

Effect of organic and inorganic sources of nutrients on potato [*Solanum tuberosum* L.] production and soil fertility build-up

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Received: 31.01.2011, Revised: 25.12.2011, Accepted: 25.04.2012

Key words: Fertilizers, organic manures, yield

Among the food crops known to mankind, potato is the fourth most important productive and nutritious food crop and comes next only to rice, wheat and maize. Because of its high protein-calorie ratio (17 g protein: 1000 Kcal) and short vegetative cycle, potato yields more substantially edible energy, protein and dry matter per unit area and time than many other crop species. It allows the farmers to harvest up to 80 % of dry matter as edible nutritious food, as compared to only 50 % of the cereals as grain (Pandey and Sarkar, 2005). In the world, India with 25 million tons produce comes in the third position in potato production next to China (75 million tons) and Russia (37 million tons) (Chaturvedi, 2007). Despite this, productivity of potato in India is quiet low as compared to that of European countries like USA, UK, Belgium, New Zealand and the Netherlands where the value ranges between 300-450 q ha^{-1} (Chadha, 2001). More than 80 % of the potato crop is raised in the Gangetic plains in the winter season during October to March. West Bengal contributes 26 % of the total potato production in India and comes next only to Uttar Pradesh with 32 % (Babu, 2008). 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 of inorganic fertilizers and their detrimental effects on soil fertility and human health, supplementing the nutrients through organic sources has become necessary to sustain production and improve or maintain soil health. Keeping these points in view, the present experiment was carried out to select suitable variety and organic sources for higher potato product on a suitable basis.

The present experiment was conducted at the Block Seed Farm, Adisaptagram, Hoogly, West Bengal during rabi season of 2006-07 and 2007-08. The experiment was laid out in split-plot design, three potato varieties (Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Jyoti) were allocated to the main plots and four different sources of nutrients FYM @ 35 t ha^{-1} , FYM @ 30 t ha^{-1} + biofertilizers (*Azotobacter* and *Phosphobacteria*), FYM @ 25 t ha^{-1} + mustard cake @ 10 q ha^{-1} , recommended dose of NPK @ 180 kg N: 150 kg P₂O₅: 150 kg K₂O ha^{-1} to the sub-plots. The

soil of the experiment field was sandy loam having pH 6.2, organic carbon 0.83 %, available nitrogen 300.27 kg, available phosphorous 12.85 kg and available potassium 218.5 kg ha^{-1} . The crop growth rate (CGR) and tuber bulking rate (TBR) were calculated by using following formulae

$$CGR = \frac{W_2 - W_1}{T_2 - t_1}$$

Where, W₁ and W₂ are dry weights of plant parts per unit area at two different times t₁ and t₂, respectively

$$TBR = \frac{M_2 - M_1}{T_2 - t_1}$$

Where, M₁ and M₂ are dry weights of tubers per unit area at different times t₁ and t₂, respectively.

The harvested tubers were graded into four different grades (< 25 g, 26-50 g, 51-75 g and > 75 g) according to their sizes. These were counted and weighed separately.

The pooled data in table- 1 revealed that Kufri Chipsona-1 recorded the maximum number of stems (3.97), number of leaves per plant (120.56), dry matter accumulation, CGR and TBR at different stages of observation. The maximum total number of tubers per hectare (675.02 thousand ha^{-1}) as well as total yield (28.28 t ha^{-1}) was recorded in Kufri Chipsona-1 (Table-4). The results are in agreement with the findings of Kumar *et al.* (2005) and Pandey *et al.* (2005) respectively. Maximum build-up of soil fertility after harvest of crop (350.25 kg ha^{-1} N, 21.45 kg ha^{-1} P₂O₅ and 239.86 kg ha^{-1} K₂O) was also recorded in Kufri Chipsona-1 (Table 5). Kufri Chipsona-2 recorded tallest height (75.01 cm) at harvest and maximum number of < 25 g tubers (191.28 thousands ha^{-1}) but Kufri Jyoti gave the highest yield (6.85 t ha^{-1}) of < 25 g tubers (Table 3).

