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Research Article

Effect of plant spacing and height on seed germination and yield of different cotton varieties sown early under climatic conditions of Bahawalnagar Punjab, Pakistan.

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Keywords

Varieties,
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Abstract

A field experiment was conducted to evaluate the effect of plant spacing and height on seed germination and yield of different cotton varieties sown early in season during two successive years 2013-14 under the climatic conditions of Bahawalnagar. The effect of plant spacing 30cm and 45cm on the yield of two approved varieties of cotton MNH-786 and FH-142 was investigated with the use of Mepiquat chloride (a growth inhibitor which regulate vegetative growth). Effect of plant spacing and height was significant in yield and yield components. Plant spacing (30cm and 45cm) and height (Mepiquat chloride sprayed and unsprayed plots) significantly affected the germination m^{-2}, plant height (cm), number of mature bolls $plant^{-1}$, seed cotton weight $boll^{-1}$, and seed cotton yield kg ha^{-1}. Average of two years results shows that Cotton variety MNH-886 in spray plot with Mepiquat chloride at plant spacing 45cm gave the highest and significant increase in seed cotton yield (2575.5 kg ha^{-1}) over FH-142 (2361 kg ha^{-1}) in sprayed plot at 45cm plant spacing.

Introduction

Cotton (*Gossypium hirsutum* L.) plays an important role in the economy of Pakistan. It contributes to the National economy by providing raw material to the local textile industry and also known as the "white gold" of Pakistan (Hakim *et al.* 2011). Cotton (Family Malvaceae) is important fiber crop in the world. It is a perennial semi shrub grown as an annual crop in both tropical and warm temperate regions. In textile manufacturing, it produces seeds with a potential multi product base such as hulls, oil, lint and food for animals (Ozyigit et al 2007). Pakistan is an agriculture country that has variable climate and almost two third of the regions show arid type of climate. Only a narrow belt of sub mountainous regions show humid climate. Most of the areas in the central and southern Pakistan are highly arid; while the northern part of the country is humid except the extreme northern mountains which are relatively dry (Chaudhry and Rasul, 2004). It contributes a huge share in the foreign exchange earnings of the country (Ahmad *et al.* 2011).Cotton height prior to harvest was approximately 13 and 17 cm less in the 30 and 50 cm row spacing's, respectively, than the 70 cm row spacing (Fowler and Ray, 1977). The initial foreign matter of seed cotton is typically higher for ultra narrow row cotton in comparison to cotton in wide rows, averaging 20 and 8%, respectively, for stripper and spindle harvested cotton (Valco et al. 2001). Ultra-narrow rows was initially defined in terms of row spacing <25 cm (Atwell, 1996), but some contemporary ultra-narrow rows row spacing's include 19, 25, and 38 cm (Parvin et al.,2000).Common characteristic of ultra-narrow rows is the use of high plant population densities (plant population density) relative to wide row cotton (Perkins, 1998; Jones, 2001; Delaney et al., 2002). Delaney et al. (2002) pointed out that a narrow row is grown at relatively high plant population density to decrease branching and facilitate machine harvesting. Although previous studies have been conducted to investigate cotton growth and yield response to row spacing, results are often conflicting (Smith et al., 1979; Kerby et al., 1990; Mohammad et al., 1982). Kasap & Killi (2004) studied the effect of three row spacing's (60, 70 and

80cm) and gained highest seed cotton yield with 60 cm row spacing. Hussain et al.,(2000) reported that 30 cm spacing between plants increased plant height, number of bolls per plant and average boll weight as compared to 10 cm and 20 cm. Muhammad et al.,(2002) concluded that the boll weight decreases by increasing plant population. The difference among varieties for plant population and interaction between plant spacing and varieties were found to be non significant. Increase in plant population with decrease in plant spacing has also been reported by Brar et al.,(2002). Alfaqeih (2002) also reported that the number of monopodial branches per plant increased by increasing plant spacing. Decrease in number of monopodial branches per plant may be due to more competition between the plants due to less space for light and nutrients. Higher vegetative tendencies in cotton have been shown to lead to losses in reproductive structures (squares, flowers and bolls) (Gausman *et al.* 1979; York, 1983b; Fletcher *et al*.1994). The loss of reproductive structures (carbohydrate sinks) can shift energy from reproductive to vegetative portions of the plant, resulting in a rapid propagation of main stem growth (Mauney, 1986). Mepiquat chloride is the most common plant growth regulator used in cotton and has been widely used by farmers in many cotton-producing countries around the world. Plant responses to mepiquat chloride are related to environmental factors encountered by the plant throughout the growing season (Hodges et al., 1991). Mepiquat chloride is used as a growth retarder and it reduces plant height, number of nodes, branch length and leaf area (Iqbal et al., 2004). Mepiquat chloride is a plant growth regulator that has been used in cotton production as a management tool in controlling vegetative growth. Mepiquat chloride is a gibberellic acid suppressant that is absorbed by the green portions of the plant and serves to reduce cell elongation, thus offering the potential of decreasing leaf area and restricting additional plant height increases (York, 1983a; Kerby, 1985). It has also been found for enhancing earliness with regards to fruiting development (York, 1983b; Kerby, 1985).

