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Effect of nitrogen and potassium levels on processing potato

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Abstract
The field experiment was conducted during *rabi* season of the year 2012-13 at Potato Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa with nine treatment combinations consisting of three levels of nitrogen viz., 225 kg N/ha, 275 kg N/ha and 325 kg N/ha and three levels of potassium viz., 225 kg K_2O/ha, 275 kg K_2O/ha and 325 kg K_2O/ha tested under factorial randomized block design with four replications. The yield of "A" and "B" grade tubers was increased upto 275 kg N/ha. nitrogen levels brought significant variation in chips colour index and content of reducing sugar. In case of Potassium, Potassium levels 325 kg K_2O/ha and 275 kg K_2O/ha behaved equally and produced significantly higher weight of 'A' and 'B' grade tuber with minimum weight of 'C' grade tubers. Maximum reducing sugar content and chips color index score were observed with the application of 325 kg K_2O/ha however increase was upto 275 kg K_2O/ha. Thus, for getting higher production of processing grade tuber yield and net realization, potato cv., Kufri Chipsona-3 should be fertilized with 275 kg N/ha and 275 kg K_2O/ha.

Keywords: potato, processing, nitrogen, potassium, tuber yield, chips colour

Introduction
Increasing trends in potato production cannot be sustained without diversification in its utilization. Potato processing industry therefore has to be essential to sustain present growth rate. Potato grown in cooler North-Western plains have lower dry matter and high reducing sugar reflecting products, hence unfit for processing. In Gujarat warm dry and mild night temperature during the crop season favours for production of high dry matter and accumulation of low sugars. Therefore, the region is ideal for potato processing. This could help in reduction of market glut at peak season of harvest. Thus, commercialization of agriculture and stress on value addition through processing, have led to evaluate the newly released processing varieties for their chips quality and yield under Gujarat condition.
Hence a study was undertaken to standardize the nitrogen and potassium requirements of chipping cv Kufri Chipsona – 3 of potato for getting higher processing grade tubers yield and quality.

Materials and Methods
The field experiment was conducted during *rabi* season of the year 2012-13 at Potato Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa (24º 12' North latitude and 72º 12' East longitude with an elevation of 136.4 meters above the mean sea level). Nine treatment combinations consisting of three levels of nitrogen viz., N_1: 225 kg N/ha, N_2: 275 kg N/ha and N_3: 325 kg N/ha and three levels of potassium viz., K_1: 225 kg K_2O/ha, K_2: 275 kg K_2O/ha and K_3: 325 kg K_2O/ha were tested under factorial randomized block design with four replications. The soils of the experimental field was loamy sand in texture having good drainage, low in available nitrogen (192.0 kg/ha), medium in available phosphorus (26.7 kg/ha) and high in potash (346.0 kg/ha). The experimental crop cv Kufri Chipsona-3 was planted on 29th November. Potato tubers of variety Kufri Chipsona-3 were cut in pieces, keeping two to three eye bud with approximately 25 to 40 g weight and planted at the spacing of 50 X 20 cm spacing. Half dose of N and full dose K (As per treatments) along with full recommended dose of phosphorus (140 kgP_2O_5/ha) were placed in bends below the seed pieces at the time of planting and remaining half dose of N was applied at earthing up 30 days after planting (DAP). Total eleven irrigations (approximately 50 mm each) were given to the experimental plot. The irrigations were discontinued one week before haulm killing.

The dehaulming was done mechanically at full maturity and harvesting was done two weeks later. Tubers were graded in to three categories viz., 'A' grade (Large size, > 60 g), 'B' grade (Medium size, 20-60 g) and 'C' grade (Small size, <20 g). For determining chip colour ten tubers from each plot were washed, hand peeled and cut into 1.75 mm thick slices. Slices were washed in normal water to remove surface starch and then the slices were dried on paper towels. The dried slices were fried in edible oil at 180°C in a deep fat fryer (Moulinex make) till the bubbling stopped. The fried chips were drained to remove excess oil and then graded from 1 to 10 (1 being lightest and 10 the darkest, the chip colour grad up to 3 is considered acceptable) under the fluorescent tube light using chip colour cards (Ezekiel *et al.*, 2003) [2]. The specific gravity of potato was calculated as:

$$\text{Specific gravity of potato (g/cc)} = \frac{\text{Specific gravity of water} \times 5000}{5000 - \text{WIW}}$$

Five tubers from each plot were chopped and mixed and prepared composite mixed samples and it put into the boiling isopropyl alcohol (80 per cent v/v) in a flat bottomed flask. The samples were than boiled at 70^0 C for two minutes for fixing. The fixed samples were put to refluxion at 70^0 C twice, and filtrate through Watman No. 1 filter paper. The filtrate was evaporated at 70^0 C to concentrate to 10 ml. The concentrated extract was diluted to 100 ml with double distilled water to make the final extract. The extract was used to determine the reducing sugar content by Nelson's method (1944) [7].

