Indian Journal of Agronomy **56**(2): 159–163 (June 2011)

Productivity and profitability of different cultivars of potato (*Solanum tuberosum*) as affected by organic and inorganic sources of nutrients

A. SARKAR*, S. SARKAR, A. ZAMAN AND W.P. DEVI

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal 741 252

Received: July, 2010

ABSTRACT

Field experiments were conducted during winter of 2005-06 and 2006-07 at Hooghly, West Bengal to investigate the effect of different organic and inorganic sources of nutrients on productivity and profitability of potato (*Solanum tuberosum* L.) cultivars. The treatments consisted 3 varieties, *viz.* 'Kufri Chipsona-1', 'Kufri Chipsona-2' and 'Kufri Jyoti' in main-plots and 4 nutrient sources, *viz.* Farmyard manure (FYM) @ 35 t/ha (N_1), FYM @ 30 t/ha + biofertilizers (N_2), FYM @ 25 t/ha + mustard cake @ 1 t/ha (N_3), recommended dose of NPK i.e. 180:66:125 kg/ha N, P, K (N_4) in sub-plots. Varieties had significant variations in growth and yield attributes, yield and nutrient uptake. Higher growth attributes were recorded under 'Kufri Chipsona-1' except plant height. Hence, 'Kufri Chipsona-1' gave maximum number of tubers, total tuber yield (28.18 and 28.39 t/ha), NPK uptake, net profit and B:C ratio (1.28, 1.22). Among sources of nutrient recommended dose of NPK showed better performance in all respects and registered 4.7 to 9.7% more tuber yield when compared with other nutrient sources. The highest B:C ratio (1.34, 1.29) was also recorded in recommended dose of NPK treatment. Higher dry weight of tubers (718.15, 722.40 g/m^2), number of tubers (680.21, 690.74 thousand/ha) and tuber yield (29.44, 29.89 t/ha) were obtained from 'Kufri Chipsona-1' potato treated with recommended dose of NPK.

Key words **:** Biofertilizers, Economics, Farmyard manure, Mustard cake, Nutrient uptake, Potato

Potato is an important tuber crop in South and West Asian (SWA) countries. In this region, India is the largest potato producer (Kadian *et al.,* 2007). However, India with 25 mt productivity stands at third position in potato production, next to China (75 mt) and Russia (37 mt), (Pandey and Sarkar, 2005). In India more than 80% of the potato crop is raised in the Gangetic Plains during winter from October to March. Despite all the progress, productivity of potato in India is quite low, when compared with European countries, where the value ranges between 30 and 45 t/ha (Chadha, 2001).This situation may be improved by using improved potato cultivars having better yield potential and also adopting proper nutrient management practices.

As potato is a highly input intensive crop, fertilization with inorganic sources of nutrients plays an important role for its higher production. But due to increased cost and detrimental effects on soil fertility and human health, supplementing the nutrients through organic sources like farmyard manure (FYM), vermicompost, mustard cake, neem cake, etc. and biofertilizers like *Azotobacter* and Phosphobacteria has become necessary to sustain production, improved food quality and to maintain soil health (Patel *et al.,* 2002). The CPRI, Shimla, released many improved potato cultivars. Since there are differences in response to applied nutrients, it is important to evaluate their efficiency and response to nutrients. Hence, the present investigation was conducted to evaluate effect of varieties and nutrient sources on productivity and profitibility of potato cultivation.

MATERIALS AND METHODS

A fixed plot field experiments was conducted during winter (*rabi*) of 2005-06 and 2006-07 at Block Seed Farm, Adisaptagram, Hooghly, West Bengal (latitude 22°57´N, longitude 88°22´ E and altitude 9.75 m above mean sea level). The soil of the experimental site was typical Gangetic alluvium and sandy loam in texture with pH 6.4 and organic carbon 0.84%. The physico-chemical analysis of the soil was done by collecting soil samples from a depth of 0 to 30 cm. The soil contained 305, 6.6 and 184.2 kg/ha available N, P and K respectively. The experiment was conducted in split plot design, replicated thrice, with three varieties, *viz.* 'Kufri Chipsona-1', 'Kufri Chipsona-2' and 'Kufri Jyoti' in the main plots and four different sources of nutrients, *viz.* FYM @ 35 t/ha, FYN 30 t/ha +

