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Response of Cotton to the Synergistic Use of Fertilizers and Growth Regulators

Abida Akram, [1]Ghulam Jilani and [2]M. Akram
Department of Botany, [1]Department of Soil Sciences, University of Arid Agriculture, Rawalpindi, Pakistan
[2]British Cotton Growers Association, Khanewal, Pakistan

Abstract: The combined effect of different rates of fertilizer (N + P) and concentrations of a growth regulator commercial product on growth and yield of cotton was studied. There were two types of treatments viz. fertilizer rates (F) and Mixtalol concentrations (M) placed randomly in the field under split-splot design with four replications. Main-plot treatments were: F_o Control/no fertilizer), F_1 (half rate of recommended N and P fertilizers viz. 575 and 28.8 kg ha^{-1}, respectively) and F_2 (full rate of recommended N and P fertilizers viz. 115 and 57.5 kg ha^{-1}, respectively). The sub-plot treatments included: M_o (Control/no Mixtalol Spray), M_1 (2 pm Mixtalol sprays thrice) and M_2 (3 ppm Mixtalol spray thrice). Thus there were nine treatments combinations in total. Data on plant height and number of branches per plant showed significantly increased values of these two with the both doses of fertilizer as well as Mixtalol over Control. The difference between M_1 and M_2 was non significant for both parameters, while the F_1 and F_2 gave statistically similar values for number of branches and F was superior to F_1 with respect to plant height. The best combination was F_2 x M_1 and the lowest values were found in F_o x M_o. As regards the number of bolls per plant and seed cotton yield, F_2 gave statistically better results than did F_1 and F_2. among Mixtalol treatments M_1 performed better than M_2. the synergistic effect was best with F_2 x M_1 and it was lowest at F_o x M_o. Thus it was concluded that cotton gave the highest response to full rate of fertilizer (F_2) along with lower concentration (2 ppm) sprays Mixtalol (M_1) as the most suitable combination.

Key words: Cotton, fertilizers effect, growth regulators

Introduction

The growth of cotton, like all other plants, is a complex process and is the net result of all the physiological phenomena which are controlled by the interactive reactions between their genetic make up and environments comprising climatic, edaphic and the nutritive factors. The nutritive factors include macronutrients and growth regulators.

Cotton is the white gold of Pakistan occupying the second largest area (2.96 m ha) of all the crops grown in Pakistan (GOP, 1999). Cotton based exports earn nearly 60% of the country's foreign exchange and cotton seed accounts for about 72% of the domestic edible oil production (Khan, 1999). In spite of this much significance of cotton to Pakistan, its per hectare yield is very low viz. 1580 kg ha^{-1}, which is even less than the world average and far below than the yield in cotton growing countries (FAO, 1997). One of the factors for low yield is the declining soil fertility as reflected by the increasing consumption of chemical fertilizers every year. Even the higher doses of nitrogen (N) and phosphorus (P) fertilizers did not enhance the crop yields significantly.

Under this situation, the use of growth regulators in combination with fertilizers seems to bear prospects to enhance crop yields. Five different types of plant regulators viz. auxins, gibberellins, cytokinins, indole acetic acid (IAA) and ethylene are recognized. They are known to influence the rooting, seed germination, flowering, fruit setting and development, plant size, tillering and environmental stresses. In cotton, there was an increase in the number of bolls per plant through GA_3 application (Sawan *et al*., 1989) and increase in the cotton yield through Pix (mepiquat chloride) application (Pol and Thombre, 1985) and by seed soaking in GA_3 (Eid and El-Aggory, 1985). Similarly, Zheng and Zu (1982) reported that exogenous application of IAA in cotton stimulated growth and decreased boll shedding. Sawan *et al.* (1989) observed that higher rate of N and P on cotton sprayed with IAA, IBA and NAA gave increased seedling vigour/length and seed cotton yield. Similar are the findings of Fan *et al.* (1990) through application of N fertilizer and mepiquat to cotton.

In Pakistan, (Jalis and Chaudhry, 1997) and in India (Chaudhri and Bathkal, 1977) got increased seed cotton yield with the spray of Planofix (NAA) to cotton.