The effect of mepiquat chloride on seed cotton yield is inconsistent. Some have observed increase in yield, some have observed decrease in yield and some has observed no effect on yield. The yield is related to environmental factors like rainfall and temperature (Iqbal et al., 2004). The time and rate of MC is also important. If it is applied early and in less concentration it would give more lint yield as compared to late and high dose application (Kerby, 1998). High temperature also increases the vegetative growth (Yeates et al., 2002). In Southern Punjab (Pakistan) farmers sow cotton end of May to end of June. Temperature is high during these two months so due to high temperature there is more vegetative growth, which ultimately reduces the no. of bolls per plant which results in fewer yields (Iqbal et al., 2004). The plant growth regulator mepiquat chloride has been labeled for use in cotton since the 1980s. Mepiquat chloride-containing products have been widely used as a means of restricting plant height. Other potential benefits of mepiquat chloride include less susceptibility to boll rot, increased early fruit retention, enhanced earliness, less lodging of plants, and increased harvest efficiency. Potential risks associated with its use are a reduced ability to withstand season-long stress, slower canopy closure, and inducement of early cutout (Stewart, 2005). Reddy et al. (1990) observed that the largest effect of the product on cotton growth occurred when the daily temperature was 30°C, with nights of 20°C. In temperatures higher or lower than these, the efficacy of the product was decreased.

The objectives of this study was to determine the feasibility of using modern cotton cultivars (MNH-886 and FH-142) in narrow rows spacing's (30 and 45 cm) and reduces the height by using Mepiquat chloride that play a significant role in seed cotton yield and its yield parameters.

Materials and Methods

This experiment was conducted at farmer's field during 2 consecutive years 2013-14. The experiment was laid out in RCBD with three replications having a net plot size of 12 ×67ft). Experiment was conducted to evaluate the effect of plant spacing and height on seed germination and yield of different cotton varieties sown early in season under the climatic conditions of Bahawalnagar. Cotton varieties MNH-886 and FH-142 were checked out at 30 and 45 cm row spacing's. In case of height Mepiquat chloride was used to retard vegetative growth, so that maximum yield was obtained. Four plots of each variety was sown, two of them was 30cm in which one sprayed and other not sprayed with Mepiquat chloride and others two of 45cm sprayed and unsprayed with MC as described in table-1. The crop was sown at the 1st week of April with bed and furrow method to achieve the require plant population. Thinning was done to maintain the desired plant population when plant attained the height of 15cm. All other agronomic and plant protection practices were kept similar for all the treatments. Ten plants from each treatment were selected at random to record number of matured bolls plant^{-1} and plant height at maturity. Ten bolls were picked randomly from each treatment, weighed and averaged to record the seed cotton weight boll^{-1}. Two pickings from the whole plot for about 75 and second about 200 days after sowing were done to obtain the seed cotton yield. The seed cotton plant^{-1} (kg) was calculated after the last picking and converted to seed cotton yield ha^{-1}. Data collected was analyzed statistically by using Fisher's analysis of variance technique. LSD test 0.05 at probability means (Steel and Torrie, 1997).

Table-1 Treatments used to evaluate the effect of plant spacing's and height.

Treatments Variety	Plant Spacing (Cm)	Canopy management
MNH-886	30 30	No spray of Mepiquat chloride Mepiquat chloride spray
	45 45	No spray of Mepiquat chloride Mepiquat chloride spray
FH-142	30 30	No spray of Mepiquat chloride Mepiquat chloride spray
	45 45	No spray of Mepiquat chloride Mepiquat chloride spray

Results and Discussion

Yield related parameters

Plant germination (m^{-2}): Plant spacing and height has non significant effect on the germination of both varieties MNH-886 and FH-142. But it was observed from table 2 during 2013 that plant germination was maximum in spray plot with mepiquat chloride rather than unsprayed plot both in case of 30 and 45cm plots. Plant germination was maximum 4.33 m^{-2} in case of 45cm spray plot of MNH-886. While minimum plant population 2.66 m^{-2} was observed in case of 30cm unsprayed plot of FH-142 cotton variety. The difference among varieties for plant population and interaction between plant spacing and varieties were found to be non significant. Increase in plant population with decrease in plant spacing has also been reported by Brar et al., (2002).

