Assiut Journal of Agricultural Science, Vol 37, No 3 , 2006

EFFECT OF GA_3 TREATMENT ON OSMOTIC-STRESSED JOJOBA SEEDLINGS: I-VEGETATIVE GROWTH

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Abstract: This Experiment was conducted during the 2003 and 2004 seasons to study the effect of GA_3 on Jojoba (*Simmondsia chinensis*, Link) seedlings which grown under osmotic stress. One-year old seedlings were grown in soil contains 0.0, 0.4 or 0.8% of NaCl + $CaCl_2$, (1:1 by weight) and irrigated up to 60, 80 or 100% of FC. Plants were sprayed 4 times with GA_3 at 0, 50 and 100 ppm to alleviate water and/or salt stress. Vegetative growth; plant height, stem diameter and stem and leaves fresh and dry weight, were gradually augmented by increasing FC up to 100%. On the contrary, root length as well as fresh and dry weights of roots were gradually reduced with the gradual increase in water supply. Growth of jojoba seedling responded negatively to salinity stress, this reduction in growth parameters was gradual up to the highest level (0.8%).

GA_3 treatment significantly improved all investigated plant growth parameters except stem diameter. Treatment with 100 ppm GA_3 gave the tallest plants, deepest root system, and heaviest fresh and dry weights of stem, leaves and roots. GA_3 significantly alleviated the diverse impact of water and/or salt stress. The reduction in plant height, stem and leaves dry weight in the first season for plants grow in soil with 60% FC and 0.8% salt, compared with plants grow in soil with 100% FC and 0.0% salinity was 26.84, 51.71 and 107.45%, respectively. However, the equivalent values when the same plants which treated with 100 ppm GA_3 were 4.43, 32.03 and 74.70% respectively. Also, root length of plant grown in soil with 0.8% salinity and 60% FC was increased by 33.04% due to 100 ppm GA_3. The highest values of plant height, fresh and dry weights of stem and leaves were obtained due to treatment with 100% FC, 0.0% salinity and 100 ppm GA_3. Whereas, highest values of fresh and dry weight of roots being for plants treated with 100% FC, 0.0% salinity and 100 ppm GA_3. So that, it is recommended to irrigate jojoba seedling up to 100% FC and with spraying 100 ppm GA_3 to achieve highest growth values especially under salt stress.

Key words: jojoba, GA_3 , salinity, vegetative growth.

Introduction

Jojoba, *Simmondsia chinensis* (Link) Schneider which is a dioecious, perennial, evergreen woody shrub had been exotic to Egypt as a new promising raw industrial material. It is a unique wild plant species, widely distributed in semi-arid regions (Benzioni 1997 and Yermanos, 1979). Jojoba seed contains 40-50% oil which used in cosmetics e.g. lotions, moisturizers, massage oil, smoothing cream, shampoos, gels, lipsticks and nail polishes. There are many potential uses of jojoba oil in pharmaceuticals, plastic, printing and lubricant industries (Benzioni, 1997). Growth of jojoba at different concentrations of salty water referred that jojoba seedlings could tolerate irrigation with salty water (up to 2000 ppm) without obvious sign of stress. However, Rana *et al.* (2003) stated that increasing salinity from 1000 to 8000 ppm significantly reduced jojoba growth for example plant height reduced by 79%. Tahir *et al*. (1992) and Baxter *et al*. (1998) indicated that germination and growth of jojoba plants as well as their production is controlled by salinity level.

Drought becomes one of the major global problem facing agricultural production. Once the tree transplant does not receive efficient quantity of water its internal water deficits increase considerably due to excessive water transpiration and non absorption of water (Kozlowski *et al*., 1991). Indeed, water deficits are the major causes of failure of newly planted trees (Percival and Sheriffs, 2002). Salinity is another osmotic stress factor which restrict agricultural production specially in arid and semi-arid area where salt becomes progressively concentrated at the root zone. Thus, unless soil salts are removed by over irrigation, rainfall or drainage, their concentration increases progressively causing seedling death. It has been estimated that about a third of the world's irrigated land and half the land in semiarid and coastal regions is influenced by surplus salinity, and that about 10 million ha of irrigated land are abandoned because of excess salinity (Abrol *et al.,* 1988).

