RESPONSE OF CARROT VARIETIES (*Daucus carota. L*) TO DIFFERENT NUTRIENT SOURCES AND THEIR COMBINATIONS

Ashmita Pandey[1*], Prof. Dr. Moha Dutta Sharma[2]

Institute of Agriculture and Animal Science, Chitwan, Nepal

Email: ashuurefresh2000@gmail.com*

A field experiment was carried out from November 2014 to April 2015 in farmer's field, Fulbari, Chitwan, Nepal to evaluate the response of carrot varieties to different nutrient sources and their combinations. The experiment was laid out in two factorial randomized complete block design with three replications. Factor A consisted of three varieties i.e. Nepadream (hybrid), New Kuroda and Early Nantes and factor B consisted of five nutrient sources: 1) 100% RDF (60:40:40 NPK kg ha^{-1}), 2) 100% FYM @ 10 t ha^{-1}, 3)50% RDF plus 50% FYM, 4) 50% RDF plus 50% vermicompost , and 5) 100% vermicompost @ 4t ha^{-1}. Significant differences were observed between the performance of the three varieties ($P<0.05$). Results revealed that all vegetative attributes were higher in Nepadream at early growth stage, but at later stage it was lower than OP varieties. However, Nepadream produced significantly higher yield (28.56 t ha^{-1}) than OP varieties. Comparing the nutrient treatments, independent on the varieties, all combinations of 50% RDF were found significantly effective in achieving better physio-morphological, growth attributes and yield and yield attributes as compared to their sole applications. The root yield obtained by 100% RDF (24.06 t ha^{-1}), 50% RDF plus 50% FYM (24.68 t ha^{-1}) and 50% RDF plus 50% vermicompost (25.28 t ha^{-1}) were comparable. However application of 50% RDF along with 50% vermicompost performed best among all nutrient sources.

Keywords: Carrot, nutrient, varieties, treatments, attributes

1. Introduction

Carrot (Daucus carota L.) is a highly nutritious cool season crop (Mehedi, 2012). It is the most widely grown crop of the family Apiaceae. It is an economically important horticultural crop that have gained popularity in recent decades due to increased awareness of its nutritional value. Carrot roots are used as vegetables, and is an excellent source of carotene (1890 mg/100 g fresh weight) and precursor of vitamin A and fiber (Chadha, 2003). It is an aromatic herb with diuretic and digestive properties, useful to stimulate uterus with anti-cancer properties and it increases the flow of urine, improves eyesight as well as skin health due to its rich source of beta-carotene (Ageless, 2009).

Carrot yield and nutritional quality are affected by the fertilizers applied and the varieties (Win, 2010). It is a heavy feeder of nutrients and removes 100 kg N, 50 kg P_2O_5 and 180 kg K_2O ha^{-1} (Schaller and Rober, 1985). Among the nutrients, Nitrogen plays a dominant role with regards to carrot yield and quality (Hochmuth et al., 1999). Both organic and inorganic sources of nitrogen fertilizers have a potential role on crop growth and development. But indiscriminate use of inorganic fertilizer changes physical, chemical and biological properties of soil as well as reduces the fertility status of soil (Zakir, 2012). Even with the balanced use of chemical fertilizer alone, high yield level could not be maintained over years because of deterioration in soil physical and biological environments (Khan et al., 2008). So, nowadays organic farming is getting wider attention by government, NGOs and farmers because consumer prefers organically grown foods which are of better quality and more nutritious (Adhikari, 2009). The application of organics such as FYM and vermicompost is becoming popular especially among the vegetable crop (Nadaf, 2007). Farm Yard Manure (FYM) is not a rich source of nutrients but increases organic carbon content to the soil and improves soil physical properties (Mallareddy and Rani, 2007). Similarly,

vermicompost is rich in both macronutrients and micronutrients, and is considered as a bio-fertilizer because of its richness in humus forming and N fixing microorganisms. These organic nutrient sources not only reduce the amount of chemical fertilizers, but improves soil physical and chemical properties and increases nitrogen, phosphorus, potassium and soil organic carbon (SOC) (Zhang et al., 2009). However, large quantities of organic fertilizers are required to supply the enough nutrients for optimum growth of a crop since they have a relatively low nutrient content (Mbatha, 2008). Along with the fertilizer, the carrot yield and nutritional quality are affected by the appropriate varieties. Appropriate fertilizer management along with the selection of the appropriate cultivar according to nutrient requirement of the crop and agro-climatic condition could be one of the successful efforts to increase the productivity of carrot. The information about yield and quality of the local and hybrid carrot cultivars in response to the different fertilizer types would be a useful knowledge especially for farmers. Therefore, an appropriate and well defined fertilizer strategy and the information about the performance of hybrid and local varieties of carrot to different nutrient sources is essential for higher productivity.

