https://doi.org/10.29321/MAJ.10.A01929

Madras Agric. J. 77(3 & 4): 125-130 Mar-Apr. 1990

P AND K UPTAKE PATTERN IN POTATO AS AFFECTED BY APPLIED NITROGEN

U.C. SHARMA [1] and B.R. ARORA[2]

ABSTRACT

Field experiments were conducted to study the effect of different rates of nitrogen application, in the absence and presence of FYM, on the tuber yield and uptake of P and K by potato at different stages of plant growth. Tuber yield and P and K accumulation by potato tubers increased significantly up to the application of 200 kg N/ha; whereas significant increase in P and K uptake of haulms was, invariably, up to the application 150 kg N/ha at different periods of plant growth. Application of FYM increased P and K uptake of tubers and K uptake of haulms at all the stages of sampling. However P uptake of haulms was significant only at later periods of plant growth. The increase in P and K uptake was mainly associated with increase in the dry matter as a result of nitrogen application.

KEY WORDS : Potato, P and K uptake, Tuber yield.

One of the essential factors for obatining high yields of potato and make its production profitable is efficient use of fertilizers. Specific information about the manner in which the mineral nutrients influence the potato yields is desirable. With the introduction of high yielding varieties, use of high analysis fertilizers and less use of organic manures, balanced application of nutrients has become all the more important. Knowledge of nutrients uptake as a result of high doses of a fertilizer nutrient is essential for better understanding of the fertility requirements necessary to produce maximum yield of tubers. Grafting experiments using tomatoes and potatoes have shown that N, P and K accumulated in the fruits and tubers roughly the same as dry matter in plants (Bunemann and Grassia, 1973). So application of a nutrient in larger amounts may increase yield thereby increasing the uptake of other nutrients. If all the nutrients are not applied in appropriate amounts, some of them may become limiting for getting maximum tuber yield. The present investigation was, therefore, undertaken to see the extent of removal of P and K, during the growing season, as a result of different rates of nitrogen application to potato crop.

MATERIALS AND METHODS

Two field experiments were conducted during the autumn 1982-83 and 1983-84 on a sandy loam soil of pH 7.7, low in available nitrogen (103 kg N and 104 kg N/ha in 1982-83 and 1983-84 respectively), low in available phosphorus and potassium (10.7 and 10.8 kg P/ha and 83 and 81 kg K/ha during 1982-83 and 1983-84 respectively), to study the effect of different rates of nitrogen application on the yield, and P and K uptake of potato. Analytical techniques described by Jackson (1967) were used. Nitrogen was applied at the rate of 0, 50, 100, 150, 200 and 250 kg N/ha, in absence and presence

1. Scientist S2, Central Potato Research Station, Shillong 793 009, Meghalaya.
2. Professor, Punjab Agricultural University, Ludhiana 141 004, Punjab.

Table 1. Effect of levels of nitrogen on the tuber yield at different periods of plant growth (q/ha).

Treatment	1982-83				1983-84			
	45 days	60 days	75 days	90 days	45 days	60 days	75 days	90 days
N (Kg/ha)								
0	28	85	119	134	27	80	125	134
50	39	128	183	202	33	120	195	196
100	50	157	213	240	47	140	224	244
150	56	172	237	262	55	156	244	272
200	50	187	265	288	54	179	272	293
250	34	171	254	285	40	171	256	284
C.D. (5%)	3.6	11.4	12.1	13.8	4.3	9.6	11.2	13.1
FYM (t/ha)								
0	41	143	197	217	43	133	205	222
30	44	156	227	255	42	148	233	252
C.D. (5%)	2.0	5.5	6.9	7.9	2.4	5.5	5.4	7.5

Table 2. Effect of levels of nitrogen on K uptake of potato at different period of plant growth (Kg/ha)

