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Response of Carrot (*Daucus carota* L.) Growth and Yields to Organic Manure and Inorganic Fertilizers

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Abstract: Pot experiments were conducted to observe the effect of different organic manures and NPK fertilizers on growth and yield of carrot at Faculty of Agriculture, Gomal University, D. I. Khan, during 2011-12 and 2012-13. These experiments were laid out in complete randomized design (CRD) with seven treatments and each treatment was replicated five times. The treatments under study were control, FYM @ 30 t ha^{-1}, poultry manure @ 10 t ha^{-1}, goat manure @ 15 t ha^{-1}, pressmud @ 20 t ha^{-1}, sewage sludge @ 20 t ha^{-1} and NPK @ 100-100-125 kg ha^{-1}. Data on leaves plant $^{-1}$, leaf length (cm), leaves weight plant^{-1}, root length (cm), root diameter (cm), root weight plant^{-1}, biomass weight plant^{-1} and root yield (t ha^{-1}) were taken and analyzed statistically. The results revealed that all growth and yield parameters were significantly improved by applying organic manures and NPK. The highest values for all attributes were recorded in NPK treated plants as it produced maximum leaves plant^{-1} (6.87 & 6.07), leaf length (29.47 & 30.17 cm), leaves weight plant^{-1} (15.00 & 14.67 g), root length (18.47 & 17.60 cm), root diameter (2.37 & 2.10 cm), root weight plant^{-1}(99.33 & 114.33 g), biomass weight plant^{-1} (114.33 & 129.33 g) and root yield (34.73 & 40.73 t ha^{-1}) during both years, respectively. Amongst the manures, poultry manure (PM) and goat manure (GM) showed far more better results for carrot growth and yield parameters, followed by sewage sludge (SS) and pressmud (PrM) and FYM, respectively.

Key words: Carrot · Farm yard manure · Press mud · Sewage sludge · Growth parameters

INTRODUCTION

Carrot (*Daucus carota* L) belongs to the Umbeliferae family and is one of the major root vegetable used as salad and cooked vegetable, which is a rich source of beta carotene [1]. Carrots are becoming more popular as they contain a high amount of beta carotene; a precursor to vitamin A which prevents infection, some forms of cancer and improves vision. They also contain vitamin C, thiamin B_1 and riboflavin B_2 [2].

In Pakistan, it occupied an area of 14,515 ha with annual production of 2,51,054 tones and average yield of 17.29 t ha^{-1}during 2013-14, while in KPK province; it was cultivated over an area of 535 ha with total production of 6,908 tones and average yield of 12.91 t ha^{-1}[3]. The average yield of carrot in Pakistan and particularly in KPK province is quite low compared to the average yields 24.30 and 26.74 t ha^{-1}of Asia and world respectively [4].

Carrot production in Pakistan is quite low as our farmers are not interested in its cultivation, due to low sale price and lower yields. Many factors are responsible for its low production, but the non-availability of nutrients in the soil is one of the basic constraints. Our soils are low in fertility and thus to get better production, it is the basic requirement to enrich our soils with the nutrients to fulfill the requirements of the crops for their better growth and yield. Balanced fertilization is one of the most important factors in maximizing the yield potential of various crops. The nutrients are either added to the soil by using chemical fertilizers or by incorporating natural organic manures. The use of mineral fertilizers is the quickest way of increasing crop production; almost 30 to 70% increase in yields of crops has been achieved through the use of optimum and balanced mineral fertilizers [5]. High output from limited resources and intensive farming results in the accelerated use of chemical fertilizers, which pose certain threats to the environment and to humans [6]. Limitations in the food supply for an ever-increasing population is a major challenge for agricultural researchers [7]. In the recent past, intensive use of chemical fertilizer was one of

