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Pandre Neel Kamal
Ph.D. Research Scholar, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Singh SS
Assistant Professor, Faculty of Agriculture, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Rai Ravi Prakash
Assistant Professor, Faculty of Agriculture, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Kumar Arya
Assistant Professor, Faculty of Agriculture, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Corresponding Author:
Pandre Neel Kamal
Ph.D. Research Scholar, MGCGV, Chitrakoot, Satna, Madhya Pradesh, India

Studies on the different amounts of nitrogen and organic sources of nutrient on growth parameters of potato

Pandre Neel Kamal, Singh SS, Rai Ravi Prakash and Kumar Arya

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Abstract
A research study titled "Studies on the different amounts of nitrogen and organic sources of nutrient on growth parameters of potato". Research Farm, Department of Horticulture, MGCGV, Chitrakoot, Satna (M.P.) during 2016-17 & 2017-18. The details of materials used in experimental they have 20 treatments with control, the experiment analysed (Pooled Basis) under Randomized Block Design (RBD), with three replications. The treatment details are T_1- Control, T_2- FYM 20 t ha^{-1}, T_3- Vermicompost 5 t ha^{-1}, T_4- Neem cake 2.5 q ha^{-1}T_5- 50 kg N ha^{-1}, T_6- 50 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_7- 50 kg N ha^{-1}+ Vermicompost 5 t ha^{-1}, T_8- 50 kg N ha^{-1} + Neem cake 2.5 q ha^{-1}, T_9- 100 kg N ha^{-1}, T_{10}- 100 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_{11}- 100 kg N ha^{-1}+Vermicompost 5 t ha^{-1}, T_{12}- 100 kg N ha^{-1}+ Neem cake 2.5 q ha^{-1}, T_{13}- 150 kg N ha^{-1}, T_{14}- 150 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_{15}- 150 kg N ha^{-1}+Vermicompost 5 t ha^{-1}, T_{16}- 150 kg N ha^{-1}+ Neem cake 2.5 q ha^{-1}, T_{17}- 200 kg N ha^{-1}, T_{18}- 200 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_{19}- 200 kg N ha^{-1}+Vermicompost 5 t ha^{-1} and T_{20}- 200 kg N ha^{-1}+ Neem cake 2.5 q ha^{-1}. The observation was recorded under the experiment (growth and yield) of potato such as Plant height (cm), Leaf length plant^{-1} (cm) and Leaf area plant^{-1} (cm^2). The result revealed that the maximum Plant height (cm) at 30, 60, and 90 DAS (37.39, 58.64 and 61.19 cm) was observed under N_4O_2 (200 kg N ha^{-1} + Vermicompost 5 t ha^{-1}), Leaf length plant^{-1} (cm) at 30, 60, and 90 DAS i.e. (5.33, 8.15 and 8.99 cm) was observed under N_4O_1 (200 kg N ha^{-1}+ FYM 20 t ha^{-1}), Leaf area plant^{-1} (cm^2) at 30, 60, and 90 DAS was observed under N_4O_2 (200 kg N ha^{-1}+Vermicompost 5 t ha^{-1}) i.e. (269.42, 532.26 and 612.44 cm^2), while the minimum was observed under Control.

Keywords: Potato, INM, FYM, NC and vermicompost

Introduction
Potato (*Solanum tuberosum* L.) belongs to family Solanaceae. Peru- Bolivian region in the Andes (South America) is the centre of origin of potato and it has introduced to India in 17th century by Portuguese traders or the Britishers and gradually become a commercial crop of all over India. Potato is one of the major vegetable crops of the India and occupies an important position among food crops and provides staple food stuff for millions of people of many part of the world. It is grown as a cash crop and capable in producing more food per unit area and time than cereals in short span of life.

Potato is a heavy feeder of nutrients and the higher food production needs higher amount of plant nutrients. As no single source is capable of supply the required quantity of nutrients, the integration of all available resources is essentially resupplying balance nutrition of plants, which should be aimed at increasing yield, nutrients deficiencies, improving lasting soil fertility restoring fertility and productivity that has been regarded by wrong and exploitive activities in the past.

INM is based on the principle of adjusting the availability of plant nutrients to maximise the desired yield. It involves using a combination of synthetic and natural fertilisers as well as bio-fertilizers that is suited for the layout of land usage and the biological, social, and economic factors.

