

Effect of phosphobacteria, nitrogen and phosphorus on the tuber yield of potato (*Solanum tuberosum*) under East Khasi hill conditions of Meghalaya

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Received: August 2001

ABSTRACT

Effect of seed inoculation and application of nitrogen and phosphorus on the tuber yield of potato (*Solanum tuberosum* L.) was studied during summer season of 1999 and 2000. Inoculation with phosphobacteria (*Pseudomonas striata*) significantly increased the tuber yield; however its effect on plant stand was not significant compared with no inoculation. Nitrogen application influenced significantly the tuber yield. Application of 100% P_2O_5 of the recommended dose significantly increased the tuber yield/ha. Response to phosphorus increased when either seed tubers were inoculated with *Pseudomonas striata* or crop was fertilized with nitrogen.

Key words : Inoculation, *Pseudomonas striata*, Nitrogen, Phosphorus, Tuber yield

Growing fertilizer needs and increasing fertilizer prices are the major concern in the agricultural production of the North-Eastern Hills (NEH) region. Furthermore, the fragile agri-ecosystem of NEH can hardly sustain unabated uprise in the use of chemical fertilizer. This situation has directed emphasis on the use of bio-fertilizer, which are known to be economically favourable and environmentally sound. Several phosphate-solubilizing micro-organisms have consistent capacity to solubilize insoluble phosphorus. Most of the soils of NEH region are acidic in nature/

reaction where phosphorus applied through fertilizer get fixed and unavailable to plants. The phospho-bacteria solubilize it and make it available to plants. Apart from this, the micro-organisms secrete phyto-hormones and build up organic status of the soil due to which the availability of other nutrients also increases. Response of potato to nitrogen is more pronounced when applied in conjunction with phosphorus. There may be an interactive effect of inoculation, nitrogen and phosphorus on the growth and yield of potato, and application of one might improve the efficacy of the

other. With this background, the present study was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during summer seasons (March–July) of 1999 and 2000 at Central Potato Research Station, Shillong (25.8°N, 91.8° E and 1,790 m above mean sea-level). The soil was acidic (pH 5.2), sandy clay loam and medium in available N (134 kg/ha), low in available P (6.66 kg P/ha) and medium in available K (149.4 kg K/ha). The treatments comprising 2 levels of phosphobacteria (no inoculation and seed inoculation with *Pseudomonas striata*), 3 levels of N (50%, 75% and 100% N of recommended dose) and 3 levels of phosphorus (50%, 75% and 100% P₂O₅ of recommended dose) were tried in split-plot design with 3 replications. Main plot received combination of seed inoculation and N levels, whereas P levels were assigned to subplots. Half of nitrogen and full dose of phosphorus as per the treatments were applied to all the plots as basal application. Rest half of N as per the treatment was top-dressed at the time of earthing up. Potash @ 60 kg K₂O/ha was applied basal uniformly to all the plots at the time of planting. Potato crop was planted on 15 April and 10 March during first and second year, respectively, with 'Kufri Jyoti' at spacing of 60 cm × 20 cm and with seed rate of 25 q/ha. The crop was raised with recommended cultural practices. The crop was harvested on full maturity during second week of July in both the years and the produce of each plot was graded to 3 grades, viz. small (<25 g), medium (25–75 g) and large (>75 g). Plant stand was counted at 45 days after planting,

plant height and number of stems were recorded at 60 days after planting. Net return was calculated taking sale price of potato @ Rs 5,000/tonne, cost of seed was 6,000/tonne, cost of nutrient was N @ Rs 7.2/kg, P₂O₅ @ Rs 24.45/kg and K₂O @ Rs 12.46/kg and other production cost was Rs 36,000/ha.

RESULTS AND DISCUSSION

The total tuber yield in 2000 was higher (24.06%) than that in 1999 owing to more favourable weather conditions, especially rainfall, which was timely and quantitatively very good and well distributed over growing period in 2000 compared with 1999 when rainfall was delayed. The delay in onset of rain shortened the growing period of potato which might have reduced the yield.

Effect of inoculation

Tuber inoculation with *Pseudomonas striata*, though improved the growth and yield attributes, this increase was significant for stems/m² and yield of large, medium and small size tubers and such an increase was significant in total tuber yield over no inoculation (Tables 1, 2). However, the effect of inoculation was not significant on plant stand of potato crop. The boosting up in yield might be owing to increased availability of nutrients and release of growth-promoting substances. Singh *et al.* (1996) and Singh (1999) also reported beneficial effects of inoculation on growth and yield of potato.

