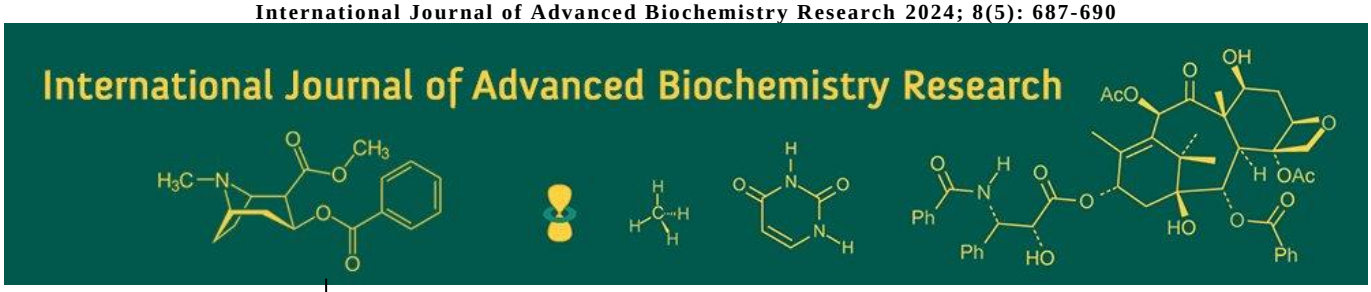

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Effect of nitrogen level on growth and yield attributing characters of radish (*Raphanus sativus* L.) cv. Pusa Chetki

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Abstract
The present investigation entitled **"**Effect of nitrogen level on growth and yield Attributing character of radish (*Raphanus sativus* L.) cv. Pusa Chetki " was carried out during Rabi season in the year 2023-24 at Research plot of Department of Vegetable Science at Rama University Kanpur. The experiment was laid out in Randomised Block Design with eight treatments randomized thrice. Pusa Chetki variety was taken to study best suitable combination of Nitrogen to get highest yield in radish. The Different Nitrogen level used *viz*., N0 (Control); N1 (60 kg Nitrogen/ha); N2 (80 kg Nitrogen/ha); N3 (100 kg Nitrogen/ha); N4 (120 kg Nitrogen/ha); N5 (140 kg Nitrogen/ha); N6 (160 kg Nitrogen/ha) and N7 (180 kg Nitrogen/ha). It is observed from the investigation that the treatment N4- 120 kg Nitrogen/ha gave the highest growth and yield parameters *viz*., Plant height at 15 DAS, 30 DAS and at harvest (13.84,26.50 and 65.10 cm), number of leaves per plant at 15 DAS, 30 DAS and at harvest(6.72,9.84 and 17.10), Fresh weight of leaves at 15 DAS, 30 DAS and at harvest (44.10,83.28 and 118.32 gm), Leaf area per plant at 15DAS, 30 DAS and at harvest (41.20,132.54 and 170.64 cm2), Length of leaves at harvesting (38.22 cm), Root length (26.78 cm), Root girth (12.10 cm), Average plant weight at Harvesting (224.15 gm), Fresh root weight (150.45 gm/plant), Yield per plot (34.15 kg) and Yield per hectare (376.52 q) respectively. While, the minimum results were found under N0 (Control) for all the parameters. So, we can suggest to farmers that the dose of 120 kg Nitrogen/ha gave the better results in term of growth and yield of Radish.

Keywords: Radish cv. Pusa Chetki, nitrogen, growth and yield parameters

Introduction
Radish (*Raphanus sativus* L.) is a widely recognized root vegetable cultivated as an annual or biennial plant within the Brassicaceae family and Raphanus genus. Its appeal stems from its adaptable nature to various climates, straightforward cultivation techniques, and versatile uses, primarily focusing on its tender taproot. Both the root and leaves of radish possess low caloric value. Nitrogen stands out as a crucial element for plant growth, being integral to numerous plant structures and essential for internal and external metabolic functions. Healthy plants typically maintain nitrogen levels ranging from 3-4% in their above-ground tissues, a concentration notably higher than other nutrients. Nitrogen plays a pivotal role among macronutrients in facilitating the growth and development of plants, forming key components of vital compounds such as proteins, nucleic acids, chlorophyll, and enzymes. Soil deficient in nitrogen leads to diminished crop harvests in terms of size, weight, and quality. To augment crop production and optimize nitrogen utilization on a global scale, nitrogen fertilization remains a widely adopted practice. In radish cultivation, nitrogen fertilization holds particular significance, with its application tailored not only to maximize yield size but primarily to enhance overall yield quality. Although nitrogen proves indispensable as a constituent of essential plant components like proteins, nucleic acids, chlorophyll, and enzymes, an imbalance in its application can lead to adverse effects. Insufficient nitrogen results in poor crop yields of inferior quality, while excessive usage negatively impacts both crop quality and yield. Specifically for leafy vegetable production such as radish, nitrogen application is crucial for sustaining robust growth, maximizing yield, and ensuring high-quality produce.

