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Influence of varieties and date of sowing on growth, yield and quality of carrot under Malwa Plateu of Madhya Pradesh

KAVERI B.R.*, R.K. SHARMA*, S.S. KUSHWAH* AND O.P. SINGH**

*Department of Vegetable Science, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, College of Horticulture, Mandsaur-458002, Madhya Pradesh, India

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ABSTRACT

An experiment was conducted at College of Horticulture, Mandsaur (MP) during Rabi season, 2019 to study the effect of varieties and date of sowing date on growth, yield and quality of carrot. The research experiment was laid out in Factorial Randomized Block Design with three replications during the year 2019. The investigation was carried out with three varieties namely Pusa Kesar, Pusa Rudhira, and Pusa Vristi with four different date of sowing viz., 1st September, 10th September, 20th September and 30th September. The total twelve treatment combinations were tested. Observations were recorded on growth, yield and quality parameters. Among the varieties Pusa Rudhira (V_2) recorded maximum plant height (39.60 cm), number of leaves (13.77), leaf length (17.32 cm), fresh weight of plant (265.88 g), dry weight of plant (18.75 g), root length (28.62 cm), root diameter (3.86 cm), fresh weight of root (107.74 g), dry weight of root (12.31 g), root yield (359.12 q/ha), specific gravity (1.06 g/cc) and total soluble solids (8.36°B). Among the date of sowing, 20th September (D_3) recorded significantly maximum plant height (42.24 cm), number of leaves (14.25), leaf length (18.47 cm), fresh weight of plant (306.63 g), dry weight of plant (21.09 g),root length (29.99 cm), root diameter (4.18 cm), fresh weight of root (118.74 g), dry weight of root (13.29 g), root yield (395.81 q/ha) specific gravity (1.07 g/cc) and total soluble solids (8.60˚B).

Key words: Carrot, varieties, date of sowing, growth, yield, quality

INTRODUCTION

Amongst the root vegetables, carrot (*Daucus carota* L.) is the popular cool season vegetable. Carrot is grown all over the world in spring, summer and autumn in temperate countries and during winter in tropical and sub-tropical climate. The area under this vegetable crop is increasing rapidly but the production per unit area is very poor. One of the major factors responsible for low yield of this crop is its climatic limitations. Changes in environmental conditions including the day and night temperatures associated with planting date affect carrot yield and quality (Latha *et al.,* 2012). The carrot 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 and vitamin-C. 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 (Kabir *et al.,* 2013). The total area under carrot crop in India is about 97 thousand ha with production of 1648 thousand metric tonnes (Anonymous, 2018).

Many agronomic practices need to be adjusted to maximize yield and quality of carrot roots. Among them, time of sowing is one of the most important factors, which influences the vegetative growth, quality of carrot and ultimately the yield. Carrot is very sensitive to temperature and photoperiod. This is the reason why the root yield has been greatly affected by different sowing dates (Latha *et al.,* 2012). Spacing and planting density recommendations for crops in general have sought to meet specific needs of cultural practices and improve productivity. However, changes in these recommendations induce a series of changes in the plant growth and development requiring adaptations to meet local peculiarities. Regarding planting density, results in studies vary depending on the cultivar and producing region (Resende *et al.,* 2016). Yield of any crop can be increased up to substantial quantity by using improved varieties. The varieties fail to give best performance if there is slight deviation in their sowing time. Proper sowing time again depends on the varieties and prevailing environment. Selection of right varieties for sowing at optimum time is

**Corresponding Author's Email ID: rksharma3006@gmail.com, ** Department of Plant Physiology, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, College of Horticulture, Mandsaur (MP) India*

the key factor for successful carrot production (Latha *et al.,* 2012). There is a need to find out the best time of sowing and suitable variety for high yields under early sown conditions at Mandsaur.