The harmful impact of water stress on growth of some woody plants has been widely investigated, Shehata by (1992) on *Cupressus sempervirens* and *Eucalyptus camaldulensis* seedlings, El–Tantawy *et al.* (1993) on *Eucalyptus camaldulensis* seedlings, Sayed (2001) on *Khaya senegalensis* seedlings and Uday *et al.* (2001) on *Simmondsia chinensis* seedlings.

Asmaael (1997) irrigated *Casuarina equisetifolia* seedlings with a salty solution of NaCl and $CaCl_2$. He reported that a concentration of 5000 mg l^{-1} caused seedling death, however concentration of 1500 and 2000 mg l^{-1} decreased vegetative growth. Ahmed (1998) investigated the response of *Robinia pseudoacacia* seedlings to soil salinity (NaCl + $CaCl_2$) and found that soil salinity particularly at 0.4 and 0.6% caused a significant reduction in seedling growth. Abd El–Fattah (2001) studied the effect of salinity on *Adhatoda vasica*, *Hibiscus rosa sinensis* and *Phyllanthus embmlica* and found that both of vegetative and root growth decreased by increasing salinity level especially at 7000 mg 1^{-1}. The diverse effect of salinity on vegetative growth of some fast growing species (*Acacia saligna*, *Casuarina cunninghamiana* and *Eucalyptus camaldulensis*) was observed by El-Baha *et al.*, (2003), El–Settawy and El–Gamal (2003).

Plant growth regulators play an integral role in the plant growth under stress conditions. GA_3 has been reported to promote cell division and cell elongation, may also enhance germination and adaptation of plants to stress conditions (Taiz and Zeiger, 1998). Gibberellic acid has been reported to increase percentage of germination and seedling growth in different tree species under water or salt stress.

Therefore, the present investigation was planned to explore the role of GA_3 in minimizing injurious effects of drought and/or salinity in jojoba seedlings. This is first part of the study will deal with seedling growth whereas, the second part will investigated the influence of that factors in chemical constitute of seedlings.

Material and Method

This study was carried out at Horticultural Department, Faculty of Agriculture Minia University during two successive seasons of 2003 and 2004. A one-year old jojoba seedlings with 33-35 cm height and 3.03–3.27 mm stem diameter were transplanted in polyethylene bags filled with 6 kg of soil in the first week of March in both seasons. Physical and chemical properties of the experimental soil are shown in Table (1). Before filling the bags the assigned amount of salt was thoroughly mixed with the soil. Salinity treatment was conducted by mixing equal weights of NaCl and $CaCl_2$ at 0.0, 0.4 and 0.8%. Plants were irrigated to maintain 60, 80 and 100% of FC as described by El-Tomi *et al*. (1984). GA_3 was foliar at 3 concentrations, 0, 50, and 100 ppm containing 2-3 drops of "Tween 20" (surfactant) on the first week of June, July, Aug., Sept., and Oct. of each season.

A spilt-spilt plot design with 3 replicates was followed in the experiment where, FC was distributed in the main plots, salinity levels in the sub-plots and GA_3 concentrations in the sub-sub-plots. Subsequently, the experiment included 27 treatments (3x3x3), each one of them consisted of 5 plants. Plants were fertilized with 20 g of complete fertilizer 18-9-9 added in 4 equal portions during the first week of June, July, August and September on both seasons. At the first week of November plants were cut just above the soil surface to estimate plant height, stem diameter (just above the soil surface) and fresh weights of leaves and stem. Then, the bags were carefully cut in water tank to had root system. Root length and fresh weight were measured after riddance of excess water. Leaves, stem and roots were individually oven dried at 70° C to estimate dry weight. Data were statistical analysis according to Little and Hills (1978) using M-State-C computer program.