Farmyard Manure is a heterogeneous treated the soil natural material comprising of manure, crop residue, as well as family clearing in different phases of disintegration. In many nations, particularly the semi-arid parts of India, farmyard manure is a valuable natural resource for agricultural productivity in animal-based cultivating systems.

Therefore, there is plenty of flexibility to add farmyard manure to the potato manure programme and eliminate the need for synthetic composts completely. There is between 0.4% and 1.5% nitrogen in very spoiled farm yard fertiliser, along with 0.3% to 1.9% phosphorus oxide and 0.5% to 1.9% potassium oxide.

Materials and Methods

A research study titled "Studies on the different amounts of nitrogen and organic sources of nutrient on growth parameters of potato". Research Farm, Department of Horticulture, MGCGV, Chitrakoot, Satna (M.P.) during 2016-17 and 2017-18. The details of materials used in experimental they have 20 treatments with control, the experiment analysed (Pooled Basis) under Randomized Block Design (RBD), with three replications. The treatment details are T_1- Control, T_2- FYM 20 t ha^{-1}, T_3- Vermicompost 5 t ha^{-1}, T_4- Neem cake 2.5 q ha^{-1}T_5- 50 kg N ha^{-1}, T_6- 50 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_7- 50 kg N ha^{-1}+ Vermicompost 5 t ha^{-1}, T_8- 50 kg N ha^{-1} + Neem cake 2.5 q ha^{-1}, T_9- 100 kg N ha^{-1}, T_{10}- 100 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_{11}- 100 kg N ha^{-1}+Vermicompost 5 t ha^{-1}, T_{12}- 100 kg N ha^{-1}+ Neem cake 2.5 q ha^{-1}, T_{13}- 150 kg N ha^{-1}, T_{14}- 150 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_{15}- 150 kg N ha^{-1}+Vermicompost 5 t ha^{-1}, T_{16}- 150 kg N ha^{-1}+ Neem cake 2.5 q ha^{-1}, T_{17}- 200 kg N ha^{-1}, T_{18}- 200 kg N ha^{-1}+ FYM 20 t ha^{-1}, T_{19}- 200 kg N ha^{-1}+Vermicompost 5 t ha^{-1} and T_{20}- 200 kg N ha^{-1}+ Neem cake 2.5 q ha^{-1}. The observation was recorded under the experiment (growth and yield) of potato such as Plant height (cm), Leaf length plant^{-1} (cm) and Leaf area plant^{-1} (cm^2).

Leaf area plant^{-1} (cm^2): For measuring the leaf area, five plants were randomly selected and tagged. The area of leaf was measured with help of graph at 30 days interval, up to 90 days in centimeters square.

Results and Discussion

Plant height (cm)

On the basis of pooled analysis the maximum plant height of potato at 30, 60, and 90 DAS was observed under the treatment combination N_4O_2 (200 kg N ha^{-1} + Vermicompost 5 t ha^{-1}) i.e. (37.39, 58.64 and 61.19 cm), followed by the treatment combination N_3O_2 (150 kg N ha^{-1} + Vermicompost 5 t ha^{-1}) i.e. (36.49, 57.94 and 60.59 cm) and N_4O_3 (200 kg N Ha^{-1}+ Neem cake 2.5 q ha^{-1}) i.e. (35.71, 57.51 and 59.81 cm), while the minimum plant height at 30, 60, and 90 DAS was observed under Control (N_0O_0) i.e. (30.29, 45.94 and 46.93 cm). The increase in plant height with higher doses of fertilizer, in combination with organic manures, underscores the role of organic amendments in improving soil fertility and crop performance. Organic manures enhance nutrient availability while improving the physical structure, chemical composition, and biological activity of the soil, all of which contribute to healthier and more robust plant growth. According to Lal and Stewart (2010) [4], the addition of organic matter improves water retention, nutrient cycling, and microbial activity, which collectively support optimal plant development. Similarly, Ayoola and Adeniyan (2006) [2] demonstrated that the use of organic and inorganic fertilizers together results in synergistic effects, enhancing nutrient uptake and plant growth by improving root development and overall plant health.