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the most suitable tools for getting a higher yield for food security. To get a high yield by limiting the use of chemical fertilizers and supplementing them with organic-based fertilizers is a new concept for sustainable agriculture. Now, the growers are showing interest in utilizing organic manures, primarily due to the exorbitant price of imported chemical fertilizers and their freely availability. Organic wastes serve not only as a source of plant nutrients but also in restoring soil fertility and soil quality, thereby improving the chemical, physical and biological properties of soil [8]. A major component of organic production is providing organic sources of nutrients to promote plant growth as well as sustain soil quality [9]. Several workers have documented positive effects of organic manures as Maerere *et al*. [10], Ojeniyi *et al*. [11] and Akanni and Ojeniyi [12] reported significant improvement in the production of amaranths and tomato by sole application of poultry manure and goat manure, respectively. Mohammad and Athamneh [13] found that addition of 40 t ha^{-1}sewage sludge increased lettuce growth. Scott *et al*. [14] reported increased growth and yield of carrot by the application of Sewage Sludge. Partha and Sivasubramanian [15] mentioned that pressmud can be used as source of fertilizer for better production of crops. Baloch *et al*. [16] recorded highest carrot yield (29.7 t ha^{-1}) with high levels of NPK *viz* 100kg N, 100 kg P and 125 kg K ha^{-1}. Cheuk *et al*. [17] investigated the effect of waste management on vegetables and found that application of agricultural wasted increased the yields of tomato and pepper up to 10%. Khan and Khan [18] produced the highest yield (12.00 t ha^{-1}) by using NPK (120-90-60kg ha^{-1}) in carrot. Keeping in view, the importance of organic and inorganic nutrients for the better production of carrot, the present work was undertaken to study the effect of recommended rates of different organic manures including farm yard manure, poultry manure, goat manure, press mud and sewage sludge and inorganic fertilizers (NPK) on the yield and yield contributing traits of carrot.

MATERIALS AND METHODS

Pot experiments were conducted to check the growth and yield of carrot against the application of recommended rates of different organic manures, at Horticulture Department, Gomal University, D. I. Khan, during 2011-12 and 2012-13. Two year experiments were laid out in complete randomized design (CRD) with seven treatments and each treatment was repeated five times. The treatments included Control (with no fertilizer added), Farm yard manure (FYM @ 30 t ha^{-1}), Poultry manure (PM @ 10 t ha^{-1}), Goat manure (GM @ 15 t ha^{-1}), Press mud (PrM @ 20 t ha^{-1}), Sewage Sludge (SS @ 20 t ha^{-1}) and NPK @ 100-100-125 kg ha^{-1}. All pots were filled with equal and uniform amount (20 kg) of river soil along with the calculated amount of pre assigned organic manure (FYM @ 300 g pot^{-1}, PM @ 100 g $pot^{-1,}$ GM @ 150 g pot^{-1}, PrM @ 200 g $pot^{-1}$and SS @ 200g pot^{-1})and fertilizer viz NPK (2.609 g urea+3.421 g SSP+2.00 g SOP pot^{-1}). A set of pots without any additives (manures and fertilizers) served as control. The required amount of manures were applied well before sowing of seeds (10 days), mineral fertilizers (Phosphorus and Potash) were applied in the form of single super phosphate (SSP) and sulphate of potach (SOP), respectively, at the time of sowing, whereas Nitrogen was applied in the form of Urea in two split doses, firstly at the time of seed sowing and secondly after one month of seed sowing. Five seeds of carrot (local variety) were sown in the second week of October, in the pot (35 cm diameter) and then were thinned to two plants at equidistance to avoid plant competition. Pots were irrigated manually and all the cultural practices were conducted as usual. Data regarding leaves $plant^{-1}$, leaf length (cm), leaves weight $plant^{-1}$(g), root length (cm), root diameter (cm), root weight $plant^{-1}$(g), biomass weight $plant^{-1}$(g) and root yield (t ha^{-1}) were taken and analyzed statistically by computing Analysis and Variance and LSD using data across two years through MSTATC computer program.

RESULTS AND DISCUSSIONS

Number of Leaves $plant^{-1}$: Number of leaves $plant^{-1}$ was significantly affected by applying organic manures and fertilizers, during both years. During 2011-12, significantly the highest number of leaves $plant^{-1}$ (6.87) was found in plants receiving 100% RDF, which was significantly different from all other treatments (Table 1). Among manures, PM excelled in enhancing leaves number of carrot plants (5.67) that varied significantly from all other manures. It was followed by GM, FYM and SS and PrM by producing 5.47, 5.40 and 5.36 leaves $plant^{-1}$. The plants from control pots recorded statistically the least number of leaves $plant^{-1}$ (4.53). During 2012-13, significantly the highest number of leaves plant (6.07) was recorded in RDF amended plants followed by PM, GM and SS but all the three treatments differed significantly. The number of leaves plant in FYM treated plants was similar to T_6 but varied significantly from PrM and control.

