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Original Research Paper

Growth and yield enhancement of carrot through integration of NPK and organic manures

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ABSTRACT

A pot experiment was conducted at Horticulture Experimental Area, Gomal University, Dera Ismail Khan, Pakistan to investigate the combined effects of NPK and organic manures on growth and yield of carrot, for two consecutive years. The experiment was laid out in CRD with six treatments and four replications. Five different organic manures such as poultry manure (PM), sewage sludge (SS), farmyard manure (FYM), press mud (PrM) and goat manure (GM) were applied in combination with NPK, each at recommended levels for two successive years. A fertilizer check (control) was also included as treatment where no fertilizer and manure were used. The study revealed significant improvements in almost all growth and yield attributes by combined application of NPK and organic manures. Among different combinations, NPK + PM surpassed all other treatments by giving maximum leaves per plant (8.73 and 8.13), leaf length (38.17 and 36.77cm), root length (29.30 and 24.83cm), root diameter (3.10 and 3.27cm), root weight per plant (142.40 and 142.00g), total biomass per plant (169.33 and 166.67g) and root yield (56.67 and 56.83 t/ha), during both the experimental years. Similarly, NPK combination with green manure and sewage sludge also produced better results pertaining to carrot growth and production for two consecutive years. It was also observed during the study that control treatment showed poorest findings and placed at lowest levels.

Keywords: Carrot, NPK, organic manures, root length, root weight and total biomass

INTRODUCTION

Carrot is one of the major vegetable crops grown throughout the world (Cho *et al*., 2021) and considered to be an important economical vegetable as it has large yield per unit area (Sikora *et al*., 2020). In Pakistan, carrot is one of the cheaply available vegetables and is equally used by poor and rich people (Amjad *et al.*, 2013). Besides, vitamin A and fiber carrot is also enriched with carbohydrates, protein, minerals, fibers, iron and so on (Khomich *et al*., 2020). From therapeutic point of view carrot is more useful in curing human diseases especially eye sight (Nagraj *et al*., 2020). This root vegetable is used for different purposes in daily human diet and its roots are eaten uncooked in steamed or boiled vegetable salad and can also be used in soup and other food stuff (Rahman *et al*., 2020). According to survey in Pakistan (2017-18) the carrot was grown on area of 13.95 thousand ha and its total production was 241.91 thousand tones (Noor *et al.*, 2020). The proper application of nutrients increase the soil fertility and crop production (Silveria and Kohmann, 2020). Plants and crops fulfill their nutritional requirements by the uptake of minerals largely through soil (Vijayprabhakar *et al.*, 2020). Balanced nutrition application is considered as an important factor to boost production. Both soil fertility and crop production are adversely affected by misuse of fertilizers without any significant knowledge (Pandey *et al*., 2020). Generally, most carrot growers use inorganic fertilizers to realize higher yields. The rising level of inorganic fertilizers adversely affect the human health (Toor *et al.*, 2020) soil texture and structure. So, the farmers tried the integrated plant nutrients which significantly increased the fertility of

soil and crop production (Singh *et al*., 2020). There are several organic soil amendments which include materials such as chicken manure, cattle manure, cocoa pod husk, compost and solid waste (Ameen, 2020). So, the mineral fertilizers can be substituted by organic manures. Manure application provides nutrients, enhances water holding ability, soil structure and porosity, moisture retention, bulk density, enhance the microbial growth and crop quality (Goel *et al.,* 2020). Organic fertilizers are cheaper than inorganic sources, thus farmers can easily afford the cost of organic fertilizers (Hafez *et al*., 2020) In order, to achieve high yield and quality product, the proper use of mineral fertilizers and organic manure are of considerable importance. They also display a vital role in avoiding harmful effects on soil and environment as well (Fallah *et al*., 2020) The effectiveness of the combined application of mineral and organic fertilizers assigned to the increased efficiency of mineral fertilizer and the balanced supply of all the essential nutrients. Integrated use of organic and inorganic fertilizers can improve crop productivity and sustain soil fertility (Hammad *et al*., 2020) However, the main important issue is that the organic fertilizers are slowly available to the crops as compared to the inorganic fertilizers. Recently, the researchers focused to practice the combination of mineral fertilizers and organic manures. The combination of both the organic and inorganic fertilizer increase the soil fertility, crop production and decrease the level of soil pollution (Karmakar *et al*., 2020). Taking into consideration the beneficial aspect of integrated fertilizers, an experiment was conducted to study the response of growth and yield of carrot towards the combined effect of NPK dose and organic manures.

