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Effect of Water Stress on the Growth and Yield of Greenhouse Cucumber (*Cucumis sativus* L.)

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Abstract
Efficient irrigation plays a vital role in the production of vegetables and fruits. Too low or high water application can reduce the growth and development process of plants which may negatively affect the crop yield. To investigate the fact, a field experiment was carried out to check the growth and yield of cucumber on a sandy soil, under greenhouse conditions by using drip irrigation system having flow rate of drippers 2 liters per hour respectively. The field study was carried out on a randomized complete block design (RCBD) having five different rates of irrigation treatments, i.e. (T_1 = one time, T_2 = two times, T_3 = three times, T_4 = four times, and T_5 = five times) application per day respectively. The results revealed that different levels of irrigation with constant doses of fertilizers brought a positive effect in cucumber production. Amongst all the treatments, T_5 was observed to be more suitable and economical as it took less days to develop flowers (30.385 days), fruit setting (9.055 days), fruit maturity (6.178 days), give more number of fruits per plant (33.746), highest fruit length (17.812 cm), highest fruit weight (131.977 g), maximum vine length (2.73 m), and highest fruit yield (57.644 tons ha^{-1}) respectively. However, treatment T_1 showed inadequate results regarding all the parameters. Results suggests that five times application of water for five minutes per day to the cucumber plants, with 45 minutes gap were found suitable for best possible growth and yield of cucumber under greenhouse conditions using drip irrigation system.
Keywords: Cucumber, Water Stress, Drip Irrigation, Greenhouse, Agriculture.

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INTRODUCTION

Due to the fast growing demand in domestic and local markets, vegetables production in UAE is gaining importance day by day. In general farmers usually grow vegetable during the winter season on large scale, as the winter season is of a short duration and the rest of the year the agro-ecological environment and conditions are not fit for the open field production of vegetable (Arshad *et al.,* 2017). Moreover, during the summer season the yield and quality of the vegetables are also not up to the mark. Greenhouse vegetable production is a newly introduced technology in UAE to produce vegetables like cucumbers, tomatoes, marrow (koosa), chilies, bell pepper etc, during summer season (Arshad *et al.,* 2015). According to the statistics, currently there are around 3,150 greenhouses across Abu Dhabi, likely to supply 32,125 tons of good vegetables per year to the local markets. These vegetables mainly comprised of 71% cucumber and 29% other variety (Times, 2015). Farmers' in UAE are more interested to grow cucumber as it easy to grow in all types of soils and can tolerate salinity up to some extent. Cucumbers are climbing vines that belong to *Cucurbitaceae family* which is known scientifically as "*Cucumis Sativus L.*" (Hashem *et al.,* 2011). Cucumbers require plenty of water, especially during the flowering and fruiting period, as the fruits contains about 95% of water in it. Therefore, the shortage of water during flowering and fruit development stages in soil may result in flower and fruit dropping (Kaya *et al.,* 2005).

In order to get good yield it is essential that soil water supply should be kept at optimal level during cucumber production (Kirnak *et al.,* 2006). In greenhouse farming, the plants usually being irrigated through drip irrigation system, as it minimizes the soil storage and provides optimum water supply to the roots and helps in controlling soil matric potential in the rhizosphere which ultimately reduce the plant water stress (Wang *et al.,* 2009). One of the most excellent features of drip irrigation is that, water and nutrients can be supplied directly to the plants, which ultimately boost the vigorous growth of plants and helps in getting maximum yield (Kunyanga *et al.,* 2012). Various studies show that cucumber harvested yield was found more with drip irrigation system as the fruit parameters (length, diameter, number of

fruits, and weight of fruit etc), were significantly affected by irrigation quantities (Zhang *et al.,* 2011).

Based on the above discussed facts the present research work was conducted to evaluate the effect of different levels of irrigation treatments with constant doses of fertilizers on the growth and production parameters of cucumber under greenhouse conditions by using the drip irrigation system.

