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Impact of growth and quality on radish (*Raphanus sativus* L.) as influenced by different doses of NPK

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Abstract
The present investigation entitled "Impact of Growth and Quality on Radish (*Raphanus sativus* L.) as influenced by different doses of NPK" was conducted at Vegetable Research Farm at College of Horticulture, Banda University of Agriculture and Technology, Banda, Uttar-Pradesh during *Rabi* season of 2021. The experiment was laid out in Randomized Block Design with three replications. The treatments involved in the study were 10 in numbers *i.e.*,T_1 50:100:50 NPK/ha (control), T_2 100:100:50 NPK/ha, T_3 150:100:50 NPK/ha, T_4 200:100:50 NPK/ ha, T_5 50:150:50 NPK/ha, T_6 50:200:50 NPK/ha, T_7 50:250:50 NPK/ha, T_8 50:100:100 NPK/ha, T_9 50:100:150 NPK/ha and T_{10} 50:100:150 NPK/ha and they were applied with an objective to study the effect of NPK on growth and quality of Radish. On the basis of result obtained and summarized from the present study, it can be concluded that all the observations taken for radish were found to be superior with the application of NPK. In the present study, it was observed that the application of 200:100:50 NPK/ha increased all the parameters [*i.e.* plant height (cm), number of leaves plant-1, leaf length (cm), leaf width (cm), weight of leaves per plant (g) and TSS (^{0}Brix)] followed by 150:100:50 NPK/ha and 50:250:50 NPK/ha. Therefore among all the combinations of NPK applied 200:100:50 NPK/ha was found significantly most effective in increasing the growth and quality attributing traits.

Keywords: Radish, NPK, Growth, Quality

Introduction
Among the root vegetables, Radish (*Raphanus sativus* L. 2n=18.) is an important vegetable crop belongs to the family Brassicaceae and originated from Europe. It is one of the important root vegetable extensively cultivated throughout India particularly in Uttar Pradesh, Bihar, West Bengal, Assam, Punjab, Haryana, Himanchal Pradesh and Gujrat during winter season throughout the world. It is also called 'Mooli' which is an annual or biennial herb has a rosette of leaves vary in size. It is predominantly a cool season vegetable crop and sown during winter from September to January in northern plains. In India radish is cultivated on area of 204'000 ha with total production of 3107'000 MT ((NHB 2019-20). Radish is consumed as raw or as a salad. It is rich in calcium 50mg, potassium 138mg, phosphorus 22mg, Vitamin C 15mg and a variety of minerals. The edible portion of radish root different in colour from white to red develops from both primary root & the hypocotyls. It attains best flavor, texture and size at 10 to 15 ℃ temperature. Pinked skinned radish is generally richer in Vitamin C than the white skinned one. The characteristic pungent flavor of radish is due to the presence of volatile Isothiocynates. (Bose *et al*., 2000) [5]. Radish is widely acclaimed for its excellent nutritional and medicinal values. Its roots are considered as an appetizer and are also useful in recovering from piles, urinary complaints and in gastrodynia. It can be cultivated under cover for early production but large-scale production in field is more common in India. It has refreshing and diuretic properties. It is also used for neurological headache, sleeplessness and chronic diarrhea. The leaves of radish are good source for extraction of protein on a commercial scale and radish seeds are potential source of nondrying fatty oil suitable for soap making illuminating and edible purposes. Being a short duration and quick growing crop, the root growth should be rapid and uninterrupted. The productivity of radish is influenced by several factors such as soil, varieties, fertilizer management and various agro techniques used for growing crop. Nutrients play a vital role in functioning of normal physiological processes during the period of growth and development of plants. However, for obtaining higher economic yield, balanced supply of nutrients is one of the key factors (Singh, 1976) [21]. Too low or high fertilizers levels can reduce the growth and development process of plants which

