

BIOFERTILIZER OPTIONS IN NUTRIENT MANAGEMENT OF POTATO



Botany

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ABSTRACT

High dose of fertilizers raises the cost of cultivation of potato. An experiment was conducted at the Orissa University of Agriculture and Technology, Bhubaneswar during rabi seasons of 2012-13 and 2013-14. Use of biofertilizers was evaluated as an option in nutrient management for studying growth, yield, nutrient uptake and economics of potato cv. KufriChandramukhi. The yield (28.98 t ha⁻¹) and uptake of nutrients (94.4 kg N ha⁻¹ and 17.1 kg P ha⁻¹) of a crop raised from seed tubers soaked in 1% each of urea and NaHCO₃ and biofertilizer treatment (*Azotobacter*+phosphorus solubilizing bacteria) under 75% of recommended NP was significantly higher than that from 100% nutrients from inorganic sources. It also resulted in maximum net return (₹ 55186) and return per rupee investment (2.03) indicating 25% saving of NP over full nutrient application through inorganic sources.

INTRODUCTION

Potato involves high cost of cultivation due to its heavy requirements of seed and fertilizers. The nutritional requirement of the crop is much more for its high bulking rate. Nitrogen and phosphorus are the major nutrients in potato production along with potassium. A potato crop yielding 25-30 t ha⁻¹ removes about 120-140 kg Nha⁻¹ (Sharma & Upadhyaya, 1993) which can hardly be supplied by the soil fully within the short period of crop growth. The high cost of chemical fertilizers along with the related ecological and health hazards necessitate to find out the alternate nutrient sources to sustain the crop yield without any adverse effect on soil and environment. The bio-fertilizers viz. *Azotobacter*, and Phosphobacteria (PSB) have been recognized as cheap fertilizer inputs for improving soil health and fertility for optimum crop production. However, their effects vary with crops, soil and environmental conditions. The present investigation was carried out to study the effect of seed soaking and bio-fertilizer treatments in combination with chemical fertilizers on growth, yield, nutrient uptake and economics of potato under field conditions.

MATERIALS AND METHODS

The experiment was conducted during rabi seasons of 2012-13 and 2013-14 at the Orissa University of Agriculture and Technology, Bhubaneswar. The soil of the experimental plot was loam with a pH of 5.8. It was low in available N (190 kg ha⁻¹), medium in both available P (18 kg ha⁻¹) and available K (130 kg ha⁻¹). Nine treatments, viz. T₁ (50 % of recommended N and P dose of 150 kg ha⁻¹ and 50 kg P₂O₅ ha⁻¹, respectively), T₂ (75 % of recommended NP), T₃ (100 % of recommended NP), T₄ (T₁ + tuber soaking with 1 % each of urea and NaHCO₃ solution), T₅ (T₂ + tuber soaking with urea and NaHCO₃), T₆ (T₃ + tuber soaking with urea and NaHCO₃), T₇ (T₄ + treatment with biofertilizers, i.e. *Azotobacter* and PSB), T₈ (T₅ + treatment with biofertilizers), T₉ (T₆ + treatment with biofertilizers) were arranged in a randomized block design with four replications. Well sprouted foundation seed tubers of KufriChandramukhi were planted in plots of size 4.2 m x 3.0 m at spacing of 60 cm x 20 cm in the second week of November in both the years. Seed tuber treatment with urea and NaHCO₃ was done by soaking tubers in respective solutions for five minutes and drying in shade. *Azotobacterchroococcum* culture solution was prepared by mixing 50 grams bacterial culture and 100 grams jaggery in one litre of water and stirring well. This culture solution was poured over 40 kg of partially shade dried seed tubers previously treated with urea and NaHCO₃ to have a uniform coating. PSB (*Pseudomonas stratra*) was used @ 2.5 kg ha⁻¹ after mixing with FYM in the rows of potato at the time of planting. Normal intercultural operations and plant protection measures were adopted for the potato crop. The crop was dehaulmed at 65 days after planting (DAP) and harvesting was done 10 days later.

