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RESPONSE OF COTTON TO DIFFERENT PLANT SPACING AND FOLIAR APPLICATION TIMES AND CONCENTRATIONS OF GROWTH REGULATOR (MEPIQUAT CHLORIDE) ON THE CANOPY STRUCTURE OF COTTON

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ABSTRACT

Optimizing yield and quality suppressing excess growth using plant growth regulators (PGRs) in cotton production an experiment was set in 2017 at Cotton Seed Multiplication, Training and Research Farm, Sreepur, Bangladesh to evaluate the response of cotton yield and quality in respect of different plant spacings, concentration and time of application of mepiquat chloride (MC) growth regulator. Plant spacings like 45 cm × 30 cm, 60 cm × 30 cm and 75 cm × 30 cm; MC spray @ 1.0, 2.0, 3.0 and 4.0 ml L^{-1} water at 25, 50 and 75 DAE for each concentration along with water spray as control, were the treatment variables. Maximum leaf canopy size 0.36 m^2 was observed from 75 cm×30 cm spacing but lower leaf canopy size 0.33m^2 was recorded at spacing of 45 cm × 30 cm. In case of MC application, the maximum leaf canopy size 0.37 m^2 was obtained from control but minimum leaf canopy size 0.32 m^2 was observed from 2 ml MC L^{-1} water at 25 DAE treatment. Combined influence of plant density and time of application as well as concentration of growth regulator revealed that the maximum leaf canopy size (0.46 m^2) was observed with water sprayed at 75 cm × 30 cm spacing but lower canopy size 0.16 m^2 was obtained from 2 ml MC L^{-1} water at 25 DAE with 60 cm × 30 cm spacing treatment combination. So, cotton cultivation in Sreepur, Gazipur areas may be accelerated with foliar application of mepiquat chloride @ 2 ml L^{-1} water at 25 DAE along with plant spacing of 60 cm x 30 cm for higher yield and quality.

Key words: Plant spacing, growth regulator, time of foliar, canopy, cotton.

