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Effects of different nitrogen, phosphorus and potassium levels on growth and yield parameters of radish (*Raphanus sativus* L.) Variety Pusa Himani

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Abstract
The proper amount of nitrogen, phosphorus and potassium is required to maximize the yield of radish. Thus, the study entitled "Effects of different nitrogen, phosphorus and potassium levels on growth and yield parameters of radish (*Raphanus sativus* L.) variety Pusa Himani" was conducted to determine the effect of nitrogen, phosphorus and potassium levels on growth and yield parameter in radish from 20th February to 20th April 2022 in the field of Rama University, Mandhana, Kanpur, Uttar Pradesh, India. The study was conducted on the Pusa Himani variety of radish. The study was conducted on the Randomized Complete Block Design (RCBD) with three replications and each replication consist of eight treatments i.e. eight different rates of nitrogen phosphorus and potassium. Different rates of fertilizers were: T_1 (0:0:0 NPK kg/ha), T_2 (20:10:15 NPK kg/ha), T_3 (40:20:30 NPK kg/ha), T_4 (60:30:45 NPK kg/ha), T_5 (80:40:60 NPK kg/ha), T_6 (100:50:75 NPK kg/ha), T_7 (120:60:90 NPK kg/ha) and T_8 (140:70:105 NPK kg/ha). Different treatments showed significant effects on all observed parameters. Among various treatments, T_5 recorded the highest germination percentage (94.67%), number of leaves (14.330), shoot length (16.530 cm), shoot weight (0.111 kg), root length (29.270 cm), root diameter (11.133 cm), root weight (0.151 kg), total biomass (0.262 kg), root yield per plot (3.775 kg) and root yield per hectare (37.750 t/ha). Thus it is suggested to use nitrogen (N), phosphorus (P) and potassium (K) at the rate of 80, 40 and 60 kg respectively.

Keywords: Radish, growth, yield

Introduction
Radish (*Raphanus sativus* L.) is a member of the Brassicaceae family with chromosome number 2*n*= 2*x*= 18 and is closely related to *Brassica rapa* (Shen *et al.*, 2012) [13]. Radish is native to Europe or Asia (Lakra *et al.*, 2017) [9]. It is a winter season crop that is popular in both temperate and tropical countries. It is a root vegetable whose taproot is enlarged to form fleshy root as the edible organ widely cultivated around the globe and is a nutritionally well-balanced vegetable in existence (Liao *et al.*, 2009) [10]. The enlarged edible roots are fusiform botanically which may differ in color from white to red (Singh and Bhandari, 2015) [15]. Carbohydrates, protein, crude fiber and vitamin C are the nutritious constituents of radish (Bakhsh *et al.*, 2006) [3], broadly used as core plant, green sprouts and flabby leaves (Alam *et al.*, 2010) [1].

Radish is a short-duration crop so judicious and proper use of fertilizer is required to enhance the yield and quality of radish root. Nitrogen (N), phosphorus (P) and potassium (K) are macro nutrients that play a significant role in the determination of the yield and quality of radish.Among macronutrients, nitrogen is indispensable for the growth and development of plants (Pervez *et al.*, 2004) [11]. An optimum dose of nitrogen is required for the building up of protoplasm and protein that induce cell division and commence meristematic activities (Lakra *et al.*, 2017) [9]. Nitrogen helps in the improvement of the absorption and respiration process in plants and the activation of vegetation (Lakra *et al.*, 2017) [9]. More number of leaves in radish can give more root yield than the radish with fewer leaves (Lakra *et al.*, 2017) [9]. The deficiency of nitrogen in the soil leads to poor size, weight, and quality during harvesting (Hussain *et al.*, 1977) [6]. Adequate nitrogen helps to enhance yield due to positive effects on plant growth, fresh leaf weight, and root development (Jilani *et al.*, 2010) [8]. Phosphorus is an important macro nutrient required for the growth and development of plants (Baloch *et al.*, 2014) [2]. The deficiency of phosphorus limits the growth of plants and makes them immature

(Sadia *et al*., 2013) [12]. Phosphorus shortage causes reddish or purple leaves, stems, and branches, stunted top growth that results in low yield, and ultimately poor quality of crops (Zeb *et al*. 2016) [16]. The lack of phosphorus reduces the production of the plant due to its low mobility in soil and the root system (Lakra *et al*., 2017) [9]. Potassium is another important macro nutrient required for the proper growth, development and production of crops. Potassium promotes plant growth and is helpful in different processes like photosynthesis, translocation of food, cell extension and formation of proteins (Inam *et al*., 2011) [7]. Potassium is required for the transport of sugars to the storage organs (Chhetri *et al*., 2019) [4]. Potassium regulates the opening and closing of stomata and also activates enzymes that are required for the generation of ATP (Chhetri *et al*., 2019) [4].