MATERIALS AND METHODS

The two years study to investigate the integrated use efficiency of different organic manures in addition to NPK on growth and production of carrot was carried out at Horticulture Experimental Area, Gomal University, Dera Ismail Khan, Pakistan. Experimental site is located between 32º 4' N (latitude), 71º 2' (longitude) and 173 m (altitude) above sea level. Climatic conditions of the study area are arid, subtropical, and continental with an average rainfall ranging 180-300 mm. The trial was conducted in pots using CRD layout with six treatments (i.e.) T_1:Control (no fertilizers), T_2: NPK (100:100:125 kg ha^{-1}) + FYM (30.0 t ha^{-1}), T_3:NPK + PM (10.0 t ha^{-1}), T_4:NPK + GM (15.0 t ha^{-1}), T_5: NPK + PrM (20.0 t ha^{-1}) and T_6:NPK + SS (20.0 t ha^{-1}) each treatment replicated four times. All pots were filled with equal and uniform amount (20.0 kg) of river soil along with respective quantities of NPK and organic manures. A set of pots without any additives (manures and fertilizers) treated as control. The required quantity of mineral fertilizers (phosphorus and potash) were applied in the form of Single super phosphate and Sulphate of potash at sowing, while different manures were incorporated well before sowing of seeds (10 days). Nitrogen was applied in the form of urea in two splits i.e., before sowing and after one month of sowing. Five seeds of carrot (local variety) were sown on 20th October, each year in pots and all cultural practices were performed uniformly.

Data on various attributes pertaining to plant growth and yield including number of leaves per plant, leaf weight and length, root weight, length, diameter, plant biomass and yield were recorded, and statistical analysis was done as per ANOVA techniques, while means' comparison was done by Duncan's multiple range (DMR) test.

RESULTS AND DISCUSSION

Application of NPK and organic manures significantly influenced number of leaves per plant during both the experimental years (Table1). Application of NPK + PM recorded the significantly higher number of leaves per plant (8.73 and 8.13) during both the years. It was followed by the application of NPK + GM (8.17 and 7.60). The study also showed statistically on par number of leaves per plant by applying SS (7.83 and 7.33), FYM (7.73 and 7.27) and PrM (7.60 and 7.07) in addition to NPK. The control treatment recorded the least number of leaves per plant was (4.53 and 3.27). The obtained results showed that the integrated mineral and organic manure increased the number of leaves by providing macro and micro nutrient to plants. The increase in the number of is attributed to the use of variant nature of the organic manures. The obtained results are in accordance to previously reported literature (Singh *et al.*, 2007). Kirad *et al*. (2010), also recorded 8.26 and 16.06 leaves per plant. The addition of various organic fertilizers along with NPK greatly increased the leaf length of the carrot. The results related to the combined effect of organic fertilizers along with NPK on the leaf length are shown

in Table 1). Among the treatments, the longest leaves (38.17 and 36.77 cm) were produced by the combination of NPK + PM, followed by NPK + GM (35.17 and 36.50 cm) and NPK + SS (34.13 cm). Significantly shortest leaves (17.33 and 15.70 cm) were found in control treatment, during two years of experimentation. The results of this experiment are also supported by numerous references already cited in literature (Singh *et al.*, 2007, Singh *et al.*, 2020 and Sunandarani and Mallareddy, 2007). Data pertaining to weight of carrot leaves (Table 1) expressed significant variations by comparing organic manures, as well as comparison over control for two succeeding years. During 1st year, highest and statistically leaf weight per plant (25.00g) was recorded with T_3, which remained on par with only T_4 (24.33 g) only. During second year significantly higher leaf weight per plant (23.67 g) was recorded in T_4, which remained on par with T_3 (23.00 g) and T6 (22.67g). The significantly lowest values of 9.0 and 7.67 gm were recorded with T_1 during first and second year respectively. It can be concluded from the results that the application of organic manures in combination with NPK substantially increased the weight of carrot leaves. The combined introduction of manures along with NPK raised the leaf weight 163.7% to 226.1% over control in the first year, while the same was 144.4% to 162.9% in the next year, higher in NPK + PM (first year) and NPK + GM (second year), while during both years the minimum increase was noted NPK + PrM. This might be attributed to the combination of inorganic and organic fertilizers that decreased the loss of nutrients. The proper use of the integrated manures and fertilizers increased the leaf weight by providing higher rate of nutrients availability (Toor *et al*., 2020).

