Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP5: 77-80

Kharsan M
Department of Horticulture, FAST, AKS University Satna, Madhya Pradesh India

Nag K
Research Scholar, Department of FLA, CoA, IGKV Krishak Nagar, Raipur, Chhattisgarh, India

Sahu DK
Department of Horticulture, FAST, AKS University Satna, Madhya Pradesh, India

Bhardwaj LP
Department of Horticulture, FAST, AKS University Satna, Madhya Pradesh, India

Ajeet
Department of Horticulture, FAST, AKS University Satna, Madhya Pradesh, India

Correspondence
Kharsan M
Department of Horticulture, FAST, AKS University Satna, Madhya Pradesh, India

(Special Issue- 5)
International Conference on
"Food Security through Agriculture & Allied Sciences"
(May 27-29, 2019)

To assess the effect of spacing on growth and yield of carrot (*Daucus carota* L.) Cv. Pusa Kesar

Kharsan M, Nag K, Sahu DK, Bhardwaj LP and Ajeet

Abstract
Field experiment entitled "To assess the effect of spacing on growth and yield of carrot (*Daucus carota* L.) Cv. Pusa Kesar" have been conducted at the research farm of AKS University, Sherganj Satna during rabi season of 2015-16. Experiment comprised of three level of spacing's *viz*. - 8 x 10 cm, 8 x 20 cm and 8 x 30 cm. Experiment was laid out in Randomized Block Design with factorial concept with three replications. Plant spacing of 8 x 30 cm caused significant influence on growth parameters such as height of the plant, number of leaves per plant, yield and yield attribute were also affected by plant spacing. Wider spacing (8 x 30cm) was found highly significant on all growth and yield attributes, however maximum root yield *i.e.*113.45q/ha was obtained when plant spacing *i.e.* 8 x 30 cm was kept.

Keywords: Carrot (*Daucus carota* L.) Cv. Pusa Kesar, effect of spacing, growth and yield

Introduction
Carrot (*Daucus carota* L.) belongs to the family Umbeliferae, it is an important vegetable, cultivated throughout the India for its edible roots. It is cool season crop and it is grown all over the world in spring, summer and autumn in temperate countries and during winter in tropical and subtropical countries. Primary center of origin of carrot is Afghanistan and secondary centre are Asia, Europe and North Africa. Today, China is the leading producer of carrots in the world, followed by Russia, US, Uzbekistan, Poland, Ukraine, UK, Turkey, Japan and France. India's ranks 14th in the production of carrots. Carrot is cultivated in about 125 countries. The total production of about 35,654,873 metric tonne during 2014-15 as per the estimates of FAO (Food and Agriculture Organization of the United Nations), China's share is 45.52 percent and that of Russia is 4.87 per cent, whereas that of India is just 1.44 percent. During the 1990s, India was in the sixth position in the world with respect to the production of carrots. However, it has fallen to the 14th position today. In India, carrot is grown across the country. Haryana is the leading producer, followed by Andhra Pradesh, Punjab, Bihar, Tamil Nadu, Karnataka and Assam, Jammu and Kashmir. The total area under this crop in India is 64.33 thousand hectares, and the production was 1147.08 thousand metric tonne. In Madhya Pradesh carrot is cultivated in Area in '000 ha Production in '000 Tonne Area 1.90 Production 32.00. (*Source: Ministry of Agriculture, Government of India*) It is taken raw as well as in cooked form. It is used as Pickles, sweets, curries and pies etc. Carrot juice is a rich source of carotene and used for coloring butter and other food articles. Orange colored carrots are rich in carotene, a precursor of vitamin "A" and contain appreciable quantity of thiamine and riboflavin. Black carrot is used for the preparation of a beverage called "kanji" considered to be a good appetizer. The edible fresh root contain 85% moisture and large number of chemical components including vitamin "A" and "C" (3150 I.U and 3.0mg respectively) and minerals contents in ample quality, which are valuable for human nutrition. Carrot roots are good source of potassium, calcium, phosphorus and some important micro-nutrients (Salunkhe and Kadam 1998) [6]. It has got Ayurvedic and many medicinal properties. 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. 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.