MATERIALS AND METHODS

The present investigation was conducted during Rabi season of 2019 at Vegetable Research Field, College of Horticulture, Mandsaur, Madhya Pradesh. Mandsaur is situated in Malwa plateu in western part of Madhya Pradesh at latitude of 23°45' to 24°13' North and longitude of 74°44' to 75°18' East at an altitude of 435.20 m above mean sea level. The topography of experimental field is plain. This region lies under 9th Agro climatic zone of the state. Mandsaur region comes under sub-tropical and semi-arid climatic conditions with temperature ranges from minimum of 4°C to maximum of 45°C during winter and summer, respectively. This investigation was carried out with three varieties of carrot (Daucus carota L.) with respect growth, yield and quality parameters under different dates of sowing during Rabi season 2019-20, comprising three varieties Pusa Kesar (V1), Pusa Rudhira (V2), Pusa Vristi (V3) and four dates of sowing i.e. 1st September, 10th September, 20th September and 30th September. The total twelve treatment combinations were tested in factorial randomized block design with three replications. The five tagged plants from each plot at 30, 45 and 60 DAS were recorded the parameters like plant height (cm), number of leaves and leaf length (cm) and their mean was calculated. Mean data recorded on fresh weight of plant (g), dry weight of plant (g), root length (cm), root diameter (cm), fresh weight of root (g), dry weight of root (g), root yield (q/ha), specific gravity(g/cc), and total soluble solids(˚B) was subjected to statistical analysis using analysis of variance technique suggested by Panse and Sukhatme (1984). Where the "F" test was found significant at 5% level of significance, the critical differences for the treatment's comparison were worked out.

RESULTS AND DISCUSSION

Growth parameters

The data presented in the Table 1 revealed that all the growth parameters were significantly differed among varieties and date of sowing. The findings pertaining to growth parameters *viz.,* plant height, number of leaves per plant, length of leaves, fresh and dry weight of plant were observed at 30, 45 and 60 DAS, respectively. All the parameters indicated significant influence of variety and different date of sowing. There was increase in plant height with advancement of growth period. Variety V_2 (Pusa Rudhira) recorded highest plant height (9.00, 17.70, 39.60 cm) at all the growth stages under study. Lowest plant height (6.98, 14.01, 35.89 cm) was observed in case in case of variety V_1 (Pusa Kesar) at all the growth stages. The difference in plant height of varieties may be due to genetic makeup of varieties. Latha *et al.* (2012) in carrot and Malek *et al.* (2011) in radish also reported significant influence of varieties on plant height. Among the different date sowing, D_3 (20^{th} September) recorded the maximum value of plant height (8.92, 16.98, 42.24 cm) during the different stages of growth, while minimum value of plant height (6.98, 13.28, 33.78 cm) was observed with D_1 (1^{st} September) at all the stages of crop growth. D_3 (20^{th} September) significantly improve the plant height. The increase in plant height was due to optimum environmental conditions for carrot grown on 20^{th} September among the other three sowing dates in carrot. All environmental factors especially temperature supported for vegetative growth simultaneously (Kabir *et al.,* 2013). Similar results were reported by Sumrah *et al.* (2003) in beet root.

Among the varieties, highest number of leaves per plant (5.98, 8.69, 13.77) was recorded with variety V_2 (Pusa Rudhira) at all the growth stages. Lowest number of leaves per plant (3.58, 7.48 and 12.99) was observed with the variety of V_1 (Pusa Kesar). The differentiation in number of leaves in varieties responds differently to environmental factors based on their genetic makeup and their adaptation ability (Kabir *et al.,* (2013). These findings are in agreement with Pervez *et al.* (2003) and Amur *et al.* (2019) in radish. Different date of sowing had exerted significant effect on number of leaves

