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Influence of Crop Geometries and Growth Regulators on Weed Growth and Yield of Machine Sown High Density Cotton

Uma Maheswari M* and Kavitha M P

Department of Natural Resource Management, Horticultural College and Research Institute, Periyakulam

Corresponding Author Mail Id: umavalarmathi987@gmail.com

Abstract

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore, during Winter irrigated seasons of 2017-18 and 2018-19 to study the effect of weed growth by growth retardants on machine-sown cotton under high-density planting system. The experiment was laid out in a split-plot design, and the treatments were replicated thrice. Main plot treatments comprised of three crop geometries *viz.*, 75 cm x 10 cm (M_1), 75 cm x 20 cm (M_2) and 75 cm x 30 cm (M_3) and seven sub plots of foliar application of growth retardants along with one control *viz.*, Cycocel 400 ppm (S_1), Cycocel 500 ppm (S_2), Mepiquat Chloride 100 ppm (S_3), Mepiquat Chloride 200 ppm (S_4), Maleic Hydrazide 400 ppm (S_5), Maleic Hydrazide 500 ppm (S_6) and Control (No Spray) (S_7). Cotton genotype TCH 1819, developed for synchronized maturity exclusively to fit into high density planting system, was used as the test crop. The cotton crop was raised under raised bed and the major cultivation practices were carried out with machines namely; inclined plate planter for sowing, power weeder for weeding and drip system for irrigation and fertigation. However, harvesting was done manually. Weed infestation in cotton increased with 75 cm x 10 cm spacing compared to wider spacing. With respect to foliar application of growth retardants, there were no significant differences observed among the treatments tested during both the years of the study.

Key words: *Cotton: High density planting system: growth Growth retardants: Weed growth*

Introduction

Cotton (*Gossypium hirsutum* L.) is an important commercial crop of India as it sustains the cotton textile industry which is the largest segment of organized industries in the country. But the farmers are facing the problem of stagnating yields from cotton hybrids due to increased labour demand, increased labour costs, increased seed costs and increased costs for cotton picking and nutrient requirements. To sustain 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, are the need of the hour. The concept of high-density cotton planting, more popularly called Ultra Narrow Row (UNR) cotton, was initiated by Briggs *et al.* (1967). Weeds primarily compete during the early crop growth period for solar radiation, moisture, and nutrients. The critical period of weed competition in cotton was found to be 15 to 60 days (Rajiv Sharma, 2008). Since, cotton has a long development cycle; it needs to go through incessant downpours, and along these lines, weeds additionally represent a difficult issue. Losses caused by weeds in cotton ranges from 50 to 85 per cent depending upon the nature and intensity of the weeds. 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, a moderate increase in plant densities may not increase the output 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, and light and thus reduce cotton yield substantially. Optimum cotton yield and quality for high-density planting cotton require good weed control throughout the growing season. The weeds can severely decrease cotton productivity. Though growth retardants are used for reducing plant heights in cotton to bring short plant stature that can suit machine harvesting, the effect of growth retardants on weed growth was unknown. Hence, to manage the cropefficiently, it is worthwhile to understand the effect of growth retardants on weed growth under high density planting system.

Materials and Methods

The field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore. The farm is situated in Western Agro climatic zone of Tamil Nadu. It is located with 11°N longitude and 77° E latitude at an altitude of 426.7 m above mean sea level, and the farm receives the average total annual rainfall of 674.2 mm on 45.8 rainy days. The trial was conducted with sandy clay loam type of soil. It was medium in organic carbon content, and the available nutrient status was low in nitrogen, medium in phosphorus and high in potassium.

Experimental design and treatments

The experiment was laid out in a split-plot design, and the treatments were replicated thrice. Main plot treatments comprised of three crop geometries *viz.*, 75 cm x 10 cm (M_1), 75 cm x 20 cm (M_2) and 75 cm x 30 cm (M_3) and seven sub plots of foliar application of growth retardants along with one control *viz*., Cycocel 400 ppm (S_1), Cycocel 500 ppm (S_2), Mepiquat Chloride 100 ppm (S_3), Mepiquat Chloride 200 ppm (S_4), Maleic Hydrazide 400 ppm (S_5), Maleic Hydrazide 500 ppm (S_6) and Control (No Spray) (S_7). Cotton genotype TCH 1819 which was developed for synchronized maturity exclusively to fit into high density planting system, was used as the test crop. The cotton crop was raised under raised bed, and the major cultivation practices were carried out with machines namely; inclined plate planter for sowing, power weeder for weeding and drip system for irrigation and fertigation. However, harvesting was done manually. The observations on weed parameters were taken on 40 DAS of Cotton.

