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Performance of nutrient management (NPK) on growth and yield of potato based cropping system

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ABSTRACT

Nutrient management and soil health are critical aspects of potato-based cropping system to ensure optimal yield, quality, and sustainability. Potato is nutrient-intensive crop, and their nutritional requirement must be carefully managed to prevent soil degradation and nutrient imbalance. An experiment on "Nutrient Management and their effect on Soil Health in Potato-Based Cropping System" was conducted at the Vegetable Farm of Acharya Narendra Deva University of Agriculture and Technology during the 2019-20 seasons. The experiment was laid out in a randomized block design with eight treatments, varying in the application of the recommended dose of NPK (R) and NPK based on soil test (ST) for rice, potato, and bottle gourd crops. The soil had low organic carbon and nutrient levels initially. The results indicated that treatment T8, where NPK was applied based on soil tests in each crop, exhibited the highest growth and yield, while the control plot with no soil test-based nutrient application showed the lowest growth and yield.

Key words : *Rice, Potato, Bottle gourd, Nutrients management, Soil test basis nutrients application.*

Introduction

Nutrient management is critical for maintaining soil fertility, ensuring agricultural production stability and ensuring sustainability, and it increasingly depends on chemical fertilizers. Efficient use of plant nutrient supply systems is additionally a pre-requisite for achieving continuous advances in the biological productivity of vegetable crops in an ecologically sustainable manner (Sreenivas *et al*., 2000).

Fertilizer is an expensive and precious input. To determine an appropriate dosage application that would be both economical and appropriate for enhancing productivity and consequent profit for the grower in the given situation, it needs intensive study. At present, the world is facing the problem of the storage of the major fertilizer nutrients, especially nitrogen and phosphorus. Our country (India) is more sensitive to this storage because the fertilizer production in this country is expensive and less than its demand. Even when the fertilizer supply is satisfactory, the importance of increasing its efficient use cannot be underestimated. The application of nitrogen fertilizer, either in excess or less than the optimum rate, affects both yield and quality of crops to a remarkable extent; hence, proper management of

crop nutrition is of immense importance (Yahago *et al*., 2014).

Rice - Potato - bottle gourd is major cropping systems in the state, adopted by 50% of the farmers. Rice is planted once a year in rotation with potatoes as well as other vegetables. The productivity of rice and rabi crops (potato) has stagnated despite an increase in fertilizer use and other inputs (Ali *et al.* 2012). Cropping and soil management practices that collect plant residue can improve soil quality by improving aggregate stability, change strength, and splash detachment resistance (Achmad *et al.*, 2003). Cropping systems, including crop diversification, crop rotation, and intercropping, as well as related agronomic methods used in agriculture, have a diversity of geographical and temporal effects on soil health and quality. Cropping systems were originally designed to enhance agro-system productivity; however, modern agriculture is seriously concerned with cropping systems' environmental sustainability.

The goal of soil health maintenance is to substantiate the long-term stability, high productivity and environmental sustainability of cropping systems under five essential function evaluation standards, namely nutrient cycling, water relations, biodiversity and habitat (Tony Yang *et al.* 2020).

Therefore, these are needed to optimize nutrient requirements in potato-based cropping systems through soil test-based fertilizer (NPK) application.

Materials and Methods

The experiment was carried out during *rabi, kharif* and summer season of 2019 - 20 at Main Experiment Station Vegetable Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The experiment was laid out in Randomized Block Design (RBD) with three replications. There were eight treatments, i. e. T1: Rice (R) - Potato (R) - Bottle gourd (R), T2: Rice (R) - Potato (R) - Bottle gourd (ST), T3: Rice (R) - Potato (ST) - Bottle gourd (R), T4: Rice (R) - Potato (ST) - Bottle gourd (ST), T5: Rice (ST) - Potato (R) - Bottle gourd (R), T6: Rice (ST) - Potato (ST) - Bottle gourd (R), T7: Rice (ST) - Potato (R) - Bottle gourd (ST), T8: Rice (ST) - Potato (ST) - Bottle gourd (ST) where, R denotes Recommended dose of NPK application and ST denotes NPK application on soil test basis. The soil of experimental field was silt loam, having low organic carbon (0.31%), available N (140 kg/ha), available P (15.6 kg/ha) and available K (246.5 kg/ha). The rice variety NDR - 97, potato variety Kufri Khyati and bottle gourd variety Narendra Rashmi were planting/ sowing on July 2019, November 2019 and April 2020 in the respective seasons. Recommended dose of fertilizers (NPK) for rice (120:60:60), potato (150:100:120) and bottle gourd (60:40:40) were applied. For soil test basis application of N has to be increased by 30% for low fertility soil (available N).

