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Effect of Nitrogen and Potassium on Yield and Quality of Carrot

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Abstract: A study was conducted at the Horticulture Farm of Bangladesh Agricultural University, Mymensingh. The experiment was conducted to study the effect of nitrogen and potassium on quality and yield of carrot root. The experiment involved four doses of nitrogen, namely 0, 100, 150, 200 kg ha^{-1} and four doses of potassium namely, 0, 150, 200, 250 kg ha^{-1}. Nitrogen was assigned to the main plots and potassium to the sub-plots. Root yield increased progressively and significantly with the increased application of nitrogen and potassium. Application of $N_{200}K_{250}$ increases the yield 324% over the control. The highest carotene content (20.47 μg g^{-1}) was recorded in the plants received 200 kg ha^{-1} nitrogen and the lowest carotene content (9.50 μg g^{-1}) from the plant grown without nitrogen. Potassium also showed significant effects on root carotene content being 21.85μg g^{-1} in plants fertilized with 250 kg ha^{-1} potassium and 9.45 μg g^{-1} in the plants without potassium. The maximum carotene content (33.43 μg g^{-1}) was obtained from the plant under treatment N_{200} K_{250} and minimum (4.47 μg g^{-1}) was obtained from plants under control treatment. The highest reducing sugar content (573.9 mg g^{-1}) was found from the plants receiving 200 kg ha^{-1} nitrogen and the lowest (450.6 mg g^{-1}) from the plants receiving no nitrogen. Potassium had adverse effects on sugar accumulation in the carrot root. The lowest (287.7 mg g^{-1}) reducing sugar content was obtained from K_{250} and highest reducing sugar content (704.4 mg g^{-1}) recorded in plants grown without potassium. The highest (755 mg g^{-1}) reducing sugar content was found in plants grown without nitrogen and potassium and lowest (329.3 mg g^{-1}) were found in plants under treatment N_{200} K_{250}. Root cracking was increased progressively and significantly with increasing application of both nitrogen and potassium but their interaction effects was insignificant.

Key words: Nitrogen, potassium, quality and carrot

INTRODUCTION

Carrot, is a member of the family Umbeliferae and important root vegetable crops of the world. It is grown in spring, summer and autumn in temperate countries and during winter in tropical and subtropical countries (Bose and Som, 1990). It is mainly a cold requiring crop but it can also be grown at a relatively higher temperature without much difficulty. According to Barnes (1936) 15.6 to 21.1°C temperature is the best for its growth and development. In Bangladesh it is grown during winter when the temperature ranges from 11.17 to 28.9°C (Alim, 1974). Risk of growing carrot is also much less due to fewer problems of diseases and insects pests. It contains high quantities (18.9 μg g^{-1}) of carotene (Anonymous, 1991). Reports indicate that the quality of carrot roots influenced by both nitrogen and potassium. Michalik (1985), Evers (1989), Bose and Som (1990), reported that the carotene content of root was significantly influenced by nitrogen and potassium application. Carrot increases the quantity of urine and helps eliminate uric acid. Addition of large amount of carrot to the diet has favourable effect on the nitrogen balance (Bose and Som, 1990). The normal yield usually ranges from 20 to 46 ton ha^{-1} (FAO, 2001). The objective of this study was to find out the interaction effects of different levels of nitrogen and potassium on quality and yield of carrot and to determine best combination of these two nutrient elements for quality yield.

MATERIALS AND METHODS

The experiment was conducted at the Horticulture Farm of the Bangladesh Agricultural University, Mymensingh during the period from October 1993 to April 1994. A 4x4 factorial experiment was laid out in split plot design with 3 replications. The unit plot size was 1.5 m X 1.0 m with row-to-row 25 cm and plant-to-plant 10 cm spacing. The soil of the experimental plot belongs to Brahmaputra Alluvium Tract and sandy loam in texture with a pH of 6.8.The experiment included four doses of nitrogen, namely 0, 100, 150, 200 kg ha^{-1} and four doses of potassium namely, 0, 150, 200, 250 kg ha^{-1}. Nitrogen was assigned to the main plots while potassium to the

