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EFFECT OF NPKS ON THE GROWTH AND YIELD OF CARROT

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ABSTRACT

An experiment was conducted at the Horticulture farm of Bangladesh Agricultural University, Mymensingh during the period from December, 2006 to March, 2007 to evaluate the effect of NPKS on the growth and yield of carrot. Various doses of NPKS viz. 0,59,78, and 98kg N; 0, 54, 72 and 90kg P; 0, 65, 87, and 109kg K and 0,10,14, and 18 kg S/ha and cow dung only (4t/ha) were tested in 15 treatment combinations. The experiment was laid out in Randomized Complete Block Design with three replications. The treatments had significant effect on plant height, number of leaves, fresh weight of leaves and roots, root length and root diameter, percent cracked root, branched root and rotten roots, gross yield and marketable yield of carrot. The maximum plant height, number of leaves, fresh weight of leaves and root per plant, root length and root diameter, cracked root and branched root were obtained from the $N_{98}P_{72}K_{87}S_{14}$Kg/ha treatment. The highest marketable yield (38.53/ha) resulting maximum economic return (Tk. 1,62,575/ha) with a benefit cost ratio of 4.29 was produced by $N_{98}P_{72}K_{87}S_{14}$Kg/ha while the lowest yield of carrot (19.40 t/ha) was obtained from the control treatment (no manure and fertilizer).

Key words: Nutrient, carrot, root yield, marketable yield.

Introduction

In carrot cultivation, fertilizer is the single most important factor that plays a crucial role in increasing growth and yield. The soil of Bangladesh is deficient in nitrogen, potassium and for which farmers are advised to use Urea, TSP, MOP and gypsum for the production of crops including carrot. Nitrogen (N) increases the vegetative growth produces good quality foliage and promotes carbohydrate synthesis (Rai,1981). Phosphorus (P) fertilizers stimulate the diameter growth of root and increase the rate of growth. The deficiency of phosphorus causes reduction in yield, with a concomitant increase in dry matter, sugar and carotene contents of roots (Mitra *et al*.,1990). All root crops respond to liberal applications of potassium (K). Potassium helps in the root development and increasing the efficiency of leaf in the manufacture of sugar and starch. It is essential for the translocation of sugar and it exerts a balancing role in the effect of both nitrogen and phosphorus. Consequently, it is especially important in a micronutrient fertilizer application (Brady, 1995). Sulphur (S) plays an important role for plant growth and is involved in the synthesis of amino acids, co-enzyme, thiamine and chlorophyll (Tisdale *et al*., 1984). Excessive or under dose of N, P, K and S can affect the growth and yield of good quality carrot. Excess of N tends to increase root splitting, which reduce the marketable yield (Orphanos and krentos, 1988). It is considered that doses of nitrogen, phosphorus and sulphur are four important fertilizer variables for carrot. There is sufficient scope for increasing the yield of this crop by judicious application of nitrogen, phosphorus, potassium and sulphur. Optimum requirement of nutrients especially N, P, K and S is obviously needed. An attempt was therefore made to study the effect of different levels of nitrogen, phosphorous, potassium and sulpher on the growth and yield of carrot. The production of carrot in Bangladesh is still in the hand of marginal farmers. Its production technology has not yet been standardized. Moreover, proper knowledge and information regarding the use of different doses of N, P, K, and S fertilizer in carrot production under Bangladesh condition is in adequate. Therefore, a detailed and systematic study is needed to find out the best combination of fertilizer dose for growth yield of carrot which will ultimately help in increasing production and economic return of carrot in Bangladesh. Under the above circumstances, the present study

was undertaken with the objectives of- i) to study the effect of different levels of NPKS on the growth and yield of carrot, ii) to find out the optimum dose of NPKS fertilizers; and iii) to determine the most economic dose of NPKS fertilizers for successful carrot production.