Nitrogen, phosphorus and potassium are macro-nutrients so deficiencies of nitrogen, phosphorus and potassium in soil result in poor crop yield with low quality. While excessive use of nitrogen, phosphorus and potassium also negatively affects the quality as well as yield of crops including radish. Heavy use of fertilizer increases the toughness and fiber content of radish. Further, high doses of fertilizer reduce the health condition of the soil as well as human. Fertilizers are expensive and a high dose of fertilizer increases the cost of production due to which farmers can not achieve maximum benefit. Thus, the appropriate dose of nitrogen, phosphorus and potassium is required for the optimum performance of the crop. Thus, this study was conducted to determine the appropriate dose of nitrogen, phosphorus and potassium for radish to some extent. Further, the information obtained during this research would be helpful to the growers or local farmers of the area to enhance the production of radish.

Material and Method

The research was conducted from 20th February to 20th April, 2022 in the field of Rama University, Mandhana, Kanpur, Uttar Pradesh, India. The study was conducted on the Randomized Complete Block Design (RCBD) with three replications and each replication consist of eight treatments i.e., T_1 (0:0:0 NPK kg/ha), T_2 (20:10:15 NPK kg/ha), T_3 (40:20:30 NPK kg/ha), T_4 (60:30:45 NPK kg/ha), T_5 (80:40:60 NPK kg/ha), T_6 (100:50:75 NPK kg/ha), T_7 (120:60:90 NPK kg/ha) and T_8(140:70:105 NPK kg/ha. The field was divided into 24 smaller plots according to the layout plan where the area of the individual plot was maintained at 1 mx 1 m (1 m^2). The total area of the field was 62.5 m^2 in which length was 12.5 m and breadth was 5 m. The space between each replication and treatment was 0.5 m. the field border of 0.5 m was maintained. Then the data were analyzed with the help of Genstat Fifteen Edition. The Analysis of Variance (ANOVA) in Randomized Complete Block Design (RCBD) was used to determine the level of significance. The treatment means were compared by the Least Significant Difference (LSD) test at 1% and 5% levels of probability (Gomez and Gomez, 1984; Shrestha, 2019) [5, 14].

Results and Discussion

1. Effect of different doses of nitrogen, phosphorus and potassium on germination percentage, number of leaves and shoot length of radish

The highest germination percentage (94.670%) was recorded on T_5 followed by 90.000% on T_4. The lowest germination percentage (75.330%) was recorded on T_1. A significant effect was observed on the number of leaves of radish with different treatments (Table 1). Among various treatments, T_5 recorded the highest number of leaves (14.330). T_4 recorded 13.670 leaves which was the highest after T_5. T_1 recorded the lowest number of leaves (9.800). T_1 and T_8 did not show significant differences on the number of leaves. Different rates of nitrogen, phosphorus and potassium showed a significant effect on shoot length. Among various treatments, the highest shoot length (16.530 cm) was noted on T_5 which was followed by T_4 which recorded a 15.830 cm shoot length while the lowest shoot length (11.900 cm) was noted on T_1. T_1 and T_8 did not any significant differences in terms of shoot length.

Table 1: Effect of different doses of nitrogen, phosphorus and potassium on germination percentage, number of leaves and shoot length of radish

Treatment	Germination percentage (%)	Number of leaves	Shoot length (cm)
T_1	75.33	9.800	11.90
T_2	81.33	10.97	13.03
T_3	86.00	12.40	14.53
T_4	90.00	13.67	15.83
T_5	94.67	14.33	16.53
T_6	84.00	13.03	15.13
T_7	78.67	11.33	13.53
T_8	77.33	10.03	12.23
Grand mean	83.420	11.950	14.090
CV (%)	1.100	2.100	1.700
LSD (0.05)	4.931	1.722	1.673
F test	***	***	***

Treatments means followed by the common letter or letters within the column are not significantly different among each other at a 5% level of significance. LSD = Least significant difference, CV = Coefficient of variation and ***= Significant at $P \leq 0.001$.

