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Impact of Plant Growth Regulators on the Growth and Yield of Cotton

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Abstract The experiment was carried out in a three replicated randomized complete block design, having net plot size of 6 x 8 m = (48 m^2), during the year 2013-14 at the experimental fields of Cotton Section, Agriculture Research Institute, Tandojam. The treatments are comprised such as control or un-treated plots, Planofix at 50 ml/500 litres of water at bud formation, Planofix at 100 ml/500 litres of water at bud formation, Planofix at 150 ml/500 litres of water at bud formation, Pix at 500 ml/500 litres of water at bud formation, Pix at 1000 ml/500 litres of water at bud formation, Pix at 1500 ml/500 litres of water at bud formation.Theobersation were recorded on parameters of economic importance such as plant height (cm) Monopodial branches per plant, Sympodial branches per plant, Opened bolls per plant, Un-opened bolls per plant, Seed cotton weight per plant (g), Seed cotton yield (kg ha^{-1}), Ginning out-turn G.O.T. (%). All the growth and yield character of cotton variety of sindh-1 was significantly at ($P<0.05$) affected by various plant growth regulators. The maximum plant height (137 cm), monopodial branches per plant (1.9), symonopodial branches per plant (23.0), opened bolls per plant (30.1), un-opened bolls per plant (4.0), seed cotton yield per plant (97.4 g), seed cotton yield (3074.0kgha^{-1}) and G.O.T (34.5%) were observed underPix at 1000 ml/500 litres of water at bud formation. It is concluded from studies that all the characters of cotton variety sindh-1 was significant at 5% probability level except G.O.T % which was non-significant Plant growth hormones are effective for enhancing the yield of cotton crop.Pix at 1500 ml/500 litres of water at bud formationis more effective for obtaining more number of bolls per plant and maximum seed cotton yield per plotsas well as seed cotton yield kg ha^{-1}.

Keywords: Growth regulators Pix, Planofixgrowth cotton

Introduction

Cotton is one of the most important fiber crops playing a key role in the economic and social affairs of the world providing basic input to the textile industry. It is the oldest among the commercial crops of the world and is regarded as white gold Akhtar *et al*., 2013) Cotton has played a significant role

in agriculture, industrial development, employment, financial stability and economic viability ever since the country attained the independence. It is the most beneficial fiber and cash crop of Pakistan and earns a good fortune for the country in the form of foreign exchange (Ahmed *et al*., 2009). It is the world's leading source of natural textile fiber and fifth largest oilseeds crop which covers 40% of the global textile need (APTMA, 2012) and 3.3% of edible oil (FAS, 2014), respectively. Pakistan is a fourth largest cotton producing country of the world while ranks third in consumption and is a leading story exporter (ICAC, 2012) with a production of 12.8 million bales from an area of 2.8 million hectares (Anonymous, 2014).

There are several problems associated with the growth and development limiting the yield. Abscission of leaves and reproductive parts is one of the major problems, in irrigated and heavy rainfall areas. Excessive vegetative growth reduces yield. Plant growth regulators are known to modify the source to sink relationship and increase the translocation and photosynthetic efficiency resulting in increased square and boll retention and boll set per cent (Kiran Kumar, 2001). 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. Pix (mepiquat chloride) are a plant growth regulator widely used in inhibiting gibberellic acid formation and plant height.

Plant growth regulators such as Pix and TurBopamuk increase seed cotton yield, but do not affect fiber quality (Gencsoylu, 2009). However, there are also some findings supporting that Pix decreases seed cotton yield (O'Berry *et al.*, 2009). Abro *et al.* (2004) reported that naphthalene delay maturing and increase plant height, number of boll and seed cotton yield. Producers tend to use commercially available plant growth regulators to increase yield per unit area; however, there are some problems regarding the selection of plant growth regulators. Therefore, information is needed on the effects of commercially available plant growth regulators on seed cotton yield and fibre quality properties. Manipulation of cotton plant architecture using plant growth regulators/ growth hormones can be an agronomic strategy for obtaining high yields (Souza and Rosolem, 2007).

