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Effect of organic manures and fertility levels on yield attributes of carrot (*Daucus carota* L.) cv. Pusa Rudhira

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Abstract
A field experiment was conducted to study the effect of organic manures and fertility levels on yield of carrot (*Daucus carota* L.) cv. Pusa Rudhira during *Rabi* season 2015-16 at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur) on loamy sand soil. The experiment consisting 16 treatments *viz*., four doses of organic manures (control, 5 t/ha vermicompost, 5 t/ha poultry manure and 15 t/ha FYM) and four fertility levels (control, 75 per cent RD of NPK, 100 per cent RD of NPK and 125 per cent RD of NPK) alone and in-combination with fertility levels was laid out in RBD with three replications. The application of organic manures and fertility levels under the treatment 5 t/ha poultry manure with 100 per cent RD of NPK remaining at par to 125 per cent RD of NPK with 5 t/ha vermicompost, exhibited maximum fresh weight of plant, top root ratio, average weight of root per plant, diameter of root, length of edible root, core diameter, percentage of core to flesh, weight of core, weight of flesh and root yield.

Keywords: carrot, organic manure, fertility level, harvest index, yield attributes and Pusa Rudhira

Introduction
Carrot (*Daucus carota* L.) is a cool season crop and belongs to family Apiaceae. It is one of the major root vegetable used for different purposes in daily human diet. The two types of carrot are found in world Tropical and Temperate. Carrot originated in South-west Asia and later spread throughout China and the Mediterranean basin [13]. It is a major source of vitamin A and has a high carotene, a pro-vitamin that is converted by the body into vitamin A and contains appreciable quantities of thiamine and riboflavin [24].

Carrot is one of the important and major root vegetable used as salad and cooked vegetable, canned pickles, preserves, sweets (especially Gajar halwa), carrot powders, kanji an appetizing drink *etc*. [9]. Beta carotene is one of hydrocarbon carotenoids while the oxygenated derivatives of these hydrocarbons are known as Xanthophylls [7]. Carrot roots are consumed uncooked in salads steamed or boiled in vegetables and may also be prepared with other vegetables in the preparation of soups and sweets [2]. Besides being food, carrot has therapeutic importance as it enhances resistance against blood and eye diseases [16].

A number of factors are responsible for successful cultivation of high quality roots. Among these the judicious application of fertilizers especially Phosphorus, vermicompost and FYM are responsible for affecting qualitative, quantitative and yielding capacity of carrot roots [12]. Keeping in view the above facts, the experiment was undertaken to find out the effect of organic manures and fertility levels on yield of carrot cv. Pusa Rudhira.

Material and Methods
The experiment was conducted at Horticulture farm, S.K.N. College of Agriculture, Jobner, Jaipur during *Rabi* season, from November, 2015 to March, 2016.The experiment was comprised of 16 treatment combination of organic manures [control (M_1), 5 t/ha vermicompost (M_2), 5 t/ha poultry manure (M_3) and 15 t/ha FYM (M_4)] with fertility levels [control (O_1), 75% RD of NPK (O_2), 100% RD of NPK (O_3) and 125% RD of NPK (O_4)]. The variety of carrot that is used for the experiment was Pusa Rudhira. The experiment was layed out in randomized block design. The bed size was 1.5 x 1.0 m and plants were spaced at 15 x 10 cm.

Results and Discussion

Organic manures

Application of 5 t/ha poultry manure (M_3) was recorded the maximum fresh weight of plant (206.95 g), top: root ratio (0.756), weight of root (98.37 g), diameter of root (2.78 cm) and length of edible root (16.91 cm), while minimum was under control (Table 1). The treatment M_3 was found significantly higher over control and M_4 but statistically at par with M_2. Minimum diameter of core (1.05 cm) was recorded under the treatment M_3 *i.e*. 5 t/ha poultry manure, while maximum diameter of core (1.22 cm) was recorded under control. Application of 5 t/ha poultry manure (M_3) being at par with 5 t/ha vermicompost (M_2) (Table 1).

Poultry manure also enhanced the vegetative growth of carrot. It might be due to fact that poultry manure contains uric acid having 60 per cent nitrogen. The uric acid rapidly changes to ammonia from causing its immediate and efficient utilization for better plant growth and development. These results are agreement with findings of pillai *et al.* [17], Sharhidhara *et al.* [21] and Vijaykumari *et al.* [25].