may affect the crop. Nitrogen is abundantly available (70-80%) in the atmosphere but the plants cannot take it directly from the atmosphere, hence nitrogen requirement of the plant is generally met out with the use of chemical fertilizers however, on the other hand, some microorganisms are available, which can fix atmospheric nitrogen in the plant roots. The balanced fertilization in radish is important factor to boost growth attributes. The application of nitrogen with different doses increases plant growth and yield of radish (Patel *et al*., 1992) [15]. Its deficiency causes interveinal yellowing, development of anthocyanin pigment, rolling of leaves, chlorosis and necrosis (Singh and Srivastava, 1962) [23]. Phosphorus is indispensable constituent of nucleic acids, phospholipids and several enzymes. It is also needed for the transfer of energy within the plant system and is involved in its various metabolic activities (Yalwalker *et al*., 1962) [27]. Phosphorus has its beneficial effect on early root development, plant growth, yield and quality. Indian soils have poor to medium status in available phosphorus for crops and remaining part is converted to insoluble phosphorus. Phosphorus plays a key role in the formation of energy bound phosphate (ADP and ATP). Potassium is one of the three major nutrient elements (N, P and K) required by plants. There are evidences of direct involvement of potassium in photosynthesis and its involvement in leaf tissues metabolic activities of chloroplast. It regulates transpiration through opening and closing of the stomata by affecting activities of guard cells. In these organelles, Potassium activates & the fat producing enzymes and thuds enhances the oil content (Mandal and Chatterjee, 1973) [8].

Materials and Methods

The field experiment was carried out to evaluate the effect of NPK on growth and quality traits of radish at Vegetable Research Farm at College of Horticulture, Banda University of Agriculture and Technology, Banda, Uttar-Pradesh during Rabi season of 2021. The experiment was laid out in randomized block design with three replications, measuring a net plot size of 3m × 2m = 6 m².The healthy and disease free authentic seeds of radish variety Kashi Hans was used for conducting experiments. Seeds were sown in recommended spacing of 20 x 10 cm. The treatments involved in the study were 10 in numbers i.e.,T1 50:100:50 NPK/ha (control), T2 100:100:50 NPK/ha, T3 150:100:50 NPK/ha, T4 200:100:50 NPK/ ha, T5 50:150:50 NPK/ha, T6 50:200:50 NPK/ha, T7 50:250:50 NPK/ha, T8 50:100:100 NPK/ha, T9 50:100:150 NPK/ha and T10 50:100:150 NPK/ha. A uniform dose of FYM @ 25 t/ha and different doses of NPK fertilizers (Nitrogen through Urea, Phosphorus through Single Super Phosphate and Potassium through Murate of Potash) according to treatments will be applied in all the treatments and replications. The entire dose of FYM, phosphorus and potassium and half dose of nitrogen will be applied at the time of last ploughing whereas, half dose of nitrogen will be applied at 25 days after sowing at the time of weeding-cum hoeing. All other cultural operations were kept normal and uniform for all treatments as per package of practices recommended for this crop during the course of study. The observations were recorded by selecting five plants randomly from each plot. Experimental data was analyzed statistically with the analysis of variance at five percent probability level as per the statistical methods described by Panse and Sukhatme (1984) [14].

Result and Discussion

Plant height (cm)

Application of NPK had positive increased in growth of the plants, in turn the yield attributing parameters. The maximumplantheight at 20 DAS, 40 DAS and at the time of harvesting(14.33, 32.26, and 45.26 cm respectively) was recorded in T_4 200:100:50 NPK followed by $T_3$150:100:50 NPK (12.66, 29.53 and 43.00cm) and $T_2$100:100:50 NPK (11.16, 26.03 and 40.00 cm), whereas, the minimum plant height at 20 DAS, 40 DAS and at the time of harvesting (6.83,17.66 and 28.60cm respectively) was recorded in $T_1$50:100:50 NPK (Control). [Table -1]. According to Poudel *et al.,* (2018) [18] highly significant results of plant height for different nitrogen levels was observed in radish. Highest plant height was observed in 250kg/ ha N (49.875cm) which is statistically *at par* with 200kg/ha and 300kg/haN. Minimum plant height was observed in 100kg/ha N that is statistically *at par*with 150kg/ha N. Similar results were obtained by Sharma and Kanuzia 2004 [19]. 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 *et al.*, (2004) [19] Plant height is an indicator of vegetative growth. lower plant height might be due to the result of unavailability of nitrogen and other nutrients required by the plants for their normal growth and development. It was observed that an increase in nitrogen levels positively affected the plant height which might be due to the role of nitrogen for cell division, cell enlargement and protein synthesis characteristics. An improvement in plant height with increasing nitrogen applications has also been confirmed with the findings of Sharma (2004) [19]. Similar results have also been reported earlier by Bhuvaneswari *et al*. (2016) and Pathak *et al*. (2017) [3, 16].