Application of recommended dose of NPK @ 180 kg N: 150 kg P₂O₅: 150 kg K₂O ha^{-1} showed the maximum height (76.76 cm) at harvest, number of leaves (122.70), dry matter accumulation, CGR and TBR at all stages of observation (Table 1). Ultimately, this treatment also produced the maximum total number of tubers (604.89 thousands ha^{-1}) and total tuber yield (27.60 t ha^{-1}). It was also observed that yield of large and very large sized tubers were highest in plants receiving recommended

dose of NPK indicating that increase in yield was due to increases in size of tubers (Table 3). The results also confirmed the findings of Upadhyay *et al.* (2003) who reported the importance of organic farming in production of seed size tubers (< 50 g). Maximum soil fertility build-up (353.75, 21.73 and 240.03 kg ha⁻¹ available N, P₂O₅, and K₂O, respectively) was

observed where FYM @ 30 t ha⁻¹ along with biofertilizers were applied (Table 5). These observations are in agreement with the findings of Kumar *et al.* (2007). This may be due to the availability of micro-organisms to fix atmospheric nitrogen and increase its availability to the growing plants.

Table 1: Effect of varieties and nutrients on growth parameters of potato (pooled)

Treatments	No. of stems	No. of leaves	Total dry matter accumulation (g m ⁻²)			CGR (g m ⁻² day ⁻¹)		TBR (g m ⁻² day ⁻¹)	
			60 DAP	75 DAP	90 DAP	60 – 75 DAP	75 – 90 DAP	60 – 75 DAP	75 – 90 DAP
Variety									
V ₁	3.97	120.56	455.25	695.14	889.39	16.00	12.96	15.35	13.03
V ₂	3.52	92.04	412.76	623.75	771.03	14.07	9.82	12.76	9.35
V ₃	3.33	86.60	377.17	598.19	759.95	14.74	10.78	13.17	9.75
SEM (±)	0.04	0.31	0.78	0.94	1.09	0.01	0.01	0.07	0.03
LDS (0.05)	0.11	1.00	2.56	3.05	3.54	0.05	0.07	0.23	0.08
Nutrient									
N ₁	3.30	91.54	414.49	638.11	805.04	14.91	11.13	13.71	10.69
N ₂	3.61	98.51	417.88	642.50	810.85	14.96	11.22	13.80	10.76
N ₃	3.19	86.17	400.27	622.25	787.77	14.80	11.04	13.59	10.55
N ₄	4.32	122.70	427.62	653.24	823.49	15.04	11.36	13.94	10.84
SEM (±)	0.04	0.32	0.89	0.98	1.03	0.02	0.01	0.06	0.02
LDS (0.05)	0.12	0.93	2.54	2.81	2.95	0.07	0.04	0.16	0.07

Table 2: Interaction effect of varieties and nutrients on growth parameters of potato (pooled)

