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Effect of hormonal growth regulator spraying and topping on some agronomic traits in the newly released cotton (*Gossypium hirsutum*) cultivars

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Abstract

This study was aimed to effect of hormonal growth regulator spraying and topping on yield components of new released cotton cultivars. The experiment was conducted in Parsabad, Moghan, Iran, in a randomized complete block design. In 15 and 30 days after flowering the cotton cultivars were foliar sprayed by with recommended doses of (Pix), and topping at 30 days after flowering. Crop height in topping treatment of Mehr cultivar at 30 days after flowering reduced 19.5% compared to the control. Short internodes of 5 to 6 cm observed in spraying of Pix and topping, while long internodes below 8 cm developed in control. Ripening stage of the Sahel cultivar in topping and Pix spraying at 30 DAF treatments happened 5.5 days earlier, while Bakhtegan in Pix spraying at 30 DAF ripened 4 days earlier than control. Yield in topping at 30 DAF of Mehr harvested 61.5 days after sowing. In Sahel those plants with shorter height had higher yield. Response of Mehr to Pix spraying was better than topping. As a conclusion topping and Pix is spraying of the Sahel, Bakhtegan and Mehr cultivars could be resulted in reduction of stem height, earliness and finally improved yield. The stepwise regression analysis verified that the crop height, internode length and bolls weight of cotton had a marked increasing effect on total yield of cotton cultivars.

Keywords : Internode, pix spraying, ripening stage and stepwise regression.

Introduction

Mepiquat chloride as a hormonal growth regulator agent is available in the market in several brans (for example, Pix, Mepex-Griffin, Mepachlor-Microflo, Top-It, from Gowan). Plant growth regulators are substances when added in small amounts modify the growth of plant usually regulation, they are considered as a new generation of agro-chemicals after fertilizers, pesticides and herbicides (Niakan and Habibi, 2013). The use of these compounds to reduce plant height in cotton results in earlier maturity and, under some circumstances, increased the yield. Plant growth regulators play a key role in internal control mechanism of plant growth by interacting with key metabolic processes such as nucleic acid and protein synthesis (Gencsoylu, 2009).

Moisture supply and heat generally result in vigorous growth in early season. Plant height may easily exceed 80 cm at early bloom in some cotton fields. Growers need adequate vegetative growth to support the soon-to-develop boll load, but if the plant is allowed to run away, it can impact management, especially fruit retention. History of vigorous early season growth and current crop condition may be the major factors in selecting the proper program.

Cotton (*Gossypium hirsutum* L.) is a subtropical perennial crop with an indeter- minate growth habit and one it is one of the important cash crops in the

world (Gencsoylu, 2009). Vegetative and reproductive growth occurs simultaneously while vegetative growth is necessary to support reproductive growth. Cotton plant has a natural mechanism to prevent excessive vegetative growth, which leads leads to severe production problems such as fruit abortion, delayed maturity, boll rot and harvest difficulties. In many cases growth regulators are needed to maintain proper plant size and to promote boll set and early maturity (Niakan and Habibi, 2013).

Pix is commonly used as growth retardant, when applied as foliar spray vegetative growth, reduced, leaves become coarser and dark green in color (Brigg (Brigg and Beltwide, 2008; York, 2008). Pix inhibits gibberellin biosynthesis, which implies that they cause growth reduction by decreasing cell elongation and reduce the elongation of the internodes below the meristem (Gencsoylu, 2009). This work was aimed to study the effect of hormonal growth regulator spraying and topping on yield components of newly released cotton cultivars.

Material and Methods

This experiment was conducted in Parsabad, Moghan, Iran, in a sandy loam soil with a pH of 7.6 and organic matter of 1.3%. The climate of research site is sub-tropic with an average annual precipitation of 270 mm.

Seeds of cotton used for this study were obtained from Seed and Plant Improvement Institute of Karaj, Iran. The experimental field had been in a corn-wheat rotation cycle for the last two years. The experiment was laid out factorially in a randomized complete block design in field condition with three replicates.

