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EFFECT OF INTRA SPACING ON YIELD AND YIELD COMPONENTS CARROT (*DAUCUS CARROTA* L.SUB SP. *SATIVUS*)

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ABSTRACT

The experiment was conducted in 2014 cropping seasons to study the effect of intra row spacing on yield and yield components of carrot. The crop was grown in July to October (105 days) with five treatments (5, 7.5, 10, 12.5 and 15 cm) in randomized complete block design with three replications. Root length, leaf fresh weight, root fresh weight, and root diameter weight were significantly different among treatments. The maximum root length (20.3 cm), root diameter (59.67 mm), root fresh weight (182. 33g plant^{-1}) and fresh leave weight (129.67 g plant^{-1}) were found in 15 cm spacing, whereas the highest total root yield per hectare was found in treatment 5 and 7.5cm; 55.15, and 54.75 ton, respectively.

Keywords: *Daucus carrota*, Spacing, Intra Row, Weight, Yield, Yield component.

Contribution/ Originality

The paper's primary contribution is finding that to study the effect of intra row spacing on yield and yield components of carrot on field. Then develop a correct intra row spacing to address the issues for carrot growers in Western Shawa of Ethiopia. The input gathered at this study provided an important perspective on the carrot intra row spacing and techniques used on the field.

1. INTRODUCTION

Carrot (*Daucuscarota* L. ssp.*sativus*(Hoffm.) originates from the wild forms growing in Europe and southwestern Asia [1]. Root crops covered more than 1.42% of the area under all crops and contributed 6.15% to the production of all crops total in the country among of these carrot is considered as one of the important vegetable crops roduced on small scale in Ethiopia. It also occupies an economically important place among vegetables in the country. A total of 13,550.2 tones of production under irrigation and rain fed by the peasant holders, contributing about 0.81% to the total country level all vegetable crops Production [2].

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The area under carrot is increasing from time to time mainly due to its ease of production, and the increases in small scale rain fed and irrigation areas. In many areas of the country, the rain fed season constitutes much of the area under carrot production. Despite areas increase, the productivity of carrot production is much lower than other African countries. The low productivity could be attributed to poor cultural practices including plant to plant spacing.

Sugar and volatile terpenoids are the two major components of carrot flavor; glucose, fructose and sucrose which make up more than 95% of the free sugars and 40% to 60% of the stored carbohydrates in the carrot root [3]. It also contains high amount of carotene (10 mg/100 g), thiamin (0.04 mg/100 g), riboflavin (0.05 mg/100 g) and also serves as a source of carbohydrate, protein, fat, minerals, vitamin-C and calories [4]. The ratio of sucrose to reducing sugar increases with root maturity but decreases following harvest and during cold storage. Blindness in children for the severe Vitamin-A deficiency is a problem of public health in some countries, particularly in the rice dependent countries of Asia [5]. Hence, carrot (rich in Vitamin-A) may contribute a lot of Vitamin-A to overcome this situation in Ethiopia.Plant spacing is one of the important factors for the increased production of carrot. Pavlek [6] Lipari and McCollum, et al. [7] reported that there is a positive correlation between the number of plants and yield of carrot. But many workers reported that different plant densities of spacing have different effect for the marketable yield of carrot [8, 9]. To increase the importance and yield production of carrot during the period of growing season may play a critical role. Also quality and size of the roots depends on the spacing plant to plant and row to row under Ethiopian condition. There is also a significant interaction between plant spacing and size of carrot. Hence, the present study was under taken to found optimum spacing for better growth of carrot yield and yield components.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The study was conducted under field condition in rain fed from July to October 2014 at Ambo University, Ethiopia. Ambo University is 112 km far away to the west from Addis Ababa, having an altitude of 2287 meter above sea level, latitude of 08°7`0`` North and longitude of 38°7`0``East. The mean maximum and minimum temperature of the field was 21 1±2°C and 14.8±2°C, respectively, during the study period.

2.2. Treatment and Experimental Design

The experiment was laid out in Randomized Compete Block Design (RCBD) with three replications. It was conducted to evaluate intra row (Plant-to-plant) spacing effects on yield and yield components of carrot. The following five treatments of plant-to-plant with constant 30 cm between raw to raw distances were evaluated.

