EFFECT OF NITROGEN AND POTASSIUM FERTILIZERS ON YIELD, STORABILITY AND PROCESSING QUALITIES OF POTATO FOR THE CHIPS

I. P. Gautam*, M.D. Sharma**, B.B. Khatri*, R.B. Thapa**, K. Shrestha*** and D.Chaudhary*
*National Potato Research Program, NARC, Lalitpur, Khumaltar,
**Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan.
***National Academy of Science and Technology (NAST), Khumaltar, Nepal.

ABSTRACT

Field and storage experiments were conducted to find out the main effects and interactions between different levels of nitrogen and potassium fertilizers on total yield, yield of different size grade, storability and better processing quality for chips of potato variety Kufri Jyoti at Hattiban farm Khumaltar and storage house of National Potato Research Program (NPRP) Khumaltar and at Balaju cold store, respectively. After harvesting and curing of potato, 5 kg of tubers weight each tuber more than 60 gram weight were used for the storage and processing quality determination. The storage experiments were conducted in CRD design with 3 replications. Plastic racks and net bags were used for storage of potato in dark room and cold storage house, respectively. Potato was stored for 90 days in dark room and 120 days in cold house. Laboratory analyses were carried out at National Academy of Science and Technology (NAST) at Lalitpur before and after storage of potato in ordinary conditions and before immediately after removing from cold store and 15 days after re-conditioned. Observations were recorded on yield, storage losses, sprouting, chips quality parameters like specific gravity (SG), dry matter (DM) and reducing sugar (RS). The storage loss and sprouting percentage was recorded at 15 days intervals of dark sore potatoes and before storage, immediately after removing from cold and 15 days after reconditioned of cold store potatoes. The results showed a significant effect of N and K_2O and there interaction on yield, sprouting, weight loss percentage and quality parameters. Based on the yield and quality parameters the combination of 150:100:60 kg N: P_2O_5: K_2O along with 20 tons compost / ha is found suitable for storage and production of processing chips quality potato at Lalitpur and similar soil and environment condition of Nepal.

Key words: Potato, nitrogen, potash, processing qualities for chips and yield.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important crop in Nepal and plays an important role in the country's food security and poverty alleviation because of its short vegetative cycle and high cash and food value as compared to any other major cereals (Adhikary *et al.*, 2008). Increase in potato production in last few years has created postharvest problems because of inadequate storage and processing facilities. In the developing countries of the tropics and sub tropics, post harvest handling and storage losses of seed and ware potatoes have been estimated to be 20-30% (Prasad *et al.*, 1989; Satter *et al.*, 2002). The reducing post harvest losses is the best option for increasing food availability than by increasing the same amount of yield (Gautam and Bhattari, 1996; Karki, 2002).

The storage loss of potato is governed by many factors like temperature, relative humidity, duration of the crops, fertilizer management, irrigation etc. Among the several fertilizers, nitrogen and potassium play an important role for potato production as is evident from numerous studies conducted in different locations over the years. The intensive cropping year after year in same piece of land without proper combination of manure and fertilizer creates soil quality deterioration, causes severe nutrients deficiency, disturb the nutrients status of soil and may cause destructive soil if not replenish properly. Potato is a heavy feeder crop and requires a large amount of nutrients. The production of 20 ton crop extract 140: 140: 190 kg N, P_2O_5, K_2O, while the average application of 15-30 t/ha FYM would supply maximum of 35-50:50-100 and 35-70 kg of N, P_2O_5, K_2O, not enough to support the potential higher yield (Khatri and Shrestha, 1998). The response of fertilizers depends up on the nutrient level of soil, irrigation, climatic condition and purpose of crops grown. However, the response of potassium and

nitrogen was found more for potato production in different climatic and soil conditions. Potato tubers remove 1.5 times more potassium than nitrogen and 4-5 times than phosphorus (Perrenoud, 1993). Potassium has a crucial role in the energy status of the plant, translocation and storage of assimilates and maintenance of tissue water relations (Marschner, 1995). It helps on photosynthesis, maintains cell turgid, favors carbohydrate transport, enhances shipping quality, extends shelf life and improves chips colour and decreases storage losses (Marschner, 1995). Similarly, nitrogen is the second most important nutrient which increases the vegetative growth, crop duration, tubers quality and decides the yield level. However, its excessive application resulted tuber with lower reducing sugar at harvest and accumulated less reducing sugar during storage (Iritani and Weller. 1978). The application of both nitrogen and potassium can increase dry matter if there is a yield response from their application and their specific response is partly dependent upon variety and field environment (Schippers, 1976).

NPRP recommended 80:80:60 Kg NPK/ha along with 20 tons FYM for on farm and 100:100:60 Kg NPK/ha along with 20 tons FYM for on-station experiment based on the reviews (Khatri *et al.*, 1999) a decade ago, which could not be the same in present situation due to intensive cropping system and purpose of crop grown. Likewise, the requirement of N and K for long term storage and processing grade may be different from table or seed potato, but studies were not yet undertaken in Nepalese situation due to new technology of potato processing in commercial scale. Therefore, present study was conducted in the mid-hills condition at Khumaltar to find out the appropriate combination of N and K for higher production, good storability and better processing qualities of potato for chips making in the mid hills condition.

