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Influence of foliar fertilization of amino decanate® on growth and yield of eggplant (*Solanum melongena*) under water stress condition

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ABSTRACT

Water stress in semiarid areas limits eggplant productivity for which the application of amino decanate® has shown significant improvement in yield but, the concentration and intensity is not yet standardized. A field trial was conducted during 2018 in greenhouse condition located at Fallujah city, Iraq to study the effects of water stress (50, 75, 100% based on field capacity) and rate of foliar application of amino decanate® (0, 100 and 200 mg/L) on vegetative growth and production of eggplant. The results revealed that 100% irrigation level recorded higher plant height (65.70 cm), stem diameter (8.05 mm), chlorophyll content (73.48 SPAD) with increased yield (5.78 t/ha) and water use efficiency (WUE) (5.99 kg/m^3). The foliar application of 200 mg/L amino decanate® rate increased plant height (73.49 cm), stem diameter (7.84 mm), chlorophyll content (62.99 SPAD) and yield (5.44 t/ha). Interaction effect of 100% irrigation level and foliar application of 200 mg/L amino decanate® treatments produced higher plant height (83.99 cm), stem diameter (9.92 mm), chlorophyll content (85.11 SPAD) and yield (7.12 t/ha). The maximum WUE (7.67 kg/m^3) was produced at 100% irrigation level with foliar application of 100 mg/L amino decanate® concentration. The vegetative growth, yield and WUE of eggplant under water stress conditions increased with increasing concentrations of amino decanate®.

Key words : Amino decanate®, eggplant, foliar fertilization, *Solanum melongena*, water deficit

INTRODUCTION

Eggplant (*Solanum melongena*) is considered as one of the most common vegetable crops grown in Iraq and other parts of the world. Its fruits are utilized as a staple food. Eggplant is only the third most important crop in consumption terms, behind potatoes and tomatoes belonging to the Solanaceae family. The varieties of eggplant show a wide range of fruit shapes and colors, ranging from oval or egg-shaped to long club-shaped and from white, yellow, green and purple pigmentation to almost black. Eggplant fruits contain a considerable amount of carbohydrates, proteins and some minerals (Mahmoud, 2000). Eggplant fruits are known for being low in calories and having a mineral composition useful for human health. They are also a wealthy source of potassium, magnesium, calcium and iron (Zenia and Halina, 2008). The eggplant fruit possesses antioxidant activities (Plazas *et al.,* 2013; Minh, 2020).

Water is a key determinant of plant productivity in agriculture in numerous world regions, particularly in dry and semi-dry regions (Tahi *et al.,* 2007; Phad *et al.,* 2016). With increasing human population, urbanization and industrialization, competition for fresh water is increasing worldwide. The divergence between water availability and demand is widening. Worldwide, more than 40% of food production rely on supplementary irrigation (Ahmad, 2016). In Iraq, agriculture uses more than 93% of good quality fresh water

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(Aldulaimy *et al.,* 2019). There is a need to stretch freshwater resources to keep pace with the ever-increasing demand of varied users (Hsiao *et al.,* 2009). Given the circumstance of not having much prospect of additional freshwater resources to be developed, the only choice is to control the available freshwater resources and improve management procedures (Halinski and Stepnowski, 2016).

Since agriculture is the prime consumer of freshwater resources, any effort towards improving WUE in this sector will be worthwhile. Increasing WUE through upgraded irrigation technology and improving efficiency of retaining soil productivity are complementary towards making the best use of irrigation water and conserving water for other uses. The average irrigation efficiency for surface irrigation is between 30-50% (Al-Shammari *et al.,* 2018; Aldulaimy *et al.,* 2019). Poor irrigation efficiency provides an opportunity for improvement that will lead to additional water resource for agriculture or other uses; however, this should not be by negatively affecting yields.

It is proved that drought conditions damage cellular membranes, slow down water movement and nutrient absorption, reduce photosynthesis efficiency, respiration rate, enzyme activity, hormone balance and increase reactive oxygen species production, which negatively affect the production (Maloney *et al.,* 2010; Bayat *et al.*, 2019).

Amino acid applied to foliage or added to soil have recently been used as a method to promote plant growth and productivity (Spann and Little, 2010). Amino acids have a direct function in increasing tissue protein content and enzyme activity necessary for metabolic antioxidant on-site events. Also, amino acids are precursors and proteins constituents which are necessary for cell growth. They contain acid and basic groups and act as buffers, which helps to maintain favorable pH within the plant cells. Amino acids can influence physiological activities in plant growth and development (Sadak *et al.,* 2015).

