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RESEARCH PAPER

Effect of potato varieties and nitrogen levels on dry matter accumulation, chlorophyll content, grade wise tuber yield and post harvest nutrient content in plant and soil

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Abstract : A field investigation was carried out at vegetable research field, College of Horticulture, Mandsaur during *Rabi* season 2010-11. The soil of the experimental field was light alluvial with sandy loam texture and uniform topography. Sixteen treatment combinations of four varieties (V_1-Kufri Jyoti, V_2-Kufri Chipsona-2, V_3-Kufri Chipsona-1 and V_4-Kufri Pushkar) and four nitrogen doses (N_1-100 kg /ha, N_2-125 kg /ha, N_3-150 kg /ha and N_4-175 kg /ha) were replicated thrice in Factorial Randomized Block Design. The findings of the experiment revealed that among the varieties, Kufri Pushkar recorded maximum leaf area per plant, chlorophyll content in leaves, dry weight of shoot, root and tuber. Maximum 'A' grade tuber yield was found with variety Kufri Jyoti followed by Kufri Pushkar. 'B' grade tuber yield was found maximum in case of variety Kufri Pushkar followed by Kufri Chipsona-1 and Kufri Jyoti. Analysis of plant after harvesting revealed significant influence of varieties on nitrogen, phosphorus and potassium content in plant. Maximum nitrogen and phosphorus content in plant was recorded with variety Kufri Pushkar. Potassium content in plant showed highest values with variety Kufri Jyoti. Analysis of soil after harvesting recorded significant influence of varieties on available NPK in soil. Highest available nitrogen, phosphorus and potassium were recorded with Kufri Chipsona-2. Nitrogen application enhanced the leaf area and chlorophyll content. Dry weight of shoot, root and tuber was recorded significant influence of nitrogen levels at all the stages. Highest dry weight of shoot, root and tuber was found with application of 150kg N/ ha. Nitrogen application had significant effect on grade wise tuber yield. There was increase in 'A' grade tuber yield with increasing levels of nitrogen upto 150kg/ha. Application of nitrogen showed increase in nitrogen, phosphorus and potassium content upto 150kg/ha. It also caused increase in available nitrogen and decrease in available phosphorus and potassium in soil. Combined effect of varieties and nitrogen recorded significant effect on chlorophyll content in leaves at 60 DAP. Highest chlorophyll content was found with V_4N_3. Dry weight of shoot, root and tuber showed significant interaction effect of varieties and nitrogen levels at 90 DAP. Highest fresh weight of tuber and 'A' grade tuber yield was found under V_4N_3. There was significant effect of varieties and nitrogen levels interaction on nitrogen and phosphorus content in plant and available potassium in soil after harvesting.

Key Words : Potato, Varieties, Nitrogen, Chlorophyll, Grade wise tuber, Nutrient, Plant, Soil

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important crop among all vegetables and has pivotal place in our daily diet. This is next to rice, wheat and maize. Next to cereals, potato is the only crop which could supplement the need of the food of the country (Das, 2000). This crop has special significance to the developing countries as it has high production potential per unit area and time, and has high nutritional value to sustain burgeoning population and to overcome malnutrition and hunger (Pandey, 2002). It is a main source of starch and carbohydrates. The average composition of potato tuber per 100g edible portion (Das, 2000) is moisture (74.7g), protein (1.6g), fat (0.1g), carbohydrates (22.6g), energy (97kcal), calcium (10mg), phosphorus (40mg), iron (0.70mg), carotene (24µg), thiamine (0.10mg), riboflavin (0.01mg), vitamin-C (17mg). Potato is a balanced food containing less energy but nutritional high quality of protein, essential vitamins and minerals including trace elements (Mehdi *et al.*, 2008).

Nutritional requirement of potato is much more due to high bulking rate (Nandekar *et al.*, 2006). Nitrogen is a key element in growth and development of crop plants. It influences the yields mainly through leaf area expansion, crop development, crop quality and susceptibility to lodging and can also influence the behavior of other elements (Poljak *et al.*, 2007). Nitrogen is an integral part of purin-pyrimidins which forms RNA and DNA essential for photosynthesis. It associates with porphyrine ring in chlorophyll. N also plays an important role in multiplication and elongation of cells. Experiments conducted at Modipuram showed that nitrogen fertilizer increased the maximum rate of net photosynthesis (Shekhawat *et al.*, 1999). Nitrogen application, in beginning helps in early vegetative growth. Sufficient quantity of nitrogen helps in vigorous plant growth, increase leaf area, tuber size, total sugars, reducing sugars, protein content and resistance to leaf spots. Nitrogen deficiency leads to yellowing and finally dropping of lower leaves due to which photosynthetic area is decreased. Tuber initiation is delayed due to excess N. The onset of the linear phase of tuber growth is also delayed, leading to reduction in tuber yield. The response to N is generally linear up to 100 kg N/ha and start decreasing at higher levels of N application. It has been observed that N application helps in rapid bulking of tubers and produces tubers of large size resulting in high yields. The increased nitrogen dose increases protein content of potato tubers and decrease starch content (Pandey, 2002). Ciecko *et al.* (2000) reported higher chlorophyll content at higher dose of fertilizer application. Singh and Raghav (2000) reported that increasing levels of nitrogen produced significantly higher tuber yield.