The different treatments significantly influenced root length, root diameter, root weight, biomass weight and root yield (Table 2). Application of poultry manure (PM) in addition to NPK produced significantly higher values for root length (29.30 and 24.83 cm), which

Table 1 : Effect of NPK and organics manures on leaf characters in carrot in response of NPK and organic manures

Treatment	No. of leaves per plant		Leaf length (cm)		Leaf weight (g per plant)	
	I year	II Year	I year	II Year	I year	II Year
T_1	4.53	3.27	17.33	15.70	9.00	7.67
T_2	7.73	7.27	33.87	32.73	22.33	21.33
T_3	8.73	8.13	38.17	36.77	25.00	23.00
T_4	8.17	7.60	36.50	35.17	24.33	23.67
T_5	7.60	7.07	32.70	32.17	22.00	20.22
T_6	7.83	7.33	34.77	34.13	23.00	22.67
LSD (0.05)	0.239	0.289	0.670	1.013	0.878	1.434

Table 2 : Effect of NPK and organics manures on root characters and yield

Treatment	Root length (cm)		Root diameter (cm)		Root weight (g/plant)		Biomass weight (g/plant)		Root yield (t/ha)	
	I year	II Year	I year	II Year	Iyear	II Year	Iyear	II Year	I year	II Year
T_1	12.03	10.80	1.43	1.22	47.33	38.33	56.33	46.00	18.93	15.33
T_2	22.00	19.57	2.79	2.50	128.00	114.33	150.33	135.63	51.04	45.73
T_3	29.30	24.83	3.27	3.10	142.40	142.00	169.33	166.67	56.83	56.67
T_4	26.03	23.87	2.93	2.90	141.33	136.67	166.0	160.00	55.15	51.75
T_5	23.77	20.73	2.80	2.67	128.67	120.33	150.73	140.57	53.83	45.90
T_6	25.17	21.83	2.83	2.73	130.33	129.37	153.0	152.33	54.37	48.83
LSD (0.05)	1.829	1.157	0.133	0.176	5.116	4.598	2.876	4.608	1.301	1.936

remained on par with only T_4 during the second year of experimentation. Among different organic fertilizers, poorest results (22.00 and 19.57 cm root length) were recorded in NPK + FYM. However, the shortest roots (10.80 cm and 12.03 cm) were found in control treatment. The current study revealed that the use of organic manure in conjunction with NPK significantly enlarged carrot roots, thereby advocating positive impact on root growth from the combined use of manures and fertilizers. These results are supported by previously work done in literature (Sunandarani and Mallareddy, 2007)

Root length and diameter greatly contributes to carrot weight and yield. Amongst different organic manures applied in addition to NPK, poultry manure (PM) superseded other treatments by producing maximum root diameter (3.27 and 3.10 cm), respectively for two successive years. It was followed by NPK + GM (2.93 and 2.90 cm) and NPK + SS (2.83 and 2.73 cm) respectively for two years. The lowest root diameter (1.43 and 1.22 cm) was recorded in control treatment. The study showed that the combined use of organic manures together with NPK substantially increased the carrot root diameter. Addition of PM proved superior amongst treatments,while FYM was least effective that might be due to lower nutrient concentrations in FYM as well as its slow release and delayed decomposition. From the obtained results it was concluded that the integrated nutrients increased the root diameter (Toor *et al*., 2020).

Maximum root weight per plant (142.4 and 142.0 g) was recorded in combined application of NPK and PM, which was followed by NPK + GM (141.33 and 136.68 g) for two years. Addition of FYM along with NPK resulted in poor root weight (128.00 and 114.33 g) during both the cropping seasons. However, control treatment, where no fertilizers (chemical + organic) were mixed into the soil showed lowest root weight per plant (47.33 and 38.33 g), respectively for two consecutive years. The results of this study showed that the combined use of organic and mineral fertilizers substantially increased the root weight of carrot, which might be attributed to the well solubilization of plant food, contributing to the increased nutrient uptake. These results suggested that combination of organic manures and mineral fertilizers with appropriate ratios can significantly increase the root weight (Vijayaprabhakar *et al*., 2020).