Dias *et al.* (2016) reported that foliar application of Spirufert® increased vegetative growth and yield traits of eggplant. Al-Shmmari *et al.* (2019) reported increased tomato yield and WUE following foliar application of a Tecamin flower under water deficit conditions. Tecamin flower treatment improved the plant ability for drought tolerance. In addition, Abd El-Gawad and Osman, (2014) reported increased eggplant yield following foliar application of ascorbic acid under field conditions. Therefore, this study was conduced to determine the response of eggplant to amino decanate® application for reducing the negative impact of water deficit.

MATERIALS AND METHODS

A field experiment was conducted during November 2018 in greenhouse condition, Fallujah city, west of Iraq. The soil of the study site is classified as well-drained sandy loam. The chemical properties of the soil were $CaCO_3$ (157.79 g/kg), EC1:1 (13.17 dS/m), organic matter (0.91 g/kg), and nitrogen, phosphorous and potassium as 32.60, 9.70 and 160.6 mg/kg, respectively. Bulk density was 1.35 M mg/m^3. Field capacity was 25%. The EC of irrigation water was 0.82 dS/m. Poultry litter was added at the rate of 1.0 kg/m^2 during soil preparation. The large amount of poultry litter was used because high temperatures in the summer (average 45°C) for 5 months leads to quick oxidation of organic matter.

The experimental design was laid out in 450 m^2 area arranged in a 3 × 3 split plot, in a randomized complete block design, with 2 factors replicated in 5 blocks. The first factor was three levels of irrigation (50, 75 and 100% of field capacity) determined according to Allen (1998). The second factor was three levels of amino decanate® (0, 100 and 200 mg/L). Amino decanate® contains several nutrients (Table 1) and was applied with a backpack sprayer 4 times at a 10-days interval beginning at flowering stage of the crop. All foliar applications were sprayed in early morning.

Seeds of eggplant cv. Barcelona were planted in cork trays with 209 cavities on 28

Table 1. Composition of amino decanate®

Component	Amount (weight)	Component	Amount (weight)
L-Leucinen	5 g	L-Threonine	500 mg
L-Valinen		L-Phenylalanine	
L-Isoleucine		L-Tyrosine	
L-Glutamine		L-Asparagine	
L-Alanine	500 mg	L-Aspartate	
L-Arginine		L-Cysteine	
L-Histidine		L-Lysine	
L-Proline		L-Serine	
L-Methionine		L-Tryptophan	
L-Threonine		Glycine	

September 2018 using previously saturated peat moss as the substrate in a commercial nursery with temperature of 35.5±2.8°C maximum and 23.5±3.1°C minimum. The relative humidity (%) was ranging between 73.8±4.1 to 90.5±1.8 without any supplemental lighting during seedling growth. Irrigation, fertilizer and pesticide applications were done as described by Hamdi (2017).

When seedlings reached to the 3-5 true leaf stage, they were established by hand in greenhouse on 8 November 2018. The soil was ploughed and formed into raised beds. The soil was irrigated and brought to field capacity 2 days before seedlings were transplanted on 6 November 2018. The spacing was kept as 1.25 m between rows and 0.4 m between plants, with 15 plants per experimental unit and a density equivalent to 20,000 plants/ha.

Irrigation was supplied through a surface drip irrigation T-Tape (Bowsmith, Exeter, CA). The maximum capacity of water flow of emitters was 1 L/h with a wall thickness of 1 mm, and 11 cm between emitters. Irrigation was applied when 50% of water-holding capacity water was consumed (Faberio *et al.,* 2002) in 30 cm soil depth to bring the soil moisture content again to field capacity. The quantity of irrigation water was calculated using the equation of Allen *et al.* (1998). Irrigation was applied until the end of the last harvest. The soluble 20:20:20 NPK fertilizer in 4 split applications throughout the growth period at the rate of 100 kg/ha was applied along with irrigation water.

Plant height was measured from the root collar to the shoot apex. Stem diameter was measured from 10 randomly selected plants by Vernier Caliper. Chlorophyll (SPAD) were extracted and analyzed according to procedure described by Black *et al.* (1965). Total yield was converted to per hectare basis. The values of WUE (kg/m^3) were calculated for different treatments after harvesting using the following equation given by Jensen (1983) :

$$WUE = \frac{Y}{WA}$$

Where, WUE is water use efficiency (kg/m^3), Y is yield (kg/ha) and WA is amount of applied water (m^3/ha).

