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Effect of Different Levels of Water Soluble $NPK_{(20-20-20)}$ Fertilizers on the Growth and Yield of Carrot *(Daucus Carota l.)* by Using Drip Irrigation Technology

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An Abstract- Fertilizers application plays an important in the production of fruits and vegetables. Over-application of fertilizers can slow down the growth and development of fruits and vegetables. The present research work was carried out to check the yield and growth rate of carrot in open field by using drip irrigation along with the application of different rates of poly-feed water soluble $NPK_{(20-20-20)}$ fertilizer. The field study was carried out on randomized complete block design (RCBD) having four different rates of poly-feed water soluble NPK fertilizer, i.e. (T_0 = control, T_1 = 0.7 grams per plant fertigation^{-1}, T_2 = 1 grams per plant fertigation^{-1}, and T_3 = 1.4 grams per plant fertigation^{-1}) respectively. All the data analysis and statistical analysis for agronomic parameters were done through ANOVA procedure accordingly. The outcome of the conducted research tantamount that the poly-feed water soluble $NPK_{(20-20-20)}$ fertilizers application with different rates brought a positive effect in carrots cultivation under the open field arrangements. Amongst different treatments rates of NPK, treatment T_3 was observed to be more suitable and economical dose as it took the tallest carrot plants (44.67cm), highest number of leaves (5.52), highest leaf length (44.38 cm), the highest root core diameter (1.76 cm), maximum root shoulder diameter (5.09 cm), highest root length (19.11 cm) and highest root yield (11.07 t/ha) respectively. However, control plots showed un-satisfactory results regarding all the parameters. Therefore, from the current study it may be concluded that application of $NPK_{(20-20-20)}$ (treatment T_3 = 1.4 grams / plant fertigation^{-1} were suitable for optimum growth and yield of carrot. Application of fertilizers beyond this level seems to be an un-economical and wasteful practice. Statistical analyses of all the research parameters are elaborated in Table I.
Keywords: Carrots, Fertigation, NPK Fertilizers, Drip Irrigation, Agriculture, Abu Dhabi, UAE.

I. INTRODUCTION

Carrots (Daucus Carota L.) is one of the most important and major root vegetable used for different purposes in daily human diet (Kwabena. et al., 2011) [1]. The taproot is the edible portion of the carrot; the foliage has no economic value. Since the taproot is the edible portion of the plant, the field should be tilled to a 30 cm (12 inches) deep to ensure that root penetration is not restricted. Carrots favour well-drained, fine textured soils with good water-holding capacity. Sandy, loamy or muck-based soils are suitable for carrot production. A pH range of 5.5 to 8.0 is desirable. There are four main types of carrots i.e. Nantes, Imperator, Chantenay, and Danvers but among all Nantes is most popular. Nantes is popular because of its sweet taste. Nantes carrots are almost cylindrical in shape, and round off at the end rather than tapering off. They have a small core and a larger outer cortex. Sugars accumulate in the cortex, giving Nantes their sweet taste. General seeding rates are: 10 to 16 plants per 30 cm (12 inches) of row for Nantes varieties (Waterer., 2005) [2].

Fertilizers applications play an important in the production of carrots. Over-application of nitrogen can lead to excess top-growth, which will slow the growth and development of the edible taproot. Fertilizers should to apply according to the recommendation of fertilizers plan based on soil testing. Generally, most carrot growers use inorganic fertilizers to realize higher yields (Dauda et al., 2008) [3]. The use of inorganic fertilizers as a source of nutrient has however, been associated with human health problems and environment degradation (Arisha and Bardisi 1999) [4].

Carrots do not respond well to lack of water, particularly in high temperatures. For the bulk of the growing season, carrots require

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approximately 2.5 cm (1 inch) of water per week. Carrots should have their field heat removed as soon as possible after harvest. If possible, harvest the crop close to 0°C (32°F). Once in storage, the crop should be kept at 0°C (32°F) and 100 percent relative humidity to ensure minimal moisture loss. Harvest occurs when carrots reach an adequate size. However, sweetness and storage potential increase with maturity accordingly. The primary focus of this research work is to evaluate the effect of N.P.K $_{(20\text{-}20\text{-}20)}$ on growth, and yield of carrots (Nantes Variety) in Al Mansoori Farm, UAE.