Weed density

A quadrat (0.25 m^2) was placed at four randomly selected places in sampling area of each plot, and the weed species were accounted and expressed as number/m^2 on 40 DAS (Burnside and Wicks, 1965). Weeds were grouped into three categories *viz.*; grasses, sedges and broad leaved weeds.

Weed dry weight

Two quadrates of 0.25 m^2 each were placed at random places outside the net plot, and the weeds falling within the quadrat were removed, shade dried, and oven dried at 70°C for 72 hours and the dry weight of weeds were expressed as g/m^2.

Weed control efficiency (WCE)

Weed control efficiency (WCE) was calculated as per the procedure given by Mani *et al.* (2007).

$$WCE = \frac{WDc - WDt}{WDc} \times 100$$

Whereas, WCE: weed control efficiency (%), WDc: weed dry weight (g/m^2) in control plot WDt: weed dry weight (g/m^2) in treated plot.

Statistical Analysis

Statistical Analysis Data were statistically analysed following the procedure given by Gomez and Gomez (2010) . Data pertaining to weeds were transformed to square root scale whenever significant variation existed, critical difference was assembled at a five per cent probability level. Such of those treatments where the difference is not significant are denoted as NS.

Results and Discussion

Weed infestation

The weed flora of the experimental field predominantly comprised of four broad leaved weeds species, two grass species and a sedge. The predominant grassy weeds were *Dactyloctenium aegyptium* and *Chloris barbata.* Among the broad leaved weeds, *Trianthema potulacastrum*, *Digera arvensis, Parthenium hysterophorus* and *Euphorbia geniculata* were dominant. *Cyperus rotundus* was the only sedge present in the experimental site.

In the study, reduced weed population was noticed with closer spacing. Among the crop geometries, an increase in the plant density decreased the weed population indicated inverse proportionality in both the years of study.

Weed density

The data on the weed density of cotton at 40 DAS are presented in Table 1. The different crop geometries significantly influenced the weed density.

Among the crop geometries, spacing of 75 cm x 10 cm (M_1) registered reduced weed density of 55.43 numbers/m^2 and 70.27 numbers/m^2 of total weeds during 2017-18 and 2018-19, respectively, when compared with other spacings. . It might be due to the fact that closer spacing would develop enough foliage favoring rapid canopy closure, compared to conventionally spaced cotton (Jost and Cothren, 2000). Rapid canopy closure could lead to; reduced weed competition (Snipes, 1996; Culpepper and York, 2000), increased light interception (Krieg, 1996), and possibly decreased soil water evaporation. It might be due to better weed control with power weeder and drip irrigation which restricted the wetting area near the plants. Similar result was reported by Choudhary and Bhambri (2013). This was followed by 75 cm x 20 cm spacing (M_2). Increased weed density was noticed under the spacing of 75 cm x 30 cm (M_3) during both the years.

There was no significant difference in foliar application of growth retardants on weed density during both years of the study. Influence due to interaction was also absent.

Weed dry weight

The data on weed dry weight of cotton at 40 DAS as influenced by different crop geometry and foliar application of growth retardants are presented in Table 30.

Among the crop geometries, 75 cm x 10 cm spacing (M_1) recorded a reduced total weed dry weight of 27.03 g/m^2 and 50.93 g/m^2, during 2017-18 and 2018-19, respectively, than the other spacings tried. Increased weed dry weights of 59.66 g/m ^{2} and 85.84 g/m^2 were recorded during 2017-18 and 2018-19, respectively, in 75 cm x 30 cm spacing (M_3). This might be due to that the weed control during initial period is more effective than making weed free at later stages. A similar result was also reported by Yadav *et al.* (2016).

No significant difference was observed with the foliar application of growth retardants on weed dry weight during both the years of the study besides, interaction was also absent.