Plant height (cm): The plant height and spacing has a significant effect on plant height of both cotton varieties MNH-886 and FH-142 as described in table 2 during 2013. The maximum plant height (108cm) was observed in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride followed by (107cm) plant height as observed in case of FH-142 variety 45cm row spacing in spray plot of mepiquat chloride. The minimum plant height (101cm) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride. Hussain et al., (2000) reported that 45 cm spacing between plants increased plant height, number of bolls per plant and average boll weight as compared to 10 cm and 20 cm. Mepiquat chloride is a gibberellic acid suppressant that is absorbed by the green portions of the plant and serves to reduce cell elongation, thus offering the potential of decreasing leaf area and restricting additional plant height increases (York, 1983a; Kerby, 1985).

Table-2 Effect of plant spacing's and height on yield and yield parameters of different cotton varieties during 2013.

Treatments Variety	Plant Spacing (Cm)	Canopy management	Germination (m^{-2})	Plant height (cm)	No.of bolls $plant^{-1}$	Boll weight (g)	Yield (kg ha^{-1})
MNH-886	30 30	No spray of Mepiquat chloride Mepiquat chloride spray	3.00e 3.33d	103e 105c	23cd 25bc	2.25d 2.38c	2066d 2238c
	45 45	No spray of Mepiquat chloride Mepiquat chloride spray	3.32d 4.33a	104d 108a	24c 28a	2.41c 2.71a	2410b 2582a
FH-142	30 30	No spray of Mepiquat chloride Mepiquat chloride spray	2.66g 2.99f	101f 104d	19e 22d	2.10e 2.26d	1894e 2066d
	45 45	No spray of Mepiquat chloride Mepiquat chloride spray	3.33d 3.66c	105c 107b	24c 26b	2.44c 2.57b	2238c 2410b
Lsd (0.05)			NS	0.78	1.81	0.11	7.509

Number of mature bolls plant^{-1}: The number of mature bolls plant^{-1} was significantly affected by the plant height and spacing as mentioned in table 2during 2013. The maximum number of mature bolls plant^{-1} (28) was observed in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride followed by (26) as observed in case of FH-142 variety 45cm row spacing in spray plot of mepiquat chloride. The minimum mature boll plant^{-1} (19) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride.

Boll weight (g): Average boll weight is one of the major components of seed cotton yield in cotton. Data given in Table 2 during 2013 indicates that maximum boll weight (2.71g) was observed in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride followed by (2.57g) as observed in case of FH-142 variety 45cm row spacing in spray plot of mepiquat chloride. The minimum mature boll plant^{-1} (2.10g) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride.

Seed cotton yield kg per hectare: Data pertaining to seed cotton yield per hectare as influenced by plant spacing's and height mentioned in Table 2 during 2013 indicates that plant height and spacing's had significant effect on the seed cotton yield per hectare. Maximum seed cotton yield per hectare (2582kg ha^{-1}) in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride followed by (2410kg ha^{-1}) as observed in case of FH-142 variety 45cm row spacing in spray plot of mepiquat chloride. The lowest seed cotton yield (1894kg ha^{-1}) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride. The time and rate of MC is also important. If it is applied early and in less concentration it would give more lint yield as compared to late and high dose application (Kerby, 1998). These results are similar to those of (Smith et al., 1979; Kerby et al., 1990; Mohammad et al., 1982 and Kasap & Killi (2004).

Plant germination (m^{-2}): Plant spacing and height has non significant effect on the germination of both varieties MNH-886 and FH-142. But it was observed from table 3 during 2014 that plant germination was maximum in spray plot with mepiquat chloride rather than unsprayed plot both in case of 30 and 45cm plots. Plant germination was maximum 4.66 m^{-2} in case of 45cm spray plot of MNH-886. While minimum plant population 3.00 m^{-2} was observed in case of 30cm unsprayed plot of FH-142 cotton variety. The difference among varieties for plant population and interaction between plant spacing and varieties were found to be non significant. Increase in plant population with decrease in plant spacing has also been reported by Brar et al., (2002).