Genetic architecture has great influence on yield and quality of potato. Various varieties of potato having wide variation in their yield potential and quality attributes have been evolved. These varieties further show variation in their attributes under different agroclimatic conditions. Different variety of potato has different nitrogen use efficiency (Trehan, 2003).

Sustainability of the production is essential which could only be realized with optimum supply of nutrients so that there is no or lesser reduction in fertility as well as optimum production of crop. Hence, different nitrogen levels and varieties of potato were evaluated to see the effect on dry matter accumulation, chlorophyll content, grade wise potato tuber yield and post harvest nutrient content in plant and soil.

MATERIAL AND METHODS

A field investigation was carried out at research field, Department of Vegetable Science College of Horticulture, Mandsaur during *Rabi* 2010-11. Sixteen treatment combinations comprising of four varieties (V_1-Kufri Jyoti, V_2-Kufri Chipsona-2, V_3-Kufri Chipsona-1 and V_4-Kufri Pushkar) and four nitrogen doses (N_1-100 kg /ha, N_2-125 kg /ha, N_3-150 kg /ha and N_4-175 kg /ha) were tested in Factorial Randomized Block Design with three replications. The soil of the experimental field was light alluvial with sandy loam texture having 55% sand, 30% silt, 15% clay, 7.15 pH and 0.53 dSm^{-1} EC. Pre planting nutrient analysis of the soil revealed available nitrogen 190 kg/ha, available phosphorus 8.04kg/ha and available potassium 406kg/ha. The healthy and uniform size tubers were planted at a spacing of 60×20 cm on 21 October, 2010. The crop was harvested on 15 February, 2011. Nutrients *viz.*, P_2O_5 @80kg/ha, K_2O @100kg/ha and different doses of nitrogen (according to treatment) were supplied through urea, DAP and muriate of potash. The full quantity of phosphorus, potash and half dose of nitrogen were applied as basal in furrows at the time of planting. The remaining quantity of nitrogen was applied in two split doses at 25 and 45 days after planting. Recommended package of practices were followed to raise the healthy crop. The observations were recorded at various successive growth stages for leaf area (Licor

leaf area meter), chlorophyll content in leaves (as suggested by Thimmaiah, 2004), dry weight of shoot root and tuber, average weight of tuber at harvesting stage, grade wise tuber yield, NPK content in plant [nitrogen was estimated by Kjeldal method; P in wet digested samples by ammonium molybdate method (Chapman and Pratt, 1961) and K by flame photometer (Holiday and Preedy, 1953) and post harvest available NPK [available nitrogen by Volumetric method (Walkley and Black, 1934), available phosphorus (method of Olsen's *et al*., 1954), available potassium by flame photometer (Holiday and Preedy, 1953) in soil. The dry matter content of tuber was determined by oven drying method. Fresh tuber sample was weighed from each treatment and dried in oven at 80°C till constant weight than dry weight of tuber was measured and calculated in percentage. The data recorded under the experiment were subjected to test of significance as per standard procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth parameters:

Growth of the potato plant was studied with respect to leaf area per plant (Table 1) and dry weight of shoot, root and tuber per plant (Table 2 and 3).

Leaf area per plant, was recorded at 30, 60 and 90 days after planting, showed significant influence of varieties. Among the varieties, Kufri Pushkar recorded maximum leaf area per plant at all the stages. However, the difference between Kufri Pushkar and Kufri Chipsona-1 at 90 DAP was non significant. There was decrease in leaf area under each variety at 90 days after planting as compared to their leaf area at 60 days after planting. Kumar *et al.* (2008) also found significant difference among varieties. Highest dry weight of shoot, root and tuber was observed in case of Kufri Pushkar. Though, at early stage *i.e.* 30 DAP highest dry weight of tuber was found with Kufri Jyoti followed by Kufri Chipsona-1 with non significant difference. More number of leaves along with higher leaf area might have accompanied with more photosynthesis and accumulation of food material resulting in higher fresh and dry weights. Kumar *et al.* (2008) also found significant influence of varieties on fresh biomass yield in potato.