subplots. The seeds were sown on 16 November 1993 and harvested on 26 February 1994. Japanese hybrid variety K. S. Kuroda was used. Observations were made on carotene content, sugar content, nitrogen, phosphorus, potassium contents of both root and shoot and yield. Number of cracked root per plot was calculated and than percentage of cracked root was calculated. For biochemical analysis 3 plants from each plot were selected randomly to determine the carotene and sugar content of the roots. Carotene was estimated by using the methods described by Mahadevan and Srihar (1982). Reducing sugar was estimated by somogyi method (Mahadevan and Srihar, 1982). For chemical analysis of the roots and shoot samples were dried in an oven at 70°C for 72 h and then they were ground by a grinding mill to pass through a 2 mm sieve and stored in brown paper bags into a desicator. Total nitrogen of root and shoot was determined by the Kjeldhal digestion method (Page *et al.* 1989). Total phosphorus of root and shoot was determined by colorometrically (Page *et al.*, 1989) by $SnCl_2$ reduction method at 660 nm wavelength. Total potassium was determined by Flame Photometer (Page *et al.*, 1989). Percent yield increased was calculated:

$$\%\text{Yield increased} = \{(Yt - Yc)/Yc\}*100$$

Where,

Yt= Yield of treatment

Yc= Yield of control

RESULTS AND DISCUSSION

The root yield significantly increased by different doses of nitrogen and potassium. The percent yield increased over control treatment due to different doses of nitrogen and potassium are shown in Fig. 1.The treatment N_{100} increased the yield by 15.95%, N_{150} by 121.8% and N_{200} by 136.7% over control. The yield increased due to different K levels were 67% by K_{150}, 82.5% by K_{200} and 96.2% by K_{250} over control. Polach (1982) reported that application of potassium at 196 kg ha^{-1} gave the best yield and quality carrot. Yield increased by different treatment over control treatment due to interaction effect of nitrogen and potassium are shown in Fig. 2. Application of N_{200} K_{250} increased the yield by 324% and the lowest (39%) in $N_{100}K_0$. Matev (1971) noticed that the application of fertilizers at the dose of N_{60} P_{60} K_{90} (kg ha^{-1}) improved the yield by 42.1% (7.6 t ha^{-1}) and dose of N_{120} P_{120} K_{180} (kg ha^{-1}) increased the yield by 71.15% (12.3 t ha^{-1}). Yield is a quantitative character, which results from the interactions of many components such as plant height, root diameter, length fresh weight etc. Root yield was considered as the resultant variable. It was observed that root yield had a significant positive correlation with all the growth and yield components except leaf number (Table 2).

Different doses of nitrogen showed significant effect on carotene content of roots. The highest carotene (20.47 μg g^{-1}) was recorded when crop was fertilized with 200 kg nitrogen per hectare and minimum (9.50 μg g^{-1}) in the control treatment (Table 1). Evers (1989) reported that phosphorus and potassium in presence of nitrogen fertilization had a tendency to increase carotene. Bose and Som (1990) reported that carotene content of roots was significantly influenced by nitrogen application. Potassium had a significant effect on root carotene content. It increased with the increasing levels of potassium. The highest carotene content (21.85 μg g^{-1}) was recorded when the crop was fertilized with 250 kg ha^{-1} potassium and lowest (9.35 μg g^{-1}) in control treatment (Table 1). The results of the present experiment support the findings of the study of Michalik (1985). Carotene content varies significantly from 4.47 to 33.43 μg g^{-1} due to interaction effect of nitrogen and potassium (Fig. 3). Application of N_{200} K_{250} showed maximum and minimum in control treatment. The results of the experiment are in accord with the findings of the study of Evers (1989). Reducing sugar content of carrot root significantly influenced by the application of nitrogen. The highest (573.9 mg g^{-1}) reducing sugar content was recorded when the nitrogen was applied at the rate of 200 kg ha^{-1} (Table 1) and the minimum (450.7 mg g^{-1}) in control treatment. Sugar production ability of carrot root declined by the application of potassium (Table 1). The effect was found reversed as found in case of nitrogen application. The interaction effect of nitrogen and potassium also showed the declined sugar production ability (Fig. 4). Highest (755 mg g^{-1}) sugar content was found in control treatment and lowest (329.3 mg g^{-1}) in plants under treatment N_{200} k_{250}. Evers (1989) noticed that unfertilized treatments had a tendency to yield higher glucose and fructose and thus also sugar content than did the fertilized treatments.