Perusal of data presented in Table 2 indicated that biomass of carrot plants was significantly affected by integrated use of NPK and organic manures, during both the years. Amongst different treatments, significantly higher biomass per plant (169.33 and 166.67g) was recorded in plants amended with NPK + PM than other treatments during two years of cropping. It was followed by the combined use of NPK with GM (166.00 and 160.00 g) and SS (153.0 and 152.33 g). The lowest biomass weight (56.33 and 46.00g) was recorded in control treatment. The results revealed that the effectiveness of NPK supplied with PM and GM was remarkable, suggesting that these organic sources provided more nutrients to plants. These results are in the agreement with previously report literature (Singh *et al.*, 2020).

Considerable variations existed in carrot root yield due to combined application of inorganic and organic fertilizers, for two years study (Table 2). Application of NPK + PM recorded significantly higher root yield (56.83 and 56.67 t/ha) than all the treatments in both the years. It was followed by NPK + GM (55.15 and 51.75 t/ha) and NPK + SS (54.3 and 48.83 t/ha). Among integrated treatments, NPK + FYM produced statistically lowest yield (51.04 and 47.73 t/ ha), respectively during both the experimental years. Combination of organic and inorganic treatments recorded the higher yield to the tune of 170-200 and 198-269 per cent than the control treatment during both the years. The study exposed that amongst various combinations, NPK + PM surpassed rest of the treatments in enhancing root yield. The NPK incorporation with manures significantly increased the root yield, which might be attributed to the plant nutrient solubilization leading to increased macro and micronutrients uptake. The advantage of the use of mixture of organic and mineral fertilizers is it increase the efficiency of the fertilizers, minimized the nutrient loss and enhanced the yield of carrot (Vijayaprabhakar *et al*., 2020).

CONCLUSION

It is concluded that collective application of NPK and organic manures has significantly improved vegetative growth and yield of carrot, as compared to control. Integration of NPK and poultry manure (both at recommended levels) has out yielded all other combinations and control in almost all parameters. Hence, for getting more root yield of

carrot, poultry manure must be incorporated into the soil in addition to NPK. Moreover, use of goat manure along with NPK is also a viable combination for getting higher root yield of carrot.

REFERENCES

Ameen, A. 2020. Comparison of crop production efficiency of compost leachate with chemical fertilizer and evaluating its effect on germination and growth of wheat crop. *Afr. J. Biotechnol.*, **19**(5): 282-286.

Amjad, M., Ahmad,T., Iqbal, Q., Nawaz, A. and Jahangir, M.M. 2013. Herbicide contamination in carrot grown in Punjab, Pakistan. *Pak. J. Agric. Sci.* **50**(1): 1-4.

Cho, Y., Kim, B., Lee, J. and Kim, S. 2021. Construction of a high-resolution linkage map and chromosomal localization of the loci determining major qualitative traits in onion (*Allium cepa* L.). *Euphytica*, **217**(1): 1-12.

Fallah, S., Mouguee, S., Rostaei, M., Adavi, Z., Lorigooini, Z. and Shahbazi, E.2020. Productivity and essential oil quality of *Dracocephalum kotschyi* under organic and chemical fertilization conditions. *J. Clean. Prod.*, **255**: 120189.

Goel, R., Debbarma, P., Kumari, P., Suyal, D.C., Kumar, S. and Mahapatra, B.S., 2021. Assessment of soil chemical quality, soil microbial population and plant growth parameters under organic and conventional rice–wheat cropping system. *Agric. Res.*, **10**(2)**:** pp.193-204.

Hafez,M., Popov, A.I. and Rashad, M.2020.Integrated use of bio-organic fertilizers for enhancing soil fertility–plant nutrition, germination status and initial growth of corn (*Zea mays* L.). *Environ. Technol. Innov.*, **21**: 101329.

Hammad, H.M., Khaliq, A., Abbas, F., Farhad, W., Fahad, S., Aslam, M., Shah, G.M., Nasim, W., Mubeen, M. and Bakhat,H.F.2020. Comparative effects of organic and inorganic fertilizers on soil organic carbon and wheat productivity under arid region. *Commun. Soil Sci. Plant Anal.***, 51**(10): 1406-1422.