In the light of above situation, the present investigation was aimed with the objective to assess appropriate fertilizer management so as to increase the productivity of carrot in sustainable way.

2. Methodology

The research was carried out from November 2014 to April 2015 in farmer's field, Fulbari, Chitwan, Nepal. A composite soil sample from 0-15 cm depth was collected from experimental site before imposing treatments, and sent to laboratory for analysis of various physico-chemical properties by adopting appropriate method. The soil of experimental site was sandy loam, with pH 5.2, medium organic matter content (3.80%), medium total nitrogen (0.14%), medium available phosphorus (45.0 kg/ ha), and medium available potassium (250.9 kg/ ha). The

experiment was laid out in two factorial randomized complete block design with three replications. Factor A consisted of three varieties i.e. Nepadream (hybrid), New Kuroda and Early Nantes (OP) and factor B consisted of five nutrient sources as 100% RDF (60:40:40NPK kg ha^{-1}), 100% FYM @ 10 t ha^{-1} 3), 50% RDF plus 50% FYM, 50% RDF plus 50% vermicompost, and 100% vermicompost @ 4t ha^{-1}.

Altogether, there were 45 plots with individual plot size of 1.5 m×2 m ($3m^2$). There were 5 rows with 100 plants per plot. The seeds were uniformly distributed in furrows at a depth of about 1 cm with a spacing of 30 cm between rows and covered with fine soil at about 2 cm thick. Farmyard manure and vermicompost were applied half month prior to the sowing of seeds by working out on their quantities based on the nutrient content. The plots were fertilized according to the treatment with nitrogen, phosphorus and potassium at 60:40:40 kg/ha (DADO, 2012) in the form of urea, single super phosphate and muriate of potash. Half dose of nitrogen and full dose of phosphorus and potash were applied as basal dose whereas the remaining dose of nitrogen was side dressed after 40 days after sowing. Thinning was done at 20 days after emergence to final spacing of 10 cm between plants.

Five plants from each plot were selected and tagged for recording of observations on morpho-physiological, growth, and yield parameters at 60, 80 days after sowing and at harvest. To determine root dry weight, whole plant fractions were oven dried at 70^0 C till constant weight was obtained. Analysis of variance of all parameters were determined by using MSTAT program. Data were systematically arranged on the basis of various observed parameters in Microsoft excel, and

used for drawing graphs. The significant difference between treatments means were compared by using Duncan's Multiple Range Test (DMRT) with 5% level of significance.

3. Results and Discussion

3.1 Phenological and morphological parameters

Significant variations were observed regarding phenological and morphological parameters of carrot, among different tested varieties (Table 1). Early Nantes took relatively longer period (8.00 days) to 75% germination whereas Nepadream took 7.47 days. Non-significant differences were noticed in days to 75% germination in response to different nutrient treatments. Similarly, significant differences were observed in morpho-physiological characters via plant height, number of leaves to both nutrient sources and varieties. Early Nantes recorded significantly higher plant height and number of leaves per plant followed by New Kuroda at all growth stages expect 40 DAS while Nepadream recorded the lowest at all stages, except 40 DAS. This might be due to the genetical makeup. Among the nutrient treatments, the combination of 50% RDF and 50% vermicompost followed by 50% RDF and 50% FYM recorded significantly higher plant height and number of leaves at all growth stages. This might be due to better uptake of nutrients by the plants treated with 50% RDF in combination with 50% vermicompost. It might be also due to higher nitrogen content in the vermicompost treatment.