MATERIALS AND METHODS

Field experiment was conducted at Hattiban Farm, Lalitpur (1340 m asl) during the summer season of 2010 in clay type soil below 6.0 soil pH. The experiment was laid out in RCB design with factorial arrangement of the treatments. Total of 16 treatment combinations consisting 4 levels of nitrogen (50,100,150 and 200 kg /ha) and 4 level of potash (30, 60, 90 and 120 kg/ha) were replicated three times. The recommended variety of potato Kufri Jyoti was used as the standard check. The trial was planted on 25th January, 2010.The plot size was maintained at 10.5 m^2 (3 m x 3.5 m) in 60 cm row to row and 25 cm plant to plant spacing. Compost were applied @20 mt/ha) and phosphorus (@100 kg/ha) in all the treatments at the time of planting. Other cultural practices were carried out as per NPRP recommendation. The crop was harvested on 17th May (103 days after planting). Observations were recorded on processing grade tubers and yields.

The harvest from different treatments were used for storage experiments. Storage experiments were conducted at storage house of PRP, Khumaltar in ordinary dark room condition (28 ± 0.6 ° C temperature and 88 - 89% RH) and cold storage at Balaju, respectively. Laboratory analyses were carried out in the laboratory of NAST at Lalitpur before and after storage of potato in ordinary condition and before, immediately after removing from cold storage and 15 days after re-conditioning of cold store potato. A total of 16 treatments were laid out in CRD with three replications both in ordinary and cold store. Five kilogram potatoes of each treatment were stored in plastic trays under dark room for 90 days (21 May to 18 August). Trays were kept in three layers and altered at 15 days intervals as upside down order. For cold store, potatoes were packed in net bags and stored in wooden rack for 120 days (21 May to 27 September).

Observations were taken on yield, storage losses, sprouting percentage, chips quality parameters like specific gravity (SG), dry matter (DM) and reducing sugar (RS) before and after storage. Storage loss and sprouting percentage was recorded at fortnight intervals in ordinary condition and before storage, immediately after removing from the store and 15 days after reconditioning of cold storage potato. DM was determined by chopping and mixing of tubers in to small pieces and oven drying 100 gram sample at 80° C for 6 hours and then at 65° C till constant weight. SG was determined by using potato hydrometer (developed by Snack Food Association) by weighting 8 pound of potato before storage and by water displacement methods after storage. Reducing sugar was determined by using di-nitrosalicyclic colorimetric method (Miller, 1959) by recording the absorbance in spectrophotometer at 575 nm. The observed data were analyzed by using Gen-stat 532-2 program and DMRT of MSTAT C for mean comparison.

RESULT AND DISCUSSION

Tuber Size Distribution and Total Yield:
There is highly significant effect of nitrogen for production of 30-60 and more than 60 gram tubers and total yield of potato. The application of 150 kg N produced the highest 30-60 g tubers (13.71 t/ha), > 60 g tubers (13.46 t/ha) and total yield (29.62 t/ha). There is linear increase of these parameters up to 150 kg N/ha and decease thereafter but not at significant level (Fig 1). The effect of K_2O showed significant and highly significant differences only for the production of more than 60 gram tuber and total tuber yield. There is linear increase of more than 60 gram tubers and yield of potato up to 120 kg K_2O (Fig 2).

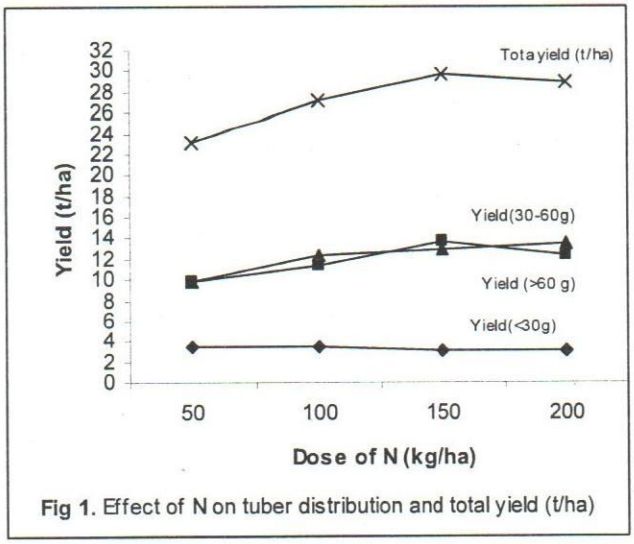

Fig 1. Effect of N on tuber distribution and total yield (t/ha)

The combine effect of N and K_2O showed a significant effect on production of 30-60 gram tubers and total yield of potato. The highest percentage (14.16%) of 30-60 g tuber yield was produced with 150 kg N and 90 kg K_2O/ha and it was found at a par with 200 kg N 90 kg K_2O, 150 kg N and 60 kg K and a50 kg N and 30 kg K. The total highest yield (30.69 t/ha) was recorded on 200 kg N and 120 kg K_2O and it was found at par with 200 kg N and 90 kg K_2O (30.59 t/ha), 150 kg N and 60 kg K_2O (30.22 t/ha) and 150and 90 kg K_2O (29.84 t/ha) where as lowest yield (21.43 t/ha) was recorded on 50 kg N and 30 kg K_2O and it was at a par with 50 kg N and 60 kg K_2O(22.81 t/ha).

The detail effect of N, K and their interaction effect is presented in Table-2. This finding is agreement with finding of Khatri and Shrestha, 1998. They review fertilizer trials conducted in different part of country and reported, that potassium and nitrogen had the greatest effect on tuber yield both in mid and high hills. The three years trial conducted in Kathmandu valley, showed that yield was increased with increase of nitrogen application up to 160 along with 25 tons of FYM/ha (Khairgoli,1978).

