

Effect of Combined Application of Inorganic, FYM and *Azotobacter* on Chemical Properties and N, P, K Availability after Potato Harvest

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Abstract

Results of field experiment conducted during 2005-06 on sandy loam soil having pH 7.57, EC 0.36 (dS/m) and OC 0.47 (%). The experiment comprising three levels of inorganic, organic and two levels of bio-fertilizer in three replication. The experiment indicates that the chemical properties of soil and availability of nitrogen, phosphorus and potassium were significantly influenced by application of inorganic, organic and bio-fertilizer. The value of soil pH and EC were recorded with marginal difference, which was non-significant in all treatment level either alone or in combination levels. During estimating the OC%, medium range values (0.75, 0.66 and 0.64) were obtained in individual treatment level of inorganic, organic and bio-fertilizer respectively, while the highest value of 0.79% was recorded in T₁₇ (I₂ O₀ B₁) treatment combination, which was significant. The maximum available N in kg/ha 261.78, 249.02 and 246.01 were recorded in individual treatment level of I₁, O₂ and B₁ respectively. Response of individual and combined levels of inorganic, organic and bio-fertilizer on available P and K showed same trend as of N. Similarly, their interaction effect also influenced significantly alone and interaction between inorganic, organic and bio-fertilizer. The combined application of chemical, FYM and bio-fertilizer improved quality and production.

Key words : Inorganic fertilizers, FYM, *Azotobacter*, Crop, Nutrient availability.

Potato is an important crop of Uttar Pradesh. The economy of the people of Allahabad is dependent upon cash crops mainly potato and peas. The cost of cultivation generally experienced high due to inputs like seed, fertilizer and labors. Nutritional requirement of potato is much higher due to its high bulking rate. Farm yard manure and bio-fertilizer being eco-friendly, play a major role in providing nutrient supply at lower cost and helpful in improving production (1). Keeping these in view and for proper utilization of residual nutrients an attempt was made to evaluate fertilizer economy by the use of chemical fertilizers in consumption with FYM and Bio-fertilizer in potato. Application of chemical fertilizers with supplementary and complementary use of organic manures and bio-fertilizers improves physical, chemical and biological properties of soil, fertilizer use efficiency, mitigates short supply of micro-nutrients, stimulates the proliferation of diverse group of micro-organisms and play an important role in the maintenance of soil fertility and also improve the ecological balance of rhizosphere (2). Thus, with the object of redefining prevalent nutrient management practices, the present study was undertaken.

Methods

The experiment was conducted at the Soil and Environmental Sciences Research Farm of Allahabad Agricultural Institute-Deemed University, Allahabad, UP. The experiment consisted of 18 treatments comprising of three levels of inorganic fertilizer as the form of nitrogen 0, 60 and 120 kg N/ha, as urea (46%, N), phosphorus 0, 45 and 90 kg P₂O₅/ha SSP (16%, P₂O₅) and potassium 0, 37.5 and 75 kg K₂O/ha MoP (60%, K₂O) as (I₀I₁I₂), three levels of organic manure

Table 1. Soil properties before sowing.

Particulars	Results	Methods followed
pH (1 : 2)	7.57	pH meter (Systronics type, 331)
EC (dS/m)	0.36	EC meter (Conductivity meter)
Organic carbon (%)	0.47	Walkley and Black (3)
Available N (kg/ha)	230.07	Kjeldahl's method
Available P (kg/ha)	24.37	Olsen's colorimeter (4)
Available K (kg/ha)	241.68	Flame photometer

Table 2. Effect of different levels of inorganic fertilizers, FYM and *Azotobacter* on pH, EC and organic carbon of post-harvest soil of potato crop.