Nitrogen caused statistically significant variation in nitrogen content of roots but not of shoots. Nitrogen contents increased gradually with the gradual increase in the dose of nitrogen (Table 1). Nitrogen content varied from 1.53 to 2.06% in roots and from 2.83 to 3.10% in shoots. Hipp *et al.* (1978) reported that nitrogen content of root and shoot increase due to application of nitrogen. Potassium did not cause any significant variation in root nitrogen content while it significantly increased the shoot nitrogen content (Table 1). The interaction effect of nitrogen and potassium was insignificant. Phosphorus content of both root and

Table 1: Main effect of nitrogen and potassium on chemical composition of carrot root.

Treatments		Carotene content (mg g^{-1})	Reducing sugar content (mg g^{-})	Nitrogen content %		P_2O_5 content %		K_2O content %		Cracked root/plot (%)
				Root	Shoot	Root	Shoot	Root	Shoot	
Nitrogen (kg ha^{-1})	0	9.50d	450.7c	1.53c	2.83	0.87	0.79	2.95	3.35	1.10d
	100	15.20c	472.8b	1.81b	2.89	0.90	0.72	3.23	2.81	6.50c
	150	18.19b	473.4b	2.06a	2.90	0.97	0.70	3.48	2.62	7.5b
	200	20.47a	573.9a	2.06a	3.10	1.20	0.69	3.60	2.62	9.00a
Potassium (kg ha^{-1})	0	9.45d	704.4a	1.67	2.83b	0.84	0.73	3.2	2.6	1.67c
	150	12.61c	495.5b	1.88	2.89ab	0.95	0.72	3.4	2.8	2.83b
	200	19.44b	423.2c	1.97	3.10a	1.20	0.70	3.5	3.1	4.33ab
	250	21.85a	287.7d	1.94	2.90ab	0.95	0.69	3.5	3.1	5.24a

Means bearing the same letter(s) in a column do not differ significantly at 0.05 level (DMRT)

Table 2: Correlation between different plant parameters.

	Plant height	Leaf number/plant	Root diameter	Root length	FW of individual root	DW of individual root	Carotene content	Yield
Leaf/plant	0.479***							
Root diameter	0.399*	0.241NS						
Root length	0.587***	0.342*	0.513***					
FW of individual root	0.449***	0.192NS	0.763***	0.545***				
DW of individual root	0.352*	0.089NS	0.480***	0.503***	0.536***			
Carotene content	0.360*	0.202NS	0.441**	0.599***	0.479***	0.490***		
Yield	0.386***	0.185NS	0.640***	0.611***	0.615***	0.721***	0.523***	

