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Article: **Effect of Exogenously Applied Plant Growth Regulators (PGRs) on Two Maize (*Zea mays L.*) Cultivars**

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Effect of Exogenously Applied Plant Growth Regulators (PGRs) on Two Maize (*Zea mays* L.) Cultivars

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Abstract

Maize plant is quite sensitive to lower temperatures before reaching maturity and needs to be nurtured in an optimal environment during cultivation. The purpose of this study was to determine the effect of foliar application of plant growth regulators (PGRs), such as humic acid, ascorbic acid, and thiourea, on two maize cultivars (Pioneer 1543 and Monsanto 8441). PGRs were used at three stages of plant development, namely, seedling stage, 10- to 15- leaf stage, and the blooming stage. 3 treatments, T_1 = 20ml/L, T_2 = 30ml/L and T_3 = 50ml/L, along with one control were compared using a randomized complete block design having three replications. The foliar application of PGRs showed ameliorative effects on maize growth and significantly increased growth parameters, plant biomass, and yield of the plant. Though all the PGR treatments enhanced the growth, biomass, and yield of the crops; however, thiourea application significantly increased plant height, root length, leaf length, leaf area, fresh weight, and cob length. Overall, Monsanto 8441 showed significant improvement under all treatments as compared to Pioneer 1543. The findings of this research revealed an increased growth rate of the crops (height of plant, area of leaf, number of leaves, number of nodes, fresh weight per plant) after foliar application of PGRs. Further studies may be conducted to investigate the physiological, anatomical, and molecular-level changes that caused this increase in growth parameters of the cultivars after foliar application of the selected PGRs.

Keywords: maize cultivars, exogenous application, plant growth regulators (PGRs), maize

Introduction

Maize (corn) is considered the third main cereal crop in Pakistan. It is considered one of the most important cereal grains in the world because it can acclimate itself to a broad range of environmental conditions [1]. It is also one of the major cereal grains in the globe. In terms of performance, it has outperformed all other food and feed components [2, 3, 4]. It can also be used as feedstock make biofuels [5-7]. Maize grain oil is used in the preparation of several meals since it has a high concentration of nutrients. In 2018, 193.7 million hectares (Mha) of maize cultivation produced 1147.6 million metric tons of grain (Mt) across the world [8]. Maize is categorized as a warm-season crop because it is tolerant to a wide range of temperatures and climates, ranging from subtropical to temperate. As a result, this crop can only be grown in areas where the average night temperature is consistently at least 15 degrees Celsius [9].

Fertilizer application and use is necessary for optimal plant growth and yield [10]. Various intensification techniques (also known as "ecological intensification") are now being studied to improve mineral efficiency, disease control efficiency, and water efficiency while conserving resources [11]. Ecological intensification decreases energy use while boosting energy output [12]. To meet current and future demands, crop yields must be raised. We may boost crop yields by using exogenous growth-promoting compounds such as humic acid [13], ascorbic acid [14], and other related substances. Plant growth regulators (PGRs) are those chemicals that can be used to modify the development of a plant life cycle. They are naturally produced chemicals and can be synthesized to improve the crop yields as well. [15]. Additionally, light and temperature are two variables that affect the production of high-quality crops. It is very difficult and expensive to control and maintain these variables. Plant growth substances (PGS) can change a plant's hormonal balance quickly, which is why they can also be used to improve crop yield [16].