Effect of nitrogen

Application of N influenced significantly the yield of different grades of

Table 1. Effect of phosphobacteria, nitrogen and phosphorus on growth and tuber yield of potato crop

Treatment	Plant stand/m ²		Plant height (cm)		Stems/ m ²		Tuber yield (tonnes/ha)								Net return (Rs/ha) pooled
	1999	2000	1999	2000	1999	2000	Large size		Medium size		Small size		Total		
							1999	2000	1999	2000	1999	2000	1999	2000	
<i>Phosphobacteria</i>															
No inoculation	7.6	7.9	66.0	66.7	24	26	2.09	5.13	5.67	8.03	2.99	0.66	10.75	13.82	21,811
Inoculation	8.0	8.2	71.1	73.4	30	33	3.11	6.33	7.49	9.94	3.68	0.96	14.27	17.23	38,944
CD (P=0.05)	NS	NS	2.1	3.2	3.6	3.4	0.13	0.51	0.59	0.36	NS	NS	1.70	0.98	1,045
<i>N level</i>															
50% rec. dose	7.7	7.9	63.7	65.3	26	28	2.21	5.12	5.34	7.96	2.96	0.79	10.49	13.87	21,433
75% rec. dose	7.8	8.0	69.3	70.1	27	29	2.73	5.71	6.68	9.12	3.56	0.72	12.96	15.56	31,577
100% rec. dose	8.2	8.3	72.6	74.7	28	31	3.14	6.34	7.46	9.89	3.47	0.92	14.08	17.15	38,112
CD (P=0.05)	NS	NS	2.3	3.3	1.23	1.3	0.26	0.42	0.38	0.19	0.47	0.14	0.43	0.44	1,234
<i>P level</i>															
50% rec. dose	7.7	7.9	62.3	64.6	25	27	1.89	4.86	5.12	7.53	2.97	0.74	9.98	13.13	18,186
75% rec. dose	7.9	8.1	70.2	70.2	27	29	2.67	5.78	6.72	9.15	3.59	0.79	12.98	15.72	32,044
100% rec. dose	8.1	8.2	73.1	75.3	29	32	3.27	6.53	7.87	10.3	3.44	0.91	14.58	17.72	40,272
CD (P=0.05)	NS	NS	2.2	3.1	3.3	3.2	0.23	0.30	0.33	0.30	0.38	NS	0.46	0.37	1,345

Rec., Recommended

tubers (Table 2). Likewise, total tuber yield was also influenced with N application. Tuber yield increased with each successive increment in N. Maximum tuber yield was recorded in the treatment receiving 100% N of the recommended dose. However, N application could not induce perceptible increase in final plant stand of crop. These findings are in agreement with those reported by Singh and Sharma (1994).

Effect of phosphorus

Graded dose of P significantly influenced stems/m², plant height and tuber yield of different grades of tuber as well as total tuber yield. However, different levels of P did not show their significant influence on plant stand. The maximum tuber yield was obtained with 100% P₂O₅ of recommended dose, which was superior to rest of the doses. These results are in

accordance with those reported by Singh and Sharma (1994) and Singh *et al.* (1996).

Interaction effect

Inoculation × phosphorus: Application of full-recommended dose of P along with tuber inoculation significantly increased the total tuber yield over its application without inoculation (Table 3). Application of P @ 50% of the recommended dose and inoculation with PSB gave tuber yield comparable with that obtained by the application of 75% of recommended dose only through chemical fertilizers. Similarly, P application at 75% P₂O₅ of the recommended dose and tuber inoculated with PSB gave significantly higher yield than sole application of 100% P₂O₅ of the recommended dose.

Nitrogen × phosphorus: The maximum increase in total tuber yield was obtained

Table 3. Interaction effect of inoculation and phosphorus on the total tuber yield of potato

Inoculation level	Recommended P					
	50%		75%		100%	
	1999	2000	1999	2000	1999	2000
No. inoculation	8.38	11.64	11.13	14.01	12.74	15.81
Inoculation	11.58	14.62	14.83	17.43	16.41	19.63
CD (P=0.05)	0.61	0.64				

Table 4. Interaction effect of nitrogen and phosphorus on total tuber yield of potato

Recommended N	Recommended P					
	50%		75%		100%	
	1999	2000	1999	2000	1999	2000
50%	7.78	11.5	11.52	14.35	12.18	15.17
75%	10.65	13.55	13.6	15.7	14.63	17.42
100%	11.5	14.35	13.83	17.11	16.92	19.98
CD (P=0.05)	0.80	0.63				

when full recommended dose of P was applied along with full recommended dose of N (Table 4). It is interesting to note that treatments receiving lower dose of N and higher dose P resulted in significantly higher tuber yield than treatments receiving higher dose of N but lower dose of P.

Adequate supply of P is required to efficiently utilize N, as it helps in development of extensive root system for better use of soil moisture and nutrients (Singh *et al.*, 1996).

Economics

Inoculation with PSB increased the mean net return by Rs 17,133/ha over no inoculation. Application of 100% N of recommended dose increased the net income by Rs 6,545/ha and Rs 16,689/ha over 75% and 50% N of recommended dose respectively. Average net returns with 100% P_2O_5 of the recommended dose increased by Rs 8,228 and Rs 21,456/ha over 75% and 50% P_2O_5 of the recommended dose respectively. Inoculation with phosphobacteria coupled with 100% P_2O_5 of the recommended dose increased the net income by Rs 18,517/ha over its control (no inoculation).

Net income with combined application of 100% N of recommended dose + 100%

P_2O_5 of recommended dose along with inoculation of phosphobacteria increased by Rs 19,000/ha over its control (no inoculation). Tuber inoculation along with application of 100% N + 100% P_2O_5 registered the maximum net return, while the minimum net income was obtained in case of non-inoculated NP control.

Thus in soil of Shillong under rainfed condition, seed inoculation and application of 100% N and P was beneficial. The maximum net returns were obtained when application of 100% N + 100% P_2O_5 /ha was made to potato inoculated with *Pseudomonas striata*.

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