Plant height (cm): The plant height and spacing has a significant effect on plant height of both cotton varieties MNH-886 and FH-142 as described in table 3 during 2014. The maximum plant height (108cm) was observed in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride followed by (106cm) plant height as observed in case of FH-142 variety 45cm row spacing in spray plot of mepiquat chloride. The minimum plant height (101cm) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride. Hussain et al., (2000) reported that 45 cm spacing between plants increased plant height, number of bolls per plant and average boll weight as compared to 10 cm and 20 cm. Mepiquat chloride is a gibberellic acid suppressant that is absorbed by the green portions of the plant and serves to reduce cell elongation, thus offering the potential of decreasing leaf area and restricting additional plant height increases (York, 1983a; Kerby, 1985).

Number of mature bolls plant^{-1}: The number of mature bolls plant^{-1} was significantly affected by the plant height and spacing as mentioned in table 3 during 2014. The maximum number of mature bolls plant^{-1} (28) was observed in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride followed by (26) as observed in case of FH-142 variety 45cm row spacing in spray plot of mepiquat chloride. The minimum mature boll plant^{-1} (21) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride.

Boll weight (g): Average boll weight is one of the major components of seed cotton yield in cotton. Data given in Table 3 during 2014 indicates that maximum boll weight (2.70g) was observed in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride. The minimum mature boll plant^{-1} (1.89g) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride.

Seed cotton yield kg per hectare: Data pertaining to seed cotton yield per hectare as influenced by plant spacing's and height mentioned in Table 3 during 2014 indicates that plant height and spacing's had significant effect on the seed cotton yield per hectare. Maximum seed cotton yield per hectare (2569kg ha^{-1}) in case of MNH-886 variety at 45cm row spacing in spray plot of mepiquat chloride. The lowest seed cotton yield (1927kg ha^{-1}) was observed in case of FH-142 variety at 30cm row spacing in unsprayed plot of mepiquat chloride. The time and rate of MC is also important. If it is applied early and in less concentration it would give more lint yield as compared to late and high dose application (Kerby, 1998). These results are similar to those of (Smith et al., 1979; Kerby et al., 1990; Mohammad et al., 1982 and Kasap & Killi (2004).

Table-3 Effect of plant spacing's and height on yield and yield parameters of different cotton varieties during 2014.

Treatments Variety	Plant Spacing (Cm)	Canopy management	Germination (m^{-2})	Plant height (cm)	No.of bolls $plant^{-1}$	Boll weight (g)	Yield (kg ha^{-1})
MNH-886	30	No spray of Mepiquat chloride	3.33e	103e	23f	2.37bc	2255d
	30	Mepiquat chloride spray	3.66d	106c	26c	2.42bc	2312c
	45	No spray of Mepiquat chloride	3.66c	105d	26c	2.45bc	2312c
	45	Mepiquat chloride spray	4.66a	108a	28a	2.70a	2569a
FH-142	30	No spray of Mepiquat chloride	3.00g	101f	21g	1.89e	1927f
	30	Mepiquat chloride spray	3.33e	105d	24e	2.13d	2184e
	45	No spray of Mepiquat chloride	3.32f	105d	25d	2.10d	2184d
	45	Mepiquat chloride spray	4.00b	107b	27b	2.50b	2441b
Lsd (0.05)			NS	0.95	0.76	0.18	4.757

Table-4 Effect of plant spacing's and height on yield and yield parameters of different cotton varieties (average of two years).

Treatments Variety	Plant Spacing (Cm)	Canopy management	Germination (m^{-2})	Plant height (cm)	No.of bolls $plant^{-1}$	Boll weight (g)	Yield (kg ha^{-1})
MNH-886	30	No spray of Mepiquat chloride	3.16f	103e	23d	2.31cd	2160.5f
	30	Mepiquat chloride spray	3.49d	105.5c	25.5b	2.40c	2275d
	45	No spray of Mepiquat chloride	3.49d	104.5d	25b	2.43bc	2361c
	45	Mepiquat chloride spray	4.49a	108a	28a	2.70a	2575.5a
FH-142	30	No spray of Mepiquat chloride	2.83g	101f	20e	1.99e	1910.5h
	30	Mepiquat chloride spray	3.16f	104.5d	23d	2.19d	2125g
	45	No spray of Mepiquat chloride	3.32e	105c	24.5c	2.27d	2211e
	45	Mepiquat chloride spray	3.83b	107b	26.5b	2.53b	2425.5b
Lsd (0.05)			NS	0.865	1.285	0.145	6.133

Conclusion

Application of mepiquat chloride on cotton variety MNH-886 at row spacing 45cm produces the maximum germination m^{-2} (4.39), plant height (108cm), No. of boll $plant^{-1}$(28), boll wt (2.70g) and seed cotton yield (2575.5kg ha^{-1}) as shown by the average results of two years as mentioned in table-4.

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