Treatment combinations	Plant height (cm)	No. of stems	No. of leaves	Total dry matter accumulation (g m ⁻²)			CGR (g m ⁻² day ⁻¹)		TBR (g m ⁻² day ⁻¹)	
				60 DAP	75 DAP	90 DAP	60 – 75 DAP	75 – 90 DAP	60 – 75 DAP	75 – 90 DAP
V ₁ N ₁	66.50	3.58	112.60	452.45	692.00	885.42	15.97	12.90	15.29	13.04
V ₁ N ₂	67.23	4.07	123.20	457.12	698.07	893.00	16.00	13.00	15.45	13.10
V ₁ N ₃	63.88	3.47	105.37	443.08	680.73	872.58	15.84	12.79	15.13	12.80
V ₁ N ₄	72.32	4.75	141.07	468.38	709.78	906.58	16.09	13.15	15.53	13.18
V ₂ N ₁	72.68	3.35	87.17	413.31	623.96	770.29	14.04	9.76	12.72	9.31
V ₂ N ₂	74.85	3.53	91.13	414.63	626.06	774.29	14.10	9.87	12.78	9.38
V ₂ N ₃	70.88	3.20	80.05	397.90	607.00	752.20	13.94	9.68	12.60	9.24
V ₂ N ₄	81.62	3.98	109.80	425.21	637.96	787.59	14.18	9.98	12.95	9.47
V ₃ N ₁	66.23	2.97	74.85	377.70	598.37	759.40	14.71	10.74	13.13	9.72
V ₃ N ₂	68.23	3.22	81.20	381.91	603.38	765.53	14.77	10.81	13.18	9.79
V ₃ N ₃	64.13	2.90	73.10	359.83	579.03	738.55	14.61	10.64	13.04	9.63
V ₃ N ₄	76.33	4.22	117.23	389.27	611.99	776.32	14.85	10.96	13.33	9.88
SEM (±)*	0.53	0.07	0.56	1.56	1.70	1.78	0.04	0.02	0.10	0.04
LSD (0.05)*	1.53	0.20	1.61	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of varieties and nutrients on number and yield of tubers (pooled)

Treatments	Number of tubers (thousand ha ⁻¹)				Total	Yield of tubers (t ha ⁻¹)				Total
	< 25 g	26 – 50 g	51 – 75 g	> 75 g		< 25 g	26 – 50 g	51 – 75 g	> 75 g	
Variety										
V ₁	169.64	248.63	144.36	112.09	675.02	5.76	6.66	8.65	7.21	28.28
V ₂	191.28	236.56	96.89	58.63	583.27	6.78	5.88	5.83	5.19	23.82
V ₃	171.22	203.63	98.41	51.13	524.41	6.85	7.03	6.84	5.90	26.63
SEm (±)	0.42	0.27	0.24	0.25	0.22	0.20	0.26	0.27	0.54	0.19
LSD (0.05)	1.38	0.88	0.77	0.82	0.73	0.64	0.86	0.90	1.75	0.61
Nutrient										
N ₁	178.35	230.70	110.16	71.51	590.76	6.38	6.33	7.07	6.03	25.81
N ₂	180.44	227.70	112.73	73.20	594.12	6.45	6.51	7.17	6.17	26.30
N ₃	183.60	239.58	98.49	65.52	587.16	6.13	6.25	6.96	5.94	25.27
N ₄	167.12	220.43	131.50	85.57	604.89	6.90	7.02	7.24	6.26	27.60
SEm (±)	0.37	0.32	0.27	0.25	0.34	0.35	0.29	0.28	0.65	0.31
LSD (0.05)	1.06	0.91	0.79	0.72	0.97	1.00	0.08	0.79	1.86	0.90

Table 4: Interaction effect of varieties and nutrients on number and yield of tubers (pooled)

