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Short Communication

Response of carrot (*Daucus carota* L.) cultivars to different sowing dates on growth and yield

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Amongst the root vegetables, carrot (*Daucus carota* L.) is a popular cool season root vegetable. It is grown in spring, summer and autumn in temperate climate and during winter in tropical and subtropical 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 condition including the day and night temperatures associated with planting date affect carrot growth and yield. It is difficult to raise the good quality carrot roots because of excessive forking and splitting, if crop is grown very early in season. 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 and ultimately the yield. Carrot crop can be successfully raised by sowing the seeds in the month of November to October in Andhra Pradesh. However, time of sowing varies according to the cultivar selected for cultivation and agro climatic conditions. There is a need to find out the best time of sowing for high yields under late sown conditions, if sowing is delayed due to reasons beyond control.Keeping this in view, the present investigation was undertaken to ascertain the best sowing date and suitable varieties giving high yield.

The study was undertaken during rabi 2010-2011 at Horticultural College and Research Institute, Dr. Y.S.R.H.U, Venlkataramannagudem, West Godavari district, Andhra Pradesh. The experiment was laid out in split plot design with four different dates of sowing and three varieties and replicated thrice. The main plots were devoted to sowing dates (10th November, 25th November, 10th December, 25th December) whereas, subplots were assigned to the carrot cultivars *viz.,*Pusa Kesar, Pusa Rudhira and Kuroda Improved. Total 12 treatment combinations were evaluated to find out the optimum sowing date and suitable variety with high yields and best quality roots.Seeds were sown in the plotsas per the experimented sowing dates. After 25 days from sowing at (4 leaf stage), the plants were thinned to leave one plant per hill. Irrigation applied once in every four days intervals using flood irrigation system. Data on growth attributes*viz.,* plant height, number of primary and secondary branches were collected at 60 days after sowing.The yield attributes were judged after harvesting the roots. Data were recorded to statistical analysis of variance according to the methods described by Panse and Sukhatme (1967).

The data reflected significant variations in plant height among all the dates and varieties as observed at 60 days after sowing with the highest value being in D1 – 10th November (44.41 cm) followed by the treatments D2-November 25th (42.29cm) and D3-December 10th (36.77cm), however D3 found to be on par with D4. The treatment D4-December 25th recorded minimum height of plant (35.56 cm). This might be due to favourable conditions prevailing during the growing period when planted earlier *i.e*., 10th November and also due to longer growth experienced by plants resulted from the seeds sown earlier (10th November). Similar results were obtained under different climatic conditions as influenced sowing time by Kanwar (1993) and Gill and Gill (1995). Regarding varieties, significantly maximum plant height was observed with the variety Kuroda Improved (44.28cm) and minimum plant height was observed with the variety Pusa Kesar (34.59cm). While, the plant height was found significantly maximum in

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Table 1: Effect of sowing dates on growth attributes of carrot (*Daucus carota* L.) cultivars

Sowing dates	Plant height				No. of primary branches				No. of secondary branches				Root shoot ratio			
	Varieties															
	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean	V_1	V_2	V_3	Mean
D1(10th November)	37.86	45.40	49.97	44.41	11.7	12.4	13.8	12.6	113.7	129.3	142.4	128.4	1.22	1.31	1.62	1.38
D2 (25th November)	36.18	42.82	47.86	42.29	11.0	11.8	13.2	12.1	102.7	114.3	134.1	117.1	1.12	1.22	1.53	1.29
D3 (10thDecmeber)	32.84	37.53	39.93	36.77	9.8	11.0	12.7	11.2	94.1	101.5	122.4	106.1	0.98	1.09	1.24	1.10
D4 (25th December)	31.47	35.87	39.35	35.56	8.5	10.4	11.7	10.2	86.1	93.5	108.3	96.0	0.86	0.93	1.03	0.94
Mean	34.59	40.41	44.28		10.2	11.4	12.9		99.2	109.6	126.9		1.04	1.14	1.35	
Interaction effect																
Source	D	V	D xV	V xD	D	V	D xV	V x D	D	V	D xV	V xD	D	V	D xV	V x D
S.Em ±	0.49	0.36	0.77	0.85	0.10	0.11	0.21	0.17	1.71	1.53	3.03	2.95	0.01	0.02	0.03	0.02
CD at 5%	1.70	1.10	2.47	2.34	0.35	0.34	NS	NS	5.89	4.58	NS	NS	0.04	0.05	0.09	0.10

treatmentcombination D1V3 (10th November sowing with Kuroda Improved) due to interaction.