Levels		pH (1 : 2)	EC (dS/m)	OC (%)
Inorganic Fertilizer (I) (kg/ha)				
I ₀	N ₀ P ₀ K ₀	7.72	0.35	0.51
I ₁	N ₆₀ P ₄₅ K _{37.5}	7.61	0.30	0.62
I ₂	N ₁₂₀ P ₉₀ K ₇₅	7.48	0.28	0.75
<i>F</i> -test		NS	NS	S
SE (±)		-	-	0.002
CD at 5%		-	-	0.004
Organic Manure (O) (t/ha)				
O ₀	FYM 0	7.64	0.32	0.59
O ₁	FYM 15	7.60	0.31	0.62
O ₂	FYM 30	7.57	0.29	0.66
<i>F</i> -test		NS	NS	S
SE (±)		-	-	0.002
CD at 5%		-	-	0.004
Biofertilizer (B) (kg/ha)				
B ₀	<i>Azotobacter</i> 0	7.61	0.31	0.61
B ₁	<i>Azotobacter</i> 12	7.59	0.30	0.64
<i>F</i> -test		NS	NS	S
SE (±)		-	-	0.002
CD at 5%		-	-	0.003
<i>F</i> -test		NS	NS	S
Interaction SE (±)		-	-	0.003
(I × O) CD at 5%		-	-	0.007
<i>F</i> -test		NS	NS	S
Interaction SE (±)		-	-	0.003
(O × B) CD at 5%		-	-	0.006
<i>F</i> -test		NS	NS	S
Interaction SE (±)		-	-	0.003
(I × B) CD at 5%		-	-	0.006
<i>F</i> -test		NS	NS	S
Interaction SE (±)		-	-	0.005
(I × O × B) CD at 5%		-	-	0.010

0, 15 and 30 t FYM/ha (0.5% N, 0.25% P and 0.50% K) as (O₀O₁O₂) and two levels of bio-fertilizer 0 and 12 kg *Azotobacter*/ha (10—15 kg N—fixing/ha per year) as (B₀B₁) replicated three times in 3 × 3 × 2 factorial in randomized block design.

Soil samples (0—15 cm depth) before and after harvest of crop were collected and analyzed by standard methods in the laboratory. Important soil characteristics of the experimental field are presented in below (Table 1).

The economics regarding the cultivation of the

Table 3. Interaction effect of different levels of inorganic fertilizers, FYM and *Azotobacter* on pH, EC and organic carbon of post-harvest soil of potato crop.

Treatment combination	pH (1 : 2)	EC (dS/m)	OC (%)
T ₀ (I ₀ O ₀ B ₀)	7.78	0.38	0.48
T ₁ (I ₀ O ₀ B ₁)	7.75	0.36	0.48
T ₂ (I ₀ O ₁ B ₀)	7.72	0.36	0.49
T ₃ (I ₀ O ₁ B ₁)	7.70	0.35	0.51
T ₄ (I ₀ O ₂ B ₀)	7.70	0.32	0.52
T ₅ (I ₀ O ₂ B ₁)	7.69	0.31	0.56
T ₆ (I ₁ O ₀ B ₀)	7.64	0.31	0.57
T ₇ (I ₁ O ₀ B ₁)	7.64	0.31	0.59
T ₈ (I ₁ O ₁ B ₀)	7.61	0.30	0.62
T ₉ (I ₁ O ₁ B ₁)	7.60	0.30	0.63
T ₁₀ (I ₁ O ₂ B ₀)	7.58	0.30	0.64
T ₁₁ (I ₁ O ₂ B ₁)	7.56	0.29	0.69
T ₁₂ (I ₂ O ₀ B ₀)	7.53	0.29	0.70
T ₁₃ (I ₂ O ₀ B ₁)	7.51	0.28	0.72
T ₁₄ (I ₂ O ₁ B ₀)	7.48	0.28	0.74
T ₁₅ (I ₂ O ₁ B ₁)	7.47	0.28	0.75
T ₁₆ (I ₂ O ₂ B ₀)	7.46	0.27	0.77
T ₁₇ (I ₂ O ₂ B ₁)	7.42	0.26	0.79
Interaction (I × O × B)			
<i>F</i> -test		NS	NS
SE (±)		-	-
CD at 5%		-	-

crop were calculated separately for all treatments on hectare basis. The cost of cultivation for each treatment was calculated separately taking into consideration all the cultural practices followed in cultivation. The gross return from each treatment was calculated taking into consideration the cost of cultivation and the market price of the produce. The net profit from each treatment was calculated separately by using the formula :

Net profit (Rs/ha) = Gross return – Cost of cultivation

The benefit cost ratio for each treatment was calculated by using the formula :

$$\text{Benefit cost ratio} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

Results and Discussion

Effect on Chemical Properties of Soil

Among soil properties particularly, soil pH and EC there were a marginal difference of value in both

Table 4. Effect of different levels of inorganic fertilizers, FYM and *Azotobacter* on available nitrogen, phosphorus and potassium of post-harvest soil of potato.