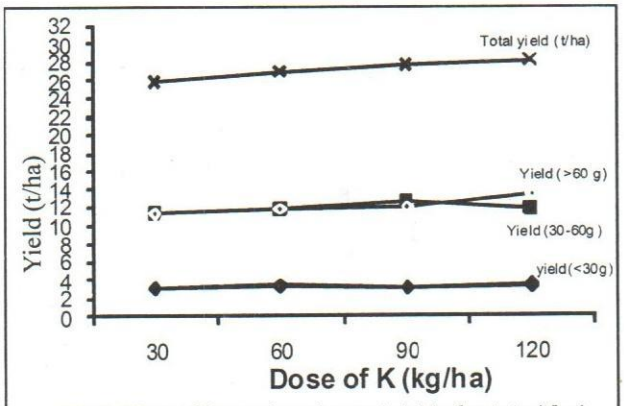

Fig 2 Effect of K on tuber size and yield of potato (t/ha)

Weight loss Percentage:
The effect of nitrogen on weight loss percentage was found only significant difference at 15 days after storage. The minimum percentage (3.65 %) was observed on application of 100 kg N and it was at a par with 50 kg N (4.09%). Since there is no significant effect of N on weight loss percentage in different dates after storage but 50 kg N /ha has minimum weight loss (11.61 %) than higher doses of nitrogen (Fig 3).

The effect of potash on weight loss percentage was found non-significant up to 15 days storage and then showed significant and highly significant differences at 30, 45 and 60, 75, 90 days, respectively (Fig 4). However, the application of 60 kg and higher dose of potassium showed similar results. The detail effect of N and K_2O on weight loss percentage after different dates of storage is presented in Table 3 and 4.

The interaction effect of N and K_2O showed a significant effect on weight loss percentage at 15 days storage and thereafter did not show a different on weight loss percentage. However, there is a linear decrease the weight loss percentage with the increasing trend of K_2O (Fig 4 and 5). The cold storage for 120 days and reconditioning 15 days after removing from cold storage showed non-significant effect of N , K_2O and their interaction on weight loss percentage (Table 3)

Table 1. Combined effect of nitrogen and potash on tuber distribution and total yield (t/ha) at Khumaltar, 2009/10

Dose of N:K_2O (kg/ha)	Tuber Yield (< 30 g)	Tuber Yield (30-60 g)	Tuber yield (> 60 g)	Total tuber yiel (t /ha)
50 : 30	3.43	8.85 *E*	9.14	21.43 *h*
50 : 60	3.42	9.55 *Ef*	9.84	22.81 *gh*
50 : 90	3.30	11.21 *cdef*	9.35	23.86 *fg*
50 :120	3.83	9.72 *Ef*	10.86	24.41 *f*
100 :30	3.43	11.77 *bcde*	11.47	26.67 *e*
100 : 60	3.89	11.48 *bcdef*	11.52	26.89 *e*
100 :90	3.28	9.72 *ef*	13.52	26.52 *e*
100 :120	3.27	12.15 *bcde*	13.11	28.53 *cd*
150 :30	3.39	13.83 *abc*	11.54	28.76 *bcd*
150 : 60	3.48	13.29 *abc*	12.79	30.22 *ab*
150 :90	2.72	15.00 *a*	12.12	29.84 *abc*
150 :120	2.71	12.05 *bcde*	14.90	29.67 *abcd*
200 :30	2.73	10.84 *def*	13.04	26.61 *e*
200 : 60	3.18	11.78 *bcde*	13.16	28.12 *de*
200 :90	3.32	14.16 *ab*	13.11	30.59 *a*
200 :120	3.36	12.79 *abcd*	14.53	30.69 *a*
Mean	3.30	11.80	12.13	24.23
F-test	NS	*	NS	*
LSD (± 0.05)	-	2.412	-	1.483
CV (%)	19.6	12.3	13.0	3.3

+ Common small letters in a column are not significantly different by DMRT at 0.05 levels.
NS and *,**, *** represent non significant and significant differences at 0.05, 0.01 and <0.001 levels, respectively

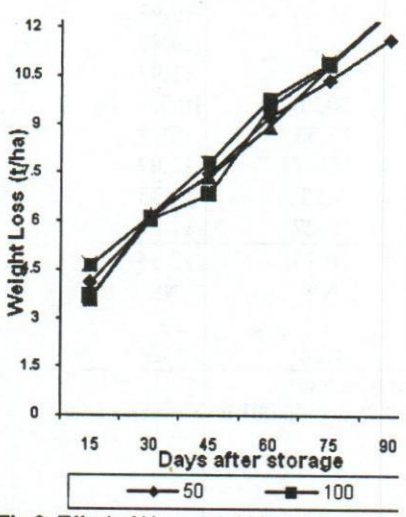

Fig 3. Effect of N on weight loss (t/ha) at

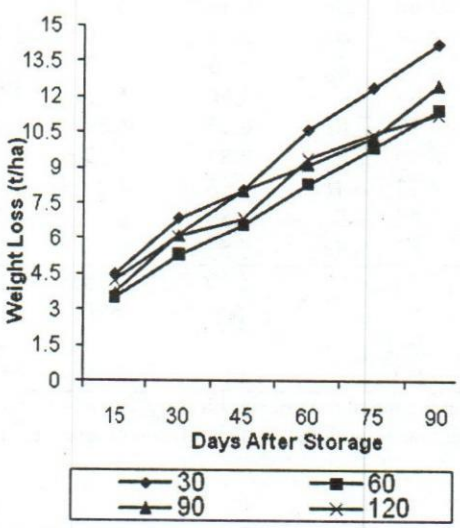

Fig 4. Effect K on weight loss (t/ha) at different

Table 2: Effect of nitrogen and potash on weight loss percentage of potato at 15, 30, 45, 60, 75 and 90 days storage in ambient temperature (28 ± 0.6 °C tem.. & 88-89 % RH) under dark room at Khumaltar, 2010