The present experiment was planned to study the effect of spraying 'Mixtalol' a growth regulator product marketed by Lever Brothers Pakistan Ltd., on cotton in addition to different levels of N and P fertilizers application. It is claimed to enhance seed germination, vegetative and reproductive growth of crop contributing favorably to increase the productivity potential. In a field trial with

Mixtalol-fertilizer interaction on cotton, plant height, number of branches and bolls per plant and seed cotton yield were significantly increased, by Mixtalol foliar spray (Saeed *et al.*, 1986).

Materials and Methods

The study was undertaken at University of Agriculture, Faisalabad on cotton CV. B-557 as a test variety. This field experiment was laid out according to split-plot design with four replications. Each sub-plot had a dimension of 8 m x 3 m (24 m^2). The treatments were as below.

Main-plot treatments = Fertilizer rates (F):

F_o = Control (no N and P fertilizer)
F_1 = Half rate of N and P fertilizers viz. 57.5 and 28.8 Kg ha^{-1} N and P_2O_5, respectively.
F_2 = Full rate of N and P fertilizers viz. 115 and 57.5 Kg ha^{-1} N and P_2O_5, respectively.

Sub-plot treatments = Mixtalol concentrations (M):

M_o = Control (no Mixtalol spray but only water).
M_1 = Mixtalol @ 2 ppm in foliar spray.
M_2 = Mixtalol @ 3 ppm in foliar spray.

Phosphatic fertilizer DAP was whole applied at the time of land preparation before sowing and N fertilizer Urea was applied just before first irrigation. The Mixtalol foliar sprays were done thrice, first at 15 days after sowing, on 10th June, second on 12 July and third on 12th August with Solo Knop Sack hand spray pump. All the other agronomic and plant protection measures were applied equally to all the treatments. Data regarding growth and yield parameters were recorded during the crop duration. Data were analyzed statistically through Analysis of Variance (ANOVA) technique (Steel and Torrie, 1982) and the treatments were compared by Duncan's Multiple Range Test (Duncan, 1961).

Results and Discussion

Plant height: Data regarding the effect of different rates of N and P fertilizers, Mixtalol concentrations and the interaction of fertilizer with Mixtalol are given in Table 1. It indicates that maximum plant height was under F_2 (full rate of fertilizer), which was statistically significant over that of F_1 (half rate of fertilizer), which was superior to F_o (Control). Among Mixtalol treatments, M_1 (2 ppm) and M_2 (3 ppm) caused statistically equal plant height, however both concentrations gave statistically higher value than that of M_o (Control). Results of this study show that Mixtalol foliar spray causes increase in the plant height of cotton, however, both the concentrations have non significant difference, although the M_2 (higher concentration) caused smaller increase in plant height. Misra and Malik (1980) also recorded an increased plant height of cotton through foliar spray of 0—200 ppm Cycocel (Chloromequat), but it was less at increasing concentrations. In contrast, Kerby (1983) and Cathey (1984) observed that application of Pix (mepiquat chloride) and triacontol, respectively, to cotton reduced the plant height.

The interaction of fertilizer and Mixtalol (F x M) revealed that the maximum plant height was under F_2 x M_1 and F_2 x M_2 both being statistically similar. The lowest values were recorded under F_o x M_o, F_o x M_2 and F_1 x M_o which had non significant difference among themselves. This reveals that F_2 (full fertilizer) along with M_1 (2 ppm Mixtalol) gives the maximum plant height, where as in the absence of both viz. F_o x M_o, the plant height is minimum. Similar results were obtained by Saeed *et al.* (1986) who observed in a field trial with Mixtalol-fertilizer interaction on cotton that plant height was significantly increased. However, McConnell *et al.* (1992) found decreased plant height with mepiquat chloride.

Number of branches: Table 2 presents the data on number of branches per plant as influenced by the application of fertilizers and Mixtalol. The average results show the positive effect of the both, however, the differences between half and full rate of fertilizer and that between Mixtalol concentrations viz. 2 ppm and 3 ppm were statistically non significant. Among the interactions of both type treatments (F x M), the best results were obtained by F_2 x M_1 (full fertilizer x 2 ppm Mixtalol) and the lowest value was in control viz. F_o x M_o. Misra and Malik (1980) also found increased number of branches of cotton plant through foliar spray of Cycocel. Similar results were recorded by Saeed *et al.* (1986) with Mixtalol x fertilizer applications to cotton.

