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Effect of Integrated Nutrient Management on Growth and Yield of Potato (*Solanum tuberosum* L.) var. Kufri Pushkar

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ABSTRACT:

An experiment was conducted at Crop Research Centre, School of Agriculture, Uttaranchal University, Dehradun, Uttarakhand during the Rabi season of 2021-2022. To evaluate the effect of Integrated Nutrient Management on Growth and Yield of Potato (*Solanum tuberosum* L.) cv. Kufri Pushkar. Investigation was laid out in Randomized Block Design (RBD) with three replications and seven treatments namely; T_1 (Control), T_2 (75% RDF+ 25% Vermicompost), T_3 (50% RDF + 50% Vermicompost) T_4 (75% RDF + 25% Poultry manure) T_5 (50% RDF + 50% Poultry manure) T_6 (75% RDF + 12.5% Vermicompost + 12.5% Poultry manure) T_7 (50% RDF + 25% Vermicompost + 25% Poultry manure). Among all the treatments T_7 (50% RDF + 25% Vermicompost + 25% Poultry manure) was significantly superior over the other treatments for growth and yield parameters. T_7 (50% RDF + 25% Vermicompost + 25% Poultry manure) recorded the maximum plant height i.e., (28.66cm), number of leaves (39.06), leaf area (47.85 cm^2), number of haulms (32.94 m), fresh and dry weight of haulms (336.75 g, 32.07 g) and the highest yield parameters viz., number of tubers per plant (34.66), weight of tubers per plant (0.718 g) and weight of tubers per plot (3.857 kg) was also recorded in T_7 (50% RDF + 25% Vermicompost + 25% Poultry manure). It was concluded that potato cultivar var. Kufri Pushkar should be fertilized with T_7 (50% RDF + 25% Vermicompost + 25% Poultry manure) to obtain highest potato yield.

KEYWORDS: INM, Potato, Poultry Manure, Vermicompost, Yield

INTRODUCTION:

Potato (*Solanum tuberosum* L.), commonly known as the king of vegetables, is a South American native that covers the most land of any single vegetable crop in the world. Asia & developing countries currently account for more than 46 percent of the world output. This phenomenal expansion in developing countries demonstrates its expanding relevance as a source of food for growing populations, rural employment, and revenue production. Potato is an essential food crop on a global and national scale. Potato (*Solanum tuberosum* L.) is a staple food in many regions of the world. It was first grown in the Andean mountains of South America. The Portuguese were the first to bring it to India in the 17th century. After China, India is the second-largest producer of potatoes, accounting for 10–11% of global production and producing 50.33 million tonnes of potatoes over an area of 1.843 million ha (**Ajay Dev *et. Al* 2020**). The world's entire area under potato cultivation is 193.03 m tones/ha, and its total production is 388.19 m tonnes, with a productivity of 20.11 tonnes (**FAOSTAT 2017**). In contrast, India's total area is 21.24 million hectares, and its production is 50.30 million tonnes with a productivity of 23.9 tonnes. The area and production contribution of U.P. alone is 0.614 million ha and 15.56 million tonnes with a productivity of 22.77/ha, respectively **(NHB, 2017–18).** Regarding the essential amino acids for human nutrition, the protein in potatoes is of good quality. Additionally, it contains a healthy dose of vitamins, minerals, and traces of other nutrients. With all these characteristics, potatoes are clearly an essential crop for nations with high human population densities, such as India, where sufficient protein and calories may be supplied affordably for dietary needs, earning the title "Poor man's crop" **A.S. Subha *et al.* (2018).**

Chemical fertilizers are expensive and in short supply in developing nations like India. Chemical fertilizer costs are rising daily, and continued usage of these fertilizers has a negative impact on soil health, which is a big issue for farmers. For sustainable productivity and to maintain superior soil health, an integrated supply of nutrients through organic, inorganic fertilizers is essential **(Jagadeesh *et al.*, 1994).** The focus of modern nutrient management strategies has evolved to include sustainability and environmental friendliness. Numerous issues have arisen as a result of the intensive usage of just chemical fertilizers to attain high production. Continuously applying high doses of chemical fertilizers without using organic manures or bio fertilizers has resulted in a decline in the physical and chemical properties of soil, a decline in soil microbial activity, a decrease in soil humus, and an increase in soil, water, and air pollution **A.S Subha *et al.* (2018).**

The basic concept of integrated nutrient management is to maximize the benefits from all potential sources of plant nutrients in order to maintain or change plant nutrient supply in order to achieve a certain crop production level. The fundamental goals of integrated plant nutrition systems are to minimize inorganic fertilizer use, restore organic matter in the soil, increase nutrient utilization efficiency, and maintain soil quality in terms of the physical, chemical, and biological factors.