Table 1: Effect of varieties and date of sowing on growth parameters of carrot

Treatment	Plant height (cm)			Number of leaves			Leaf length (cm)			Fresh weight of plant (g)	Dry weight of plant(g)
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS		
Varieties											
V_1 (Pusa Kesar)	6.98	14.01	35.89	3.58	7.48	12.99	3.57	7.30	15.82	232.42	16.66
V_2 (Pusa Rudhira)	9.00	17.70	39.60	5.98	8.69	13.77	4.13	8.58	17.32	265.88	18.75
V_3 (Pusa Vristi)	7.84	15.14	37.69	4.09	8.05	13.06	3.70	7.90	16.59	239.55	17.59
SEm±	0.14	0.52	0.60	0.13	0.14	0.20	0.12	0.19	0.27	7.84	0.27
CD at 5%	0.42	1.53	1.75	0.37	0.40	0.59	0.35	0.55	0.80	22.98	0.79
Date of Sowing											
D_1 (1^{st} September)	6.98	13.28	33.78	4.16	7.68	12.56	2.46	6.61	15.11	189.52	14.75
D_2 (10^{th} September)	7.45	16.34	34.24	4.27	7.94	12.89	3.26	7.52	15.79	226.58	16.67
D_3 (20^{th} September)	8.92	16.98	42.24	5.15	8.51	14.25	5.46	9.41	18.47	306.63	21.09
D_4 (30^{th} September)	8.42	15.28	40.64	4.62	8.16	13.40	4.02	8.17	16.83	262.55	18.15
SEm±	0.17	0.60	0.69	0.15	0.16	0.23	0.14	0.21	0.31	9.05	0.31
CD at 5%	0.48	1.77	2.02	0.43	0.46	0.68	0.41	0.63	0.92	26.53	0.91

per plant during all the growth stages. Highest number of leaves per plant (5.15, 8.51, 14.25) was observed with third date of sowing *i.e.* D_3 (20^{th} September), whereas the minimum number of leaves per plant (4.16, 7.68, 12.56) was counted with first date of sowing D_1 (1^{st} September) at all the stages of crop growth. The variation of leaves number per plant as affected by time of sowing might be due to the variation in the environmental conditions during growing period (Kabir *et al.,* 2013) and also early sowing possibly endorsed to maximum photosynthesis with longer growth period than the later sowings (Lavanya *et al.,* 2014). These findings are in agreement with Sahu *et al.* (2018) in radish.

In general, there was increase in length of leaves with advancement of growth stage up to harvesting stage. Variety V_2 (Pusa Rudhira) recorded significantly maximum length of leaves (4.13, 8.58, 17.32 cm) at 30, 45 and 60 DAS, respectively, where as minimum length of leaves (3.57, 7.30, 15.82 cm) was observed in variety V_1 (Pusa Kesar). Alam *et al.* (2010) and Ebrahim *et al.* (2013) in radish also reported significant variations of leaf length among varieties. Among the different date of sowing maximum length of leaves per plant (5.46, 9.41, 18.47 cm) was recorded with D_3 (20^{th} September), while minimum length of leaves per plant (2.46, 6.61, 15.11 cm) was observed under D_1 (1^{st} September) at 30, 45 and 60 DAS, respectively. Highest length of leaves with third date of sowing (20^{th} September) might to be due to the month of September is suitable for carrot growing under suitable climatic condition for higher growth and yield components of tropical carrot. Similar outcome was reported by Ebrahim *et al.* (2013) in radish and Ali *et al.* (2016) in onion.

The results revealed that the varieties had significant difference on fresh weight of plant at harvesting stage. Variety V_2 (Pusa Rudhira) recorded highest fresh weight of plant (265.88 g) as compared to other varieties. Variety V_1 (Pusa Kesar) had registered minimum fresh weight of plant (232.82 g) at harvesting stage. Higher plant height and number of leaves might have resulted more photosynthesis and accumulation of food material in V_2 (Pusa Rudhira) resulting in higher fresh weight of plant. Similar results were reported by Kabir *et al.* (2013) in carrot and Kandil *et al.* (2013) in onion. Different date of sowing indicated significant effect on fresh weight of plant at harvesting stage. Maximum fresh weight of plant (306.63 g) was observed with third date of sowing *i.e*. D_3 (20^{th} September), while minimum fresh weight of plant (189.52 g) was observed under D_1 (1^{st} September) at harvesting stage in carrot. The present results were supported by Kabir *et al.* (2013) in carrot and Kandil *et al.* (2013) in onion. Dry weight of plant was significantly affected with various varieties and different date of sowing. Maximum dry weight of plant (18.75 g) was recorded in variety V_2 (Pusa Rudhira) at harvesting stage, while the minimum dry weight of plant (16.66 g) was found in case of variety V_1 (Pusa Kesar). More number of leaves and larger leaf length might have enhanced the photosynthesis, accumulation of photosynthates consequently in higher dry weight of plant in variety V_2 (Pusa Rudhira). Among the date of sowing, the maximum dry weight of plant (21.09 g) was

