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Growth of Different Olive Varieties Influences with Foliar Application of GA_3 under Saline Conditions

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Research Article

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Abstract

Salinity is an important factor affecting plant productivity and constitutes a problem concerning a significant portion of the earth planet. Olives are a good source of iron which helps to transport oxygen in blood. Calcium present in olives is essential for bones and muscles. Gibberellins (GA_3) play a vital role in the detoxification of heavy metals and in tolerance to salt stress by improving plants growth, chlorophyll synthesis and activities of antioxidant enzymes, and by preventing lipid per oxidation. The study was carried out at NARC Islamabad during August, 2018 to October, 2018 to examine olive varieties growth influences with foliar application of GA_3 under saline conditions in tunnel. Soil salinity was developed artificially with the mixture of different salts at 2.0dSm^{-1}. Completely randomized design was applied with three replications. Foliar spray of Gibberellic acid @ 0, 200 and 400 mgl^{-1} was done. Growth parameters of plant height stem diameter, # of leaves plant^{-1} and leaf area were recorded at the end of the experiment. Megaron olive variety attained the highest plant height at 200 and 400 mgl^{-1} GA_3 foliar sprays than other two olive varieties. Stem diameter was the maximum in Coratina olive variety that was higher than control and other two olive varieties. Number of leaves plant^{-1} and leaf area were gained the highest position by Chetoui olive variety at 200 and 400 mgl^{-1} GA_3 foliar spray than other two olive varieties under artificially saline conditions.

Keywords: Gibberelic Acid; Growth Hormone; Olea Europaea; Coratina; Chetoui; Megaron

Introduction

Olive tree (Olea europaea L.) of the Oleaceae family has a high economic value and many countries such as Iran and Mediterranean countries use its oil and conserved fruits [1]. Olive is very well adapted to the high temperature; tolerate dry weather, high soil salinity levels and infertile soil. The size of the fruit is important, not only because it is a component of productive yield, but also determines the acceptance by the consumer as conserved fruits. Olive tree (Olea europaea L.) of the Oleaceae family has a high economic value and many countries such as Iran and Mediterranean countries use its oil and conserved fruits [1]. Olive is very well adapted to the high temperature; tolerate dry weather, high soil salinity levels and infertile soil. Olives represents a group

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of evergreen trees and shrubs distributed in warm temperate and tropical region of the world. Olive is a unique subtropical fruit crop which requires chilling for fruiting [2-4]. Olive is very important as an oil producing plant of the Mediterranean region and in areas having etesian or dry subtropical climate like Cuba, California, New Zealand and South East Australia. Its origin is probably in the eastern regions of the Mediterranean Sea, from where it has spread around the Basin [5,6]. Although the olive trees are moderately tolerant to salinity and significant differences in salt tolerance have been reported among cultivars [7]. The size of the fruit is important, not only because it is a component of productive yield, but also determines the acceptance by the consumer as conserved fruits. Gibberellins are known for their ability to increase cell enlargement, thus enhancing fruit growth in certain species such as citrus, litchi, guava, and pear [8-14]. In all species so far studied, gibberellins had the potential for increasing fruit size. The beneficial effects of Gibberellic acid (GA_3) and nutrient elements sprays specially zinc on yield and fruit quality of different fruit crops were mentioned by many investigators including Swietlik [15]. Olives are also good source of iron which helps to transport oxygen in blood. Calcium present in olives is essential for bones and muscles [16]. Olive reduced risk of heart diseases and even help to fight cancer [17]. Olive oil is the healthy component of our diet. Oleonalic acid protects liver and improves blood flow [18]. It release stress and boost up immune system in human body. Its fruit contains all essential elements that are necessary for human health. Regularly consuming olives are good for skin health [19]. Olive oil is also used in cosmetics products and in pharmaceutical industry. 100 milliliter (ml), of one type of olive oil, contains Energy: 800 kcal with Fat: 93.3 g, or which 13.33 g is saturated and 66.6 g is monounsaturated [20]. Olive trees are also persistent, easily sprouting back even when cut to the ground [21].

Salinity is an important factor affecting plant productivity and constitutes a problem concerning a significant portion of the planet, especially in regions with hot, dry climates [22,23]. The availability of fresh water is one of the major limitations for crop production. Therefore, the use of non-conventional water resources, such as saline water and reclaimed sewage effluent, has increased in recent years. The utilization of such water resources accelerates the salinization of the upper layer of the soil, where most root activity takes place, and generally decreases crop production [24].

