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Effect of Nitrogen Levels and Spacing on Growth and Yield of Radish (*Raphanus sativus* L.) Cv. Kashi Sweta

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ABSTRACT

The results of the present investigation revealed that wider spacing and 100% nitrogen fertilizer level significantly increased the plant height, number of leaves (7.17) at 25 DAS, length of leaves, root length (18.81 cm), root diameter (3.66), biomass (270.86 g) and yield of root in tonnes (453.27) q/Ha in similar treatments. It was concluded that increment in yield due to higher spacing and nitrogen fertilizer level.

Key words: *Fertilizer, Nitrogen, Spacing.*

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 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:

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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[3] (according to NHB, 2013 estimation). 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 require 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. The Egyptian soils in general suffered from low content of nitrogen, therefore yield was drastically reduced, and may even be halved on most its. 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 play a vital role in the physiological process of 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 play a vital role in 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 makes 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 yield and quality. Higher yield in radish crop depends upon cultural practices on which proper application of fertilizers and plant populations have been found to contribute greatly. Among macro nutrients nitrogen plays a vital role in the growth and development of plants. It is an essential constituent of metabolically active compounds like protein, nucleic acids, chlorophyll and enzymes etc. When nitrogen is deficient in the soil, the harvest is poor in size, weight and quality[2]. Plant population affects the plant growth, development and yield. In the case of spacing, competition among plants is more and the development of the radish is badly affected. Similarly, in wider spacing, individual plants will yield more but per hectare yield may be reduced due to low plant population. Therefore, a suitable plant population must be worked out at which average yield per hectare is maximum. Under the normal agro climatic condition, the varieties which are most suitable and in which nitrogen is supplied for two chief factor which influences yield and quality of radish. In the view of low yield and its contribution to the poor quality and low income. It becomes imperative for to go apply the measured amount of nitrogen, with adequate spacing for plant population, the present investigation effect of nitrogen levels and spacing on growth and yield of radish (*Raphanus sativus* L.).

MATERIALS AND METHODS

The present investigation was conducted on "Effect of nitrogen levels and spacing on growth and yield 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 Uttar 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 apply 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 from 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. Observations were recorded at five randomly selected and labeled plants from each treatment and each replication for growth and yield parameters 25th days after sowing and at harvest (45 DAS). Growth parameters of the following traits were recorded i.e., Number of leaves, Length of leaves, Plant height (cm), Plant biomass(g) and Yield Parameters i.e., Root length (cm), Root diameter (cm), Yield per plot (kg), Yield per hectare (tones). Total of 12 treatments combination with Randomised block design (RBD) replicated thrice. Statistical analysis of the data obtained in the different sets of the experiments was calculated as suggested by Panse and Sukhatme[4], (1985) (Table.1).

Table 1: Treatments 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

RESULTS AND DISCUSSION

Plant height (cm)

The data showed that the maximum plant height at 25 DAS was recorded in N_1S_1 (16.57cm) followed by N_1S_2 (15.63 cm), and minimum in N_0S_3 (8.44cm) but found statistically at par. At 45 days after sowing maximum plant height was recorded in N_1S_1 (34.77cm) followed by N_2S_1 (31.22cm), and minimum N_0S_3 (17.21cm). Different nitrogen levels, spacing and interaction between two factors significantly affected the plant height (Table.3). Highest plant height of 34.77 cm was observed at 100% Nitrogen /ha while lowest value of 17.21 was observed at 0 kg ha^{-1}. As regards spacing, highest plant height of 26.237 cm was recorded at 5 cm spacing and 10 cm spacing (25.22) which were statistically at par with each other. The lowest value of 24.125 cm was observed in case of 5 cm spacing. It would be observed from the mean values of interactions that maximum plant height of 34.773cm was observed at 100% N ha^{-1} with 5 cm spacing followed by 75% N ha^{-1} with 5 cm spacing (31.22cm) and 100% N ha^{-1} with 10 cm spacing (30.99) which were statistically at par with each other. The minimum height of 17.21 was produced by 0 kg N ha^{-1} with 15 cm spacing. Height of plant can be considered as one of the indices of plant vigour ordinarily and it depends upon vigour and growth habit of the plant. Soil nutrients are also very important for the height of plants. So, higher dose of nitrogen increased plant height. It has a positive effect in this study of increasing plant spacing and nitrogen dose on plant height.