Treatment	45 days			60 days			75 days			90 days		
	Tubers	Haulms	Total	Tubers	Haulms	Total	Tubers	Haulms	Total	Tubers	Haulms	Total
					1982-83							
N (kg/ha)												
0	10.2	20.0	30.0	29.9	18.5	48.4	44.4	13.5	57.9	51.7	9.4	61.1
50	14.1	28.3	42.4	43.7	25.9	69.6	66.9	18.5	85.4	76.9	13.2	90.1
100	17.2	38.2	55.6	53.0	35.2	88.2	76.2	25.3	101.5	88.1	17.8	105.9
150	19.5	47.9	67.4	55.9	42.6	98.5	83.2	30.1	113.3	97.3	21.0	118.3
200	16.9	49.3	66.2	60.4	43.6	104.0	93.0	31.7	124.7	107.1	23.1	130.2
250	11.3	49.0	60.3	55.2	42.5	97.7	88.6	31.3	119.9	106.2	23.4	129.6
C.D. (5%)	1.9	5.1	6.1	4.1	5.3	7.0	5.8	3.2	8.2	8.9	2.0	10.5
FYM (t/ha)												
0	14.4	34.0	48.4	48.5	32.6	81.1	70.4	23.9	94.3	80.0	17.0	97.0
30	15.3	43.6	58.9	50.9	36.8	87.7	80.3	26.2	106.5	95.7	19.0	114.7
C.D. (5%)	NS	2.8	3.4	NS	3.1	3.9	3.3	1.8	NS	5.0	1.1	5.8
					1983-84							
N (kg/ha)												
0	10.1	21.2	31.3	28.4	21.3	49.7	47.4	14.5	61.9	51.2	10.3	61.5
50	11.4	29.4	40.9	41.5	28.7	70.2	71.0	19.9	90.9	73.9	13.4	87.3
100	16.1	40.0	56.1	46.8	38.0	84.8	80.1	26.9	107.0	92.2	17.9	110.1
150	19.3	48.4	67.7	50.8	46.8	97.6	87.1	32.1	119.2	103.9	23.1	127.0
200	19.0	48.5	67.5	58.0	45.7	103.7	94.3	33.0	127.3	110.1	23.9	134.0
250	13.7	48.5	62.2	55.3	45.3	100.6	89.6	32.6	122.2	107.4	24.0	131.4
C.D. (5%)	2.3	4.9	5.9	5.8	3.6	5.8	5.6	2.9	9.5	6.2	2.1	8.2
FYM (t/ha)												
0	15.3	34.7	50.0	45.3	33.0	88.3	73.1	25.5	98.6	85.4	18.9	104.3
30	14.5	44.0	58.5	48.4	42.3	90.7	83.4	27.4	110.8	93.7	19.6	113.3
C.D. (5%)	NS	2.7	3.4	NS	2.0	3.2	3.1	1.6	5.3	3.5	1.2	4.6

of 30 t/ha FYM. The treatments were replicated four times in a randomized block design. Basal dose of 60 kg P_2O_5/ha and 150 kg K_20/ha was applied at the time of planting.

Tubers of potato variety kufri chandramukhi were planted in plots measuring 5.4m × 4.0m at an inter and intra-row spacing of 60 cm and 20 cm respectively. Tubers and haulms yield was recorded at 45, 60, 75 and 90 (harvesting) days after planting (DAP) and samples taken for the dry matter content and determination of P and K. The samples were washed in deionied water, followed by 0.1 N HCl and again with delonized water; dried in hot air oven at 65 to 75°C and ground in a stainless steal willoy mill. Samples were digested in triple acid mixture (HNO_3, $HClO_4$ and H_2SO_4 in the ratio of 9 :3:1, respectively). The P concentration was determined by Vando - molybdophosphoric yellow colour in nitric acid system and K determined in the extracts on flame-photometer. P and K uptake by tubers and haulms was determined on the basis of their concentration and the dry matter produced.