Statistical Analysis

Data were subjected to analysis of variance using SAS JMP (ver. 9.1, SAS Institute, Cary, NC). The interactions were separated with the Tukey-Kramer HSD test and simple regressions were calculated using GraphPad Prism (ver. 8, La Jolla, CA).

RESULTS AND DISCUSSION

Effects of Water Stress on Yield Traits

Linear regression indicated strong relationship in all measured variables as irrigation levels increased (Fig. 1). Plants irrigated at 100% field capacity recorded higher plant height (65.70 cm), stem diameter (8.05 mm), chlorophyll content (73.48 SPAD), higher yield (5.78 t/ha) and WUE (5.99 kg/m^3).

Effects of Foliar Application of Amino decanate® on Yield Traits

Linear regression indicated strong relationship in all measured variables as amino decanate® concentration increased except WUE (Fig. 2). The foliar application of 200 mg/L amino decanate® concentration had highest plant height (73.49 cm), highest diameter stem (7.84 mm), most Chlorophyll (62.99 SPAD) and more yield (5.44 t/ha). The maximum WUE (6.86 kg/m^3) was recorded at 100 mg/L amino decanate® concentration.

Effects of Water Stress x Amino decanate® Interaction on Yield Traits

Linear regression indicated strong relationship in all measured variables as irrigation levels and amino decanate® concentration increased except for WUE (Fig. 3). Irrigation at 100% field capacity level and foliar application of 200 mg/L amino decanate® treatments produced the tallest plants (83.99 cm), widest stems (9.92 mm), higher Chlorophyll (85.11 SPAD) and highest yield (7.12 t/ha). However, the maximum WUE (7.67 kg/m^3) was recorded under the interaction treatment of irrigation at 100% field capacity x foliar application of 100 mg/L amino decanate® concentration.

