Eco. Env. & Cons. 30 (1) : 2024; pp. (103-107)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2024.v30i01.019

Influence of Inorganic Fertilizers on Growth, Yield and Nutrient content in Potato (*Solanum tuberosum* L.)

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(Received 16 July, 2023; Accepted 23 September, 2023)

ABSTRACT

The study titled "Influence of NPK on Growth, Yield and Nutrient Content in Potato (*Solanum tuberosum* L.)" was conducted during the Rabi season of 2021-2022 at the Research cum Demonstrational Farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment followed a Randomized Block Design with three replications. It consists of twelve nutrient (NPK) treatments included absolute control *viz.*, (T_0) 0:0:0 NPK kg/ha, (T_1)-0:80:150 NPK kg/ha, (T_2) 120:80:150 NPK kg/ha, (T_3) 180:80:150 NPK kg/ha, (T_4) 240:80:150 NPK kg/ha, (T_5)-300:80:15 NPK kg/ha, (T_6)-240:0:150 NPK kg/ha, (T_7)-240:40:150 NPK kg/ha, (T_8) 240:120:150 NPK kg/ha, (T_9) 240:80:0 NPK kg/ha, (T_{10}) 240:80:50 NPK kg/ha, (T_{11}) 240:80:100 NPK kg/ha and (T_{12}) 150:100:100 NPK kg/ha. The growth, yield and Nutrient content attributes of Potato including the, number of leaves per plant(449), number of compound leaves per plant (79.3), total weight of tuber (11.94 kg/plot), total tuber yield (35.80 kg/plot), fresh haulm weight (336.33g), Dry haulm weight (39.00g), nitrogen content (2.96%), phosphorus content(0.227%) and potassium content (0.573%) was recorded highest in T_5; 300:80:150 NPK kg/ha which, was statistically *at par* with T_8;240:120:150 NPK kg/ha but unmarketable yield (kg/plot) was foundhighest in T_{12}; 150:100:100 kg/ha (4.90 kg) which was noted statistically *at par* with T_2; 120:80:150 NPK kg/ha (4.67 kg).

Key words: *Number of leaves per plant, Potato, NPK content, Fresh haulm weight and total weight of tuber*

Introduction

Potato (*Solanum tuberosum* L.) is a versatile herbaceous annual plant belonging to the Solanaceae family and the Solanum genus. It holds a prominent position as a crucial vegetable and starch-producing crop, valued for its remarkable yield potential and nutritional richness. A 100-gram serving of fresh potato tuber typically contains 70-80% water, 20.6% carbohydrates, 2.1% protein, 0.3% fat, 1.1% crude fiber, and 0.9% ash. Potatoes are abundant sources of essential nutrients, including vitamin C, minerals, and vital amino acids such as leucine, tryptophan and isoleucine (Bist and Sharma, 1997).

Chhattisgarh's diverse Agro-climatic zones offer conducive conditions for potato cultivation, particularly under irrigated settings. The potato plant thrives when essential macronutrients, including nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur, are adequately available. A mature potato crop, yielding between 25-30 tonnes per hectare, necessitates the application of approximately 110 kg of nitrogen, 50 kg of P_2O_5, and 225 kg of K_2O per hectare (Choudhary, 1990). This nutrient demand underscores the classification of potatoes as heavy feeders, emphasizing the critical need for balanced and judicious nutrient management.

Among these essential macronutrients, nitrogen stands out as the primary limiting factor influencing potato growth and tuber yield. Nitrogen plays a pivotal role in chlorophyll synthesis, essential for photosynthesis and is indispensable for overall plant development. Adequate nitrogen application has been shown to elevate dry matter content, protein levels in tubers and total tuber yield (Belanger *et al*., 2002).

Phosphorus ranks as the second most critical macronutrient governing plant growth, following nitrogen. Its significance lies in facilitating cellular energy transfer, sustaining photosynthesis and aiding in respiration. Phosphorus is integral to various vital plant components, including phospholipids, phosphorylated sugars, nucleic acids and nucleotides.

Potassium, another essential macronutrient, significantly impacts both potato production and tuber quality. Beyond enhancing yield, potassium strengthens the plant's resistance to environmental stressors such as drought and frost. This mobile element plays a central role in fundamental plant processes, including photosynthesis, carbohydrate metabolism, osmotic regulation, assimilate translocation, nitrogen uptake and a spectrum of physiological functions (Kelling *et al*., 1998).

The potato holds paramount importance in India's agricultural landscape, offering high yields and nutritional benefits. To unlock its full potential, meticulous attention to nutrient management, particularly in the case of nitrogen, phosphorus and potassium, is imperative. This paper delves into the intricate dynamics of these macronutrients and their profound impact on Growth, yield and Nutrients content in Potato after Harvesting.