So, carrot (rich in Vitamin-A) may contribute a lot of Vitamin-A to overcome this situation in India. Plant spacing is one of the important factors for the increased production of carrot. To extend the availability of carrot during the early and late period of growing season and sowing time may play a critical role. Also quality of the roots depends on the harvesting time. There is also a significant interaction between plant spacing and sowing date. Plant population affects growth, development and yield. In case of closer spacing, competition among plants is more and the development of carrot is badly affected. Similarly at wider spacing, individual plants will yield more but per hectare yield may reduced due to low plant population.Plant spacing is one of the important factors for the increased production of carrot. The wider spacing promoted vegetative growth and increased root length of carrot but planting at closer spacing of 20cm x 5cm resulted in higher total and marketable yields and also increased income and profit.

Materials and Methods

The present research works "To assess the effect of spacing on growth and yield of carrot (*Daucus carota L.*) Cv. Pusa kesar*"* have been undertaken in the Department of Horticulture, AKS University, Satna (M.P.) during 2015-2016. Experiment has been conducted at the farm of AKS University, Satna M.P. (80°21' to 81°23' east longitude and 23°58' to 25°12' north latitude). The experimental plot was located about 2000 meters East of AKS University, Campus. Experimental design - Factorial RBD (Randomized Block Design), Number of replication – 3**,** Number of treatments – 9, Total number of plot - 27, Plot size - 2 × 1 m^2, Row to row distance - 10, 20 and 30 cm, Plant to plant distance -8 cm and Total area under layout - 7.5 × 13.00 m^2 etc.

Observations

1. **Plant height:** The plant height was measured with the help of a meter scale from the ground level of the root up to the tip of leaf at 35, 50 days after sowing DAS and at harvest.
2. **Number of leaves per plant:** Number of leaves was counted 15 days interval and was started from 35 days after sowing and continued to harvest, i.e. 35, 50 DAS and at harvest. Five plants in each plot were used to count number of leaves per plant.
3. **Length of root per plant (cm):** Five plants are uprooted and detached from foliage parts. Then the length of modified roots was measured by scale and recorded in centimetre.
4. **Diameter of root per plant (cm);** Five selected plants are used to determine root diameter. Root diameter was measured at the time of harvesting from the middle portion with Vernives callipers and recorded in centimetre (cm).
5. **Fresh weight of roots (g):** Five selected carrot roots were used to determine the fresh weight of root. Modified roots were detached by knife from the foliage part and fresh weight was taken by using balance and recorded in gram (g).
6. **Dry weight of roots (g):** Sundry and oven dry roots of selected plants each treatment and replication were weighted to determine the average dry weight of root.
7. **Total yield of roots per plot (kg):** The root obtained from each plot and replication was weighted and the yield/ plot were worked out.
8. **Total yield of roots per hectare (quintal):** The yield of roots per hectare was computed from the per plot yield and was recorded in quintals.

Results

The present research works entitled "To assess the effect of spacing on growth and yield of carrot (*Daucus carota L.*) Cv. Pusa Kesar*"* have been undertaken in the Department of Horticulture, AKS University, Satna (M.P.) during 2015-2016. Data on different parameters were results have been presented in tables and figures.