Materials and Methods

The present experiment was conducted at the Horticulture Farm and the laboratory, Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from December, 2006 to March, 2007 to evaluate the effect of different levels of NPKS on the growth and yield of carrot. The experiment consisted of four nutrient elements (NPKS) which were tested in 15 treatment combinations viz. i) No manure and fertilizer, ii) Cow dung only (4 t/ha), iii) N0P72K87S14 kg/ha, iv) N49P72K87S14 kg/ha, v) N78P72K87S14 kg/ha, vi) N98P72K87S14 kg/ha, vii) N78P0K87S14 kg/ha, viii) N78P54K87 S14 kg/ha, ix) N78P90K87S14 kg/ha, x) N78P72K0S14 kg/ha, xi) N78P72K65S14 kg/ha, xii) N78P72 K109S14 kg/ha, xiii) N78P72K87S0 kg/ha, xiv) N78P72K87S11 kg/ha, xv) N78P72K87S18 kg/ha. The single-factor experiment was set up in Randomized Complete Block Design (RCBD) with three replications. The size of each unit plot was 1.0 m × 1.0 m and the treatments were distributed randomly in each block. There were 40 plants in each unit plot maintaining a spacing of 25 cm × 10 cm. The seeds of carrot cv. New Kuroda, a Japanese variety were sown on 9 December and harvested on 14 March. Data were collected from 5 randomly selected plants of each unit plot. Data were collected on growth and yield parameters namely, plant height, leaf number, root length, root diameter, shoot fresh weight, shoot dry matter, root fresh weight, root dry matter, cracked root, branched root, rotten root and root yield per plot and recorded in ton (t/ha). The marketable yield of carrot per plot was calculated by subtracting the total amount of non-marketable yield (cracked root + branched root + rotten root) from the gross yield of roots per plot and was recorded as kilogram per plot as well as t/ha. The data obtained from the experiment on various parameters were statistically analyzed in MSTAT-C computer program. The mean values for all the parameters were calculated and the analysis of variance for the characters was accomplished by F variance test. The significance of difference between pair of means was tested by the least significant differences (LSD) test at 5% and 1% levels of probability (Gomez and Gomez, 1984). The cost of production was analyzed in order to find out the most profitable combination of the treatments. Economic analysis was done according to the procedure of Alam *et al.* (1989). All the non-material and material input costs and overhead cost were recorded for all the treatments and calculated per hectare basis. The price of carrot root (marketable yield) at farm gate was taken into consideration for economic analysis.

Results and Discussion

The results of the experiment showed that the different levels of NPKS had significant effect on all the parameters. The highest plant height and maximum number of leaves per plant were increased with increasing the amount of NPKS. Maximum plant height (43.53 cm per plant) and leaves (13.60 per plant) were observed in the treatment of N98P72K87S14 kg/ha which was significantly different from other treatments (Figs. 1-2). The minimum plant height (29.67 cm) and leaves per plant (7.80) were observed from control (no manure and fertilizer) treatment. Root length and diameter of carrot were found to be significant due to the application of different levels of NPKS. The highest root length and diameter (15.72 cm and 4.85 cm per plant, respectively) were recorded from N98P72K87S14 kg/ha while the lowest (7.13 cm and 2.7 cm per plant, respectively) were in the control (no manure and fertilizer) treatment. The fresh weight of shoot and root per plant was significantly influenced by the application of different levels of NPKS. The maximum shoot and root fresh weight per plant (83.53 g and 143.15 g, respectively) were found from N98P72K87S14 kg/ha treatment combination while the lowest fresh weight of leaves (51.45 g per plant) and root (95.34 g per plant) were observed in control (without fertilizer and manure) treatment. Application of NPKS had significant effect on shoot and root dry matter contents as shown in the Table 1. Lenka *et al.* (1990) and Balooch *et al.* (1993) also reported that application of NPK fertilizer increased the root length of carrot. Orphanos and Krentos (1988) reported that dry matter content of the root was not influenced by nitrogen fertilizer.