Increased uptake and accumulation of Na^+ and Cl^- ions decreases the absorption of essential minerals and imposes toxicity to plants [25]. Fruit trees such as citruses and grapevines, accumulation of both Na^+ and Cl^- in the roots and aerial parts is the most damaging to the plants oft en by inhibiting photosynthesis [26]. Na^+ is the primary cause of ion-specific damage (such as reduction in K+ activity) [27]. Improving plant resistance to salinity may provide yield stability in subsistence agriculture [28].

Gibberellins (GA_3) play a vital role in the detoxification of heavy metals and in tolerance to salt stress by improving plants growth, chlorophyll synthesis and activities of antioxidant enzymes, and by preventing lipid per oxidation [29,30]. Some researchers have used plant growth regulators (PGRs) for reducing or eradicating the negative effects of salinity [31,32]. For example, the exogenous application of PGRs [auxins, gibberellins, cytokinins] produces some benefit in alleviating the adverse effects of salt stress and also improves germination, growth, development, seed yield, and yield quality [33-36]. Azooz, et al. reported that indole acetic acid (IAA) and gibberellic acid stimulate growth in sorghum under stress conditions. Significant differences in salt tolerance have been reported among cultivars [7,37]. Gibberellins generally stimulate cell division and stem elongation and standardize growth by stretching internodes. GA_3 promotes flowering and fruiting in olive plants. GA_3 promotes stem elongation. Gibberellic acid play important role in germination by breaking seed dormancy. GA_3 encouraged cell elongation [38,39]. GA_3 standardizes flower initiation and development. GA_3 contributes in pollination. GA_3 improves fruit quality and promote generation of female flowers [40]. GA_3 application on olive plants diminishes the chances of alternate bearing in olive plants [41]. GA_3 performs key role in protein synthesis and in regulating nucleic acid. Higher concentration of GA_3 can suppress root initiation [42]. Aids plant to swing at suitable time in reproductive phase [43]. Gibberellins are known for their ability to increase cell enlargement, thus enhancing fruit growth in certain species such as citrus, litchi, guava, and pear [8-14].

The beneficial effects of Gibberellic acid (GA_3) and nutrient elements sprays specially zinc on yield and fruit quality of different fruit crops were mentioned by many investigators including Swietlik [15]. Plant growth regulators are produced by the plants and also produce artificially to regulate growth and development under various physiological actions. They are also called plant hormones. These hormones are applied to plants in

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different concentrations in order to control and regulate plant growth in different ways. All functions like normal growth, development, root and shoot growth are control by these hormones [45]. Plant growth is inhibited by abscisic acid result in dormancy and abscission. Auxins promote cell elongation and root initiation in cuttings. Natural auxins like Indole butyric acid (IBA) and Naphthalene acetic acid (NAA) hormones play an important role in root formation of stem cuttings [46]. Cytokinins help in cell division. Gibberellins are the very important plant growth regulators and promote cell elongation and also help in fruit developing. Ethylene helps in fruits ripening [47]. Stem elongation is response of signal transduction pathway with different environmental factors. There is a great importance of gibberellic acid in agriculture. Foliar application of GA_3 increases yield. Also improve the quality of fruits and increase the fruit size [48]. An important accumulation of GAs during the flowering transition was found in the petioles of Arabidopsis by Gocal, et al. [49]. Ben Nissan, et al. observed that GIP1 expression (which is a protein induced by GA_3) coincided with cell elongation in stem and flowers transition in Petunia hybryda. Mistra and Datta revealed a significant role of GA in the induction of shoots buds on leaf segments of Marigold and Hall and Camper successfully used GA_3 to develop an in vitro culture protocol for Goldenseal species. During favorable condition and germination permissive environment too, seed germination is poor and erratic due to seed dormancy [50-54]. Stratification under cool and moist condition or gibberellic acid treatment improves germination rates. Treatment with 2500ppm of gibberellic acid gives 31.67% germination [55]. The higher concentration of gibberellic acid of about 2000ppm to 6000ppm for 24 hours shortens the germination period. The use of GA_3 primed seed is believed to increase the seed germination and seedling vigor. Since, the germination of Kiwi seed is low and there were unsatisfactory researches based on single factor it was necessary to combine several factors to increase Kiwi seed germination [56]. The role carried out from carbohydrates during the rooting is controversial, but several reasons can explain their behavior. The levels of total carbohydrates and starch in the cuttings are positively related with the rooting but not through one cause-effect relationship [57]. Keeping in view the slow growing of olive plant, this study was designed with an idea to enhance the plant growth in shorten time period for propagation of olive cutting until its transplantation. Therefore foliar spray of Gibberellic acid (GA_3) is more researchable issue to study the effect of gibberelic acid foliar spray on the olive growth.