Table 1. Days to 75% germination, carrot plant height and the number of leaves per plant as influenced by varieties, nutrient sources and their combinations at different growth stages

Treatments	Days to 75% germination	Plant height (cm)			No. of leaves per plant (cm)		
		40 DAS	60 DAS	At harvest	40 DAS	60 DAS	At harvest
Varieties							
Nepadream	7.47^{b}	8.35^{a}	19.23^{b}	33.04^{c}	6.27^{b}	7.99^{b}	9.97^{b}
New Kuroda	7.60^{b}	7.09^{c}	20.34^{a}	39.39^{b}	6.27^{b}	8.01^{b}	10.05^{b}
Early Nantes	8.00^{a}	7.87^{b}	21.38^{a}	44.42^{a}	6.83^{a}	8.69^{a}	10.71^{a}
LSD (5%)	0.39	0.31	1.05	1.53	0.52	0.43	0.46
SEm±	0.13	0.10	0.36	0.53	0.06	0.15	0.16
Nutrients sources							
$RDF_{100\%}$	7.78	7.88^{bc}	20.21^{bc}	39.17^{b}	6.42	8.33^{a}	10.31^{a}
$FYM_{100\%}$	7.56	6.82^{d}	17.25^{d}	36.16^{c}	6.18	7.47^{b}	9.56^{b}
$RDF_{50\%}$ + $FYM_{50\%}$	7.67	8.13^{ab}	21.56^{b}	39.28^{b}	6.56	8.51^{a}	10.51^{a}
$RDF_{50\%}$ + $VC_{50\%}$	7.78	8.35^{a}	23.19^{a}	43.94^{a}	6.78	8.53^{a}	10.51^{a}
$VC_{100\%}$	7.67	7.65^{c}	19.39^{c}	36.21^{c}	6.33	8.31^{a}	10.29^{a}
CD (0.05)	NS	0.40	1.37	1.98	NS	0.55	0.59
SEm±	0.17	0.13	0.48	0.68	0.23	0.19	0.20
CV%	6.82	5.37	6.97	5.26	10.71	6.95	6.02
Interaction A×B							
CD (0.05)	NS	0.69	1.24	3.42	0.26	NS	NS
SEm±	0.51	0.24	0.42	1.18	0.09	0.26	0.29
Grand mean	7.68	7.77	11.03	38.95	6.45	8.23	10.24

Means followed by the same letter (s) within a column are non-significant at 5 % level of significance as designed by DMRT. Note: DAS (days after sowing); RDF (recommended dose of fertilizer); FYM (farmyard manure); VC (vermicompost); A (variety); B (Nutrient sources)

3.2 Growth parameters

Early Nantes recorded the highest fresh weight of leaves at 80 DAS and at harvest while effect was non-significant at 60 DAS (Table 2). Similarly, Nepadream obtained the highest fresh root weight per plant as compared to others at all growth stages. This might be due to genetical makeup. Fresh weight of root and leaves per plant was significantly influenced by varieties and nutrient sources at 60, 80 DAS and at harvest. Among the nutrient treatments, application of 50% RDF along with 50% vermicompost recorded the highest fresh weight of root and leaves per plant while

lowest with 100% FYM alone at all growth stages. This has been the consequence of higher nutrient availability and increased nitrogen from organic manure along with inorganic fertilizers.

Table 2. Growth parameters of carrot as influenced by varieties, nutrient sources and their combinations at different growth stages

Treatments	Fresh weight of leaves per plant (g)			Fresh weight of roots per plant (g)		
	60 DAS	80 DAS	At harvest	60 DAS	80 DAS	At harvest
Varieties						
Nepadream	2.80	9.21^{c}	22.00^{b}	3.13^{a}	22.52^{a}	106.7^{a}
New Kuroda	3.08	10.33^{b}	43.27^{a}	1.96^{c}	14.81^{b}	75.73^{c}
Early Nantes	3.07	13.56^{a}	44.71^{a}	2.58^{b}	15.73^{b}	86.55^{b}
LSD (5%)	NS	0.55	2.78	0.29	2.27	1.53
SEm±	0.18	0.19	0.95	0.10	0.78	0.53
Nutrients sources						
$RDF_{100\%}$	3.04	11.29^{a}	39.62^{a}	2.45^{bc}	16.18^{b}	91.33^{ab}
$FYM_{100\%}$	2.93	9.79^{c}	24.89^{c}	1.93^{d}	16.12^{b}	81.56^{c}
$RDF_{50\%}$ + $FYM_{50\%}$	2.82	11.62^{a}	40.44^{a}	2.82^{ab}	18.59^{ab}	92.78^{ab}
$RDF_{50\%}$ + $VC_{50\%}$	3.17	11.92^{a}	43.33^{a}	3.17^{a}	21.22^{a}	94.81^{a}
$VC_{100\%}$	2.40	10.56^{b}	35.00^{b}	2.40^{c}	16.30^{b}	87.89^{c}
CD (0.05)	NS	0.71	3.58	0.37	2.93	4.77
SEm±	0.23	0.24	1.23	0.13	1.01	1.64
CV%	23.64	6.72	10.14	15.26	17.16	5.51
Interaction A×B						
CD (0.05)	NS	1.24	6.21	0.65	5.07	8.26
SEm±	0.40	0.42	2.14	0.25	1.75	2.85
Grand mean	2.98	11.03	36.65	2.55	17.68	89.67