Table(1): Physical and chemical properties of experimental soil

Soil characters	Value	Soil character		Value
Soil type	Sandy	Available P %		3.50
Sand %	91.0	Ex. cations (mg/100 g soil)	Ca^{++}	3.80
Silt %	5.8		Mg^{++}	1.60
Clay %	3.2		Na^{+}	2.00
Organic matter %	0.08		K^{+}	0.60
$CaCO_3$ %	12.71	DTPA Ext. (ppm)	Fe	1.20
pH (1: 2.5)	8.15		Cu	0.43
EC m mhos	1.09		Zn	0.30
Total N %	0.06		Mn	0.60

Results and Discussion

Plant height

Data in table 2 show that plant height of jojoba seedlings was gradually increased by the gradual increase in FC in both seasons. Moreover, the differences between each two successive FC levels were significant. Plant height increased by 3.8 and 13.7% in the first season and by 9.6 and 24.8 % in the second one as a result of increasing FC from 60% to 80 and 100%, respectively. Plant height was significantly decreased by the gradual increase in salinity level in both seasons, the highest salinity level (0.8%) caused a significant reduction in plant height by 11.04 and 13.69% of these plant grown in soil without artificial salinity in the both seasons, respectively.

All GA_3–treated seedlings were significantly taller than the untreated plants in both seasons (Table 2). This increment paralleled to the rise in GA_3 concentration with significant differences between each two successive treatments. Such increase reached 11.6 and 19.0%, respectively, due to the use of 50 and 100 ppm GA_3 in comparison with the control plants in the first season. In the second one, the corresponding values for the same treatments reached 19.9 and 29.2%, respectively. GA_3 had alleviated the

impact of water and salinity stresses on jojoba seedlings as, 100 ppm the–treated plants grown in soil with 60% FC or 0.8% salinity were significantly taller than the untreated plants grown in soil with 100% FC or 0.0% salinity in both seasons (Table 2).

The various interactions between different involved factors were significant in both seasons. Overall, the shortest seedlings in both seasons (45.87 & 39.66 cm) were obtained when seedling grown in soil with 60% FC, 0.8% salinity and without GA_3, whereas, the tallest ones (67.18 & 80.45 cm) in both seasons, respectively were resulted from 100% FC, 0.0% salinity and 100 ppm of GA_3.

Stem diameter

It is clear from table 3 that stem diameter was significantly augmented by increasing soil moisture content in both seasons. In the first one, the increments in stem diameter were 7.7 and 23.3 % when FC increased from 60 and 80 to 100%, respectively. However, increasing salinity level significantly decreased stem diameter in both seasons. The highest reduction in stem diameter in comparison with that of the control seedlings (24.3%) was obtained in the first season when salinity increased from 0.0 up to 0.8%. Similar results were recorded in the second season.

Stem diameter of jojoba seedlings was insignificantly decreased as a result of GA_3 application (Table 3). Regardless the level of FC the plants treated with 50 ppm GA_3 had a thicker stem than control plants or those treated with 100 ppm of GA_3. The medium concentration of GA_3 had more alleviated effect than the highest concentration as plants grown in soil with highest salinity concentration and lowest FC had a stem diameter 5.10 mm once they treated with 50 ppm GA_3, meanwhile plants treated with 100 pp GA_3 a stem diameter 5.07 mm.

The interactions among different involved factors were not significant in both seasons as clearly noticed in Table 3. Overall, the thinnest seedling stem (5.07 and 6.22 mm) were obtained from 60% FC, 0.8% salinity and 100 ppm GA_3 treatment in both seasons, respectively. Whereas, the thickest stem (7.94 and 8.86 mm) being for irrigation at 100% FC and without salinization or GA_3 application.

Stem fresh weight

Stem fresh weight of jojoba seedlings was gradually and significantly increased in both seasons by each increase in FC level. These increments were (19.8 & 30.4%) and (25.4 and 41.1%) for both seasons respectively due to the use of the high and medium FC levels in comparison with that of the lowest ones in both seasons,

respectively as shown in table 4. Salinity treatments significantly reduced stem fresh weight than those of control plants in the both seasons. Overall, the highest values (29.32 and 28.60 g in both seasons respectively) were obtained when seedling grown in soil without salinity treatment (Table 4).

Concerning GA_3, the stem fresh weight was gradually increased in both seasons as the concentration of GA_3 was sloping upward. Moreover, significant differences were obtained among the effect of different GA_3 concentrations (Table 4). The increments in stem fresh weight compared to the control plants were 10.1 and 18.9%in the first season and 14.2 and 25.5% in the second one due to using GA_3 at 50 and 100 ppm, respectively. In the first season, there was insignificant difference in stem fresh weight between 50 ppm GA_3-treated plants grown in soil with 0.8% salinity and 60% FC without using GA_3. Whereas, the treated plants with 100 ppm had significantly higher stem fresh weight compared to untreated ones.

