row planting. This might be due to sufficient space provided to crop which in turn resulted in better nourishment for growth of crop, thereby creating smothering effect on weeds population and its growth ¹⁰. Weed management practices showed significant difference in weed drymatter of total weeds at all the stages. At all the stages the highest weed drymatter production was recorded under unweeded control (W₄). At 30 DAS, the lowest drymatter of total weeds was observed with pendimethalin 1.0 kg ha⁻¹ (PE) fb HW at 20 and 45 DAS (W₃) and was on par with early PoE tank mix application of pyrithiobac sodium 62.5 g ha⁻¹ +quizalofop-p-ethyl 50 g ha⁻¹ at 15 DAS fb directed spray of glyphosate ammonium salt 2.13 kg ha⁻¹ at 45 DAS (W₂) and pendimethalin 1.0 kg ha⁻¹ (PE) fb HW at 20 and 45 DAS (W₁) respectively. These were significantly superior over unweeded control (W₄) treatment, which recorded higher weed drymatter at all the stages. This reduced dry matter in W₁ treatment might be due to imposition of treatment up to 60 DAS using selective broad leaf and grass control herbicides.

Interaction effect of plant densities and weed management practices did not show any significant influence on drymatter of total weeds in Bt cotton at all the stages of crop growth.

**Weed control efficiency**

Data pertaining to weed control efficiency is presented in Table 2. At 30 and 90 DAS, the treatment which was scheduled with 55,555 plants ha⁻¹ (D₁) recorded maximum weed control efficiency (WCE) of 49.84 and 61.96 %, respectively. But, at 60 and 120 DAS the maximum WCE of 61.88 and 55.33 % was registered due to the treatment up to 60 DAS using selective broad leaf and grass control herbicides.

Interaction effect of plant densities and weed management practices did not show any significant influence on drymatter of total weeds in Bt cotton at all the stages of crop growth.
and 45 DAS (W3). But later stages the highest WCE of 73.34, 84.66, 75.25 and 61.40 percent were registered with the application of pendimethalin 1.0 kg ha\(^{-1}\) fbPoE application of pyrithiobac sodium 62.5 g ha\(^{-1}\)+quizalofop-p-ethyl 50 g ha\(^{-1}\) at 20, 40, 60 DAS (W1) at 60, 90, 120 DAS and at harvest stage respectively. The lowest WCE was registered under weedy check (W4) treatment during all the stages of crop growth. The higher WCE was attributed due to effective weed control achieved under effective method of weed management in terms of reduced biomass of weeds and higher weed control efficiency\(^{10}\).

**Weed Index**

The data pertaining to weed index (WI) is presented in Table 2. Among the plant densities the lowest WI (0.00) was recorded due to the scheduling of 1, 11,111 plants ha\(^{-1}\) (D\(_{2}\)) normal planting and the highest WI of 30.29 percent was registered due to the scheduling of 55,555 plants ha\(^{-1}\) (D\(_{1}\)). The weed index was drastically reduced in herbicide applied treatment when compared to control treatment (W4). Among weed management practices the lowest WI (0.01) was noticed by the application of pre emergence application of pendimethalin 1.0 kg ha\(^{-1}\) fbPoE tank mix application of pyrithiobac sodium 62.5 g ha\(^{-1}\)+quizalofop-p-ethyl 50 g ha\(^{-1}\) at 20, 40, 60 DAS (W1) and the highest WI (70.35) was registered in weedy check (W\(_{i}\)). In unweeded control (W\(_{d}\)), higher weed index values indicates reduced yield due to weeds. The reduced weed index values might be due to higher dry matter accumulation of weeds, consequently, reduced the seed cotton yield\(^7\).