In all the plots two cultivations with a tractor-drawn cultivator along with the manuring 16 t ha^{-1} followed by planking were given to achieve desirable soil structure. Then the fields were furrowed in the early spring before sowing. Seeds were hand sown on 3rd May in rows about 80 cm apart and 20 cm in the rows at 5 cm depth. Based on soil analysis fertilizers P and K were applied basally at the rate of 100 and 140 kg ha^{-1} respectively. Nitrogen was applied at the rate of 130 kg ha^{-1}, of which 50% was applied basally and the rest at stem elongation stage. 10 irrigations were given to all treatments until 30 days prior to final harvesting.

No herbicide before sowing was used to control weeds. After 15 and 30 days of flowering in spring the four cotton cultivars (Sahel, Varamin, Bakhtegan, Mehr) were foliar sprayed with recommended doses of Mepiquat chloride (Pix), and topping at 30 days after flowering. Plots receiving neither Pix nor topping treatment served as control.

At harvesting stage, the middle four cotton rows of each plot were hand harvested. No pesticide used to control insects. The yield harvested separately from each plot during 27th September until 17th October. Agronomic traits and yield components were examined by standard procedures. Data were statis- tically analyzed using the software MSTAT-C. Analysis of variance was used to test the significance of variance, while Duncan's Multiple range test ($p = 0.05$) was used to compare the differences among treatment means.

In statistics, stepwise regression includes regression models in which the choice of predictive variables is carried out by an automatic procedure. In this study, to formulate the relationship between six independent growth variables measured in our experiment for cotton crop with a dependent variable, multiple regression analysis was carried out for the crop height (X_1), internode length (X_2), stem diameter (X_3), leaves number per plant (X_4), earliness (X_5), bolls weight (X_6), 300 seed weight (X_7) and total yield (Y) as a dependent variable. Furthermore, the stepwise regression analysis was also carried out for the data obtained to test the

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significance of the independent variables affecting the total yield.

Results and Discussion

Analysis of variance for response of cotton cultivars to hormonal growth regulator spraying and topping are indicated in Table - 1. Crop height was affected by cultivar and hormonal growth regulator spraying and topping.

Crop height in topping treatment of Mehr cultivar at 30 days after flowering reduced 19.5% compared to the control. This cultivar may have responded to Pix at later spraying. When crop plants were Pix sprayed 15 for days after flowering, their heights were taller than the control, but delaying in Pix spraying at 30 days after flowering lead to shortening of height in cotton. In Mehr cultivar, the height in topping treatment at 30 days after flowering reduced to 13.5% in comparison to control. Whereas, in Bakhtegan, the stem height in Pix sprayed plants at 15 days after flowering reduced significantly compared to other treatments. Also, in MehrPix spraying at 15 days after flowering was more effective than the other ones with a view to stem height (Table - 2).

Plant growth regulators like promoters, inhibitors or retardants play a key role in internal control mechanism of plant growth. In an experiment conducted by Niakan and Habibi (2013) spraying of Pix in concentrations of 1.5 and 2 L ha^{-1} cause decrease in nodes number in cotton and stem height in comparison with control. Plant growth regulators decrease cotton vegetative growth by modifying the production of plant hormones such as gibberellins, auxins and cytokinins. Pix is an anti-gibberelin which decreases vegetative growth by reducing gibberellic acid formation, reduces plant height, that inhibits cell expansion, but not cell division (Gencsoylu, 2009 and Muhammad *et al.*, 2007). It was reported Pix which is commonly used as growth retardant, when applied as foliar sprayer reduce the vegetative growth of plant (Gencsoylu, 2009).

Short internodes of 5 to 6 cm observed in spraying of Pix and topping, while long internodes below 8cm developed in control (Fig.- 1). According to the results of this research, application of Pix and topping decreased the average leaf number in cotton cultivars, but it was not significant, which is in agreement with the report of Niakan and Habibi (2013) that leaf number and leaf area decreased due to application of Pix. Souza and Rosolem (2007) also observed a decrease in the cotton leaf area when plants were treated with this growth regulator. The researches showed that application of gibberellic acid cause an increase in the leaves number and leaf area in plants (Abou Dahab *et al.*, 1986). Since Pix is an anti-gibberellin (Gencsoylu, 2009), cotton plants treated with Pix have smaller leaves and leaf number than the control.