Table 2: Effect of varieties and date of sowing on yield and quality parameters of carrot

Treatment	Root length (cm)	Root diameter (cm)	Fresh weight of Root (g)	Dry weight of Root (g)	Root yield (q/ha)	Specific gravity (g/cc)	Total soluble solids (^{o}Brix)
Varieties (V)							
V_1 (Pusa Kesar)	24.87	35.69	84.13	8.96	280.43	0.99	8.20
V_2 (Pusa Rudhira)	28.62	38.62	107.74	12.31	359.12	1.06	8.36
V_3 (Pusa Vristi)	26.27	36.68	93.61	10.18	312.04	1.03	8.22
SEm±	0.83	0.70	3.92	0.40	13.08	0.01	0.15
CD at 5%	2.45	2.06	11.51	1.17	38.36	0.03	0.44
Date of sowing (D)							
D_1 (1st September)	23.54	32.03	63.42	7.00	211.41	0.97	7.77
D_2 (10th September)	25.64	36.91	88.03	9.78	293.43	1.01	8.21
D_3 (20th September)	29.99	41.77	118.74	13.29	395.81	1.07	8.60
D_4 (30th September)	27.16	36.27	101.04	11.85	368.13	1.05	8.47
SEm±	0.96	0.81	4.53	0.46	15.10	0.01	0.17
CD at 5%	2.83	2.37	13.29	1.36	44.30	0.04	0.51

recorded under D_3 (20th September), while minimum dry weight of plant (14.75 g) was recorded in case of D_1 (1st September) at harvesting stage. Similar findings have been reported by Kabir *et al.* (2013) in carrot. Combined effect of varieties and different date of sowing had recorded non significant effect on all growth parameters in carrot.

Yield parameters and yield

The data presented in the Table 2 revealed that all the yield parameters were significantly differed among varieties and date of sowing. Yield parameters of the carrot was studied with respect to length of root (cm), diameter of root (cm), fresh weight of root (g), dry weight of root (g) and yield of root (q/ha).The data indicated significant effect of varieties on length of root. Variety V_2 (Pusa Rudhira) was recorded maximum length of root (28.62 cm) at harvesting stage. Highest root length in variety V_2 (Pusa Rudhira) which might be due to genetic diversity in different varieties. Similar findings have been reported by Alam *et al.* (2010) in radish, Latha *et al.* (2012) and Ladumor *et al.* (2020) in carrot. Maximum length of root (29.99 cm) recorded under the D_3 (20th September) and it was followed by D_4 (30th September). Under D_1 (1st September) found minimum length of root (23.54 cm). Such results are obtained on account of favourable conditions available during the growing period and also early sowing possibly attributed to maximum photosynthesis with longer growth period than the later plantings (Ladumor *et al.,* (2020). Present results are in conformity with findings of Dahiya *et al.* (2007) and Latha *et al.* (2012) in carrot.

Data recorded in the present study indicated that variety V_2 (Pusa Rudhira) recorded significantly maximum diameter of root (38.62 cm) of carrot followed by V_3 (Pusa Vristi), while minimum diameter of root (35.69 cm) recorded with variety V_1 (Pusa Kesar). The root diameter was significantly influenced among the different varieties. This showed that these differences might be due to genetic composition in the expression of growth potentials. The similar variations in diameter of root among different carrot varieties have reported by Latha *et al.* (2012) and Ladumor *et al.* (2020). Different date of sowing recorded significant effect on diameter of root of carrot. Maximum diameter of root (41.77 cm) was found under D_3 (20th September). The minimum diameter of root (32.03 cm) was observed under D_1 (1st September). The rapid increase in diameter of root was because of more vigorous growth in earlier sowing, which supplies more photosynthates from leaves to roots (Ladumor *et al.,* 2020). These findings are in agreement with Latha *et al.* (2012) in carrot and Sahu *et al.* (2018) in radish.