Nitrogen application showed significant influence on leaf area per plant with increasing dose of nitrogen upto 150kg/ha which was declined with application of 175kg N/ha. Though the difference was non significant. Similar findings have been reported by Kumar *et al.* (2008). Dry weight of shoot, root and tuber was recorded significant influence of nitrogen levels at all the stages. Highest dry weight of shoot, root and tuber was found with application of 150kg N/ha. Further, increase in nitrogen dose showed decline in these parameters which indicate that dry weight of shoot, root and tuber could be enhanced upto a certain levels of nitrogen only which may be due to maximization of assimilation rate of food material at optimum level of nitrogen. Singh and Grewal (1979) reported that dry matter accumulation in plant tops was most rapid in early stages and on an average 94% of the maximum leaves and stem growth was recorded after 50 days of planting. They further reported decline in dry matter accumulation by potato tops with plant maturity.

Combined effect of varieties and nitrogen levels showed significant influence on dry weight of shoot at 90 DAP, dry weight of root at 90 DAP and dry weight of tuber at 30 and 90 days after planting. Dry weight of shoot showed significant interaction effect of varieties and nitrogen levels at 90 DAP with maximum values under V_3N_3. Dry weight of root had registered maximum values at 90 DAP under V_4N_3 followed by V_3N_3 and V_4N_4 with significant difference. There was significant effect of interactions between varieties and nitrogen levels on dry weight of tuber at 30 DAP and 90 DAP. At early stage *i.e.* 30 DAP maximum dry weight of tuber was determined with V_3N_3. Later on 90 DAP highest dry weight of tuber was found with V_4N_3 followed by V_4N_4 with non significant difference. Higher genetic potential along with higher dose of nitrogen might have promoted more photosynthesis and accumulation of dry matter resulting in these findings.

Chlorophyll content in leaves :

Chlorophyll content in leaves (Table 1) was recorded at 30, 60 and 90 days after planting. There was significant difference in chlorophyll content in leaves of different varieties. Kufri Pushkar recorded highest chlorophyll content which was followed by Kufri Jyoti and Kufri Chipsona-1. The difference between Kufri Pushkar and Kufri Jyoti was non-significant. In general, there was increase in chlorophyll content upto 60 DAP which

declined at 90 DAP in all the varieties. These findings are in line with Singh *et al*. (2007).

Nitrogen application enhanced the chlorophyll content in leaves. However, the difference between chlorophyll content at 150kg N/ha and 175kg N/ha was non significant at 60 DAP as well as 90 days after planting. Similar findings have been reported by Shahi *et al.* (2003) and Singh *et al*. (2007).

Combined effect of varieties and nitrogen recorded significant effect chlorophyll content in leaves at 60 days after planting only. Highest chlorophyll content was found with V_4N_3 followed by V_1N_4, V_4N_4 and V_1N_3. These results are corroborated with those of Singh *et al*. (2007).

Yield parameters and yield :

Yield parameters (Table 4) *viz.*, average weight of tuber and grade wise tuber yield was recorded at the time of harvesting.

Table 1: Average leaf area (cm^2) per plant and chlorophyll content (mg/g) as influenced by various treatments at different stages

Treatments	Leaf area (cm^2) per plant			Chlorophyll content (mg/g) in leaves		
	30 DAP	60 DAP	90 DAP	30 DAP	60 DAP	90 DAP
Varieties (V)						
V_1	421.83	653.43	501.08	1.013	1.232	0.973
V_2	357.28	595.57	424.07	0.918	1.067	0.905
V_3	429.76	756.66	594.84	0.949	1.147	0.951
V_4	498.05	886.40	597.71	1.032	1.303	0.987
S.E.±	17.87	24.57	19.45	0.010	0.011	0.005
C.D. (P=0.05)	51.61	70.97	56.18	0.030	0.032	0.014
Nitrogen levels (N)						
N_1	365.28	620.53	463.33	0.940	1.114	0.937
N_2	406.75	702.81	506.26	0.957	1.125	0.948
N_3	490.39	804.20	592.28	0.989	1.266	0.960
N_4	444.49	764.53	555.83	1.025	1.244	0.971
S.E.±	17.87	24.57	19.45	0.010	0.011	0.005
C.D. (P=0.05)	51.61	70.97	56.18	0.030	0.032	0.014
Interaction (VxN)						
V_1N_1	370.40	531.27	436.30	0.982	1.148	0.957
V_1N_2	407.53	602.30	451.87	0.990	1.149	0.967
V_1N_3	488.50	748.07	588.80	1.017	1.237	0.979
V_1N_4	420.87	732.10	527.33	1.061	1.392	0.988
V_2N_1	265.10	537.63	415.43	0.867	1.048	0.887
V_2N_2	358.27	553.80	394.00	0.895	1.061	0.899
V_2N_3	428.23	673.90	454.47	0.942	1.073	0.914
V_2N_4	377.53	616.93	432.37	0.969	1.086	0.921
V_3N_1	386.43	683.70	450.80	0.926	1.131	0.935
V_3N_2	396.00	752.00	587.67	0.935	1.151	0.945
V_3N_3	483.80	821.57	676.63	0.945	1.165	0.956
V_3N_4	452.80	769.37	664.27	0.987	1.140	0.967
V_4N_1	439.20	729.50	550.77	0.984	1.127	0.969
V_4N_2	465.20	903.13	591.50	1.008	1.140	0.980
V_4N_3	561.03	973.27	649.20	1.052	1.587	0.991
V_4N_4	526.77	939.70	599.37	1.084	1.359	1.008
S.E.±	30.95	42.56	33.69	0.018	0.019	0.008
C.D. (P=0.05)	NS	NS	NS	NS	0.055	NS