Levels		Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
Inorganic Fertilizer (I) (kg/ha)				
I ₀	N ₀ P ₀ K ₀	228.44	25.58	244.49
I ₁	N ₆₀ P ₄₅ K _{37.5}	244.20	28.70	255.37
I ₂	N ₁₂₀ P ₉₀ K ₇₅	261.78	30.79	267.89
F-test		S	S	S
SE (±)		0.41	0.09	0.59
CD at 5%		0.83	0.18	1.21
Organic Manure (O) (t/ha)				
O ₀	FYM 0	239.77	27.48	252.68
O ₁	FYM 15	245.63	28.43	255.71
O ₂	FYM 30	249.02	29.16	259.36
F-test		S	S	S
SE (±)		0.41	0.09	0.59
CD at 5%		0.83	0.18	1.21
Biofertilizer (B) (kg/ha)				
B ₀	<i>Azotobacter</i> 0	243.61	28.20	255.42
B ₁	<i>Azotobacter</i> 12	246.01	28.51	256.41
F-test		S	S	S
SE (±)		0.33	0.07	0.48
CD at 5%		0.68	0.15	0.99
	F-test	S	S	S
Interaction	SE (±)	0.71	0.16	1.03
(I × O)	CD at 5%	1.44	0.32	2.09
	F-test	S	S	NS
Interaction	SE (±)	0.58	0.13	-
(O × B)	CD at 5%	1.18	0.26	-
	F-test	S	NS	NS
Interaction	SE (±)	0.58	-	-
(I × B)	CD at 5%	1.18	-	-
	F-test	S	S	S
Interaction	SE (±)	1.00	0.22	1.45
(I × O × B)	CD at 5%	2.04	0.45	2.96

the character which was non-significant in all treatment levels either alone or in combination (Tables 2 and 3). The OC%, medium range values (0.75, 0.66 and 0.64) were recorded in individual treatment of inorganic, organic and bio-fertilizer respectively, while the highest value (0.79%) was recorded in T₁₇(I₂O₀B₁) treatment combination, which was significant. Similar results were obtained earlier (5) for soil pH and EC and for OC (6).

Table 5. Interaction effect of different levels of inorganic fertilizers, FYM and *Azotobacter* on available nitrogen, phosphorus and potassium of post-harvest soil of potato crop.

Treatment combination	Nitrogen (kg/ha)	Phosphorus (kg/ha)	Potassium (kg/ha)
T ₀ (I ₀ O ₀ B ₀)	227.60	23.91	242.00
T ₁ (I ₀ O ₀ B ₁)	228.75	24.60	243.09
T ₂ (I ₀ O ₁ B ₀)	229.26	25.66	243.91
T ₃ (I ₀ O ₁ B ₁)	230.36	25.80	244.93
T ₄ (I ₀ O ₂ B ₀)	232.46	26.60	246.04
T ₅ (I ₀ O ₂ B ₁)	234.20	26.92	246.98
T ₆ (I ₁ O ₀ B ₀)	240.03	27.98	251.94
T ₇ (I ₁ O ₀ B ₁)	241.62	28.08	252.01
T ₈ (I ₁ O ₁ B ₀)	242.32	28.73	253.18
T ₉ (I ₁ O ₁ B ₁)	243.93	28.81	254.30
T ₁₀ (I ₁ O ₂ B ₀)	246.69	28.97	260.09
T ₁₁ (I ₁ O ₂ B ₁)	250.63	29.63	260.68
T ₁₂ (I ₂ O ₀ B ₀)	251.67	29.91	262.81
T ₁₃ (I ₂ O ₀ B ₁)	260.95	30.39	264.20
T ₁₄ (I ₂ O ₁ B ₀)	263.61	30.84	268.13
T ₁₅ (I ₂ O ₁ B ₁)	264.30	30.74	269.83
T ₁₆ (I ₂ O ₂ B ₀)	264.82	31.22	270.69
T ₁₇ (I ₂ O ₂ B ₁)	265.31	31.64	271.67
Interaction (I × O × B)			
F-test	S	S	S
SE (±)	1.00	0.22	1.45
CD at 5%	2.04	0.45	2.96

