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

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ABSTRACT

The studies were carried out to observe the effect of various nitrogen levels (0, 100, 150 & 200 kg ha^{-1}) and spacing (5, 10 & 15 cm) on growth and yield of radish. The experiment was laid out according to randomized complete block design in factorial arrangement with three replications. Application of 200kg N $ha.^{-1}$ planted at 10 cm plant to plant distance was found the best treatment than others in relation to growth and yield of radish.

Key Words: Nitrogen; Radish; *Raphanus sativus*

INTRODUCTION

It has been observed that radish being cultivated by the vegetable growers in Pakistan is low in yield and quality. Higher yield in radish crop depends upon cultural practices on which proper application of fertilizers and plant population have been found to contribute greatly (Work, 1945). 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 soil, the harvest is poor in size, weight and quality (Hussain *et al.*, 1977). Plant population affects the plant growth, development and yield. In 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.

Present studies were conducted to find out the effect of different levels of nitrogen and spacing on growth and yield of radish grown under ecological conditions of Faisalabad.

MATERIALS AND METHODS

These studies were carried out at experimental vegetable area Institute of Horticultural Sciences, University of Agriculture, Faisalabad, during the year 2002. The experiment comprised of the following nitrogen levels and spacing.

Nitrogen Levels		Intra Row spacing	
No	0 kg ha^{-1}	S_1	5 cm
N_1	100 kg ha^{-1}	S_2	10 cm
N_2	150 kg ha^{-1}	S_3	15 cm
N_3	200 kg ha^{-1}		

Nitrogen fertilizer in the form of urea was applied in two split doses, half at the time of sowing and half after 20 days of sowing.

Sowing of crop. The seeds of radish cultivar "Forty Days" were sown with chocka method (the seed are sown by hands) on double row beds where row to row distance was 37.5 cm. The net plot size was 4.5 m x 1.5 m. The crop was sown on a well prepared seed bed. Full doses of potash and phosphorus in the form of murate of potash @ 50 kg $ha.^{-1}$ and single super phosphae @ 100 kg $ha.^{-1}$, respectively were applied at the time of sowing along with half dose of nitrogen and irrigation was given immediately. Subsequent irrigation, cultural practices and plant protection measures were carried out as and when required for all plots. The following parameters were studied: days to germinate; germination percentage; plant height (cm); number of leaves/plant; root length (cm); root diameter (cm); total biomass / plant (g); root yield per plot (kg); root yield per hectare (t/ha).

The data collected were analyzed using Fisher's analysis of variance technique and differences among the various treatments were determined by using least significant difference test at 5% probability level (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

Days to germinate. There were non significant results for different nitrogen levels, spacing and interaction between nitrogen levels and spacing (Table I). This may be due to the fact that different cultivars take different days to germinate because factors like temperature, soil moisture, seed vigour and dormancy of seed which usually influence the days to germinate. This is in conformity with the findings of Shrivastava *et al.* (1992).

Table I. Effect of nitrogen levels and spacing on growth and yield of radish (*Raphanus sativus* L.)

	NoS_1	NoS_2	NoS_3	N_1S_1	N_1S_2	N_1S_3	N_2S_1	N_2S_2	N_2S_3	N_3S_1	N_3S_2	N_3S_3
Days to Germnate	4.7	4.3	4.3	4.3	4.3	4.7	4.3	4.0	4.0	4.3	4.3	4.3
Germination Percentage	7.78	80.6	78.8	81.5	86.0	81.9	81.6	84.1	83.9	80.5	85.5	84.4
Plant height (cm)	43.3 i	47.2 h	50.3 g	56.7 ef	58.9 e	54.5 f	57.9 e	66.7 d	72.2 c	71.1 b	83.0a	78.7 b
Number of Leaves/Plants	8.1 i	9.2 h	10.2 g	11.4 f	12.2 e	11.8 ef	12.1 e	15.3 c	18.7 a	14.6 d	16.3 b	15.6 c
Root length (cm)	18.6 j	20.5 i	22.1 h	25.2 f	26.3 e	24.1 g	25.8 ef	30.2 d	33.0 c	35.4 b	38.4 a	36.2 b
Root diameter (cm)	2.9	3.7	4.2	3.0	3.9	4.5	3.5	4.9	4.9	3.9	4.6	4.9
Total biomass/plant (g)	28.6 k	29.0 k	31.8 j	35.5 h	34.4 i	38.5 j	39.2 f	41.3 e	42.8 d	44.8 c	45.9 b	46.4 a
Root Yield per plot (kg)	12.8 j	13.2 ij	13.7 hi	14.2 fgh	14.6 efg	13.9 ghi	14.7 def	15.3 cd	15.6 bc	16.0 ab	16.6 a	15.1 cde
Root yield /hectare (t/ha	18.9 h	19.5 gh	20.3 fg	21.0 ef	21.6 de	20.5 fg	21.9 de	22.6 cd	23.2 bc	23.8 ab	24.6 a	22.4 cd