1. **Plant height (cm):** Application of Phosphorus significantly influenced plant height at 35, 50 days after sowing (DAS) and at harvest. Plant height was significantly affected due to the use of three different spacing's 8 x 10, 8 x 20 and 8 x 30cm. The plant height increased gradually and continued up to harvest. The tallest plant height (18.82cm) was recorded in S2 (8 x 30cm) and the shortest plant height (13.21cm) was produced by S_0 (8 x 10cm) at 35 days after sowing (DAS). At 50 DAS, the longest plant height (25.50cm) was produced by S_2 and the shortest plant height (17.32cm) was recorded in S_0. The longest (36.46cm) plant height was recorded in S_2 and the shortest plant height (24.76 cm) was obtained in S_0 at harvest.
2. **Number of leaves per plant:** Use of phosphorus significantly influences the number of leaves per plant at 35, 50 days after sowing (DAS) and at harvest. Number of leaves per plant was significantly affected due to use in different spacing's 8 x 10, 8 x 20 and 8 x 30cm at 35, 50 days after sowing (DAS) and at harvest. The highest number of leaves per plant (2.47) was recorded in S_2 and the lowest number of leaves per plant (2.07) was counted in S_0 at 35 DAS. The maximum number of leaves per plant (5.58) was obtained in S_2 whereas treatment S_0 showed the minimum number of leaves per plant (3.93) at 50 DAS. At harvest, the highest number of leaves per plant (6.88) was recorded in S_2 and the treatment S_0 performed the lowest number of leaves per plant (5.03).
3. **Length of root per plant (cm):** The length of root of carrot was significantly influenced with the application of different levels of phosphorus. The length of root of carrot was significantly affected by spacing. The length of root was observed to be gradually increased with increasing row to row spacing. The highest length of root per plant (14.59cm) was produced at wide spacing S_2 and lowest length of root per plant (10.67cm) was observed at close spacing S_0. (Fig no. 1.0)

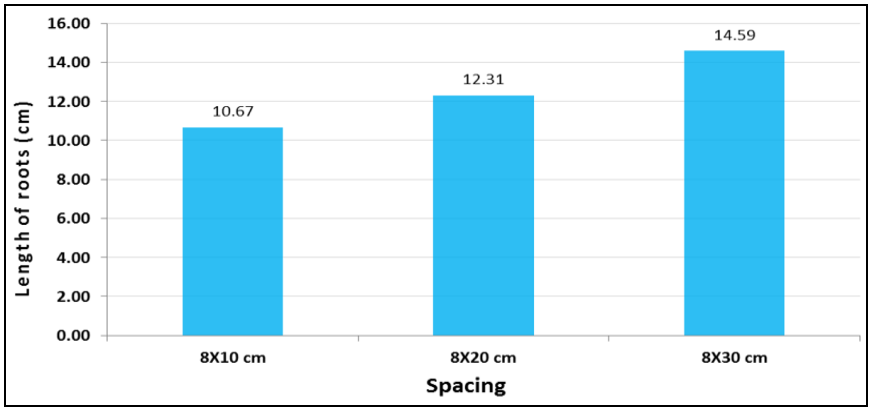

Fig 1: Length of roots (cm) of carrot as influenced by different plant spacing

iv. Diameter of root per plant (cm): Significant variation in diameter of root of carrot was found due to application of different levels of phosphorus. The diameter of root of carrot was significantly affected by spacing. The diameter of root was observed to be gradually increased with increasing spacing. The highest diameter of root (3.79cm) was recorded in S_2 (8 x 30) that significantly higher than others. The minimum diameter of root (2.84cm) in this regard was found in the treatment of S_0.

v. Fresh weight of root per plant (g): Fresh weight of root per plant significantly varied due to the application of different levels of phosphorus. Spacing significantly influences the fresh weight of root per plant due to spacing. The maximum fresh weight of root per plant (120.83g) was noted in S_2 (8 x 30cm) whereas the treatment S_0 (8 x 10cm) showed the minimum fresh weight of root per plant (96.80g) (Table no 1.0).

Table 1: Length of roots (cm) of carrot as influenced by different plant spacing

Fresh weight of roots (g)	
Levels of phosphorus	**Fresh weight of roots**
Spacing	
S_0 = 8X10 cm	96.80
S_1 = 8X20 cm	100.13
S_2 = 8X30 cm	120.83
SEm±	5.03
CD (P=0.05)	15.09

vi. Dry weight of root (g): The dry weight of root was also varied significantly with the application of different levels of phosphorus. The dry weight of root was also varied significantly with the different plant spacing. The maximum dry weight of root (29.40g) was recorded when S_2 (8X30cm) and the minimum dry weight of root (23.55g) in this regard was found in the treatment of S_0.