II. OBJECTIVES

The objective of this research work was to find out the carrot response to different levels of NPK$_{(20\text{-}20\text{-}20)}$ fertilizers and to study the growth and production parameters accordingly. The drip irrigation technology was used for irrigating the carrots.

III.MATERIALS AND METHODS

A. Location

The research work was carried out at Al Mansoori Farm, Seih Al Khair, Western Region of Abu Dhabi, UAE in November 2014. The soil of the open field 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 65 meter deep due to which farmer was utilizing the fresh water provided by municipality.

B. Farm Size and Drip Irrigation System

The covered area of the open field was approximately 2 hectares and it was further divided into various subplots. One water storage pond with the capacity to supply 3-5 days of water requirements of the vegetables and date palm trees was also installed. The drip irrigation system for each sub-plot contained 10 laterals, and each lateral contains upto 10 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 7m. The spacing among emitter was 5cm and spacing among lateral was kept 30cm. 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(c) describes the different views of subject land.

Fig: 1a. Front View of Experimental Farm

Fig: 1b. Saline Water Tank

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Fig: 1c. Desalination Apparatus

C. Field Experiment

The field study was carried out on randomized complete block design (RCBD) having four different rates of poly-feed water soluble NPK fertilizer, i.e. (T_0 = control, T_1 = 0.7 grams per plant fertigation^{-1}, T_2 = 1 grams per plant fertigation^{-1}, and T_3 = 1.4 grams per plant fertigation^{-1}) respectively. As the area under study was sandy therefore initially the land preparation had been done by using traditional hoes in order to obtain flat seedbed suitable for carrot crops, to improve water holding capacity of the soil, and to destroy the insects and pests. After the completion of flat seedbed preparation operation drip irrigation lines were installed for the irrigation purpose accordingly. Small holes were dig adjacent to the emitters and 10 gram poultry mixture along with $NPK_{(12\text{-}12\text{-}17)}$ and sand mixed and filled in to the holes and pre-irrigated accordingly. The spacing among plant to plant installed emitter was 5cm and spacing among lateral was kept 30cm. The carrot (Nantes) variety sourced from Australia was used in this research and sown at rate of 2 kg per acre in November 2014. The fertilization was done by applying fertilizers in lines by using drip irrigation system and hoeing and weeding were done after growth exceed soil level and was repeated every time it was needed. In addition to this for the enhancement of plant quality and early ripening Calcium and Manganese in equal amount applied to all sub-plots. The moles have been controlled by using physical traps. Figure 2a – 2d describes the overall irrigation and fertigation operations in the farm observed during this research period.

Fig: 2a. Fertigation Apparatus

Fig: 2b. Automatic Fertilizer Mixing Control Panel

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Fig: 2c. Lateral Lines and Holes Preparation for Carrot Sowing

Fig: 2d. Laterals and drippers installation on the open field

The first harvesting was done after 95 days from sowing date. Irrigation prior to lifting was done to reducing root damage. At harvest, fresh roots were weighed plot-wise and then recorded, treatment by treatment in order to know the best treatment. Finally altogether ten plants from each of laterals were randomly selected and tagged in order to find out the agronomic parameters i.e. plant height (cm), no. of leaves, leaf length (cm), root core diameter (cm), root shoulder diameter (cm), root length (cm), and total root yield (tons ha^{-1}). Finally all the data analysis and statistical analysis were done through ANOVA procedure accordingly. Figure 3a – 3b elaborates different agronomic characters pictorial view in the farm observed during this research period.

Fig: 3a. Carrots after 75 Days of Sowing

Fig: 3b. Checking the Leaf Length of Carrots

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IV. RESULTS AND DISCUSSION

The subject research was carried out to check the yield and growth rate of carrot in open field by using drip irrigation along with the application of different rates of poly-feed water soluble $NPK_{(20\text{-}20\text{-}20)}$ fertilizer. The subject study revealed that carrot plant height, no. of Leaves, leaf length, root core diameter, root shoulder diameter, root length, and total root yield differed very significantly between applications of different rates of water soluble $NPK_{(20\text{-}20\text{-}20)}$ fertilizer as mentioned in Table: 01. The critical gathered observations and data for the above discussed parameters during the subject research are appended below:

A. Plant Height

Statistically significant results were observed for plant height among the different fertilizers levels as shown in Table 01. The tallest plant (44.67 cm) was recorded in treatment T_3. On the other hand, the shortest plant (33.43 cm) was recorded in control plot respectively. These results are in agreement with Ali et al. (2003) [5].