T1= 5cm T4= 12.5cm

T2 = 7.5cm T5= 15 cm

T3= 10 cm

2.3. Data Collection

Growth parameters were recorded from five randomly selected plants from each plot until the crop was harvested. Plants in each plot was used to count number of leaves per plant, weight of fresh leaves per plant, root length, diameter of root, weight of fresh roots, percentage of branched root and percentage of cracking roots were calculated. Yields from all plots were taken and weighed to determine plants response from plant to plant spacing.

2.4. Data Analysis

The recorded data on different growth parameters and yield parameters were calculated for statistical analysis. Analyses of variances (ANOVA) for most of the characters under consideration were performed with the help of SAS version 9 program. Treatment means were separated by Duncane's Multiple Range Test (DMRT) at 1% level of significance for interpretation of the results.

3. RESULTS AND DISCUSSION

3.1. Diameter of Root

The diameter of carrot roots was measured during harvesting period; it was showed that significant differences were observed between intra spacing on size of diameter (Table 1). At spacing of 15 cm between plant to plant was showed the highest diameter (59.67 mm), while the other treatments almost no significant effect on root diameter during the study period.

3.2. Growth Parameter

Significance differences were observed in intra row spacing with regard to root length and diameter per plant (Table 1). Increasing intra row spacing resulted in increased length of plants and diameter. Regards to number of leaves per plant showed non-significant differences were found except intra row spacing (15cm between plants), it showed that better leaf number as compared to other treatments (Table 1).

3.3. Root Length

The root length of carrot was significantly influenced by intra row spacing (Table 1). The longest root (20.3cm) was observed from the plants spacing 15cm which was significantly different from other treatments. The shortest root length was recorded (11.57 cm) was found from the plants spaced 5cm. This result revealed that the root length gradually increased when increasing intra row spacing. The present results supported Rashid and Shakur [10].

3.4. Weight of Fresh Leaves

Weight of fresh leaves per plant showed that significantly (P<0.01) different due to different intra row spacing (Table 2). The weight of fresh leaves varied from 21.33 to 129.67 g/plant. The maximum leaf fresh weight (129.67g) was obtained from the plants when grown on 15cm intra row spacing. The minimum fresh weight of leaves (21.33 g) was observed when grown on 7.5cm intra row spacing. Results revealed that the weight of fresh leaf gradually increased from 5cm to 15cm intra row spacing with constant inter row spacing (30 cm).

Table-1. Effect of intra row spacing on number of leaves, length and diameter of root/plant

Treatments (cm)	No. of Leaves/plant	Length of plant (cm)	Diameter of plant (mm)
5	8.60^{b}	11.57^{c}	36.13^{b}
7.5	10.07^{b}	14.8^{bc}	40.33^{b}
10	9.67^{b}	15.5^{bc}	43.33^{ab}
12.5	11.07^{b}	18.67^{ab}	50.17^{ab}
15	15.2^{a}	20.3^{a}	59.67^{a}
MSE	1.22	1.74	6.35
LSD (at .01)	3.34	4.76	17.39
CV (%)	11.18	10.74	13.82

Note: Means of treatment set followed by unlike letter(s) are significantly difference

There was a significant difference among the different spacing of carrot production in respect of root length.

3.5. Weight of Fresh Roots

Weight of fresh roots presented in (Table 2) indicted that significant (P<0.01) differences were observed among the treatments during the study period. The highest fresh root weight per plant 73.33 and 182.33 g were recorded from the plants at spacing 5cm and 15cm, respectively. The highest intra row spacing could not provide the highest yield per hectare, but it gave the highest root yield per plant, as a result 5 to 10cm intra row spacing gave the better fresh weight of root per hectare. Therefore, different intra spacing for carrot production was found to have significant effect on fresh root weight per hectare as well as per plant. From this experiment we observed that when the number of plant to plant spacing increased the wight of root yield also increased, but yield per hectare relatively decreased (fig. 1 and table 2). The maximum fresh root weight (55.15 ton) and (54.75 ton) per hectare was obtained from the plants grown at the spacing of 30 X 5cm and 30 X 7.5cm, respectively, which was significantly differed from others. The minimum fresh root weight (45.77) was obtained from the plants grown at the spacing of 30 X 12.5cm. The result was agreed with the work of Ashraful, et al. [3].