Urea, single super phosphate and mutate of potash were the source of fertilizers used for supplying nitrogen, phosphorus, and potassium respectively. The full dose of phosphorus, and potassium fertilizers was applied at the time of land preparation. Half a dose of N was used at the time of seed sowing as a basal dose. The remaining half dose of N was side-dressed at 30 DAS and 60 DAS. The emergence of rice-potato-bottle gourd plants per plot were recorded at 30 DAS and calculate emergence per cent. The data on plant height and vine length of bottle gourd were recorded from the area already marked by tag. Yield attributes were recorded for rice, the producer of each net plot was threshed separated and clean grain were sun dried to maintain 12-14% moisture. The grain yield was recorded in kg plot^{-1} and finally values were converted into t ha^{-1}. For potato and bottle gourd crop after harvesting, the yield per plot were recorded in kg separately and converted into t ha^{-1}. The data statistically analyzed using the F test as per the procedure given by Gomez and Gomez (1984).

Results and Discussion

Plant population/emergence

The plant populations at 30 days after sowing (DAS) for rice, potato, and bottle gourd are summarized in Table 1 and visually depicted in Figure 1. The data clearly indicate that there were no significant differences in plant populations among the three crops (rice, potato, and bottle gourd). In all three crop, the highest plant populations were observed under the T8 treatment. Specifically, in rice, the number of tillers reached 52 m^{-2}. For potato, the tuber emergence rate was at its maximum, reaching 96%. In the case of bottle gourd, the plant population was highest, with a rate of 92%. The T8 treatment involved the application of N, P, and K nutrients at specific ratios based on soil test results. For rice, the nutrient

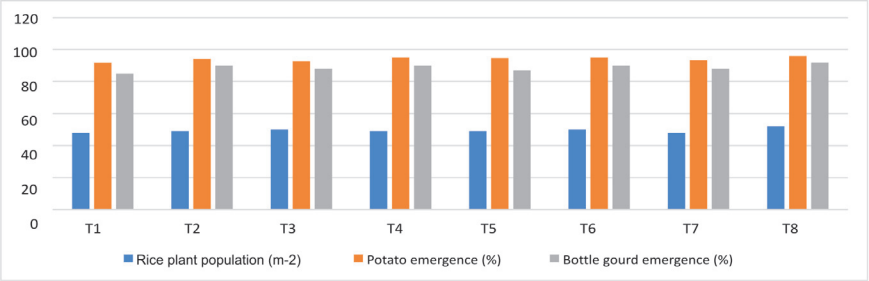

Fig. 1. Effect of different treatments on plant population/emergence of crops at 30 DAS/DAT (Rice - Potato - Bottle gourd)

Table 1. Effect of different treatments on plant population/emergence of crops at 30DAS/DAT (Rice-Potato –Bottle gourd)

Treatments	Rice plant population (m^{-2})	Potato emergence (%)	Bottle gourd emergence (%)
T1 : R -R -R	48	91.8	85
T2 : R -R -ST	49	94	90
T3 : R-ST-R	50	92.8	88
T4 : R-ST -ST	49	95	90
T5 : ST -R -R	49	94.6	87
T6 : ST -ST -R	50	95	90
T7 : ST -R -ST	48	93.4	88
T8 : ST -ST -ST	52	96	92
SEm±	-	-	-
C.D.at5%	NS	NS	NS

*ST=NPK application on soil test basis; R= Recommended NPK

application was at a ratio of 156:60:60, for potato it was 195:100:120, and for bottle gourd, it was 78:40:40. These nutrient levels resulted in optimal plant population for all three crops. Conversely, the T1 treatment, which involved applying the recommended doses of N, P, and K nutrients throughout the season, led to the minimum plant populations in all three crops. These findings highlight the importance of tailored nutrient management practices, as exemplified by the success of the T8 treatment in promoting robust plant populations in rice, potato, and bottle gourd.

