

Original Research Article

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Effect of Boron and Sulphur Application on Postharvest Quality after Storage and Reconditioning of Potato (*Solanum tuberosum* L.)

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ABSTRACT

Keywords

Potato, Boron, Sulphur, Postharvest, Storage, Reconditioning.

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Present study was carried out at Horticulture Research Farm and Postharvest Laboratory of Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India. Potato crop was grown 2 years i.e. 2015-16 and 2016-17 in the field. Experiment consisted of control, recommended dose of fertilizer (RDF: 150,80,120 kg/ha), RDF + 1 kg B, RDF + 2 kg B, RDF + 3 kg B, RDF + 30 kg S, RDF + 40 kg S, RDF + 1 kg B + 30 kg S, RDF + 2 kg B + 30 kg S, RDF + 3 kg B + 30 kg S, RDF + 1 kg B + 40 kg S, RDF + 2 kg B + 40 kg S, RDF + 3 kg B + 40 kg S treatments in a Randomized Block Design and replicated thrice. Significant effect of application of boron and sulphur during growing of crop was observed after storage and reconditioning of potato. The treatment RDF + 2 kg B + 40 kg S showed maximum starch content, specific gravity and total soluble solids after storage and reconditioning. This treatment also exhibited maximum dry matter content after storage and minimum number of sprouted tubers after reconditioning which was significant with application of RDF + 3 kg B + 30 kg S.

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important Solanaceous tuber crop and grown in more than 125 countries. Potato is consumed almost daily by more than a billion people and used as vegetable, stock feed and in industries for manufacturing starch, alcoholic beverages and other processed products (Lutaladio *et al.*, 1995). Its cultivation is mounting strongly in the developing countries accounted for about 31.66%, where the ease of potato cultivation and nutritive content has made it a valuable food security and cash crop for millions of farmers (Anonymous, 2014). Potato tuber contains about 80% water and rest is dry matter.

Starch is the major component of the dry matter portion accounting for about 70% of the total solids (Dutt, 2008). It contains starch (13-16%), protein (2%), total sugars (0-2%), fibre (0.6%), lipids (0.1%), vitamin C (31 mg/100 g fresh weight) and ash (1-1.5%) as reported by Shekhawat in 2001.

Pre-harvest nutrient application affects plant biochemistry and physiology and therefore product quality and storability (Dris *et al.*, 2003). Micro and macro nutrient are known to enhance the quality of the vegetable produce both pre and postharvest in a positive manner (Weston and Barth, 1997). The cultivated

soils of Varanasi region having emerging deficiency of secondary and micronutrient due to the use of high analysis NPK fertilizers and limited manuring (Singh *et al.*, 2015). Therefore, balanced supply of essential nutrients is necessary for maintaining fertility of soil which helps in better growth, yield and extending postharvest quality of tubers. Boron, an essential micronutrient, present in cellular form in the cell wall (Blevin and Lukaszewski, 1998), plays an important role in maintaining the structural integrity of plant membrane (Pilbeam and Kirkby, 1983) and enhances absorption of calcium ion by improving uptake of it which results in reduce levels of common scab and other tuber diseases (Karlsson and Palta, 2006). Sulphur improves tuber quality through increased content of protein, starch, carotene, vitamin C and gives resistance against *Streptomyces scabies* and *Rhizoctonia solani* (Mishra and Srivastava, 2004; Klikocka *et al.*, 2005; Kumar *et al.*, 2007; Klikocka 2009a; Klikocka 2009b). Apart from the application of nutrients, storage (<5°C) and reconditioning (15-20°C) is essential for maintaining the level of sugar accumulated in tubers. High level of sugar in potato tubers after cold storage necessitates reconditioning to interconvert sugars into starch and to respire off residual sugars.

Keeping the above content in view, the present study aims to find out the effect of boron and sulphur application in the crop of potato cv. Kufri Lalima on the postharvest quality of tubers after storage and reconditioning.