Table-2. Effect of yield per hectare and per plant intra row spacing on total weight, fresh leaves, fresh root and root weight

Treatments (cm)	Total mean weight (g/plant)	Weight of fresh leaves (g/plant)	Root weight (t/ha)
5	96.00^{e}	22.67^{cd}	55.12^{a}
7.5	117.66^{d}	21.33^{d}	54.75^{ab}
10	165.34^{c}	37.67^{c}	49.15^{abc}
12.5	218.00^{b}	78.00^{b}	45.77^{c}
15	312.00^{a}	129.67^{a}	49.02^{bc}
MSE	4.87	5.95	2.18
LSD (at .01)	13.33	16.32	5.90
CV (%)	2.67	10.29	4.30

Note: Means of treatment set followed by unlike letter(s) are significantly difference

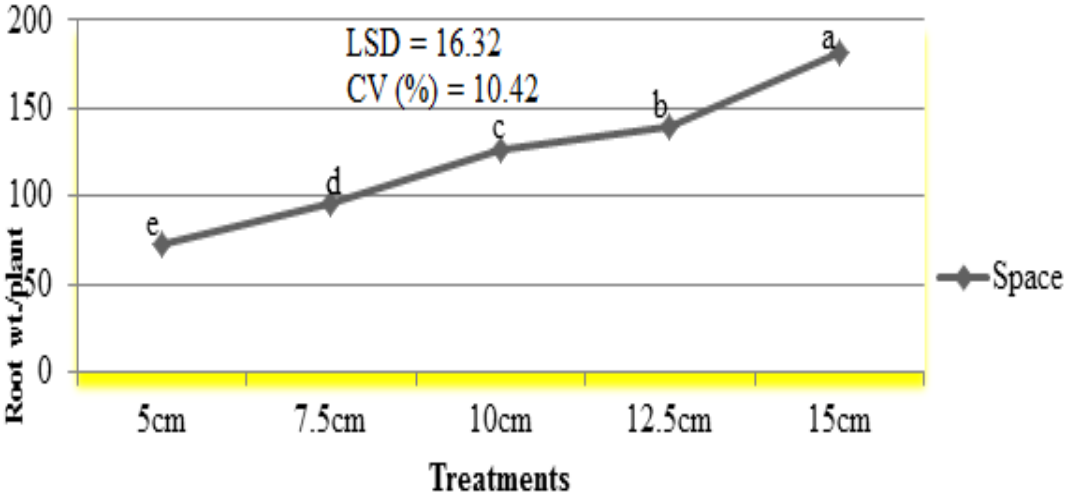

Figure-1. Effect of intra raw spacing on weight root yield of carrot per plant

3.6. Percentage of Branched Root

The smallest spacing gave minimum percentage of breached root. This might be caused by competition of nutrients. The mean value of branched percentage with the treatments varied significantly different. It ranged from 0.33% to 8.33%. The minimum percentage (0.33%) of branched root was observed to the plants planted at the spacing of 5cm x 30cm (T_1) and the maximum percentage (0.33%) of branched root was obtained at the spacing of 15cm x 30cm (T_5). This might be caused by low competition of nutrients helps in development, branched and vigorous growth of carrot root. The result revealed that the smallest spacing (T_1) gave minimum branched root percentage and maximum branched percentage was found from the highest spacing (T_5) i.e when number of spacing from plant to plant increased at constant row spacing (30 cm) percentage of branching also increased and vice-versa.

3.7. Percentage of Cracking Root

The percentage of cracking root was varied significantly among the five treatments). The minimum cracking percentage (2.72%) was obtained from 5cm x 30cm (T_1) it gave a small

amount of cracking roots. But the highest spacing plant planted gave maximum percentage of cracking root which was 12.67% was obtained from 15cm x 30cm (T_2). This might be caused by low competition of nutrients helps in development and vigorous growth of carrot root.

4. CONCLUSION AND RECOMMENDATIONS

Increasing intra raw spacing (15 cm) significantly increased the root length, weight of fresh leaves/plant, and total weight/plant of carrot; but, significantly increased marketable yield per hectare at spacing of 5 and 7.5cm. Even though intra row spacing played a significant role in the productivity of carrot *Daucuscarota*L.), and recommendations can be made 5 to 7.5cm between plant to plant at 30 cm constant row to row spacing.

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