Results of this study indicated that

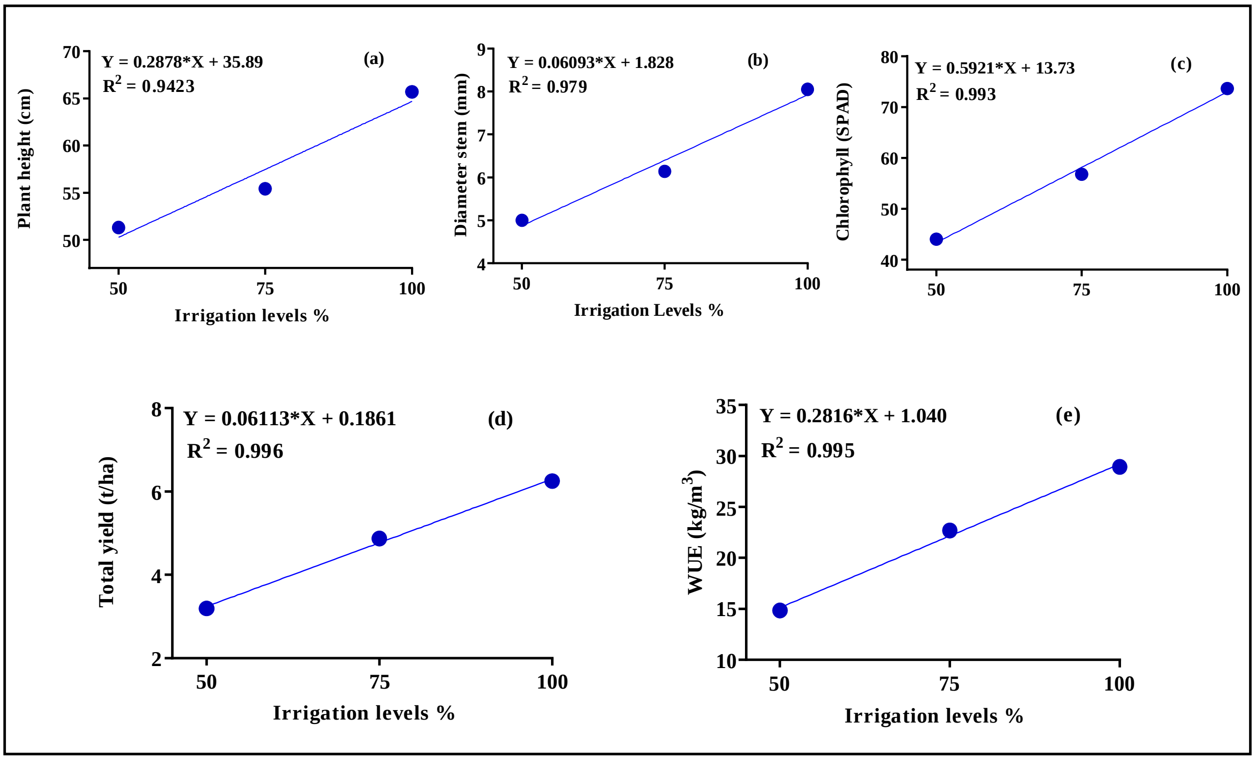

Fig. 1. Effect of irrigation levels on plant height (a), stem diameter (b), chlorophyll (c), total yield (d) and WUE (e) of eggplant.

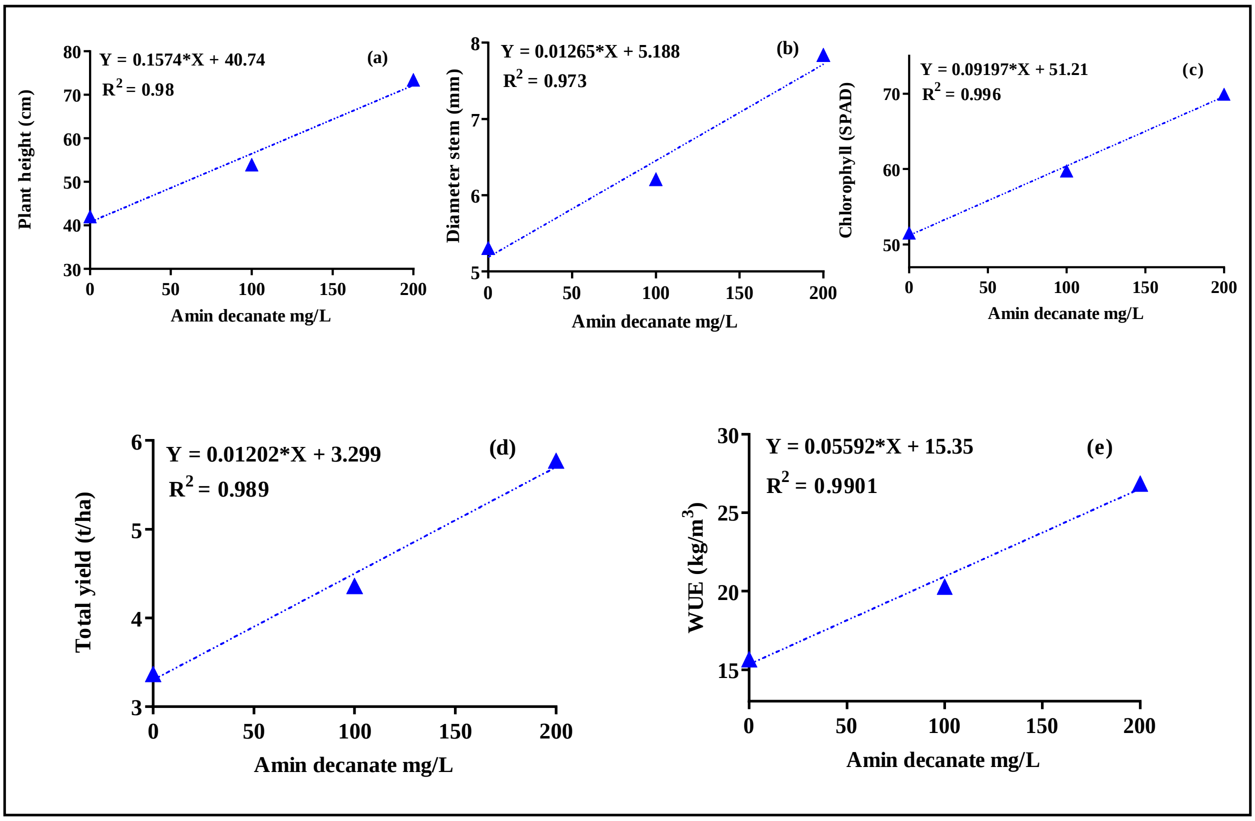

Fig. 2. Effect of amino decanate®.on plant height (a), stem diameter (b), chlorophyll (c), total yield (d) and WUE (e) of eggplant.