MATERIALS AND METHODS

Location

The research work was carried out at a private farmhouse, in September 2016. The experiment site was located in the Tharwaniyah, (Liwa Oasis) which is about 95 km south of the Persian Gulf coast and 145 km south-south-west (SSW) of the city of Abu Dhabi in the Al Gharbia (Western) Region, on the northern of Rub' al Khali desert. The soil of the farmhouse was sandy in nature, with hydraulic conductivity (1.202 x 10^{-4} m/sec), bulk density (1.3 g/cm^3), and porosity (0.44) respectively. In order to increase the moisture holding capacity within the soil poultry manure was mixed with sand and irrigation was done through drip irrigation system by using a drippers having flow rate 2 liters per hour, respectively.

Field Experiment

The present research was carried out on a randomized complete block design (RCBD) having five different rates of irrigation treatments with three replications. The irrigation water applied in such a way that (T_1 = one time, T_2 = two times, T_3 = three times, T_4 = four times, and T_5 = five times) application per day respectively. The size of the experimental field was 148.5 m^2 i.e. (9.9m x 15m) and consists of 15 laterals with 20 mm internal diameter and each lateral contains 30 online pressure compensating emitters while the internal diameter of sub-main line and mainline was 40 mm and 60 mm respectively. The water source was at a distance of 10 m from the sub-main line. The spacing of emitters along the lateral was 0.50 m, and spacing of laterals was 0.66 m. Water was supplied to the drip unit at constant present head 20 psi (1.36 atm) pressure with 2 inch water pump respectively.

The time of water application to the plants was 5 minutes long in each treatment and there was a gap of 45 minutes between each irrigation application respectively. Initially the seed bed was prepared by digging small holes adjacent to the emitters with the help of traditional hoes and drip irrigation lines were installed for the irrigation purpose accordingly (Wallace, 2000). For the cultivation of cucumber the nursery was initially developed with the help of plastic tray and coco peat respectively. The plastic trays were filled with coco peat and seeds were sown at the depth of 5mm. After the development of 2 or 3 well established leaves, the plants were then transplanted with proper covering of plastic sheet and irrigated in such a way that the plant could take firm foot hold with regard to the root taking process (Arshad *et al.,* 2014).

The fertilizers were applied in equal amount to all sub-plots through drip irrigation system. The pruning, stacking and tying took place after few days of transplanting to improve the aeration process within the plants and cultural practices i.e., pesticide application, hoeing and weeding were carried out throughout the growing season respectively. To maintain the quality of cucumbers the fruits were harvested when they were slightly unripe (Jilani *et al.,* 2009). Ten randomly selected plants from each treatment was taken to determine the agronomic parameters during study i.e. days taken to flowering, days to fruit setting, days to fruit maturity, number of fruit per plant, fruit length (cm), fruit weight (grams), vine length (m) and yield (tons ha^{-1}). Finally all the data analysis and statistical analysis were done through ANOVA procedure accordingly.

RESULTS AND DISCUSSION

The subject study revealed that the different agronomic parameters of cucumber i.e. (days taken to flowering, fruit setting, fruit maturity, number of fruits, fruit length, fruit weight, vine length and fruit yield) differed very significantly between application of different rates of irrigation water as elaborated in Table 1 and Table 2 respectively.

Days Taken to Flowering

Statistically remarkable results were observed for time taken to flowering for all treatments as shown in Table 1. Treatment T_5 took less number of days (30.835 days) to produce flowers, followed by T_4 (32.489 days) and T_3 (33.445 days) respectively. While maximum number of days was recorded for T_1 with (37.624 days) to produce flowers. The plants which are irrigated with required amount water took fewer days to develop flowers. While, plants irrigated with less amount of water took more days to set flowers. These results are in agreement with Arshad *et al.* (2016), who concluded that continuous increase in irrigation levels can reduce the days taken to set flowers in alfalfa up to a some extent and vice versa.