Treatments	Percent weight loss at different days after storage											
Nitrogen (kg/ha)	15 days	+	30 days		45 days		60 days		75 days		90 days	
50	4.09	*Ab*	6.06		7.76		9.20		10.36		11.61	
100	3.65	*B*	6.02		6.82		9.53		10.82		12.63	
150	3.57	*B*	6.20		7.37		8.93		10.83		12.53	
200	4.62	*A*	6.12		7.80		9.77		10.90		12.58	
F-test	*		NS		NS		NS		NS		NS	
LSD (0.05)	0.795		-		-		-		-		-	
Potash (kg/ha)			+		+		+		+		+	
30	4.48		6.85	*a*	8.05	*a*	10.59	*a*	12.38	*a*	14.22	*A*
60	3.70		6.14	*ab*	8.01	*a*	9.13	*b*	10.26	*b*	12.46	*B*
90	3.50		5.33	*b*	6.57	*b*	8.33	*b*	9.87	*b*	11.44	*B*
120	4.23		6.07	*ab*	6.82	*ab*	9.37	*ab*	10.40	*b*	11.23	*B*
F-test	NS		*		*		***		***		***	
LSD (0.05))	-		1.034		1.315		1.241		1.245		1.466	
Interaction (N_2:K_2O (kg/ha)		+										
50 : 30	3.60	*Bc*	6.67		7.73		9.60		10.80		12.47	
50: 60	3.55	*Bc*	5.11		*7.89*		8.67		*9.78*		11.78	
50: 90	3.87	*Bc*	6.00		6.93		8.93		10.07		11.0	
50: 120	5.33	*Ab*	6.47		7.27		9.60		10.8		11.20	
100: 30	3.67	*Bc*	7.13		8.40		12.20		13.60		15.73	
100: 60	3.60	*Bc*	5.60		6.40		8.27		9.47		11.53	
100: 90	3.73	*Bc*	5.20		5.87		8.13		9.87		11.47	
100: 120	3.60	*Bc*	6.13		6.60		9.53		10.33		11.80	
150 : 30	4.27	*Bc*	5.73		6.40		8.90		11.60		12.93	
150: 60	2.93	*C*	7.33		9.53		10.33		11.53		14.47	
150: 90	2.93	*C*	5.60		6.73		7.73		10.0		11.97	
150: 120	4.13	*Bc*	6.13		6.80		8.73		10.20		10.73	
200: 30	6.40	*A*	7.87		9.67		11.67		13.53		15.73	
200 : 60	4.73	*Abc*	6.53		8.20		9.27		10.27		12.07	
200: 90	3.47	*Bc*	4.53		6.73		8.53		9.53		11.33	
200: 120	3.87	*Bc*	5.53		6.60		9.60		10.27		11.20	
Mean	3.98		6.10		7.36		9.36		10.73		12.34	
F-test	*		NS		NS		NS		NS		NS	
LSD (± 0.05)	1.590		-		-		-		-		-	
CV (%)	24.0		20.4		21.5		15.9		14.0		14.3	

+ Common small letters in a column are not significantly different by DMRT at 0.05 levels.

NS and *,**, *** represent non significant and significant differences at 0.05, 0.01 and <0.001 levels, respectively

Tables 3. Weight loss percentage of potato after 120 days cold store and 15 days recondition in room temperature at Khumaltar, 2010

Factor A. Nitrogen (kg/ha)	Weight loss Percentage	
	120 days cold store	15 days after recondition
50	7.25	10.02
100	7.08	9.63
150	6.60	9.32
200	6.87	9.49
F-test	**NS**	**NS**
LSD (0.05)		
Factor B. Potash (kg/ha)		
30	6.90	9.97
60	6.827	9.35
90	7.24	9.78
120	6.85	9.35
F-test	**NS**	**NS**
LSD (0.05))	-	-
Interaction (N_2:K_2O kg/ha)		
50 : 30	6.83	10.0
50 : 60	7.83	9.77
50 : 90	6.83	9.87
50 :120	7.50	10.43
100: 30	7.17	9.97
100: 60	7.42	10.0
100: 90	7.17	9.40
100:120	6.58	9.13
150: 30	7.33	10.47
150: 60	5.33	8.40
150: 90	7.75	10.17
150:120	6.0	8.23
200: 30	6.25	9.43
200:60	6.69	9.23
200: 90	7.71	9.69
200: 120	*7.33*	9.60
Mean	6.95	9.61
F-test	NS	**NS**
LSD (± 0.05)	-	-
CV (%)	16.8	11.0

Dry Matter Content:

The application of different rates of nitrogen and potassium alone and their combined effect showed the highly significant and significant effect on dry matter percentage of potato after harvesting of crop and before storage. The application of 50 kg N (17.39%) and 100 kg N (16.99%) produced the statistically same results on dry matter percentage. The lowest dry matter, which is not desirable for processing was observed in treatment of 150 kg N (16.58 %) and it was at par with 200 kg N/ha (16.48%). The application of K_2O showed mixed results and did not show any increasing or decreasing trends on dry matter percentage. The storage of potato for 90 days in ambient room temperature (28.1 ± 0.6 °C) had no effect on dry matter percentage among treatments due to the effect of N, K_2O alone and their interaction. However, potato stored in cold store for 120

days and 15 days after recondition showed significant and highly significant effect on DM percentage due to interaction effect of N and K_2O , but not in any sequential order.

