

# Effect of Cropping situations and Integrated Nutrient Management Practices on growth, yield, quality and Economics of growing carrot in Ber-based Cropping system

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**ABSTRACT :** Carrot (cv. Early Nantes) was grown by underplanting and intercropping in fifteen year old ber (cv. Gola) plantation besides its sole cropping with different integrated untrient management practices viz., application of vermicopmost, neem cake, castor cake, and FYM in conjunction with inorganic fertilizers and also with inorganic fertilizers (NPK) only. Different cropping situations had a significant effect on the performance of associated carrot. Though the underplanted crop recorded significantly higher plant height (39.99) cm shoot to root ratio (1.70) and girth (7.74 cm), fresh (40.48 g/pl) and dry weight (3.51 g/plant) carotene (3.96 mg/ 100g), total sugars (7.81%) and TSS cantent (11.99<sup>0</sup> brix) were lower compared sole crop of carrot. Further among the different INM practices application of neem cake and castor cake in combination with half the recommended dose of NPK recorded higher yield (14.71 and 15.86 t ha<sup>-1</sup> respectively) and quality compared to other organic manures viz., vermicompost, FYM. The gross monetary returns in general were higher when carrot was intercropped in ber (Rs. 61,761 ha<sup>-1</sup>) and underplanted carrot (Rs. 56.872 ha<sup>-1</sup>). In general, the benefit cost ratio was found to be greater than unity in all treatments indicating fairly higher returns on every rupee invested. The Income Equivalent Ratio (IER) in ber based cropping system was also greater than unity indicating advantage of either underplanting or intercropping of carrot with ber over its sole cropping.

**Key words :** Inter cropping , Carrot ber cropping system, INM practices.

Carrot (*Daucus carota* L.) is an important salad and cooked vegetable, consumed throughout the world and its demand is constantly increasing. The area under carrot cultivation is also continuously increasing around urban areas to cater to the needs of the growing population. The existing orchards around the cities can serve as a source to provide additional land area for its cultivation through intercropping. In the context the possibility of underplanting of shade tolerant crops can be explored besides their intercropping. Being a root vegetable, carrot tolerates shade and performs well under partial shading (Anderson *et al.*, 1988). Carrot is a heavy feeder of nutrients and removes 100 kg N, 50 kg P<sub>2</sub>O<sub>5</sub> and 180 kg K<sub>2</sub>O ha<sup>-1</sup> (Schaller and Rober, 1985). Therefore judicious and proper use of manures and fertilizers is essential not only for obtaining higher yields and better quality but also to maintain soil fertility and sustainability. The present investigation was aimed at studying the performance of carrot under different

cropping situations viz., underplanting, intercropping and sole cropping with the conjunctive use of organic manures (vermicomposts, neem cake, castor cake, FYM) and inorganic fertilizers besides the seed treatment with bio-fertilizers and also to evaluate the economics of these practices.

## Materials and Methods

A field experiment was conducted during rabi season of 2003-04 at Students Farm, College of Agriculture, Rajendranagar, Hyderabad to study the performance of carrot under different integrated nutrient management practices in Ber-based cropping system. The main treatments consisted of three cropping situations viz., Underplanting, Intercropping and Sole cropping, while the six sub-treatments were different INM practices comprising of four organic manures viz., vermicompost (@ 10 t ha<sup>-1</sup>), neem cake (@ 4 t ha<sup>-1</sup>), castor cake (@ 4 t ha<sup>-1</sup>) and FYM (@ 15 t ha<sup>-1</sup>) each in combination with

half the recommended dose of NPK ( 50 kg N, 30 kg  $P_2O_5$ ) and 40 kg  $K_2O$ ) besides application of and full dose of (100 kg N, 60 kg  $P_2O_5$  and 80 kg  $K_2O$ ) of inorganic fertilizer only.

The treatments were replicated thrice adopting the split-plot design. Seeds of carrot variety Early Nantes treated with bio-fertilizers (Azotobacter and Phosphobacterium 25 g each per kg seed) were sown at a spacing of 30 cm x 5 cm in 15 years old ber plantation (cv. Gola) spaced at 8 m x 8 m. the gross plot size for each treatment was 4 m x 4 m, with in the interspaces of two ber trees for intercropping and a plot of 4 m x 4 m in the tree basin of ber i.e. 2 m from either side of the tree for underplanting, besides plot of similar size for sole crop of carrot away from ber trees in the same field. All the organic manures were incorporated in the soil before sowing. Nitrogen was applied as per treatment in two split doses while  $P_2O_5$  and  $K_2O$  were applied as a basal dose. The carrot crop was sown on 9-11-2003 and harvested on 2-2-2004. The growth parameters like plant height, root length, root girth, fresh and dry weight of carrot was measured at 20 days interval and quality parameters were estimated at harvest.