The use of fertilizers has increased dramatically over recent years. Furthermore, organic fertilizers are favoured over synthetic fertilizers in many circumstances because they are less damaging to the environment and plant processes as compared to synthetic fertilizers [17]. Humic acids (HAs) are among the most active components in soil and manure since they serve

as precursors to other humic compounds (compost organic matter). PGRs affect cell respiration, photosynthetic activity, protein synthesis, and nutrition and water absorption functions in plants. Humic acid was found to enhance agricultural output in many studies [18, 19]. Ascorbic acid (AA), commonly known as vitamin C, was also revealed to be an essential agent that controls oxidative stress in plants. Ascorbic acid (AA) is a non-enzyme antioxidant that is necessary for plants to regulate oxidative stress [20, 21]. AA is needed for the synthesis of hydroxyproline-containing proteins, which help plants develop faster and manage their stress levels [22]. Aside from cytokinins, thiourea includes a sulfhydryl molecule that has been demonstrated in the laboratory to induce dormancy and limit bacterial growth. Plants contain large quantities of many of these chemicals, which regulate plant growth and phonological development [23]. Despite its extensive usage as a C4 cereal crop throughout the world, maize (Zea *mays* L.) is very sensitive to salt stress [24, 25].

This study aimed to determine the effect of exogenously applied humic acid, ascorbic acid, and thiourea on maize plants to examine their development. Two maize cultivars were evaluated to determine the influence of foliar applications of the three selected PGRs on plant growth, yield, and feed quality.

This study had two main objectives. First, it aimed to find out the best performing cultivar after the application of PGRs. Second, it aimed to find out the most effective treatment with regard to plant growth and yield.

2. Materials and Methods

A field experiment was conducted at a research area of the Islamia University of Bahawalpur, Sub campus Bahawalnagar with three replications in a randomized complete block design. The maize cultivars Pioneer 1543 and Monsanto 8441 were the test subjects in this study. The pH was set to 7.3 and the EC was set to 45 dS m–1. Irrigation and fertilizer requirements were fulfilled according to the area and weather.

The concentration of exogenous treatments of humic acid, ascorbic acid, and thiourea were T1=20ml/L, T2=30ml/L, and T3=50ml/L. One control T0=No dose was also applied. The treatments were sprayed on the leaves at three stages of the plant's development, namely seedling stage, 10- to 15-

leaf stage, and the blooming stage. Five plants were selected randomly from each 1m row to collect the data. After a week of each foliar spray, eight parameters were measured, namely, plant height, root length, leaf length, leaf area, cob length, fresh weight, number of nodes, and number of leaves per plant. In order to guarantee the accuracy the results, each measurement was repeated three times. Parameters regarding height and length were recorded with the help of scale in cm. The number of nodes and leaves were measured manually. Fresh weight was measured with electrical weight balance in grams. The leaf area was calculated with the following formula:

Leaf Area = Leaf Length × Leaf Width × Correction Factor (0.75).
Data was tabulated and graphs were made by MS excel.

3. Results and Discussion

In this experiment, exogenous treatments of humic acid, ascorbic acid, and thiourea were applied to maize plants to determine their effect. The plants of both the cultivars (Pioneer 1543 and Monsanto 8441) grown in sandy loam soil under treatments showed a significant increase in plant height, leaf area, root length, and leaf number per plant as compared to the plants grown in a loamy soil. PGRs, when sprayed to the leaves of hybrid maize, resulted in improved morphology, yield-related metrics, and grain yield.

Treatments of Humic acid, Ascorbic acid and Thiourea, when applied exogenously, enhanced the plant height of maize cultivars significantly. A significant increase in plant height was observed in the maize cultivar P1543 as compared to M8441 when a mixture of humic acid, ascorbic acid and thiourea was applied in (T2 and T3) (Figure 1). P1543 gained more plant height as compared to M8441 after receiving the same concentrations of PGRs (T1, T2 and T3). The root length of P1543 increased more as compared to M8441 at all the applied concentrations of PGRs (T1, T2, and T3). The foliar application of humic acid, ascorbic acid, and thiourea to maize plants significantly enhanced the total root length, while the effect remained slightly lower than the control plants (Figure 2). In maize plants, foliar treatment of humic acid, ascorbic acid, and thiourea significantly increased the root length (34.33>30.33) after the application of T1, as contrasted to (30.33>29.33) T2 and (33.67>31.33) T3. T1 also demonstrated the largest improvement in P1543 than M8441 (Figure 2).