Materials and Methods

Present investigation entitled “Effect of boron and sulphur application on postharvest quality after storage and reconditioning of potato” was carried out at Horticulture Research Farm, Department of Horticulture, Institute of

Agricultural Sciences, Banaras Hindu University, Varansi (Uttar Pradesh). Postharvest studies were carried out after storage and reconditioning of tubers in the Postharvest Laboratory of the Department of Horticulture. The district Varanasi is situated 25° 10'North latitude, 83° 03'East longitudes and at an altitude of 123.23 m above the mean sea level. Uniform sized, disease free tubers of cv. Kufri Lalima having white flesh and deep eyes were taken as planting material in both the years of experiment. Tubers were planted on 20th October of 2015 during 1st year and harvested on 20thFebruary of 2016. 2nd year planting was done on 20th October of 2016 and harvested on 20th February of 2017. Planting was done with a spacing of 20 cm × 60 cm in a plot of 3 m × 1.2 m size. Thirteen treatments i.e. control, recommended dose of fertilizer (RDF:150,80,120 kg/ha), RDF + 1 kg B, RDF + 2 kg B, RDF + 3 kg B, RDF + 30 kg S, RDF + 40 kg S, RDF + 1 kg B + 30 kg S, RFD + 2 kg B + 30 kg S, RDF + 3 kg B + 30 kg S, RDF + 1 kg B + 40 kg S, RDF + 2 kg B + 40 kg S, RDF + 3 kg B + 40 kg S were taken. Experiment was laid out in a Randomized Block Design and replicated thrice. Nitrogen, phosphorus and potassium were given in the form of urea, single super phosphate and muriate of potash, respectively. Full dose of phosphorus, potassium, boron, sulphur and half dose of nitrogen were applied as basal dose at the time of planting and the rest of nitrogen was applied after 40 days of planting at the time of earthing up. Agronomic practices including regular weeding, earthing up, irrigation and pest control were practiced as and when needed. Fully matured tubers were harvested for further postharvest studies. After harvesting the tubers were cleaned and placed in the cold storage for three months. Reconditioning of tubers was done after storage in the Postharvest Laboratory of the Department of Horticulture for 10 days. Various physio-chemical and quality parameters of tubers i.e.

dry matter, starch, T.S.S., specific gravity, number and weight of diseased and sprouted tubers, weight loss were observed after storage and reconditioning of tubers.

Results and Discussion

Response of boron, sulphur and their combination significantly affect the weight loss after storage and reconditioning, number and weight of diseased after reconditioning but a non-significant difference was found in the number and weight of diseased tubers after storage due to the effect of boron, sulphur and their combination during both the years of experiment (Table 1). A minimum weight loss (1.43%, 5.07% and 3.45%) was recorded with treatment RDF + 2 kg B during both years of storage and first year of reconditioning of tubers. During second year RDF + 3 kg B + 30 kg S (7.50%) was found to loss minimum weight after reconditioning which was statistically at par with RDF + 2 kg B. No diseased tubers were observed during storage condition and a non-significant effect of number and weight of diseased tubers was found among all the treatments due to the effect of boron, sulphur and their combination during first and second year of storage. After reconditioning an increased trend in number and weight of diseased tubers was noticed among all the treatments. Minimum number of diseased tubers (1.00%) was found with treatment RDF, RDF + 3 kg B and RDF + 1 kg B + 40 kg S which was significant with RDF + 2 kg B, RDF + 30 kg S, RDF + 40 kg S, control, RDF + 1 kg B + 30 kg S, RDF + 3 kg B + 30 kg S and RDF + 2 kg B + 40 kg S and during first year of study. Whereas, during second year of reconditioning, RDF + 40 kg S produced minimum number of diseased tubers (1.00%) which was statistically at par with treatment control, RDF + 3 kg B + 30 kg S and RDF + 3 kg B + 40 kg S. The minimum weight (1.00%) of diseased tuber was observed in treatment RDF, RDF + 3 kg B and RDF + 1 kg B + 40

S during first year whereas during second year of reconditioning, minimum weight of diseased tubers (1.00%) were recorded under RDF + 40 kg S which was significant with all the treatments. Loss in weight after digging of potato tubers influenced by various factors i.e. storage temperature, relative humidity of storage area, condition of tubers, stage of harvesting but if all these parameters are taken constant then only nutritive constitution of them is the only affecting factor (Byju *et al.*, 2007). The reason behind weight loss may be due to the application of optimum dose of sulphur and boron maintains cell turgidity which results in minimum loss of water and solutes. It is also might be due to under the adequate state of plant sulphur nutrition, is an increase in their resistance and tolerance to abiotic and biotic stresses during storage (Haneklaus *et al.*, 2000). These findings are supported by Sharma *et al.*, (2011) and Pandey *et al.*, (2015) in potato. Minimum number of diseased tubers was found might be due to increase in abiotic stress results in the tolerance ability and adequate nutrition in plant (Haneklaus *et al.*, 2000).