The results revealed that different varieties had significant difference in fresh and dry weight of root at harvesting stage. Variety V_2 (Pusa Rudhira) recorded highest fresh (107.74 g) and dry weight (12.31 g) of root followed by the variety V_3 (Pusa Vristi), while minimum fresh (84.13 g) and dry weight (8.96 g) of root was found with variety V_1 (Pusa Kesar). Higher root length and diameter of root might have resulted

in higher fresh weight and dry weight of root in carrot. Therefore, cultivar Pusa Rudhira produced more weight of fresh roots per plant than other cultivars as they have more number of leaves, plant height and root length. Similar findings were reported by Pervez *et al.* (2003) and Ladumor *et al.* (2020) in carrot and Ebrahimi *et al.* (2013) in radish. Different date of sowing indicated significant effect on fresh dry weight of root. Maximum fresh (118.74 g) and dry weight (13.29 g) of root was observed under D_3 (20th September), whereas minimum fresh (63.43 g) and dry weight (7.00 g) of root was observed under D_1 (1st September). Early sowing resulted in higher fresh and dry weight of root because of congenial growing condition and leads to maximum volume of root (Ladumor *et al.,* 2020). These results are conformity with the finding of Alam *et al.* (2010) Kabir *et al.* (2013) and Patel *et al.* (2015).

The data indicated significant effect of varieties on root yield per hectare. Among the varieties, maximum root yield per hectare (359.12 q/ha) was found with variety V_2 (Pusa Rudhira), while the minimum yield of root (280.43 q/ha) with variety V_1 (Pusa Kesar) with significant difference. This varietal difference is attributed to vigorous growth and potential genetic makeup of the variety (Latha *et al.,* (2012). Such variability in root yield per hectare of carrot is also in conformity with the earlier findings reported by Pervez *et al.* (2003) Ladumor *et al.* (2020) in carrot. Yield of root significantly affected by different date of sowing. The maximum root yield per hectare (395.81 q/ha) recorded under D_3 (20th September), while minimum root yield (211.41 q/ha) was recorded under D_1 (1st September). The higher yield in above treatments is due to better plant survival owing to the favourable environmental conditions for growth and development of roots (Lavanya *et al.,* 2014). Similar findings have been reported by Dahiya *et al.* (2007), Latha *et al.* (2012) and Ladumor *et al.* (2020) and Somveer and Choudhary (2024) in carrot.

Combined effect of variety and different date of sowing had revealed non significant influence on yield parameters in carrot.

Quality parameters

Quality parameters *viz*., specific gravity and total soluble solids content were determined to study the effect of variety and different date of sowing. Observations was recorded on specific gravity of roots revealed that variety V_2 (Pusa Rudhira) was recorded maximum value of specific gravity (1.06 g/cc) followed by V_3 (Pusa Vristi). The minimum value of specific gravity (0.99 g/cc) was recorded with Variety V_1 (Pusa Kesar) in carrot. Among different date of sowing, D_3 (20th September) was recorded highest specific gravity (1.07 g/cc) of root. The minimum value of specific gravity (0.97 g/cc) was recorded under D_1 (1st September) in carrot root. Similar findings have reported by Ladumor *et al.* (2020) in carrot. Observations on total soluble solids content in roots revealed that variety V_2 (Pusa Rudhira) had maximum total soluble solids (8.36˚B) followed by the variety V_3 (Pusa Vristi), while minimum total soluble solids (8.20˚B) content in roots was observed in variety V_1 (Pusa Kesar) with significant difference. The variation in total soluble solids might be due to genetic make-up of varieties (Ladumor *et al.,* 2020). Among different dates of sowing, D_3 (20th September) recorded maximum total soluble solids (8.60 ˚B) content, while minimum total soluble solids (7.77˚B) content was determine in case of D_1 (1st September). These findings are in line with Ladumor *et al.* (2020) in carrot and Kandil *et al.* (2013) in onion

On the basis of present experiment, it may be concluded that variety V_2 (Pusa Rudhira) recorded significantly higher growth, yield and quality parameter as compare to other varieties. Among different date of sowing, D_3 (20th September) registered highest growth and yield as well as quality parameters.

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