RESULTS AND DISCUSSION

Tuber yield increased significantly up to the application of 150 kg N/ha at 45 DAP and 200 kg N/ha at 60, 75 and 90 DAP during both the years of study (Table 1). FYM did not show any effect at 45 DAP but it recorded a significant increase in the tuber yield at rest of the stages of sampling. Since N forms the constituent of chlorophyll, amino acids and proteins and takes part in cell division and expansion, the increase in the weight of tubers with applied nitrogen in N deficient soils was expected. Increase in the potato tuber yield with the application of nitrogen has been reported by numerous workers including Sharma *et al.*(1979) and Singh and Grewal (1979).

The effect of nitrogen application on K uptake of tubers and haulms is presented in Table 2. Increase in the applied N significantly increased the uptake of K by tubers up to the application of 150 kg N/ha at 45 DAP and 200 kg N/ha at 60, 75 and 90 DAP during both the years. FYM helped in more assimilation of K by tubers but effect was significant at later periods of plant growth only. Significant increase in K by haulms was up to the application of 150 kg N/ha at all the dates of sampling and it levelled off at higher rates of applied N. Application of FYM significantly increased K uptake of haulms at 75 and 90 DAP only during both the years. Maximum tuber and haulms increase in the uptake of K was found to be 229.4 per cent and 192.0 per cent during 1982-83 and 1983-84 respectively, with the application of 250 kg N/ha in the presence of FYM over zero level of N and FYM. Uptake of K increased in tuber and decreased in haulms, but total K accumlation increased with maturity.

Increase in uptake of K with applied N and FYM was mainly associated with the increase in dry matter production with the application of successive levels of N. Similar results have been reported by Moorby (1968) and Bunemann and Grassia (1973), who observed that K accumulation by potato roughtly corresponds with the dry matter produced by tubers. Decrease in k uptake of tubers at early periods of sampling with higher rates of N was because of delay in plant emergence and initiation of tuberization. Higher rates of N application have been reported to delay the tuberization in potato (Ivins and Bremner, 1965). The

Table 3. Effect of levels of nitrogen on P uptake of potato at different periods of plant growth (kg/ha).

Treatment	45 days			60 days			75 days			90 days		
	Tubers	Haulms	Total	Tubers	Haulms	Total	Tubers	Haulms	Total	Tubers	Haulms	Total
					1982-83							
N (kg/ha)												
0	0.88	1.35	2.23	2.41	1.18	3.59	3.43	0.77	4.20	4.04	0.42	4.46
50	1.21	1.94	3.15	3.66	1.66	5.32	5.32	1.14	6.46	6.11	0.60	6.71
100	1.51	2.69	4.20	4.62	2.35	6.97	6.39	1.64	8.03	7.45	0.77	8.22
150	1.76	3.39	5.15	4.90	2.85	7.75	6.98	1.86	8.84	7.93	1.01	8.94
200	1.55	3.48	5.03	5.39	3.04	8.43	7.84	2.04	9.88	8.80	1.14	9.94
250	1.02	3.46	4.48	4.95	2.92	7.87	7.58	2.14	9.72	8.77	1.12	9.89
C.D. (5%)	0.16	0.34	0.33	0.43	0.24	0.57	0.56	0.16	0.70	0.72	0.08	0.73
FYM (t/ha)												
0	1.28	2.69	3.97	4.15	2.29	6.44	5.78	1.53	7.31	6.62	0.79	7.41
30	1.36	2.58	3.94	4.49	2.37	6.86	6.74	1.66	8.40	7.75	0.89	8.64
C.D. (5%)	NS	NS	NS	0.24	NS	0.31	0.32	0.09	0.39	0.41	0.04	0.40
					1983-84							
N (kg/ha)												
0	0.84	1.45	2.29	2.24	1.33	3.57	3.54	0.83	4.37	4.14	0.48	4.62
50	1.02	2.03	3.05	3.44	1.77	5.21	5.56	1.26	6.82	6.28	0.68	6.96
100	1.43	2.79	4.22	4.21	2.44	6.65	6.19	1.65	7.84	7.56	0.82	8.38
150	1.75	3.38	5.13	4.55	3.01	7.56	7.10	2.09	9.19	7.69	1.12	8.81
200	1.68	3.55	5.23	5.10	3.04	8.14	7.77	2.03	9.81	8.73	1.20	9.93
250	1.23	3.46	4.69	4.79	2.96	7.75	7.18	1.99	9.17	8.46	1.23	9.69
C.D. (5%)	0.15	0.23	0.39	0.34	0.22	0.54	0.59	0.17	0.60	0.61	0.09	0.82
FYM (kg/ha)												
0	1.34	2.73	4.07	3.85	2.38	6.23	5.67	1.59	7.26	6.77	0.89	7.66
30	1.30	2.82	4.12	4.26	2.47	6.73	6.77	1.69	8.46	7.84	0.95	8.79
C.D. (5%)	NS	NS	NS	0.19	NS	0.30	0.34	0.09	0.33	0.35	0.05	0.45