B. Number of Leaves

Statistically remarkable results were observed for number of leaves per plant for all treatments as shown in Table 01. The number of leaves per plant was range between (4.31-5.52). 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.

C. Leaf Length

During the research study it had been observed that maximum leaf length 44.38 cm was noted for treatment T3, while the minimum 33.69 cm leaf length was observed in control plots. The detailed results for all fertilizers rates are given in Table: I. These results are in agreement with Habimana et al. (2015) [6].

D. Root Core Diameter

Statistically remarkable results were observed for root core diameter with maximum 1.76 cm and minimum 1.14 cm with treatment $T_3$and in control (no fertilizer) respectively. The detailed results for all fertilizers rates are given in Table I. The study clearly implies that the increment in fertigation rate directly increases the root core diameter which means that they are directly proportional to each other up to some extent. These results are in agreement with Agyarko et al. (2007) [7].

Table: I. Effect of Different Rates of Water Soluble $NPK_{(20\text{-}20\text{-}20)}$ Fertilizer on Different Statistical Agronomic Parameters of Carrot

Treatments	Plant Height	No. of Leaves	Leaf Length	Root Core Diameter	Root Shoulder Diameter	Root Length	Total Root Yield
	(cm)		(cm)	(cm)	(cm)	(cm)	(t/ha)
$T_{0\ (control)}$	33.43d	4.31a	33.69d	1.14b	3.38b	15.45b	5.89c
T_1	42.82b	5.09a	42.59b	1.47ab	3.98b	16.88b	6.41c
T_2	39.07c	4.64a	38.81c	1.55ab	3.82b	18.35a	8.94b
T_3	44.67a	5.52a	44.38a	1.76a	5.09a	19.11a	11.07a
Sem±	0.176	0.182	0.126	0.314	1.36	0.290	0.392
LSD (p=0.05)	0.613	0.629	0.437	0.347	0.651	1.02	1.36
CV%	11.07	6.56	8.52	11.46	8.13	2.84	8.23

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

E. Root shoulder Diameter

Statistically considerable results were observed for root shoulder diameter as shown in Table I. Once again maximum 5.09 cm and minimum 3.38 cm root shoulder diameter were recorded in treatment T_3 and control plot respectively. The present finding is in agreement with (Habimana, 2014) [8] who reported that in sandy soil, combination of organic and inorganic fertilizers improves the soil structure and apart from this it also allows the shoulder of carrots to expand with ease.

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F. Root Length

During the research study it had been observed that maximum root length 19.11 cm was noted in treatment T_3, while the minimum 15.45 cm root length was observed in control plots. The detailed results for all fertilizers rates are given in Table: I. These results are in conformity with the finding of Murwira et al. (2002) [9].

G. Total Root 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} of carrots. Maximum yield was found to be 11.07 tons per hectare for treatment T3. Likewise the minimum production was recorded in control 5.89 tons per hectare. The increase in yield of carrot root might be attributed to higher individual root length and core diameter (Atakora K, 2011) [10]. The results are in conformity with the finding of Moniruzzaman et al., (2013) [11], who reported that high crop yield can be obtained with careful and reasonable NPK fertilization.

V. SUMMARY AND CONCLUSIONS

The outcome of the conducted research in Al Mansoori farm, Western Region of Abu Dhabi, – UAE tantamount that the water soluble $NPK_{(20\text{-}20\text{-}20)}$ fertilizers application with different rates brought a positive effect in carrot cultivation under open field arrangements. Amongst different treatments rates of NPK, treatment T_3 was observed to be more suitable and economical dose as it took the tallest carrot plants (44.67cm), highest number of leaves (5.52), highest leaf length (44.38 cm), the highest root core diameter (1.76 cm), maximum root shoulder diameter (5.09 cm), highest root length (19.11 cm) and highest root yield (11.07 t/ha) respectively. However, control plots showed un-satisfactory results regarding all the parameters.