Table 1: Leaves plant^{-1}, leaf length (cm) and leaf weight plant^{-1} of carrot as affected by applying recommended doses of different organic manures and inorganic fertilizers, for two consecutive years.

	Leaves plant $^{-1}$		Leaf length (cm)		Leaf weight plant $^{-1}$	
Treatments	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Control	4.53 e	3.27 f	17.33 e	15.700 e	7.67 d	9.00 e
FYM @ 30 t ha^{-1}	5.40 c	4.67 d	20.17 c	19.60 c	9.00 c	10.40 cd
PM @ 10 t ha^{-1}	5.67 b	4.97 b	25.30 b	21.17 b	11.00 b	11.33 b
GM @ 15 t ha^{-1}	5.47 c	4.80 c	25.10 b	20.27 c	10.67 b	11.00 be
PrM @ 20 t ha^{-1}	4.90 de	4.03 e	18.80 d	18.73 d	8.33 cd	10.03 d
SS @ 20 t ha^{-1}	5.36 c	4.67 d	20.97 c	20.07 c	10.67 b	11.00 be
NPK @ 100-100-125 kgha^{-1}	6.87 a	6.07 a	29.47 a	30.17 a	15.00 a	14.67 a
LSD @ P0.05	0.120	0.109	0.833	0.840	0.977	0.918

Means followed by similar letter(s) do not differ significantly at 5% level of significance

The results indicated that incorporation of full dose of manures as well as NPK supplied the macro and micro nutrients to plants, which resulted in additional leaves production. Commercial fertilizers were more productive due to easily available nutrients as compared to organic manures. However, manured plants were also superior to control. The increment in number of leaves plant^{-1}due to sole application of NPK, FYM, GM, GM, PrM and SS was 51.5%, 19.1%, 25.0%, 20.6%, 8.1% and 18.2%, respectively compared to control in 2011-12 crop, whereas in 2012-13 produce, the increase was 85.7%, 42.9%, 52.0%, 46.9%, 23.4% and 42.9%, respectively. The number of leaves plant^{-1} varied from 4.53-6.87 during 2011-12 while 3.27 to 6.07 during 2012-13. However, Kirad *et al*. [19] recorded 8.26-16.06 leaves plant^{-1} in carrots. The difference may be due to difference in cultivars and nature of tested organic manures. Likewise, Azad [20] investigated the effect of organic manures supplemented with chemical fertilizer and recorded higher number of leaves plant^{+} .

Leaf Length (cm): Application of full doses of organic manures and commercial fertilizers alone significantly enhanced the length of leaves of carrot (Table 1). The significantly highest leaf length of 29.47 and 30.17 cm was recorded in (100% RDF) in 1st and 2012-13, respectively that differed significantly from all other treatments. In both years, PM ranked first in increasing the length of leaves amongst manures by producing 25.30 and 21.17 cm long leaves. It was preceded by GM with 25.10 and 20.27 cm long leaves and was statistically identical to PM during 2011-12 but varied significantly during 2012-13. The FYM and SS amended plants proved significantly similar in enlarging leaves during both years while PrM treated plants produced shortest leaves during both years among fertilized treatments. The shortest leaves of 17.33 and 15.70 cm were found in control plants in 2011-12 and 2012-13, respectively. The results revealed that like other parameters, leaf length of carrot was considerably increased with the incorporation of full dose of manures and NPK. During 2011-12, the sole use of NPK as well as organic manures increased leaf length by 70.0%, 16.4%, 46.0%, 44.8%, 8.5% and 21.0% over control with NPK, FYM, PM, GM, PrM and SS, respectively, while the enhancement during 2012-13 was 92.1%, 24.8%, 34.8%, 29.1%, 6.6% and 27.8%, respectively. These results correspond to the findings reported by Kumar [21], Khan and Khan [18], Kirad *et al*. [19], Rani and Reddy [22] and Azad [20], who observed significant variation in length of leaves with the application of chemical fertilizers and organic manures.