The storage of potato in dark room at ambient temperature for 90 days increased the mean dry matter percentage from 0.94 to 1.6 % due to effect of N and 0.82 to 2.15 % due to effect of K_2O) and nearly 1.37% due to their interaction before storage (Table 3) but the increasing percentage of DM in cold storage stored potato is 0.41 and 0.59 % percentage after 120 days cold store and 15 days after recondition, respectively.

Khatri and Shrestha, (1998) reported that, the increase in amount of nitrogen and potassium reduced the dry matter content in Jumla condition. Other authors also reported that K_2O has very important effect on DM content, which is normally inversely proportional to K_2O content of soil (White *et al.*, 1974; Beukena and Van der Zaag, 1979). The finding of this experiment is in agreement with findings of other authors up to 200 kg N and 90 kg K_2O /ha for production of potato.

Reducing Sugars:

The main effect of N showed a highly significantly, significant, highly significant and non significant differences on the reducing sugars content of potato before storage, 90 days after dark storage, 120 days after cold storage and 15 days after reconditioning respectively. The increasing rate of both N decreased the reducing sugars before storage and after 90 days dark storage but it was not in any order in cold stored potatoes. The main effect of K_2O showed non-significant effect on reducing sugars before storage and 90 days after dark storage. Similarly, there was significant effect of K_2O on reducing sugar content of cold stored potato after 120 days and after 15 days after recondition. There was linearly decreasing trend of reducing sugars as increased rate of K_2O up to 90 kg/ha and again increased at 120 kg K_2O/ha.(Table 3).

The interaction effect of N and K_2O showed significant effect on reducing sugars before storage, 120 days after cold storage and 15 days after reconditioned but not significant effect for storage of potato in dark room at ambient temperature. The increasing rate of both fertilizers reduces the reducing sugar in decreasing order before storage but not in any systematic order in cold stored potato.

The reducing sugars (glucose + fructose) content of potato is an important parameter for chips quality. Many authors reported that, the reducing sugar content up to 150 mg/ 100 gram fresh weight is consider good and up to 250 g /100 g fresh weight is consider acceptable for chips making. The decreasing trend of reducing sugars with increasing dose of N and K_2O might be due to the increase in water uptake and turgidity of cells. This finding is not in agreement with the findings of Banu *et al.* (2007) in India but agreement with other authors' findings (Herlihyand, 1969, Sharma and Arora,1988, Chapman *et.al.*, 1992).

Table 4: Dry matter percentage of potato after harvesting, at 90 days storage in dark (28.1 ± 0.6 ° C tem. & 88-89 % RH), at 120 days storage in cold store and after 15 days recondition , during 2010.

Treatment	After harvesting		After 90 days storage in dark	After 120 days cold storage		After 15 days recondition	
Nitrogen (kg/ha)		+					
50	17.39	*a*	18.56	17.2		17.63	
100	16.99	*a*	18.03	17.57		17.68	
150	16.26	*b*	18.06	16.83		17.14	
200	16.48	*b*	17.95	17.04		17.07	
F-test	***		NS	NS		NS	
LSD (0.05)	0.4028		-	-		-	
Potash (kg/ha)		+					
30	17.12	*a*	17.94	16.97		17.38	
60	16.43	*b*	18.58	17.29		17.17	
90	16.58	*b*	17.87	17.05		17.19	
120	17.01	*a*	18.22	17.47		17.78	
F-test	***		NS	NS		NS	
LSD (0.05))	0.4028					-	
Interaction (N_2:K_2O kg/ha)		+			+		+
50 : 30	17.80	*a*	18.35	17.97	*a*	18.80	*A*
50: 60	17.50	*ab*	19.20	17.25	*abc*	17.43	*Bcdef*
50: 90	16.70	*bcde*	17.73	16.42	*c*	16.47	*Ef*
50: 120	17.57	*ab*	18.96	17.38	*abc*	17.81	*Abcd*
100: 30	17.30	*abcd*	18.04	17.01	*abc*	17.67	*Abcde*
100: 60	16.43	*de*	18.41	17.38	*abc*	16.83	*Def*
100: 90	17.37	*abc*	17.97	18.12	*a*	18.30	*Ab*
100: 120	16.87	*bcd*	17.72	17.77	*ab*	17.90	*Abcd*
150 : 30	16.97	*abcd*	17.69	16.75	*bc*	16.80	*Def*
150: 60	15.87	*e*	18.68	17.32	*abc*	17.50	*Bcdef*
150: 90	15.80	*e*	17.91	16.73	*bc*	17.07	*Bcdef*
150: 120	16.47	*cde*	17.97	16.73	*bc*	17.20	*Bcdef*
200: 30	16.40	*de*	17.68	16.14	*c*	16.23	*F*
200 : 60	15.93	*e*	18.02	17.23	*abc*	16.91	*Cdef*
200: 90	16.47	*cde*	17.87	*16.92*	*abc*	16.94	*Cdef*
200: 120	17.13	*abcd*	18.22	18.00	*ab*	18.20	*Abc*
Mean	16.785		18.15	17.195		17.379	
F-test	*		NS	*		***	
LSD (± 0.05)	0.8055		-	1.0832		1.138	
CV (%)	2.9		4.7	3.8		3.9	

Table 5 Reducing sugar content of potato (mg/100 g fre wt.) after harvesting, at 90 days storage in dark (28.1 ± 0.6 °C tem & 88-89 % RH), at 120 days storage in cold store and after 15 days recondition during 2010.