Days to Fruit Setting

Different irrigation levels had a significant effect on time required to fruit setting as shown in Table 1. The lowest numbers of days to set fruit were observed for treatment T_5 (9.055 days), followed by T_4 (10.623 days) and T_3 (11.666 days); however the difference between T_3 and T_4 was not significant. Once again the maximum number of days for fruit setting was recorded for T_1 with (14.637 days). These results are in agreement with Muhammed *et al.* (2006), who concluded that high pulse irrigation levels can reduce the days taken to set fruit in cucumbers.

Days to Maturity

The time taken to fruit maturity was significantly affected by different levels of irrigation treatments as shown in Table 1. The maximum numbers of days (10.576 days) for fruit maturity were recorded for treatment T_1, followed by T_2 with (9.510 days) respectively. While minimum numbers of days for fruit maturity, once again recorded for treatment T_5 with (6.178 days), followed by T_4 (7.424 days) and T_3 (8.436 days) with no significant difference among them respectively. The less number of days required to fruit maturity are beneficial and inversely proportional to obtain earlier yield of cucumber. These results are in agreement with Aassouline *et al.* (2006), who concluded that there is a proportional relation between pulse irrigation and days to mature fruit, as high pulse irrigation gives early maturity of capsicum bell.

Number of Fruits per Plant

The outcome of the data showed statistically remarkable results for number of fruits per plant for all treatments as shown in Table 1. The highest numbers of fruits were observed for treatment T_5 (33.746 fruits) followed by T_4 (30.138 fruits) respectively. However the difference between T_5 and T_4 was not significant. The lowest number of fruits per plant was recorded for treatment T_1 (23.290 fruits) per plant. Proper amount of water application boost up the vigorous growth of cucumber which eventually increases the number of fruits per plant, which conforms the findings of Sahin *et al.* (2015), for cucumber when water is applied to the plants through pulse irrigation at high rate.

Table 1. Effect of different rates of irrigation treatment on days taken to flowering, fruit setting, fruit maturity and number of fruits per plant.

Treatment	Days taken to flowering	Days taken to Fruit setting	Days taken to fruit maturity	No of Fruits per Plant
T_1	37.624d	14.637cd	10.576d	23.290d
T_2	35.100c	13.320c	9.510c	25.807cd
T_3	33.445b	11.666b	8.436bc	26.001b
T_4	31.489ab	10.623ab	7.424b	30.138ab
T_5	30.835a	9.055a	6.178a	33.746a
LSD (P< 0.05)	0.627	0.361	0.933	2.006

Means followed by different letter shows significant result at 5% level of significance.

Fruit Length

Statistically significant results were observed for fruit length per plant as shown in Table 2. In general the length of cucumber were found usually more in those plants which received high pulses per irrigation as compared to those that received less number of pulses per irrigation. The maximum fruit length (17.812 cm) was recorded for treatment T_5, followed by T_4 (15.872 cm) and T_3 (14.456 cm), with no significant difference among them. Once again the overall minimum fruit length (12.923 cm) was observed for treatment T_1. As cucumber required ample amount of water to be juicy and crunchy, therefore increasing the amount of irrigation water to a certain level T_5, the fruit length may increased and vice versa. Similar results were obtained by El-Mogy *et al.* (2012), for green beans, who concluded that plants that do not get required amount of water produce undersized and deformed fruits.

Fruit Weight

The results of fruit weight (Table 2) showed that the high pulse irrigation directly affected the weight of fruit and there were significant differences between the irrigation treatments. The overall maximum fruit weight (131.977 g) was recorded for treatment T_5 and minimum fruit weight (106.334 g) was recorded for treatment T_1 respectively. The results showed that high pulse irrigation along with appropriate amount of NPK fertilizers can increase the fruit weight. These results are in agreement with the findings of Arshad *et al.* (2014), for cucumber, who also observed that by the application of appropriate amount of irrigation water and fertilizers the fruit weight can be increased.