increase in K uptake of tubers with maturity was partially because of increase in tuber weight and partially because of translocation of K from haulms to tubers which also caused decrease in K uptake of haulms as the crop matured. During tuber growth the demand of nutrients by developing tubers may cause their translocation from top into tubers (Harris, 1978). The increase in the uptake of K with applied FYM was because of additional supply of K as well as improved soil physical condition for better tuberization.

P uptake increased significantly with increase in the successive rates of applied N. Significant increase in the P uptake was found to be invariably upto the application of 200 kg N/ha during both the years (Table 3). Delay in emergence of seed tubers at 250 kg N/ha, caused a significant decrease in P uptake at this level of applied nitrogen at 45 and 60 DAP. In haulms, significant uptake of P was up to the application of 150 kg N/ha at 45 and 60 DAP and 200 kg N/ha at 75 and 90 DAP. FYM application helped in increasing the uptake of P by haulms and tubers but the effect was significant at later periods of plant growth. P assimilation of tubers increased and that of haulms decreased but the total uptake increased with maturity.

Application of nitrogen increased accumulation of P by the tubers and haulms, at different periods of plant growth, mainly because of increase in the dry matter produced. Decrease in P uptake at 45 DAP was because of slight delay in plant emergence and late tuberization when N was applied at 250 kg/ha. Heavy N fertilization delays plant emergence and tuberization (Ivins and Bremner, 1965). The increase in the uptake of P by tubers with maturity was mainly associated with increase in the bulking of tubers as well as translocation of P from tops into tubers. The translocation of P from tops to tubers also caused decrease in P uptake of haulms with age. The results confirm the earlier findings of Ezeta and McCollum (1972), Sharma *et al.*(1979) and Singh and Grewal (1979).

It is concluded from the above study that the application of nitrogen increase the uptake of P and K by potato crop. So with applied N, it is necessary to apply P and K too in proper amounts so that these may not become limiting for good yields of potato tubers.

REFERENCES

BUNEMANN, G. and GRASSIA, A. 1973. Growth and mineral distribution in grafted tomato/potato plants according to sink number. Sci. Hortic. 1 : 13-24.

EZETA, F.N. and McCOLLUM, R.E. 1972. Dry matter production and nutrient uptake and removal by **Solanum andigena** in the Peruvian Andes. Am. Pot. J. 49 : 151-63.

HARRIS, P.M. 1978. **The Potato Crop : The Scientific Basis for Improvement.** Chapman and Hall Ltd. London.

IVINS, J.D. and BREMNER, P.M. 1965. Growth, development and yield in potato. Outlook on Agriculture, 4 : 211-17

JACKSON, M.L. 1967. **Soil Chemical Analysis.** Prentice Hall of India, New Delhi.

MOONDY, J. 1968. The influence of carbohydrates and mineral nutrient supply on the growth of potato tubers. Ann. Bot. 32 : 57-68.

SHARMA, R.C.; GREWAL,J.S. and SINGH, M. 1979. The value of farmyard manure as source of P and K for potatoes. J. Ind. Soc. Soil Sci. 27 : 161-66

SINGH, S.N. and GREWAL, J.S. 1979. Dry matter production and NPK uptake by the potato variety 'Kufri Chandramukhi' in alluvial soil. J. Ind. Pot. Assoc. 6 : 78-86