Means followed by the same letter (s) within a column are non-significant at 5 % level of significance as designed by DMRT. Note: DAS (days after sowing); RDF (recommended dose of fertilizer); FYM (farmyard manure); VC (vermicompost); A (variety); B (Nutrient sources)

3.3 Yield and yield attributing character

Varieties and nutrient sources caused significant effect on all yield characters at harvest (Table 3). Yield parameters viz. root length, root diameter, root biomass, and dry root weight were comparatively higher in Nepadream. This might be due to genetical makeup. Hybrids with high

harvest index are sometimes better in nutrient use efficiency, and perform better than traditional cultivars (Inthapanyaa et al., 2000). Among the nutrient treatments, the effect on yield characters was more pronounced with the combined application of 50% RDF and 50% vermicompost followed by the combination of 50% RDF and 50% FYM. The increase in root length may be attributed to solubilization of plant nutrients by the addition of vermicompost (Subbaiah *et al.*, 1982). Similarly, decrease in bulk density and increase in porosity and water holding capacity of the soil due to organic manures (Dhananjaya, 2007) along with the readily available nutrients through RDF might have contributed to increased root diameter of the plants. These results were in accordance with the findings of Nadaf (2007).

Table 3. Yield and yield parameters of carrot as influenced by varieties and different nutrient sources

Treatments	Root diameter (cm)	Root length(cm)	Root biomass	Top biomass	Total biomass	Dry root weight (g plant^{-1})
Varieties						
Nepadream	2.80^{a}	20.03^{a}	28.56^{a}	8.72^{c}	37.29^{b}	2.24^{a}
New Kuroda	2.39^{b}	18.36^{b}	20.21^{c}	11.13^{b}	31.34^{c}	1.46^{c}
Early Nantes	2.48^{b}	19.40^{a}	22.81^{b}	16.55^{a}	39.36^{a}	1.84^{b}
LSD (5%)	0.14	0.70	1.19	1.36	1.68	0.25
SEm±	0.05	0.24	0.41	0.47	0.58	0.08
Nutrient sources						
$RDF_{100\%}$	2.60^{bc}	19.37^{b}	24.06^{ab}	12.82^{b}	36.88^{b}	1.78
$FYM_{100\%}$	2.22^{d}	17.78^{c}	21.69^{c}	9.08^{c}	30.77^{d}	1.86
$RDF_{50\%}$ +	2.64^{b}	19.49^{a}	24.68^{ab}	14.31^{ab}	38.99^{ab}	1.76
$FYM_{50\%}$	2.90^{a}	20.70^{a}	25.28^{a}	15.08^{a}	40.36^{a}	1.98
$RDF_{50\%}$ + $VC_{50\%}$	2.44^{c}	18.99^{b}	23.58^{b}	9.38^{c}	32.97^{c}	1.84
$VC_{100\%}$						
LSD (5%)	0.19	0.90	1.54	1.76	2.17	NS
SEm±	0.06	0.31	0.53	0.60	0.75	0.11
CV%	7.69	4.86	6.68	15.06	6.25	18.20
Interaction A×B						
CD (0.05)	0.33	1.80	NS	3.05	3.76	0.56

SEm±	0.11	0.62	0.92	1.05	1.29	0.19
Grand mean	2.56	19.26	23.86	12.13	35.99	1.84

Means followed by the same letter (s) within a column are non-significant at 5 % level of significance as designed by DMRT. Note: RDF (recommended dose of fertilizer); FYM (farmyard manure); VC (vermicompost).

4. CONCLUSION

On the basis of above analysis, it can be concluded that both the organic and inorganic fertilization are essential for increased carrot yield. The combination of 50% RDF and 50% vermicompost or 50% RDF and 50% FYM performs better than the sole applications of RDF and organic manures, leading to sustainable production. However, when concern to yield and quality attributes Nepadream was found best to other varieties. The findings must be viewed in the specific context of the conditions prevailing in the study area, and cannot be generalized for wider geographical area.

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