Treatments	Before storage		After 90 days dark storage		After 120 days cold storage		After 15 days recondition	
Nitrogen (kg/ha)		+		+				
50	182.86	*a*	156.8	*a*	202.0	*a*	164.3	
100	169.27	*b*	143.7	*ab*	183.4	*b*	164.1	
150	158.45	*c*	144.1	*ab*	208.4	*a*	170.5	
200	157.68	*c*	136.3	*b*	179.8	*b*	155.6	
F-test	***		*		***		**NS**	
LSD (0.05)	4.258		13.69		14.38		NS	
Potash (kg/ha)								+
30	170.94	*a*	149.1		183.5	*b*	153.8	*b*
60	167.81	*ab*	146.8		199.7	*a*	166.8	*a*
90	165.70	*b*	146.0		190.1	*ab*	164.3	*a*
120	163.80	*b*	139.0		200.3	*a*	169.3	*b*
F-test	*		**NS**		*		*	
LSD (0.05))	4.258		-		14.38		11.12	
Interaction (N x K_2O kg/ha)		+				+		+
50 : 30	197.46	*a*	154.8		184.0	*cd*	141.3	*d*
50: 60	185.14	*b*	162.7		190.0	*cd*	156.7	*cd*
50: 90	173.25	*c*	160.0		193.7	*cd*	172.3	*abc*
50: 120	175.57	*c*	149.8		240.3	*a*	186.7	*a*
100: 30	170.34	*cd*	154.6		183.7	*cd*	167.0	*abcd*
100: 60	166.44	*cde*	140.1		193.7	*cd*	174.7	*abc*
100: 90	169.71	*cd*	147.3		182.3	*cd*	158.7	*cd*
100: 120	170.58	*cd*	132.7		174.0	*d*	156.0	*cd*
150 : 30	159.17	*ef*	149.9		190.7	*cd*	152.7	*cd*
150: 60	163.14	*def*	148.0		225.7	*ab*	175.7	*abc*
150: 90	157.84	*ef*	141.4		207.0	*bcd*	169.0	*abc*
150: 120	153.65	*f*	137.1		210.3	*abc*	184.7	*ab*
200: 30	156.79	*ef*	137.2		175.7	*d*	154.3	*cd*
200 : 60	156.50	*e*	136.3		189.3	*cd*	160.2	*bcd*
200: 90	162.0	*def*	135.5		*177.6*	*cd*	157.1	*cd*
200: 120	155.42	*f*	136.3		176.7	*d*	151.0	*cd*
Mean	167.06		145.2		193.4		164.3	
F-test	**		**NS**		**		***	
LSD (± 0.05)	8.518		-		28.76		22.24	
CV (%)	3.1		27.37		8.9		8.1	

Specific Gravity

It is reported that high specific gravity has positive role on the processing quality of tuber. As a rule, high specific gravity means high dry matter content and high recovery percentage of chips. In this experiment, the main effect of N and K showed a highly significant and significant response to specific gravity of tubers before storage and after 120 days storage in cold house (Table 6). The highest specific gravity (1.067) was recorded with 50 kg N and it was found at par with 100 kg N (1.065), whereas the lowest specific gravity was recorded on 150 and 200 kg N/ha (1.062). However, after 90 days storage there is non significant effect of N on specific gravity. The response of K on specific gravity was found significant up to 90 kg K/ha before

storage and after 120 days cold storage but non significant effect on storage of potato for 90 days in ambient room temperature and 15 days reconditioned of 120 days cold stored potato.

The interaction effect of N and K showed a non significant differences on specific gravity before storage of potato but significant after 90 storage in ambient room temperature (Fig 7). The application of 200 kg N and 30 kg K showed the highest specific gravity (1.0885) and it was found at a par with 100:90 (1.0786) and 100:60 (1.0758) kg N and K/ha respectively.

The interaction effect of N and K showed highly significant effect on specific gravity to dark storage potato for 90 days and after reconditioning of 120 days cold stored potato but did no show any effect on specific gravity before storage and after 120 days cold storage.

Sprouting Percentage:

There was not sprouting of potato up to 45 days stored at ambient room temperature (28.1 ± 0.6 °C tem & 88-89 % RH) under dark condition. At 75 days after storage sprouting was observed in all treatments. The main effect of N showed non significant and highly significant differences on sprouting percentage at 60 days and 75 and 90 days, respectively (Table 7). At 75 days of storage, 100 kg N/ha recorded the maximum sprouting percentage (43 %) and it was observed the minimum in 200 kg N/ha. At 90 days, the minimum sprouting percentage (85.6%) was observed 200 kg N /ha and significantly differed with other treatments. The application of different dose of potash showed a highly significant effect on sprouting at 60 and 75 days and non significant thereafter. The minimum sprouting percentage (8.9 % and 24.9 %) was observed in application of 90 kg K/ha at 60 and 75 days, respectively.

The interaction effect of N and K showed a highly significant effect of sprouting only at 75 days after storage. At 90 days there was no significant combine effect of N and K on sprouting percentage. However, sprouting was found maximum (100%) with the application of 100 kg and 120 kg K /ha (Fig 5).

Sprouting of potato causes relatively the height weight losses. First of all, the sprouting itself is a direct weight of fresh potato and second it losses intensive evaporation of water from the sprout surface, which caused shrunken of tubers and peeling losses while processing. The correlation of sprouting on weight loss percentage was found positive at 60 days (r=0.27), 75 days (r=0.380) and 90 days (r=0.091) of storage potato in dark room.