N_0S_1 = 0kg N hac.$^{-1}$ with 5cm spacing; N_0S_2 = 0kg N hac.$^{-1}$ with 10cm spacing; N_0S_3 = 0kg N hac.$^{-1}$ with 15cm spacing; N_1S_1 = 100kg N hac.$^{-1}$ with 5cm spacing; N_1S_2 = 100kg N hac.$^{-1}$ with 10cm spacing; N_1S_3 = 100kg N hac.$^{-1}$ with 15cm spacing; N_2S_1 = 150kg N hac.$^{-1}$ with 5cm spacing; N_2S_2 = 150kg N hac.$^{-1}$ with 10cm spacing; N_2S_3 = 150kg N hac.$^{-1}$ with 15cm spacing

Plant height (cm). Different nitrogen levels, spacing and interaction between two factors significantly affected the plant height (Table I). Highest plant height of 83.0 cm was observed at 200 kg ha^{-1} while lowest value of 43.3 was observed at 0 kg ha^{-1}. Similar results were obtained by Sharma and Kanuzia (1994). As regards spacing, highest plant height of 72.2 cm was recorded at 15 cm spacing and 10 cm spacing (66.7 cm) which were statistically at par with each other. The lowest value of 57.9 cm was observed in case of 5 cm spacing.

It would be observed from the mean values of interactions that maximum plant height of 83.0 cm was observed at 200 kg N ha^{-1} with 10 cm spacing followed by 200 kg N ha^{-1} with 15 cm spacing (78.8 cm) and 200 kg N ha^{-1} with 5 cm spacing (71.1 cm) which were statistically at par with each other. The minimum height of 43.3 cm was produced by 0 kg N ha^{-1} with 5 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. These results are in conformity with the findings of Sharma and Rastogi (1992).

Number of leaves. Data for number of leaves spelt out highly significant results for different nitrogen levels indicating superiority of 200 kg ha^{-1} and 150 kg ha^{-1} over 100 kg ha^{-1} and 0 kg ha^{-1}. 200 kg ha^{-1} and 150 kg ha^{-1} produced 16.3 and 18.7 number of leaves per plant, respectively (Table I). The least number of leaves (8.1) were produced by control. Similar results were obtained by Sharma and Kanaujia (1994). It would be observed from the means of spacing that more number of leaves (18.7) was produced by the treatment 15 cm spacing followed by 10 cm spacing (16.3) and 5 cm spacing (14.6), respectively. These results are confirmed by the findings of Shrivastava *et al*. (1992). In case of interactions, maximum number of leaves was produced by the treatment 150 kg N ha^{-1} with 15 cm spacing which was statistically different from all other treatments whereas, minimum number of leaves per plant (8.1) was produced by the treatment 0kg N ha^{-1} with 5 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.

Root length (cm). Highly significant results for different nitrogen levels, spacing and interaction between two factors were observed (Table I). Mean values in relation to different nitrogen levels indicated significant superiority of 200 kg ha^{-1} over 150 kg ha^{-1}, 100 kg ha^{-1} and 0 kg ha^{-1}. Treatment 200 kg ha^{-1} produced maximum root length of 38.4 cm followed by 150 kg ha^{-1} (33.0 cm), 100 kg ha^{-1} (26.3 cm) and 0 kg ha^{-1} (22.1 cm) while minimum root length was produced by control. These results are evidently in accordance with those of Kolta and Oriowski (1984).

