International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 537-540

Received: 06-09-2017
Accepted: 07-10-2017

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Studies on the effect of nitrogen levels and spacing on quality traits of radish (*Raphanus sativus* L.) cv. Kashi Sweta

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Abstract
An experiment on "effect of nitrogen levels and spacing on quality traits of radish (*Raphanus sativus* L.) cv. Kashi Sweta" was carried out during the winter season November 2013 to January 2014 at the experimental field of Department of Applied Plant Science, BBAU, Lucknow. The result revealed that higher level of nitrogen fertilizer and spacing maximizes the ascorbic acid content (8.433) in T_8, sugar content in T_6 (20.06) and total soluble solid at T_5 (4.35 ^{0}Brix). It was concluded that the increases in the nitrogen fertilizer increase the quality of radish.

Keywords: Nitrogen, quality, radish, spacing

1. Introduction
Radish (*Raphanus sativus* L.) is a member of the Brassicaceae family native to Europe or Asia. It is a popular root crop grown all over the world. In India, it is grown in one or the other part of the country throughout the year. It is grown for its young fleshy tuberous roots consumed mainly as a salted vegetable, eaten as a grated salad.

Radish is a cool season crop and divided broadly into two groups: European or temperate and Asiatic or tropical. Asiatic types produce roots and seeds under tropical climate, whereas, European types produce roots under sub-tropical and tropical climate. However, seed production of European types is possible only under temperate conditions in hills since these require chilling temperature for seed production. The Asiatic varieties although are higher yielders yet poor in quality attributes, whereas, European varieties are small in size, mild in pungency, early in maturity and rich in quality parameters.

It is a good source of Vitamins C and minerals like calcium potassium and phosphorus. It has refreshing and diuretic properties. Radish is also used for neurological headache, sleeplessness. The roots are useful in urinary complaint and piles. The leaves of radish are the good source for extraction of protein on a commercial scale and radish seed are potential source of nondrying fatty oil edible purposes. The chemical composition of per 100g radish is following: Energy 66 kJ (16 kcal), Carbohydrates 3.4 g, Sugar 1.86 g, Dietary fiber 1.6 g, Fat 0.1 g, Protein 0.68 g, Thiamine (vit. B_1) 0.012 mg (1%), Riboflavin (vit. B_2) 0.039 mg (3%), Niacin (vit. B_3) 0.254 mg (2%), Pantothenic acid (B_5) 0.165 mg (3%), Vitamin B_6 0.071 mg (5%), Folate (vit. B_9) 25 µg (6%),Vitamin C 14.8 mg (18%), Calcium 25 mg (3%), Iron 0.34 mg (3%), Magnesium 10 mg (3%), Manganese 0.069 mg (3%), Phosphorus 20 mg (3%), Potassium 233 mg (5%), Zinc 0.28 mg (3%).

The area of the radish in all over country 167.85mha with the production of 2410.88mt (according to NHB, 2013 estimation) [1], the largest area under this crop in India, west Bengal 40mha with the production of 496.20mt followed by Haryana 28.68mha with the production of 438.41 mt.

The growth and yield of radish greatly depend upon soil and climatic conditions. India is a vast country with varied agro-climatic regions. Among nutrients, nitrogen is one of the major nutrients required by the plants for their growth, development and yield. Radish requires a well-balanced supply of minerals throughout their life cycle for maximum growth, available minerals especially nitrogen affected plant growth and radish productivity. This effect resulted in improving the colour and vigour of the leaf canopy, net assimilation rate and dry matter accumulation.

Thereby, it must be determining optimum nitrogen dose, which produces maximum root yield and best root quality parameters, at the same time reduce environmental pollution. Recently, there are many investigations concerned with optimizing application of nitrogen in order to maximize yields and quality parameters.

Nitrogen plays a vital role in the physiological process of the plant, nitrogen makes plant dark green, increase the plant vegetative growth, and also responsible for protein content. nitrogen encourage the formation of good quality foliage which plays a vital role in the accumulation of food starch via photosynthesis process because nitrogen is an important constituent of chlorophyll, it increases the cation exchange capacity of plant roots and these make them more efficient in absorbing other nutrient ions like phosphorus, calcium etc.

Among the agro techniques, nutrition and plant population is one of the main factors which govern the growth and yield of radish. It has been observed that radish being cultivated by the vegetable growers in India is low in quality. Nutrient and spacing are the most important and play a major role in deciding the quality.

Under the normal agro climatic condition, the varieties which are most suitable and in which nitrogen is supplied for two chief factor which influences the quality of radish. In the view of low contribution to the poor quality and low income. The T.S.S., of radish, significantly increased with increasing level of Nitrogen (Desuki *et al*., 2005) [2].