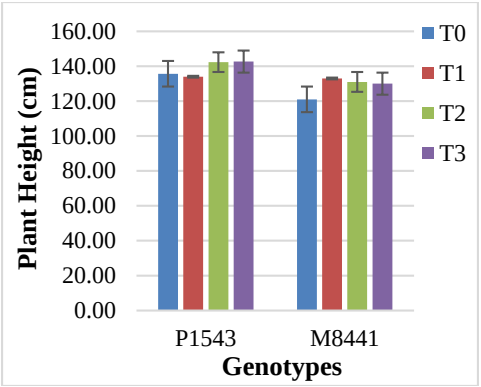

Figure 1. Comparison of plant height per plant among 2 genotypes of maize under various levels of plant growth regulators

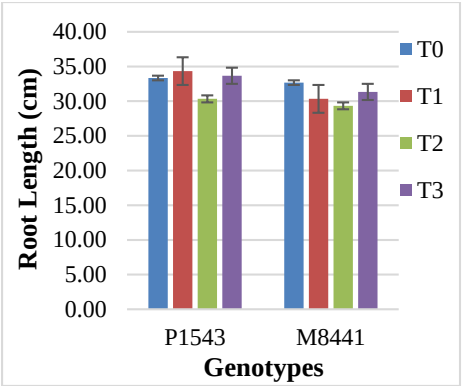

Figure 2. Comparison of root length per plant among 2 genotypes of maize under various levels of plant growth regulators

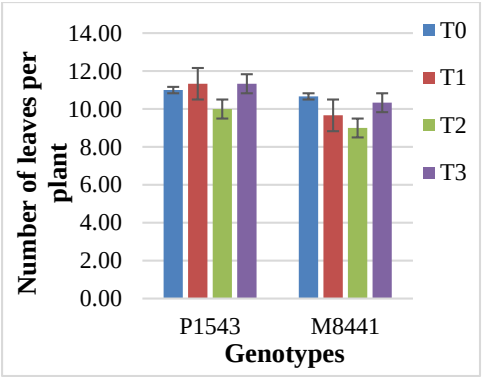

Figure 3. Comparison of Number of leaves per plant among 2 genotypes of maize under various levels of plant growth regulators

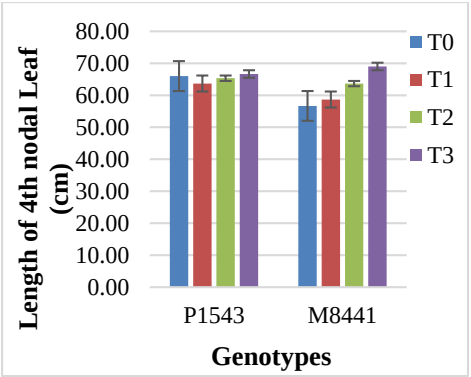

Figure 4. Comparison of length of 4th nodal leaf among 2 genotypes of maize under various levels of plant growth regulators

The number of leaves per plant were significantly higher in P1543 as compared to M8441, although the values were higher in the control plants (Figure 3). Overall, all the treatments were more effective on P1543 than M8441; however, T1(11.33>9.6) enhanced a greater number of leaves in P1543 than in M8441. Furthermore, PGR treatments resulted in a

considerable increase in the length of the 4th nodal leaf in P1543 as compared to M8441 after the application of T1 (63.67>58.67) and T2 (65.33>63.67). However, the length of the 4th nodal leaf decreased more in P1543 than M8441 after the application of T3 (66.67<69.00) (Figure 4). Overall, all the treatments were again more effective in increasing the leaf length in P1543 than in M8441.

