Influence of Water Soluble NPK Fertilizers on the Growth and Yield of Greenhouse Pepper (Capsicum Annum L.) by Using Drip Irrigation Technology

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Abstract

The present research work was conducted to find out the Pepper (Capsicum Annum L.) response to poly-feed 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 parameters for the pepper (Capsicum Green Bell Variety) were studied under controlled conditions of greenhouse atmosphere. The humidity and moisture retention in the soil inside the greenhouse is high as compared to the outside atmospheric conditions. Due to such remarkable atmospheric conditions in greenhouses the yield and quality of pepper maintained and assured. The field study was carried out on randomized complete block design (RCBD) having nine different rates of poly-feed water soluble NPK fertilizer, i.e. (control, 250, 500, 750, 1000, 1250, 1500, 1750, and 2000) grams fertigation^{-1} respectively.

The outcome of the conducted research tantamount that the poly-feed water soluble NPK fertilizers application with different rates brought a positive effect in pepper cultivation under the greenhouse arrangements. Amongst different treatments rates of NPK, 1000 grams fertigation^{-1} was observed to be more suitable and economical dose as it took number of leaves per plant 47.134, plant height 31.204 cm, days for 50% flowering 24.304, total number of fruits per plant 43.906, fruit length 7.068 cm, and fresh fruit yield 22.0617 tons per hectare respectively. Nearly same results were achieved by 2000 grams fertigation^{-1} but consumption of fertilizers was recorded more. However, control plots showed un-satisfactory results regarding all the parameters. Too low or high NPK levels reduced the yield and yield parameters of pepper. Application of NPK beyond 1000 grams fertigation^{-1} seems to be an un-economical and wasteful practice. Statistical analyses of all the research parameters are elaborated in Table I.

Keywords: Green Pepper (Capsicum annuum L.); Drip Irrigation System; Greenhouse; Agriculture; Poly-feed Fertilizer

INTRODUCTION

The pepper (Capsicum annuum L.) is a leafy perennial plant which belongs to the solanaceous family. It has a unique annual growth cycle. This plant acquires many roots having a deep axle root system. Ample amount of light is imperative for its growth and flowering as its plays a very vital role in pertinent context. The ideal requisite humidity level ranges between 50% and 70%. It is not particularly sensitive to soil acidity and adapts well to a pH range between 5.5 and 7 (Infoagro, 2011). However, in waterlogging and excessive rains adversely affected it both in growth and yield. A sandy loam soil capable of holding moisture, supplemented with organic matter is an excellent choice to ensure maximal positive results (Udoh et al., 2005).

It has been conceived through intensive research study that whenever farmers grows pepper in an open field the growth of the plant was compromised because of different climatic changes, continuous attack of pests and diseases, which results in fruit size and fruit shape variation which entails in farmers financial losses. In order to avoid these losses many farmers around the globe nowadays growing pepper in greenhouses in order to keep their vegetable safe from pests and climatic changes. In the most arid part of the country (dry and hot climate) growth season of pepper in greenhouses starts on August and ends by the end of April. If the temperature and humidity is maintained the season is last longer till June (Hafia, 2014).

Greenhouse cultivation has a cutting edge over the traditional techniques by adopting this farmers can attain a handsome yield for a long time period. In addition to this by growing pepper in greenhouses the farmers can take good care of their vegetables in a less number of days which ultimately increase the production. 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.

The commercial importance of pepper as a vegetable with large scale cultivation in both tropical and sub tropical regions are increasing (Kannan et al., 2009). It has been observed that standard pepper plant density in Israel is 30,000 – 35,000 plants/ ha with an average yield of 50 – 70 T/ha depending upon how efficient and suitable fertilizers given to the plants (Hafia, 2014). The pepper plant requires plenty of nitrogen during the first phases of growth, phosphorous is necessary when the first flowers appear and throughout the seed ripening process. Potassium is required in order to obtain early fruit colour and quality, and magnesium is needed during the ripening stage. The main plagues to affect peppers are white fly, plant lice, and thrips.

Keeping the above facts in view the subject study was carried out in a greenhouse at Western Region of Abu Dhabi, UAE to evaluate the effects of different rates of NPK fertilizers on the growth and yield of greenhouse pepper under controlled atmospheric conditions. Drip irrigation

technology was used to cater for irrigation and fertigation purposes.

OBJECTIVES

The potential motive of the subject research work is to evaluate the pepper (Capsicum green bell variety) response in the wake of application of various ratios of water soluble NPK fertilizers through drip irrigation technology under controlled agro-ecological conditions in an arid region of Abu Dhabi, UAE, and eventually to measure the growth and production aspects.

MATERIALS AND METHODS

Location

The research work was carried out at Al Mezaira, Western Region of Abu Dhabi, UAE. In order to start cultivation in October the nursery was prepared in September 2013. The soil of the greenhouse 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 70 meter deep due to which farmer was utilizing the fresh water provided by municipality.