## Results and Discussion

### Plant growth

There was significant increase in plant height of carrot at all stages of the plant growth when underplanted in ber followed by intercropping and least in sole crop. This may be due to the ability of the plant to reorient its leaves as high as possible for light interception. Among the different organic manures, neem cake followed by castor cake in combination with half the recommended dose of NPK fertilizers improved the plant height over other treatments. This may be attributed to the higher N content (5.22 and 4.37% respectively) of these manures.

There was a significant reduction in root length, girth, fresh and dry weight of carrots when underplanted in ber is followed by the intercrop compared to sole crop. Reduction in available PAR to the extent of 51 and 30 per cent in underplanting and intercropping situations respectively compared to sole crop might have hampered the assimilation and translocation of photosynthates to the roots. Sreenivasulu (2002) also reported significant reduction in root length, girth, fresh

and dry weight when carrot was intercropped in the strips away from guava tress and also in sole crop. Similar results were also observed by Reddy *et al.* (2000) with radish when intercropped in ber. Among the different organic manures, neem cake with half the recommended dose of NPK improved root length at all the stages of plant growth compared to other treatments, but root girth, fresh and dry weight of carrot was significantly higher with castor cake in combination with half the recommended dose of NPK. This may be due to higher content of P (1.85%) in castor cake which might have stimulated the root growth through greater absorption and translocation of nutrients. Phosphorus is also a part of various enzymes, co-enzymes and energy rich ATP and might have resulted in increased root growth (Mangal, 1985). Full recommended dose of NPK only without organic manures also resulted in increased root length, girth, fresh and dry weight of carrot root. Accelerated synthesis of chlorophyll and aminoacids and increased bio-chemical activity resulting in increased translocation of photosynthates from leaves to roots might have resulted in increased root length and girth.

### Root yield

There was a significant reduction in root yield of carrot in underplanted crop to the tune of 48 per cent followed by intercrop (34%) compared to sole crop. The reduction in yield of carrot roots in underplanted crop is not only the result of reduced availability of Par on the crop canopy but also due to the reduction in net cropped area to the extent of 10 per cent that was occupied by ber tree base. The results reported by Reddy *et al.* (2000) also indicated a reduction in root yield and dry matter production of radish when intercropped with ber to the extent of 25 and 9 per cent in the intercrop strip closer to ber and the one away from ber respectively.

Among the organic manures castor cake in combination with half of the recommended dose of NPK recorded significantly higher carrot yield compared to inorganic fertilizers and other manures. This may be due to the positive effect of all yield components viz., root girth, fresh and dry weight of roots in this treatment. The full recommended dose of NPK only was the next best treatment in respect of carrot yield in which readily available nutrients and their uptake might have resulted in faster synthesis and translocation of photosynthates from source (leaves) to sink (root) and in turn might

**Table 1. Growth and quality parameters of carrot under different treatments as affected by cropping system and INM practices at 80 DAS (Harvest)**

Treatments	Growth parameters									Quality parameters		
	Plant Height (cm)	Root length (cm)	Root right (cm)	Fresh weight (g plant <sup>-1</sup> )	Dry weight (t ha <sup>-1</sup> )	Root yield (t ha <sup>-1</sup> )	Shoot yield ratio	Shoot root	Carotene (mg/100g)	Total sugars (%)	TSS ( <sup>o</sup> Brix) (mg/100g)	Total chlorophyll
<b>Cropping system</b>												
UP	39.99	12.13	7.74	40.48	3.51	10.02	16.96	1.70	3.96	7.81	11.99	1.56
IC	36.23	13.97	8.20	41.56	4.72	12.63	18.06	1.44	4.5	8.02	12.37	1.37
SC	29.50	14.68	8.72	51.64	6.49	19.15	18.03	1.01	4.22	8.19	13.09	1.26
S.Ed±	0.64	0.38	0.15	1.99	0.04	0.54	0.93	0.06	0.05	0.10	0.10	0.02
CD (at 5%)	1.79	1.07	0.43	5.52	0.12	1.49	NS	0.18	0.15	0.28	0.28	0.05
<b>INM practices</b>												
VC+ ½ RD NPK	35.59	14.03	7.73	45.81	4.95	14.14	17.21	1.31	4.09	7.99	12.50	1.38
NC+ ½ RD NPK	37.79	14.71	8.21	48.82	5.07	14.71	18.78	1.47	4.42	8.14	12.81	1.39
CC+ ½ RD NPK	36.51	13.18	8.92	48.83	5.19	15.86	18.73	1.25	4.08	8.09	12.53	1.40
FYM+ ½ RD NPK	34.59	13.88	8.60	44.23	4.87	13.93	18.14	1.41	4.00	7.92	12.33	1.38
½ RD NPK only	31.68	11.71	7.55	35.93	4.35	10.10	14.19	1.47	3.82	7.83	12.29	1.39
RD NPK only	35.27	14.04	8.32	43.73	5.01	14.87	19.05	1.38	4.05	8.05	12.42	1.42
S.Ed±	0.79	0.46	0.32	2.74	0.10	0.40	0.94	0.07	0.08	0.16	0.14	0.17
CD (at 5%)	1.62	0.93	0.65	5.60	0.20	0.82	1.92	0.15	0.17	NS	0.28	NS