NS= Non-signifncant

Yield parameters *viz.*, average weight of tuber and grade wise tuber yield exhibited significant influence of varieties. Amongst the varieties, maximum fresh weight of tuber was recorded with Kufri Pushkar which was followed by Kufri Chipsona-1. The difference between Kufri Chipsona-1 and Kufri Jyoti was non significant. Maximum 'A' grade tuber yield was found in variety Kufri Jyoti followed by Kufri Pushkar and Kufri Chipsona-2 yielded least with regard to grade 'A' tuber. 'B' grade tuber yield was maximum in case of variety Kufri Pushkar followed by Kufri Chipsona-1 and Kufri Jyoti. Maximum 'C' grade tuber yield was observed in Kufri Pushkar followed by Kufri Chipsona-1, Kufri Jyoti and Kufri Chipsona-2. The difference between Kufri Chipsona-1, Kufri Jyoti and Kufri Chipsona-2 was non significant with regard to 'C' grade tuber yield. Variety Kufri Jyoti recorded maximum proportion of 'A' grade tuber yield (54.47%) followed by Kufri Chipsona-1

Table 2 : Average dry weight of shoot (g) per plant as influenced by various treatments at different stages

Treatments	Dry weight of shoot (g) per plant				Dry weight of root (g) per plant			
	30 DAP	60 DAP	90 DAP	At harvest	30 DAP	60 DAP	90 DAP	At harvest
Varieties (V)								
V_1	5.17	19.05	16.52	13.47	0.85	1.39	1.57	1.40
V_2	5.25	16.63	15.67	11.72	0.78	1.26	1.48	1.42
V_3	5.55	21.99	20.65	15.69	0.83	1.61	1.72	1.53
V_4	5.99	22.71	20.81	16.65	0.88	1.74	1.78	1.59
S.E. ±	0.23	1.05	0.96	0.68	0.03	0.07	0.08	0.06
C.D. (P=0.05)	0.66	3.02	2.77	1.96	0.08	0.22	0.23	0.16
Nitrogen levels (N)								
N_1	3.98	15.28	12.23	10.27	0.71	1.11	1.27	1.28
N_2	5.09	18.41	15.69	13.14	0.82	1.30	1.40	1.32
N_3	6.91	25.57	26.35	18.57	0.94	1.91	2.17	1.75
N_4	5.97	21.11	19.38	15.54	0.88	1.69	1.71	1.61
S.E. ±	0.23	1.05	0.96	0.68	0.03	0.07	0.08	0.06
C.D. (P=0.05)	0.66	3.02	2.77	1.96	0.08	0.22	0.23	0.16
Interaction (VxN)								
V_1N_1	3.77	15.37	10.50	9.84	0.75	1.20	1.35	1.25
V_1N_2	4.81	18.06	11.58	13.21	0.84	1.27	1.27	1.32
V_1N_3	6.41	23.21	26.33	16.43	0.93	1.56	1.99	1.55
V_1N_4	5.66	19.54	17.67	14.40	0.88	1.54	1.67	1.48
V_2N_1	3.58	11.80	12.92	7.92	0.65	0.92	1.34	1.11
V_2N_2	4.70	16.79	14.25	11.05	0.75	1.20	1.36	1.22
V_2N_3	6.59	19.75	19.17	14.95	0.92	1.58	1.62	1.76
V_2N_4	6.11	18.18	16.33	12.95	0.81	1.36	1.60	1.60
V_3N_1	4.06	16.26	12.58	12.56	0.68	1.15	1.21	1.35
V_3N_2	5.39	19.45	15.67	13.74	0.80	1.34	1.56	1.37
V_3N_3	7.05	27.99	33.25	19.92	0.95	2.13	2.27	1.75
V_3N_4	5.69	24.25	21.08	16.54	0.90	1.81	1.83	1.67
V_4N_1	4.51	17.70	12.92	10.77	0.77	1.15	1.17	1.40
V_4N_2	5.46	19.34	21.25	14.56	0.89	1.40	1.39	1.35
V_4N_3	7.58	31.34	26.67	22.98	0.95	2.36	2.80	1.91
V_4N_4	6.41	22.47	22.42	18.27	0.91	2.06	1.75	1.68
S.E. ±	0.40	1.81	1.66	1.18	0.05	0.13	0.14	0.09
C.D. (P=0.05)	NS	NS	4.78	NS	NS	NS	0.40	NS

