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Response of Nutrient Management on Yield and Economics in Potato-Based Cropping System in Eastern Uttar Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during 2019-20 at Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during kharif, rabi and summer season to judge the "effect of nutrient management on potato-based cropping system". The experiment was laid out in randomized block design with three replications. 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 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 have to be increased by 30% for low fertility soil (available N). The result revealed that maximum yield like rice grain (3.8 t ha^{-1}), potato tuber (35.42 t ha^{-1}) and bottle gourd (30.40 t ha^{-1}) were got under T_8 treatment (N, P and K applied on soil test basis), while minimum in T_1 plot (control plot). The highest net return and B:C ratio in rice (Rs 29519 and 1.21), potato (Rs 207040 and 2.68) and bottle gourd (Rs 135003 and 7.81) were recorded under T_8 treatment (N, P and K nutrients applied on soil test basis). While minimum net return with T_1 plot (control plot) in each season during investigation.

Keywords: Cropping system; Khufri Khyati; nutrient management.

1. INTRODUCTION

"Potato (*Solanum tuberosum* L.) is an ingredient in many dishes and salads. it's a non-fattening. Nutritious and wholesome food that supplies many important nutrients to the diet. It contains approximately 78% water, 22% dry matter and fewer than 1% fat. About 82% of dry matter is carbohydrate, mainly starch, with some dietary fiber and have the more nutritional quality than cereals. Potato contains a minimum of 12 essential vitamins and can be a source of vitamin C, thiamine, iron, folate. The current global production of potato is around 388.2 million tones and China being the largest producer globally, India ranks 2nd in area and production of potato after the China which contribute 11 percent of the worldwide potato production" (FAO STAT, 2019). "In India potato production is meanly confined to Uttar Pradesh, West Bengal, Punjab, Assam, Gujarat and Haryana. In India, it's grown on an area of 2.179 million tones" [1].

"Rice (*Oryza sativa L.*) belongs to Gramineae family. it's one amongst the foremost important cereal crop of kharif season. it's one in every of the richest starch food at consumed by about half the planet population. Rice ranks second in Production among the cereal and half the world population receiving the absolute best (26.2%) calories intake from it, within the developing countries 20% of their dietary protein". (FAO, 2009) "At the present rice production alone consumes nearly 24.7 Mt of fertilizer (N + P_2O_5 + K_2O) which accounts for about 14.0 percent of total global fertilizer consumption during a year. Scientists have predicted that a hike of a minimum of 60% in rice yield is very important so on ensure food and nutritional security of 9 billion populations that are expected to inhabit the world by 2050. With increasing demand for food production, demand for nutrients is probably getting to extend further" [2].

"Bottle gourd (*Lagenaria siceraria* (Molina) Standl; 2n=22) is a very important cucurbitaceous crop grown throughout the country. it's native in South Africa. calabash or white flowered gourd is usually referred to as Lauki or Ghiya in India. it's one among Introduction 2 the foremost important cucurbits cultivated in India. it's grown in summer season also as in rainy season" [3]. "The immature fruits are usually used as vegetable dishes. The anti-cancerous, heart protective, diuretic, aphrodisiac, general tonic, antidote to some poisons and scorpion stings, alternate purgative, and cooling effects of bottle gourd have all been described. it's getting to be wont to cure pain, ulcers and fever and is used for pectoral cough, asthma and other bronchial disorders using prepared syrup from the tender fruits. Bottle gourds are known to lower cholesterol, triglyceride, rarity lipoproteins, pain and inflammation, free radicals and oxidation" (Das et al. 2015).

2. MATERIALS AND METHODS

The experiment was carried out during the rabi, kharif, and summer seasons of 2019–20 at the Main Experiment Station Vegetable Farm of Acharya Narendra Deva University of Agriculture

and Technology, Kumarganj, Ayodhya (U.P.). The soil was partially reclaimed sodic soil with silt loam texture, slightly alkaline in reaction (pH 8.20) with low in organic carbon (0.31%), low available nitrogen (140.00 kg ha^{-1}), medium in available phosphorus (15.60 kg ha^{-1}) and available potassium (246.50 kg ha^{-1}). The experiment was comprised of eight treatments *viz.* T_1: Rice (R) - Potato (R) - Bottle gourd (R), T_2: Rice (R) - Potato (R) - Bottle gourd (ST), T_3: Rice (R) - Potato (ST) - Bottle gourd (R), T_4: Rice (R) - Potato (ST) - Bottle gourd (ST), T_5: Rice (ST) - Potato (R) - Bottle gourd (R), T_6: Rice (ST) - Potato (ST) - Bottle gourd (R), T_7: Rice (ST) - Potato (R) - Bottle gourd (ST), T_8: Rice (ST) - Potato (ST) - Bottle gourd (ST) where R denotes the recommended dose of NPK application and ST denotes NPK application on a soil test basis. All the treatments were randomly allocated and replicated three times in a randomized block design. The recommended dose of NPK was applied through urea, SSP and muriate of potash, respectively. The rice variety NDR-97, potato variety Kufri Khyati, and bottle gourd variety Narendra Rashmi were planted or sown in the respective seasons. The recommended doses of fertilizer (NPK) for rice (120:60:60), potato (150:100:120), and bottle gourd (60:40:40) were applied. For soil testing, the 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. 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 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}. Net return was calculated by deducting the cost of cultivation from the gross return of the individual treatment and benefit: cost ratio was worked out by dividing the net return to the cost of cultivation of the individual treatment combination. The data statistically analyzed using the F test as per the procedure given by Gomez and Gomez [4].