Leaves Weight Plant^{-1} (g): The statistical analysis of two years data regarding weight of leaves plant^{-1} showed that significant variations existed among sole application of RD of organic manures and RDF (Table 1). The significantly highest leaves weight plant^{-1} of 15.00 and 14.67 g was recorded in (RDF) during 1st and 2012-13, respectively that varied significantly from all other treatments. It was followed by PM, GM and SS with leaves weight of 11.00, 10.67 and 10.67 g plant^{-1} and were statistically identical during 2011-12. These were followed by statistically similar FYM and PrM with 9.00 and 8.33 g leaves weight plant^{-1}, respectively. The minimum leaves weight plant^{-1}was recorded in control which was also significantly at par with T_5. During 2012-13, (RDF) was succeeded by PM (11.33 g), GM (11.00 g) and SS (11.00 g) which possessed statistically similar leaves weight plant^{-1}. GM and SS were also significantly identical to

FYM (10.40 g) which in turn was at par with PrM (10.00 g). The lowest leaves weight plant^{-1}(9.00 g) was found in control that differed significantly from all other treatments. It can be inferred from the data that sole application of 100% RD of organic manures and 100% RDF of inorganic fertilizers (NPK) significantly improved the weight of leaves plant^{-1} of carrots during both years of study. This may due to provision of macro and micro nutrients released from organic manures and chemical fertilizers. The sole application of FYM, PM, GM, PrM, SS and NPK increased leaves weight by 13.4%, 43.5%, 39.1%, 8.7%, 39.1% and 95.6%, respectively during 2011-12 and 15.6%, 25.9%, 22.2%, 11.4%, 22.2% and 62.9% during 2012-13. The variation in weight of leaves plant^{-1}due to application of different manures can be attributed to the fact that manures differed in nutrients contents and in efficiency of boosting leaf weight. Similar findings were reported by Tennakoon and Bandara [23] and Lester [24], who indicated that animal manures possess variable quantities of macro and micronutrients. Likewise, significant effects of PrM have been observed on sugarcane by Solaimalai *et al*. [25] and Narwal *et al*. [26], while Khan and Khan [18]. Significant effects of SS on carrots and lettuce growth was also reported by Mohammad and Athamneh [13]. Similarly, the improvement in growth parameters of carrots has been registered with the application of NPK by Baloch *et al*. [16].

Root Length (cm): The length of root is an important parameter contributing to yield of root vegetables. Significant variations existed in root length due to sole application of 100% recommended dose of organic manures and 100% RDF (Table 2). The longest roots (18.47 and 17.60 cm) were registered in plants amended with 100% RDF that varied significantly from all other treatments during both years. Amongst manures, PM surpassed all others by enlarging the roots of carrot (15.20 and 13.63 cm), followed by GM, SS, PrM and FYM, which produced 14.67, 14.67, 14.57 and 13.20 cm long roots during 2011-12 and 13.60, 12.73, 11.97 and 11.60 cm long roots during 2012-13, respectively. In 2011-12, PM, GM, SS and PrM were statistically akin, while in 2012-13, PM and GM was significantly similar but varied from SS, PrM and FYM. The shortest roots (12.03 and 10.80 cm) were recorded in control plants, which differed significantly from all other treatments during both years. The results revealed that sole application of 100% RD of organic manures and 100% RDF considerably promoted root length of carrot, advocating positive effect of manures and fertilizers. The response of 100% RDF (NPK) was more pronounced than 100% RD of organic manures, which may be due to readily available nutrients as compared to slow release of nutrients from organic manures. The sole application of manures increased 9.7%, 26.3%, 21.9%, 21.0% and 22.0% root length with FYM, PM, GM, PrM and SS, respectively over control during 2011-12, whereas the increase in root length was 7.4%, 26.2%, 25.9%, 10.8% and 17.9% in 2012-13 crop. However, the enhancement with application of full dose of NPK (100% RDF) was 53.5% and 63.0% during 1st and 2012-13 respectively. These results are in agreement with the findings of Baloch *et al*. [16], Khan and Khan [18] and Mohammad and Athamneh [13], who reported remarkable increase in root length due to application of recommended doses of NPK and manures.