Vine Length

During the research study it had been observed that different irrigation treatments, significantly affected the vine length of cucumber. The treatment T_5 produced maximum vine length (2.736 m), followed by T_4 (2.455 m), and T_3 (2.067 m) respectively. The minimum vine length (1.892 m) was recorded for treatment T_1 were irrigation was applied once in a day as shown in Table 2. The increase in vine length mainly depends on the environmental and agronomic factors; therefore the plants receiving more amount of irrigation water may increase the water in root zone which ultimately boost the movement of macro-element from the soil by plants on cucumber. Likewise soil condition and texture also plays a critical role in enhancing the root length. The present results supported by the findings of Kirnak *et al.* (2006), who concluded that the high pulse irrigation may increase the vine length of cucumber up to some extent; however over-irrigation may encourage diseases and yellowish scars on the fruit.

Table 2. Effect of different rates of irrigation treatment on fruit length (cm), fruit weight (g), vine length (m) and yield per hectare (tons)

Treatment	Fruit length (cm)	Fruit Weight (g)	Vine Length (m)	Fruit Yield (tons ha^{-1})
T_1	12.923d	106.334d	1.892cd	43.910d
T_2	13.971c	116.647c	1.921c	45.743c
T_3	14.456bc	123.370b	2.067b	50.431bc
T_4	15.872b	129.199ab	2.455ab	54.887b
T_5	17.812a	131.977a	2.736a	57.644a
LSD ($P \leq 0.05$)	0.960	15.077	0.117	0.826

Means followed by different letter shows significant result at 5% level of significance

Fruit Yield

The observed data showed that the fruit yields were significantly affected by different rates of irrigation treatments for cucumber as shown in Table 2. The fruits were harvested when the skin was completely dark green and they were large enough to use. High pulse irrigation treatment T_5 increased the fruit yield up to (57.644 tons ha^{-1}), followed by T_4 (54.887 tons ha^{-1}) and T_3 (50.431 tons ha^{-1}) respectively. However, there was no significant difference among T_4 and T_3. The minimum fruit yield per hectare was recorded for treatment T_1 (43.910 tons). High pulse irrigation increased the vegetative growth and chemical composition of fruits which resulted in more fruit length and fruit weight and ultimately affected the fruit yield. Similar results were obtained by Arshad *et al.* (2014), who also concluded that different levels of irrigation water with proper dozes of fertilizers increased the fruit yield of capsicum green bell.

CONCLUSION

From the results obtained it could be concluded that different levels of irrigation treatments with constant doses of fertilizers brought a positive effect in cucumber production under greenhouse conditions. Amongst all the treatments, T_5 was observed to be more suitable and economical as it took less days to develop flowers (30.385 days), fruit setting (9.055 days), fruit maturity (6.178 days), give more number of fruits per plant (33.746), highest fruit length (17.812 cm), highest fruit weight (131.977 g), maximum vine length (2.73 m), and highest fruit yield (57.644 tons ha^{-1}) respectively. However, treatment T_1 showed inadequate results regarding all the parameters. Too low or high irrigation application per day through drip irrigation system may negatively affect the vigorous growth and yield parameters of cucumber. Hence it can be concluded that the five times application of water for five minutes per day to the cucumber plants, with 45 minutes gap were found suitable for best possible growth and yield of cucumber under greenhouse conditions using drip irrigation system. As an area under study was sandy; therefore these suggestions are applicable for only sandy soils while the results may vary for other types of soil.

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CONFLICT OF INTEREST

The authors declare that they don't have any conflicts of interest and are also not interested in competing with anyone.

REFERENCES

Aasouline, S., Moller, M., Cohen, S., Ben-Hur, M., Grava, A., Narkis, K., 2006. Soil-Plant System Response to Pulsed Drip Irrigation and Salinity: Bell Pepper Case Study. Soil Sci. Soc. Amer. J., 70(5): 1556-1568.

Arshad, I., Abbasi, A.U.R., 2017. Comparison of Pre-Cooling Unit with Normal Refrigeration under Control Atmosphere Storage. PSM Biol. Res., 02(1): 1-6.

Arshad, I., Ali, W., Khan, Z.A., Bhayo, W.A., 2016. Effect of Nitrogen and Phosphorus on the Growth and Yield of Alfalfa (*Medicago sativa* L.) under Agro-Climatic Conditions of Tando Adam. PSM Biol. Res., 01(2): 74-77.