***Corresponding author Email**: amitava_agro@rediffmail.com

biofertilizer (*Azotobacter* + Phosphobacteria), FYM @ 25 t/ha + mustard cake @ 1 t/ha and recommended dose of N, P, K i.e. 180:65.5:125 kg/ha in the sub-plots of 3.0 m × 3.0 m size. Each year a basal dose of half of N, full P and K were applied through urea, single super phosphate and muriate of potash respectively and rest half of N was top dressed at 30 days after planting. FYM, mustard cake as per the treatments were applied as basal in both years. *Azotobacter chrococcum* and Phosphobacteria (*Bacillus*) were applied as seed inoculation. Tubers weighing 30 to 40 g each were placed in upright position in furrows 60 cm apart at a distance of 20 cm and depth of 3 to 4 cm. Planting was done on 27 November in 2005 and 21 November in 2006. Two hand-weedings were done at 20 and 45 days after planting (DAP) and earthing up was done at 30 DAP in both years. To protect from pathological diseases two sprayings with Dithane M-45 (Mancozeb) @ 2.5 kg/ha were done at 40 and 60 DAP and for protecting against aphids and other insects, Metasystox (oxydemeton-methyl) 25 EC (1.0%) was also sprayed at 45 and 65 DAP in both years. The rainfall received during the crop growth period was 19 mm and 13 mm in first and second year, respectively. Two light irrigations were given at 5 days interval within 12 DAP for proper germination. Then five irrigations were given at an interval of 7 to 8 days and the last two irrigations were given at 12 days interval in both years. The water level in each irrigation was maintained below two-third height of the ridges. Dehaulming was done 80 DAP when haulms start yellowing and falling on the ground. Harvesting was done 10 to 12 days after dehaulming.

RESULTS AND DISCUSSION

Growth attributes

The growth attributes of potato were significantly affected due to both variety and nutrients applied in both the years (Table 1). Among potato varieties, *viz.* 'Kufri Chipsona-2' recorded higher plant height when compared with 'Kufri Chipsona-1' and 'Kufri Jyoti', which may be attributed to its growth habit governed by genetic traits. Similar findings were reported by Kumar *et al.* (2004). 'Kufri Chipsona-1' potato was superior to other two varieties recording maximum number of stems/plant, whereas Kufri Jyoti recorded minimum number. The other growth parameters, i.e. number of leaves/plant, dry weight of haulm, dry weight of tubers, total dry matter has shown the similar trend as in stems/plant. Regarding the nutrient treatments, recommended dose of NPK recorded the maximum plant height, number of stems/plant, leaves/plant, dry weight of tubers, total dry matter in 2005-06 and 2006-07 and proved superior to other nutrient treatments. But in first year, maximum dry weight of haulm was observed in FYM @ 30 t/ha + biofertilizers, which was at par with N_1 and N_4 treatments. However, in 2006-07, RDF showed the maximum dry weight of haulm. Minimum values of all the growth attributes were recorded in N_3 (FYM @ 25 t/ha + mustard cake @ 1 t/ha) treatment. The recommended dose of fertilizer showed better performance with respect to growth parameters, when compared with the other treatments involving organic source of nutrients only. Similar findings were reported by Lal and Khurana (2007).

Yield attributes and yield

Yield attributes as total number of tubers was found to

Table 1. Effect of potato varieties and nutrient sources on growth attributes of potato

Treatment	Plant height (cm)		Number of leaves/ plant		Dry weight of haulms (g/m²)		Dry weight of tubers (g/m²)		Total dry matter production (g/m²)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Variety										
'Kufri Chipsona-1'	68.9	66.1	116.8	124.4	174.9	197.9	701.3	707.3	873.2	905.6
'Kufri Chipsona-2'	70.7	79.3	93.3	90.8	168.7	182.2	583.2	593.6	757.7	784.3
'Kufri Jyoti'	70.5	67.0	85.6	87.6	162.2	180.0	568.9	579.6	743.7	776.2
SEm±	0.36	0.16	0.27	0.55	2.09	0.51	0.52	0.45	2.08	0.63
CD (P=0.05)	1.41	0.65	1.08	2.14	8.21	1.99	2.05	1.77	8.17	2.46
Nutrient										
FYM @ 35 t/ha	69.0	68.0	90.3	92.7	170.2	188.9	614.0	623.7	789.0	821.1
FYM @ 30 t/ha+ biofertilizer	70.5	69.7	99.8	97.2	171.4	186.4	621.7	630.4	796.7	825.1
FYM @ 25 t/ha+ mustard cake @ 1 t/ha	66.5	66.1	86.5	85.8	164.4	178.4	603.3	615.6	773.2	802.3
Recommended dose of NPK	75.6	77.9	117.5	127.9	168.4	193.1	632.2	637.7	807.4	839.6
SEm±	0.43	0.44	0.44	0.48	1.45	1.81	1.59	1.63	2.32	2.59
CD (P=0.05)	1.28	1.31	1.31	1.42	4.31	5.37	4.71	4.93	6.89	7.68