Number of leaves

The data showed that the maximum number of leaves at 30 DAS was recorded 7.25 cm in T_6 (N_1S_3) followed by T_5 (N_1S_2) 7.17 and minimum T_3 (N_0S_3) 4.37. At par at 45 days after sowing the data showed that the maximum plant height was recorded in T_6 (N_1S_3) 15.33 followed by T_5 (N_1S_2) 14.55 and minimum T_3 (N_0S_3) 9.33 but found statistically at par. Data for number of leaves spelt out highly significant results for different nitrogen levels indicating superiority of 100% ha^{-1} and 50 % ha^{-1} over 75% ha^{-1} and 0 kg ha^{-1} 100% ha^{-1} and 50 %ha^{-1} produced 13.8 and 12.5 number of leaves per plant, respectively (Table.4). The least number of leaves (9.8) were produced by control. It would be observed from the means of spacing that more number of leaves (12.24) was produced by the treatment 10 cm spacing followed by 15 cm spacing (16.3) and 5 cm spacing (14.6), respectively. In case of interactions, maximum number of leaves was produced by the treatment 100% N ha^{-1} with 15 cm spacing which was statistically different from all other treatments whereas, minimum number of leaves per plant (9.33) was produced by the treatment 0kg N ha^{-1} with 15 cm spacing. The leaves are the plant factories, manufacturing carbohydrates. The photosynthesis occurs in leaf cells and carbohydrates are formed there. Vegetative growth was increased with increasing plant spacing and nitrogen levels as compared with 5 cm spacing and 0 kg ha^{-1} treatments. Increasing number of leaves/Plants observed in this study may be due to increasing assimilation rate resulting in higher growth[5].

Length of leaves (cm)

The data showed that the maximum length of leaf at 25 DAS was recorded 8.46 cm in T_4 (N_1S_1) followed by T_7 (N_2S_1) 7.82 and minimum T_3 (N_0S_3) 5.03. At par at 45 days after sowing the data showed that the maximum leaf length was recorded in T_4 (N_1S_1) 22.56 followed by T_5 N_1S_2 20.46 and minimum T_3 (N_0S_3) 13.82 but found statistically at par. Highly significant results for different nitrogen levels, spacing and interaction between two factors were observed (Table.5). Mean values in relation to different nitrogen levels indicated significant superiority of 100% ha^{-1} over 75 % ha^{-1}, 50% ha^{-1} and 0 kg ha^{-1}. Treatment 100% ha^{-1} produced maximum leaf length of 7.78 cm followed by 75 % ha^{-1} (7.35 cm), 50% ha^{-1} (6.99 cm) and 0 kg ha^{-1} (5.73cm) while minimum length was produced by control. In case of spacing, treatment 15 cm spacing produced leaf of 6.57

cm length which was statistically at par with spacing (10 cm) which produced leaf length of 6.75 cm. Both were statistically different from 5 cm spacing which produced leaf length of 7.56 cm. In case of interactions between different nitrogen levels and spacing, maximum leaf length (8.46 cm) was obtained from 100 % N ha^{-1} with 5 cm spacing which was statically at par with 75 % N ha^{-1} with 5 cm spacing and statistically different from rest of the treatments whereas, minimum leaf length (5.03 cm) was produced by 0 kg N ha^{-1} with 15 cm spacing. These results are supported by the findings of Chatterjee and Som[1]. Environmental and genetic factors strongly effect on leaf lengths, so plants with more number of leaves have more root length. Similarly, soil conditions might have also effected on leaf length. Increment in leaf length may be due to the increasing in plant density and higher light competition[5].

Root length (cm)