Table 4 shows significant inter-actions among different involved factors. GA_3 treatment had improved stem fresh weight of plants grown under water stress, reduction of FC from 100% to 60% reduced stem fresh weight by 27.43 when plants did not treated with GA_3. However, this reduction was 8.29% when plants treated with 100 ppm of GA_3. There was insignificant difference between plants grown in soil with 0.8% salinity and those grown in soil with their control and sprayed with 100 ppm of GA_3. The heaviest stem fresh (38.18 and 40.11 g in both seasons respectively), were for plants irrigated at 100% FC, without salinization and sprayed with 100 ppm GA_3 respectively.

Stem dry weight

Water stress significantly reduced stem dry weight of jojoba seedling in both seasons, with significant differences among FC levels (Table 5). In the first season, the increments in stem dry weight reached 18.7 and 30.0% by increasing FC from 60% and 80% to 100%, respectively. Corresponding values in the second season for the same irrigation treatments were 25.2 and 40.9%, respectively. Concerning salinity, the stem dry weight was significantly decreased by the gradual increase in salinity level in both seasons in regard to that of the control showed in Table 5. It was obvious that the highest salinity level (0.8%) caused the highest reduction (17.76 and 15.40%) in both seasons respectively.

On the contrary to osmotic stress, GA_3 treatment had a positive influence in stem dry weight which became significantly heavier than that of the untreated ones in both seasons (Table 5). The heaviest stem dry weight (12.04 and 12 g/plant) in

both seasons respectively, were obtained due to the use of GA_3 at 100 ppm. Theses values were 20.4 and 26.3%, higher than that of untreated seedlings. Moreover, the plants which grown in soil with 0.8% salinity, 60% FC and treated with 100 ppm GA_3 had stem dry weight (9.02 g/plant) which was significantly higher than those of untreated ones grown in the same conditions.

The interactions among different involved factors were significant in both seasons (Table 5). The highest stem dry weight (15.63 and 16.35 g/plant in both seasons respectively), were obtained from 100% FC, 0.0% salinity and 100 ppm GA_3 treatment. Whereas, the lowest stem dry weight (7.85 and 7.40 g/plant in both seasons respectively) were obtained from 60% FC, 0.8% salinity and 0.0 ppm GA_3 treatment.

Leaves fresh weight

Table 6 shows that leaves fresh weight of jojoba seedlings was significantly and gradually increased with increasing FC in both seasons. The leaves fresh weight was increased by 32.7 & 59.1% in the first season and by 25.3 & 51.2% in the second one when FC maintained at 60 and 100% in comparison with the lowest one, respectively. Salinity treatments significantly reduced leaves fresh weight in both seasons. The highest salinity level gave significantly the lowest values (24.14 and 24.01 g/plant respectively in both seasons) as shown in table 6.

Leaves fresh weight of jojoba seedlings was significantly increased as a result of GA_3 treatment in both seasons. The heaviest leaves fresh weight in both seasons was obtained due to treatment with 100 ppm GA_3 (Table 6). The increment in leaves fresh weight due to 100 ppm GA_3 treatment reached 25.2 and 27.7% in the first and second seasons, respectively, in comparison with that of untreated plants. Plants which grown under any level of water and/or salt stress and treated with 100 ppm GA_3 had leaves fresh weight significantly higher than those of untreated ones grown in the same conditions, in both seasons (Table 6).

The interactions among different involved factors were significant in both seasons (Table 6). Overall, the heaviest leaves fresh weight 45.06 and 45.81 g in both seasons, respectively, were obtained when plants treated with 100% FC, 0.0% salinity and 100 ppm GA_3. These values are 162.68 and 169.31% higher than these of seedling grown under 60% FC, 0.8% salinity and 0.0 ppm GA_3 in both seasons respectively.