MATERIALS AND METHODS:

The experiment was conducted at Crop Research Centre, School of Agriculture, Uttaranchal University, Dehradun, Uttarakhand. Geographically, this experimental site falls under the Northern Hill Zone of Uttarakhand, located at near western Himalayan region at 30 0 18' 59.3856" North latitude and 78 0 1' 55.8768" East longitude at an altitude of 1410 ft. above the mean sea level. The region is characterized by humid sub-tropical climate with maximum temperature ranging from 30°C to 43°C in summer and minimum from 5°C to10°C in winter. The summer is dry and hot, the winter is cold and chilly with temperatures going below 0^0 C and the rainy season is with heavy rainfall, annual rainfall of 2115.4 mm/year. The experimental study was performed using a Randomized Block Design with 7 different treatment T_1 (Control), T_2 (75% RDF + 25% vermicompost), T_3 (50% RDF + 50% vermicompost), T_4 (75% RDF + 25% poultry manure), T_5 (50% RDF + 50% poultry manure), T_6 (75% RDF + 12.5% vermicompost + 12.5 % poultry manure), and T_7 (50% RDF + 25% vermicompost + 25% poultry manure). 3 separate replications of each treatment combination were performed. The soil in the experiment field had a sandy clay loam texture, a pH of 7.2 and 1.32 % organic carbon. There were 301.5 kg ha^{-1} of available nitrogen, 12.14 kg ha^{-1} of available phosphorus, and 233.6 kg ha^{-1} of available potassium. Statistics were conducted on observations made on growth and yield factors.

RESULT AND DISCUSSION:

Observation on various growth parameters viz., plant height, no. of leaves. Leaf area, no. of haulms, Fresh and dry weight of haulms and yield parameters viz., number of tubers per plant, weight of tubers per plant and weight of tubers per plot was recorded at 30,60 and 90 days after sowing (DAS) and at harvest of the crop.

Plant height (cm):

Table 1 shows that the plant height was highest in T_7 (50% RDF + 25% Vermicompost + 25% Poultry manure) at 90 DAS (28.66 cm) which was followed by T_4 (75% RDF + 25% Poultry manure) (27.95 cm). This increase in height might be due to increase in uptake of nitrogen, phosphorus, potassium, Vermicompost and poultry manure. Lowest plant height at 90 DAS was recorded in T_1 control (21.66cm). The plant height reached its maximum height at 90 DAS in all the treatments. Treatment T_7 (50% RDF + 25% vermicompost + 25% poultry manure) was effective and significant over control. The treatments T_3 (50% RDF + 50% Vermicompost) and T_4 (75% RDF + 25% Poultry manure) were statistically *at par* and T_5 (50% RDF + 50% Poultry manure) with T_6 (75% RDF + 12.5% Vermicompost + 12.5% Poultry manure). Similar results were obtained by **Baishya *et al.* (2012)** who revealed that applying RDF via chemical fertilizers, RDF via farm yard manure, RDF via chemical fertilizers resulted in increased plant height.

Number of leaves:

Table 1 shows that the number of leaves at 90 DAS was measured to be between 28.63 and 39.06. The maximum measurement (39.06) was found in T_7 (50% RDF + 25% vermicompost + 25% poultry manure) followed by T_4 (75% RDF + 25% Poultry manure). Lowest number of leaves at 90 DAS was recorded in T_1 control (28.63). Treatment T_7 (50% RDF + 25% vermicompost + 25% poultry manure) was effective and significant over control. The treatment T_2 (75% RDF + 25% Vermicompost) was statistically *at par* with T_3 (50% RDF + 50% vermicompost). Similar results were obtained by **Chettri *et al.* (2005)** who observed that using 125 percent of the needed amount of inorganic fertilizer (NPK) resulted in the highest plant height and number of leaves.