All the treatments were failed to exert any any conspicuous effect on number and weight of sprouted tubers during first year of storage and reconditioning, whereas it was significant during second year (Table 2). Minimum number and weight of sprouted tubers (0.00%) was recorded in all treatments which was significant with treatment RDF + 2 kg B during second year of storage. During second year of reconditioning, minimum number of sprouted tubers (1.00%) was found in treatment RDF + 1 kg B, RDF + 3 kg B, RDF + 1 kg B + 30 kg S, RDF + 2 kg B + 40 kg S and minimum weight (1.00%) of sprouted tubers was observed in treatment RDF + 1 kg B, RDF + 40 kg S, RDF + 3 kg B, RDF + 1 kg B + 30 kg S and RDF + 2 kg B + 40 kg S which was statistically at par with RDF, RDF + 2 kg B, RDF + 30 kg S, RDF + 3 kg B + 30 kg S and RDF + 1 kg B + 40 kg S.

Table.1 Effect of boron and sulphur on weight loss, no. of diseased tubers and weight of diseased tubers in potato after storage and reconditioning

Treatments	Loss of weight (%)				No. of diseased tubers (%)				Weight of diseased tubers (%)			
	Storage		Reconditioning		Storage		Reconditioning		Storage		Reconditioning	
	I year	II year	I year	II year	I year	II year	I year	II year	I year	II year	I year	II year
Control	2.53	6.26	4.81	8.88	0.00 (1.00)	0.00 (1.00)	1.45	1.89	0.00 (1.00)	0.00 (1.00)	2.26	1.84
RDF (NPK 150:80:120 kg/ha)	2.61	5.80	4.76	7.90	0.00 (1.00)	0.00 (1.00)	1.00	3.29	0.00(1.00)	0.00 (1.00)	1.00	3.49
RDF + 1 kg B	2.45	5.61	4.76	8.36	0.00 (1.00)	0.00 (1.00)	1.42	2.40	0.00 (1.00)	0.00 (1.00)	1.53	2.86
RDF + 2 kg B	1.43	5.07	3.45	7.70	0.00 (1.00)	0.00 (1.00)	1.82	2.54	0.00 (1.00)	0.00 (1.00)	1.96	2.31
RDF + 3 kg B	2.37	6.61	4.34	9.56	0.00 (1.00)	0.00 (1.00)	1.00	2.90	0.00 (1.00)	0.00 (1.00)	1.00	2.87
RDF + 30 kg S	3.00	5.39	5.24	7.76	0.00 (1.00)	0.00 (1.00)	2.45	3.34	0.00 (1.00)	0.00 (1.00)	2.73	3.63
RDF + 40 kg S	2.12	7.74	4.23	9.59	0.00 (1.00)	0.00 (1.00)	2.01	1.00	0.00 (1.00)	0.00 (1.00)	2.49	1.00
RDF + 1 kg B + 30 kg S	2.29	6.60	4.82	9.13	0.00 (1.00)	0.00 (1.00)	1.48	2.47	0.00 (1.00)	0.00 (1.00)	1.57	2.66
RDF + 2 kg B + 30 kg S	1.79	5.57	3.73	7.96	0.00 (1.00)	0.00 (1.00)	1.50	2.79	0.00 (1.00)	0.00 (1.00)	1.42	2.11
RDF + 3 kg B + 30 kg S	2.54	5.23	4.76	7.50	0.00 (1.00)	0.00 (1.00)	1.56	1.72	0.00 (1.00)	0.00 (1.00)	1.36	2.44
RDF + 1 kg B + 40 kg S	2.70	6.19	4.75	8.64	0.00 (1.00)	0.00 (1.00)	1.00	3.28	0.00 (1.00)	0.00 (1.00)	1.00	3.19
RDF + 2 kg B + 40 kg S	2.79	5.46	4.97	7.89	0.00 (1.00)	0.00 (1.00)	2.37	3.04	0.00 (1.00)	0.00 (1.00)	2.45	1.95
RDF + 3 kg B + 40 kg S	2.81	5.25	5.07	7.78	0.00 (1.00)	0.00 (1.00)	1.46	2.06	0.00 (1.00)	0.00 (1.00)	1.60	1.85
C.D. at 5%	1.36	1.48	1.62	1.83	NS	NS	0.49	1.24	NS	NS	1.08	0.14

Table.2 Effect of boron and sulphur on no. of sprouted tubers, weight of sprouted tubers and dry matter in potato after storage and reconditioning