Treatment combinations	Number of tubers (thousand ha ⁻¹)				Total	Yield of tubers (t ha ⁻¹)				Total
	< 25 g	26 – 50 g	51 – 75 g	> 75 g		< 25 g	26 – 50 g	51 – 75 g	> 75 g	
V ₁ N ₁	171.47	249.21	140.47	110.36	671.50	5.74	6.29	8.52	7.22	27.77
V ₁ N ₂	170.38	248.70	144.08	111.95	675.11	5.71	6.52	8.87	7.23	28.34
V ₁ N ₃	174.54	254.71	134.92	103.83	668.00	5.50	6.28	8.52	7.07	27.37
V ₁ N ₄	162.17	241.88	157.96	122.24	685.48	6.10	7.56	8.71	7.30	29.67
V ₂ N ₁	191.13	236.29	94.58	57.57	579.56	6.50	5.80	5.93	5.10	23.34
V ₂ N ₂	194.66	236.54	92.87	59.46	583.64	6.79	5.96	5.81	5.23	23.80
V ₂ N ₃	197.28	238.09	89.90	50.86	576.10	6.34	5.60	5.66	5.06	22.66
V ₂ N ₄	182.06	235.34	110.19	66.61	593.78	7.48	6.14	5.91	5.38	25.47
V ₃ N ₁	172.46	206.61	95.42	46.60	521.22	6.91	6.89	6.75	5.76	26.31
V ₃ N ₂	176.29	197.88	101.23	48.20	523.62	6.85	7.04	6.82	6.05	26.76
V ₃ N ₃	178.97	225.93	70.65	41.88	517.39	6.53	6.86	6.71	5.70	25.79
V ₃ N ₄	157.15	184.08	126.35	67.87	535.42	7.11	7.35	7.10	6.09	27.65
SEm (±)*	0.64	0.55	0.48	0.43	0.59	0.60	0.51	0.48	1.12	0.54
LSD (0.05)*	1.84	1.58	1.36	1.24	NS	1.73	1.46	1.38	NS	1.56

Table 5: Effect of varieties and nutrients on soil available NPK (kg ha⁻¹) after cropping (pooled)

Treatments	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)
Variety			
V ₁	350.25	21.45	239.86
V ₂	349.85	21.27	238.14
V ₃	350.07	21.50	239.33
SEm (±)	0.32	0.17	0.31
LSD (0.05)	NS	NS	NS
Nutrient			
N ₁	345.60	20.03	237.07
N ₂	363.63	24.46	246.53
N ₃	337.24	19.40	232.75
N ₄	353.75	21.73	240.03
SEm (±)	0.42	0.35	0.34
LSD (0.05)	1.21	1.01	0.98

Table 6: Interaction effect of varieties and nutrients on soil available NPK (kg ha⁻¹) after cropping (pooled)

Treatment combinations	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)
V ₁ N ₁	346.41	20.33	237.62
V ₁ N ₂	362.76	24.14	247.28
V ₁ N ₃	336.61	19.53	233.69
V ₁ N ₄	355.24	21.81	240.85
V ₂ N ₁	345.68	19.99	236.45
V ₂ N ₂	363.98	24.45	245.21
V ₂ N ₃	336.91	19.28	231.58
V ₂ N ₄	352.85	21.35	239.35
V ₃ N ₁	344.73	19.79	237.13
V ₃ N ₂	364.17	24.78	247.10
V ₃ N ₃	338.22	19.40	233.00
V ₃ N ₄	353.16	22.03	240.08
SEm (±)*	0.73	0.61	0.59
LSD (0.05)*	NS	NS	NS

Variety Kufri Chipsona-1 when supplied with recommended dose of NPK recorded the maximum number of stems (4.75), number of leaves per plant (141.07), dry matter accumulation, CGR and TBR at all stages of observation (Table 2). Sarkar *et al.* (2007) also found similar results. This treatment combination also showed the maximum total number of total tubers (685.48 thousands ha⁻¹) and total tuber yield (29.67 t ha⁻¹). Regarding soil fertility build-up, interaction of variety and nutrients did not show any significant result. However, maximum soil available N and P (364.17 kg ha⁻¹ and 24.78 kg ha⁻¹), respectively were observed in Kufri Jyoti and

maximum soil available K (247.28 kg ha⁻¹) in Kufri Chipsona-1 when treated with FYM @ 30 t ha⁻¹ along with bio-fertilizers (Table 6). These results are in accordance with findings of Kumar and Lal (2003).

The above results confirmed the importance of fertilizers for increasing production in potato crop. However, supplementing plant nutrients through organic sources like FYM and biofertilizers may be recommended to potato farmers to promote potato production on an eco-friendly manner. It may also be concluded that organic farming may be followed as a promising technique to produce more seed size tubers and solve the problem of lack of potato seed tubers.

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