The Pusa Chetki variety of radish was bred at the Indian Agricultural Research Institute (IARI) in New Delhi. It yields medium-long, white roots with a desirable texture. Notably, this variety exhibits resilience to high temperatures, making it suitable for planting from mid-March to mid-August in the northern and central regions of India. In the southern and western parts of the country, it can be cultivated year-round. Pusa Chetki demonstrates effective seed setting in the plains, particularly due to its tendency to bolt early during October-November. Under optimal conditions, it can yield approximately 250-500 quintals of fresh radish per hectare.

Materials and Methods

Location of Experimental site

The experiment was carried out at Agriculture Research Farm of Rama University, Mandhana, Kanpur, India, during 2022-2023 Geographically, Kanpur district falls in semiarid subtropical zone and is situated between 25.26" and 26.58" north latitude and 79.31" and 80.34" east longitude. It is located at an elevation of 125.9" meters above mean sea level.

Seed rate and sowing

The pure, healthy, disease and insect free vigorous and good quality seed of Pusa Chetki variety was used for sowing (@ 10 kg ha). The sowing process involved manual dibbling, ensuring a row spacing of 35 centimeters and a plant-to-plant distance of 10 centimeters. Seeds were sown at a depth of 1.25 centimeters to promote optimal root development, followed promptly by irrigation to facilitate germination.

Nutrient Management

The only sources of nitrogen, phosphorus, and potassium utilized were urea, triple superphosphate (applied at 125 kg per hectare), and muriate of potash (applied at 175 kg per hectare), respectively. Additionally, well-decomposed cow dung was applied at a rate of 12 tonnes per hectare to the field. During land preparation, the total amount of cow dung and half of the total doses of urea and muriate of potash, along with triple superphosphate, were incorporated. The remaining portions of urea and muriate of potash were applied after 35 days from the date of seed sowing. Intercultural activities such as thinning, weeding, irrigation, and pest management were carried out as needed to optimize crop growth.

Treatment combinations

Treatments Symbol used	Treatments details
N0	Control
N1	60 Kg/ha
N2	80 Kg/ha
N3	100 Kg/ha
N4	120 Kg/ha
N5	140 Kg/ha
N6	160 Kg/ha
N7	180 Kg/ha

Results and Discussion

Growth Parameters

In the present study, the maximum Plant height (13.84 cm) at 15 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha. While, the minimum plant height (7.20 cm) at15 DAS was recorded with the treatment N_0- Control. The maximum Plant height (26.50 cm) at 30 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum plant height (16.38 cm) at 30 DAS was recorded with the treatment N_0- Control. The maximum Plant height (65.10 cm) at harvest was recorded with the treatment N_4- 120 kg Nitrogen/ha. Moreover, the minimum plant height (35.30 cm) at harvest was recorded with the treatment N_0- Control. This clearly supports the fact that higher application of nitrogen has a vital role in betterment of plant physiological process such as cell division, cell elongation along with timely metabolic processes and also favored the greater assimilation of photosynthates. Similar result reported by Moniruzzaman *et al.* (2013) [8], Tripathi *et al.* (2017) [18], Baloch *et al.* (2014) [2], Pathak *et al.* (2017) [10] and Dash *et al.* (2018) [3].

Similarly, The maximum number of leaves per plant (6.72) at 15 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha. While, the minimum number of leaves per plant (4.38) at 15 DAS was recorded with the treatment N_0- Control. The maximum number of leaves per plant (9.84) at 30 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum number of leaves per plant (6.16) at 30 DAS was recorded with the treatment N_0- Control. The maximum number of leaves per plant (17.10) at harvest was recorded with the treatment N_4- 120 kg Nitrogen/ha. Moreover, the minimum number of leaves per plant (8.96) at harvest was recorded with the treatment N_0- Control. This could be attributed to the enhanced availability of nutrients at the appropriate time, which might have resulted in increased photosynthetic rate and accumulation of metabolites in plants. Similarly type of findings were also reported by Moniruzzaman *et al.* (2013) [8], Tripathi *et al.* (2017) [18], Thapa *et al.* (2013) [17] and Yuan *et al.* (2015) [19].