Treatments	No. of sprouted tubers (%)				Weight of sprouted tubers (%)						Dry matter (%)	
	Storage		Reconditioning		Storage		Reconditioning		Storage		Reconditioning	
	I year	II year	I year	II year	I year	II year	I year	II year	I year	II year	I year	II year
Control	0.00 (1.00)	0.00	0.00	1.00	0.00 (1.00)	0.00	1.00	1.00	19.83	22.10	18.21	20.34
RDF (NPK 150:80:120 kg/ha)	0.00 (1.00)	0.00	0.00	1.77	0.00 (1.00)	0.00	1.00	2.04	16.68	21.54	16.66	21.05
RDF + 1 kg B	0.00 (1.00)	0.00	0.00	1.00	0.00 (1.00)	0.00	1.00	1.00	18.80	22.36	16.42	19.47
RDF + 2 kg B	0.00 (1.00)	2.57	0.00	2.92	0.00 (1.00)	2.30	1.00	3.46	18.52	23.01	17.90	21.16
RDF + 3 kg B	0.00(1.00)	0.00	2.78	1.00	0.00 (1.00)	0.00	2.03	1.00	16.59	25.68	16.42	22.38
RDF + 30 kg S	0.00 (1.00)	0.00	0.00	1.97	0.00 (1.00)	0.00	1.00	2.09	18.04	23.21	18.35	20.94
RDF + 40 kg S	0.00(1.00)	0.00	0.00	2.21	0.00 (1.00)	0.00	1.00	1.00	15.29	20.49	16.10	21.27
RDF + 1 kg B + 30 kg S	0.00 (1.00)	0.00	0.00	1.00	0.00 (1.00)	0.00	1.00	1.00	21.13	24.08	17.43	22.20
RDF + 2 kg B + 30 kg S	0.00 (1.00)	0.00	3.33	3.01	0.00 (1.00)	0.00	2.30	10.34	17.48	22.87	16.92	20.62
RDF + 3 kg B + 30 kg S	0.00 (1.00)	0.00	0.00	3.72	0.00 (1.00)	0.00	1.00	3.82	14.88	20.17	16.17	21.24
RDF + 1 kg B + 40 kg S	0.00 (1.00)	0.00	0.00	3.88	0.00 (1.00)	0.00	1.00	3.90	16.26	21.65	17.42	19.89
RDF + 2 kg B + 40 kg S	0.00 (1.00)	0.00	3.70	1.00	0.00 (1.00)	0.00	2.23	1.00	17.82	23.28	20.62	22.90
RDF + 3 kg B + 40 kg S	0.00 (1.00)	0.00	0.00	3.98	0.00 (1.00)	0.00	0.00	18.27	19.55	18.32	18.66	21.24
C.D. at 5%	NS	2.57	NS	1.56	NS	2.30	NS	3.86	2.61	2.81	1.96	2.56

Table.3 Effect of boron and sulphur on starch, specific gravity and TSS in potato after storage and reconditioning

Treatments	Starch (%)				Specific gravity (%)				T.S.S. (%)			
	Storage		Reconditionin g		Storage		Reconditionin g		Storage		Reconditionin g	
	I year	II year	I year	II year	I year	II year	I year	II year	I year	II year	I year	II year
Control	13.67	15.69	12.23	14.14	1.07	1.08	1.08	1.08	7.17	5.50	6.50	5.43
RDF (NPK 150:80:120 kg/ha)	10.82	15.20	10.86	14.76	1.06	1.08	1.06	1.08	6.50	5.33	7.17	5.00
RDF + 1 kg B	12.76	15.93	10.65	13.35	1.07	1.09	1.06	1.07	6.83	5.50	7.57	5.07
RDF + 2 kg B	12.51	16.51	11.96	14.87	1.07	1.09	1.06	1.08	7.00	6.00	7.33	4.90
RDF + 3 kg B	10.79	16.75	10.65	15.95	1.06	1.07	1.06	1.09	6.83	5.83	6.50	5.37
RDF + 30 kg S	12.08	16.68	12.36	14.67	1.07	1.09	1.07	1.08	7.00	6.00	7.67	5.17
RDF + 40 kg S	9.64	14.27	10.36	14.96	1.05	1.08	1.06	1.09	6.50	5.00	7.50	5.27
RDF + 1 kg B + 30 kg S	11.89	17.46	11.55	15.79	1.06	1.09	1.06	1.08	7.17	5.67	7.00	5.83
RFD + 2 kg B + 30 kg S	11.59	16.38	11.24	14.39	1.06	1.09	1.06	1.08	7.00	5.67	7.17	5.17
RDF + 3 kg B + 30 kg S	9.27	13.98	10.43	14.93	1.05	1.08	1.05	1.08	6.83	5.33	7.50	5.67
RDF + 1 kg B + 40 kg S	10.50	15.30	11.47	13.73	1.06	1.08	1.06	1.07	6.83	5.67	7.50	5.93
RDF + 2 kg B + 40 kg S	14.80	18.88	14.38	16.41	1.08	1.09	1.07	1.09	7.40	5.67	7.84	6.00
RDF + 3 kg B + 40 kg S	13.43	12.33	12.64	14.93	1.07	1.10	1.07	1.08	7.33	5.33	7.83	5.03
C.D. at 5%	2.62	2.50	1.74	2.27	0.01	0.01	NS	0.01	0.90	NS	1.33	0.80