Sahel cultivar in topping and Pix spraying at 30 DAF showed ripening stage 5.5 days earlier, while Bakhtegan in Pix spraying at 30 DAF ripened 4 days earlier than the control. Varamin did not respond to treatments, while yield in topping at 30 DAF of Mehr harvested 61.5 days after sowing (Fig.- 2). Topping at 30 DAF in Sahel, topping and Pix spraying at 30 DAF in Bakhtegan and Varamin, and Pix spraying at 15 DAF and 30 DAF in Mehr had the highest bolls weight (Fig.- 3).

Manipulation of cotton plant architecture using plant growth regulators such as Pix can be an agronomic strategy for obtaining a higher yield (Niakan and Habibi, 2013). In Sahel those plants with shorter height had higher yield. The cultivar of Varamin did not respond to treatments studied with a view to total yield. When Bakhtegan treated with Pix or topping, its

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Table - 1. Analysis of variance for response of cotton cultivars to hormonal growth regulator spraying and topping

	df	Crop height	Internode length	Stem diameter	Leaves number per plant	Earliness	Bolls weight	300 seed weight	Total yield
Replication	2	0.89	154.20	2.03	2.98	176.22	1.59	33.54	444375.00
Cultivar	3	735.68**	25.30	29.20	14.29	572.95**	1990.63**	69.26	565725.00**
Pix or topping	3	9256.96**	100.20*	12.01	6.20	397.58*	178.33**	33.59	386458.33*
Interaction	9	63.35**	50.51	20.26	15.51	1231.62**	154.50*	80.00	165000.00**
Error	30	8.18	28.55	39.56	5.99	97.35	20.963	25.26	117986.11
CV (%)	-	13.38	19.99	20.00	21.20	22.12	11.37	20.16	21.42

*،**: mean significant at 5% and 1% probability levels respectively.

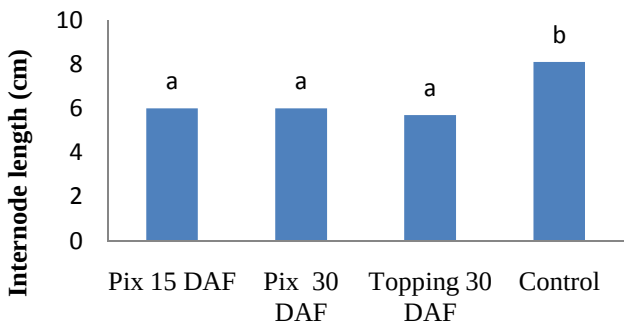
Table - 2. Crop height and total yield of cotton as affected by cultivar, growth regulator spraying and topping

Cotton cultivar		Crop height (cm)	Total yield (kg ha^{-1})
Sahel	Pix spraying 15 days after flowering	109 h	4831cde
	Pix spraying 30 days after flowering	77 b	5003 a
	Topping 30 days after flowering	71 a	4911 b
	Control	88 de	4793 de
Varamin	Pix spraying 15 days after flowering	75ab	4889bc
	Pix spraying 30 days after flowering	73ab	4878bc
	Topping 30 days after flowering	70 a	4712fg
	Control	81bc	4852bcd
Bakhtegan	Pix spraying 15 days after flowering	78bc	4760ef
	Pix spraying 30 days after flowering	87 de	4700fg
	Topping 30 days after flowering	83 cd	4640fg
	Control	101 g	4108 h
Mehr	Pix spraying 15 days after flowering	83 cd	5033 a
	Pix spraying 30 days after flowering	89 e	5019 a
	Topping 30 days after flowering	92ef	4861bcd
	Control	97fg	4011i

Means in each column with the same letter have not significant difference at 5% probability level in DMRT.