Application of 5t/ha poultry manure (M_3) being at par with the treatment 5t/ha vermicompost (M_2). The maximum percentage of core to flesh was recorded under control (41.63). Minimum weight of core (33.76 g) was recorded under 5 t/ha poultry manure (M_3), while maximum weight of core (37.56 g) was recorded under control. Application of 5 t/ha poultry manure (M_3) statistically at par with 5 t/ha vermicompost (M_2) (Table 2). A critical examination of the data presented in Table 2 revealed that weight of flesh increased significantly with various organic manures. The maximum weight of flesh root (64.61 g) was recorded under 5 t/ha poultry manure (M_3) while minimum was recorded under control (52.96 g). Application of 5 t/ha poultry manure (M_3) was recorded maximum root yield (230.25 q/ha) which was statistically at par to 5 t/ha vermicompost (M_2) (Table 2).

The increased yield and yield attributes with poultry manure might be because of rapid availability and utilization of nitrogen for various internal plant processes for carbohydrate production. Later on these carbohydrates undergo hydrolysis and get converted into reproductive sugars which ultimately helped in increasing yield. Singh *et al*. [23] reported that high carbohydrates content due to application of poultry manure might be attributed to balanced C: N ratio and increased activity of plant metabolism.

The beneficial effect of vermicompost in all yield attributes and yield might be due to enhanced supply of macro and micro nutrients during entire growing season significant increase yield under the influence of vermicompost was largely a function of improved growth and the consequent increase in different yield attributes and yield as mentioned above. The significant improvement in yield and yield attributes on account of 5t/ha vermicompost along with nutrients from soil particularly at later stage of crop growth might have enhanced the rate of photosynthesis which further increase vegetative growth and provided more site for translocation of photosynthates which ultimately increased the yield.

These results are in accordance with the findings of Buckfield *et al.* [8] and Shelke *et al*. [22]. Vermicompost have been reported to have between 40 to 60 per cent higher levels of humic substances and are superior in quality than conventional composts, Dominguez *et al*., [10]. The increase in yield and yield parameters especially with the application of poultry dropping could be done to its ability in improvement of soil structure, increase exchanges sites thus increasing photosynthesis leading to greater cell division, elongation, differentiation and finally body growth as reported by Saleh *et al*. [18]. Similar results were obtained by Babaji [4], Miko [14] and Akoun [1] confirming that manure increased the nutrient status of soil which leads to increase in yield.

Fertility levels

Maximum fresh weight of the plant (208.20 g) was recorded under 125 per cent RD of NPK (O_4) which was significantly higher over control (159.74 g) and O_2 (188.23 g) (Table 1). Data (Table 1) further showed that application of different fertility levels significantly increased the top root: ratio. Maximum top: root ratio (0.757) was recorded under 125 per cent RD of NPK *i.e.* O_4 which was significantly higher over control (0.618). Maximum weight of the root per plant (100.17 g) recorded under 125 per cent RD of NPK (O_4) which was significantly higher over control (87.39 g) and 75 per cent RD of NPK (94.11 g) *i.e.* O_2. However, 100 per cent RD of NPK (O_3) statistically at par with 125 per cent RD of NPK (Table 1). A perusal of data (Table 1) revealed that application of different fertility levels significantly increased the diameter of root. The maximum diameter of root (2.84 cm) was recorded under the treatment 125 per cent RD of NPK (O_4). The treatment 125 per cent RD of NPK (O_4) statistically at par with O_3 *i.e.* 100 per cent RD of NPK. The maximum length of root (17.26 cm) was recorded under 125 per cent RD of NPK (O_4) while minimum was under control (14.00 cm) (Table 1).