Weed Control Efficiency and Yield

75 cm x 10 cm spacing (M_1) recorded higher weed control efficiency 79.64% and 76.98 % during 2017-18 and 2018-19, respectively, than the other spacings tried. Weed control efficiency was lower in 75 cm x 30 cm spacing (M_3) during both the years of the study.

Though no significant difference was observed in the sub plot treatments, foliar application of growth retardants 200 ppm mepiquat chloride (S_4) recorded higher weed control efficiency than control (Fig. 1&2).

Conclusion

From the experiment, it could be concluded that crop geometry of 75 cm x 10 cm spacing recorded lower weed density due to closer spacing. Foliar spray of different growth retardants did not significantly influence weed growth. Therefore, mechanical cultivation of cotton under HDPS reduces weed growth.

Table 1. Effect of crop geometries and growth retardants on weed density and weed dry weight of machine sown cotton (2017-18 & 2018-19)

Treatment	Weed density (No./m^2)	Weed dry weight (g/m^2)	Weed density (No./m^2)	Weed dry weight (g/m^2)
	2017-18		2018-19	
Spacing				
M_1	7.48 (55.43)	5.24 (27.03)	8.41 (70.27)	7.71 (50.93)
M_2	9.10 (82.52)	6.21 (38.03)	9.98 (99.23)	7.94 (62.65)
M_3	10.95 (119.65)	7.75 (59.66)	11.79 (138.84)	9.28 (85.84)
SEd	0.05	0.02	0.10	0.10
CD (P=0.05)	0.13	0.06	0.27	0.27
Growth retardants				
S_1	9.28 (87.72)	6.46 (42.22)	10.36 (108.98)	8.35 (70.12)
S_2	9.35 (89.07)	6.56 (43.71)	9.66 (94.56)	7.84 (61.58)
S_3	9.01 (82.57)	6.25 (39.52)	10.07 (102.93)	8.10 (65.83)
S_4	8.93 (81.12)	6.16 (38.43)	10.90 (121.02)	8.69 (76.28)
S_5	9.84 (99.12)	6.92 (48.90)	9.38 (88.91)	7.76 (60.41)
S_6	8.68 (76.39)	6.09 (37.65)	9.78 (96.87)	7.93 (63.10)
S_7	9.14 (85.09)	6.34 (40.58)	10.25 (106.20)	8.24 (68.02)
SEd	0.06	0.05	0.13	0.13
CD (P=0.05)	NS	NS	NS	NS
Interaction	NS	NS		NS

Figures in parenthesis are mean of original values; Data subjected to square root transformation

Spacing	Growth retardants
M_1 – 75 cm x 10 cm	S_1- Cycocel 400 ppm
M_2 - 75 cm x 20 cm	S_2- Cycocel 500 ppm
M_3 - 75 cm x 30 cm	S_3- Mepiquat chloride 100 ppm
	S_4 - Mepiquat chloride 200 ppm
	S_5 - Maleic Hydrazide 400 ppm
	S_6 - Maleic Hydrazide 500 ppm
	S_7 - Control

Fig . 1. Effect of crop geometries and growth retardants on Weed Control Efficiency and Seed Cotton yield of machine sown cotton (2017-18)