Results and Discussion

Effect of Nitrogen levels on yield of potato

Weight of tubers grade *viz.*, A, B and C were influenced significantly due to different nitrogen levels (Table 1). Both the higher levels of nitrogen N_2 (275 kg N/ha) and N_3 (325 kg N/ha) performed equally and significantly the lowest value for 'A' and 'B' grade tuber yield were observed with N_1 whereas, the lowest values of 'C' grade tuber yield were beared by N_3 (325 kg N/ha) (Table 1).This indicate that curtailing of dose of up to 25 per cent optimized the nitrogen requirement to produced quality potato. This might be due to better assimilation of carbohydrate to the tubers, which ultimately helped in the enlargement of the tuber size and weight of tuber as reported by Malik *et al.*,(2002) [6].

Nitrogen application of N_2 (275 kg N/ha) and N_3 (325 kg N/ha) realized spectacular improvement in total tubers yield of potato and increased total tubers yield to the tune of 12.99 and 13.02 per cent over N_1 (225 kg N/ha) (Table 1). Higher rate of nitrogen application provides better growth, development and translocation of photosynthesis from source to sink (tuber), which resulted in to higher yield of large size tubers, concluded by Patel and Patel (2001) [9]. These finding corroborate the reports of Singh *et al.* (2002) [6] and Vijaya Lakshmi, *et al.* (2011) [11].

Effect of Nitrogen levels on quality of potato

Nitrogen application did not show positive response on specific gravity of potato (Table 2). However, higher levels of nitrogen realized spectacular improvement in reducing sugar content (4.10). Maximum content of reducing sugar was noted with N_3 (325 kg N/ha), which accounted 19.34 and 6.41 per cent higher reducing sugar content than N_2 (275 kg N/ha) and N_1 (225 kg N/ha), respectively. The score of chips colour index increased significantly as the rate of application of nitrogen increase up to N_2 (275 kg N/ha. Nitrogen N_3 (325 kg N/ha) had higher value of chips colour index, which means more darkness in chips, whereas level N_1 (225 kg N/ha) had lower colour index. This finding is well supported by Swiniarski and Ladenberger (1970).

Effect of nitrogen on economies

Data presented in Table 1 revealed that treatment N_2 (275 kg N/ha) recorded maximum net realization of `289036 /ha with the BCR 5.18 followed by treatment $N_3$ (325 kg N/ha) which recorded net realization of ` 288481 /ha and BCR 5.14. The lowest net realization ` 248471 /ha was recorded under treatment N_1 (225 kg N/ha) with BCR 4.63.

Effect of Potassium levels on yield of potato

Conspicuous difference in weight of different grades of tuber were observed due to potassium application (Table 1). Potassium levels K_3 (325 kg K_2O/ha) and K_2 (275 kg K_2O/ha) performed equally good and produced significantly higher weight of 'A' and 'B' grade tubers with minimum weight of 'C' grade tubers. The lowest value for 'A' and 'B' grade tuber yield were observed with K_1 (225 kg K_2O/ha) whereas, for 'C' grade tuber yield the lowest values were beared by K_3 (325 kg K_2O/ha). Potassium application @ 275 kg K_2O/ha recorded highest net realization of ` 279593 /ha. These finding corroborate the reports of Parveen Kumar *et al.*, (2004). Potassium promote large size tubers by increasing water accumulation in tubers (Vijya Lakshmi *et al.*, (2011) [11].