Leaf Area per plant (cm^2):

Table 1 shows the leaf area per plant was measured to be between (28.95$cm^{2)}$ and (47.85 cm^2) at 90 DAS. The maximum measurement (47.85 cm^2) was found in T_7 (50% RDF + 25% vermicompost + 25% poultry manure) followed by T_4 (75% RDF + 25% Poultry manure). Lowest leaf area per plant at 90 DAS was recorded in T_1 (control) (28.95). T_7 (50% RDF + 25% vermicompost + 25% poultry manure) was effective and significant over control. The treatment T_3 (50% RDF + 50% vermicompost) was statistically *at par* with T_6 (75%

RDF + 12.55 vermicompost + 12.5% Poultry manure). Similar results were found by **Subha AS *et al*. (2019)** who observed that the combination of RDF, biofertilizer and Micronutrient mixture resulted in the maximum leaf area per plant.

Number of haulms (m^{-1}):

At 90 DAS the number of haulms m^{-1} was measured to be between (29.80 m^{-1}) and (32.94 m^{-1}). Table 1 shows the maximum measurement (32.94 m^{-1}) was found in T_7 (50% RDF + 25% vermicompost + 25% poultry manure) followed by T_4 (75% RDF + 25% Poultry manure). Lowest number of haulms at 90 DAS was recorded in T_1 (control) (29.80 m^{-1}). Treatment T_7 (50% RDF + 25% vermicompost + 25% poultry manure) was effective and significant over control. The treatments T_2 (75% RDF + 25% Vermicompost), T_3 (50% RDF + 50% vermicompost), T_5 (50% RDF + 50% poultry manure) and T_6 (75% RDF + 12.55 vermicompost + 12.5% Poultry manure) were statistically *at par* with each other. Similar results were obtained by **Baishya *et al.* (2013)** who found out that applying 75 per cent RDF via chemical fertilizers, 25 per cent RDF via farm yard manure, and 100 per cent RDF via chemical fertilizers resulted in increased number of haulms.

Fresh and Dry Weight of Haulms (g):

Table 1 shows the fresh weight of haulms (g) at the dehaulming stage as affected by integrated nutrition management techniques. Data reported in Table shows that integrated nutrient management strategies had a significant impact on the fresh weight of haulms (g). At dehaulm, the fresh weight of haulm was in the range of (280.25-336.75 g). T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) recorded the highest fresh weight of haulms (336.75 g), followed by T_4 (75 % RDF + 25 % poultry manure) (316.18 g). The least number of fresh weight of haulms was recorded in T_1 (control) (280.25 g). Treatment T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) was most effective and significant over control.

The range of the dry weight of haulm at dehaulm was (28.83- 32.07g). T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) recorded the highest dry weight of haulms (32.07 g), followed by T_4 (75 % RDF + 25 % poultry manure) (31.80 g). The lowest dry weight of haulms was recorded in T_1 (control) (28.83 g). T_7 (50% RDF + 25% vermicompost + 25% poultry manure) was effective and significant over control. The treatments T_5 (50% RDF + 50% poultry manure) and T_6 (75% RDF + 12.55 vermicompost + 12.5% Poultry manure) were statistically *at par* with each other. Similar results were found by **MA Haque and MM Ali (2020)** who found out that Integrated effects of vermicompost with chemical fertilizers increased growth attributes in mustard.

Table 1: Growth attributes of Potato as influenced by integrated nutrient management practices:

Treatments	Height of plant (cm) at 90 DAS	No. of leaves at 90 DAS	Leaf Area(cm^2) at 90 DAS	No. of Haulms (m^{-1})	Fresh weight of Haulms (g)	Dry weight of Haulms (g)
T_1: (Control)	21.66	28.63	28.95	29.80	280.25	28.83
T_2: (75% RDF + 25% Vermicompost)	24.55	29.83	39.21	31.99	296.11	29.21
T_3: (50% RDF + 50% vermicompost)	27.65	29.73	37.18	31.20	312.04	28.85
T_4: (75% RDF + 25% poultry manure)	27.95	35.46	43.52	32.21	316.18	31.08
T_5: (50% RDF + 50% poultry manure)	26.93	30.12	33.34	31.50	305.07	30.25
T_6: (75% RDF + 12.55 vermicompost + 12.5% Poultry manure)	26.48	32.73	37.83	31.30	290.62	30.82
T_7: (50% RDF + 25% vermicompost + 25% poultry manure)	28.66	39.06	47.85	32.94	336.75	32.07
S Em±	0.34	0.30	0.60	0.76	0.42	0.4
CD at 5%	1.05	1.03	1.38	1.55	1.16	1.12

Yield Attributes:

The data on yield attributes as influenced by integrated nutrient management practices are presented in table 2.