Plant height/vine length

The plant heights of rice, potato, and bottle gourd at 60 days after sowing (DAS) or days after transplanting (DAT) and data are presented through Table 2 and Figure 2. The data clearly illustrate that the plant height for each crop increased with the progression of plant age. Various treatments were effective in augmenting plant height compared to the control (T1) at 60 DAS/DAT. At 60 DAS/DAT, the tallest plant heights were recorded with the T8 treatment, which involved the application of N, P, and K nutrients based on soil test results for each crop. Specifically, the plant heights were 80.5 cm for rice, 51.8 cm for potatoes, and 4.8 m for bottle gourd under the T8 treatment. Conversely, the minimum plant heights at 60 DAS/DAT for rice (65.8 cm), potato (42.8 cm), and bottle gourd (3.2 m) were observed in the T1 treatment, which served as the con-

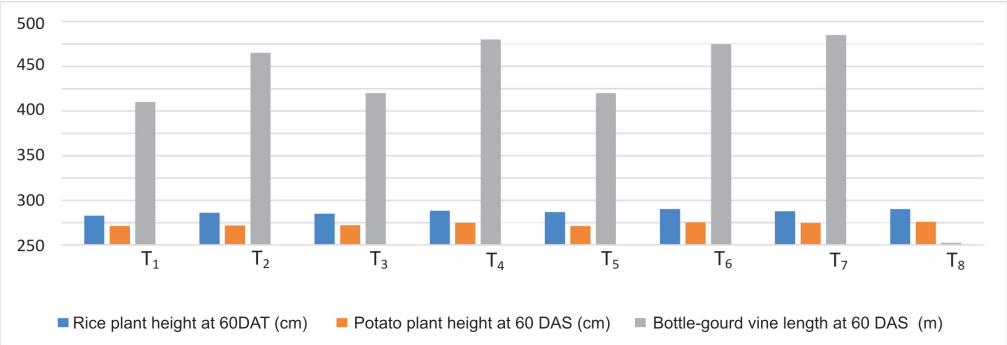

Fig. 2. Effect of different treatments on plant height/vine length of crops at 60 DAT/DAS (Rice – Potato – Bottle gourd)

Table 2. Effect of different treatments on plant height/ vine length of crops at 60 DAT/DAS (Rice – Potato – Bottle gourd)

Treatments	Rice plant height at 60 DAT (cm)	Potato plant height at 60 DAS (cm)	Bottle gourd vine length at 60 DAS (m)
T1 : R - R - R	65.8	42.8	3.2
T2 : R - R - ST	72.0	43.5	4.3
T3 : R - ST - R	70.0	43.8	3.4
T4 : R - ST - ST	76.3	50.0	4.6
T5 : ST - R - R	73.6	42.8	3.4
T6 : ST - ST - R	80.3	50.6	4.5
T7 : ST - R - ST	75.4	49.4	4.7
T8 : ST - ST - ST	80.5	51.8	4.8
SEm±	2.24	1.41	0.12
C.D.at 5%	6.79	4.3	0.37

trol plot. The treatment T1 involved applying the recommended doses of N, P, and K nutrients for each crop. The T8 treatment consistently resulted in the highest values for both plant population and plant height. This outcome suggests that the T8 treatment facilitated a more balanced and effective nutrient supply system to the crops throughout each season (rice-potato-bottle gourd). The application of N, P, and K nutrients based on soil test results contributed to vigorous plant growth at various growth stages. These findings align with similar results reported by Meena *et al.* (2013), Mishra Nityamanjari (2018), and Chaudhary *et al.* (2019), emphasizing the positive impact of a well-managed nutrient supply system on plant growth parameters.