NS= Non-significant

(47.48%) and Kufri Pushkar (44.45%). Highest proportion of 'B' grade tuber yield was found in case of variety Kufri Pushkar. Whereas, variety Kufri Chipsona-1 yielded highest proportion of 'C' grade tubers. Similar findings have been reported by Singh *et al.* (2001) and Kumar *et al.* (2001).

Nitrogen application had significant effect on fresh weight of tuber and grade wise tuber yield. Application of nitrogen enhanced the fresh weight of tuber with increasing dose of nitrogen upto 150kg/ha which was declined slightly at further higher level of 175kg N/ha. There was increase in 'A' grade tuber yield with increasing levels of nitrogen upto 150kg/ha. Further increase in nitrogen levels did not show any remarkable influence on 'A' grade tuber yield. Yield of 'B' grade tubers showed non significant effect with 125kg N/ha over 100kg N/ha. However, yield with 150kg N/ha application was significantly higher as compared to both

Table 3: Average dry weight of tuber (g) per plant as influenced by various treatments at different stages

Treatments	Dry weight of tuber (g) per plant			
	30 DAP	60 DAP	90 DAP	At harvest
Varieties (V)				
V_1	1.47	27.80	64.33	93.24
V_2	1.27	20.48	40.59	54.47
V_3	1.35	29.15	68.21	80.08
V_4	1.04	36.22	91.02	109.05
S.E.±	0.06	1.37	2.52	4.52
C.D. (P=0.05)	0.17	3.96	7.27	13.04
Nitrogen levels (N)				
N_1	1.09	18.36	47.15	55.90
N_2	1.09	23.50	57.83	68.29
N_3	1.73	38.61	88.10	119.61
N_4	1.22	33.18	71.06	93.05
S.E.±	0.06	1.37	2.52	4.52
C.D. (P=0.05)	0.17	3.96	7.27	13.04
Interaction (VxN)				
V_1N_1	1.10	19.44	44.50	62.38
V_1N_2	1.07	25.26	57.00	74.87
V_1N_3	2.21	35.09	83.50	131.13
V_1N_4	1.52	31.42	72.33	104.59
V_2N_1	1.23	11.19	31.95	31.96
V_2N_2	1.23	15.61	38.25	38.30
V_2N_3	1.37	31.50	56.83	88.98
V_2N_4	1.26	23.60	35.33	58.64
V_3N_1	1.02	17.26	49.08	57.95
V_3N_2	1.03	20.40	60.08	68.17
V_3N_3	2.27	41.29	92.58	108.42
V_3N_4	1.08	37.66	71.08	85.76
V_4N_1	1.02	25.55	63.08	71.31
V_4N_2	1.03	32.74	76.00	91.80
V_4N_3	1.06	46.56	119.50	149.88
V_4N_4	1.04	40.05	105.50	123.21
S.E.±	0.10	2.37	4.36	7.82
C.D. (P=0.05)	0.30	NS	12.59	NS

NS= Non-significant

lower levels. Application of 175kg N/ha showed at par yield when compared with 150kg N/ha application. Similar trend were observed for grade 'C' tuber yield. Trehan (2003) also reported increase in large size tubers with higher nitrogen dose.

Combined effect of varieties and nitrogen levels showed significant influence on fresh weight of tuber as well as grade wise tuber yield. Highest fresh weight of tuber was observed in case of V_4N_3 which was followed by V_4N_4 with non-significant difference. Highest 'A' grade tuber yield was found under V_4N_3 followed by V_4N_4, V_1N_3 and V_1N_4. Combination V_4N_3 recorded maximum 'B' grade tuber yield which was followed by V_4N_4, V_4N_2 and V_4N_1. Yield of grade 'C' tubers was highest under combination of V_4N_3 followed by V_4N_4, V_1N_3 and V_3N_3.