UP=Underplanting; IC=Intercropping; SC=Solcropping; VC=Vermicompost; NC=Neem cake; CC=Castor cake; FYM=Farmyard manure; RD=Recommended dose

**Table 2. Gross and net income (Rs. ha<sup>-1</sup>), B:C ratio and IER under different treatments as affected by corpping system and INM practices**

Treatments	Gross income			Total net income	B:C ratio	IER
	Ber	Carrot	Total			
UP x VC + 50% RD NPK	28000	28800	56800	10718	1.23	1.69
UP x NC + 50% RD NPK	29667	31600	61266	19585	1.47	1.82
UP x CC + 50% RD NPK	26667	33800	60467	19585	1.48	1.67
UP x FYM + 50% RD NPK	25333	29600	54933	23201	1.73	1.66
UP x 50% RD NPK only	23667	25600	49267	21185	1.75	1.71
UP x 100% RD NPK only	27500	31000	58500	28852	1.97	1.70
IC x VC + 50% RD NPK	25167	36900	62067	15985	1.35	1.69.
IC x NC + 50% RD NPK	24167	40800	64967	23285	1.58	1.73
IC x CC + 50% RD NPK	24833	43000	67833	26951	1.66	1.73
IC x FYM = 50% RD NPK	23167	37900	61067	29335	1.92	1.66
IC x 50% RD NPK only	22667	27533	50167	22085	1.79	1.72
IC x 100% RD NPK only	23167	41300	64467	34819	2.17	1.68
SC x VC + 50% RD NPK	-	61600	61600	29172	1.90	-
SC x NC + 50% RD NPK	-	60000	60000	31972	1.90	-
SC x CC + 50% RD NPK	-	65900	65900	38672	2.42	-
SC x FYM + 50% RD NPK	-	57900	57900	33796	2.40	-
SC x 50% RD NPK only	-	37800	37800	23372	2.62	-
SC x 100% RD NPK only	-	61500	61500	45506	3.84	-
Sole ber	23000	-	23000	9346	1.68	-
S.Ed.±			2519	3122		
CD (at 5%)			5134	6363		

have contributed to increased root length, girth and root yield. These findings are in conformity with the observation made by Devlin (1973).

### Crop quality

In general, improvement in quality of carrot with the use of organic manures over inorganic fertilizers was

observed. Higher carotene content was recorded with neem cake (4.22 mg/100g) followed by vermicompost (4.09 mg/100g). Kolodzie and Kostecka (1994) also observed better root quality when carrot was grown with vermicompost than mineral fertilizers. Higher TSS content (12.81<sup>0</sup> brix) and total sugars (8.14%) in carrot roots were recorded with neem cake. This may be due

to better availability and uptake of nitrogen and other nutrients with the application of these manures which might have led to balanced C/N ratio and increased plant metabolism as suggested by Emura and Hosoya (1979).

### Economics of Intercropping

The gross monetary returns, in general, were higher when carrot was intercropped followed by underplanted in ber compared to either sole carrot or sole ber, irrespective of the INM practices adopted. The higher gross monetary returns under intercropping may be attributed to the relatively better performance of carrot in this situation compared to underplanting, due to less competition with the tree for above and below ground resources. The combined yield of the component crops (ber and carrot) gave higher monetary returns over sole cropping of either ber or carrot. The Income Equivalent Ratio (IER) in ber based cropping system was greater than unity indicating advantage of either underplanting or intercropping of carrot with ber over its sole cropping due to better competitive ability of the component crops and more over the under storied component. This can be explained in the light of the findings of Cannel (1983) who opined that crops whose harvestable parts or vegetative trend to be less affected when grown in proximity to trees.

Growing of carrot in association with ber (intercropping/underplanting) with conjunctive use of organic manures (neem cake/castor cake and chemical fertilizers (half the recommended dose of NPK) proved highly productive and remunerative. Through the full recommended dose of NPK only was also equally good in promoting growth and yield of carrot, but it is not recommended considering its possible adverse effects on soil health and environment besides substantiality. The present findings indicate that carrot can be grown in the entire orchard area covering not only the interspaces between grown up ber trees but also in the tree basins for effective

utilization of available land without much reduction in yield and thereby increasing overall productivity and returns from the orchard.

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