Number of leaves per plant

The data on number of leaves plant^{-1} was recorded at 20, 40 DAS and at the time of harvesting influenced by different treatments. The maximum number of leaves plant^{-1} (7.00, 10.33 and 13.53 respectively) was recorded in T_4(200:100:50 NPK) followed by T_3 150:100:50 (6.46,10.06 and 13.06) and T_2 100:100:50 NPK (6.26, 9.86 and 12.80). Whereas, the minimum number of leavesplant^{-1}at 20, 40 DAS and at the time of harvesting (4.00, 6.80 and 9.53) was recorded in T_1 50:100:50 NPK (Control). [Table-1]. Jawad *et al*. (2015) [6] Observed that the application of 200 kg N/ha gave the maximum number of leaves per plant. Moniruzzaman *et al.* (2013) [12] found that application of nitrogen significantly influenced the number of leaves of carrot at all stages. It might be due to the higher level of N application which increased the plants height and ultimately the leaf number.Similar finding shave been reported by Sharma (2004) [19] and Bilekudari *et al.* (2005) [4] inradish.

Table 1: Effect of NPK and their combinations on Plant height (cm) and Number of leaves per plant of Radish

Treatments	Plant height (cm)			Number of leaves per plant		
	20 DAS	40 DAS	At the time of harvesting	20DAS	40DAS	At the time of harvesting
T_1 50:100:50 (control)	6.83	17.66	28.60	4.00	6.80	9.53
T_2 100:100:50	11.16	26.03	40.00	6.26	9.86	12.80
T_3 150:100:50	12.66	29.53	43.00	6.46	10.06	13.06
T_4 200:100:50	14.33	32.26	45.26	7.00	10.33	13.53
T_5 50:150:50	10.16	25.13	37.80	6.00	9.53	12.33
T_6 50:200:50	9.66	24.20	36.50	5.73	9.33	11.93
T_7 50:250:50	9.06	23.50	35.13	5.40	9.13	11.73
T_8 50:100:100	8.03	22.26	34.20	5.20	8.93	11.46
T_9 50:100:150	7.20	20.06	32.46	4.93	8.73	11.13
T_{10} 50:100:200	7.00	18.76	30.46	4.66	8.40	10.20
Sm±	0.31	0.30	0.13	0.07	0.06	0.17
CD	0.94	0.90	0.40	0.23	0.20	0.51

Length of leaves (cm)

The data as regards the length of leaves was recorded at 20, 40DAS and at the time of harvesting influenced by different treatments. The maximum and significantly maximum length of leaves (9.26, 28.00, and 38.00 cm respectively) was recorded in T_4 (200:100:50 NPK). Followed by T_3 150:100:50 NPK (8.93, 27.46 and 36.36 cm) and T_2 100:100:50 NPK (8.70, 26.43 and 35.82 cm). Whereas, the minimum lengthof leaves at 20, 40 DAS and at the time of harvesting (4.00, 16.00 and 20.00 cm) was recorded in T_1 50:100:50 (Control). Jilani *et al.* (2010) [7] studied the Effect of different levels of nitrogen on growth and yield of radish and the results showed that higher N levels gave better results for all parameters studied. Maximum leaf length (33.33, 32.80 and 31.10 cm) was recorded when N was applied @ 200, 250 and 150 kg per hectare, respectively. [Table-2]. Mehwish *et al.* (2016) [9] revealed that all growth attributes and yield were significantly enhanced by the application of organic manures and NPK. The highest values were found in NPK treated plants followed by PM, GM, SS, PrM and FYM, respectively. Assimilatory surface area is a pre-requisite for prolonged photosynthetic activity and ultimate crop productivity. Leaf size fairly gives a good idea of the photosynthetic capacity of the plant. The large leaves receive more sunlight for photosynthesis as compared to smaller leaves.

Width of leaves (cm)

The data as regards width of leaves was recorded at 20, 40 DAS and at the time of harvesting influenced by different treatments. The maximum and significantly higher Width of leaves (5.26, 9.00 and 14.50 cm. respectively) was recorded in T_4 (200:100:50 NPK) Followed by T_3 150:100:50 NPK (4.90, 8.73 and 13.46 cm) and T_2 100:100:50 NPK (4.66, 8.16 and 12.96 cm). Whereas, the minimum width of leaves (3.40, 6.00 and 10.00 cm) was recorded in T_1 50:100:50 NPK (Control) at all the growth stages. [Table-2]. The present finding also corroborate the findings of Pervez *et al.* (2004) [17] who observed the effect of various nitrogen levels (0, 100, 150 & 200 kg/ha.) and spacing (5, 10 & 15 cm) on growth and yield of radish and found that application of 200kg N/ha planted at 10 cm plant to plant distance was found the best treatment than others in relation to growth and yield of radish. The present finding also corroborate the findings of Baloch *et al.*, (2014) [1], Mohammad *et al.* (2015) and Verma *et al.* (2017) [26] in radish. Thakar *et al.* (2006) [24] also reported that increase in parameters like leaves plant^{-1}, leaf area, leaf numbers, leaf weights etc. in response to heavier dose of nitrogen fertilizer. Leaf area being the photosynthetic surface plays an important role in determining the total biomass accumulation. The doses of nitrogen fertilizer were positively correlated vegetative growth in radish.