Introduction

Upland cotton (*Gossypium hirsutum* L.) is a leading cash crop in Bangladesh. Bangladesh produces 156,509 bale or 28,328 ton lint and 86484 ton seed cotton from 43050 hectare of land per year (CDB, 2018). In these circumstances, the high demand of cotton could be met up by increasing per hectare yield following appropriate crop management techniques and using short durated varieties. Optimum plant population or spacing is important for crop production through efficient utilization of light, nutrients and water uptake by the plants. In some cases, higher plant populations adversely affect yield per unit area simultaneously vegetative and reproductive growth of plants but is important to compensate yield loss due to short canopy of plant (Wright *et al*., 2008; Silvertooth, 1999 and Hake *et al.*, 1991). While Jahedi *et al.* (2013) obtained reduced number sympodia in cotton having narrow row spacing. Sowmiya and Sakthivel (2018) noted that sympodial branches $plant^{-1}$ was found significant in wider spacing (75 cm x 30 cm) in cotton. Sowmiya and Sakthivel (2018) reported that the closer plant spacing of 60 cm x 15 cm recorded significantly higher leaf area index in cotton. Optimizing cotton yield through manipulation of plant spacing has been reported by many researchers that increasing plant population density (number of plants per unit ground area) consistently increases leaf area index (LAI) and light interception but its effects on yield have been inconsistent. Understanding how the arrangement of plants in the field affects cotton growth requires consideration of many interacting factors, such as genetics, physiology, and canopy structure (Heitholt and Sassenrath-Cole, 2010). Stewart *et al.* (1997) suggested that decreasing row spacing increased relative leaf area and light interception by the canopy in peanuts. Alterations in plant spacing through row spacing and plant population have a significant effect on canopy development and yield components. Application of plant growth regulator (either auxin or retardant) can also lead to improve the growth of many crops. Plant growth regulators are organic compounds, other than nutrients, that affect physiological processes of plants when applied in small concentrations. These compounds represent diverse chemistries and modes of action and provide numerous possibilities for altering crop growth and development. Their time of use extends from early season when they are applied in-furrow or as seed treatments at planting to late season in preparing the crop for harvest. Timing the first application of mepiquat chloride has caused concerns among cotton producers in that too much applied too soon can result in serious damage to plant structure and subsequent lint yields. Too little material applied too late can increase production costs and still leave the grower with a rank plant and difficult harvest. Overall benefits from plant growth regulator use in cotton include yield enhancement, improved fiber quality, and greater ease of harvest; more specific responses include alteration of C partitioning, greater root: shoot ratios, enhanced photosynthesis, altered nutrient uptake, improved water status, and altered crop canopy; these responses are a reflection of the interaction of heritable characteristics, cultural inputs, and environment (Cothren *et al.,* 1983). Copur *et al.* (2010) studied that the applied PGRs had significant positive effects on the number of sympodia. Use of plant growth retardant is an eye-catching technology today which improves seed cotton yield through increased number of sympodia by controlling undesirable vegetative development of cotton plant thus giving a short statured plant canopy. Kumar *et al.* (2005) had found reduced plant height (restructuring canopy size) with MC (50 ppm) sprayed at 90 DAS as compare to Chlormequat Chloride (CCC) application in cotton plant. Raoofi *et al.* (2014) opined that NAA can promotes flower sex ratio in leafy vegetabes and field crops. Planofix (Naphthalene Acetic Acid) had a significant effect on number of fruiting branches in cotton (Abro *et al.,* 2004). Naphthalene Acetic Acid 20 ppm showed better performance in enhancing the straw yields of wheat cultivars (Alam *et al.*, 2002). Zhao *et al.* (2019) reported that application of MC reduced plant height, fruit branch length and fruiting branch under different plant densities, resulting in a lower and more compact plant canopy in cotton. Rademacher (2016) opined that growth retardants reduce shoot elongation, thereby lowering the risk of lodging in cereals, rice and oilseed rape, and making ornamentals more compact. Gu *et al.* (2014) narrated that canopy structure became more compact with the decrease of leaf area index and internode length due to the application of MC in cotton. The changes in plant structure and canopy development with altered plant spacing observed in cotton canopies result, at least in part, from photomorphogenetic responses to the altered light quality within the canopy, the photomorphogenetic responses are mediated via the phytochrome system which provides a mechanism for plants to sense and respond to the light environment of the canopy as suggested by Ballare *et al.* (1992) in cucumber. Edgerton (1983) observed that the application of BA (benzlaminopurine), or the BA + GA_4 + A_7 (gibberellins) formulation has also been beneficial in promoting a more desirable branching and canopy development in young spur type 'Delicious' and 'McIntosh' cultivars of apple tree. Ponnuswami and Rani (2019) obtained that the treatment combination of 40 cm x 20 cm with organic compound 20 kg ha^{-1} recorded the better canopy size under high density planting system. Systematic and comprehensive research effort on blending plant spacing, concentration and time of application of mepiquat chloride (MC) in order to increase yield of cotton are inadequate or absent at home or abroad. Keeping these views in mind, the present research programme was undertaken with the objectives to determine optimum plant density of cotton and to optimize time of application and concentration of MC as foliar spray on cotton to have a restructured plant lowering plant height shortening internodes that switch over the reproductive growth achieving the desired yield from cotton in Bangladesh.

Materials and Methods

The experimental field belongs to the agro-ecological zone of Modhupur Tract (AEZ-28). Cotton inbred cultivar CB 14 was selected as it is early maturing (short duration) and high yielding cultivar. A factorial experiment with three levels of plant spacing and thirteen different concentrated MC foliar applications along with time of spraying was as Factor A: level of Plant spacings (3): 60 cm × 30 cm (55,555 plants ha^{-1}) as check selected from first year experiment as promising treatment, 45 cm × 30 cm (74,074 plants ha^{-1}), 75 cm × 30 cm (44,444 plants ha^{-1}); and Factor B: MC concentrations along with time of spraying (13): Water spray (control), Mepiquat Chloride spray @ 1.0, 2.0, 3.0 and 4.0 ml L^{-1} water at 25 DAE, Mepiquat Chloride spray @ 1.0, 2.0, 3.0 and 4.0 ml L^{-1} water at 50 DAE and Mepiquat Chloride spray

@ 1.0, 2.0, 3.0 and 4.0 ml L^{-1} water at 75 DAE respectively. MC was sprayed around the crop canopy on 20 September (25 DAE), 20 October (50 DAE) and 14 November, 2017 (75 DAE). The crop was finally harvested on 28 February, 2018. Data recorded on canopy size of cotton were analyzed with the help of computer package MSTAT-C. Least Significant Difference (LSD) was used for mean separation at 5% level of probability (Gomez and Gomez, 1984).