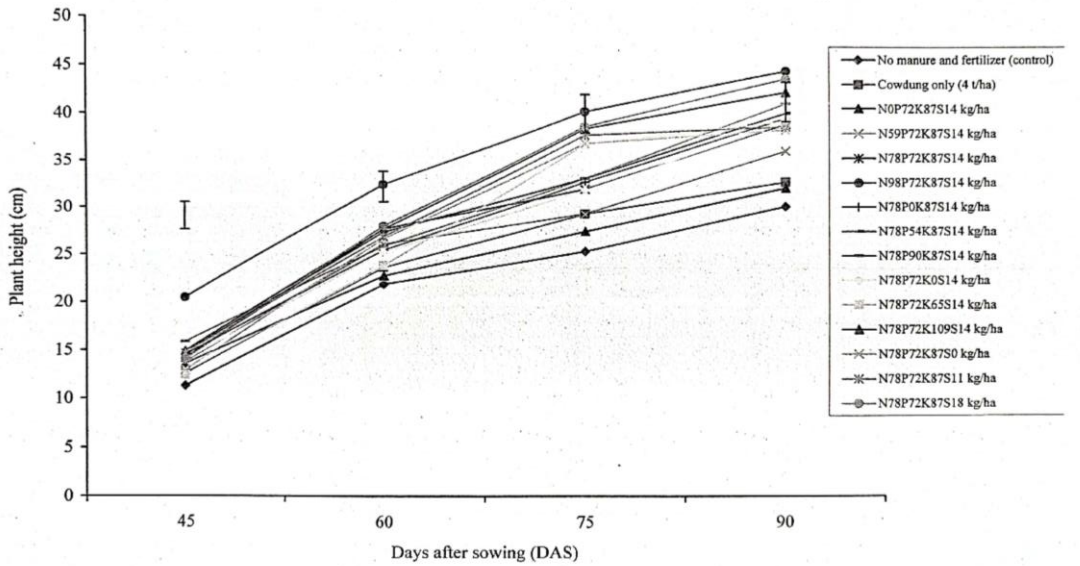

Fig. 1. Effect of NPKS treatments on plant height (cm) of carrot at different stages of plant growth . Vertical bars represent LSD value at 5% level of probability

