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The Effect of Plant Growth Regulators on the Growth and Development of Cotton in Calcareous Soil of Uzbekistan

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ABSTRACT

Experiments were conducted to determine the stimulatory effect of three commercial plant growth regulators (PGRs) TJ85, BIST and Vitavax 200 on the growth and yield of cotton in semi-arid soils of Uzbekistan. Vitavax 200 increased the germination rate as much as 95%. The total plant weight showed a 25% increase when treated with Vitavax 200, and 21% with BIST. PGRs, when applied to cotton seeds, caused a 13% increase in leaf weight and 34% in shoot weight. BIST and Vitavax 200 most successfully increased cotton yield, which was maximum with Vitavax 200 (21%) compared to control plants. Vitavax 200 may be a potential PGR in the management of cotton production in semi-arid soils.

Keywords: PGRs, plant growth, semi-arid soils, yield

INTRODUCTION

Plants need several elements for healthy growth, one being plant growth regulators (PGRs), which are considered to be agrochemicals after fertilizers and pesticides (Rafeekher *et al.* 2002). They can be used to stimulate growth and development of plants and might be useful alternatives to increase crop production (Sharma and Kumar 2011).

The exogenous application of PGRs produced some benefits in stimulating germination, growth and seed yield (Khan *et al*. 2004; Afzal *et al.* 2005). Further, the physicochemical quality of the crop is also influenced by PGRs.

Various PGRs are now commercially being used on a large number of crops across diverse geographical and climatic areas and several of them have reached considerable importance in crop production (Cavusoglu and Kabar 2007). The effect of PGRs, especially Atonik, cycocel, Crop+2, Cytokin, Early Harvest, Maxon, PGR-IV, mepiquat chloride, Pix Plus, PHCA, mepiquat chloride and mepiquat pentaborate on cotton growth and development is well documented (Zhao and Oosterhuis 2000; Dodds *et al*. 2010). Using growth chamber studies, Oosterhuis and Zhao (1995) reported that PGR-IV increased root length and root dry weight of cotton one week after planting. Biological stimulators based on plant growth-promoting rhizobacteria (PGPR) can improve germination and stimulated cotton growth and development (Egamberdiyeva and Hoflich 2004; Ardakani *et al.* 2010). PGPR can reduce the adverse effects of stresses during seed germination and plant growth and development of cotton (Wu *et al*. 2012). Although extensive research exists regarding individual PGRs, the impact of several commercially available synthetic and biological PGRs on cotton growth and yield is lacking. Therefore, the aim of this research was to determine the effect of synthetic and biological PGRs on cotton growth and yield in semi arid soil.

MATERIALS AND METHODS

Cotton seeds (*Gossypium hirsutum* L.) cv. 'Oqdaryo-5' was obtained from the Research Institute of Cotton Production, Tashkent, Uzbekistan. 'Oqdaryo-5' is a short duration, early maturing, salt- and drought-tolerant variety of upland cotton having medium-sized green leaves, round bolls with a good fluffy opening.

The experiment was conducted at the experimental station of the Research Institute of Cotton Production, Tashkent, Uzbekistan. The field has an EC value of 450 mS m^{-1} soil. The organic matter content of the soil is 1.4%; total C, 1.89%; total N, 0.1%; K, 7.2%; P, 1.34%, and the pH is 7.2. The climate of the area is continental with a yearly average rainfall of 200 ± 36 mm and > 90% of the total rain falling between October to May. The average minimum monthly air temperature is 0°C in January, the maximum of 37°C in July, and the soil temperature ranges between -2 to 35°C. The average highest relative humidity is slightly more than 80% in January and the minimum is less than 45% in June. The combination of high temperatures and low rainfall under continental climate makes irrigation essential for crop production.

The following PGRs were applied: TJ85 (Adpros 85, "Varichem" Ostrowski (0.5%), BIST (Mangit-Mineral Ltd., Uzbekistan) (1%), Vitavax 200 FF (Chemtura Agrosolutions) (5%). The biological preparation BIST is based on the bacterial strain *Pseudomonas putida*. For cultivation of the bacteria, 750-ml flasks containing 100 ml of KB medium (King *et al*. 1954) was inoculated with 5 ml of a bacterial suspension and grown in a shaker (220 rpm) at 28°C for 48 h. These flasks were used for inoculation of 5 liter bottles, each containing 1 liter of growth medium. After cultivation in a shaker (220 rpm) at 28°C for 48 h, the cell suspensions were aseptically transferred into sterile 10 L canisters and stored at 5°C.

