Effect of Different Levels of NPK Fertilizers on the Growth and Yield of Greenhouse Cucumber (*Cucumis Sativus*) By Using Drip Irrigation Technology

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Abstract

The present research work was conducted to find out the cucumber response to water soluble NPK (20-20-20) compound fertilizer by using drip irrigation technology in available agro-ecological conditions of Western Region of Abu Dhabi – UAE. In this study different production scenarios were studied for the safe keeping of the greenhouse cucumbers. It is one of the most important summer vine vegetable crop, and been rated suitable for greenhouse cultivation in comparison with traditional agricultural practices. Due to such controlled atmospheric conditions in greenhouses the yield and quality of cucumbers maintained. Greenhouse is composed of a network of Galvanized pipes and plastic sheets. These Galvanized pipes designed aerodynamically in order to resist the heavy winds and the average life of these pipes is about 10 – 15 years. These plastic sheets are 200 micron thick and having durability around 3 years. The humidity and moisture retention in the soil inside the greenhouse is high as compared to the outside atmospheric conditions.

Keeping the above facts in view, the different treatments of water soluble NPK (20-20-20) compound fertilizer were applied in five sub-plots i.e. control (no fertilizer), 500 grams fertigation^{-1}, 750 grams fertigation^{-1}, 1000 grams fertigation^{-1}, and 1250 grams fertigation^{-1} respectively. In order to achieve the precise results on the basis of field observation and statistical analysis we evaluated that different treatments of NPK application had an optimistic effect on the growth and production of greenhouse cucumbers. Amongst different treatments levels of NPK, it had been noted that application of NPK at 1000 grams fertigation^{-1} is the most suitable dose, as it took least days to flowering 31.464, fruit setting 9.240, maturity 6.304, maximum fruit per plant 34.435, maximum fruit length 18.176 cm, maximum fruit weight 134.670 grams and yield per hectare 58.820 tons. However, application of NPK fertilizers treatments at 1250 grams fertigation^{-1} also shown some positive effect on some parameters including fruit weight 149.183 g and vine length 3.812 m. Control plots showed un-satisfactory results regarding all the parameters.

Statistical analysis of all the research parameters in terms of growth and yield for all five sub-plots i.e. days taken to flowering, fruit setting, fruit maturity, number of plants, fruit length, fruit weight, vine length and yield per hectare (tons) are elaborated in Table I and Table II respectively.

Keywords: Cucumber, Drip Irrigation System, Greenhouse, Agriculture, Fertilizer Application.

INTRODUCTION

The cucumber is the vegetable that belongs to the (Cucurbitaceae family) which is known scientifically as "Cucumis Sativus". It is an annual monoecious, trailing, climbing and herbaceous plant. The root system consists in a main root which branches out into very fine secondary roots which are white in color. The main stem is angular and thorny, with nodes at the point where thorns and leaves developed. Secondary shoots will be bud from each leave axle. The flowers are yellow dropping leave axles which are generally unisexual. The fruit is a fleshy, smooth or rough depending upon the variety used. The pulp is watery and whitish in color with seeds on the inside situated travel length of the fruit. The seeds can be found in variable quantities and they are oval, slightly flat in shaped with whitish yellow color. The optimum day time temperatures vary between 20^0c to 30^0c. As the temperature increases within this range early growth rate increases. A cucumber is a plant that requires high level of humidity due to the large surface area of its leaves. The optimum relative humidity during the day is in between 60% - 70% and in night in between 70% - 90% respectively.