It is apparent from table 6, the length of roots under different treatments continues to increase till harvest and the maximum rate of root development took place during maximum length was obtained under T_4 (N_1S_1) (100% N with 5 cm spacing) 21.23 cm followed by T_7 (N_2S_1) 20.58 cm. The shortest roots were recorded under T_3, followed by T_2 and followed by T_1 the plants which were not supplied with Nitrogen. Highly significant results for different nitrogen levels, spacing and interaction between two factors were observed (Table.6). Mean values in relation to different nitrogen levels indicated significant superiority of 100% ha^{-1} over 75 % ha^{-1}, 50% ha^{-1} and 0 kg ha^{-1}. Treatment 100% ha^{-1} produced maximum root length of (18.55cm) followed by 75% ha^{-1} (17.12cm), 50% ha^{-1} with 10 cm (18.81cm) and 0 kg ha^{-1} (8.61cm) while minimum root length was produced by control. In case of spacing, treatments of 5 cm spacing produced roots of 17.38 cm length which was statistically at par with spacing 10 cm which produced root length of 14.88 cm. Both were statistically different from 15 cm spacing which produced root length of 12.08 cm. In case of interactions between different nitrogen levels and spacing, maximum root length (21.23 cm) was obtained from 100 % N ha^{-1} with 5 cm spacing which was statically at par with 75 % N ha^{-1} with 5 cm spacing and statistically different from rest of the treatments whereas, minimum root length (7.55 cm) was produced by 0 kg N ha^{-1} with 15 cm spacing. These results are supported by the findings of Chatterjee and Som[1]. Environmental and genetic factors strongly effect on root lengths, so plants with more number of leaves have more root length. Similarly, soil conditions might have also effected on root length. Closer spacing increases the root length.

Root diameter (cm)

The data showed that the maximum diameter of roots was recorded in T_8 (N_2S_2) 3.60 cm followed by T_5 (N_1S_2) 3.51 cm and minimum recorded in T_1 (N_0S_1) 1.95 cm. Results related to root diameter are depicted in (Table.7) The perusal of this table indicated highly significant results for different nitrogen levels and plant spacing and non-significant results for interaction between two factors. Mean values in relations to different nitrogen levels indicated significant superiority of 75 % N ha^{-1} N level over 100 %N ha^{-1} and 0 kg N ha^{-1} and was found at par with 50 % N ha^{-1}. Mean values showed root diameter 3.3, 3.2, 2.8 and 2.1cm respectively at four N levels. Different plant spacing data indicated superiority of 10 cm spacing over 15 cm spacing and found at par with 10 cm spacing. Mean values for different spacing (15, 10 and 5) showed root diameter 2.92, 3.09 and 2.69 cm respectively. Higher N level and higher spacing provided more N and more space for the development of root which resulted in maximum diameter of root. Sirkar *et al*[5]., also found that root diameter increased which may be due to competition for nutrients for nitrogen.

Total biomass per plant (g).

The data showed that the highest biomass of plant was recorded in T_8 (N_2S_2) 270.86 g followed by T_5 (N_1S_2) 261.22 g and minimum recorded in T_1 (N_0S_1) 116.6 g. The data for total biomass are given in the Table.8, which revealed highly significant results for nitrogen levels and spacing while, significant results for their interactions. Mean values in relation to nitrogen levels declared superiority of 75 % ha^{-1} over all other treatments. 100 % ha^{-1} occupied the 2nd best position whereas; 50% ha^{-1} and 0 kg ha^{-1} occupied 3rd and 4th position, respectively. As regards spacing, minimum total biomass per plant was observed in case of 5 cm spacing while, maximum total biomass per plant was observed at 15 cm spacing followed by 10 cm spacing. In case of interactions, data indicated superiority of 75% N ha^{-1} with 10 cm spacing over rest of the treatments. 75% N ha^{-1} with 10 cm spacing produced maximum total biomass per plant followed by 100% N ha^{-1} with 10 cm spacing, whereas, minimum total biomass per plant was produced by 0 kg N ha^{-1} with 5 cm spacing. Total biomass is gained by the combination of leaves and root. So, total biomass is directly proportionate to number of leaves, length of leaves, root length, root diameter, fresh root weight and weight of fresh leaves per plant. These results are a sequence of previous results and there was no change in trends. Maximum total biomass per plant was produced with higher doses of nitrogen and increased spacing. The plant biomass increases due to the competition for nutrients[5].

Root yield per plot (kg)

The data recorded on the yield of whole plants were analyzed statistically. It is evident from the mean values presented in that treatment of 75% Nitrogen and 10 cm spacing (N_2S_2) 8 4.08 kg have the maximum values followed by treatment of 100% nitrogen with 10 cm(N_1S_2) 3.69kg plant to plant spacing the minimum values recorded under control treatment. Observations recorded on root yield per plot were analyzed and results obtained are presented in the Table.9, which revealed highly significant results for nitrogen levels and interaction, while significant results for spacing. Mean values in relation to different nitrogen levels indicated significant superiority of 75 % ha^{-1} over 100% ha^{-1}, 50 % ha^{-1} and 0 % ha^{-1}. Treatment 75 % ha^{-1} produced maximum root yield (3.46 kg) per plant followed by 100% ha-1 (3.42 kg), 50% ha^{-1} (3.20 kg) and 0 % ha^{-1} (1.40 kg) whereas, minimum root yield per plot was produced by control. It was observed from the mean values of different spacing that maximum root yield of 2.99 kg and 2.90 kg par plot were produced by the treatments 10 and 5cm spacing.