Number of bolls: Total number of bolls per plant were directly affected by fertilizer application being highest number under F_2 (full fertilizer), which was statistically superior to F_1 and F_o (Table 3). Mixtalol gave highest value at M_1 (2 ppm) which was significantly better than that with M_2 (3 ppm). The interaction of F x M gave best results under F_2 x M_1 followed by F_1 x M_1. increased number of bolls per plant were also observed by Khan and Hanif (1980) through spray of 20 ppm NAA /acre. Sawan *et al.* (1981) got similar results with IBA spray, while Kerby (1983) had same experience with Pix application. Higher number of bolls were also obtained by GA_3 application (Eid and El-Aggory, 1985), NAA and IAA application (Tanveer *et al.*, 1986) and Mixtalol fertilizer interaction (Saeed *et al.*, 1986).

Table 1: Effect of fertilizer and Mixtalol application on cotton plant height

Treatments	F_0 (Control)	F_1 (Half fertilizer)	F_2 (Full fertilizer)	Average
M_o (Control)	125.5a*	131.5ab	147.5c	134.9B*
M_1 (Mixtalol@2 ppm)	133.6b	152.7cd	160.5e	149.0A
M_2 (Mixtalol@3 ppm)	130.5ab	150.4cd	156.0de	145.5A
Average	129.9C*	144.9B	154.7A	

Standard errors
F = 2.05, M = 1.24, F x M = 2.15

* Average means in a column/row or columns x rows bearing similar letter(s) are statistically alike at 5% probability level

Table 2: Effect of fertilizer and Mixtalol application on cotton branches (# plant^{-1})

Treatments	F_o (Control)	F_1 (Half fertilizer)	F_2 (Full fertilizer)	Average
M_o	21.2a*	24.3b	24.4b	23.3B*
M_1	24.2b	30.2c	32.5d	29.0A
M_2	23.6b	29.2c	29.6c	27.5A
Average	23.1B*	27.8A	28.9A	

Standard errors
F = 2.79, M = 0.37, F x M = 0.65

* Average means in a column/row or columns x rows bearing similar letter(s) are statistically alike at 5% probability level

Table 3: Effect of fertilizer and Mixtalol application on cotton bolls (# plant^{-1})

Treatments	F_o	F_1	F_2	Average
M_o	28.2a*	30.3b	32.3c	30.2C*
M_1	34.2d	40.6f	43.5g	39.5A
M_2	29.6ab	36.4e	38.0e	34.7B
Average	30.7C*	35.8B	37.9A	

Standard errors
F = 0.18, M = 0.33, F x M = 0.57

* Average means in a column/row or columns x rows bearing similar letter(s) are statistically alike at 5% probability level

Table 4: Effect of fertilizer and Mixtalol application on seed cotton yield (t ha^{-1})

Treatments	F_o	F_1	F_2	Average
M_o	1.81a*	2.14d	2.21e	2.05C*
M_1	2.08c	2.48f	2.57h	2.38A
M_2	1.98b	2.50fg	2.51g	2.29B
Average	1.96C*	2.33B		

Standard errors
F = 0.016, M = 0.007, F x M = 0.012

* Average means in a column/row or columns x rows bearing similar letter(s) are statistically alike at 5% probability level

Seed cotton yield: The results of fertilizer and Mixtalol application are similar on seed cotton yield (Table 4) as stated for number of bolls. The best combination of F x M was F_2 x M_1 followed by F_2 x M_2, however, both have statistically significant difference and the lowest value was under F_o x M_o. A number of scientists working on different growth regulators found increased seed cotton yield through application of NAA (Jalis and Chaudhry, 1977; Chaudhry and Bathkal, 1977; Fan *et al*., 1990), IAA, IBA and NAA (Sawan *et al*., 1989), GA_3 (Eid and El-Aggory, 1985) and Pix (Pol and Thombre, 1985). Mixtalol-fertilizer interaction was studied by Saeed *et al*. (1986), they got exactly the same results as recorded in the present study. In contrast McConnell (1992) reported decreased cotton yields with the application of mepiquat chloride.

Cotton gave best response to the application of full dose of fertilizer even in the presence of Mixtalol treatment. The Mixtalol sprays gave maximum growth and yield of cotton at lower concentration viz. M_1 (2 ppm), whereas, higher dose viz. M_2 (3 ppm) got smaller response of cotton. Therefore, the most suitable combination of fertilizer-Mixtalol was the F_2 x M_1 viz. full fertilizer along with 2 ppm Mixtalol spray thrice starting from 15 days after sowing with one month interval between each application.

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