Cucumber may be grown in all types of loose soils which may be well drained and having sufficient organic matter. It is a plant which tolerates certain amount of salinity up to some extent. The optimum pH range is 5.5 – 7.0. Cucumber plants required very large amount of water especially at the fruit formation stage and throughout the growth stage. This is a crop which requires a large quantity of macro and micro nutrients especially Manganese and Iron. 100 kg N ha^{-1} had significantly maximized cucumber fruit length, fruit weight and vine length, which are indirectly related to the yield, but 80 kg N ha^{-1} was the most economical dose for minimizing the days to flowering, days to fruit setting and days to fruit maturity and getting higher number of fruits and ultimately higher yield Waseem et al. (2008). An increase in nitrogen application resulted in maximum fruit length, and fruit weight of cucumber Ahmed et al. (2007). Similarly the fertigation of 150 mg N L^{-1} gave the highest leaf number, leaf area, fresh and dry weight of shoot and roots, in cucumber Watcharasak et al. (2005). Likewise application of 150:90:90 kg NPK ha^{-1} through fertigation give maximum number of fruits per vine, and

yield ha-1 (tons) of cucumber plant accordingly Choudhari et al. (2002).

Depending upon both crop and temperature the growth period from flowering to harvest will take between 55 to 60 days. The fruits are usually harvested while still slightly unripe and before they harden. Due to the fact the cucumber itself contains large amount of water dehydration should be prevented by cutting the fruit during the coolest hours of the day. It is one of the most important summer vine vegetable crop, and been rated suitable for greenhouse cultivation in comparison with traditional agricultural practices (El-Amir et al., 2001). Commercial production of cucumbers and other vegetables has increased steadily under green house as compare to severe climate (El-Aidy, 1992). Due to such controlled atmospheric conditions in greenhouses the yield and quality of cucumbers maintained. Greenhouse is composed of a network of Galvanized pipes and plastic sheets. These Galvanized pipes designed aerodynamically in order to resist the heavy winds and the average life of these pipes is about 10 – 15 years. These plastic sheets are 200 micron thick and with durability around 3 years and can easily resist the 140 km/hr wind and sandstorms. The humidity and moisture retention in the soil inside the greenhouse is high as compared to the outside atmospheric conditions. In order to maintain the inside temperature and humidity of greenhouse the 100 – 150 micron foggers are used to maintain the inside temperature and humidity.

Keeping all the above facts in view the subject study was conducted at Western Region of Abu Dhabi, UAE by focusing the effect of different levels of NPK fertilizers on the growth and yield of greenhouse cucumber under controlled atmospheric conditions by using the drip irrigation technology in available agro-ecological conditions.

OBJECTIVES

The objective of this research work was to find out the cucumber response to different levels of NPK fertilizers by using drip irrigation technology in available agro-ecological conditions of Western Region of Abu Dhabi, UAE. And to study the growth and production parameters required for the safe keeping of the commodity.

MATERIALS AND METHODS

Location

The research work was conducted at Western Region of Abu Dhabi, UAE in the month of March 2014. The experiment site was located in the Liwa Oasis which is about 95 km south of the Persian Gulf coast and 145 km 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 green house was mostly sandy and the farmer mixed some amount of poultry manure in order to increase the

soil moisture holding capacity. The ground water table was around 60 meter deep due to which farmer was utilizing the fresh water provided by municipality.

Greenhouse Size and Drip Irrigation System

The greenhouse comprises of 2 hectares which was divided into 10 plots with 1 water storage pond in order to store water for at least three days requirements. The drip irrigation system for each cucumber sub-plots consists of 10 laterals each with 20 mm external diameter and each lateral contain 72 cucumber plants along with emitters accordingly. While the external diameter of submain and mainline were 40 mm and 60 mm respectively. The water source was at the distance of 10 m from the submain line. The spacing of emitters along the lateral was 1 m, and spacing of laterals was 2 m. Water was supplied to the drip unit at constant present head 20 psi (1.36 atm) pressure with 2 inch water pump. Figure 1a – 1b describes the front and side view of greenhouse.

Fig: 1a. Side View of Greenhouse

Fig: 1b. Front View of Greenhouse

Greenhouse Land Preparation

The present research work was conducted in the 7th plot which was further divided into the 5 sub-plots. Before the preparation of soil bed, poultry manure was mixed with the soil inside greenhouse and formalin was used for the prevention of fungus and nematodes etc accordingly. Mixture of formalin is spread over the flat prepared land with the help of hand held watering wand and covered with polyethylene sheet accordingly. After that the soil was washed with clean water. After 2 weeks the bed preparation for cucumber plantation and drip irrigation network prepared accordingly. Figure 2a - 2f describes the overall land preparation operations in greenhouse.