Results and Discussion

Effect of plant spacing: Leaf canopy size of cotton was not significantly affected due to plant spacing (Fig. 1). The maximum leaf canopy size (0.36 m^2) was recorded at wider spacing 75 cm × 30 cm. The minimum (0.33m^2) was from 45 cm × 30 cm spacing followed by 60m × 30 cm spacing. Stewart *et al.* (1997) reported that leaf canopy size in peanuts increased as plant density decreased compared to control (Emilie and Kufimfutu, 1995 in oats; Liu *et al.*, 2011 in maize; Ponnuswami and Rani, 2019 in moringa).

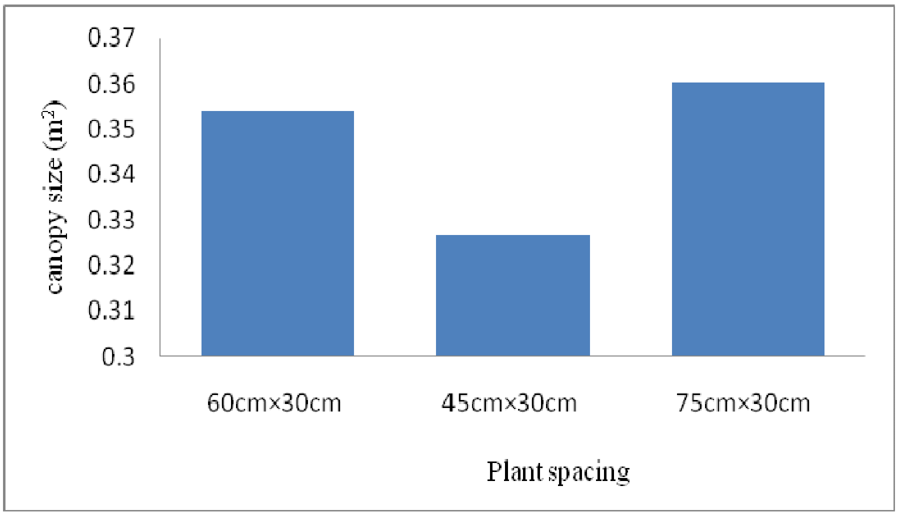

Fig. 1. Influence of plant spacing on canopy size of cotton (LSD $_{(0.05)}$ = 0.056)

Effect of time of application and concentration of MC growth regulator: A significant variation in leaf canopy size of cotton was observed due to the effect of MC application at different growth periods ranges between 0.32 to 0.37 m^2 which was also not significant (Fig. 2). The maximum value for leaf canopy size (0.37 m^2) was obtained from water spray and the minimum (0.32 m^2) from 2 ml MC L^{-1} water at 25 DAE. Intermediate plant canopy size was recorded when MC sprayed at early (25 and 50 DAE) or late (75 DAE). Gu *et al.* (2014) reported that canopy structure became more compact with the decrease of leaf area index due to the application of MC in cotton. Zhao *et al*. (2019) found that leaf canopy size was decreased as MC sprayed compared to control in cotton (Gollagi *et al.*, 2019 in guava; Singh and Chanana, 2005 in guava; Edgerton, 1983 in apple). Eveleigh *et al.* (2010) opined that Plant hormone reduced the production of the gibberellic acid, which in turn slowed cell expansion resulting in reduced canopy (leaf growth) in cotton.

Combined effect of plant spacing and time of application and concentration of MC growth regulator: Leaf canopy was significantly affected by combined effect of plant density and MC concentration and application time (Table 1). Leaf canopy size was found to be increased with decreasing plant density. The wider spacing (75 cm × 30 cm) accompanied with plants grown without MC spray gave the highest leaf canopy size (0.46 m^2). The relatively closer spacing (60m × 30 cm) accompanied with 2 ml MC L^{-1} water at 25 DAE gave the lowest (0.16 m^2) canopy size. Zhao *et al*. (2019) reported that application of MC resulting in a lower and more compact plant canopy in cotton.