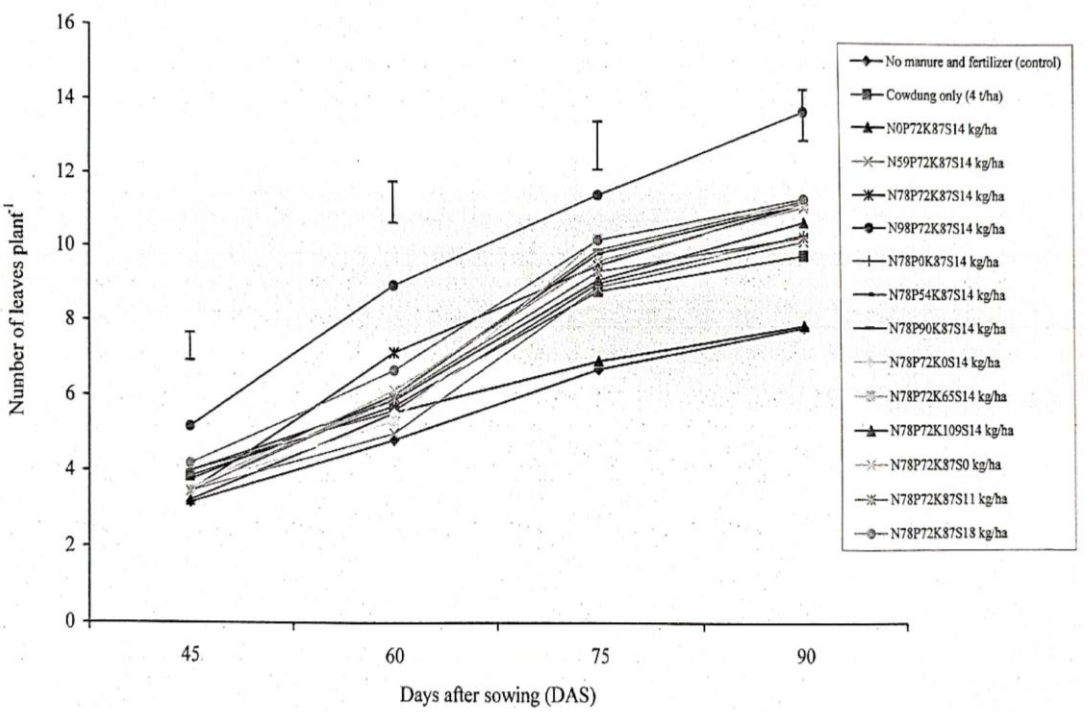

Fig. 2. Effect of NPKS treatments on number of leaves palnt^{-1} of carrot at different stages of plant growth. Vertical bars represent LSD value at 5% level of probability

Table 1. Effect of NPKS on growth and yield component of carrot

Treatment combination	Leaves fresh weight of plant^{-1} (g)	Length of root plant^{-1} (cm)	Diameter of root plant^{-1} (cm)	Root fresh weight of plant^{-1} (g)	Dry matter content of shoot (%)	Dry matter content of root (%)
No manure and fertilizer (control)	51.45	7.13	2.70	90.59	16.49	11.65
Cow dung only (4 t/ha)	60.03	8.51	2.91	108.20	14.48	9.91
N59P72K87S14 kg/ha	53.70	8.65	2.83	102.70	10.28	9.16
N98P72K87S14 kg/ha	70.48	10.29	3.13	127.36	14.40	9.40
N78P72K87S14 kg/ha	78.63	10.85	3.83	128.55	13.58	10.51
N98P72K87S14 kg/ha	83.53	15.73	4.85	143.15	10.07	9.04
N78P0K87S14 kg/ha	79.40	10.38	3.58	132.18	13.08	10.25
N78P54K87S14 kg/ha	73.26	10.55	3.84	131.47	13.77	10.03
N78P90K87S14 kg/ha	80.56	12.27	4.02	134.95	12.32	9.30
N78P72K0S14 kg/ha	76.37	8.31	2.70	106.19	10.87	10.18
N78P72K65S14 kg/ha	77.13	9.65	3.57	123.10	11.38	9.21
N78P72K109S14 kg/ha	80.26	14.78	4.77	141.34	13.21	10.49
N78P72K87S0 kg/ha	74.19	10.69	3.53	125.30	14.46	10.47
N78P72K87S11 kg/ha	66.33	11.94	3.82	128.98	13.89	9.94
N78P72K87S18 kg/ha	81.17	11.50	3.88	133.10	14.03	10.70
LSD 0.05	7.055	2.017	0.461	11.370	2.440	1.554
Level of significance	**	**	**	**	**	*

Table 2. Effect of NPKS on root characters and yield component of carrot

Treatment combination	% of cracked root	% of branched root	% of rotten root	Gross yield of root plot^{-1} (kg)	Marketable yield of root plot^{-1} (kg)
No manure and fertilizer (control)	0.83	0.83	0.00	2.03	1.94
Cow dung only (4 t/ha)	2.50	2.00	1.67	2.93	2.68
N59P72K87S14 kg/ha	1.67	1.67	3.33	3.14	2.85
N98P72K87S14 kg/ha	3.33	2.50	4.16	3.32	2.98
N78P72K87S14 kg/ha	3.33	5.00	3.33	3.48	3.10
N98P72K87S14 kg/ha	12.50	8.33	6.66	4.76	3.85
N78P0K87S14 kg/ha	4.16	3.33	2.50	3.89	3.51
N78P54K87S14 kg/ha	5.83	4.17	5.83	3.97	3.41
N78P90K87S14 kg/ha	5.00	5.83	5.00	4.25	3.58
N78P72K0S14 kg/ha	4.16	2.50	2.50	3.65	3.34
N78P72K65S14 kg/ha	5.66	4.17	4.16	3.91	3.52
N78P72K109S14 kg/ha	10.00	7.50	8.33	4.46	3.60
N78P72K87S0 kg/ha	4.00	3.33	3.33	3.32	2.93
N78P72K87S11 kg/ha	2.50	6.66	5.83	3.45	2.84
N78P72K87S18 kg/ha	8.3	5.00	7.50	4.10	3.38
LSD 0.05	0.610	0.451	0.419	0.264	0.445
Level of significance	0.823	0.610	0.566	0.357	0.601