Arshad, I., Hanaffy, I.I., Bly, M., Yerla, R., Jamali, L.A., Khan, Z.A., 2015. Assessment of the Performance of Pre-Cooling Unit under Control Atmosphere Storage". American-Eurasian J. Agric. & Environ. Sci., 15(12): 2331-2336.

Arshad, I., Ali, W., Khan, Z.A., 2014. Influence of Water Soluble NPK Fertilizers on the Growth and Yield of Greenhouse Pepper (Capsicum Annum L.) by Using Drip Irrigation Technology. Int. J. Res., 1(11): 179-186.

Arshad, I., Ali, W., Khan, Z.A., 2014. Effect of Different Levels of NPK Fertilizers on the Growth and Yield of Greenhouse Cucumber (Cucumis Sativus) By Using Drip Irrigation Technology. Int. J. Res., 1(8): 650-660.

El-Mogy, M.M., Abuarab, M.E., Abdullatif, A.L., 2012. Response of Green Bean to Pulse Surface Drip Irrigation. J. Hort. Sci. Ornament. Plants, 4(3): 329-334.

Hashem, F.A., Medany, M.A., El-Moniem, E.M.A., Abdallah, M.M.F., 2011. Influence of Greenhouse Cover on Potential Evapo-Transpiration and Cucumber Water Requirements. Fac. Agr. Ain Shams Univ. Ann. Agr. Sci., 56(1): 49-55.

Jilani, M.S., Bakar, A., Waseem, K., Kiran, M., 2009. Effect of Different Levels of NPK on the Growth and Yield of Cucumber (Cucumis sativus) Under the Plastic Tunnel. J. Agric. Soc. Sci., 5(1): 99–101

Kaya, C., Higgs, D., Kirnak, H., 2005. Influence of Polyethylene Mulch, Irrigation Regime, and Potassium Rates on Field Cucumber Yield and Related Traits. J. Plant Nut., 28(2): 1739-1753.

Khaleej times., 2015. Abu Dhabi Farmers Gear up for Next Agricultural Season. A news paper article published by Khaleej Times on 21/07/2015.

Kirnak, H., Demirtas, M.N., 2006. Effects of different Irrigation Regimes and Mulches on Yield and Macro Nutrition Levels of Drip-Irrigated Cucumber under open Field Conditions. J. Plant Nut., 29(1): 1675-1690.

Kunyanga, C.N., Imungi, J.K., Okoth, M.W., Biesalski, H.K., Vadivel, V.K., 2012. Total Phenolic Content, Antioxidant and Antidiabetic Properties of Methanolic Extract of Raw and Traditionally Processed Kenyan Indigenous Food Ingredients. Food Sci. Tech., 45(1): 269-276.

Mohammed, H.E., Ahmed, M.K., 2006. Effect of Irrigation Levels on Cucumber (Cucumis sativus L.) Yield Under Cooled Plastic Tunnels. 36th proceedings of the Meetings of the National Crop Husbandry Committee – NCHC.

U. Sahin, U., Kuslu, Y., Kiziloglu, F.M., 2015. Response of Cucumbers to Different Irrigation Regimes Applied Through Drip-Irrigation System. J. Anim. Plant Sci., 25(1): 198-205.

Wang, Z., Liu, Z., Zhang Z., Liu, X., 2009. Subsurface Drip Irrigation Scheduling for Cucumber (cucumis sativus l.) Grown in Solar Green House Based on 20cm Standard Pan Evaporation in Northeast China. Sci. Hort. J., 123(1): 51–57.

Wallace, J.S. (2000). Increasing Agricultural Water Use Efficiency to Meet Future Food Production. Agr. Ecosyt. Environ. 82(1): 105-119.

Zhang, H.X., Chi, D.C., Wang, Q., Fang, J., Fang, X.Y., 2011. Yield and Quality Response of Cucumber to Irrigation and Nitrogen Fertilization under Sub Surface Drip Irrigation in Solar Greenhouse. Agr. Sci. China. 10(1): 921-930.