vii. Root yield per plot (kg/ plot): Per pot yield of root was significantly varied due to the application of different levels of phosphorus carrot. Per plot yield of root was significantly varied due to. The highest yield of carrot per plot (14.72kg/plot) was obtained in (8X30 cm) and lowest yield of carrot per plot (11.25kg/plot) was found in (8X10 cm).

viii. Root yield per hectare (q/ha): Per hectare yield of root was significantly varied due to use of different phosphorus doses applied in carrot. The highest root yield of carrot per hectare (111.73q/ha) was obtained in P_2 (60 kg P_2O_5/ha) treatment while the treatment P_0 (0 kg P_2O_5/ha) was produced the lowest root yield of carrot per hectare (88.18q/ha). Per hectare yield of root was significantly varied due to different level of spacing. The yield was found to increase with increasing plant spacing. The highest yield of carrot per hectare (113.45q/ha) was obtained when (8X30 cm) and the lowest yield (89.99q/ha) was found when (8X10 cm).

Discussion

Growth parameters: Various treatments showed significant variations in growth attributes *viz*., plant height and number of leaves per plant. The data on plant height and number of leaves per plant recorded at different intervals revealed that these parameters in general progressively increased with the increase in age of crop till maturity. The expression of growth parameters is generally controlled but to some extend these traits are also affected by environmental factors i.e. temperature, humidity and nutrient status of the soil and their effective utilization by plant. Plant height was significantly affected due to the use of three different spacing's 8 x 10, 8 x 20 and 8 x 30cm. The plant height increased gradually and continued up to harvest. The tallest plant height (18.82cm) was recorded in S_2 (8 x 30cm) and the shortest plant height (13.21cm) was produced by S_0 (8 x 10cm) at 35 days after sowing (DAS). At 50 DAS, the longest plant height (25.50cm) was produced by S_2 (8 x 30cm) and the shortest plant height (17.32cm) was recorded in S_0 (8 x 10cm). The longest plant height (36.46cm) was recorded in S_2 (8 x 30cm) and the shortest plant height (24.76 cm) was obtained in S_0 (8 x 10cm) at harvest. Norman *et al.* (1992) [5] observed that higher plant density per unit area or closer spacing increases the competition for essential growth factors among individual plants which do not attain their normal size. Number of leaves per plant was significantly affected due to use in different spacing's 8 x 10, 8 x 20 and 8 x 30cm at 35, 50 days after sowing (DAS) and at harvest. The highest number of leaves per plant (2.47) was recorded in S_2 and the lowest number of leaves per plant (2.07) was counted in S_0 at 35 days after sowing DAS. The maximum number of leaves per plant (5.58) was obtained in S_2 whereas treatment S_0 showed the minimum number of leaves per plant (3.93) at 50 DAS. At harvest, the highest number of leaves per plant (6.88) was recorded in S_2 and the treatment S_0 performed the lowest number of leaves per plant (5.03). Uddin *et al.*, (2004) [7] also recorded similar results earlier.

Yield Attributes: The length of root of carrot was significantly affected by spacing. The length of root was observed to be gradually increased with increasing row to row

spacing. The highest length of root per plant (14.59cm) was produced at wide spacing S_2 and lowest length of root per plant (10.67cm) was observed at close spacing S_0. This result revealed that the root length gradually increased when increasing plant row spacing. The diameter of root of carrot was significantly affected by spacing. The diameter of root was observed to be gradually increased with increasing spacing. The highest diameter of root (3.79cm) was recorded in S_2 (8 x 30) that significantly higher than others. The minimum diameter of root (2.84cm) in this regard was found in the treatment of S_0 (8 x 10). Farazi *et al.* (1983) [3] also reported that spacing had significantly effect on the diameter. Spacing significantly influences the fresh weight of root per plant due to spacing. The maximum fresh weight of root per plant (120.83g) was noted in S_2 whereas the treatment S_0 (8 x 10) showed the minimum fresh weight of root per plant (96.80g). The result was agreed with the work of Ashraful, *et al*. (2013) [1]. The dry weight of root was also varied significantly with the different plant spacing's. The maximum dry weight of root (29.40g) was recorded in S_2 (8X30cm) and the minimum dry weight of root (23.55g) was found in the treatment of S_0 (8 x 10). Similar results were obtained by Chattarjee, R. and M.G. Som, *et al.* (1991) [2]. Per plot yield of root was significantly varied due to spacing's. The highest yield of carrot per plot (14.72kg/plot) was obtained in (8X30 cm) and lowest yield of carrot per plot (11.25kg/plot) was found in (8X10 cm). Carrot yield is also adversely affected by low planting density. Per hectare yield of root was significantly varied due to different level of spacing. The yield was found to increase with increasing plant spacing. The highest yield of carrot per hectare (89.99q/ha) was obtained when (8X30 cm) and the lowest yield (113.45q/ha) was found when (8X10 cm). Muck *et al.*, 1980 [4] who reported that carrot yield increased when plant density was increased with closer row to row spacing.