Fig: 2a. Formalin Application

Fig: 2b. Polyethylene Sheet Covering

Fig: 2c. Fertilizer Mixing Tank

Fig: 2d. Water Storage Pond

Fig: 2e. Drip Emitters

Fig: 2f. Lateral Lines for Cucumber Plants

Field Experiment

The field experiment was laid out in randomized complete block design (RCBD) having five different levels of

Nitrogen, Phosphorous, and Potassium, including control plots. After the completion of bed preparation operation the transplantation operation of cucumber baby plants from nursery was done accordingly. In order to grow the cucumber first the nursery was developed for cucumber cultivation. For this purpose a plastic tray and coco peat was used. After filling the plastic trays with coco peat, the seed sown at the depth of 5mm accordingly. Once they have produced 2 or 3 well established leaves they are ready for transplantation. In order for transplanting to take place hole are made in soils and planted the baby plants accordingly. It is then covered with plastic sheet and watered so that the plant can take firm foot hold with regard to the root taking process. . Figure 3a - 3f describes the overall cucumber planting and growing operations in greenhouse which were studied during this research period.

Fig: 3a. Cucumber Plant Nursery

Fig: 3b. Cucumber Baby Plant

Cucumber plants required very large amount of water especially at the fruit formation stage and throughout the growth stage. All the fertilizers are applied through fertigation process by using drip irrigation system. Water soluble NPK compound fertilizer (20-20-20) was given in split doses throughout the study depending upon the plant need. The NPK fertilizer doses were applied on split basis to the cucumber plants. Different treatments of NPK applied per fertigation to the five sub-plots were no fertilizer (control), 500 grams, 750 grams, 1000 grams, 1250 grams accordingly. Apart from NPK application during both at root taking and flowering stages the Calcium, Manganese and Iron in equal amount applied to all sub-plots with regard to enhancing plant quality and protecting the plant against diseases. The pruning takes place a few days after transplanting has been carried out. The old yellow leaves are removed from time to time in order to facilitate the aeration process in plants. Stacking and tying the plants maintain them in one position and it will improve the aeration process in plants which is ultimately easier to take sunlight in good quantity. Once the plant moves the wire it will

then move to the next wire. With the objective of increasing the cross pollination bee hives of (Bombus Terrestries) was placed inside the greenhouse.

Fig: 3c. Checking the leaves condition

Fig: 3d. Drip Lateral along Cucumber plantation

Fig: 3e. Checking the Fruit Length

Fig: 3f. Stacking of Cucumber Vines

The fruits were harvested while still slightly unripe and before they harden. All cultural practices i.e., irrigation, hoeing and weeding were carried out throughout the growing season as recommended. The thermometer and hygrometer used for temperature and humidity checking accordingly. The data was recorded for 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 the data analysis and statistical analysis were done through ANOVA procedure.

RESULTS AND DISCUSSION

Days Taken to Flowering

Statistically significant results were observed for days taken to flowering

with maximum 38.392 days and minimum 31.464 days in control (no fertilizer) and 1000 grams fertigation^{-1} respectively. The detailed results for all plots are given in Table I. From the obtained results it is clear that due to the deficiency of major nutrients in cucumber plants the growth of the plants becomes slow which tends to maximum days taken to flowering.

Days to Fruit Setting

Fertilizers levels had significant effect on days to fruiting as shown in Table I. From the obtained results it is clear that as the NPK level was increasing the days taken to fruiting is decreasing and vice versa. Maximum and minimum days taken to fruit setting were 14.936 days and 9.240 days in control and 1000 grams fertigation^{-1} recorded respectively. Once again 1000 grams fertigation^{-1} took fewer days i.e. 9.240 days taken to fruit setting.