Table 4: Average weight of tuber and grade wise tuber yield (q/ha) as influenced by various treatments

Treatments	Fresh weight of tuber (g) per plant at harvest	Grade wise tuber yield (q/ha)		
		Grade 'A' (>50g)	Grade 'B' (25-50g)	Grade 'C' (<25g)
Varieties				
V_1	434.96	115.95	58.23	38.68
V_2	237.98	60.98	46.30	35.49
V_3	398.99	89.83	60.64	38.70
V_4	590.98	115.18	94.01	49.89
S.E.±	12.71	3.24	2.52	1.44
C.D. (P=0.05)	36.70	9.35	7.27	4.14
Nitrogen levels (N)				
N_1	332.80	78.92	58.52	33.74
N_2	365.01	87.44	60.79	36.26
N_3	517.93	111.02	71.04	47.58
N_4	447.18	104.56	68.84	45.18
S.E.±	12.71	3.24	2.52	1.44
C.D. (P=0.05)	36.70	9.35	7.27	4.14
Interaction (VxN)				
V_1N_1	341.20	106.79	54.36	33.41
V_1N_2	372.57	111.43	54.04	36.60
V_1N_3	572.00	126.66	63.82	43.89
V_1N_4	454.07	118.91	60.69	40.82
V_2N_1	164.40	51.34	44.81	32.42
V_2N_2	188.97	61.04	45.80	34.09
V_2N_3	347.10	66.72	47.84	38.78
V_2N_4	251.43	64.83	46.76	36.67
V_3N_1	361.13	70.46	64.97	33.50
V_3N_2	366.07	78.71	65.44	35.94
V_3N_3	464.13	108.44	57.39	43.75
V_3N_4	404.63	101.69	54.78	41.60
V_4N_1	464.47	87.08	69.93	35.62
V_4N_2	532.43	98.60	77.90	38.41
V_4N_3	688.47	142.24	115.09	63.91
V_4N_4	678.57	132.79	113.13	61.61
S.E.±	22.01	5.61	4.36	3.57
C.D. (P=0.05)	63.56	16.20	12.59	10.32

Post harvest analysis of plant :

Analysis of plant after harvesting (Table 5) revealed significant influence of varieties on nitrogen content in plant. Maximum nitrogen content in plant was recorded with variety Kufri Pushkar followed by Kufri Jyoti, Kufri Chipsona-1. Kufri Chipsona-2 showed least values of nitrogen content in plant. Varieties have different genetic potential which might have resulted in differed uptake and absorption of nitrogen resulting in varied nitrogen content in plant. Kumar *et al.* (2008) also reported significant difference among varieties for nitrogen content in potato. Phosphorus content was highest in case of variety Kufri Pushkar which showed significantly higher values over other varieties. Potassium content in plant showed highest values with variety Kufri Jyoti followed by Kufri Pushkar and Kufri Chipsona-1 with non significant difference. Variety Kufri Chipsona-2 recorded lowest phosphorus content in plant.

Table 5: NPK content in plant and available NPK in soil after harvesting

Treatments	N content (%) in plant	P content (%) in plant	K content (%) in plant	Available N (kg/ha) in soil	Available P (kg/ha) in soil	Available K (kg/ha) in soil
Varieties (V)						
V_1	0.511	0.164	1.97	134.08	12.55	394.83
V_2	0.498	0.161	1.81	144.33	13.75	423.42
V_3	0.505	0.162	1.95	144.17	12.62	410.92
V_4	0.558	0.172	1.95	133.58	12.22	396.08
S.E. ±	0.009	0.002	0.020	2.71	0.29	8.90
C.D. (P=0.05)	0.025	0.005	0.058	7.84	0.85	25.70
Nitrogen levels (N)						
N_1	0.436	0.154	1.89	131.67	14.79	415.58
N_2	0.497	0.158	1.91	137.83	13.53	405.25
N_3	0.588	0.182	1.99	138.00	10.79	387.25
N_4	0.553	0.165	1.90	148.67	12.05	417.17
S.E. ±	0.009	0.002	0.020	2.71	0.29	8.90
C.D. (P=0.05)	0.025	0.005	0.058	7.84	0.85	25.70
Interaction (VxN)						
V_1N_1	0.440	0.139	1.93	127.00	15.21	346.67
V_1N_2	0.440	0.155	1.95	131.33	12.87	409.67
V_1N_3	0.590	0.191	2.02	137.33	10.61	359.67
V_1N_4	0.573	0.172	1.95	140.67	11.54	463.33
V_2N_1	0.413	0.154	1.78	137.00	15.45	427.33
V_2N_2	0.493	0.161	1.81	144.67	14.32	425.00
V_2N_3	0.580	0.167	1.86	133.00	11.52	387.67
V_2N_4	0.507	0.162	1.79	162.67	13.75	453.67
V_3N_1	0.393	0.145	1.92	136.67	14.32	443.67
V_3N_2	0.497	0.154	1.95	143.33	13.54	412.67
V_3N_3	0.590	0.190	2.04	144.33	10.62	404.33
V_3N_4	0.540	0.160	1.91	152.33	12.02	383.00
V_4N_1	0.497	0.177	1.92	126.00	14.19	444.67
V_4N_2	0.557	0.163	1.94	132.00	13.41	373.67
V_4N_3	0.590	0.180	2.03	137.33	10.40	397.33
V_4N_4	0.590	0.168	1.93	139.00	10.89	368.67
S.E. ±	0.015	0.003	0.035	4.70	0.51	15.41
C.D. (P=0.05)	0.043	0.009	NS	NS	NS	44.52