**Kapas yield (kg ha\(^{-1}\))**

Data pertaining to kapas yield under varied plant densities and weed management practices are furnished in Table 1. Among the plant densities the highest kapas yield of 3134 kg ha\(^{-1}\) was registered with the treatment of 11,111 plants ha\(^{-1}\) (D\(_{2}\)) normal planting and it was significantly superior over rest of the treatments. The lowest kapas yield of 2184 kg ha\(^{-1}\) was registered in the treatment where the plant population was low i.e., 55,555 plants ha\(^{-1}\) (D\(_{1}\)). Higher plant density at closer spacing recorded significantly higher seed cotton yield than lower plant density at wider spacing due to significantly more number of bolls m\(^{-2}\) and higher plant stand per ha\(^{1}\).

Application of herbicides at different stages in different formulation significantly increased the kapas yield as against un-weeded control plot (W4). Among weed management practices the lowest kapas yield of 925 kg ha\(^{-1}\) was recorded in control plot and the highest kapas yield of 3119 kg ha\(^{-1}\) was recorded due to the application of pre emergence application of pendimethalin 1.0 kg ha\(^{-1}\) fbPoE tank mix application of pyrithiobac sodium 62.5 g ha\(^{-1}\)+quizalofop-p-ethyl 50 g ha\(^{-1}\) at 20, 40, 60 DAS (W\(_{1}\)) . However, the remaining two treatments which were reciving herbicides (W2 and W3) also registered similar kapas yield to W\(_{1}\) treatment, this indicates that different herbicides did not influenced the kapas yield significantly. The yield reduction of 70.34% was observed from unweeded control (W\(_{d}\)) treatment. Cotton being a widely spaced and relatively slow growing crop during its initial stages suffers from severe weed competition and causing substantial reduction in seed cotton yields\(^{13}\).

The increased kapas yield due to occurrence of less competition between cotton plants and weeds leading to more number of bolls and resulted in higher seed cotton yield\(^7\). Further, timely and effective control of weeds through herbicides coupled with cultural methods which resulted in better availability of soil moisture and nutrients\(^{11}\).
Conclusively, the lowest dry matter of weeds was recorded at 120 DAS with plant population of 1,11,111 plants ha⁻¹ (D₂) normal planting and was on par with 1,11,111 plants ha⁻¹ (D₁) paired row planting. But at harvest lower dry matter of weeds was noticed with 1,11,111 plants ha⁻¹ (D₃) paired row planting and was on par with 1,11,111 plants ha⁻¹ (D₂) normal planting. However, plant densities did not showed any significant influence on weed dry matter at 30, 60 and 90 DAS. Significantly lower weed dry matter was recorded with pendimethalin 1.0 kg ha⁻¹ (PE) fb HW at 20 and 45 DAS (W₃) at 30 DAS. However, remaining at all other stages the lowest weed dry matter was recorded with pre emergence application of pendimethalin 1.0 kg ha⁻¹ fbPoE

Table 1: Weed dry matter of total weeds and Kapas yield of Bt cotton under varied plant densities and weed management practices during kharif-2015

<table>
<thead>
<tr>
<th>Densities</th>
<th>Treatment</th>
<th>Weed dry matter (g. m⁻²)</th>
<th>Kapas yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 DAS</td>
<td>60 DAS</td>
<td>90 DAS</td>
</tr>
<tr>
<td>D1</td>
<td>60 cmx30 cm (55,555)</td>
<td>7.54 (66.55)</td>
<td>7.14 (74.34)</td>
</tr>
<tr>
<td>D2</td>
<td>60 cmx15 cm (1,11,111)</td>
<td>5.89 (33.02)</td>
<td>7.93 (79.8)</td>
</tr>
<tr>
<td>D3</td>
<td>60 cmx15 cm (Paired row 45x75)</td>
<td>8.08 (75.33)</td>
<td>8.49 (75.02)</td>
</tr>
<tr>
<td>D4</td>
<td>45 cmx15 cm (1,48,148)</td>
<td>6.95 (55.58)</td>
<td>8.67 (81.03)</td>
</tr>
</tbody>
</table>