Number of Tubers per plant:

At harvest the number of tubers per plant was recorded. Table 2 contains information about the number of tubers produced by each plant. According to the statistics, T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) produced the most tubers per plant during harvest (34.66) followed by T_4 (75 % RDF + 25 % poultry manure) (29.00). T_1 (control) had the fewest tubers per plant (14.00) according to the data. T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) demonstrated superiority over all treatments and

was significant over control. The treatments T_3 (50% RDF + 50% vermicompost) and T_6 (75% RDF + 12.55 vermicompost + 12.5% Poultry manure) were statistically *at par* with each other. Similar results were found by **Shubha AS et al. (2019)** who found out that combination of 75 % RDF + Azotobacter + PSB + KSB + $MgSO_4$ + Micronutrient mixture recorded the maximum Yield attributes like number of tubers per plant.

Weight of tubers per plant (g):

Table 2 contains information on the weight of tubers per plant. The findings clearly show that T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) had the maximum weight of tubers per plant (0.781 g) followed by T_4 (75 % RDF + 25 % poultry manure) (0.639 g). The lowest weight of tuber per plant was recorded in T_1 (control) (0.298 g). It was found that T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) was the most effective as compared to all other treatments and was significant over control. Similarly, according **to Singh and Gupta (2014)** the application of 100 percent N of the prescribed amount also boosted potato growth and yield. The usage of FYM led in a 60 kg N/ha savings. Azotobacter has been demonstrated to boost potato tuber production and growth. FYM, nitrogen, and Azotobacter all had a substantial interaction impact. The maximum tuber production was achieved using FYM @15 t/ha + Azotobacter + 100 percent of the prescribed nitrogen dose.

Weight of tuber per plot (kg):

Table 2 contains information on the weight of tubers per plot. The findings clearly show that T_7 (50 % RDF + 25 % vermicompost + 25 % poultry manure) had the highest weight of tubers per plot (3.857 kg), followed by T_4 (75 % RDF + 25 % poultry manure) (3.327 kg). The lowest weight of tuber per plot was recorded at T_1 (control) (1.840 kg). **According to Bashir and Qureshire (2005)** combining 180 kg N per hectare with 24 t FYM per hectare resulted in a considerable increase in output. The concentrations of N, P, and K in tubers rose as the amount of N and FYM increased. The addition of N and FYM to the potato considerably increased its quality. The application of FYM resulted in a considerable rise in the output of potato tubers.

Table 2: Yield Attributes of Potato as influenced by Integrated Nutrient Management Practices:

Treatments	No. of tubers per plant	Weight of tubers per plant (g)	Weight of tubers per plot (kg)
T_1: (Control)	14.00	0.298	1.840
T_2: (75% RDF + 25% Vermicompost)	20.00	0.354	2.917
T_3: (50% RDF + 50% vermicompost)	21.66	0.453	2.447
T_4: (75% RDF + 25% poultry manure)	29.00	0.639	3.327
T_5: (50% RDF + 50% poultry manure)	17.00	0.361	2.550
T_6: (75% RDF + 12.55 vermicompost + 12.5% Poultry manure)	21.00	0.472	2.350
T_7: (50% RDF + 25% vermicompost + 25% poultry manure)	34.66	0.781	3.857
S Em±	0.86	0.011	0.19
CD at 5%	1.65	0.18	0.78

CONCLUSION:

Thus, it maybe concluded that application of integrated nutrient 50 % RDF + 25 % vermicompost + 25 % poultry manure was found to be effective for growth and yield of potato. Among various integrated nutrient management higher nutrient uptake were recorded with application of 50 % RDF + 25 % vermicompost + 25 % poultry manure. On the basis of the experiment, it is recommended that potato crop cv. Kufri Pushkar should be fertilized with 50 % RDF + 25 % vermicompost + 25 % poultry manure to obtain higher yield.

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