In case of interactions, maximum root yield (3.6 kg) per plot was produced by 75% N ha^{-1} with 10 cm spacing followed by 100 % N ha^{-1} with 10 cm spacing, 75% N ha^{-1} with 15 cm spacing, 100% N ha^{-1} with 15 cm spacing and 75% N ha^{-1} with 5 cm spacing which produced root yield of 3.6, 3.5, 3.4 and 3.3 kg per plot, respectively. The minimum root yield (1.2 kg) per plot was produced by Control with 5 cm spacing. Similar results were supported by Vishnu and Probhakar[6]. It is fact that yields are related to number of plants survived per plot, root wt., root length and root size.

Data concerning yield of roots per hectare were subjected to statistical analysis and results obtained are presented in the Table.10, which demonstrated highly significant results for different nitrogen levels and interaction between two factors while significant for spacing. Mean values for different nitrogen levels declared superiority of 75% ha^{-1} over all other treatments. 100 % ha^{-1} occupied the 2nd best position while, 50% ha^{-1} and 0 % ha^{-1} remained at 3rd and 4th positions (Table.10).

Mean values in relation to different spacing indicated superiority of 10 cm spacing although 10 cm spacing and 15 cm spacing were statistically at par with each other. Similarly, 5 and 15 cm spacing were statistically at par with each other. It would be observed from the means of interactions that 75% ha^{-1} with 10 cm spacing produced maximum root yield per hectare which was statistically at par with 100 % N ha^{-1} with 5 cm spacing. The minimum root yield per hectare was reduced by the control. Superiority of one treatment over the others presented in this write up are in league with the findings of Hussain *et al*[2].

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 Plant Height at 25 and 45 DAS

PLANT HEIGHT 25 DAS	S_1	S_2	S_3	Mean	**PLANT HEIGHT 45 DAS**	S_1	S_2	S_3	Mean
N_0	9.11	8.58	8.44	8.71	N_0	18.44	17.44	17.21	17.69
N_1	16.57	15.63	14.56	15.59	N_1	34.77	30.99	29.55	31.77
N_2	15.58	13.41	13.85	14.28	N_2	31.22	27.21	27.50	28.64
N_3	11.02	12.39	11.08	11.49	N_3	20.51	25.25	22.23	22.66
Mean	13.07	12.50	11.98		**Mean**	26.23	25.22	24.12	

Factors	**C.D at 5%**	**SE(d)±**	**SE(m)±**	**Factors**	**C.D at 5%**	**SE(d)±**	**SE(m)±**
Nitrogen	0.47	0.23	0.16	Nitrogen	1.14	0.54	0.38
Spacing	0.41	0.19	0.14	Spacing	0.98	0.47	0.33
Interaction	0.83	0.39	0.28	Interaction	1.97	0.94	0.67

Table 4: Effect of nitrogen levels and spacing on number of leaves at 25 and 45 DAS

No. of leaves 25 DAS	S_1	S_2	S_3	Mean	No. of leaves 45 DAS	S_1	S_2	S_3	Mean
N_0	4.93	4.76	4.37	4.69	N_0	10.43	9.76	9.33	9.84
N_1	5.63	7.17	7.25	6.68	N_1	11.55	14.55	15.33	13.81
N_2	5.81	5.96	6.22	6.00	N_2	12.21	11.99	11.00	11.73
N_3	5.98	6.28	5.63	5.96	N_3	11.66	12.66	13.22	12.51
Mean	5.59	6.04	5.87		**Mean**	11.46	12.24	12.22	

Factors	**C.D at 5%**	**SE(d)±**	**SE(m)±**	**Factors**	**C.D at 5%**	**SE(d)±**	**SE(m)±**
Nitrogen	0.33	0.16	0.11	Nitrogen	0.70	0.33	0.24
Spacing	0.29	0.13	0.09	Spacing	0.61	0.29	0.20
Interaction	0.58	0.27	0.19	Interaction	1.22	0.58	0.41

Table 5: Effect of nitrogen levels and spacing on length of leaves at 25 and 45 DAS