Materials and Methods

The study was carried out at NARC Islamabad during August, 2018 to October, 2018 to examine to examine the **growth of three olive varieties** i.e. Coratina, Chetoui and Megaron **influences with foliar application of GA_3 under saline conditions** in tunnel. Soil salinity was developed artificially with the mixture of different salts at $2.0dSm^{-1}$. Completely randomized design was applied with three replications. Foliar spray of Gibberellic acid @ 0, 200 and 400 mgl^{-1} was done. Growth parameters of plant height stem diameter internodal distance, # of leaves $plant^{-1}$, leaf area, fresh weight and dry weight were recorded at the end of the experiment. Data were statistically analyzed according to completely randomized design and compared treatment means using LSD test with statistical software, Statistix 8.1 [57].

Results and Discussions

Table1 showed the effects of GA_3 foliar application on olive plant height. Maximum height (21.5 cm) was attained at T_2 (400 mgl^{-1}) in Megaron olive variety. Over all Megaron olive cultivar gained the highest plant height (19.66 cm) and Coratina displayed second highest plant height (18.72cm). Maximum plant height was attained at T_2 (400 mgl^{-1}) i.e., 19.17 cm. GA_3 foliar application on olive plant number of leaves was influenced as indicate in Table 1. Maximum number of leaves were attained at T_0 (0 mgl^{-1}) in Chetoui olive variety followed by T_2 (400 mgl^{-1}) i.e., 26.6 in Coratina. Overall Chetoui olive variety attained the maximum number of leaves (29.36). T_0 (00mg/l) showed the maximum number of leaves i.e., 27.46 followed by 24.66 in T_1 (200 mgl^{-1}). Data in Table 1 depicted the effects of GA_3 foliar application on olive plant stem diameter. Maximum stem diameter (0.32cm) was attained at T_0 (0 mgl^{-1}) in two varieties i.e., Coratina and Chetoui. Over all Coratina and Chetoui olive cultivars gained the highest stem diameter i.e., 0.3 cm and 0.29 cm respectively, and T_0 (0 mgl^{-1}) displayed highest stem diameter (0.30cm). The effects of GA_3 foliar application on olive plant leaf area. Maximum leaf area ($4.18cm^2$) was attained at T_1 (200 mgl^{-1}) by the Chetoui olive cultivar. On the whole chetoui variety attained maximum leaf area of 3.98 cm^2 followed by Coratina i.e., 3.89 cm^2. T_o (control) showed maximum leaf area of 3.96 cm^2 followed by 3.86 cm^2 in T_2 (400 mgl^{-1}).

This study demonstrated that T_2 (400 mgl^{-1}) depicted maximum vegetative growth of Olive plant as compare to T_1 (200 mgl^{-1}). GA_3 is responsible for cell elongation rather than cell division. Plant hormones, enzymes and phenolic

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compounds play a major role in internal control mechanism of rooting in olives. The endogenous phenolic compounds have different effects especially on rooting cuttings [58-60]. GA_3 foliar application enhances bud sprouting and shoots elongation. GA_3 was successfully used by Grigoriadou, et al. for shoot proliferation of certain olive tree cultivars. From the above mentioned results it was noticed that GA_3 foliar sprays at 400mg/l concentration was more effective in plant height than spraying GA_3 at other concentrations and control. Highest stem diameter was obtained from cuttings sprayed with T_2 (400 mgl^{-1}) GA_3 while control treatment showed the lowest diameter of olive cuttings. The present results may be attributed to simulative impact of GA_3 on cell extension and on cell division. GA_3 is an interesting hormone for in vitro shoot elongation of many other species such as Macadamia, Acacia [60-65].

Treatment	**Plant height (cm)**			**Stem diameter(cm)**			**# of leaves plant^{-1}**			**Leaf area (cm^2)**		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
T_o	18.7	19.6	19	0.32	0.32	0.27	21.9	36.2	24.3	4.16	4.14	3.6
T_1	18	17. 5	18.5	0.27	0.3	0.27	25.3	26	22.7	3.49	4.18	3.4
T_2	19. 5	16.5	21.5	0.31	0.27	0.27	26.6	25.9	20.9	4.02	3.63	3.95
Mean	18.7	17.9	19.7	0.3	0.29	0.27	24.6	29.4	22.6	3.89	3.98	3.65

Table1: Olive Varieties Growth in Tunnel Influences with Foliar application of GA_3 under Saline Conditions.
$T_{o=}$ 0 mgl^{-1} GA_3, **$T_{1=}$** 200 mgl^{-1} GA_3, **$T_{2=}$** 400 mgl^{-1} GA_3, **$V_{1=}$** Coratina, **$V_{2=}$** Chetoui, **$V_{3=}$** Megaron

Conclusion

In three olive varieties studied in this protocol, gibberellins foliar spray had potential for the improvement of growth characteristics.

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