NS means not significant, *P<0.05, **P<0.01, ***P<0.001

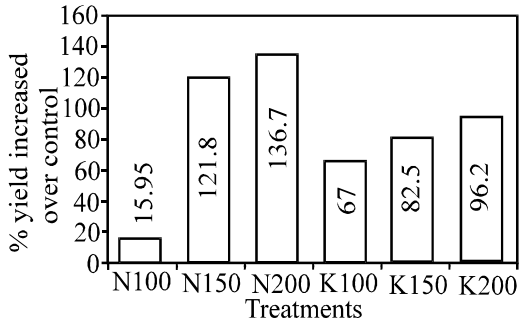

Fig. 1: Yield increased due to different doses of N and K

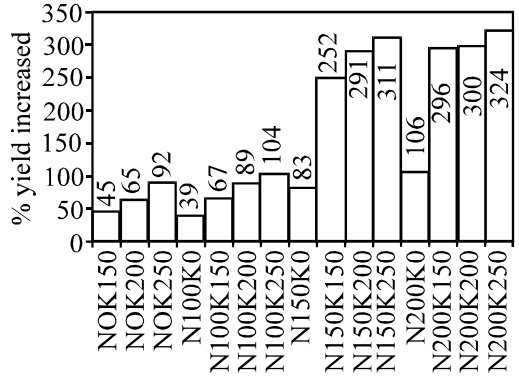

Fig. 2: Yield increased due to interaction effects of N and K over control

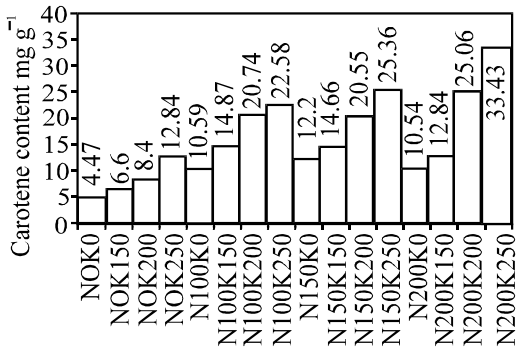

Fig. 3: Interaction effects between seen N ad K increase vitamin content

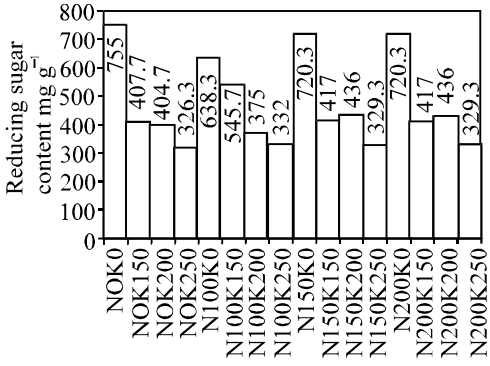

Fig. 4: Sugar content decrease due to interaction effects between N and K

shoot were not influenced by the application of nitrogen and potassium (Table 1). The Phosphorus content of root and shoot was also unaffected by their interaction effect. Chemical analysis of root and shoot showed that the application of nitrogen and potassium had no statistically significant effect on potassium content of root and shoot (Table 1). Interaction effect of nitrogen and potassium had

insignificant influence on the potassium content of root and shoot.

The application of nitrogen had significant effects on cracking of root (Table 1). Roots were highly cracked with the increased levels of nitrogen. The results of the present experiment are also in agreement with the observation of Goodman (1953). Potassium also showed significant effect on cracking of roots. The roots were highly cracked when the crop was fertilized with 250 kg ha^{-1} potassium and the minimum in control treatment (Table 1). The interaction between different doses of nitrogen and potassium had no significant effects on root cracking but the result showed that root cracking was increased gradually with the increasing levels of both nitrogen and potassium.

Carrot root yields were significantly influenced by different doses of nitrogen and potassium. Overall nitrogen doses produces higher yield than potassium doses. It indicated that higher doses of nitrogen gave the higher yield compare to higher doses of potassium. Interaction effect of nitrogen and potassium increase the yield of roots with the increase in the level of nitrogen and potassium. Application of N_{200} K_{250} increase the yield 324% over the control. The carotene content of carrot root increased with gradual increase in nitrogen level. The highest carotene content (20.47 μg g^{-1}) was recorded in the plants received 200 kg ha^{-1} nitrogen and the lowest carotene content (9.50 μg g^{-1}) from the plants grown without nitrogen. Potassium also showed significant effects on root carotene content, 21.85 μg g^{-1} in plants received 250 kg ha^{-1} potassium and 9.45 μg g^{-1} in control plants. Their interaction effect was also significant. The maximum carotene content 33.43 μg g^{-1} was obtained from the plant under treatment N_{200} K_{250} and minimum 4.47 μg g^{-1} in control plant. Different doses of nitrogen increase the sugar content of the roots but it decline with increasing doses of potassium and their interaction effects also reduces the sugar content of the roots. Nitrogen caused statistically significant variation in nitrogen content of roots but P and K composition was unaffected by the application of nitrogen and potassium.

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