Materials and Methods

A field study was carried out during the Rabi season of 2021-2022 at the Research cum Demonstrational farm located at the College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya in Raipur, Chhattisgarh. The soil composition at the experimental site was determined to be clay loam with a pH level of 7.12. The experiment was designed following a Randomized Block Design and was replicated three times. It involved 12 different nutrient (NPK) treatment groups, including an absolute control: Absolute control (T0): No NPK application (0:0:0 NPK kg/ha), T1: 80:150 NPK kg/ha (0:80:150 NPK kg/ha), T2: 120:150 NPK kg/ha (120:80:150 NPK kg/ha), T3: 180:150 NPK kg/ha (180:80:150 NPK kg/ha), T4: 240:150 NPK kg/ha (240:80:150 NPK kg/ha), T5: 300:150 NPK kg/ha (300:80:150 NPK kg/ha), T6: 240:0:150 NPK kg/ha (240:0:150 NPK kg/ha), T7: 240:40:150 NPK kg/ha (240:40:150 NPK kg/ha), T8: 240:120:150 NPK kg/ha (240:120:150 NPK kg/ha), T9: 240:80:0 NPK kg/ha (240:80:0 NPK kg/ha), T10: 240:80:50 NPK kg/ha (240:80:50 NPK kg/ha), T11: 240:80:100 NPK kg/ha (240:80:100 NPK kg/ha), T12: 150:100:100 NPK kg/ha (150:100:100 NPK kg/ha) For data collection, five randomly selected potato plants were tagged in each replication and the following parameters were observed: Growth Parameters: Number of leaves per plant and Number of compound leaves per plant, Yield Parameters: Total Weight of tuber (kg/plot), Unmarketable yield (kg/plot), Total tuber yield (kg/plot) and Fresh and dry haulm weight (g/plant) and Nutrient content in tubers after harvest. Uniform cultural practices, including fertilizer application, irrigation, earthing-up, weed management, haulm cutting and plant protection measures, were consistently implemented throughout the entire research period. Healthy sprouted potato tubers were subjected to a 0.25% Dithane M-45 fungicide treatment before being planted in a well-prepared field with a spacing of 60 x 20 cm. The application of different doses of NPK fertilizers was meticulously carried out, ensuring uniformity across all cultural practices associated with potato cultivation.

Results and Discussion

Growth parameters

Number of leaves per plant

Number of leaves per plant were recorded at 70DAP are presented in Table 1. It reveled from the data that there were significant difference for number of leaves per plant by different doses of nutrients. Number of leaves per plant at 70DAP, varied from 242(absolute control) T_0; 449 T_5; (300:80:150 NPK kg/ha) with an average of 375.56. The significantly highest number of leaves per plant was found in T_5; 300:80:150 NPK kg/ha (449) which was statically *at* par with T_8; 240:120:150 NPK kg/ha (418), T_4; 240:80:150 NPK kg/ha (416), followed by T_{11}; 240:80:100 kg/ha (415), T_7; 240:80:150 NPK kg/ha (408) and T_{10}; 240:80: 50 NPK kg/ha (403). Whereas, the lower number of leaves per plant was recorded in absolute control T_0; (242). The result is close refers with the findings of Yadu *et al*. (2013), Mohan *et al.* (2020) and Alimkhanov *et al*. (2021).

Number of compound leaves per plant

Number of compound leaves per plant were recorded at 70DAP are presented in Table 1. It revealed from the data that there were significant difference for number of leaves per plant by different doses of nutrients. The number of compound leaves per plant at 70DAP, was found between 40.3 (absolute control) to 79.3 (300:80:150 NPK kg/ha) with an average mean of 61.77. The highest number of compound leaves per plant was counted in T_5; 300:80:150 NPK kg/ha (79.3), however it was found statistically at par with T_8; 240:120:150 NPK kg/ha (74.7), T_{11}; 240:80:100 NPK kg/ha (69.5), T_4; 240:80:150 NPK kg/ha (64.3), and T_7; 240:40:150 NPK kg/ha (63.1). Whereas, significantly lower number of compound leaves per plant was recorded in absolute control T_0; (40.3).

Yield Parameters

Total Weight of tuber (kg/plot)

Total weight of tuber (kg/plot) was recorded under different treatments are presented in Table 1. It is revealed from the data that there were non- significant effect due to by different doses of nutrients. The total weight of tuber kg/plot ranged from 4.12 kg/plot (absolute control) to 11.94 kg/plot (300:80:150 NPK kg/ha) with an overall mean of 8.96 kg/plot. The total weight of tuber (kg/plot) were differ non-significantly due to different doses of NPK. The numerically higher total weight of tuber (kg/plot) was found in T_5; 300:80:150 NPK kg/ha (11.94 kg/plot) and the lower total weight of tuber kg/plot was found in absolute control T_0;(4.12 kg/plot). The result is close refers with the finding of Kavvadias *et al*. (2002).