Days to Maturity

Statistically significant results were observed for days to fruit maturity as shown in Table I. Maximum 10.792 and minimum 6.304 days for fruit maturity were recorded in control and 1000 grams fertigation^{-1} respectively. Due to the deficiency of major nutrients in cucumber plants the time becomes prolonged for the maturity of fruit.

Number of Fruits per Plant

According to the obtained results it has been observed that maximum 34.435 fruits per plant were recorded in 1000 grams fertigation^{-1}. Minimum 23.765 fruits per plant were recorded in control. Appropriate nutrients application boost up the growth of cucumber plant which eventually increases the number of fruits per plant accordingly.

Table I. Effect of different treatments of NPK 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
NPK - Grams /Fertigation				
Control	38.392a	14.936a	10.792a	23.765d
500	35.816b	13.592b	9.704b	27.354bc
750	33.152d	11.904c	8.608c	28.712b
1000	31.464e	9.240e	6.304e	34.435a
1250	34.128c	10.840d	7.576d	25.511cd
LSD (P< 0.05)	0.64	0.368	0.952	2.047

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

Fruit Length

During the research study it has been observed that maximum fruit length 18.176 cm was noted in 1000 grams fertigation^{-1}, while the minimum 13.187 cm fruit length was observed in control. The detailed results for all plots are given in Table II. When the NPK fertilizer application increased up to some extent i.e. 1000 grams fertigation^{-1}, the fruit length increased and beyond this level it started decreasing accordingly. This revealed that more the fertilizer application more will be the fruit length.

Fruit Weight

It had been observed that due to the application of different fertilizers levels there was a very significant increase in fruit weight in 1000 grams fertigation^{-1} with 134.670 grams. Likewise the least fruit weight 108.504 grams was observed in control. The observed results proved that by increasing NPK level the fruit weight also started increasing gradually which shows the strong relation among NPK level and fruit weight accordingly.

Table II. Effect of different treatments of NPK on fruit length (cm), fruit weight (g), vine length (m) and yield per hectare (tons)

Treatment	Fruit length	Fruit Weight	Vine Length	Yield
NPK - Grams /Fertigation	**(cm)**	**(g)**	**(m)**	**(tons ha^{-1})**
Control	13.187d	108.504c	1.931c	44.806e
500	14.256c	119.028b	1.960c	46.677d
750	14.751c	125.888b	2.109b	51.460c
1000	18.176a	134.670a	2.505b	58.820a
1250	16.196b	149.183a	3.812a	56.007b
LSD (P≤ 0.05)	0.980	15.385	0.119	0.843

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

Vine Length

It has also been observed that the different NPK levels significantly increased the vine length, which was maximum 3.812 m in 1250 grams fertigation^{-1} followed by 1000 grams fertigation^{-1} and 750 grams fertigation^{-1} with 2.505 m and 2.109 m long vines, respectively. Minimum vine length 1.931 m was recorded in control. The field results shown that if the NPK application is more, then the vegetative growth will also be more.

Fruit Yield

The fruits were harvested when the fruits are still slightly unripe and before they harden. On the basis of statistical analysis of all harvesting operations it has been observed that different levels of NPK fertilizers had a positive effect on the yield tons ha^{-1}. Fertilizer treatment

1000 grams fertigation^{-1} increased the yield up to 58.820 tons, followed by 1250 grams fertigation^{-1} and 750 grams fertigation^{-1} with 56.007 tons and 51.460 tons per hectare, respectively. Minimum production was recorded in control 44.806 tons per hectare.

SUMMARY AND CONCLUSIONS

The subject study was conducted in arid region of Abu Dhabi, Western Region – UAE in order to check the effect of different levels of NPK on greenhouse cucumber in term of growth and yield. On the basis of results obtained and statistical analysis we evaluated that water soluble NPK compound fertilizer (20-20-20) with different treatments had an optimistic effect on the growth and production of greenhouse cucumbers. Amongst different treatments levels of NPK, 1000 grams fertigation^{-1} is the most suitable dose in order to achieve the maximum production of cucumber per hectare by using drip irrigation technology.