Other growth characters like number of primary and secondary branches per plant and root-shoot ratio were recorded highest in D1 – 10th November among the four dates of sowing (Table 2). 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 which also faced severe winter months after planting causing cessation of growth. With regard to varieties, Kuroda Improved exhibited maximum vegetative growth in all characters followed by varieties Pusa Rudhira and Pusa Kesar. This denotes that these differences due to varietal response might be due to genetic composition in the expression of growth potentials. Prevailing weather and a variety grown for a particular area also jointly reflected the growth and yield expression of a variety. Varying response in respect of growth parameters with varieties have also been reported by Isik (1970).While, all the vegetative characters were found significantly maximum in treatment combination D1V3 (10th November sowing with Kuroda Improved) due to interaction.

Table 2: Effect of sowing dates on root yield (q/ ha) of different varieties of carrot

Dates (M)	Root yield (q ha^{-1})			Mean
	Varieties(S)			
	V1 (Pusa Kesar)	V2 (Pusa Rudhira)	V3 (Kuroda Improved)	
D1 (November 10th)	155.86	161.98	200.61	172.82
D2 (November 25th)	165.12	154.32	169.75	163.06
D3 (December 10th)	78.44	101.90	136.26	105.53
D4 (December 25th)	46.55	67.38	90.02	67.98
Mean	111.49	121.39	149.16	

Interaction table

Factors	F – test	S. Em ±	C.D at 5%
Factor (M)	Sig	2.24	7.73
Factor (S)	Sig	1.68	5.03
S × M	Sig	3.88	10.68
M × S	Sig	3.54	11.26

Root yield per plot and per hectare were significantly affected by different dates of sowing. Considering the date of sowing November-10th gave the highest root yield per plot and per hectare. It was found that root yield was gradually decreased in the later sowings. There is a corresponding reduction in the yield of roots with the delay in the sowing of carrots after November. This might be due to very low temperatures during later sowings, which turn energy from vegetative phase to reproductive phase. Many workers under different climatic conditions also reported the influence of time of planting on root yield per hectare *viz*. Malik *et al.,* (1999), Gill and Gill (1995) and Alam *et al.,* (2010). In this study, 10th November sowing resulted significantly maximum yield followed by 25th November. Drastic reduction in yield was noted from 10th December and 25th December sowings. The size of individual roots was found to be very small and the mean root weight was also reduced. As the sowing date was delayed, environmental conditions becoming adverse and affected the plant growth, yield and quality. Out of the three varieties in the present study Kuroda Improved has recorded the highest yield followed by Pusa Rudhira and Pusa Kesar. This varietal difference is attributed to vigorous growth and their potential genetic makeup of the variety (Arthirani *et al.,* 2008). The interaction between the dates of sowing and varieties had a significant effect on root yield of carrot. The variety Kuroda Improved which was sown at 10thNovember (D1V3) exhibited highest root yield (200.61 q /ha) than any other combinations, and it was followed by the treatment combination of D2V3 (169.75 q/ ha). However, the root yield was significantly less in the treatment combination of Pusa Kesar with final sowing *i.e.,* D4V1 (46.55 q/ ha).The experiment results revealed that all the growth characters like plant height, number of primary and secondary branches per plant, plant weight, root-shoot ratio and root yield were maximum in treatment combination D_1V_3. Therefore, the early sowing on 10th November with the cultivar Kuroda Improved is recommended for the conditions prevails at West Godavari conditions of Andhra Pradesh.

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