Leaves dry weight

Table 7 shows that leaves dry weight had been affect with FC levels in the same manner as leaves fresh weight, with a significant

differences among the different treatments in both seasons. Leaves dry weight was increased by 27.5 & 58.2% in the first season and by 25.5 & 51.3% in the second one respectively, due to irrigation up to the medium and high FC levels, in comparison with that of the lowest FC. Regarding salinity, leaves dry weight was significantly decreased with increasing salinity level with significant differences among salinity levels, in both seasons (Table 7). Plants grown in soil with no artificial salinity had the highest leaves dry weight (9.98 & 9.92 g in both seasons respectively). Leaves dry weight was increased by (14.2 & 31.1%) and (14.8 & 31.7%) in the first and second season, respectively as a result of growing in soil with 0.4 and 0.0% of salinity, in comparison with that of 0.8% level.

Concerning GA_3, leaves dry weight was gradually increased in both seasons as the concentration of GA_3 increased (Table 7). Moreover, significant differences were detected among the effect of GA_3 concentrations. In comparison with control seedlings, leaves dry weight was increased by (11.5 & 25.0%) and (16.2 & 27.8%) in the first and second season due to the use of GA_3 at 50 and 100 ppm, respectively. Regardless the level of FC or salinity leaves dry weight was increased with increasing GA_3 concentration. The highest leaves dry weight (6.67 g/plant) was recorded when unstressed plants treated with 100 ppm GA_3. The leaves dry weight was reduced by (107.45 & 102.49%) in both seasons respectively when plants suffered from the lowest FC and highest level of salinity compared with plants grown in soil with 100% FC and 0.0 % salinity. Whereas the reductions were 74.73 & 58.70% respectively once the plants treated with 100 ppm GA_3.

The interactions among different involved factors were significant in both seasons except between (salinity x GA_3) and (irrigation x salinity x GA_3) in the first season, as illustrate in table 4. Meanwhile, the heaviest leaves dry weight (14.19 and 14.40 g in both seasons, respectively) were obtained from the treatment 100% FC, 0.0% salinity and 100 ppm GA_3.

Root length

On the contrary of all vegetative growth parameters, root length took an opposite trend, it was significantly declined as the FC level was sloping upward (Table 8). So, the longest root system in both seasons (14.84 and 15.50 cm, respectively) was for seedlings supplied with the lowest FC level. On the other hand, salinity treatments decreased root length. Higher salinity level caused a significant reduction in root length and formed shortest root system (12.01 and 12.34 cm) in both seasons, respectively (Table 8).

Spraying gibberellic acid at 50 and 100 ppm significantly stimulated root length in both seasons. Such increase in root length was parallel to increment in GA_3 concentration in both seasons, as illustrated in table 8. Applying of GA_3 at 100 ppm increased seedling root length by 13.70 and 15.22% compared with untreated ones which had a root length of 11.59 and 12.31 cm in both seasons, respectively. However, the positive effect of 100 ppm GA_3 was declined with increasing salinity level (Table 8).

Table 8 indicates that the interactions among investigated factors were significant in both seasons except (irrigation x salinity x GA_3) in the first season. However, the tallest root length (18.33 and 1519.0240 cm in both seasons, respectively) were obtained from 60% FC irrigation, 0.0 % salinity and 100 ppm GA_3 (Table 8). Under water and salt stress GA_3 improved root length by 19.22 & 17.19% in both seasons compared with GA_3-untreated plants.

Roots fresh weight

The effect of FC treatment in fresh weight of root system, followed the same trend which has been obtained on root length, it was gradually and significantly decreased with rising FC level. Root fresh weight was increased by 39.5% and 38.5% in both seasons, respectively by decreasing FC from 100 to 60% (Table 9). Increasing salinity to 0.4 or 0.8% remarkably decreased roots fresh weight by (13.6 & 20.9%) and (9.0 & 20.0%) in both seasons, respectively in comparison with control seedlings which had roots fresh weight 14.88 to 16.06 g/plant (Table 9).

Regarding the influence of GA_3, roots fresh weight was significantly increased in both seasons due to GA_3 treatments. In the first season root fresh weight was increased by 12.73 and 24.78% when GA_3 was applied at 50 or 100 ppm, respectively. Similar result was recorded in the second season.