The maximum Fresh weight of leaves (44.10 gm) at 15 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha followed. While, the minimum Fresh weight of leaves (26.25 gm) at15 DAS was recorded with the treatment N_0- Control. The maximum Fresh weight of leaves (83.28 gm) at 30 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum Fresh weight of leaves (37.76 gm) at 30 DAS was recorded with the treatment N_0- Control. The maximum Fresh weight of leaves (118.32 gm) at harvest was recorded with the treatment N_4- 120 kg Nitrogen/ha. Moreover, the minimum Fresh weight of leaves (60.21 gm) at harvest was recorded with the treatment N_0- Control. The increase in fresh weight of leaves of the plant could be due to higher uptake and accumulation of greater amount of photosynthates. Similar results were observed by Moniruzzaman *et al.* (2013) [8], Jilani *et al.* (2010) [5], Sumagaysay (2014) [15] and Krishnakant *et al.* (2018) [7].

The maximum Leaf area per plant (41.20 cm^2) at 15 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha. While, the minimum Leaf area per plant (30.15 cm^2) at15 DAS was recorded with the treatment N_0- Control followed. The maximum Leaf area per plant (132.54 cm^2) at 30 DAS was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum Leaf area per plant (65.86 cm^2) at 30 DAS was recorded with the treatment N_0- Control. The maximum Leaf area per plant (170.64 cm^2) at harvest was recorded with the treatment N_4- 120 kg Nitrogen/ha. Moreover, the minimum Leaf area per plant (78.36 cm^2) at harvest was recorded with the treatment N_0- Control.

Increased leaf area could be attributed to the better availability of nutrients for growth and development of plant, which, in turn, enhances the photosynthesis of leaves. The present finding also corroborate the findings of Thakar *et al.* (2006) [16], Sharma *et al.* (2013) [13], Pathak *et al.* (2017) [10], Srinivas and Naik (1990) [14].

The maximum Length of leaves at harvesting (38.22 cm) was recorded with the treatment N_4- 120 kg Nitrogen/ha. While, the minimum Length of leaves at harvesting (22.36 cm) was recorded with the treatment N_0- Control. The increase in leaf length may be due to increased availability of higher dose of nutrients. Similar results were observed by Tripathi *et al.* (2017) [18], Jilani *et al.* (2010) [5], Sumagaysay (2014) [15] and Krishnakant *et al.* (2018) [7].

Yield Parameters

In the present investigation, the maximum Root length (26.78 cm) was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum Root length (13.94 cm) was recorded with the treatment N_0- Control. The maximum Root girth (12.10 cm) at harvest was recorded with the treatment N_4- 120 kg Nitrogen/ha. Moreover, the minimum Root girth (5.21 cm) was recorded with the treatment N_0- Control. The root length and root girth were varied significantly among different nutrition levels. The increased Nitrogen levels produced good result in increasing the root length and root girth. Similar findings were also observed by Moniruzzaman *et al.* (2013) [8], Tripathi *et al.* (2017) [18], Jilani *et al.* (2010) [5], Thapa *et al.* (2003) [17] and Thakar *et al.* (2006) [16].

Similarly, the maximum Average plant weight at Harvesting (224.15 gm) was recorded with the treatment N_4- 120 kg Nitrogen/ha. While, the minimum Average plant weight at Harvesting (124.42 gm) was recorded with the treatment N_0- Control. The increase in Average plant weight at Harvesting may be due to increased availability of higher dose of nutrients. The maximum Fresh root weight (150.45 gm/plant) was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum Fresh root weight (105.14 gm/plant) was recorded with the treatment N_0- Control. The maximum Yield per plot (34.15 kg) was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum Yield per plot (15.26 kg) was recorded with the treatment N_0- Control. The maximum Yield per hectare (376.52 q) was recorded with the treatment N_4- 120 kg Nitrogen/ha. However, the minimum Yield per hectare (168.24 q) was recorded with the treatment N_0- Control. Root weight of radish increased with increased dose of nitrogen. But, after a limit the response of nitrogen was not observed. This indicates that excess application of nitrogen in radish may increase the root length but did not increase the root weight and total plant weight. This result indicate indiscriminate use of very higher doses of nitrogen did not increase root yield rather increases mere vegetative growth as compared to increase in weight of radish root. This increase in yield as well as yield attributes by different Nitrogen level may be due to increase vegetative growth giving better opportunities for photosynthetic activities and consequently increasing carbohydrates in the root resulting high yield. Similarly type of findings were also reported by Moniruzzaman *et al.* (2013) [8], Tripathi *et al.* (2017) [18], Jilani *et al.* (2010) [5], Panwar *et al.* (2000) [9] and Akoumianakis *et al*. (2011) [1].