Foliar application of PGRs showed a significant increase in the leaf area in P1543 as compared to M8441 after the application of T1, T2, and T3. T2 (460.00>389.67) concentrations had more of an enhancing effect in the leaf area of P1543 than T1 (398.67>430.00) and T3 (443.67>430.33) (Figure 5). The fresh weight of both cultivars varied greatly after the treatment of different concentration of PGRs. Maximum fresh weight (725 g) was produced after applying T_3 in M8441. Overall, the total fresh weight of the treated plants increased significantly, although it was lower than control plants in T_1 (Figure 6).

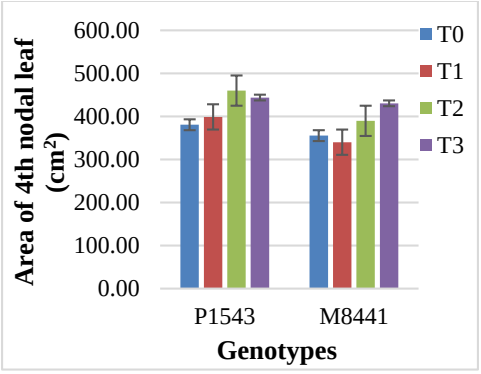

Figure 5. Comparison of Area of 4th nodal leaf among 2 genotypes of maize under various levels of plant growth regulators

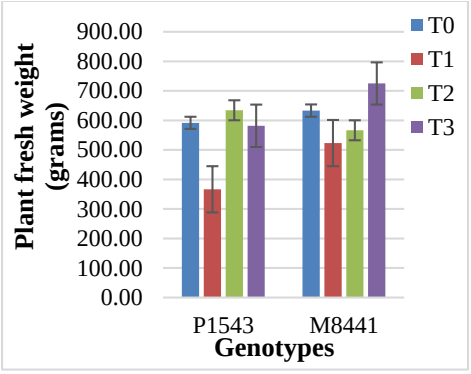

Figure 6. Comparison of fresh weight (in grams) among 2 genotypes of maize under various levels of plant growth regulators

T_1 significantly improved the number of nodes in P1543 as compared to M8441 (12.33>11.67). However, the number of nodes slightly decreased in P1543 after the application of T2 and T3. Overall, M8441 performed well under all the treatments, but there was no significant difference in its development when compared with the control plant. The length of cob

significantly increased in P1543 after the application of T2 and T3. T3 (26.00 > 25.67) was more effective than T1 and T2 in increasing the cob length of both cultivars. These results revealed that the length of the cob was more positively affected by the increase in the concentration of PGRs

Foliar sprays of HA, AA, and TU aided in the growth of hybrid maize yields under hot and dry conditions. In the current study, high levels of humic acid enhanced the plant height, root length, number of leaves, leaf length and leaf area. This might be due to humic acid's beneficial mineral impact and hormone-like action on vegetative development.

It was found that a foliar spray of humic acid, ascorbic acid, and thiourea to maize plants boosted the plant's fresh and dry biomass by a considerable amount. Many cereals and oilseeds have been found to benefit from the addition of exogenous organic osmolytes [26]. A major component, ascorbic acid (AA), promotes the growth, development, and preservation of cut flowers by enhancing their quality. It helps the plant shift from vegetative to reproductive phases, such as floral initiation, growth, and flower drop by acting as a cofactor in phytohormone-mediated signaling [27]. Humic acid (a plant growth stimulant) acts as a hormone-like growth stimulator and assists in plant development [28]. Lemongrass grew faster and exhibited better qualitative features after being treated with foliar ascorbic acid [29]. Thiourea aids plants in enduring stressful environmental conditions due to its high water solubility and fast absorption into biological tissues. Thiourea also boosts wheat vegetative development, crop protein content, and yield under dry conditions [30].

4. Conclusion

The study discovered that supplementing the maize crop with humic acid, ascorbic acid, and thiourea enhances the leaf size, leaf area, number of leaves, number of nodes, and shoot and root length, while simultaneously enhancing yield of maize plant with the same nutrients.

Conflict of Interest

The authors declare no conflict of interest.

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