There were significant interactions among different studied factors except (salinity x GA_3) in both seasons. Overall, the heaviest root fresh weight (20.44 and 22.07 g/plant) were obtained from 60% FC irrigation, 0.0% salinity and 100 ppm GA_3 in both seasons, respectively as shown in table 9.

Roots dry weight

The effect of irrigation levels on dry weight of roots had followed the same previously obtained trend on root fresh weight. Root dry weight was gradually decreased as the irrigation level was sloping upward, with significant differences among different levels in both seasons (Table 10). Plants grown in soil at 100% FC had the lowest root dry weight (5.00 and 5.61 g, in both seasons, respectively) whereas, the heaviest root dry weight (6.9 and

7.33 g in both seasons, respectively) being for seedlings grown in soil with 60% FC. The effect of the medium and high soil salinity levels (0.4 and 0.8 %) on roots dry weight was almost similar to that observed on the root fresh weight (Table 10).

Roots dry weight was gradually increased with the gradual increase in the concentration of GA_3. There were significant differences among the effect of GA_3 concentrations in the two seasons as clearly shown in table 10. In comparison with the control treatment, roots dry weights were increased by 12.4 and 24.3 % in the first season and by 11.8 and 23.6 % in the second season due to treatment with GA_3 at 50 and 100 ppm, respectively.

The interactions between different involved factors were significant except (salinity x GA_3) in both seasons. Overall, the heaviest roots dry weight, were obtained from 60% FC irrigation, 0.0% salinity and 100 ppm GA_3, (Table 10).

Discussion

There is no suspicion that an adequate supply of water is the most important factor for tree growth. Water deficits reduce vegetative growth as a result of decreasing cell enlargement and differentiation (Kozlowski *et al.,* 1991). Data presented herein indicate that water stress significantly reduced vegetative growth of jojoba seedlings; plant height, stem diameter, stem fresh and dry weight and leaves fresh and dry weight. This reduction was gradually increased with decreasing FC. Kozlowski *et al.* (1991) indicated that rates of various physiological processes, such as respiration and photosynthesis decrease under water stress. Similar, results concerning the effect of water stress in tree growth has been found by Sayed (2001), El- Baha *et al.,* (2003), El–Settawy and El–Gamal (2003) Shehata (1992). The greater root length, fresh and dry weight of root observed under low FC is consistent with reports in many species, because in environments where growth is limited by soil-derived resources such as moisture plants tend to allocate more carbon to root production than to shoots (Steinberg *et al.,* 1990). Moreover, Fitter (1996) indicated that, root growth for many plants are more resistance to water stress than shoot growth, which facilitates the extraction of moisture from dry soils.

Fresh and dry weights of all plants grown under salt stress were significantly reduced in comparison to the control, this reduction was greater once soil contains 0.4% of salinity. The decrease in plant growth with longer exposure to salinity that which exhibited by jojoba plants in this study is common for many tree species exposed to high substrate salinity levels (Kozlowski, 1997). The physiological effects of salinity on plant growth were reviewed by Kozlowski (1997) as: (1) turgor regulates stomatal conductance and cell expansion, thereby affecting growth of plants in soils of low water potential, (2) plant growth is limited by a lowered rate of photosynthesis, and (3) excessive uptake of salts affects production of a specific metabolite that directly inhibits growth.

Gibberellic acid treatment enhanced jojoba growth and significantly alleviated water and/or salt stress. Gibberellic acid has been found to play a central role in the integration of the responses expressed by plants under stress conditions either by increasing membrane permeability or by increasing the internal concentration of osmotically active solutes, also GA3 has been reported to promote cell division and cell elongation (Kaur *et al.*, 1998).

Conclusion

Simmondsia chinensis (Link) Schneider is a new industrial promising raw material has been recently exotic to Egypt. Although, jojoba plant distinguished as tolerant for water shortage and salinity stress this study amid to investigate the effect of GA_3 on seedling stage which is more sensitive to stress than old plants. Vegetative growth were gradually augmented as the level of water supply was sloping upward. The highest values of vegetative growth were obtained when plants irrigated up to 100% of FC. On the contrary, root growth was considerably and gradually reduced by the gradual increase in water supply. Salinity reduced plant growth, this reduction was gradual up to the high level (0.8%). Gibberellic acid especially at 100 ppm improved plant growth and alleviated water and/or salt stress. So that, it is recommended to grown jojoba plants in unsalinized soil and irrigate them up to 100% of FC. Treatment with 100 ppm GA3 would help plants to cope with water or salt stress.