Table 2: Effect of NPK and their combinations on Length and Width of leaf (cm) of Radish

Treatments	Length of leaves(cm)			Width of leaf (cm)		
	20 DAS	40 DAS	At the time of harvesting	20DAS	40DAS	At the time of harvesting
T_1 50:100:50 (control)	4.00	16.00	20.00	3.40	6.00	10.00
T_2 100:100:50	8.70	26.43	35.82	4.66	8.16	12.96
T_3 150:100:50	8.93	27.46	36.36	4.90	8.73	13.46
T_4 200:100:50	9.26	28.00	38.00	5.26	9.00	14.50
T_5 50:150:50	8.36	26.00	34.76	4.53	8.03	12.56
T_6 50:200:50	8.06	25.82	34.26	4.20	7.63	12.08
T_7 50:250:50	7.76	25.26	33.63	4.00	7.30	11.73
T_8 50:100:100	7.43	24.92	32.71	3.93	6.96	11.35
T_9 50:100:150	7.30	24.47	32.10	3.76	6.63	11.13
T_{10} 50:100:200	6.83	23.99	31.40	3.50	6.33	10.76
Sm±	0.16	0.18	0.57	0.19	0.12	0.38
CD	0.49	0.54	1.72	0.58	0.37	0.12

Weight of leaves per plant (g)

Maximum weight of leaves per plant at the time of harvesting was recorded with T_4 200:100:50 NPK (198.80 g) followed by T_3 150:100:50 NPK (185.66 g) and T_7 50:250:50 NPK (180.20 g), while the control plants were found to be minimum in weight of leaves per plant T_1 50:100:50 NPK (139.86 g) during the investigation. Jilani *et al.* (2010) [7] studied the effect of different levels of nitrogen on yield of radish and the results showed that higher N levels gave better results for all studied parameters. Maximum weight of leaves (160.67, 132.83 and 140.82 g) were recorded when N was applied @ 200, 250 and 150 kg per hectare, respectively.[

Table-3]. Corresponding to the findings of present investigation Pervez *et al.* (2004) [17], Jawad *et al.* (2015) [6], Mohammad *et al.* (2015) and Mehwish *et al.* (2016) [9] in radish. The increase in weight of leaves by the use of NPK may be due to beneficial influence of nitrification inhibition properties of nitrogen in the soil. Besides, it may also be due to rapid elongation and multiplication of cell in the presence of adequate quantity of nitrogen (Barman *et al.*, 2014) [2]. Similar results were reported by Singh *et al.* (2016) [22] and Verma *et al.* (2017) [26]

Total soluble solids (^{0}Brix)

Maximum TSS were recorded with T_4 200:100:50 NPK (3.76 ^{0}Brix) followed by T_3 150:100:50 NPK (3.50 ^{0}Brix) and T_7 50:250:50 NPK (3.46 ^{0}Brix), while the control plants were found to be minimum in TSS T_1 50:100:50 NPK (1.73 ^{0}Brix) during the investigation. [Table-3]. It might be due to accumulation of more reserve substances in root. These findings are in agreement with those reported by Sharma *et al.*, (2013) [20], Pathak *et al.*, (2017) [16], Tripathi *et al.*, (2017) [25] and Nargave *et al.*, (2018) [13], Mishra *et al.*, (2020) [10] in radish.

Table 3: Effect of NPK and their combinations on weight of leaves (g) and Total Soluble Solids (^{0}Brix) of Radish

Treatments	Weight of leaves (g)	Total Soluble Solids (^{0}Brix)
T_1 50:100:50 (control)	139.86	1.73
T_2 100:100:50	170.73	3.10
T_3 150:100:50	185.66	3.50
T_4 200:100:50	198.80	3.76
T_5 50:150:50	156.86	2.60
T_6 50:200:50	176.93	3.33
T_7 50:250:50	180.20	3.46
T_8 50:100:100	150.48	2.33
T_9 50:100:150	160.06	2.90
T_{10} 50:100:200	167.20	2.93
SEm±	2.88	0.27
CD	8.62	0.82

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