SEμ±

CD(P=0.05) | NS | NS | NS | 1.51 | 1.00 | 433.69 |

Table 2: Weed control efficiency and Weed index of Bt cotton under varied plant densities and weed management practices during kharif-2015

<table>
<thead>
<tr>
<th>Treatment</th>
<th>WCE (%)</th>
<th>Weed index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Densities</td>
<td>30DAS</td>
<td>60DAS</td>
</tr>
<tr>
<td>D1</td>
<td>60 cmx30 cm (55,555)</td>
<td>49.84</td>
</tr>
<tr>
<td>D2</td>
<td>60 cmx15 cm (1,11,111)</td>
<td>43.03</td>
</tr>
<tr>
<td>D3</td>
<td>60 cmx15 cm (Paired row 45x75)</td>
<td>46.96</td>
</tr>
<tr>
<td>D4</td>
<td>45 cmx15 cm (1,48,148)</td>
<td>41.88</td>
</tr>
</tbody>
</table>

Weed management

<table>
<thead>
<tr>
<th>Densities</th>
<th>Treatment</th>
<th>WCE (%)</th>
<th>Weed index (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30DAS</td>
<td>60DAS</td>
<td>90DAS</td>
</tr>
<tr>
<td>W1</td>
<td>Pre emergence application of pendimethalin @ 1kg a.i ha⁻¹ fb by POE pyriothiobac sodium @ 62.5 g a.i ha⁻¹+quizalofop-p-ethyl @ 50 g a.i ha⁻¹ at 20, 40, 60 DAS</td>
<td>7.98 (64.97)</td>
<td>6.56 (54.83)</td>
</tr>
<tr>
<td>W2</td>
<td>Early POE of pyriothiobac sodium @ 62.5 g a.i ha⁻¹+quizalofop-p-ethyl @ 50 g a.i ha⁻¹ at 15 DAS fb by glyphosate ammonium salt 2 kg a.i ha⁻¹ at 45 DAS</td>
<td>5.45 (32.47)</td>
<td>6.68 (48.83)</td>
</tr>
<tr>
<td>W3</td>
<td>Pendimethalin @ 1kg a.i ha⁻¹ (PE) followed by HW at 20 and 45 DAS</td>
<td>4.89 (26.03)</td>
<td>6.56 (45.95)</td>
</tr>
<tr>
<td>W4</td>
<td>Weedy check (no weed control)</td>
<td>10.13 (107.02)</td>
<td>12.42 (106.57)</td>
</tr>
</tbody>
</table>

SEμ±

CD(P=0.05) | 1.65 | 1.83 | 1.57 | 1.51 | 1.00 | 433.69 |

Interaction

SEμ±

CD(P=0.05) | 1.14 | 1.26 | 1.09 | 1.04 | 0.76 | 298.87 |

CONCLUSION

Significantly the lowest dry matter of weeds was recorded at 120 DAS with plant population of 1,11,111 plants ha⁻¹ (D₂) normal planting and was on par with 1,11,111 plants ha⁻¹ (D₁) paired row planting. But at harvest lower dry matter of weeds was noticed with 1,11,111 plants ha⁻¹ (D₃) paired row planting and was on par with 1,11,111 plants ha⁻¹ (D₂) normal planting. However, plant densities did not show any significant influence on weed dry matter at 30, 60 and 90 DAS. Significantly lower weed dry matter was recorded with pendimethalin 1.0 kg ha⁻¹ (PE) fb HW at 20 and 45 DAS (W₃) at 30 DAS. However, remaining at all other stages the lowest weed dry matter was recorded with pre emergence application of pendimethalin 1.0 kg ha⁻¹ fbPoE
tank mix application of pyrithiobac sodium 62.5 g ha\(^{-1}\) + quizalofop-p-ethyl 50 g ha\(^{-1}\) at 20, 40 and 60 DAS (W\(_1\)).

REFERENCES