Effect on N, P and K Availability

Application of inorganic, organic and bio-fertilizer influenced the available N of post harvest soil ; the maximum available N in kg/ha of 261.78, 249.02 and 246.01 were recorded in individual treatment level of I₂, O₂ and B₁ respectively. Thus there was an increase in available N of 14.59, 3.71 & 0.93% compared to control. The interaction between inorganic fertilizer in consumption with organic manure and bio-fertilizer significantly increased the available N kg/ha, the maximum available N was 265.31 as recorded with the treatment T₁₇ (I₂O₀B₁). Thus there was 16.96% increase in available N as compared treatment combination (I₀O₀B₀). These results were in agreement with earlier observation (7).

The response of individual and combined levels of inorganic, organic and bio-fertilizer on available P and K showed the same trend as of N (Tables 4 and 5). The maximum available P were with I₂O₂ and B₁ treatment combinations and the values were 30.79, 29.16, 28.51 and 31.64 kg/ha respectively. Similarly the values of K were 267.89, 259.36, 252.41 and 271.67. All

Table 6. Evaluation of the best treatment combination and the cost of cultivation of potato.

Treatment combination	Tuber yield (t/ha)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	Input-output/ Cost-Benefit ratio
I ₀ O ₀ B ₀	18.79	45197.50	44012.00	1185.50	1: 1.02
I ₀ O ₀ B ₁	19.91	451775.50	46772.00	3003.50	1 : 1.06
I ₀ O ₁ B ₀	21.20	52550.00	48964.00	3586.00	1 : 1.07
I ₀ O ₁ B ₁	22.47	55117.14	50329.06	4788.08	1 : 1.09
I ₀ O ₂ B ₀	23.50	57625.00	51042.91	6582.09	1 : 1.12
I ₀ O ₂ B ₁	24.14	60035.00	52493.41	7541.59	1 : 1.14
I ₁ O ₀ B ₀	27.23	68075.00	54872.09	13202.91	1 : 1.24
I ₁ O ₀ B ₁	28.72	70180.00	55916.32	14263.68	1 : 1.25
I ₁ O ₁ B ₀	30.44	75110.00	56092.42	19018.00	1 : 1.33
I ₁ O ₁ B ₁	33.13	76100.00	56849.50	19250.50	1 : 1.33
I ₁ O ₂ B ₀	36.37	82532.50	57013.22	25519.28	1 : 1.44
I ₁ O ₂ B ₁	37.29	92572.50	57149.06	35423.44	1 : 1.61
I ₂ O ₀ B ₀	38.10	95025.00	57432.69	37592.31	1 : 1.65
I ₂ O ₀ B ₁	40.00	100000.00	58106.28	41893.72	1 : 1.72
I ₂ O ₁ B ₀	41.81	102702.50	58349.16	44353.34	1 : 1.76
I ₂ O ₁ B ₁	42.60	105150.00	58961.57	46188.43	1 : 1.78
I ₂ O ₂ B ₀	43.97	107742.50	59045.62	48696.83	1 : 1.82
I ₂ O ₂ B ₁	44.23	110057.50	59851.00	50206.5	1 : 1.83

together a maximum of 24.11 and 10.92% increase in P and K were recorded in treatment combination with T₁₇ (I₂O₂B₁).

The maximum gross return of (Rs 110,057.50 per hectare was recorded with the application of N₁₂₀P₉₀K₇₅ kg/ha + B₁₂ (*Azotobacter*) kg/ha + O₃₀ (FYM) t/ha over control (Table 6). Moreover, highest cost-benefit ratio of 1 : 1.83 was also recorded in same treatment combination.

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