be significantly influenced by both variety and sources of nutrients (Table 2). The potato Kufri Chipsona-1 recorded the maximum number of tubers, whereas minimum value was observed in variety 'Kufri Jyoti'. The results corroborated with the findings of Kumar *et al.* (2005). On the other hand, RDF recorded the maximum number of tubers, whereas FYM @ 25 t/ha along with mustard cake @ 1 t/ha recorded the least number of tubers in successive years, respectively. Significant improvement in both the growth and yield parameters were more during the second year, when compared with the first year. This may be due to the residual effect of the manures and fertilizers applied during the first year, which improved growth and thus higher interception to light leading to greater production and assimilates of photosynthates.

'Kufri Chipsona-1' recorded the maximum tuber yield and it was significantly superior to other two varieties with 6.2 and 19.1% more yield than potato Kufri Jyoti and Kufri Chipsona-2, respectively (Table 2). Minimum yield was observed in Kufri Chipsona-2. The results are in agreement with the findings of Marwaha *et al.* (2007). The Pandey *et al.* (2005) also reported higher tuber yield in 'Kufri Chipsola-1' when compared with 'Kufri Chipsona-2' and 'Kufri Jyoti'.

RDF recorded the highest tuber yield, which was significantly superior to all other nutrient treatments. This was followed by the treatment N_2 (FYM @ 30 t/ha + biofertilizers). Minimum yield was recorded in plants that received FYM @ 25 t/ha + mustard cake @ 1 t/ha (N_3). Upadhyay *et al.* (2003) also reported highest tuber yield of 288.8 q/ha in Kufri Chipsona-1 potato when 100% RDF was applied through inorganic fertilizers. Recommended dose of NPK recorded more tuber yield of about 6.5, 4.7, and 8.7% in 2005-06 and 7.4, 5.2 and 9.7% in 2006-07, respectively than the treatment of FYM @ 35 t/ha, FYM @ 30 t/ha + biofertilizers and FYM @ 25 t/ha + mustard cake @ 1 t/ha. The increase in yield with the application of chemical fertilizers may be attributed to better availability of nutrients, due to higher nutrient content when compared with organic sources that are released almost immediately which ultimately improved vegetative growth, greater synthesis of carbohydrates and their translocation. While, organic manure contains comparably smaller percentage and relatively slow acting nutrients.

The dry weight of tubers was affected significantly by the interaction effect of varieties and nutrients applied in both the years (Table 3). It was revealed that Kufri Chipsona-1 potato treated with recommended dose of NPK (V_1N_4) recorded the maximum dry weight of tubers which was significantly superior to all other treatment combinations. While the minimum dry weight of tubers (Table 3) was recorded when potato variety Kufri Jyoti

Table 2. Effect of potato varieties, and nutrients on yield attributes of potato, NPK uptake and soil available NPK