Unmarketable yield (kg/plot)

Unmarketable tuber yield (kg/plot) of different treatment are presented in Table 1. It is revealed from the data that there were significance difference for marketable tuber yield under different doses of nutrients. Unmarketable yield kg/plot ranged from 1.74 kg (absolute control) to 4.90 kg (150:100:100 NPK kg/ha) with an overall mean of 3.27. The significantly higher unmarketable yield kg/plot was found in T_{12}; 150:100:100 kg/ha (4.90 kg) which was noted statistically *at par* with T_2; 120:80:150 NPK kg/ha (4.67 kg) and followed by T_4; 240:80:150 kg/ha (4.01 kg), T_1; 0:80:150 NPK kg/ha(3.73). However, Unmarketable yield kg/plot was found in absolute control T_0; (1.74 kg).

Table 1. Number of leaves per plant, Compound leaves per plant, Grade wise number of tubers, Total number of tubers per plot, Total weight of tubers per plot (kg/ha), Unmarketable tuber yield (kg/plot) and Total tuber yield (kg/plot) as affected by different doses of nutrients.

Treatment N:P:K(kg/ha)	Number of leaves per plant 70 DAS	Number of Compound leaves per plant 70 DAS	Total weight of tuber per plot (kg/ha)	Unmarketable tuber yield (kg/plot)	Total tuber yield (kg/plot)
T_0- absolute control	232	40.3	4.12	1.74	12.36
T_1- 0:80:150	252	47.7	5.51	3.73	16.52
T_2- 120:80:150	343	58.8	7.82	4.67	23.45
T_3- 180:80:150	345	59.1	8.87	3.30	26.59
T_4- 240:80:150	416	64.3	10.21	4.01	30.62
T_5- 300:80:150	449	79.3	11.94	3.10	35.80
T_6- 240:0:150	402	62.9	8.36	2.89	25.07
T_7- 240:40:150	408	63.1	8.85	3.71	26.53
T_8- 240:120:150	418	74.7	11.61	3.12	34.84
T_9- 240:80:0	401	62.3	9.14	3.14	27.41
T_{10}- 240:80:50	403	64.3	9.98	2.26	29.94
T_{11}- 240:80:100	415	69.5	10.08	1.88	30.24
T_{12}-150:100:100	399	56.7	9.96	4.90	29.52
SEm±	23.13	5.65	1.63	0.47	2.84
CD (P = 0.05)	67.51	16.49	NS	1.38	8.29

Total tuber yield (kg/plot)

Total tuber yield kg/plot for different treatment are presented in Table 1. It is revealed from the data that there were significant difference due different doses of nutrients. The total tuber yield ranged from 12.36 kg/plot (absolute control) to 35.80 kg/plot (300:80:150 NPK kg/ha) with an overall mean of 26.84 kg/plot. The significantly higher total tuber yield kg/plot was recorded in 300:80:150 NPK kg/ha (35.80 kg/plot) which, was statistically *at par* with T_8;240:120:150 NPK kg/ha (34.84 kg/plot), T_4; 240:80:150 NPK kg/ha (30.62 kg/plot), T_{11}; 240:80:100 NPK kg/ha (30.24kg/plot) and T_{10}; 240:80:50 NPK kg/ha (29.94 kg/plot). The lower total tuber yield kg/plot was recorded in absolute control T_0; (12.36 kg/plot).

Fresh and dry haulm weight (g/plant)

Fresh and dry haulm weight for different treatment are presented in Table 2. It is revealed from the data that there were significant difference due different doses of nutrients. Fresh haulm weight ranged from 172.00 g (absolute control) to 336.33 g (300:80:150 NPK kg/ha) with an overall mean of 258.26 g. The significantly higher fresh haulm weight was recorded in 300:80:150 NPK kg/ha (336.33g) which, was statistically *at par* with T_8; 240:120:150 NPK kg/ha (329.67g), T_4; 240:80:150 NPK kg/ha (315.00g) and T_7; 240:40:150 NPK kg/ha (307.67g). The lowest Fresh haulm weight was recorded in absolute control T_0; (172.00 g). The result is close refers with the findings of Yadu *et al*. (2013) and Idrees *et al.* (2018).

Dry haulm weight ranged from 19.33 g (absolute control) to 39.00 g (300:80:150 NPK kg/ha) with an overall mean of 31.256 g. The significantly higher Dry haulm weight was recorded in 300:80:150 NPK kg/ha (39.00g) which, was statistically *at par* with T_8;240:120:150 NPK kg/ha (38.67 g), T_4; 240:80:150 NPK kg/ha (37.67 g) and T_{10};240:80:50 NPK kg/ha (36.67). The lower Dry haulm weight was recorded in absolute control T_0; (19.33 g). The result is close refers with the findings of Yadu *et al*. (2013) and Idrees *et al.*, 2018).