Pix (N, N-dimethyl-piperidiniumchloride), commonly referred to as Mepex, Topit, and Mepiquat Chloride and consists of 4.2 % N, N-dimethyl piperidinium chloride, a quaternary ammonia compound. Pix which are commonly used as growth retardant, when applied as foliar spray reduce the vegetative growth of plant; leaves become coarser and dark green in color (Muhammad *et al.,* 2007). Wilson *et al.* (2007) reported reduction in plant height, main stem nodes, number of effective sympodia and total bolls per plant in response to growth hormones as compared to the control. Similar reduction

in plant height and total nodes in plants treated with growth hormones application has been reported by Nichols *et al.* (2003) and Nuti *et al.* (2006). Heilman (1985) reported reduced vegetative growth under high moisture and nitrogen environment in response to growth regulators treatment, in addition to increased calcium uptake by leaves. Lint yield and quality, however was not affected by regulators treatments. Biles and Cothren (2001) reported increased fruit retention, earlier maturity and higher yield along with reduced square abortion in response to growth regulators treatment, although yield increase was inconsistent. The main object this study evaluates the effect of plant growth regulators (Planofix/pix) on growth and yield contributing traits of cotton and find-out the most appropriate dose of plant growth regulators for maximum seed cotton yield

Materials and methods

The experiment was carried out in a three replicated randomized complete block design, having net plot size of 6 x 8m^2 = (48 m^2), during the year 2013 at the experimental fields of Cotton Section, Agriculture Research Institute, Tandojam. The study was carried out at Cotton Section, Agriculture Research Institute, Tando jam during the year of 2013 to investigate the effect of plant growth regulator on cotton. The experiment was carried out in a three replicated randomized complete block design, having net plot size of 6m x 8m = (48 m^2), during the year 2013-14 at the experimental fields of Cotton Section, Agriculture Research Institute, Tandojam. The treatments are comprised such as control or un-treated plots, Planofix at 50 ml/500 litres of water at bud formation, Planofix at 100 ml/500 litres of water at bud formation, Planofix at 150 ml/500 litres of water at bud formation, Pix at 500 ml/500 litres of water at bud formation, Pix at 1000 ml/500 litres of water at bud formation, Pix at 1500 ml/500 litres of water at bud formation.The obersation were recorded on parameters of economic importance such as plant height (cm) Monopodial branches per plant, Sympodial branches per plant, Opened bolls per plant, Un-opened bolls per plant, Seed cotton weight per plant (g), Seed cotton yield (kg ha^{-1}), Ginning out-turn G.O.T. (%). A total of 21 plots were prepared and managed in such a way to separate the plots of treatments and replications easily, while the channels and bunds were prepared to facilitate the application of irrigation water and other cultural operations. Sowing of cotton was in the 4th of April 2013 by hand drill. The row to row spacing was kept at 2.5 cm and plant to plant of 6 cm. Commercial variety Sindh-1 was used in the study.

Sowing Time and Method

The seed was applied at the rate of 12 kg per hectare, the sowing was done on flat bed in the month of 4th April 2013 with the help of hand drill. The distance between row to row 2.5 cm and plants to plant 6 cm was maintained apart. Thinning was done before first irrigation.

Fertilizer

The recommended ½ bag of DAP (Diammoniul Phosphate) was applied as basal dose and ½ bag of Urea was applied at sowing time. The rest of nitrogen, phosphorus and potassium fertilizer was applied at various growth stages just before irrigation as per plan of study.

Weeding and Interculturing

Weeding and Interculturing was carried out after two irrigations with spade to keep experiment area free from weeds and break hard surface between the crop rows.

Irrigation

The irrigations were given as per the crop requirement and soil moisture availability from sowing up to the picking the crop was irrigation six time and source of irrigation was canal water.

Picking

The picking of cotton seed was started in the 2nd week of August 2013 when more then 50 % bolls were opened.

G.O.T (%)

Ginning out-turn (%) is the ratio of lint to seedcotton produced by the Ginning process. The G.O.T (%) was obtained by separating lint from seed; percentage of the total seed cotton weight was obtained as G.O.T (%).