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تأثير المعاملة بحامض الجبريليك على شتلات الهوهوبا النامية تحت إجهاد اسموزى، 1: النمو الخضرى

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أجريت هذه التجربة خلال الموسمين المتتاليين 2003 و 2004 بقسم البساتين بكلية الزراعة جامعة المنيا بهدف دراسة تأثير GA_3 على شتلات الهوهوبا النامية تحت ظروف إجهاد اسموزى. زرعت شتلات عمر سنة فى تربة تحتوى على تركيزات صفر ، 0.4 ، 0.8% من خليط كلوريد الصوديوم و الكالسيوم (بنسبة 1 :1 بالوزن)، ورويت الشتلات بمعدل 60، 80، 100٪ من السعة الحقلية. رشت النباتات 4 مرات خلال فترة النمو والتى أمتد لمدة عام بتركيز صفر ، 50 ، 100 جزء فى المليون من GA_3.

حدثت زيادة تدريجية للصفات الخضرية مثل طول النبات وقطر الساق، الوزن الطازج والجاف للساق والأوراق نتيجة للزيادة التدريجية فى السعة الحقلية. و كانت أعلى القيم لجميع الصفات السابقة هى الناتجة من إمداد النباتات بمياه الرى بمعدل 100٪ من السعة الحقلية. لكن حدث نقص تدريجى ومعنوى لطول الجذر ووزنها الطازج والجاف نتيجة للزيادة التدريجية فى مياه الرى. أظهرت النتائج أن جميع صفات نمو النبات المدروسة تاثرت سلبياً بمعاملة الملوحة. ولقد كان هذا النقص تدريجياً حتى مستوى الملوحة المرتفع (8,. ٪).

أدى استعمال GA_3 إلى تحسن معنوى فى كل الصفات المدروسة ماعدا قطر الساق. وأدت المعاملة بـ 100 جزء فى المليون من GA_3 إلى الحصول على أفضل صفات للنمو ماعدا انخفاض قطر الساق. وأوضحت النتائج حدوث تفاعل معنوى بين عناصر التجربة المختلفة (الرى، الملوحة، GA_3) فى معظم الأحيان. وبصورة عامة تم الحصول على أعلى القيم الخاصة بطول النبات والوزن الطازج والجاف للساق والأوراق نتيجة المعاملة بمعدل 100٪ سعة حقلية، صفر ملوحة، 100 جزء فى المليون من GA_3. أما أعلى قيم لطول الجذر والوزن الطازج والجاف للجذور فنتجت من 60٪ سعة حقلية وصفر ملوحة و100 جزء فى المليون GA_3. أدت المعاملة بـ GA_3 إلى تقليل أثر انخفاض السعة الحقلية أو رفع تركيز الملوحة فى التربة. على سبيل المثال كان الانخفاض فى ارتفاع النبات، الوزن الطازج والجاف للساق والأوراق فى الموسم الأول للشتلات النامية فى تربة تحتوى على 0.8% ملوحة والمروية حتى 60% من السعة الحقلية بالمقارنة مع النباتات النامية فى تربة تحتوى على 0.0% ملوحة، والمروية بمعدل 100% من السعة الحقلية هو 26.84، و51.71، و 107.45%. على التوالى. وعندما تم معاملة النباتات تحت الظروف الأولى بالتركيز العالى من GA_3 كان الانخفاض بمعدل 4.43، و32.03، و74.70 على التوالى. كما زاد طول الجذر والوزن الطازج والجاف للجذر للنباتات النامية فى تربة تحتوى على 0.8% ملوحة والمروية بمعدل 60% من السعة الحقلية بمعدل 33.04 نتيجة المعاملة بـ 100 جزء فى المليون من GA_3. ومن ثم يوصى برى نباتات شتلات الهوهوبا بمعدل 100% من السعة الحقلية ورشها 100 جزء فى المليون GA_3 خصوصاً فى الاراضى التى تميل للملوحة.