All the statistical parameters studied had shown highly significant results for the treatment 1000 grams fertigation^{-1}, as it took least days to flowering 31.464, fruit setting 9.240, maturity 6.304, maximum fruit per plant 34.435, maximum fruit length 18.176 cm, maximum fruit weight 134.670 grams and yield per hectare 58.820 tons. However, application of NPK fertilizers treatments at 1250 grams fertigation^{-1} also shown some positive effect on some parameters including fruit weight 149.183 g and vine length 3.812 m. Control plots showed un-satisfactory results regarding all the parameters. As a consequence of incessant study it had been revealed that application of water soluble NPK compound fertilizer through drip irrigation system is very efficient in terms of growth and yields as it saves time as the fertilizer is dispensed with the irrigation water simultaneously which entail in saving the labor charges associated with fertilizer spreading in the field. However modern system demands for continuous water supply for even functioning of equipments involved.

SUGGESTIONS

In the light of the study carried out it is suggested that during production the old yellow leaves must be removed from time to time in order to facilitate the aeration process in plants. With the objective of the increasing the cross pollination bee hives of (Bombus Terrestries) should to be placed inside the greenhouse. Due to the fact that cucumber itself contains large amount of water, dehydration should to be prevented by cutting the fruit during the coolest hours of the day. Approximately every cucumber plant requires 700 ml of water every day therefore it is recommended to give proper water and fertilizer to every plant.

For the safe keeping of the drip irrigation subunit the farmers should give suitable training(s) for installation and maintenance of drip irrigation

system, so that they may become self – dependant for installation and may carry out maintenance work when in need. As cucumber is a quick cash crop, the farmers and growers are inclined to grow it on vast scale especially in arid ecological zones of the world which may entail in earning handsome foreign exchange. As the area under study was sandy; therefore these suggestions are applicable for only sandy soils while the results may vary for other types of soil.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Mr. Mohammed Al Marzouqi the owner of the farm for allowing this research to be carried out on his greenhouse, to the staff of the greenhouse especially Mr. Shahin the farm manger of the greenhouse for his kind assistance throughout the study and all other individuals who have been source of help throughout the research period.

REFERENCES

[1] Ahmed, N., M.H. Baloch, A. Haleem, M. Ejaz and N. Ahmed, 2007. Effect of different levels of nitrogen on the growth and production of cucumber. Life Sci. Int. J., 1: 99–102

[2] Choudhari, S.M. and T.A. More, 2002. Fertigation, fertilizer and spacing requirement of Tropical gynoecious cucmber hybrids. ISHS. Tsukuba, Japan. Acta Hort., 61: 588

[3] Din, M., M. Qasim and M. Alam, 2007. Effect of different levels of N, P and K on the growth and yield of cabbage. J. Agric. Res., 45: 171– 176

[4] El-Aidy, F., 1992. Protected cultivation of vegetables in Saudi Arabia. Plasticulture, 94: 7–11

[5] El-Amir, M.R., M.M. Helal, A.H. Al-Shemi and M.E. Mahmood, 2001. Economic feasibility of green house for some vegetable crops in Middle Egypt. Assiut J. Agric. Sci., 32: 377–388

[6] Rehman H.U., M.S. Jilani, M. Munir and A. Ghafoor, 1995. Effect of different levels of NPK on the performance of three varieties of cucumber. Gomal University J. Res., 15: 125–133

[7] Waseem, K., Q.M. Kamran and M.S. Jilani, 2008. Effect of different levels of nitrogen on the growth and yield of Cucumber (Cucumis sativus L.). J. Agric. Res., 46: 259–266

[8] Watcharasak, S. and T. Thammasak, 2005. Effect of nitrogen and potassium concentration in fertigation on growth and yield of cucumber. Kamphaengsaen Acad. J., 3: 18–29