In case of spacing, treatment 15 cm spacing produced roots of 26.2 cm length which was statistically at par with 10 cm spacing (10 cm) which produced root length of 38.4 cm. Both were statistically different from 5 cm spacing which produced root length of 35.4 cm. Similar results were obtained by Minami *et al.* (1998) and Sirkar *et al.* (1998).

In case of interactions between different nitrogen levels and spacing, maximum root length (38.4 cm) was obtained from 200 kg N ha^{-1} with 5 cm spacing which was statically at par with 200 kg N ha^{-1} with 10 cm spacing and statistically different from rest of the treatments whereas, minimum root length (18.6 cm) was produced by 0 kg N ha^{-1} with 5 cm spacing. These results are confirmed by the findings of Chatterjee and Som (1991). 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.

Root diameter (cm). Results related to root diameter are depicted in (Table I.) 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 200 kg N ha^{-1} N level over 100 kg N ha^{-1} and 0 kg N ha^{-1} and was found at par with 150 kg N ha^{-1}. Mean values showed root diameter 4.5, 4.4, 3.8 and 3.6 cm respectively at four N levels. These results are confirmed by the findings of Lenka *et al.* (1990), and Kolota and Orlowski (1984). Different plant spacing data indicated superiority of 15 cm spacing over 5 cm spacing and found at par with 10 cm spacing. Mean values for different spacing (15, 10 & 5) showed root diameter 4.6, 4.3 and 3.3 cm respectively. Similar results

were determined by Khushk *et al.* (1990). Higher N level and higher spacing provided more N and more space for the development of root which resulted in maximum diameter of root.

Total Biomass per plant (g). The data for total biomass are given in the Table I, 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 200 kg ha^{-1} over all other treatments. 150kg $hac.^{-1}$ occupied the 2nd best position whereas; 100 kg 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 200 kg N ha^{-1} with 15 cm spacing over rest of the treatments. 200 kg N ha^{-1} with 15 cm spacing produced maximum total biomass per plant followed by 200 kg N ha^{-1} with 10 cm spacing, where as, 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 dry wt./plant and root dry wt./plant. 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.

Root yield per plot (kg). Observations recorded on root yield per plot were analyzed and results obtained are presented in the Table I, 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 200 kg ha^{-1} over 150 kg ha^{-1}, 100 kg ha^{-1} and 0 kg ha^{-1}. Treatment 200 kg ha^{-1} produced maximum root yield (16.6 kg) per plant followed by 150 kg ha^{-1} (15.6 kg), 100 kg ha^{-1} (14.6 kg) and 0 kg ha^{-1} (12.8 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 16.6 kg and 16.0 kg par plot were produced by the treatments 10 and 5cm spacing. Similar results were obtained by Minami *et al.* (1998).

In case of interactions, maximum root yield (16.6 kg) per plot was produced by 200 kg N ha^{-1} with 10 cm spacing followed by 200 kg N ha^{-1} with 5 cm spacing, 150 kg N ha^{-1} with 15 cm spacing, 150 kg N ha^{-1} with 10 cm spacing and 200 kg N ha^{-1} with 15 cm spacing which produced root yield of 16.0, 15.6, 15.3 and 15.1 kg per plot, respectively. The minimum root yield (12.8 kg) per plot was produced by control. Similar results were obtained by Vishnu and Probhakar (1989). It is fact that yield is related to number of plants survived per plot, root wt., root length and root size. These results are in line with the findings of Partha sararthi *et al.* (1999).

Root yield /hectare (t/ha). Data concerning yield of roots per hectare were subjected to statistical analysis and results obtained are presented in the Table I, 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 200 kg ha^{-1} over all other treatments. 150 kg ha^{-1} occupied the 2nd best position while, 100 kg ha^{-1} and 0 kg ha^{-1} remained at 3rd and 4th positions. 0 kg ha^{-1} with 15 cm spacing produced highest root yield per hectare.

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 200 kg ha^{-1} with 10 cm spacing produced maximum root yield per hectare which was statistically at par with 200 kg 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 Vishnu and Probharakar (1989) Minami *et al.* (1998) and Hussain *et al.* (1997).

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