Table 6: Specific gravity of potato immediately after harvesting and at 90 days storage in ambient temperature (28.1 ± 0.6 °C) under dark at Khumaltar, 2010

Treatment	Immediately after harvesting		After 90 days dark storage		After 120 days cold storage		After 15 days recondition	
Nitrogen (kg/ha)								
50	1.067 *a*	*A*	1.0730		1.0694	*a*	1.0702	
100	1.065 *a*	*A*	1.0731		1.0702	*a*	1.0706	
150	1.062 *b*	*B*	1.0667		1.0668	*a*	1.0695	
200	1.062 *b*	*B*	1.0742		1.0645	*b*	1.0704	
F-test	***		NS		*		NS	
LSD (0.05)	0.00197		-		0.0042		-	
Potash (kg/ha)								
30	1.065	*a*	1.0732		1.0707	*a*	1.0699	
60	1.062	*b*	1.0701		1.0643	*b*	1.0709	
90	1.063	*b*	1.0713		1.0696	*a*	1.0708	
120	1.065	*a*	1.0724		1.0667	*a*	1.0691	
F-test	**		NS		*		NS	
LSD (0.05))	0.00197		-		0.0042		-	
Interaction ($N \times K_2O$ kg/ha)								
50 : 30	1.068		1.0745	*bc*	1.0740		1.0665	*b*
50: 60	1.067		1.0694	*bc*	1.0611		1.0766	*a*
50: 90	1.063		1.0740	*bc*	1.0728		1.0744	*b*
50: 120	1.068		1.0741	*bc*	1.0695		1.0634	*c*
100: 30	1.067		1.0651	*bc*	1.0734		1.0663	*b*
100: 60	1.062		1.0758	*ab*	1.0668		1.0709	*b*
100: 90	1.067		1.0786	*ab*	1.0721		1.0728	*B*
100: 120	1.064		1.0727	*bc*	1.0687		1.0724	*b*
150 : 30	1.065		1.0646	*c*	1.0665		1.0750	*A*
150: 60	1.059		1.0651	*bc*	1.0682		1.0651	*B*
150: 90	1.058		1.0678	*bc*	1.0659		1.0651	*B*
150: 120	1.062		1.0692	*bc*	1.0668		1.0728	*B*
200: 30	1.062		1.0885	*a*	1.0690		1.0720	*B*
200 : 60	1.059		1.0699	*bc*	1.0611		1.0710	*B*
200: 90	1.062		1.0647	*c*	*1.0677*		1.0708	*B*
200: 120	1.066		1.0736	*bc*	1.0600		1.0677	B
Mean	1.0637		1.0717		1.06773		1.0702	
F-test	NS		*		NS		***	
LSD (± 0.05)	0.00394		0.01287		-		0.00727	
	0.2		0.7		0.5		0.4	

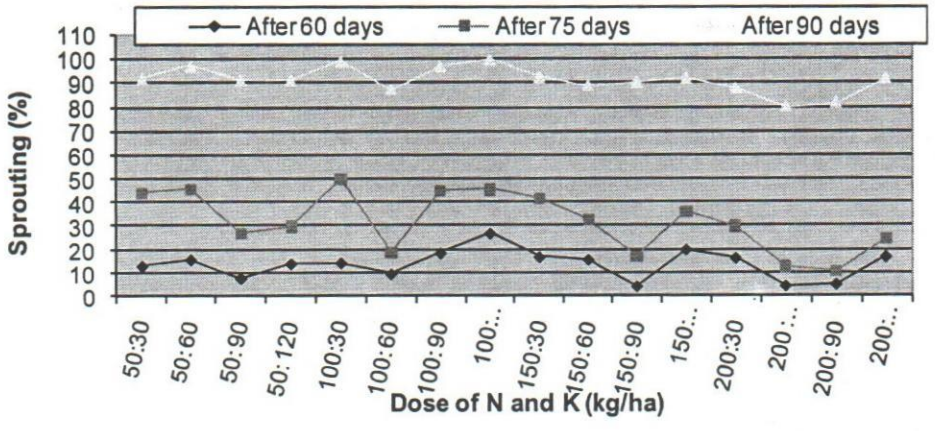

Fig 5 : Combined effect of N and K on sprouting percentage of potato after storage in ambient room temperature at Khumaltar, 2010.

Table 7. Effect of nitrogen and potash on sprouting percentage of potato at 60, 75 and 90 days storage in ambient temperature(28.1 ± 0.6 °C) under dark room at Khumaltar, 2010

Treatment	Sprouting percentage at different days after storage					
Factor A.Nitrogen (kg/ha)	60 days		75 days	+	90 days	+
50	12.7		36.9	b	92.9	*A*
100	17.4		43.0	a	96.0	*A*
150	14.2		31.9	c	91.1	*A*
200	10.7		19.5	d	85.6	*b*
F-test	**NS**		***		***	
LSD (0.05)	-		8.51		5.093	
Factor B. Potash (kg/ha)				+		+
30	15.1	*ab*	41.6	*a*	93.0	*a*
60	11.4	*b*	27.8	*b*	88.6	*b*
90	8.9	*b*	24.9	*b*	90.2	*ab*
120	19.6	*a*	37.1	*a*	93.9	*a*
F-test	*		***		**NS**	
LSD (0.05)	6.99		8.51		7.84	
Interaction (N x K) (kg/ha)				+		
50 : 30	13.1		44.4	*b*	91.8	
50 : 60	15.9		46.3	*b*	97.3	
50 : 90	7.70		27.1	*cde*	91.2	
50 : 120	14.1		29.9	*cd*	91.3	
100 : 30	14.3		50.1	*b*	99.2	
100 : 60	9.5		19.1	*efg*	87.5	
100 : 90	18.6		45.1	*b*	97.2	
100 : 120	27.2		45.7	*a*	100.0	
150 : 30	16.9		42.0	*b*	92.7	
150 : 60	15.8		32.9	*c*	89.1	
150 : 90	4.1		16.9	*fg*	90.5	
150 : 120	20.1		36.0	*cd*	92.1	
200 : 30	16.4		29.9	*cd*	88.1	
200 : 60	4.3		12.7	*g*	80.3	
200 : 90	5.0		10.7	*g*	82.0	
200 : 120	17.0		24.6	*def*	92.1	
Mean	13.8		32.8		91.4	
F-Test	**NS**		***		**NS**	
LSD (0.05)	-		17.02		-	
CV (%)	61.1		31.2		6.7	