It becomes imperative for to go apply a measured amount of nitrogen, with adequate spacing for plant population, the present investigation effect of nitrogen levels and spacing on quality of radish (*Raphanus sativus* L.).

Materials and Methods

The present investigation was conducted on "Effect of nitrogen levels and spacing on quality traits of radish (*Raphanus sativus* L.) cv. Kashi Shweta during the winter season of November 2013 to January 2014. The experimental field located, in Lucknow. Geographically, Lucknow is situated at an elevation of 111 meters above mean sea level in the sub tropical climate of central Utter Pradesh at 26^0 56' North latitude and 80^0 52' East longitudes. The climate of the region is subtropical with maximum temperature ranging from 22^0 C to 45^0 C in summer, minimum temperature ranging from 3.5^0 C to 15^0 C in winter and relative humidity ranging from 60-80% in different season of the year (Table.2). The data of weather condition prevailed during the course of field experimentation is summarized in table.1. before start of the experiment, the representative soil samples were taken randomly at a depth of 15 cm from experimented field and brought to laboratory for physical and chemical analysis. The results of soil analysis have been presented in the soil of field was texturally be classified as sandy loam and slightly alkaline in reaction. The pH of soil 8.82 and the available N (Kg/ha) 372.96, available P_2O_5 290.12 (Kg/ha) and available K_2O 510.18 (Kg/ha). Seeds of the radish were procured from the IIVR (Indian Institute of Vegetable Research) Jakhani, Varanasi.

The field was ploughed once and harrowed twice. The crop was fertilized with recommended nitrogen, phosphorus and potassium at 120:60:60 kg NPK per ha in the form of urea, single superphosphate and Muriate of potash, respectively as a basal dose as per the treatments, and 1/3 part of nitrogen applied as basal dose. Seeds were sown on 29th November 2013 during Rabi/ winter season. Seeds were sown manually at a distance of 25 cm inter row spacing, thus the spacing is 25 x 5cm, 25 x 10cm, 25 x 15cm respectively. First light irrigation was given 4-5 Days after sowing and Subsequent irrigation was given as per the need of the crop. Manual weeding was done in order to keep the soil free weeds. Earthing up was done twice once at 30th day after sowing and other at 45th days after sowing. To control the pest and disease, necessary plant protection measure was taken up as per the recommended package of practices for radish. The crop was harvested at full maturity, when the soil moisture was optimum. The plants were pulled out without damaging the roots from the net plots. The soil adhering to the roots was removed. Analysis of root for the fallowing constituent was carried out on the samples obtained at the last observation for the following parameters -total soluble solids (A.O.A.C, 1980) [3] ascorbic acid (Rangana, 1977) [4], reducing and non reducing sugar and total sugar. Statistical analysis of the data obtained in the different sets of the experiments was calculated as suggested by Panse and Sukhatme (1985) [5].

Table 1: Treatment details

S. No.	Notation	Treatments	Treatments Combination
1	T_1	N_0S_1	25cm x 5cm + 0 g(N) + PK
2	T_2	N_0S_2	25cmx10cm + 0 g(N) + PK
3	T_3	N_0S_3	25cmx15cm + 0 g (N) + PK
4	T_4	N_1S_1	25cmx5cm + 100%(N) + PK
5	T_5	N_1S_2	25cmx10cm + 100%(N) + PK
6	T_6	N_1S_3	25cmx15cm + 100%(N) + PK
7	T_7	N_2S_1	25cmx5cm + 75%(N) + PK
8	T_8	N_2S_2	25cmx10cm + 75%(N) + PK
9	T_9	N_2S_3	25cmx15cm + 75%(N) + PK
10	T_{10}	N_3S_1	25cmx5cm + 50%(N) + PK
11	T_{11}	N_3S_2	25cmx10cm + 50%(N) + PK
12	T_{12}	N_3S_3	25cmx15cm + 50%(N) + PK

Table 2: Average weekly meteorological data during course of investigation October 2013 to April 2014