The experiment was laid out in factorial randomized block design with three replications. Plot size was 10 m × 6 m, intra-row spacing was 50 cm and rows were 60 cm apart. The land was ploughed and harrowed after the harvest of previous crop. The recommended dose of fertilizers; nitrogen (100 kg/ha), phosphorous (50 kg/ha) and potash (60 kg/ha) were applied in the form of urea, diammonium phosphate and muriate of potash, respectively. Weeds were removed by hand and plots were irrigated after visual inspection of plants. The germination rate and seedling growth development were determined. Six plants were randomly selected from each plot and were tagged for recording leaf and shoot dry weight in at different stages and yield was calculated as g/plant.

Data were tested for statistical significance using the analysis of variance package included in Microsoft Excel 2007. Mean comparisons were conducted using a least significant difference (LSD) test ($P = 0.05$). Standard errors were recorded and an LSD test was performed.

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Short Communication

RESULTS

Vitavax 200 significantly increased germination as much as 95%; in the control treatment germination was 87% (**Fig. 1**). There were significant differences between treatments in shoot and root length of cotton seedlings (**Fig. 2**). Maximum root length was recorded in Vitavax 200 (14.0 cm), significantly higher than TJ85 (12.5 cm) and the control (10.4 cm). Significantly higher shoot length (15.8 cm) was recorded by Vitavax 200 among all treatments. Total plant weight showed a 25% increase with Vitavax 200 treatment and 21% with BIST (**Fig. 3**). In the branching stage, plants treated with Vitavax 200 exhibited a marked stimulation of leaf weight, up to 21% and shoot weight increased significantly (as much as 63%). Several parameters were affected by PGR treatments. Vitavax 200 caused a 13% increase in leaf weight, 34% increase in shoot weight and cotton square was increased by 25%. There were significant differences between treatments and control plants. Vitavax 200, TJ85 and BIST increased cotton yield by 21, 19 and 14%, respectively compared to control plants.

DISCUSSION

Cotton is important in Central Asia, China, India and USA and considering the demand and present status of cotton productivity, there is an urgent need to boost productivity. In this sense, the use of PGRs for increasing production potential of crops is gaining importance (Oosterhuis and Robertson 2000; Norton Borrego 2006). Application of two PGRs in this study, BIST and Vitovax 200, had a significant influence on plant parameters such as germination, shoot and root length, and yield of cotton. A study similar to the present work was conducted by other authors on a grower-cooperator field in 2004 designed to evaluate two mepiquat treatments Mepex Ginout, Pentia and Pix Ultra (Norton *et al*. 2005). Results from that project indicated that the Mepex Ginout treatment produced statistically higher yields than the other two mepiquat treatments (Pentia and Pix Ultra). According Nuti *et al*. (2006), increased yield due to mepiquat chloride may be due to the redistribution of photoassimilates between vegetative and reproductive growth. The effect of mepiquat chloride on yield and fiber quality has also been reported by Siebert and Stewart (2006). Among PGRs tested in this study, Vitavax 200 most increased cotton yield. Howard *et al*. (2001) observed that the application of a PGR, Asset RTU, increased root and shoot length and cotton yield in a tillage system. There are other reports (Gregorio *et al.* 1995; Naidu 2001) showing that PGR-IV resulted in the significant increase of cotton yield (43%) compared to PHCA (40%), cytokinin (33%), Pix (29%), and Crop+2 (20%) (Oosterhuis and Robertson 2000). In our study BIST and Vitavax 200 applied to cotton seeds caused a significant increase in leaf and shoot weight. Egamberdieva (2007) observed that *Pseudomonas alcaligenes* PsA15 stimulated growth and nutrient uptake of cotton in semi-arid soil. Biological stimulator BIST stimulated germination and plant growth probably through their ability of bacteria to produce IAA. It is known that bacterial stimulators based on PGPR are capable of producing physiologically active auxins and gibberellins that may have stimulatory effects on cotton growth and development (Egamberdieva and Gafurova 2008; Ardakani *et al.* 2010). By colonizing the roots, these bacteria may produce phytohormones and enhance the survival of some seedlings, especially during the first few days after the seeds are planted. Based upon these results, it Vitavax 200 and BIST could serve to increase cotton production in semi-arid soil.