Different fertility levels also significantly influenced the diameter of core. Minimum diameter of core (1.02 cm) was recorded under O_4 *i.e.* 125 per cent RD of NPK, while maximum (1.23 cm) was recorded under control. The minimum percentage of core to flesh (34.08) was recorded under the treatment 125 per cent RD of NPK *i.e.* O_4 and maximum under control (42.42). However, 100 per cent RD of NPK (O_3) statistically at par with the treatment 125 per cent RD of NPK (O_4) (Table 1). The minimum weight of core was recorded under 125 per cent RD of NPK *i.e.* O_4 (34.05 g) and maximum was recorded under control (37.01 g). However, the treatment 100 per cent RD of NPK *i.e.* O_3 statistically at par with the treatment 125 per cent RD of NPK *i.e.* O_4 (Table 2). The maximum flesh weight (66.12 g) was recorded under 125 per cent RD of NPK (O_4), whereas minimum was recorded under control (50.38 g) (Table 2). Data presented in Table 2 further reveal that yield of carrot was significantly influenced by different fertility levels. The application of 125 per cent RD of NPK (O_4) was recorded significantly higher yield (236.57 q/ha) over control (164.09 q/ha). The treatment O_4 was statistically at par with 100 per cent RD of NPK (O_3).

This might be due to the affect that increased NPK levels, helped in expansion of leaf area and chlorophyll content which coupled with increased net photosynthetic rates and in turn increased the supply of carbohydrates to plants. The application of NPK favoured the metabolic and auxin activities in plant and ultimately resulted in increased yield, biological yield, root length and root diameter.

These findings were similar to those reported by Farazi [11], Sarker [20], Saparov [19], Ballooch *et al.* [5], Biegon [6], Murwira *et al.* [15] and Atakora [3].

Table 1: Effect of organic manures and fertility levels on fresh weight of plant, top root ratio, average weight of root per plant, diameter of root, length of edible root and core diameter of carrot

Treatments	Fresh weight of plant (g)	Top root ratio	Average weight of root per plant (g)	Diameter of root (cm)	Length of edible root (cm)	Core Diameter (cm)
Organic manures						
M_1 (control)	164.34	0.620	90.52	1.62	14.70	1.22
M_2 (5 t/ha vermicompost)	197.23	0.713	95.88	2.62	16.35	1.10
M_3 (5 t/ha poultry manure)	206.95	0.756	98.37	2.78	16.91	1.05
M_4 (15 t/ha FYM)	186.61	0.670	93.30	2.50	15.54	1.12
SEm±	5.65	0.016	1.50	0.07	0.35	0.03
CD (P=0.05)	16.31	0.047	4.33	0.19	1.01	0.08
Fertility levels						
O_1 (Control)	159.74	0.618	87.39	1.41	14.00	1.23
O_2 (75% RD of NPK)	188.23	0.671	94.11	2.55	15.68	1.16
O_3 (100% RD of NPK)	198.96	0.713	96.40	2.72	16.62	1.09
O_4 (125% RD of NPK)	208.20	0.757	100.17	2.84	17.20	1.02
SEm±	5.65	0.016	1.50	0.07	0.35	0.03
CD (P=0.05)	16.31	0.047	4.33	0.19	1.01	0.08

RD = Recommended dose

Table 2: Effect of organic manures and fertility levels on percentage of core to flesh, weight of core, weight of flesh, sugar content, root yield and harvest index of carrot

Treatments	Percentage of core to flesh	Weight of core (g)	Weight of flesh (g)	Sugar content (%)	Root yield (q/ha)	Harvest index (%)
Organic manures						
M_1 (control)	41.63	37.56	52.96	7.42	168.69	72.36
M_2 (5 t/ha vermicompost)	35.95	34.32	61.56	7.60	223.76	78.77
M_3 (5 t/ha poultry manure)	34.48	33.76	64.61	7.67	230.25	79.42
M_4 (15 t/ha FYM)	37.45	34.80	58.50	7.54	207.25	76.31
SEm±	0.68	0.53	2.27	0.14	3.59	1.38
CD (P=0.05)	1.97	1.54	6.57	NS	10.36	3.98
Fertility levels						
O_1 (Control)	42.42	37.01	50.38	7.45	164.09	72.42
O_2 (75% RD of NPK)	37.27	35.00	59.11	7.55	202.01	76.28
O_3 (100% RD of NPK)	35.75	34.38	62.02	7.60	227.28	78.81
O_4 (125% RD of NPK)	34.08	34.05	66.12	7.63	236.57	79.35
SEm±	0.68	0.53	2.27	0.14	3.59	1.38
CD (P=0.05)	1.97	1.54	6.57	NS	10.36	3.98

RD = Recommended dose

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