Treatment	Total no. of tubers ($\times 10^3$/ha)		Total yield of tubers (t/ha)		N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		Soil available N (kg/ha)		Soil available P (kg/ha)		Soil available K (kg/ha)	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Varieties																
'Kufri Chipsona-1'	671.86	678.18	28.18	28.39	127.9	130.5	21.1	23.7	136.3	146.8	342.5	358.0	17.5	25.4	237.2	242.6
'Kufri Chipsona-2'	580.82	585.72	23.66	23.97	128.3	127.7	17.9	20.7	130.4	139.7	342.8	357.0	17.5	25.1	235.4	243.0
'Kufri Jyoti'	521.82	527.00	26.53	26.73	127.8	129.9	19.9	23.1	134.6	142.4	343.5	356.7	17.3	25.7	237.0	242.3
SEm±	0.35	0.29	0.25	0.28	0.58	0.43	0.08	0.25	0.25	0.33	0.52	0.36	0.09	0.33	0.49	0.36
CD (P=0.05)	1.36	1.12	0.98	1.09	2.28	1.69	0.33	0.97	0.98	1.30	NS	NS	NS	NS	NS	NS
Nutrients																
FYM @ 35 t/ha	589.07	592.45	25.73	25.88	123.0	126.5	17.7	20.6	129.7	139.8	339.0	352.2	16.2	23.9	235.0	239.2
FYM @ 30 t/ha+ biofertilizer	591.13	597.11	26.17	26.42	125.7	129.0	19.9	22.8	134.2	144.9	358.1	369.1	19.8	29.2	243.3	249.8
FYM @ 25 t/ha+ mustard cake @ 1 t/ha	586.40	587.92	25.20	25.35	117.2	124.3	15.7	18.6	126.8	133.6	327.8	346.7	15.9	22.9	230.6	234.9
Recommended dose of NPK	599.39	610.38	27.39	27.80	135.4	137.7	25.2	27.9	144.3	153.5	346.7	360.9	17.8	25.6	237.3	242.9
SEm±	1.33	1.57	1.46	1.62	0.51	0.42	0.39	0.54	0.44	0.52	0.58	0.62	0.57	0.41	0.45	0.52
CD (P=0.05)	3.89	4.75	4.40	4.78	1.50	1.25	1.15	1.62	1.29	1.56	1.71	1.83	1.68	1.21	1.34	1.53

was treated with FYM @ 25 t/ha + mustard cake @ 1 t/ha (V_3N_3).

Interaction effect of total yield of tubers was found to be significant but it was non-significant on total number of tubers in both the years of investigation. In Table 2 data revealed that maximum number and yield of potato tubers were recorded in Kufri Chipsona-1 potato when they were treated with RDF (V_1N_4) and it was best to all other treatment combinations.

NPK uptake and residual soil fertility

The N, P and K uptake by potato plants varied significantly due to the variety and nutrients applied in both the years (Table 2). The maximum N, P and K uptake were computed in variety Kufri Chipsona-1 (V_1). This may be because of higher growth, yield attributes and ultimately total yield. The minimum uptake was recorded in Kufri Chipsona-2 (V_2). The value of K uptake was observed higher than N, and P uptake showing higher K requirement of the crop. Among different nutrient sources, RDF recorded the highest N, P and K uptake. The minimum uptake was recorded in FYM @ 25 t/ha + mustard cake @ 1 t/ha. This is in agreement with the findings of Sood (2007). But no significant effect was observed in the available soil N, P, K after harvest of crop due to the variety used (Table 2).While, treatment 30 t/ha FYM + biofertilizers recorded maximum soil available NPK after the harvest of crop.

Economics

The cost of cultivation during the first year was lower when compared with second year in all treatments due to

Table 3. Interaction effect of varieties and nutrients sources on dry weight of tubers and tubers yield.

Treatment	Nutrients				S Em±	CD (P=0.05)
	N_1	N_2	N_3	N_4		
Potato varieties			Dry weight of tubers (g/m^2)			
			2005-06			
'Kufri Chipsona-1'	696.92	705.19	684.93	718.15	0.76	2.26
'Kufri Chipsona-2'	579.35	584.03	570.15	599.29		
'Kufri Jyoti'	565.76	575.88	554.96	579.04		
			2006-07			
'Kufri Chipsona-1'	702.13	712.00	692.81	722.40	0.81	2.39
'Kufri Chipsona-2'	591.54	597.39	584.15	601.37		
'Kufri Jyoti'	577.44	581.70	569.88	589.30		
			Tubers yield (t/ha)			
			2005-06			
'Kufri Chipsona-1'	27.75	28.31	27.24	29.44	0.69	2.08
'Kufri Chipsona-2'	23.16	23.66	22.56	25.25		
'Kufri Jyoti'	26.29	26.53	25.81	27.48		
			2006-07			
'Kufri Chipsona-1'	27.78	28.36	27.50	29.89	0.83	2.47
'Kufri Chipsona-2'	23.52	23.39	22.76	25.69		
'Kufri Jyoti'	26.34	26.98	25.78	27.82		

N_1 = FYM @ 35 t/ha, N_2 = FYM @ 30 t/ha + bio-fertilizer, N_3 = FYM @ 25 t/ha + mustard cake @ 1 t/ha, N_4 = Recommended dose of NPK

Table 4. Effect of potato varieties and nutrients on economics of cultivation of potato