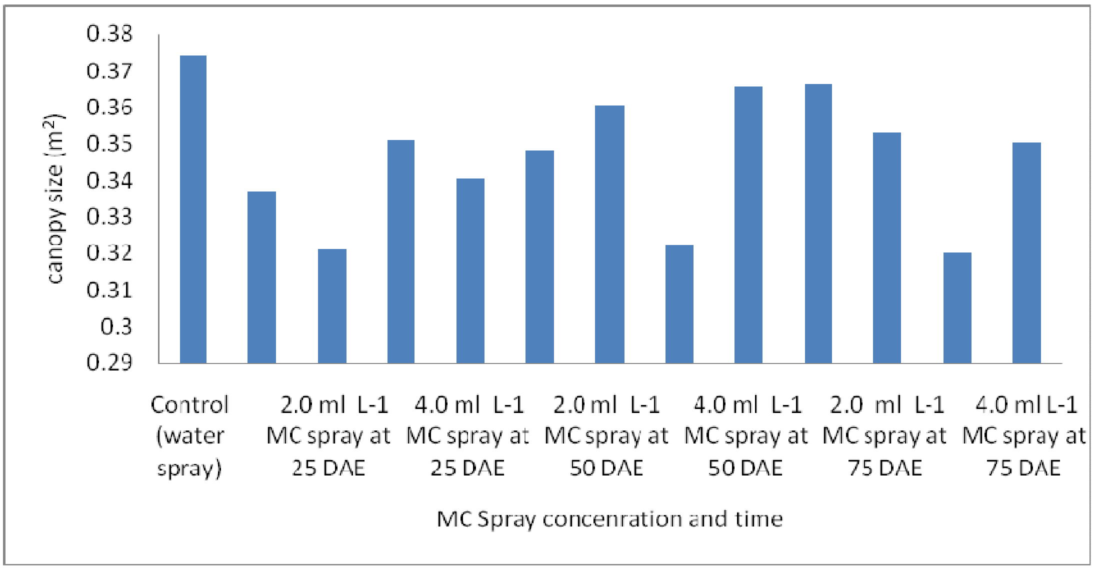

Fig. 2. Effect of different time of application and concentration of MC on canopy size of cotton (LSD $_{(0.05)}$ = 0.112)

Table 1. Combined effect of plant spacing and MC level along with application time on canopy of cotton

Treatments	Canopy size (m^2)		
	60 cm × 30 cm	45 cm × 30 cm	75 cm × 30 cm
Control (water spray)	0.36 a-c	0.37 a-c	0.46 a
1.0 ml L^{-1} MC spray at 25 DAE	0.21 bc	0.33 a-c	0.38 a-c
2.0 ml L^{-1} MC spray at 25 DAE	0.16 c	0.21 bc	0.39 a-c
3.0 ml L^{-1} MC spray at 25 DAE	0.21 bc	0.31 a-c	0.40 a-c
4.0 ml L^{-1} MC spray at 25 DAE	0.31 a-c	0.33 a-c	0.41 ab
1.0 ml L^{-1} MC spray at 50 DAE	0.32 a-c	0.30 a-c	0.42 ab
2.0 ml L^{-1} MC spray at 50 DAE	0.25 a-c	0.31 a-c	0.42 ab
3.0 ml L^{-1} MC spray at 50 DAE	0.33 a-c	0.30 a-c	0.39 a-c
4.0 ml L^{-1} MC spray at 50 DAE	0.36 a-c	0.33 a-c	0.40 a-c
1.0 ml L^{-1} MC spray at 75 DAE	0.32 a-c	0.36 a-c	0.38 a-c
2.0 ml L^{-1} MC spray at 75 DAE	0.33 a-c	0.30 a-c	0.25 a-c
3.0 ml L^{-1} MC spray at 75 DAE	0.34 a-c	0.25 a-c	0.41 ab
4.0 ml L^{-1} MC spray at 75 DAE	0.36 a-c	0.21 bc	0.38 a-c
LSD	0.241		
CV (%)	15.41		

In a column, figure(s) followed by same letter do not differ significantly at 5% level.

Conclusion

Combined influence of plant density and time of application and concentration of growth regulator exposed that the lower canopy size (0.16 m^2) was obtained from 2 ml MC L^{-1} water at 25 DAE with 60 cm × 30 cm spacing treatment combination. Maximum leaf canopy size (0.46 m^2) was observed by water sprayed with 75 cm × 30 cm spacing treatment combination. So, foliar application of mepiquat chloride @ 2 ml L^{-1} water at 25 DAE along with plant spacing of 60 cm x 30 cm can be practiced for profitable cotton production in Sreepur, Gazipur areas of Bangladesh.

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