Root Diameter (cm): The diameter and length of roots contribute considerably towards weight and finally yield of carrot. The data indicated that root diameter of carrot was significantly affected by applying full recommended dose of different organic manures and full RDF (Table 2). During both years, the significantly highest root diameter (2.37 and 2.10 cm) was recorded in plants amended with RDF that differed significantly from all other treatments. Among manures, PM surpassed all others with 2.01 and 1.63 cm root diameter succeeded by GM and SS and all three treatments were statistically at par. Similarly, PrM and FYM treated plants possessed statistically similar root diameter. The plants from check pots contained the lowest root diameter of 1.43 and 1.22 cm in 1st and 2012-13 crop, respectively. Application of RDF, FYM, PM, GM, PrM and SS enhanced root girth by 65.1%, 21.1%, 40.0%, 34.9%, 25.6% and 34.0% as compared to control during 2011-12, while the increase was 71.7%, 14.4%, 33.5%, 28.0%, 19.9% and 25.4%, respectively in 2012-13. The results suggested that root diameter of carrot was significantly enhanced by full dose of organic manures and full chemical fertilizers. Chemical fertilizers were more effective as compared to organic manures. Among manures, PM proved superior followed by GM, SS and PrM while FYM was least effective. It may be due to low nutrient contents and their slow release, probably for delayed decomposition. The results are in agreement with the findings of Rani and Reddy [22], Kirad *et al*. [19] and Azad [20], who recorded significant enhancement in root diameter with integrated use of organic manures, inorganic and bio-fertilizers.

Table 2: Root length (cm), root diameter (cm) and root weight plant^{-1} (g) of carrot as affected by applying recommended doses of different organic manures and inorganic fertilizers, for two consecutive years.

	Root length (cm)		Root diameter (cm)		Root weight plant $^{-1}$ (g)	
Treatments	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Control	12.03 d	10.80 f	1.43 d	1.22 e	38.33 e	47.33 d
FYM @ 30 t ha^{-1}	13.20 c	11.60 e	1.74 c	1.40 d	56.00 d	74.00 c
PM @ 10 t ha^{-1}	15.20 b	13.63 b	2.01 b	1.63 b	74.33 b	85.00 b
GM @ 15 t ha^{-1}	14.67 b	13.60 b	1.93 b	1.57 be	72.00 b	84.33 b
PrM @ 20 t ha^{-1}	14.57 b	11.97 d	1.80 c	1.47 cd	62.33 c	74.66 c
SS @ 20 t ha^{-1}	14.67 b	12.73 c	1.92 b	1.53 bcd	6367 c	75.67 c
NPK @ 100-100-125 kg ha^{-1}	18.47 a	17.60 a	2.37 a	2.10 a	99.33 a	114.33 a
LSD @ P0.05	1.042	0.245	1.43 d	1.22 e	2.708	1.996

Means followed by similar letter(s) do not differ significantly at 5% level of significance