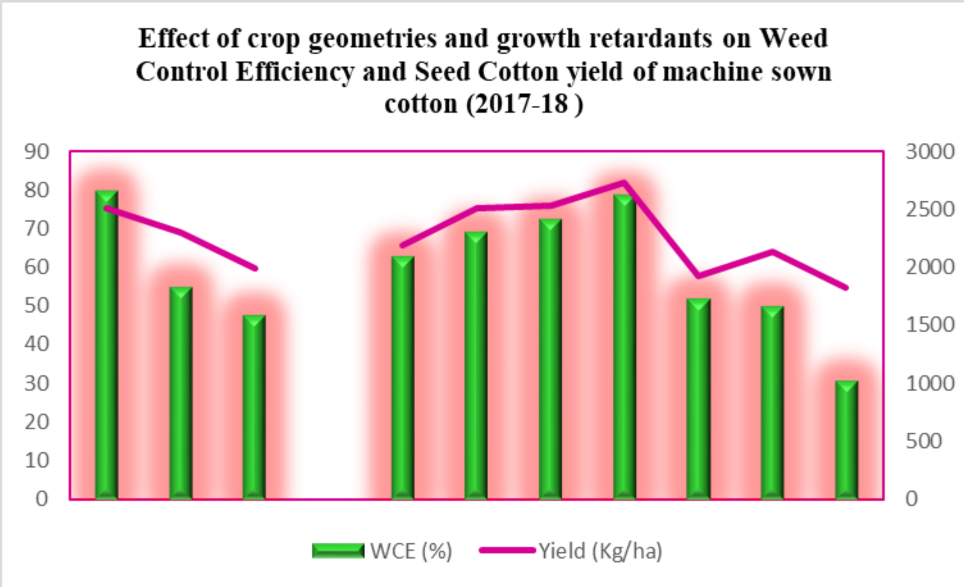

Fig. 2. Effect of crop geometries and growth retardants on Weed Control Efficiency and Seed Cotton yield of machine sown cotton (2018-19)

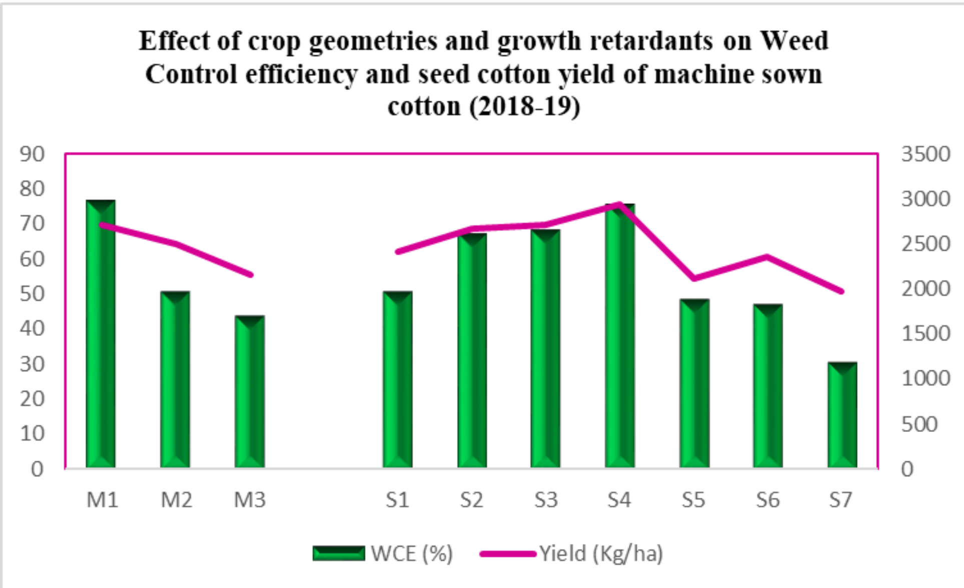

Table 2. Effect of crop geometries and growth retardants on Weed Control Efficiency and Seed Cotton yield of machine sown cotton (2017-18 & 2018-19)

Treatment	WCE (%)	Yield (kg/ha)	WCE (%)	Yield (kg/ha)
	2017-18		2018-19	
Spacing				
M_1	79.64	2505	76.98	2715
M_2	54.96	2295	50.79	2492
M_3	47.59	1988	43.97	2156
SEd	-	37	-	40
CD (P=0.05)	-	103	-	112
Growth retardants				
S_1	62.87	2191	50.75	2414
S_2	69.00	2505	67.21	2671
S_3	72.51	2532	68.51	2716
S_4	78.70	2726	75.69	2934
S_5	52.00	1926	48.69	2115
S_6	49.87	2131	47.25	2352
S_7	30.78	1826	30.91	1978
SEd	-	34	-	37
CD (P=0.05)	-	68	-	75
M x S	-	149	-	162
S x M	-	118	-	129

Spacing
M_1 – 75 cm x 10 cm
M_2 - 75 cm x 20 cm
M_3 - 75 cm x 30 cm

Growth retardants
S_1- Cycocel 400 ppm
S_2- Cycocel 500 ppm
S_3- Mepiquat chloride 100 ppm
S_4 - Mepiquat chloride 200 ppm
S_5 - Maleic Hydrazide 400 ppm
S_6 - Maleic Hydrazide 500 ppm
S_7 - Control

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