Statistical analysis

The data thus collected will be subjected to statistical analysis using

Analysis of variance technique and LSD (Least Significant Test) to determine the superiority of treatment means using Mstat-C Computer Statistical Software, following Gomez and Gomez (1984).

Result and discussion

The study was carried out at Cotton Section, Agriculture Research Institute, Tando jam during the year of 2013 to investigate the effect of plant growth regulator on cotton. The observations were recorded on the growth and yield parameters of cotton crop such as plant height, monopodial branchesper plant, sympodial branches per plant, open bolls plant per plant, un-open bolls per plant, seed cotton weight (g plant^{-1}), seed cotton yield (kg ha^{-1}), G.O.T (%).

Plant height (cm)

The results showed that plant height (cm) was significant in response to plant growth regulators treatment concentrations. The maximum plant height (137.0 cm) was recorded in control plots, followed by (132.3 cm) was observed treatment of pix at 500ml/500 litres of water at bud formation and the minmum plant height (113.6 cm) was recorded treatment of pix at 1000ml/500 liters of water at bud formation.

Monopodial branches plant

The results indicated that monopodial branches per plant showed significant results in response to plant growth regulators treatment concentrations. The maximum branches per plant (1.9) was recorded in control plots, followed by (1.8) was observed treatment of fix at 1500ml/500 litres of water at bud formation and the minmum monopodial branches per plant (1.3) was recorded treatment of pix at 100ml/500 liters of water at bud formation.

Sympodial branches plant

The results indicated that sympodial branches per plant showed significant results in response to plant growth regulators treatment concentrations. The maximum monopodia branches per plant (23.0) was recorded in control plots, followed by (21.7) was observed treatment of fix at 1000ml/500 litres of water at bud formation and the minmummonopodial branches per plant (18.0) was recorded in treatment of planofix at 50ml/500 liters of water at bud formation.

Opened bolls plant

The results indicated that opend bolls per plant showed significant results in response to plant growth regulators treatment concentrations. The maximum opend bolls per plant (30.1) was recorded in treatment of pix at 1000ml/500 liters of water bud formation followed by (27.6) was observed treatment of planofix at 100ml/500 litres of water at bud formation respectively and the minmumopend bolls per plant (25.1) was recorded in control.

Un-opened bolls plant

The results indicated that un-opend bolls per plant showed significant results in response to plant growth regulators treatment concentrations. The maximum opend bolls per plant (4.0) was recorded in treatment of pix at 1000ml/500 liters of water bud formation, followed by (3.3) was observed treatment of planofix at 150ml/500 litres of water at bud formation respectively and the minmum un-opend bolls per plant (2.8) was recorded in contro plots.

Seed cotton weight (g plant^{-1})

The results revaled that seed cotton yield per plots showed significant results in response to plant growth regulators treatment concentrations. The maximum seed cottom yield per plant (97.4) was recorded in treatment of pix at 1000ml/500 liters of water bud formation followed by (89.6) was observed treatment of planofix at 100ml/500 litres of water at bud formation and the minmum seed cotton per plant (77.2) was recorded in control plots.

Seed cotton yield (kg ha^{-1})

The results revaled that seed cotton yield kg ha^{-1} showed significant results in response to plant growth regulators treatment concentrations. The maximum seed cottom yield (3074.0 kg ha^{-1}) was recorded in treatment of pix at 1000ml/500 liters of water bud formation, followed by (2974.0 kg ha^{-1}) was observed treatment of planofix at 100ml/500 litres of water at bud formation and the minmum seed cotton yield (2407.0 kg ha^{-1}) was recorded in control plots.

G.O.T (%)

The results showed that ginning out-turn % non-significant results in response to plant growth regulators treatment concentrations. The maximum and minimum ginning out-trun% values (34.5-32.1) were recorded in treatment of planofix at 150ml/500 liters of water at bud formation.