** Significant at 0.01 level of probability, * Significant at 0.05 level of probability

The branched, cracked and rotten roots were significantly increased with the increase of NPKS at certain levels then decreased which also influenced the gross and the marketable yields of root significantly. Gross yield and marketable yield were significantly influenced due to the application of different levels of NPKS. Application of N98P72K87S14 kg/ha produced the highest gross (47.57 t/ha) and marketable (38.53 t/ha) yield of carrot, which was statistically different from the other treatments and the lowest gross (20.34 t/ha) and marketable (19.40 t/ha) yield were found in the control (no manure and fertilizer) treatment. Application of N78P90K87S14 kg/ha and N78P72K109S14 kg/ha produced 35.81 t/ha and 36.09 t/ha marketable yields, respectively which was lower than N98P72K87S14 kg/ha treatment combinations. Balooch *et al.* (1993) reported that the highest rate of NPK increases the root size and weight. So, the treatment combination of N98P72K87S14 kg/ha is the best among other treatments as shown in Table 2.

The economic analysis showed that the highest net return (Tk. 162575 /ha) was obtained from the treatment combination of N98P72K87S14 kg/ha while the lowest net return (Tk. 69898 /ha) was obtained from the control treatment. The highest benefit cost ratio (4.29) was obtained from N98P72K87S14 kg/ha treatment. From the above results it may be concluded that NPKS significantly influenced the growth and yield of carrot and the treatment combination of N98P72K87S14 kg/ha may be recommended for the profitable production of carrot (Table 3).

Table 3. Cost and return analysis of carrot as influenced by fertilizer (NPKS)

Treatment combination	Marketable yield (t ha^{-1})	Total cost (Tk. ha^{-1})	Gross return (Tk. ha^{-1})	Net return (Tk. ha^{-1})	BCR*
No manure and fertilizer (control)	19.40	36802	106700	69898	2.89
Cow dung only (4 t/ha)	26.82	41317	147510	106193	3.57
N59P72K87S14 kg/ha	28.57	46965	157135	110170	3.34
N98P72K87S14 kg/ha	29.83	48395	164065	115672	3.39
N78P72K87S14 kg/ha	31.06	48861	170830	121969	3.49
N98P72K87S14 kg/ha	38.53	49340	211915	162575	4.29
N78P0K87S14 kg/ha	35.16	46854	193380	146525	4.12
N78P54K87S14 kg/ha	34.19	48352	188045	139693	3.88
N78P90K87S14 kg/ha	35.81	49356	196955	147599	3.99
N78P72K0S14 kg/ha	34.41	45933	183755	137822	4.00
N78P72K65S14 kg/ha	35.22	48108	193710	145602	4.02
N78P72K109S14 kg/ha	36.09	49580	198495	148915	4.00
N78P72K87S0 kg/ha	29.35	48147	161425	113278	3.35
N78P72K87S11 kg/ha	28.40	48593	156200	107607	3.21
N78P72K87S18 kg/ha	33.83	49040	186065	137025	3.79

Note, sale price of carrot @ Tk. 5500/t * Benefit cost ratio (BCR) = Gross return - total cost of production

Conclusion

The economic analysis showed that the highest net return (Tk. 162575 /ha) was obtained from the treatment combination of N98P72K87S14 kg/ha while the lowest net return (Tk. 69898 /ha) was obtained from the control treatment. The highest benefit cost ratio (4.29) was obtained from N98P72K87S14 kg/ha treatment. From the above results it may be concluded that NPKS significantly influenced the growth and yield of carrot and the treatment combination of N98P72K87S14 kg/ha may be recommended for the profitable production of carrot in Bangladesh.

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