Period		Mean Temp. (°C)		Total Rainfall (mm)	Relative Humidity (%)		Wind Velocity (Km/hr)
Month	**Date**	**Min.**	**Max.**		**Min.**	**Max**	
Nov. 13	29-04	15.1	30.6	0.0	48	92	1.1
	05-11	13.0	27.3	0.0	47	93	1.1
	12-18	11.7	26.7	0.0	38	93	1.1
	19-25	9.4	26.4	0.0	38	94	1.3
Dec. 13	26-02	9.98	26.8	0.0	39	93	1.8
	03-09	7.8	25.4	0.0	39	92	1.3
	10-16	7.6	24.4	0.0	41	93	2.4
	17-23	9.9	22.6	0.0	57	97	0.9
	24-31	9.0	21.7	0.0	48	89	2.7
Jan. 14	01-07	8.8	19.6	0.0	59	95	2.4
	08-14	8.7	16.4	0.0	78	98	0.9
	15-21	10.1	16.9	0.0	72	97	1.5
	22-28	11.4	19.7	0.0	68	96	2.6
Feb. 14	29-04	10.1	18.0	0.0	67	94	1.8
	05-11	11.2	24.98	0.0	39	92	3.6
	12-18	10.1	20.1	0.0	57	91	3.5
	19-25	10.4	22.9	0.0	51	95	1.9
March 14	26-04	13.2	21.6	0.0	53	95	3.0

Data collected from-Indian Institute Sugarcane Research, Lucknow.

Table 3: Effect of nitrogen levels and spacing on ascorbic acid content

Vit. C	S_1	S_2	S_3	Mean
N_0	7.267	7.400	7.323	7.330
N_1	8.057	8.323	8.213	8.198
N_2	8.110	8.433	8.243	8.262
N_3	7.680	7.793	7.993	7.822
Mean	7.778	7.988	7.943	
Factors	**C.D. at 5%**		**SE(d)±**	**SE(m)±**
Nitrogen	0.018		0.009	0.006
Spacing	0.016		0.007	0.005
Interaction	0.031		0.015	0.011

Table 4: Effect of nitrogen levels and spacing on reducing sugar content

Reducing sugars	S_1	S_2	S_3	Mean	Non- reducing	S_1	S_2	S_3	Mean
N_0	2.290	2.377	2.470	2.379	N_0	14.670	15.323	15.777	15.257
N_1	2.783	2.887	2.893	2.854	N_1	16.747	17.117	17.170	17.011
N_2	2.640	2.833	2.847	2.773	N_2	15.833	16.830	17.070	16.578
N_3	2.587	2.683	2.727	2.666	N_3	15.477	16.090	16.483	16.017
Mean	2.575	2.695	2.734		Mean	15.682	16.340	16.625	
Factors	**C.D. at 5%**		**SE(d)±**	**SE(m)±**	**Factors**		**C.D. at 5%**	**SE(d)±**	**SE(m)±**
Nitrogen	0.013		0.006	0.013	Nitrogen		0.054	0.026	0.018
Spacing	0.012		0.006	0.012	Spacing		0.046	0.022	0.016
Interaction	0.023		0.011	0.023	Interaction		0.093	0.044	0.031

Results and Discussion

The findings of the present investigation on the chemical composition and quality of roots as influenced by nitrogenous fertilizer levels and spacing of radish have been presented in the table as below:

Data on ascorbic acid revealed that there was a remarkable increase in its content due to some of the treatments as compared to control. There was significant rise under T_8 (N_2S_2) 8.433 mg treatment followed by T_5 (N_1S_2) 8.323 treatment. The minimum percent of ascorbic acid was recorded under control (Table.3).

It was observed that T_1 (N_1S_1) 2.78 increased the reducing sugar significantly over control. Unlike reducing sugars, non-reducing sugars showed significantly increased under various treatments as compared to control. The maximum reducing and non-reducing sugars observed under T_6 (N_1S_3) treatment followed by T_5 (N_1S_2) the total sugar registered a significant rise with the application of different treatments as compared to control. The maximum total sugar content was recorded under treatment T_6 (N_1S_3) 20.06 followed by T_5 (N_1S_2) 20.00 treatment (Table.5).

Data on total soluble solids revealed that there was remarkable increase in its content due to some of the treatments as compared to control. There was significant rise under T_5 (N_1S_2) 4.35 ° Brix treatment followed by T_6 (N_1S_3) 4.34 ° Brix treatment (Table.6).The total soluble solid of root increased as the level of Nitrogen fertilizers. The significant rise under T_5 may be due to nitrogen fertilizers which required for the plants growth. The results are in alignment with the findings of Desuki *et al.*, (2005) [2] in radish. Nutrient levels have also exhibited a significant effect on ascorbic acid content in radish (Rawat *et al.*, 2014) [6] and similar results were also reported by Kumar *et al.*, 2015 [7] in Strawberry.

Conclusion

Application of 100% nitrogen with 25x15cm spacing subsequently increases the sugar content followed by 100% nitrogen with 25x10cm spacing. Application of nitrogen has beneficially affected on the T.S.S value of root. Application of nitrogen has a beneficial effect on the vitamin-c value of root.

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