Treatment	Cost of cultivation (₹/ha)		Net profit (₹/ha)		Net Benefit **:** cost ratio	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Potato varieties						
'Kufri Chipsona-1'	43,398	44,898	55,250	54,441	1.28	1.22
'Kufri Chipsona-2'	43,398	44,898	39,404	39,015	0.92	0.88
'Kufri Jyoti'	43,398	44,898	49,449	48,658	1.15	1.09
Nutrients						
FYM @ 35 t/ha	43,750	45,250	46,317	45,330	1.06	1.00
FYM @ 30 t/ha + bio-fertilizer	42,650	44,150	48,933	48,332	1.15	1.09
FYM @ 25 t/ha + mustardcake @ 1 t/ha	46,250	47,750	41,962	40,963	0.91	0.86
Recommended dose of NPK	40,940	42,440	54,925	54,860	1.34	1.29

higher cost of inputs in the second year (Table 4). Net profit and benefit:cost (B:C) ratio were also influenced by both varieties and nutrient treatments. Among varietal treatments, highest net profit (55,250.00, 54,441.25/ha) and B:C (1.28, 1.22 in successive years, respectively) were recorded in plots cultivated with potato variety 'Kufri Chipsona-1'. Whereas minimum net profit and B:C ratio were observed in potato variety 'Kufri Chipsona-2'. Among nutrient sources plots treated with recommended dose of NPK recorded maximum net profit and B:C ratio. It was followed by the treatment comprised of application of FYM @ 30 t/ha + biofertilizers in both years. The minimum response in both net profit and B:C ratio were recorded in plots treated with FYM @ 25 t/ha along with mustard cake @ 1 t/ha.

From the two years study it is concluded that potato variety 'Kufri Chipsona-1' when treated with recommended dose of fertilizers (V_1N_4) is best for higher productivity and profitability of potato to all other treatment combinations *i.e.* 180:65.5:125 kg; N:P:K /ha.

REFERENCES

Chadha, K.L. 2001. Sustaining potato revolution in India: Constraints and strategies. *Journal of Indian Potato Association* **28**(2-4): 195–200.

Kadian, M.S., Ilangantileke, S., Arif, M., Hossain, M., Roder, W., Sakla, B.M., Singh, S.V., Farooq, K. and Mazeen, A.C.M. 2007. Status of potato seed systems in South-West Asia (SWA). *Potato Journal* **34**(1-2): 25–30.

Kumar, R. Pandey, S.K., Uppal, D.S. and Marwaha, R.S. 2004. Evaluation of potato (*Solanum tuberosum*) varieties for production of chips. *Indian Journal of Agricultural Sciences* **74**(11): 578–582.

Kumar, S., Jha, M.M. and Mamta. 2005. Influence of organic manure, irrigation interval and cropping sequence on the yield and black scurf disease of potato. *Annals of Agricultural Biological Research* **10**(1): 61–64.

Lal, M. and Khurana, S.C. 2007. Effect of organic manure, biodynamic compost and bio-fertilizers on potato. *Potato Journal* **34**(1-2): 105–106.

Marwaha, R.S., Pandey, S.K., Singh, S.V. and Kumar, D. 2007. Yield, chipping and nutritive qualities of spring grown potatoes in North-Western plains. *Potato Journal* **34**(1-20): 61–62.

Pandey, S.K. and Sarkar, D. 2005. Potato in India: Emerging trends and challenges in the new millennium. *Potato Journal* **34**(3-4): 93–104.

Pandey, S.K., Singh, S.V. and Sarkar, D. 2005. Potato (*Solanum tuberosum* L.) for sustaining food and nutrition security in developing world. *Indian Journal of Agricultural Sciences* **75**(1): 3–18.

Patel, C.K., Sasani, G.V., Kadian, M.S., Patel, R.N. and Patel, N.H. 2002. Integrated nutrient management in Potato (*Solanum tuberosum*). Extended seminaries. *Vol.1, 2nd International Agronomy Congress*, 26-30, November, New Delhi, India.

Sood, M.C. 2007. Integrated nutrient supply and management for potato production in mid-hills of Shimla. *Potato Journal* **34**(1-2): 15–16.

Upadhayay, N.C. and Singh, J.P. 2003. Organic farming. *The Potato Production and Utilization in Sub-tropics,* (S.M. Paul Khurana, J.S. Minhas and S.K. Pandey, Eds.). Mehta Publishers, New Delhi, India: pp. 154-160.