Greenhouse Size and Drip Irrigation System

The covered area of the greenhouse was 5 hectares and it was further divided into various subplots, which possessing 1 water pond with the capacity to supply 3-5 days of water requirements of the vegetables. The drip irrigation system for each sub-plot contained 10 laterals, and each lateral was supplying water to 72 pepper plants through emitters, while the external diameter of submain, mainline and laterals were 40 mm, 60 mm and 20 mm respectively. The distance between main water source from the submain line was kept 15m. The spacing among emitter was 0.3m and spacing among lateral was kept 0.6m. As the water for irrigation purpose coming from municipality was saline in nature, therefore a small desalination apparatus was installed adjacent to the pond to remove the salts in order to improve the quality of water aiming to enhance the effectivity of drip irrigation system. Figure 1(a) – 1(d) describes the front and side view of greenhouse.

Fig: 1a. Side View of Greenhouse

Fig: 1b. Saline Water Tank

Fig: 1c. Desalination Apparatus

Fig: 1d. Measuring Scales for Water Flow

Field Experiment

The field study was carried out on randomized complete block design (RCBD) having nine different rates of poly-feed water soluble NPK fertilizer, i.e. (control, 250, 500, 750, 1000, 1250, 1500, 1750, and 2000) grams fertigation^{-1} respectively. After the completion of soil bed preparation operation drip irrigation lines were installed for the pre-irrigation purpose accordingly. The pepper (Capsicum Green Bell Variety) seedlings were raised in a nursery for about 40 days. Only healthy and uniformly sized seedlings were transplanted during evening time, 0.3m x 0.6 m apart accordingly for proper growth.

With the objective to attain pepper yield for long time good quality seeds and variety was used during the research. In order to grow pepper the nursery was made by using plastic tray (pro-tray) and coco peat. After filling the plastic trays with coco peat, the seed was sown accordingly as shown in Figure 2a – 2b. In the end of October, the well established seedlings were transplanted to the prepared soil bed 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.

Fig: 2a. Capsicum Green Bell Nursery

Fig: 2b.Capsicum Green Bell Seedlings

In order to irrigate the capsicum plant drip irrigation was used for watering and fertigation accordingly. The supply of ample light to the plants was ensured. Staking and pruning was also ensured to avert falling of plant and stems from snapping due to excessive fruit weight. Pruning can be observed just after the transplantation process. It is imperative to remove old yellow leaves to ensure aeration process among plants. All cultural practices i.e., irrigation, hoeing and weeding were ensured throughout the early stages as per recommendation. The temperature and humidity level was monitored through thermometer and hygrometer respectively.

All the fertilizers are applied through fertigation process by using drip irrigation system. Poly-feed water soluble NPK compound fertilizers i.e. (15-30-15) and (20-20-20) was given in split doses before and after flowering throughout the study accordingly. Different rates of NPK applied per fertigation to the nine sub-plots were no fertilizer (control), 250 grams, 500 grams, 750 grams, 1000 grams, 1250 grams, 1500 grams, 1750 grams and 2000 grams accordingly. In addition to this for the enhancement of plant quality and early ripening Calcium and Manganese in equal amount applied to all sub-plots. Figure 3a - 3f elaborates overall pepper planting and growing operation in greenhouse observed during this research period.

Fig: 3a. Fertigation Apparatus
Fig: 3b. Automatic Fertilizer Mixing Tank

Fig: 3c. Lateral Lines for Capsicum Plantation
Fig: 3d. Checking the Capsicum Flowers

Fig: 3e. Checking the Fruit Length
Fig: 3f. Stacking of Capsicum Plants

After 60 days of transplanting first harvesting was done. Ten plants from each lateral were randomly selected and tagged in order to find out the number of leaves per plant, plant height (cm), days taken to 50% flowering, total number of fruits per plant, fruit length (cm), and fresh fruit yield (tons ha^{-1}). Finally all the data analysis and statistical analysis were done through ANOVA procedure accordingly.

RESULTS AND DISCUSSION

The subject research was carried out to check the yield and growth rate of pepper in greenhouse under controlled conditions with the application of different rates of poly-feed water soluble fertilizers. The subject study revealed that pepper plant leaves, plant height, number of days taken to 50% flowering, total number of fruits per plant,

fruit length and fresh fruit yield differed very significantly between application of different rates of water soluble NPK fertilizers as mentioned in Table: 01. The critical gathered observations and data for the above discussed parameters during the subject research are appended below:

Number of Leaves per Plant

Statistically remarkable results were observed for number of leaves per plant with maximum 55.781 leaves and minimum 23.938 leaves in 2000 grams fertigation^{-1}and in control (no fertilizer) respectively. The detailed results for all fertilizers rates are given in Table I. However, the optimum dosage was found to be in between 1000 – 1250 grams fertigation^{-1} as they give 47.134 and 49.748 leaves per plant. The study clearly imply that the increment in fertigation rate directly increases the plant leaves which means that they are directly proportional to each other up to some extent.