CONCLUSIONS AND RECOMMENDATION

The effect of nitrogen and potassium have found positive role for production of processing grade tuber production and total yield of potato. The interaction effect of N and K was found significant on dry matter percentage, reducing sugar but showed non significant effect on weight loss percentage at 90 days storage in ambient room temperature. The weight loss percentage ranges from 10.73 to15.73 % at 90 days stored at ambient room temperature . The dry matter content increased from 16.785 to 18.15 %, reducing sugars decreased from 167.06 to 145.2 mg/100 fresh weight and specific gravity increased from 1.0637 to 1.0717 after 90 days storage. Based on the results and discussion following recommendation are made

- Application of 150 kg nitrogen and 60 kg potassium along with 100 kg phosphorus and 20 t FYM /ha is recommended for production of processing grade tubers and higher yield of potato in Khumaltar and similar soil and environment condition.
- Potato can be safely stored in ambient room temperature (28 ± 0.6 ° C temperature and 88-89 % R.H) under dark with minimum storage losses (15 %) up to 90 days. These potatoes were found suitable for processing due to increase in dry matter, specific gravity and decrease the amount of reducing sugars.

- There was 7% weight loss of cold potato stored potato for 120 days and it was increased up to 9.63 % after 15 days reconditioning in ordinary condition.
- The increase in the reducing sugar of cold storage potato var. Kufri Jyoti is found with in a limit required for processing potato in chips. This could be due to irregular electricity supply and blocking for formation of invertase enzymes .
- For the confirmation of results further one to two year experiment is needed.

REFERENCES

Adhikari, R.C., Rai, G. P. and Ghimire, J. 2009. Food Security: Contribution and vision for sustainable potato production in Nepal. Abstract of paper presented in third SAS-N Convention held in Khumaltar from 27-29 August 2008. Organized by Society of Agricultural Scientists. Nepal (SAS-N). 4-5.

Chapman, K.S.R., L.A. Sparrow, P.R. Hardman, D.N. Wright and J.R.A. Thorp.1992. Potassium nutrition of Kennebec and Russet Burbank potatoes in Tasmania: Effect of soil and fertilizer potassium on yield, petiole and tuber potassium concentration , and tuber quality. Aust J Expt Agric 32:521-527.

Gautam, D.M and Bhattarai, D.R. (2006). Storage of fruits and vegetables. Postharvest Horticulture. Published by Pabitra and Shanta. 87p.

Herlihy, M. and P.J. Carroll .1969. Effect of N,P, and K and their interactions on yield, tuber blight and quality of potatoes . J Sci Fd Agric 20:513-517.

Iritani, W.M. and L. Weller. 1978 . Influence of low fertility and vine killing on sugsr development in apical and stem portions of Russet Burbank potatoes. Am Potao J 55: 239-246.

Karki, T. B. 2002. Post harvest technology in Nepal. Proceedings of SAARC workshop on post-harvest technology, September 24 – 25, Kathmandu, Nepal. 53-856.

Khairgoli. L.P.1977. Report of manure and fertilizer trails, seed potato workshop held on May 25-27,1997 jointly conducted by National Potato Development Program Khumaltar and International Potato Center, Nepal country program. 5-21.

Khatri B.B., S.L. Shrestha, D.N. Ojha and G.P. Rai (1999). Field Book for Potato germplasms Evaluation. Potato Research Program. Nepal Agricultural Research Council, Khumaltar, Nepal. pp 1-16.

Khatri B.B.and S.L. Shrestha. 1998. Organic and inorganic fertilizer research on potato in Nepal: A review. Nepalese Horticulture 2 (1): 60-69.

Marschner, H. 1995. Mineral Nutrition of Higher Plants. 2 nd Ed. Academic Press, London Bergmann, W. 1992. Nutritional Disorders of Plants. Gustav Fischer Verlag, New York.

Perrenoud, S. 1993. Fertilizing for High Yield Potato. IPI Bulletin 8. 2 nd Edition. International Potash Institute, Basel, Switzerland.

Prasad, S., B. Mishra, V. Gupta and K.K.Rai .1989. Extent of losses due to post harvest fungal diseases of potato. Journal of Research, Birsa Agriculture University, 1:2 ,173-174.

Satter, M.A., S. Sheel , and M .H Kabir. 2002. Status of post-harvest technology of food crops in Bangladesh. Proceedings of SARC workshop on post-harvest technology, Sep.24-25, Kathmandu, Nepal. 15-43

Schippers , P.A.1976. The influence of rates of nitrogen and potassium application on the yield and specific gravity of four potato varieties. Eur potato J 11: 23-33

Sharma U.G. and B.R. Arora.1988. Effect of applied nutrients on the starch, proteins and sugars in potatoes. Food chem 30:313-317

Sharma, U.C. and B.R. Arora. 180988. Effect of applied nutrients on the starch, proteins and sugar in potatoes. Food Chem 30: 313-317

Singh, J.P. and S.P. Trehan. 1998. Balanced fertilization to increase the yield of potato. In: Proceedings of the IPI-PRII-PAU Workshop on: Balanced Fertilization in Punjab Agriculture, held at Punjab Agricultural University, Ludhiana, India, 15-16 December 1997. pp. 129-139.