Yield of crops

The progressive data on the yield of rice (grain and straw in t/ha), potato (tuber and haulm in t/ha) and bottle gourd (fresh bottle gourd and stalk in t/ha) are depicted in Table 3 and Figure 3 and influenced by various treatments. The table clearly shows that all treatments led to an increase in crop yield compared to the control (T_1). The T_8 treatments resulted in the highest yield for rice grain and straw (3.80 t/ha and 4.94 t/ha, respectively), potato tuber and haulm (35.42 t/ha and 60.21 t/ha, respectively), and fresh bottle gourd and stalk (30.40 t/ha and 54.72 t/

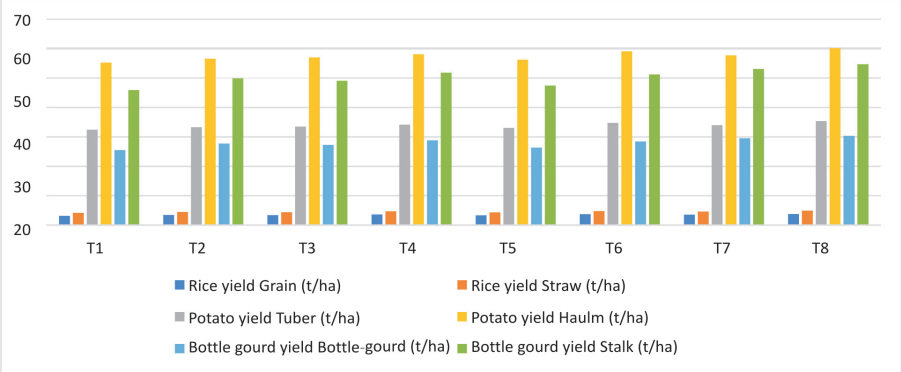

Fig. 3. Effect of different treatments on yield (t ha^{-1}) of crops (Rice - Potato - Bottle gourd)

Table 3. Effect of different treatments on yield (t/ha) of crops (Rice - Potato - Bottle gourd)

Treatments	Rice yield (t/ha)		Potato yield (t/ha)		Bottle gourd yield (t/ha)	
	Grain	Straw	Tuber	Haulm	Bottle-gourd	Stalk
T1 : R - R - R	3.19	4.14	32.48	55.24	25.52	45.93
T2 : R - R - ST	3.47	4.51	33.33	56.61	27.76	49.95
T3 : R - ST - R	3.41	4.43	33.55	57.03	27.28	49.12
T4 : R - ST - ST	3.60	4.68	34.18	58.10	28.80	51.85
T5 : ST - R - R	3.30	4.29	33.11	56.28	26.40	47.52
T6 : ST - ST - R	3.69	4.79	34.76	59.09	28.48	51.25
T7 : ST - R - ST	3.56	4.62	33.98	57.77	29.52	53.14
T8 : ST - ST - ST	3.80	4.94	35.42	60.21	30.40	54.72
SEm±	-	-	7.74	12.76	13.70	18.80
C.D.at 5%	NS	NS	2.57	4.25	4.50	6.20

ha, respectively). Conversely, the minimum yield for each crop season was observed under the T_1 treatments. The superior performance of the T8 treatment in terms of crop yield suggests that the efficient and balanced availability of nutrients (N, P, and K) contributed to enhanced growth and development of the plants, ultimately resulting in improved yield attributes. This underscores the importance of precision nutrient management in optimizing crop productivity. The findings are agreement with the findings of Meena *et al.* (2017); Shudha *et al.* (2018) and Singh *et al.* (2018).

Conclusion

Under potato based cropping system at 30 DAS/DAT the plant population of each crop (Rice, Potato and Bottle gourd) was not influenced effectively owing to various treatments. The maximum plant height at 60 DAS/DAT (rice, potato and bottle gourd) were observed with T8 treatment (NPK nutrients applied on soil test basis), while minimum plant height (60 DAS/DAT) was observed in control plot T1 (recommended dose of N, P and K nutrients applied in each season crops. The maximum rice grain and straw yield (3.8 and 4.94 t/ha), potato tuber and haulm yield (35.42 and 60.21 t/ha) and bottle gourd and stalk yield (30.40 and 54.72 t/ha) were got under T8 treatment (N, P and K applied on soil test basis), while minimum in T1 plot (N, P and K nutrients not applied on soil test basis).

Nutrients management (N, P and K) applied on soil test basis in treatment T8 was found better on growth and yield of rice, potato and bottle gourd. On the basis of experiment result under rice-potato-bottle gourd cropping system it may be concluded that nutrients (NPK) applied on soil test basis was found better nutrient management (NPK) treatment, on growth and yield over the rest of the treatments.

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Conflict of interest: The authors declare that there is no conflict of interest.

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