Table 1: Effect of nitrogen level on Plant height (cm), Number of leaves per plant and Fresh weight of leaves (gm)

Treatments	Plant height (cm)			Number of leaves per plant			Fresh weight of leaves (gm)		
	At 15 DAS	At 30 DAS	At Harvest	At 15 DAS	At 30 DAS	At Harvest	At 15 DAS	At 30 DAS	At Harvest
N_0- Control	7.20	16.38	35.30	4.38	6.16	8.96	26.25	37.76	60.21
N_1- 60 kg Nitrogen/ha	11.72	23.64	49.08	5.54	8.60	11.73	34.10	50.10	85.76
N_2- 80 kg Nitrogen/ha	12.66	25.12	53.48	5.70	8.85	12.76	38.68	64.55	97.55
N_3- 100 kg Nitrogen/ha	13.42	26.24	58.71	5.91	9.14	14.58	40.86	75.95	112.46
N_4- 120 kg Nitrogen/ha	13.84	26.50	65.10	6.72	9.84	17.10	44.10	83.28	118.32
N_5- 140 kg Nitrogen/ha	13.56	26.35	61.15	6.35	9.42	15.26	42.64	77.16	116.92
N_6- 160 kg Nitrogen/ha	12.96	25.45	56.07	5.82	8.98	13.47	40.12	69.21	105.83
N_7- 180 kg Nitrogen/ha	12.18	24.26	50.66	5.59	8.71	11.91	35.44	56.72	92.46
SEM (+/-)	0.144	0.335	1.008	0.100	0.106	0.146	0.668	1.213	1.331
C.D.at 5% of level	0.436	1.016	3.058	0.302	0.323	0.444	2.025	3.678	4.036

Table 2: Effect of nitrogen level on Leaf area per plant (cm^2) and Length of leaves at harvesting (cm)

Treatments	Leaf area per plant (cm^2)			Length of leaves at harvesting (cm)
	At 15 DAS	At 30 DAS	At Harvest	
N_0- Control	30.15	65.86	78.36	22.36
N_1- 60 kg Nitrogen/ha	36.95	88.52	97.10	29.10
N_2- 80 kg Nitrogen/ha	37.24	97.74	114.58	31.94
N_3- 100 kg Nitrogen/ha	39.78	120.38	155.12	35.45
N_4- 120 kg Nitrogen/ha	41.20	132.54	170.64	38.22
N_5- 140 kg Nitrogen/ha	40.36	128.12	167.33	36.58
N_6- 160 kg Nitrogen/ha	38.44	104.46	136.21	33.62
N_7- 180 kg Nitrogen/ha	37.10	94.75	105.29	30.54
SEM(+/-)	0.588	1.495	2.041	0.504
C.D.at 5% of level	1.784	4.535	6.191	1.530

Table 3: Effect of nitrogen level on Yield of Radish

Treatments	Root length (cm)	Root girth (cm)	Average plant weight at Harvesting (gm)	Fresh root weight (g/plant)	Yield per plot (kg)	Yield per hectare (q)
N_0- Control	13.94	5.21	124.42	105.14	15.26	168.24
N_1- 60 kg Nitrogen/ha	19.98	9.80	162.58	127.78	24.72	263.28
N_2- 80 kg Nitrogen/ha	21.54	10.48	184.72	138.92	27.56	304.85
N_3- 100 kg Nitrogen/ha	23.26	11.22	208.86	145.15	31.66	345.36
N_4- 120 kg Nitrogen/ha	26.78	12.10	224.15	150.45	34.15	376.52
N_5- 140 kg Nitrogen/ha	24.57	11.74	215.55	148.21	33.29	368.82
N_6- 160 kg Nitrogen/ha	22.45	10.86	192.21	143.35	29.48	324.58
N_7- 180 kg Nitrogen/ha	20.12	10.16	175.49	132.48	25.92	282.15
SEM (+/-)	0.345	0.174	2.886	1.443	0.379	3.974
C.D.at 5% of level	1.045	0.529	8.752	4.376	1.149	12.053

Conclusion

Based on the above investigation, it can be concluded that there was a significant effect of nitrogen level on growth and yield attributing characters of radish cv. Pusa Chetki. It is conducted that the treatment N_4- 120 kg Nitrogen/ha gave the highest growth and yield parameters *viz.*, Plant height (cm) at 15 DAS, 30 DAS and at harvest, number of leaves per plant at 15 DAS, 30 DAS and at harvest, Fresh weight of leaves (gm) at 15 DAS, 30 DAS and at harvest, Leaf area per plant (cm^2) at 15 DAS, 30 DAS and at harvest, Length of leaves at harvesting (cm), Root length (cm), Root girth (cm), Average plant weight at Harvesting (gm), Fresh root weight (gm/plant), Yield per plot (kg) and Yield per hectare (q). So, we can suggest to farmers that the dose of 120 kg Nitrogen/ha gave the better results in term of growth and yield of Radish.

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