Summary and Conclusion

The experiment consisted of three levels of spacing (*viz.* 8 x 10 cm,8 x 20 cm and 8 x 30 cm) and three levels of phosphorus (*viz*. 0, 50 and 60kg P_2O_5/ha). The two-factor experiment was set up in Randomized Block Design (RBD) with three replications. In total there were 9 treatment combinations in this investigation. A unit plot was 2.0 x 1.0 m^2 and the treatments were distributed randomly in each block. The experimental plot was fertilized from 10 t/ha cow dung, 150 kg/ha MOP (Muriate of potash) and at the rate of 200 kg Nitrogen / ha along with the phosphorus as per treatment. The carrot seeds were sown on 12 December, 2015. The crop was harvested on 15 March, 2016. Five tagged plants were selected for observations from each plot. Data on growth and yield parameters were recorded and analyzed statistically. The result showed that spacing had significant influence on all the parameters, except dry weight of roots. The longest plant height (18.82cm), the maximum number of leaves (2.47) was recorded at harvest, diameter of root (3.79cm), length of root (14.59cm) were obtained when spacing S_3 (8 x 30cm) was used. The highest (29.40g) dry weight of root was obtained in spacing S_3 (8 x 30cm). On the other hand, highest yield per plot and yield per hectare (14.72 kg/plot and 14.72 q/ha) were recorded when spacing S_3 (8 x 30cm) and the lowest yield (11.25 kg/plot) was recorded from spacing S_3 (8 x 10cm). Higher dose of even though intra row spacing played a significant role in the productivity of carrot and recommendations can be made 8 to 10 cm between plant to plant at 30 cm constant row to row spacing. Considering the contents noted above the following specific conclusions are being warranted; Experimental result revealed that plant spacing is 8 x 30cm gave the highest yield of carrot is 89.99q/ha.

References

1. Ashraful Kabir. An Introduction to Bangladesh Agriculture. First Edition, M. Alim, Dhaka, 2013, 9.
2. Chattarjee R, Som MG. Response of Radish to various levels of nitrogen, potassium and plant spacings. Indian J Hort. 1991; 48:145-7.
3. Farazi MA. Effect of plant spacing and different levels of nitrogen and potash on the yield of carrot. M.Sc. Ag. Thesis, in the Department of Horticulture, Bangladesh Agricultural University, Mymcnsingh. 1983, 20-32.
4. Muck HJ. Effect of row spacing on processing carrot root yields. American Society of Horticultural Science Journal. 1980; 15(2):144-145.
5. Norman JC. Tropical Vegetables Crops. Arthur, H. Stockwell Ltd. Elms Court Ilfracombe, Devon, UK, 1992, 232.
6. Salunkhe DK, Kadam SS. (Eds). Marcel Dekker, Inc. New York. In Handbook of Vegetable Science and Technology: Production, Composition, Storage and Processing, 1998.
7. Uddin ASMM, Hoque AKMS, Shahiduzzaman M, Sarkcr PC, Patwary MMA, Shiblce SMA. Effect of nutrients on the yield of carrot. Pakistan Journal of Biological Sciences. 2004; 7(8):1407-1409.