Too low or high NPK levels reduced the yield and yield parameters of carrot. Therefore, from the current study it may be concluded that application of $NPK_{(20\text{-}20\text{-}20)}$ (treatment T_3 = 1.4 grams / plant $fertigation^{-1}$ were suitable for optimum growth and yield of carrot. Application of fertilizers beyond this level seems to be an un-economical and wasteful practice. The cultivation of carrots by using drip irrigation technology can save fertilizer quantity and making this more farmer friendly. By adopting this technique bumper yield can be achieved by applying less fertilizer which entail in saving hidden expenditure and the labour charges associated with fertilizer spreading in the field. However, modern system demands for continuous water supply for even functioning of equipments involved. 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.

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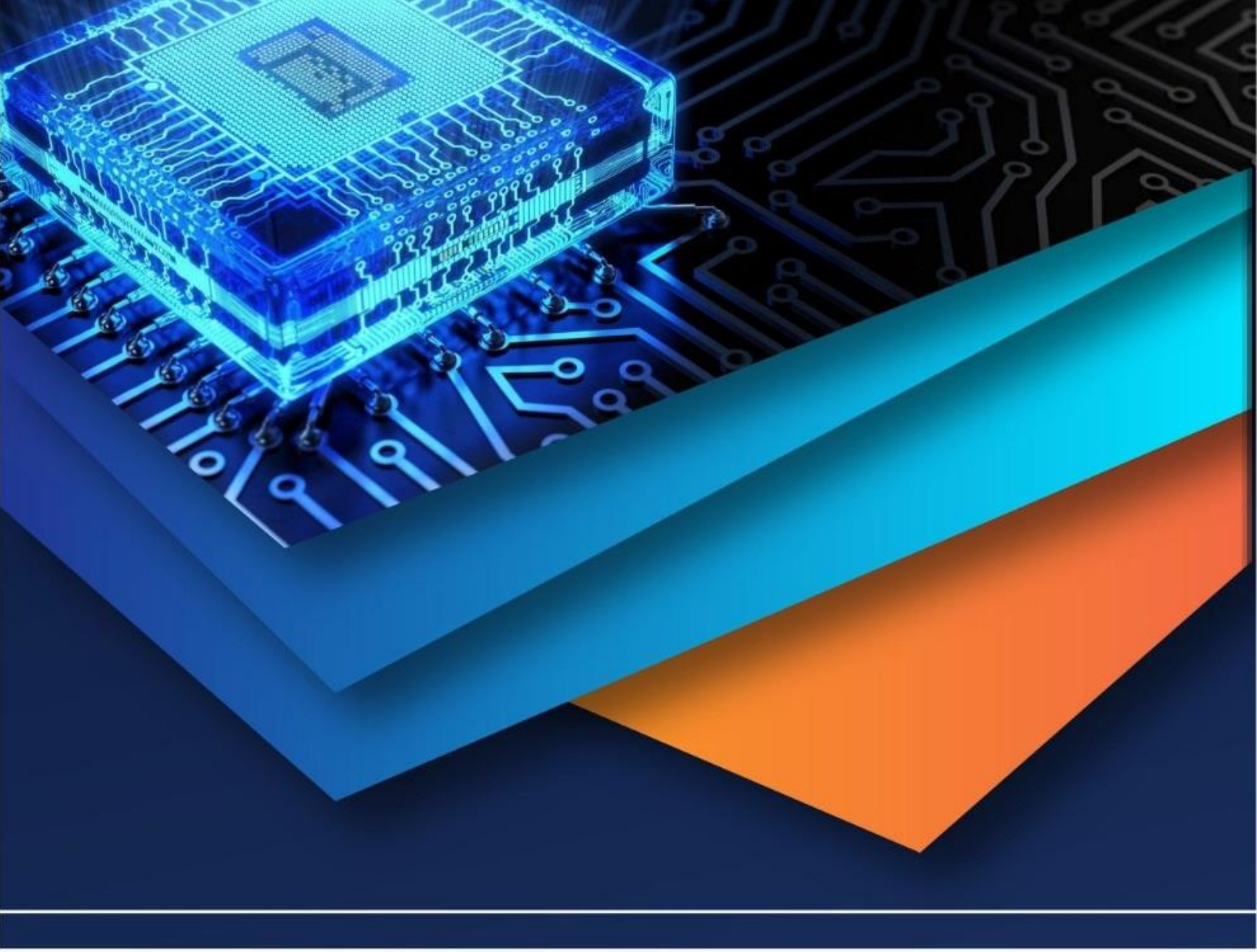

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