Table 1: Grade wise and total tuber yield (q/ha) of potato as influenced by nitrogen and potassium fertilization

Treatments	Tuber yield (q/ha)				Gross Realization (`/ha)	Cost of Cultivation (`/ha)	Net Realization (`/ha)	BCR
	A grade	B grade	C grade	Total				
Nitrogen (Kg/ha)								
N_1: 225	124.06	115.30	59.74	301.85	316945	68474	248471	4.63
N_2: 275	142.14	145.38	50.74	341.09	358147	69111	289036	5.18
N_3: 325	143.29	148.61	46.48	341.17	358229	69748	288481	5.14
S. Em. ±	3.95	3.70	1.64	7.65				
C.D.(P=0.05)	11.53	10.80	4.78	22.32				
Potassium(Kg/ha)								
K_1: 225	126.21	126.63	54.95	310.46	325979	72216	253763	4.51
K_2: 275	140.63	139.02	53.90	336.45	353577	73684	279593	4.79
K_3: 325	142.65	143.63	48.11	337.20	354065	75152	278913	4.71
S. Em. ±	3.95	3.70	1.64	7.65				
C.D.(P=0.05)	11.53	10.80	4.78	22.32				
Interaction								
N×K	NS	NS	NS	NS				
C.V. %	10.03	9.39	10.84	8.08				

Effect of potassium levels on quality of potato

Among the potassium levels, K_3 (325 kg K_2O/ha) and K_2 (275 kg K_2O/ha) did not differ from each other, and produced 8.61 and 8.37 per cent higher total tubers yield over K_1 (225 kg K_2O/ha) respectively(Table 2). Higher rate of potassium provides better yield attributes and translocation of photosynthesis from source to sink (tuber) which resulted in to higher yield of large size tubers. These finding corroborate the reports of Khandakhar *et al*. (2004) [4]. From the data (Table 2), it appeared that reducing sugar content was linearly increased with increase in potassium level. Potassium level K_3 (325 kg K_2O/ha) and K_2 (275 kg K_2O/ha) had produced tuber having 13.80 and 11.20 per cent higher reducing sugar content than that of produced by K_1 (225 kg K_2O/ha), respectively. These finding corroborate the reports of Ackarya and Mondal (2007) [1]. Potassium levels brought significant difference in chips colour index (Table 2). The maximum and minimum score values of chips colour index were noted with K_3 (325 kg K_2O/ha) and K_1 (225 kg K_2O/ha), respectively. Potassium levels K_3 and K_2 did not differ each other and were significantly higher than K_1. These finding are well supported by Khan *et al*., (2012) [5].

Table 2: Quality of potato as influenced by nitrogen and potassium fertilization

Treatments	Chips Colour index	Specific gravity (gm/cc)	Reducing sugar mg/100 gm fresh wt.
Nitrogen (Kg/ha)			
N_1: 225	1.42	1.059	55.48
N_2: 275	1.56	1.051	62.22
N_3: 325	1.68	1.058	66.21
S. Em. ±	0.04	0.031	1.99
C.D.(P=0.05)	0.13	NS	5.81
Potassium(Kg/ha)			
K_1: 225	1.44	1.059	56.59
K_2: 275	1.59	1.045	62.93
K_3: 325	1.63	1.064	64.40
S. Em. ±	0.04	0.031	1.99
C.D.(P=0.05)	0.13	NS	5.81
Interaction			
N×K	Sig	NS	NS
C.V. %	9.64	10.27	11.24

Interaction effect of nitrogen and potassium

Interaction between nitrogen and potassium levels (N×K) was found to be significant in respect of chips colour index of potato (Table 3). Chips colour index score increased with increase in N levels with correspondence increase in K_2O level. Treatment combination N_3K_3 (325 kg N/ha with 325 kg K_2O/ha) recorded significantly the highest value of chips colour index (1.88) followed by treatment N_2K_2 (1.72). These results are in accordance with those reported by Ishwori *et al*. (2011) [3].

Table 3: Interaction effect of nitrogen and potassium on chips colour index potato

Nitrogen (Kg N/ha)	Potassium (Kg K_2O/ha)		
	K_1:225	K_2: 275	K_3: 325
N_1: 225	1.38	1.38	1.51
N_2: 275	1.45	1.72	1.50
N_3: 325	1.49	1.67	1.88
S. Em. ±	0.08		
C.D.(P=0.05)	0.20		
C.V %	9.64		

Effect of potassium on economics

The data also indicated that application of different levels of potassium increased the net realization. The treatment K_2 (275 kg/ha) recorded maximum net realization of ` 279593/ha with the BCR 4.79 followed by treatment $K_3$ (325 kg/ha) which recorded net realization of ` 278913 /ha and BCR 4.71. The lowest net realization was recorded under treatment N_1 (225 kg/ha) ` 253763/ha with BCR 4.51.

Conclusion

Based on the results from one year experimentation it is concluded that to get higher production of processing grade tuber yield with maximum chips color index and reducing sugar content as well as net realization, potato cv., Kufri Chipsona-3 should be fertilized with 275 kg N/ha and 275 kg K_2O/ha.

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