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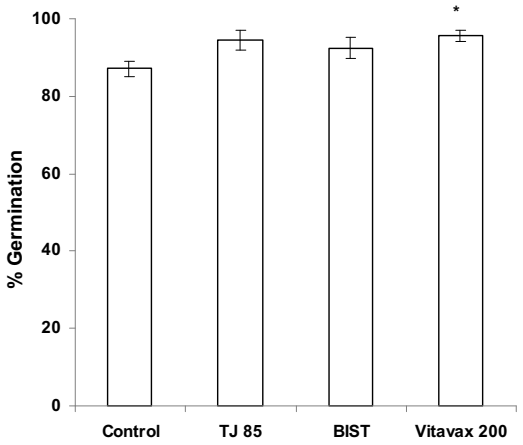

Fig. 1 Effect of plant growth regulators (Roslin, Nitrolin 6, TJ85, BIST and Vitavax 200) on seed germination (%) of cotton in arid soil. Percentage of seed germination (100 seeds) from six replicate plots (N=6), with error bars showing standard deviation. Columns marked with an asterisk differed significantly from untreated control at $P < 0.05$.

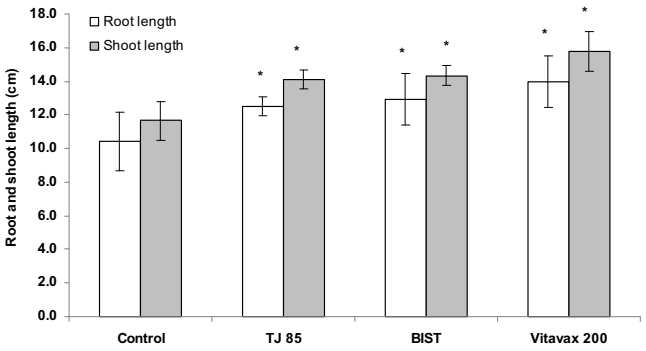

Fig. 2 Effect of plant growth regulators (Roslin, Nitrolin 6, TJ85, BIST and Vitavax 200) on the root and shoot length of cotton seedlings in arid soil. Values of root and shoot length represent means for six plants from three replicate plots (N=3), with error bars showing standard deviation. Columns marked with an asterisk differed significantly from untreated plants at $P < 0.05$.

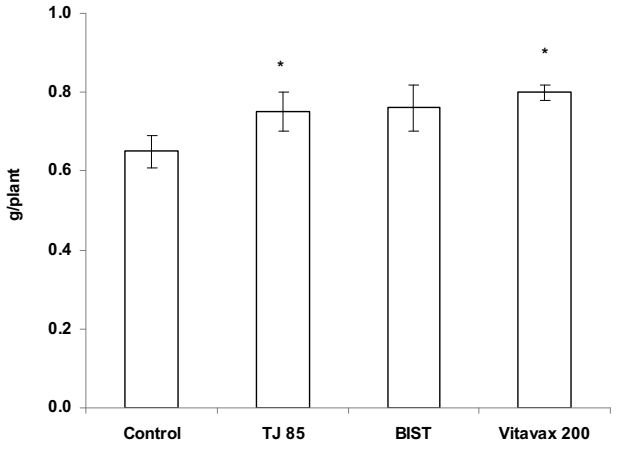

Fig. 3 Effect of plant growth regulators (Roslin, Nitrolin 6, TJ85, BIST and Vitavax 200) on the total plant weight of cotton seedlings in arid soil. Values of plant weight represent means for six plants from three replicate plots (N=3), with error bars showing standard deviation. Columns marked with an asterisk differed significantly from untreated plants at $P < 0.05$.

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