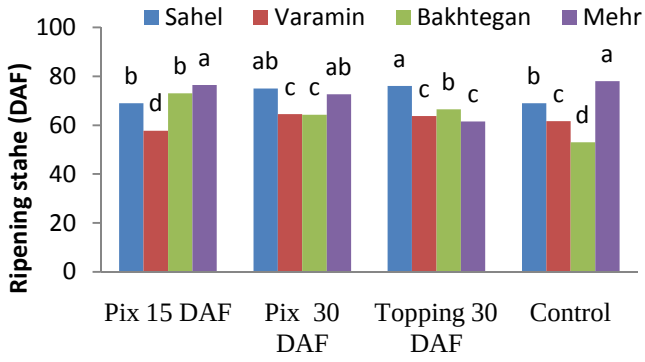
Table – 3. Standard regression coefficients, t values and probability levels of model of total yield in cotton cultivars

	Crop height	Internode length	Bolls weight
Standard regression coefficients (β)	+0.841	+0.999	+0.313
t values	+3.765	+4.555	+2.465
prob.	0.009	0.007	0.005



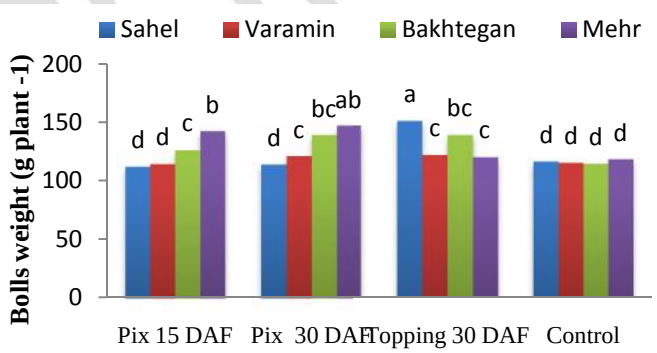
Means with the same letter have not significant difference at 5% probability level in DMRT.

Fig. – 1. Internode length of cotton as affected by Pixand topping



Means with the same letter have not significant difference at 5% probability level in DMRT.

Fig.- 2. Ripening stage of cotton as affected by cultivar, Pixand topping



Means with the same letter have not significant difference at 5% probability level in DMRT.

Fig.- 3. Bolls weight of cotton as affected by cultivar, Pixand topping

yield improved compared to the control. Also, the response of Mehr to Pix spraying was better than topping (Table - 2). Field experiments were conducted with some commercial plant growth regulators (PGRs) to determine their effects on agronomic characteristics as a foliar spray on cotton. The three commercial PGRs, Pix, Tonic, and Turbo pamuk, were sprayed at recommended doses. Application of PGRs significantly affected the yield, plant height, average number of open bolls, and predators. More yields were obtained in Pix- and Turbo pamuk-treated plots (Gencsoylu, 2009).

Stepwise regression analysis

Standard regression coefficients, 't' values and probability levels of model of yield in cotton are indicated in Table - 3.

The multiple regression equation obtained is:

Total yield (kg ha^{-1}) = 0.509 - 1.102 (X_1) - 3.000 (X_2) + 0.525 (X_3) + 1.453 (X_4) + 1.179 (X_5) + 0.999 (X_6) + 1.907 (X_7);

The resulted stepwise regression equation for cotton cultivars is :

Total yield = 1.497 - 1.555 (X_1) - 2.001 (X_2) + 0.978 (X_6); R^2 = 81

Conclusion

It can be concluded from the study that topping and Pix hormonal spraying after flowering stage of the Sahel, Bakhtegan and Mehr cultivars in cotton plants resulted in reduction of stem height, earliness and finally improved the yield. The stepwise regression analysis verified that the crop height, internode length and bolls weight of cotton had a marked increasing effect on total yield of cotton cultivars. Therefore, may be concluded that these traits are as major attributes of cotton yield offer the best guide for selection by the crop breeders.

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