NS= Non-significant

Application of nitrogen showed increase in nitrogen content upto 150kg/ha which showed lower values at 175kg N/ha. Similar findings have been reported by Singh and Grewal (1979); Adhikari *et al.* (2004); Sud (2006) and Kumar *et al.* (2008). There was increase in phosphorus content in plant with increasing dose of nitrogen application upto 150kg/ha. Further higher levels of nitrogen showed decline in phosphorus content in plant. It indicated positive effect of nitrogen application on phosphorus absorption and assimilation. Kushwah and Banafar (2003) and Sud (2006) also found synergistic effect of nitrogen on phosphorus content in potato. Application of nitrogen showed significant influence on potassium content with increasing dose of nitrogen upto 150kg/ha. Further increase in nitrogen application showed significant reduction in potassium content in plant as compared to 150kg N/ha.

Combined effect of varieties and nitrogen levels revealed significant effect on nitrogen and phosphorus content in plant. Maximum nitrogen content in plant was found under V_4N_3, V_4N_2 and V_3N_3 with same values. Combined effect of varieties and nitrogen levels recorded highest values of phosphorus content in plant under V_1N_3, followed by V_3N_3 with non-significant difference.

Post harvest analysis of soil :

Analysis of soil after harvesting (Table 5) recorded significant influence of varieties on available nitrogen in soil. Highest available nitrogen was recorded with Kufri Chipsona-2 followed by Kufri Chipsona-1 and Kufri Jyoti. Lowest value of available nitrogen was observed under Kufri Pushkar. It indicated that the variety which yielded more has taken up more nitrogen from the soil resulting in more depletion of available nitrogen in soil. These findings are corroborated by those of Kumar *et al.* (2008).

Available phosphorus was found maximum in variety Kufri Chipsona-2 followed by Kufri Chipsona-1, Kufri Jyoti and Kufri Pushkar. The difference between Kufri Jyoti, Kufri Chipsona-1 and Kufri Pushkar was non significant. But all these three varieties showed significantly lower values as compared to Kufri Chipsona-2. Higher uptake of phosphorus due to higher yield may be the reason for these findings (Baishya *et al.,* 2010). Available potassium in soil was found maximum under variety Kufri Chipsona-2 followed by Kufri Chipsona-1 with non significant difference. Variety Kufri Jyoti recorded minimum potassium in soil. Though, statistically it was at par to Kufri Pushkar and Kufri Chipsona-1.

Application of nitrogen showed increase in available nitrogen with each increasing nitrogen level resulting in highest available nitrogen with 175kg/ha. There was decrease in available phosphorus in soil with each increase in nitrogen level upto 150kg/ha. However, increase in available phosphorus was observed at 175kg N/ha as compared to 150kg N/ha. The increasing dose of nitrogen upto optimum level enhanced the absorption of phosphorus resulting in more depletion of available phosphorus in soil. Application of nitrogen caused decrease in available potassium with increasing dose of nitrogen upto 150kg/ha. Further increase in nitrogen application showed increase in available potassium resulting in highest available potassium at 175kg/ha.

Interaction effect of varieties and nitrogen showed significant effect only on available potassium in soil after harvesting. Combined effect of varieties and nitrogen levels recorded maximum available potassium with V_1N_4 which was followed by V_2N_4, V_4N_1, V_3N_1, V_2N_1 and V_2N_2 with non-significant difference. Lowest available potassium was determined under V_1N_1.

REFERENCES

Adhikari, Ram, Sharma, C. and Moha D. (2004). Use of chemical fertilizers on potatoes in sandy loam soil under humid sub-tropical condition of Chitwan. *Nepal Agric. Res. J.,* **5**: 23-26.

Baishya, L.K., Kumar, M. and Ghosh, D.C. (2010). Effect of different proportion of organic and iorganic nutrients on productivity and profitability of potato (*Solanum tuberosum* L.) varieties in Meghalaya hills. *Indian J. Agron.*, 55 (3): 230-234.

Chapman, H. D. and Pratt, F. P. (1961). Ammonium vandate-molybdate method for determination of phosphorus. In: *Methods of analysis for soils, plants and water*. 1st Ed. California: California University, Agriculture Division, pp 184-203.

Ciecko, Z., Wyszkowski, M., Zolnowski, A. and Zabielska, J. (2000). Proceedings of conference "Table and food processing potato-agrotechnical and storage factors conditioning quality", Radzikow, Poland, 23-25. February. 1999. *Binletyn Instytutu Hodowli I Aklimatyzacji Roslin*, **213**: 131-36.