Leaf length per plant (cm)

The maximum leaf length per plant of potato at 30, 60, and 90 was observed under the treatment combination N_4O_1 (200 kg N ha^{-1}+ FYM 20 t ha^{-1}) i.e. (5.33, 8.15 and 8.99 cm), followed by the treatment combination N_2O_3 (100 kg N ha^{-1} + Neem cake 2.5 q ha^{-1}) i.e. (5.30, 8.09 and 8.93 cm) and N_4O_3 (200 kg N Ha^{-1}+ Neem cake 2.5 q ha^{-1}) i.e. (5.22, 7.98 and 8.73 cm), while the minimum leaf length per plant at 30, 60, and 90 DAS was observed under Control (N_0O_0) i.e. (4.30, 7.00 and 7.43 cm). The application of nitrogen combined with organic fertilizers significantly affected the leaf length of potato plants at various growth stages. The highest leaf length observed in the treatment combination of N4O1 (200 kg N ha-1 + FYM 20 t ha-1) is consistent with previous studies that highlight the importance of nitrogen in promoting vegetative growth. For instance, Ahmad *et al*., (2014) [1] reported a similar increase in leaf area and leaf length with increasing nitrogen application, explaining that nitrogen enhances chlorophyll content and overall plant vigor, leading to improved vegetative growth. Similarly, Khan *et al*., (2017) [7] found that the combination of nitrogen with organic matter, such as farmyard manure (FYM) or Neem cake, positively affects leaf length due to the synergistic effects of nitrogen and slow-release nutrients from organic amendments. These organic fertilizers improve soil structure, nutrient availability, and water retention, contributing to better plant growth. The minimum leaf length observed in the control treatment (N0O0) reflects the importance of external nitrogen supply, as plants receiving no fertilizer showed reduced growth. This trend of increasing leaf length with higher nitrogen levels and the use of organic fertilizers aligns with the findings of Singh *et al*., (2016b) [6], who demonstrated that both nitrogen and organic matter are crucial for maintaining leaf growth and overall biomass production in potato.

Leaf area per plant (cm^2)

The maximum leaf area per plant of potato at 30, 60, and 90 was observed under the treatment combination N_4O_2 (200 kg N ha^{-1}+Vermicompost 5 t ha^{-1}) i.e. (269.42, 532.26 and 612.44 cm^2), followed by the treatment combination N_3O_2 (150 kg N ha^{-1} + Vermicompost 5 t ha^{-1}) i.e. (263.44, 522.86 and 602.79 cm^2) and N_4O_3 (200 kg N Ha^{-1}+ Neem cake 2.5 q ha^{-1}) i.e. (254.74,515.66 and 595.49 cm^2), while the minimum leaf area per plant at 30, 60, and 90 DAS was observed under Control (N_0O_0) i.e. (147.50, 367.57 and 415.23 cm^2). According to Mahmud *et al*., (2017) [5], nitrogen is essential for promoting cell division and enlargement, leading to increased leaf area. The use of vermicompost as an organic amendment further improves this effect by enhancing soil nutrient availability and promoting better root growth, which in turn supports greater nutrient uptake. The gradual release of nutrients from vermicompost allows for a steady supply of nitrogen throughout the crop's growth stages, leading to a continuous increase in leaf area. Similarly, Bhat *et al*., (2016) [3] found that nitrogen application combined with organic fertilizers like neem cake significantly improves the leaf area in potato plants by enhancing the photosynthetic capacity of the leaves. Neem cake, being a slow-release organic fertilizer, supplies essential nutrients while also improving soil health, leading to better root establishment and nutrient uptake. The minimum leaf area in the control (N_0O_0) treatment, where no fertilizers were applied, underscores the critical role of nitrogen and organic amendments in maximizing the leaf surface area, which is vital for enhancing photosynthesis and overall plant productivity.

Table 1: Effect of different levels of nitrogen and organic sources on growth parameters of potato