Data were recorded from ten randomly selected and tagged plants in each plot. Final emergence count was taken at 30 DAP, while observations on growth parameters like number of stems plant⁻¹, plant height, number of leaves plant⁻¹ and leaf area index (LAI) were recorded at 60 DAP. Yield related characters such as tuber number and tuber yield per plant were recorded at harvest. Uptake of nitrogen and phosphorus by the crop was estimated following the standard procedures (Jackson, 1973). The economics of different treatments were worked out for comparison. The data accumulated for two years were pooled and statistically analyzed following the procedure outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Final emergence per cent of plants observed at 30 DAP did not differ significantly. It varied in the range of 92.4 to 98.7 per cent. This was possibly due to the reason that healthy and well sprouted tubers were used for planting (Bhatia et al. 1992). Different treatments caused significant variations in plant growth characters, viz. plant height, number of primary stems and leaves per plant; and leaf area index (LAI) at 60 DAP (Table 1). Maximum plant height (55.3 cm), primary stems per plant (5.22), number of leaves per plant (69.2) and leaf area index (4.5) were observed with application of 100 % NP + tuber soaking with urea and NaHCO₃ + tuber treatment with biofertilizers (*Azotobacter* + PSB) which were statistically at par with the treatment T₆, T₇ and T₈ indicating that biofertilizers with all levels of fertilizers and only 100 % NP + tuber soaking with urea and NaHCO₃ had very positive effect on growth of potato plants. Nandekaret al. (2006) confirmed this finding by demonstrating that microorganisms present in biofertilizers colonize in rhizosphere and provide necessary nutrients and thereby stimulate the plant growth besides synthesizing some plant hormones. The yield related parameters like tuber number and tuber yield per plant showed a significant wide variation in respect of different treatments (Table 1). Tuber number per plant was significantly highest (10.4) in T₉ which was at par with T₆, T₇ and T₈ and lowest (6.0) in T₁. Maximum yields of tubers (352 g plant⁻¹ and 29.05 q ha⁻¹) were recorded by T₉ which was at par with only T₈. This increase in tuber yield following biofertilizers application is attributed to better supply of nutrients, especially N and P due to enhanced biological nitrogen fixation, solubilization of phosphorus, better development of root systems and secretion of plant hormones (Kushwah & Banafar, 2003; Baishya et al., 2005; Raghav & Chanda, 2005).

Uptake of nitrogen and phosphorus were observed to be maximum to the tune of 111.2 and 21.8 kg ha⁻¹, respectively, with T₉ which may be attributed to the fact that biofertilizer use might have resulted in adequate nutrient availability leading to better

growth that had increased the nutrient uptake (Kumar et al., 2008).Economic analysis of different treatments revealed that T₉ showed both maximum gross return (` 108938) and cost of cultivation (` 54166).However, T₈ could fetch maximum net return (` 55186) and return per rupee investment as indicated by B:C ratio (2.03) possibly due to the high yield of tubers and less cost of cultivation (Huntsinger, 1995;Kumar et al., 2011). This indicates the possibility of a reduction in 25% N and P nutrient application by seed tuber soaking in 1% each of urea and NaHCO₃ and use of *Azotobacter* and PSB.

CONCLUSION

Seed tuber soaking in 1% each of urea and NaHCO₃ and treatment with bifertilizers, viz. *Azotobacter* and phosphorus solubilizing bacteria can reduce 25% requirement of nitrogen and phosphorus in a potato crop. It yield at par with full dose of nutrients and gives highest B:C ratio of 2.03 and maximum net return of ` 55186 ha⁻¹.

Table 1.Plant emergence (30 DAP), growth parameters of plant (60 DAP), tuber number and yield (75 DAP) as affected by different treatments

Treatment	Emergence (%)	Growth parameters				Yield parameters		
		Primary stems/plant	Plant height (cm)	No. of leaves/plant	LAI	Tuber No./Plant	Tuber weight (g/plant)	Tuber yield (t/ha)
T ₁	92.4	4.06	40.1	55.7	2.5	6.0	228	18.02
T ₂	95.9	4.12	42.8	58.6	3.5	6.6	258	20.82
T ₃	98.7	4.25	43.6	60.4	4.1	7.3	295	24.16
T ₄	93.3	4.19	42.4	58.2	3.0	6.7	251	20.24
T ₅	97.7	4.27	45.6	61.1	3.6	7.5	293	23.96
T ₆	98.0	4.64	49.8	65.3	4.3	9.5	320	26.03
T ₇	97.0	4.61	49.2	62.8	3.8	9.0	301	24.83
T ₈	98.7	4.98	54.9	68.9	4.3	9.9	346	28.98
T ₉	96.3	5.22	55.3	69.2	4.5	10.4	352	29.05
CD (0.05)	NS	0.74	7.6	7.9	0.6	1.5	22.8	1.90

Table 2. Nutrient uptake and economics of potato as affected by different treatments

Treatment	Nutrient uptake(kg/ha)		Tuber yield (t/ha)	Cost of Cultivation (`)	Gross Return (`)	Net Return (`)	B : C Ratio
	N	P					
T ₁	68.5	9.0	18.02	52190	67575	15385	1.29
T ₂	76.7	10.1	20.82	52969	78075	25106	1.47
T ₃	82.6	11.6	24.16	53646	90600	36954	1.69
T ₄	75.6	9.9	20.24	52410	75900	23490	1.45
T ₅	82.4	11.4	23.96	53189	89850	36661	1.69
T ₆	97.3	14.0	26.03	53866	97613	43747	1.81
T ₇	88.4	15.1	24.83	52710	93113	40403	1.77
T ₈	94.4	17.1	28.98	53489	108675	55186	2.03
T ₉	111.2	21.8	29.05	54166	108938	54772	2.01
CD (0.05)	17.1	6.3	1.90	-	-	-	-

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