2. Effect of different doses of nitrogen, phosphorus and potassium on shoot weight, root length, root diameter and root weight of radish

Different rates of nitrogen, phosphorus and potassium showed significant results in the shoot weight of radish (Table 2). Among several treatments, T_5 recorded the highest shoot weight (0.111 kg) followed by 0.104 kg at T4. The lowest shoot weight (0.075 kg) was observed at T_1. All the other treatments recorded higher shot weight than T1. Different rates of nitrogen, phosphorus and potassium showed a significant effect on the root length of radish (Table 2). The highest root length (29.270 cm) was recorded at T_5 followed by 27.500 cm at T_4 while the lowest root length (17.500 cm) was recorded at T_1. T_1 and T_8 did not show any significant

difference in terms of root length.Different treatments showed a significant effect on root diameter (Table 2). Among different treatments, T_5 recorded the maximum root diameter (11.133 cm) followed by T_4 with a 10.867 cm diameter of radish while T_1 recorded the minimum root diameter (7.500 cm). Further, all other treatments recorded more root diameter than T_1. A significant effect was observed on the root weight of radish with different treatments. Among different treatments, the highest root weight (0.151 kg) was observed on T_5. The second highest toot weight (0.144 kg) was observed on T_4. The lowest root weight (0.115 kg) was observed on T_1.

Table 2: Effect of different doses of nitrogen, phosphorus and potassium on shoot weight, root length, root diameter and root weight of radish

Treatments	Shoot weight (kg)	Root length (cm)	Root diameter (cm)	Root weight (kg)
T_1	0.075	17.500	7.500	0.115
T_2	0.083	22.970	8.167	0.123
T_3	0.092	25.100	8.600	0.132
T_4	0.104	27.500	10.867	0.144
T_5	0.111	29.270	11.133	0.151
T_6	0.100	26.700	9.833	0.140
T_7	0.085	22.670	9.133	0.125
T_8	0.077	17.800	7.933	0.117
Grand mean	0.091	23.690	9.146	0.131
CV (%)	0.500	2.000	1.200	0.300
LSD (0.05)	0.008	2.146	0.761	0.008
F test	***	***	***	***

Treatments means followed by the common letter or letters within the column are not significantly different among each other at a 5% level of significance. LSD = Least significant difference, CV = Coefficient of variation and ***= Significant at $P \leq 0.001$.

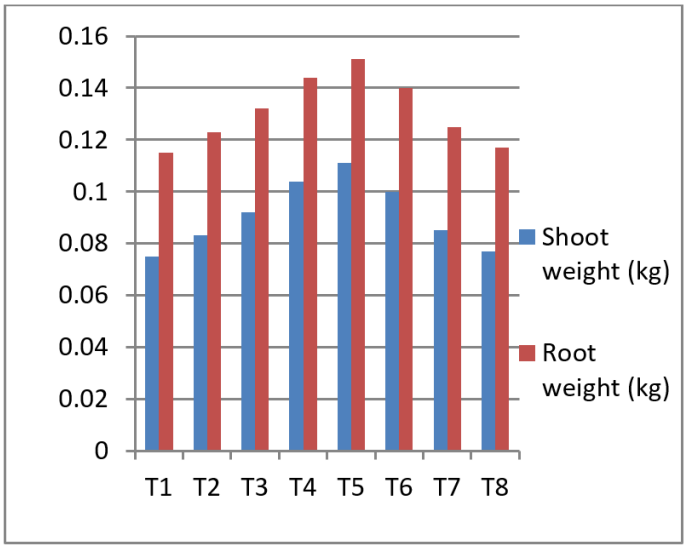

Fig 1: Effect of different doses of nitrogen, phosphorus and potassium on shoot weight, and root weight of radish

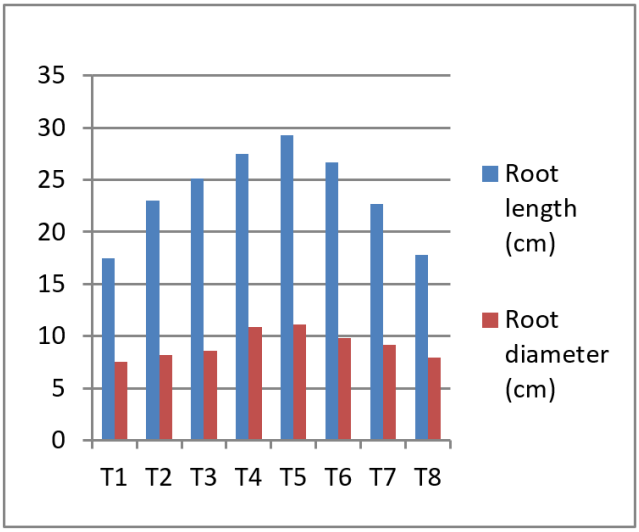

Fig 2: Effect of different doses of nitrogen, phosphorus and potassium on root length, and root diameter of radish