Treatments	Plant Height (cm)			Leaf length per plant (cm)			Leaf area per plant (cm^2)		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
N_0 O_0	30.29	45.94	46.93	4.30	7.00	7.43	147.50	367.57	415.23
N_0 O_1	30.84	48.39	51.49	4.44	7.22	7.66	151.75	377.57	427.53
N_0 O_2	31.78	51.58	53.13	4.49	7.24	7.76	172.75	398.02	454.88
N_0 O_3	31.53	51.23	52.73	4.29	7.09	7.53	165.85	391.47	444.28
N_1 O_0	31.33	50.68	51.78	4.35	7.15	7.59	158.45	384.17	436.48
N_1 O_1	32.18	52.33	54.23	4.53	7.32	7.87	190.26	425.16	493.38
N_1 O_2	33.57	54.82	57.27	4.98	7.79	8.44	224.31	477.01	545.89
N_1 O_3	32.47	53.12	55.32	4.68	7.50	8.09	197.66	432.80	505.68
N_2 O_0	31.93	51.98	53.73	4.62	7.42	7.98	181.11	407.05	471.78
N_2 O_1	33.37	54.57	56.92	4.78	7.63	8.24	216.96	466.30	534.79
N_2 O_2	34.76	56.51	58.91	5.24	8.01	8.85	243.29	504.64	579.07
N_2 O_3	34.31	56.21	58.26	5.30	8.09	8.93	238.14	496.04	570.11
N_3 O_0	32.28	52.73	54.83	4.57	7.37	7.93	185.71	415.90	480.53
N_3 O_1	32.67	53.52	55.92	4.89	7.73	8.34	205.61	446.50	520.59
N_3 O_2	36.49	57.94	60.59	5.18	7.94	8.69	263.44	522.86	602.79
N_3 O_3	35.21	57.11	59.36	5.05	7.82	8.50	249.44	509.84	584.30
N_4 O_0	32.92	54.12	56.52	4.84	7.70	8.32	210.86	458.65	529.49
N_4 O_1	34.01	55.56	57.81	5.33	8.15	8.99	232.19	486.46	553.94
N_4 O_2	37.39	58.64	61.19	5.11	7.88	8.63	269.42	532.26	612.44
N_4 O_3	35.71	57.51	59.81	5.22	7.98	8.73	254.74	515.66	595.49
S.Em. ±	0.039	0.067	0.073	0.007	0.007	0.010	0.781	1.087	1.279
CD at 5%	0.096	0.163	0.178	0.018	0.018	0.025	1.905	2.652	3.120

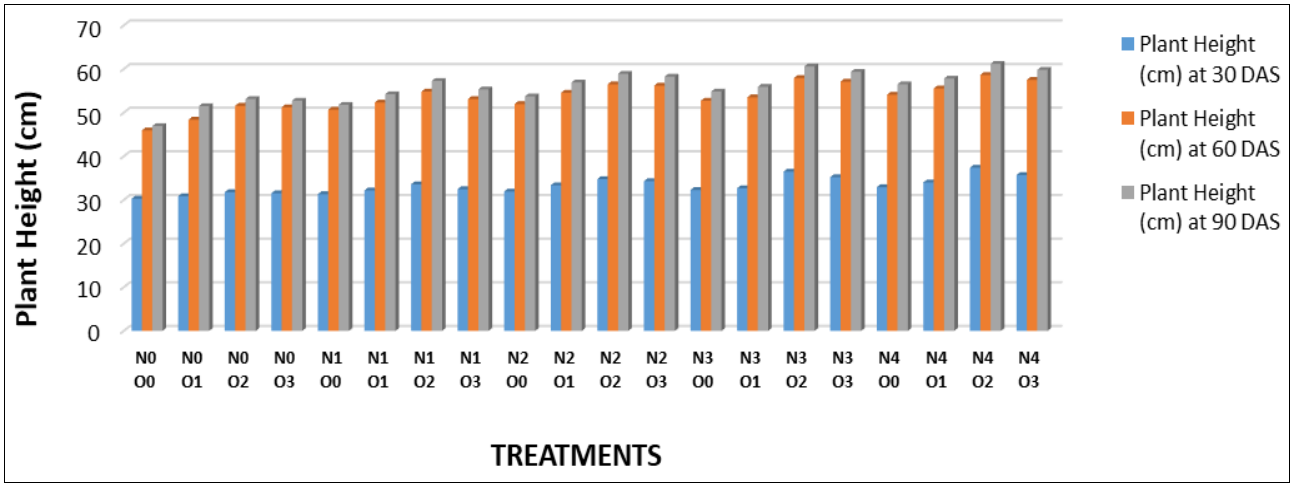

Fig 1: Effect of different levels of nitrogen and organic sources on Plant Height (cm) of potato