3. RESULTS AND DISCUSSION

3.1 Crop yield

Data on yield of rice (grain t/ha), potato (tuber t/ha) and bottle gourd (fresh bottle gourd t/ha) as influence by different treatments have been given in Table 1. Table clearly indicate that all the treatments resulted increase in crop yield as compare to control (T_1). The maximum rice grain (3.80 t/ha), potato tuber (35.42 t/ha) and fresh bottle gourd (30.40 t/ha) were recorded under T_8 treatments. While minimum yield in each crop season were found under T_1 treatments.

The crop yield under T_8 treatment was found better as compare to rest of the treatments may be due to supply of efficient and balance available of nutrients (N, P and K), which resulted better growth and development of plant vis-a-vis yield attributes.

Table 1. Effect of different treatments on yield of each crop (Rice-Potato-Bottle gourd)

Treatments	Rice		Potato		Bottle gourd	
	Grain yield (t/ha)	Straw yield (t/ha)	Tuber yield (t/ha)	Haulm yield (t/ha)	Bottle gourd yield (t/ha)	Stalk yield (t/ha)
T_1 : R - R - R	3.19	4.14	32.48	55.24	25.52	45.93
T_2 : R - R - ST	3.47	4.51	33.33	56.61	27.76	49.95
T_3 : R - ST - R	3.41	4.43	33.55	57.03	27.28	49.12
T_4 : R - ST - ST	3.60	4.68	34.18	58.10	28.80	51.85
T_5 : ST - R - R	3.30	4.29	33.11	56.28	26.40	47.52
T_6 : ST - ST - R	3.69	4.79	34.76	59.09	28.48	51.25
T_7 : ST - R - ST	3.56	4.62	33.98	57.77	29.52	53.14
T_8 : 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

Table 2. Effect of different treatments on economics of rice crop

Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
T_1 : R	23681	44660	20979	0.88
T_2 : R	23681	48580	24899	1.05
T_3 : R	23681	47740	24059	1.01
T_4 : R	23681	50400	26719	1.12
T_5 : ST	24235	46754	22519	0.92
T_6 : ST	24235	52214	27979	1.15
T_7 : ST	24235	50394	26159	1.07
T_8 : ST	24235	53754	29519	1.21

Table 3. Effect of different treatments on economics of potato crop

Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
T_1 : R	76320	259840	183520	2.40
T_2 : R	76320	266640	190320	2.49
T_3 : ST	77014	269094	192080	2.50
T_4 : ST	77014	274134	197120	2.55
T_5 : R	76320	264880	188560	2.47
T_6 : ST	77014	278774	201760	2.61
T_7 : R	76320	271840	195520	2.56
T_8 : ST	77014	284054	207040	2.68

Table 4. Effect of different treatments on economics of Bottle gourd

Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
T_1 : R	16997	127600	110603	6.50
T_2 : ST	17277	139080	121803	7.05
T_3 : R	16997	136400	119403	7.02
T_4 : ST	17277	144280	127003	7.35
T_5 : R	16997	132000	115003	6.76
T_6 : R	16997	136000	119003	7.00
T_7 : ST	17277	147600	130603	7.54
T_8 : ST	17277	152280	135003	7.81

3.2 Economics

The common cost of cultivation was added in rice (Rs 23681), potato (Rs 76320) and bottle gourd (Rs 16997) in the treatment in respective seasons of crops for calculating the cost of cultivation. The highest net return and B:C ratio in rice (Rs 29519 and 1.21), potato (Rs 207040 and 2.68) and bottle gourd (Rs 135003 and 7.81) were found in T_8 treatment (N, P and K applied on soil test basis). While minimum net return (Rs 20979, 183520 and 110603) and B:C ratio (0.88, 2.40 and 6.50) were recorded with T_1 plot (where N, P and K was not applied on soil test basis) during each season/each crop (rice, potato and bottle gourd).

Treatment (T_8) gave better net returns and B:C ratio over rest of the treatments in each season crops (rice, potato and bottle gourd) may be due to better yield as compared to lesser increase in cost of cultivation with these treatments. The results are agreement with Churpal et al. [5]., Sharma et al. [6], Kumar et al. [7], Kumar et al. [8], Mula et al. [9], Sharma et al. [10], Aktar et al. [11].

4. CONCLUSION

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 T_8 treatment (N, P and K applied on soil test basis), while minimum in T_1 plot (N, P and K nutrients not applied on soil test basis). The highest net return and B:C ratio in rice (Rs 29519 and 1.21), potato (Rs 207040 and 2.68) and bottle gourd

(Rs 135003 and 7.81) were recorded under T_8 treatment (N, P and K nutrients applied on soil test basis). While minimum net return with T_1 plot (N, P and K nutrients not applied on soil test basis) in each season during investigation.

On the basis experimental results 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 yield and economics over rest of the treatments.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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