3. Effect of different doses of nitrogen, phosphorus and potassium on total biomass, root yield per plot and root yield per hectare of radish

A significant result was observed in total biomass with different doses of nitrogen, phosphorus and potassium (Table 3). Among several treatments, T_5 recorded the highest total biomass (0.262 kg) followed by T_4 which recorded 0.248 kg total biomass while T_1 recorded the lowest total biomass (0.190 kg). T_2 and T_8 did not show significant differences. Different rates of nitrogen, phosphorus and potassium recorded a significant effect on root yield per plot (Table 3). Among various treatments, the maximum root yield per plot (3.775 kg) was noted on T_5 followed by 3.600 kg on T_4 while the lowest root yield per plot (2.875 kg) was recorded in T_1. Different rates of nitrogen, phosphorus and potassium showed a significant effect on root yield per hectare (Table 3). Among several treatments, T_5 recorded the highest root yield per hectare (37.750 t/ha) followed by 36.000 t/ha in T_4 while the lowest root yield per hectare (28.750 t/ha) was recorded on T_1.

Table 3: Effect of different doses of nitrogen, phosphorus and potassium on total biomass, root yield per plot and root yield per hectare of radish

Treatments	Total biomass (kg)	Root yield per plot (kg)	Root yield per hectare (t/ha)
T_1	0.190	2.875	28.750
T_2	0.206	3.075	30.750
T_3	0.224	3.300	33.000
T_4	0.248	3.600	36.000
T_5	0.262	3.775	37.750
T_6	0.241	3.517	35.170
T_7	0.210	3.133	31.330
T_8	0.194	2.933	29.330
Grand mean	0.222	3.276	32.760
CV (%)	0.400	0.300	0.300
LSD (0.05)	0.016	0.210	2.109
F test	***	***	***

Treatments means followed by the common letter or letters within the column are not significantly different among each other at a 5% level of significance. LSD = Least significant difference, CV = Coefficient of variation and ***= Significant at $P \leq 0.001$.

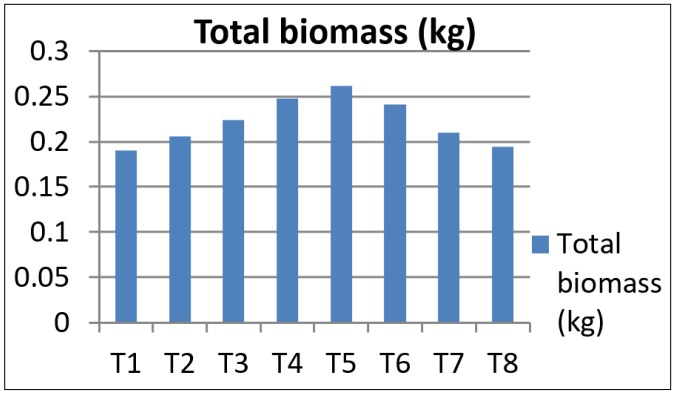

Fig 3: Effect of different doses of nitrogen, phosphorus and potassium on total biomass of radish

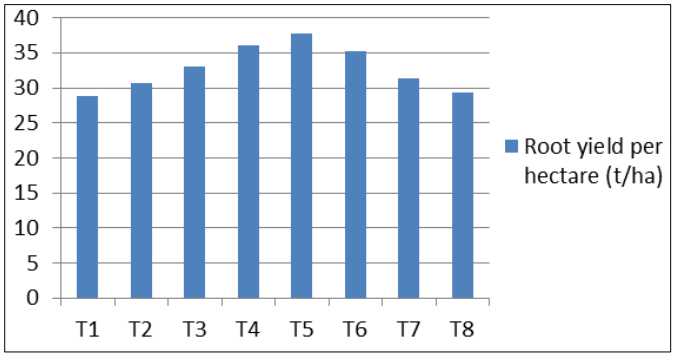

Fig 4: Effect of different doses of nitrogen, phosphorus and potassium on root yield per hectare of Radish

Conclusion

From the study, it can be concluded that T_5 (80, 40, 60 kg NPK/ha) showed the best performance as it recorded the highest germination percentage, number of leaves, shoot length, shoot weight, root length, root diameter, root weight, total biomass, root yield per plot and root yield per hectare. So, it can be suggested to use 80 kg nitrogen, 40 kg phosphorus and 60 kg potassium per hectare to obtain maximum yield from radish.This result showed that the best combination for growing PusaHimani variety of Radish in Kanpur area of India.

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