NPK content in tuber

NPK content in tuber for different treatment are presented in Table 2. It is revealed from the data that there were significant difference were noticed due different doses of nutrients. The nitrogen content in tuber ranged from 2.20% (absolute control) to 2.96% (300:80:150 NPK kg/ha) with an overall mean of 2.61%. The significantly higher nitrogen content was recorded in T_5; 300:80:150 NPK kg/ha (2.96%) which, was statistically *at par* with T_8; 240:120:150 NPK kg/ha (2.94%), T_4; 240:80:150 NPK kg/ha (2.87%), T_{11}; 240:80:100 NPK kg/ha (2.86%) and T_7; 240:40:150 NPK kg/ha (2.69%). The lower nitrogen was recorded in absolute control T_0; (2.20%). The result is close refers with the finding of Pankaj *et al*. (2021).

The phosphorus content in tuber ranged from

Table 2. Fresh haulm weight (g), Dry haulm weight (g), Nitrogen, Content in tuber (%), Phosphorus content in tuber (%), Potassium content in Tuber (%) as affected by different doses of nutrients.

Treatment Details	Fresh haulm weight (g)	Dry haulm weight (g)	Nitrogen Content in tuber(%)	Phosphorus contentin tuber(%)	Potassium content in Tuber (%)
T_0- absolute control	172.00	19.33	2.20	0.137	0.353
T_1- 0:80:150	190.33	19.67	2.24	0.143	0.460
T_2- 120:80:150	213.00	22.33	2.52	0.173	0.520
T_3- 180:80:150	243.67	24.67	2.52	0.200	0.530
T_4- 240:80:150	315.00	37.67	2.87	0.220	0.563
T_5- 300:80:150	336.33	39.00	2.96	0.227	0.573
T_6- 240:0:150	290.33	35.33	2.53	0.201	0.517
T_7- 240:40:150	307.67	33.67	2.69	0.182	0.557
T_8- 240:120:150	329.67	38.67	2.94	0.217	0.563
T_9- 240:80:0	275.67	35.67	2.55	0.205	0.547
T_{10}- 240:80:50	228.00	36.67	2.56	0.207	0.553
T_{11}- 240:80:100	266.00	34.33	2.86	0.210	0.560
T_{12}-150:100:100	189.67	29.33	2.52	0.183	0.527
SEm±	21.63	3.81	0.142	0.011	0.033
CD (P = 0.05)	63.13	11.12	0.414	0.031	0.096

0.137% (absolute control) to 0.227% (300:80:150 NPK kg/ha) with an overall mean of 0.193%. The significantly higher phosphorus content was recorded in 300:80:150 NPK kg/ha (0.227%) which, was statistically *at par* with T_8; 240:120:150 NPK kg/ha (0.217%), T_4; 240:80:150 NPK kg/ha (0.220%), T_{11};240:80:100 NPK kg/ha (0.210%) and T_{10}; 240:80:50 NPK kg/ha (0.207%). The lower phosphorus was recorded in absolute control T_0; (0.137%). The result is close refers with the finding of Pankaj *et al*. (2021).

The potassium content in tuber ranged from 0.353% (absolute control) to 0.573% (300:80:150 NPK kg/ha) with an overall mean of. The significantly higher potassium content was recorded in 300:80:150 NPK kg/ha (0.573%) which, was statistically *at par* with T_8; 240:120:150 NPK kg/ha (0.563%), T_4; 240:80:150 NPK kg/ha (0.563%), T_{11}; 240:80:100 NPK kg/ha (0.560%) and T_{10}; 240:80:50 NPK kg/ha (0.553%). The potassium content was recorded in absolute control T_0; (0.353%). The result is close refers with the finding of Pankaj *et al*. (2021).

Conclusion

Based on the present investigation, reveal that the growth, Yield and nutrient parameters were highly significant in T5; 300:80:150 NPK kg/ha, it was good performers. The Highest number of leaves per plant, number of compound leaves per plant, total weight of tuber, total tuber yield, fresh haulm weight, Dry haulm weight, nitrogen content, phosphorus content and potassium content highest were recorded in T5; 300:80:150 NPK kg/ha (39.78 t/ha) followed by T8; 240:120:150 NPK kg/ha (38.72 t/ha)). The results revealed that T5; 300:80:150 NPK kg/ha were promising for obtaining higher productivity.

Acknowledgements

The authors are thankful to Department of Vegetable Science and College of Agriculture, Raipur for providing the necessary facility during the present work from my bottom of heart I really thankful to Pravin Kumar Sharma, Vandana Yadav and Vinay Kumar Samadhiya for their kind support.

Competing Interests

Authors have declared that no competing interests exist.

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