Das, P. C. (2000). *Potato in India.* Ist Ed., Kalyani Publishers, NEW DELHI, INDIA.

Holiday, E. R. and Preedy, J. R. K. (1953). The precision of a direct-reading flame photometer for the determination of sodium and potassium in biological fluids. *Biochemistry J.*,

55 (2): 214–220.

Kumar, Dhurv, Praharaj, C. S., Sharma, R.C. and Khurana, S.M. Paul (2001). Response of potato varieties to fertility levels in Indo-Gangetic Plains of Bihar. *J. Indian Potato Assoc.,* **28** (1): 56-57.

Kumar, Praveen, Trehan, S. P., Singh, B. P., Rawal, S. and Khan, M. A. (2008). Precising nitrogen requirement of table potato (*Solanum tuberosum* L.) cultivars for different growth periods. *Indian J. Agron.,* **53** (4): 314-317.

Kushwah, S.S. and Banafar, R.N.S. (2003). Influence of different N and P levels with and without bio-fertilizers on N, P content, uptake and yield of potato cv. KUFRI JYOTI. *J. Indian Potato Assoc.,* **30** (3-4): 321-324.

Mehdi, Mohd., Saleem, Tahir, Rai, H.K., Mir, M.S. and Rai, Gyanendra (2008). Effect of nitrogen and FYM interaction on yield and yield traits of potato (*Solanum tuberosum* L) genotypes under Ladakh condition. *Potato J.,* **35** (3-4): 126-129.

Nandenkar, D. N., Sawarkar, S. D. and Naidu, A. K. (2006). Effect of biofertilizers and NPK on the growth and yield of potato in Satpura plateau. *Potato J*., **33** (3-4): 168-169.

Olson, S. R., Cole, C. V., Watanabe, F. S. and Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *U.S. Department Agriculture Circular.* No. 939. USA.

Pandey, R.P. (2002). *The potato.* Ist Ed., Kalyani Publishers, New Delhi, India, pp. 91-92.

Panse, V.G. and Sukhatme, P.V. (1985). *Statistical methods, for agricultural workers*. IVth Ed. ICAR Publication, NEW DELHI, INDIA.

Poljak, M., Herak Custic, M., Horvat, T., Coga, L. and Majic, A. (2007). Effects of nitrogen nutrition on potato tuber composition and yield. *Cereal Research Communic*., **35** (2): 937-940.

Shahi, U.P., Kumar, Suman, Singh, N.P. and Tiwari, A.K. (2003). Effect of different fertility levels on spectral characteristics, growth and yield of potato cv., KUFRI BAHAR. *J. Indian Potato Assoc*., **30** (3-4): 325-333.

Shekhawat, G. S., Lal, S. S., Pandey, S. K., Singh, B. P., Ezekiel, R., Sukumaran, N. P. and Naik, P. S. (1999). Potato physiology. Potato Research in India A success story of Fifty years, CPRI, Shimla, pp. 50-55.

Singh, J.P., Rachna, Lal, S.S., Ray, S.S. and Panigrahy, Sushma (2007). Using leaf chlorophyll meter for N-fertilizer management in precision farming of potato. *Potato J.,* **34** (3-4): 221-226.

Singh, N. P. and Raghav, Manoj (2000). Effect of different fertility levels on spectral characteristics, growth and yield of potato cv. KUFRI BAHAR. *J. Indian Potato Assoc.*, **27**: 47-48.

Singh, S.N. and Grewal, J.S. (1979). Dry matter production and NPK uptake by the potato variety Kufri Chandramukhi (*Solanum tuberosum* L.) in alluvial soil. *J. Indian Potato Assoc.,* **6** (2): 78-86.

Singh, S.V., Kumar, Dinesh and Pandey, S. K. (2001). Scope of new processing varieties, Kufri Chipsona-1 and Kufri Chipsona-2 in Malwa Region of Madhya Pradesh. *J. Indian Potato Assoc*., **28** (1): 21-23.

Sud, K. C. (2006). Anionic balance of nitrogen, phosphorus and sulphur in potato levels under rainfed condition in Shimla Hills. *Potato J.,* **33** (1-2): 68-73.

Thimmaih, S.K. (2004). *Standard methods of biochemical analysis*. Kalyani Publishers, New Delhi. pp. 307-308.

Trehan, S. P. (2003). Evaluation of N efficiency of different potato cultivars. *J. Indian Potato Assoc*., **30** (1-2): 63-64.

Walkley, A. and Black, I. A. (1934). An examination of the Degtjareff method for determining organic carbon in soils: Effect of variations in digestion conditions and of inorganic soil constituents. *Soil Sci.,* **63**: 251-263.