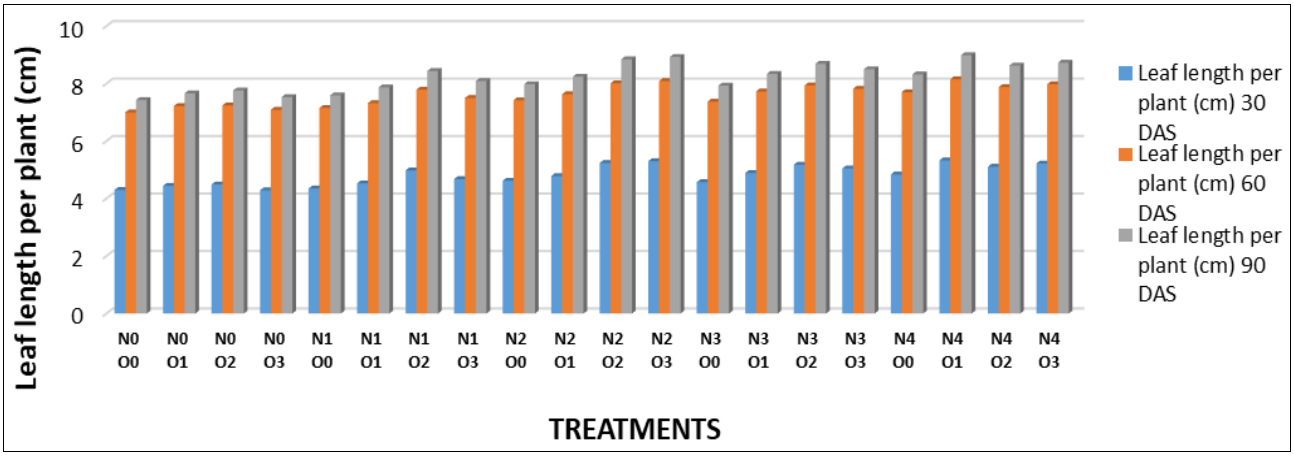

Fig 2: Effect of different levels of nitrogen and organic sources on Leaf length per plant (cm) of potato

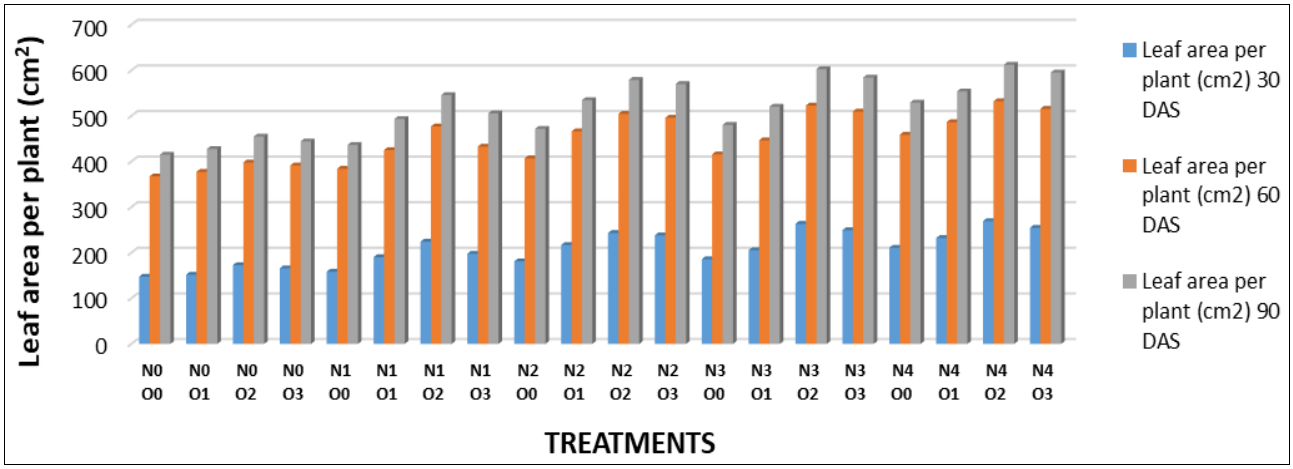

Fig 3: Effect of different levels of nitrogen and organic sources on Leaf area per plant (cm^2) of potato

Conclusion

The highest values for all parameters were achieved under specific treatments: Plant height (cm) at 30, 60, and 90 DAS was observed as 37.39, 58.64, and 61.19 cm, respectively, under N4O2 (200 kg N ha^{-1} + Vermicompost 5 t ha^{-1}). Leaf length per plant (cm) at 30, 60, and 90 DAS was recorded as 5.33, 8.15, and 8.99 cm, respectively, under N4O1 (200 kg N ha^{-1} + FYM 20 t ha^{-1}). Leaf area per plant (cm^2) at 30, 60, and 90 DAS was observed as 269.42, 532.26, and 612.44 cm^2, respectively, under N4O2 (200 kg N ha^{-1} + Vermicompost 5 t ha^{-1}). The minimum values for these parameters were observed under the control treatment.

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