Discussion

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. One of Plant growth regulators is Pix (N, N-dimethylpiperidiniumchloride), commonly referred to as Mepex, Topit, and Mepiquat Chloride and consists of 4.2 % N, N-dimethyl piperidinium chloride, a quaternary ammonia compound. Pix which are commonly used as growth retardant, when applied as foliar spray reduce the vegetative growth of plant; leaves become coarser and dark green in color. Plant growth regulators are substances when added in small amounts modify the growth of plant usually by stimulating or inhibiting part of the natural growth regulation. They are considered as new generation of agrochemicals after fertilizers, pesticides and herbicides. Plant growth regulators are capable of increasing yield by 100-200 per cent under laboratory conditions, 10 - 15 per cent in the field conditions (Kiran Kumar, 2001). Plant growth regulators like promoters, inhibitors or retardants play a key role in internal control mechanism of plant growth by interacting with key metabolic processes such as nucleic acid and protein synthesis. The most commonly used growth regulator in cotton is mepiquat chloride, which is an inhibitor of gibberlic acid. This curtails excessive vegetative growth and increases the yield. Plant growth regulators are shown to change leaf resistance by altering stomatal aperture, the rate of photosynthesis could be manipulated through this technology. IAA, GA, kinetin, phenolics and aliphatic alcohols are reported to increase and stimulate the rate of photosynthesis. In several species, the application of growth retardants is shown to stimulate photosynthesis by increasing LAI, delaying leaf senescence, increasing the functional duration of the leaf or delaying degradation of chlorophyll which has improved source-sink relationship.

Table 1. Effect of plant growth regulators on the growth and yield related characters of cotton

Treatments	Plant height (cm)	Monopodial branches plant^{-1}	Sympodial branches plant^{-1}	Opened bolls plant^{-1}	Un-opened bolls per plant	Seed cottonweight (g plant^{-1})	Seed cotton yield (kg ha^{-1})	G.O.T (%)
Control	137	1.9	23	25.1	2.8	77.2	2407	32.2
Planofix at 50 ml/500 litres of water at bud Formation	122.7	1.2	18	25.9	3.2	81.3	2751.7	34.4
Planofix at 100 ml/500 litres of water at bud Formation	114	1.1	18	27	3	85.4	2815	34.4
Planofix at 150 ml/500 litres of water at bud formation	124	1.2	18.4	26.7	3.3	85.4	2778	34.5
Pix at 500 ml/500 litres of water at bud Formation	132.3	1.4	21	27.6	3.3	89.6	2974	32.2
Pix at 1000 ml/500 litres of water at bud Formation	127	1.2	19	27.3	3.06	86.7	2829.7	34.4
Pix at 1500 ml/500 litres of water at bud Formation	132.7	1.8	21.7	30.1	4	97.4	3074	32.1
Mean	**127.1**	**1.4**	**19.9**	**27.1**	**3.2**	**86.1**	**2804.2**	**33.5**

The resultes revealed that the effect of planofix at150ml/500 litres of water at bud formation concentration gave positive and significant impact ($P<0.05$) on various growth and yield of cotton crop traits. The maximum plant height, monopodialbranchesper plant, sympodial branches per plant whiche significant effect of different plant growth regulators under as compare to control plots., However the miximumopend bolls per plant, un-open bolls per plant, seed cotton weight (g plant^{-1}), seed cotton per plant, G.O.T (%) was observed in treatment of pix at 1500ml/500 liters of water at bud formation.These finding studty also Jonathan and Alexander (2006) opined that the application of plant growth regulators reduced plant height, number of main stem nodes, increased the lint and fibre yield significantly. Derrick *et al.* (2000) suggested that mepiquatchloride application to cotton reduces plant height, vegetative growth by shortening internodal length. Ram Prakash and Mangal Prasad (2000) was indicated that foliar spray of chloromequat chloride 50 and

100 ppm reduced the plant height significantly over the control plotsthese resultes are futher supported by Zakaria *et al.* (2006) reported the effect of mepiquate chloride at 70 and 95 days after planting and observed increased number of opened bolls per plant, boll weight, seed index, lint yield per plant and lint yield per hectare.

Conclusion

It is concluded from studies that all the characters of cotton variety sindh-1 were significant at 5% probability level except G.O.T % which was non-significant Plant growth hormones are effective for enhancing the yield of cotton crop. Pix at 1500 ml/500 litres of water at bud formationis more effective for obtaining more number of bolls per plant and maximum seed cotton yield per plotsas well as seed cotton yield kg ha^{-1}.

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