Root Weight Plant^{-1}(g): Root weight is an important parameter contributing to yield of root vegetables. The data regarding root weight plant^{-1}of carrot as affected by sole application of full dose of mineral fertilizers (NPK) and different organic manures during two years study are illustrated in (Table 2) The results indicated significant differences among treatments. The maximum root weight plant^{-1} (99.33 and 114.33 g) during 1st and 2012-13 of study was recorded in T_7 (NPK @ 100-100-125 kg ha^{-1}) that differed significantly from all other treatments. It was followed by T_3 (PM @ 10 t ha^{-1}) and T_4 (GM @ 15 t ha^{-1}) with 74.33, 71.99 g, 84.33 g root weight plant^{-1}, respectively and both treatments were significantly at par. These were succeeded by SS @ 20 t ha^{-1}(T_6) and PrM @ 20 t ha^{-1} (T_5) which produced roots of statistically similar weights of 63.67 and 62.62 g during 2011-12 and 75.67 and 74.67 g in 2012-13, respectively. The application of FYM @ 30 t ha^{-} (T_2) gave carrots of 56.00 and 75.00 g root weight in 1st and 2012-13s which was significantly lowest among treatments in 2011-12 but was statistically identical to T_5 and T_6 in 2012-13. The significantly minimum root weight plant^{-1} (38.33 and 47.33 g) was recorded in carrots from control treatment, which varied significantly from all other treatments. The results suggested that application of manures and inorganic fertilizers (NPK) significantly increased root weight of carrots during both years of study. The sole application of full RDF of inorganic fertilizers performed better than sole application of full recommended doses (RD) of organic manures. This might be due to their increased and readily available nutrients which might have contributed to weight of roots. The increase in root weight due to sole application of organic manures and NPK compared to control was 46.1%, 93.9%, 87.9%, 63.4%, 66.1% and 159.1% in FYM, PM, GM, PrM, SS and NPK, respectively during 2011-12, while the increment in 2012-13, were 56.3%, 79.6%, 78.2%, 57.75%, 59.9% and 141.6%, respectively. The difference in root weight due to application of different manures implies that manures differed in nutrients contents and in their efficacy of enhancing root weight. The manure containing greater nutrients content resulted greater root weight. Among different manures, PM proved superior, followed by, GM, SS, PrM and FYM. These results collaborate with the findings of Tennakoon and Bandara [23], who found that animal manures have considerable amounts of plant nutrients. They reported that continual applications of these organic manures will not only supply plant nutrients but also enrich agricultural soils and suggested these organic manures as potential sources of fertilizers. Likewise, Lester [24] found that the organic nutrient sources can vary significantly in terms of nutrient availability. Matsumoto *et al*. [27] revealed that organic manures increased N uptake and yield of carrots. Solaimalai *et al*. [25] and Narwal *et al*. [26] indicated that press mud increased yield and quality of sugarcane. Baloch *et al*. [16] found significant increase in plant growth and yield of carrots with the application of higher dose of N than its lower dose. Whereas, positive effects of sewage sludge on the yield of carrots have been reported by where yield was increased with increasing SS levels, while Mohammad and Athamneh [13] recorded increased lettuce growth with addition of 40 t ha^{-1}sewage sludge.

Total Biomass Weight Plant^{-1} (g): The biomass weight plant^{-1} was significantly affected by exclusive use of organic manures as well as NPK during both study years (Table 3). During 2011-12, the significantly highest biomass plant^{-1} (114.33 g) was recorded in plants amended with RDF (T_7) that was succeeded by

Table 3: Total biomass weight plant^{-1} (g) and root yield (t ha^{-1}) of carrot as affected by applying recommended doses of different organic manures and inorganic fertilizers, for two consecutive years.

	Total biomass weight plant^{-1} (g)		Root yield (t ha^{-1})	
Treatments	2011-12	2012-13	2011-12	2012-13
Control	46.00 g	56.33 e	15.33 e	18.93 d
FYM @ 30 t ha^{-1}	65.00 f	84.40 d	22.40 d	29.60 c
PM @ 10 t ha^{-1}	85.33 b	96.33 b	29.73 b	33.93 b
GM @ 15 t ha^{-1}	82.67 c	95.33 b	28.80 b	33.73 b
PrM @ 20 t ha^{-1}	70.63 e	84.67 cd	24.93 c	29.74 c
SS @ 20 t ha^{-1}	74.33 d	86.67 c	25.47 c	30.39 c
NPK @ 100-100-125 kg ha^{-1}	114.33 a	129.33 a	34.73 a	40.73 a
LSD @ P0.05	2.622	2.240	1.537	1.246

Means followed by similar letter(s) do not differ significantly at 5% level of significance