Length of leaves at 25 DAS	S_1	S_2	S_3	Mean	Length of leaves at 45 DAS	S_1	S_2	S_3	Mean
N_0	6.77	5.38	5.03	5.73	N_0	15.32	14.92	13.82	14.68
N_1	8.46	7.54	7.35	7.78	N_1	22.56	20.46	17.32	20.11
N_2	7.82	7.16	7.06	7.35	N_2	19.30	17.05	16.25	17.53
N_3	7.21	6.93	6.84	6.99	N_3	17.22	15.90	15.49	16.20
Mean	7.56	6.75	6.57		**Mean**	18.60	17.08	15.72	

Factors	C.D at 5%	SE(d)±	SE(m)±	Factors	C.D at 5%	SE(d)±	SE(m)±
Nitrogen	0.03	0.01	0.01	Nitrogen	0.10	0.05	0.03
Spacing	0.03	0.01	0.01	Spacing	0.09	0.04	0.03
Interaction	0.06	0.02	0.02	Interaction	0.18	0.08	0.06

Table 6: Effect of nitrogen levels and spacing on root length

Root length	S_1	S_2	S_3	Mean
N_0	9.75	8.55	7.55	8.61
N_1	21.23	18.81	15.60	18.55
N_2	20.58	17.41	13.39	17.12
N_3	17.99	14.74	11.78	14.83
Mean	17.38	14.88	12.08	

Factors	C.D at 5%	SE(d)±	SE(m)±
Nitrogen	0.24	0.11	0.08
Spacing	0.21	0.10	0.07
Interaction	0.42	0.20	0.14

Table 7: Effect of nitrogen levels and spacing on root diameter

Root diameter in cm	S_1	S_2	S_3	Mean
N_0	1.95	2.36	2.17	2.16
N_1	3.06	3.51	3.11	3.22
N_2	3.09	3.66	3.42	3.39
N_3	2.67	2.85	2.99	2.84
Mean	2.69	3.09	2.92	

Factors	C.D at 5%	SE(d)±	SE(m)±
Nitrogen	0.05	0.02	0.01
Spacing	0.04	0.02	0.01
Interaction	0.09	0.04	0.03

Table 8: Effect of nitrogen levels and spacing on plant biomass g/plant

Biomass in g/ plant	**S_1**	**S_2**	**S_3**	Mean
N_0	116.60	125.86	137.16	126.54
N_1	192.54	261.22	225.22	226.32
N_2	217.83	270.86	240.26	242.98
N_3	240.26	158.20	169.14	189.20
Mean	193.65	189.46	200.60	

Factors	**C.D at 5%**	**SE(d)±**	**SE(m)±**
Nitrogen	3.55	1.70	1.20
Spacing	3.07	1.47	1.04
Interaction	6.14	2.94	2.08

Table 9: Effect of nitrogen levels and spacing on yield/ plot in kg

Yield kg/plot	**S_1**	**S_2**	**S_3**	**Mean**
N_0	1.23	1.55	1.41	1.40
N_1	2.60	3.69	3.00	3.09
N_2	2.82	4.08	3.23	3.37
N_3	1.94	2.23	2.40	2.19
Mean	2.15	2.89	2.51	

Factors	**C.D at 5%**	**SE(d)±**	**SE(m)±**
Nitrogen	0.11	0.05	0.03
Spacing	0.09	0.04	0.03
Interaction	0.19	0.09	0.06

Table 10: Effect of nitrogen levels and spacing on yield q/ha

Yield q/ha	**S_1**	**S_2**	**S_3**	**Mean**
N_0	137.33	172.53	157.33	155.73
N_1	288.80	409.90	334.00	344.23
N_2	313.63	453.27	359.17	375.36
N_3	215.87	248.43	267.33	243.88
Mean	238.91	321.03	279.46	

Factors	**C.D at 5%**	**SE(d)±**	**SE(m)±**
Nitrogen	0.12	0.06	0.04
Spacing	0.10	0.05	0.03
Interaction	0.21	0.10	0.07

CONCLUSION

It was concluded that effect of nitrogen levels and spacing on height of the plant is very evident. Highest plant height, maximum biomass, number of leaves in plant, length of leaves, root length, root diameter, yield of root in tonnes per hectare were recorded at application of 100 % nitrogen with 25x10cm. So it can be recommended to farmer for better yield.

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