water deficit stress negatively affect plant height, stem diameter, chlorophyll content in leaves, total yield and water use efficiency. This reduction in growth and yield of eggplant might be due to an interruption in the photosynthesis process during the water deficit period. Full irrigation at 100% field capacity provided consistent supply of water to the entire root area of plants thereby water stress conditions minimized (Shaheen *et al.,* 2013; Ransford *et al.*, 2019). Most morphological, physiological and biochemical processes associated with plant development might have compromised during water deficit and can result in poor photosynthesis, respiration and nutrient metabolism (Wakchaure *et al.,* 2020).

The interaction between irrigation levels and foliar application of amino decanate® treatment was highly significant for all measured variables. Amino decanate® generally has high uptake efficiency rates (Al-Shammari *et al,* 2018). It is a well-known bio-stimulant so it has positive effects on plant growth and plays an important role in secondary metabolism in plants (Al-Shammari *et al,* 2020).

The essential nutrients present in amino decanate® are the key components in metabolic reactions involved in optimum leaf growth and functioning, through contributions in hormone metabolism, increase in cell division and expansion and enhanced volume of intercellular space in mesocranic cells, quicker translocation of metabolites from the source to sink "fruit" (Abood *et al.,* 2019) in this study. The foliar application of amino decanate® played positive role in alleviating negative impact of water deficit.

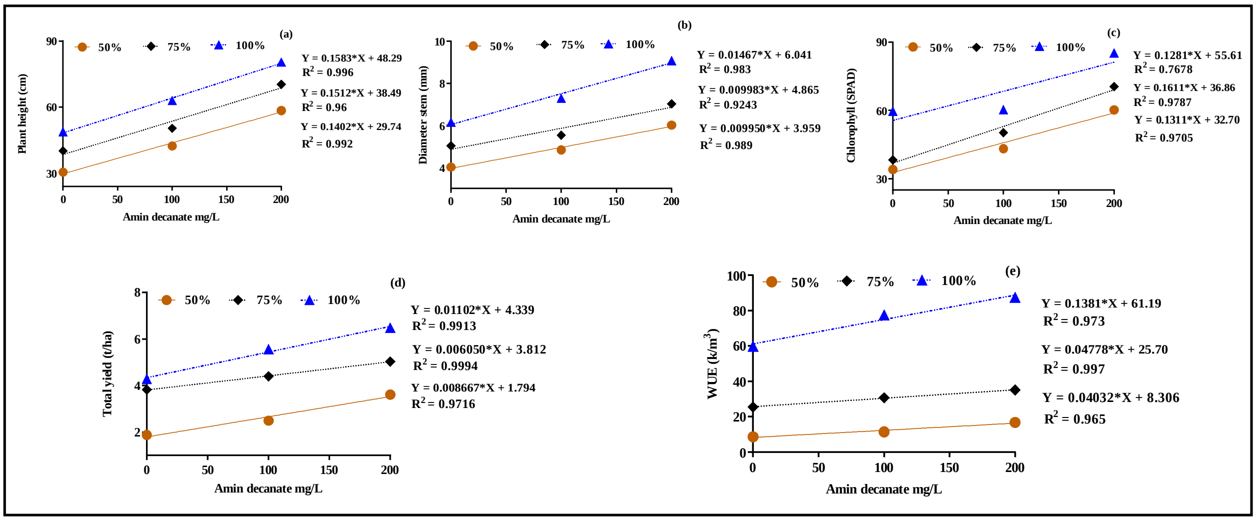

Fig. 3. Effect of interaction between irrigation levels and amino decanate® on plant height (a), stem diameter (b), chlorophyll (c), total yield (d) and WUE (e) of eggplant.

CONCLUSION

From the results of the present study, it can be concluded that foliar application of amino decanate® markedly increased the vegetative growth and production of eggplant under water stress conditions. The application of 200 mg/L amino decanate® concentration led to decrease in the water requirement of eggplant besides higher vegetative growth and yield. Therefore, on the basis of this study it can be recommended that 200 mg/L amino decanate® should be applied through foliar application for obtaining higher yields of eggplant under water deficit areas.

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