Plant Height

Poly-feed water soluble NPK Fertilizers rates had a very positive effect on plant height as shown in Table I. From the obtained results it is clear that plant height increased with the increase in NPK fertigation rates. The height of plants was maximum 49.639 cm when 2000 grams fertigation^{-1} was applied. While, minimum 20.543 cm plant height was found in control plot respectively. It was also observed that the same plant height was seen when 1000 – 1250 grams fertigation^{-1} was applied.

Days for 50% Flowering

Statistically considerable results were observed for days taken to 50% flowering as shown in Table I. Maximum 34.403 and minimum 23.250 days for fruit maturity were recorded in control and 2000 grams fertigation^{-1} respectively. Once again for the days taken to 50% flowering same observation were noted in between 1000 – 1250 grams fertigation^{-1}.

Number of Fruits per Plant

The application of proper plants nutrients can boost up the growth of pepper plant which eventually increases the number of fruits per plant accordingly. According to the obtained results it had been observed that maximum 43.946 fruits per plant were recorded in 1000 grams fertigation^{-1} and minimum 9.098 fruits per plant were recorded in control.

Fruit Length

During the research study it had been observed that maximum fruit length 7.673 cm was noted in 2000 grams fertigation^{-1}, while the minimum 6.039 cm fruit length was observed in control. The detailed results for all fertilizers rates are given in Table: I. However, the optimum NPK fertilizer application rate was found in between 1000 – 1250 grams fertigation^{-1} which gives the fruit length 7.069 – 7.168 cm respectively.

Fruit Yield

On the basis of conducted study and statistical analysis of all harvesting operations it had been observed that application of different rates of NPK fertilizers had a positive effect on the yield tons ha^{-1}. Maximum yield was found to be 22.618 tons per hectare when the fertigation rate was 1000 grams fertigation^{-1}. Likewise the minimum production was recorded in control 7.920 tons per hectare.

Table: I. Effect of different rates of poly-feed water soluble NPK fertilizer on different statistical parameters

Fertilizer Kg / Fertigation	No of leaves per plant	Plant Height	Days Taken to 50% Flowering	Total Number of Fruits Per Plant	Fruit Length	Fresh Fruit Yield
For 720 plants per plot		(cm)	days		(cm)	(t/ha)
Control	23.938e	20.543d	34.403a	9.098f	6.039a	7.920e
250	34.106d	23.394d	33.076a	18.147e	6.237a	10.944d
500	41.689c	26.978c	26.077a	30.205d	6.316a	18.048c
750	44.758c	29.809bc	26.077a	36.145c	6.316a	18.345cb
1000	47.133bc	31.204b	24.304a	43.906a	7.068a	22.617a
1250	49.747b	31.551b	23.938a	43.946a	7.167a	22.473a
1500	49.965b	32.135b	23.948a	41.995a	7.207a	22.454a
1750	55.618a	48.064a	23.949a	41.589a	7.276a	22.396a
2000	55.781a	49.638a	23.251a	40.045b	7.672a	21.907b

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

SUMMARY AND CONCLUSIONS

The outcome of the conducted research in arid region of Al Mezaira, Western Region of Abu Dhabi, – UAE tantamount that the poly-feed water soluble NPK fertilizers application with different rates brought a positive effect in pepper cultivation under the greenhouse arrangements. Amongst different treatments rates of NPK, 1000 grams fertigation-1 was observed to be more suitable and economical dose as it took number of leaves per plant 47.134, plant height 31.204 cm, days for 50% flowering 24.304, total number of fruits per plant 43.906, fruit length 7.068 cm, and fresh fruit yield 22.0617 tons per hectare respectively. Nearly same results were achieved by 2000 grams fertigation-1 but consumption of fertilizers was recorded more. However, control plots showed un-satisfactory results regarding all the parameters. Too low or high NPK levels reduced the yield and yield parameters of pepper. Application of NPK beyond 1000 grams fertigation^{-1} seems to be an un-economical and wasteful practice.

The greenhouse cultivation can save fertilizer quantity and making this more farmer friendly. By adopting this technique bumper yield can be achieved by applying less fertilizer incorporation with drip irrigation system, which entail in saving hidden expenditure and 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 as the saline water after desalination is used which may adversely affects the drip irrigation system due to some residues and other impurities which may endanger the proper functioning of the system. Therefore, ratio of fresh water must be increased in saline water to avert any potential harm of the system. In addition to

this flushing of the system should to be done once or twice in six months to ensure the durability and maximum efficiency of drip irrigation system. Uniform distribution of fertilizer entails in augmenting fruit quality due to which the yield will be sold on high prices, which is very beneficial for the farmers.

The thorough training to the farmers is imparted to carryout installation, maintenance of drip irrigation system for the effective functioning of the system. It will make the farmers self dependant, and will save their time and extra efforts to be exerted in maintenance and installation regard. 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 Ibrahim Rehmati the owner of the farm for allowing this research to be carried out on his greenhouse, to the staff of the greenhouse especially Mr. Shapon Khan 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.

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