Karmakar, S., Bhattacharyya, A., Ghosh, B., Roy, R., Kumar, S., Kar, B. and Saha, G. 2020.Suitability of coupling application of organic and inorganic fertilizers for crop cultivation. Ecological and Practical Applications for Sustainable Agriculture, Springer, pp. 149-177.

Khomich, L., Perova, I., and Eller, K.2020.Carrot juice nutritional profile. *Vopr. Pitan.*, **89**(1): 86-95.

Kirad, K., Swati, B. and Singh, D.2010. Integrated nutrient management on growth, yield and quality of carrot. *Karnataka Journal of Agricultural Sciences*, **23**(3): 542-543.

Kushwah, G., Sharma, R., Kushwah, S. and Mishra,S. 2019. Effect of organic manures, inorganic fertilizers and varieties on growth, yield and quality of tropical carrot. *Indian J. Hortic.,* **76**(3): 451-456.

Nagraj, G.S., Jaiswal, S., Harper, N. and Jaiswa,A.K. 2020. Carrot, In: Nutritional Composition and Antioxidant Properties of Fruits and Vegetables. p.323-337.

Nisar, F., Mufti, S., Afroza, B., Khan, F., Din, S., Andrabi, N., Saleem, S., Shah, L.R. and Nabi, J. 2019.Effect of integrated nutrient management on growth and yield attributes of black carrot (*Daucus carota* subsp. *sativus* var. *atrorubens* Alef.), Indian J. Chem. Stud., **7**(4): 2019-2022

Noor, A. Ziaf, K., Ghani, M.A., Ayub, C.M, Ahmad, I. and Amjad, M. 2020. Plant spacing effects on seed yield and quality of carrot cultivar T-29. *Pure Appl. Biol.*, **9**(4): 2563-2570.

Pandey, M., Shrestha, J., Subedi, S. and Shah, K.K. 2020. Role of nutrients in wheat: A review, *Trop. Agrobiodiversity*, **1**(1):18-23.

Rahman, N., Uddin, M.B., Quader, M.F.B and Bakar, M.A. 2020.Optimization of mixed peels from banana, carrot and apple to develop high fiber biscuit. *Int. J. Nat. Soc. Sci.*, **7**(1): 21-5.

Sikora, J., Niemiec, M., Tabak, M., Gródek-Szostak, Z., Szeląg-Sikora,. Kuboń, A., M and Komorowska, M. 2020. Assessment of the efficiency of nitrogen slow-release fertilizers in integrated production of carrot depending on fertilization strategy. *Sustainability*, **12**(5):1982.

Silveira, M.L. and Kohmann, M.M. 2020. Maintaining soil fertility and health for sustainable pastures. In: Management Strategies for Sustainable Cattle Production in Southern Pastures, Elsevier, pp. 35-58.

Singh, B., Singh, A., Singh, T. and Singh, N. 2007. Integrated nutrient management in carrot (*Daucus carota* L.). *Progress. Agric.*, **7**(1&2): 84-86.

Singh, S., Patel, C.R. and K. Paikra. K. 2020. Integrated Nutrient Management: An Effective Approach for Sustainable Agriculture in Chhattisgarh: A Review, *Int. J. Curr. Microbiol. App. Sci.*, **9**(5):1652-1662.

Sunandarani, N. and Mallareddy, K.2007. Effect of different organic manures and inorganic fertilizers on growth, yield and quality of carrot (*Daucus carota* L.). *Karnataka J. Agril. Sci.*, **20**(3): 686.

Toor, M.D., Amin, M.M., Khan, B.A., Nadeem, M.A.,Usman, M., Faizan, M., Arshad, A., and Zafar, K. 2020. Consequence of surplus fertilizers and nutrients: a review on effect on plants and humans, *Int. J. Bot. Stud.,* **5**(3): 360-364.

Vijayaprabhakar, A., Hemalatha, M. and Joseph, M. 2020. Utilization of paddy straw as a source of nutrients for succeeding paddy and its effect on soil available nutrients, nutrient uptake and crop yield. *Int. J. Farm Sci.*, **10**(1): 53-58.

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