T_3 (PM), T_4 (GM), T_6 (SS), T_5 (PrM) and T_2 (FYM) with biomass weight plant^{-1}of 85.33, 82.67, 74.33, 70.63 and 65.00 g, respectively. All the treatments varied significantly from each other. The significantly lowest biomass of 46.00 g plant^{-1} was found in control plant. In 2012-13, the highest biomass weight plant^{-1} (129.33 g) was reported in T_7 (RDF) that differed significantly from all other treatments. It was followed by T_3 (PM) and T_4 (GM) with statistically similar biomass of 96.33 and 95.33 g, respectively. The T_6 (SS) and T_5 (PrM) produced significantly identical biomass plant^{-1} of 86.67 and 84.67 g while T_5 and T_2 (FYM) were also statistically alike. The control plants possessed the minimum biomass (56.33 g) that varied statistically from all other treatments. The results suggested that incorporation of full dose of inorganic fertilizers (NPK) and organic manures considerably enhanced the biomass weight plant^{-1} of carrot. The effectiveness of NPK was obvious due to higher nutrients content and their readily availability. Poultry manure (PM) addition was remarkable among the manures. It was followed by GM, SS, PrM and FYM suggesting that PM and GM supplied more nutrients to crops, while FYM provided the least as PM and GM contained greater amount of N, P, K as compared to FYM. More over due to bulky and waxy nature of FYM, the availability of nutrients was slow and the short season crops cannot get full benefit from this organic source. Sewage Sludge and PrM also contained fair amount of N, P, K but the potential hazard of toxic metals in SS limits its use. The sole incorporation of FYM, PM, GM, PrM, SS and NPK increased 41.3%, 85.5%, 79.7%, 53.6%, 61.6% and 148.6% biomass plant^{-1} as against control plant during 2011-12 while increase was 49.8%, 71.0%, 69.2%, 50.3%, 53.8% and 138.11% during 2012-13. These results are supported by the finding of Tennakoon and Bandara [23], Lester [24], Solaimalai *et al*. [25], Narwal *et al*. [26], Khan and Khan [18] and Mohammad *et al*. [13], who reported variation in macro and micronutrients amongst organic manures, industrial and municipal wastes and their effects on growth and yields of crops. The enhancement in growth parameters of carrot with application of recommended doses of NPK has been an established [16].

Root Yield (t ha^{-1}): Considerable variations existed in root yield ha^{-1} of carrot due to sole application of 100% RD of organic manures and 100% RDF of inorganic fertilizers (NPK) during two years study (Table 3). The highest root yield of 34.73 and 40.72 t ha^{-1}were recorded in plants amended with NPK (T_7) in 1st and 2012-13 crops that differed significantly from all other treatments. It was followed by PM (29.73; 33.93 t ha^{-1}) and GM (28.80; 33.73 t ha^{-1}) and both treatments were significantly akin. Similarly SS (T_6) and PrM (T_5) also produced statistically identical root yields during both years. The root yield obtained from FYM (22.40 t ha^{-1}) differed significantly from SS and PrM during 2011-12 but was statistically identical during 2012-13 (29.60 t ha^{-1}). The lowest root yield (15.33; 18.93 t ha^{-1}) was noticed in control in both years. The results illustrated that root yield ha^{-1}was significantly enhanced by the sole use of 100% RD of organic and 100% RDF. The application of RDF, FYM, PM, GM, PrM and SS produced 126.5%, 46.1%, 93.9%, 87.8%, 62.6% and 66.1%, more root yield ha^{-1}respectively over control in 2011-12, whereas the increment during 2012-13, was 115.1%, 56.3%, 79.2%, 78.2%, 57.1% and 60.51%, respectively. The sole application 100% RDF performed better in improving carrot root yield. The PM surpassed all manures in enhancing root yield which was followed by GM. This might be due to steadily available nutrients in greater quantity as against organic sources. Analogous results have been reported by Tennakoon and

Bandara [23], Lester [24] who stated that the organic manures differ significantly in terms of nutrient availability [16] found significant increase in yield of carrot with the application of higher dose of N. Solaimalai *et al*. [25] and Narwal *et al*. [26] revealed that press mud increased yield of sugarcane while [18] reported enhanced yields of carrot with sewage sludge application.

CONCLUSION

It can be concluded that application of organic manures and inorganic fertilizers substantially increased all growth and yield parameters like leaves plant $^{-1}$, leaf length (cm), leaves weight plant^{-1}, root length (cm), root diameter (cm), root weight plant^{-1}, biomass weight plant^{-1} and root yield (t ha^{-1}) of carrot. The highest values for all the parameters under study were recorded with NPK, succeeded by poultry manure and goat manure which were almost statistically identical.

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