After storage and reconditioning of tubers, the dry matter content was positively influenced by the application of Sulphur, boron and their combined application along with recommended fertilizer doses (RDF). An increase in dry matter content was observed after recondition of tubers. Maximum dry matter (21.13%) was found in treatment RDF + 1 kg B + 30 kg S during first year; whereas, during second year of storage it was found maximum (25.68%) with treatment RDF + 3 kg B. After reconditioning, RDF + 2 kg B + 40 kg S was found to contain maximum dry matter (20.62% and 22.90%) which was statistically at par with RDF + 3 kg B + 40 kg S in both the years of experiment. Undesirable sprouting reduces the weight, the nutritional and processing quality of tubers during potatoes storage (Delaplace *et al.*, 2008). Sprouting affects the internal composition of the tuber and destruction of edible material and changes in nutritional quality (De Carvalho and da Fonseca, 2006). As a result it reduces the weight of tubers (Burton, 1951). Dry matter content increases after reconditioning of tubers that increases the quality of tubers due to the effect of boron and sulphur. Singh *et al.*, (1995) also suggest the positive effect of boron and sulphur on dry matter content. Mondal *et al.*, (2002) had the similar findings in the green gram.

A significant effect on starch content was found due to the application of boron, sulphur and their combination during the storage and reconditioning of tubers (Table 3). RDF + 2 kg B + 40 kg S was found to contain maximum starch content (14.80%) which was statistically at par with RDF + 2 kg B during both years of storage and statistically at par with RDF + 3 kg B + 40 kg S during both years of reconditioning. Specific gravity was significantly influenced by the application of boron, Sulphur and their combination except the first year of reconditioning. In storage condition, specific gravity was found maximum (1.08%) with treatment RDF + 2

kg B + 40 kg S during first year and RDF + 3 kg B + 40 kg S (1.10%) during second year; both was statistically at par with RDF + 1 kg B, RDF + 2 kg B and RDF + 30 kg S. After reconditioning, treatment control was found to contain maximum specific gravity (1.08%) during first year and RDF + 3 kg B, RDF + 40 kg S and RDF + 2 kg B + 40 kg S during second year (1.09%). RDF + 2 kg B + 40 kg S was recorded maximum T.S.S. content during both years of storage and reconditioning except second year of storage.

A non-significant effect on T.S.S content was found during second year of storage due to the application of boron, sulphur and their combination. RDF + 2 kg B + 40 kg S was recorded for maximum T.S.S. (7.84%) during both the year of reconditioning which was statistically at par with RDF + 3 kg B + 40 kg S during first year and during second year (6.00%), it was statistically at par with RDF + 1 kg B + 40 kg S.

There was no findings found regarding to starch content of the tubers which can be influenced by the application of boron and sulphur. In contrast with the finding, Boylan *et al.*, (1991) reported that starch content increases during the early stage development of tomato fruit. There was an increase in the conversion of sucrose into starch with addition of KCl and further stimulated by K⁺ ion. A rise in specific gravity is directly affected by dry matter content of tubers which was largely a function of improved growth, translocation of more photosynthates towards sink and consequent accumulation of dry matter in potato tubers Verma and Singh (2012). Similar findings has been also reported by Sharma *et al.*, (2011) and El-Fayoumy and El-Gamal (1998). While in case of T.S.S, the increment might be due to hydrolysis of different insoluble constituent like starch, vitamins and proteins; high T.S.S. shows better quality of tubers with superior nutritive value (Pathak and Mitra, 2008).

Based on the present study, the overall evaluation of boron, sulphur and their combination indicated that the application of boron and sulphur along with recommended dose of fertilizers resulted in better quality and physico-chemical composition of potato tubers. The application of 2 kg boron and 40 kg sulphur along with recommended dose of fertilizers found best in dry matter content, starch content, and total soluble solids whereas, having minimum values in number of diseased tubers, number of sprouted tubers during storage and reconditioning. Hence, application of 2 kg boron and 40 kg sulphur along with recommended dose of fertilizers could be recommended to enhance number of healthy tubers and postharvest quality of potato, to enhance the farmers earning and to encourage them for potato cropping under indo-gangatic alluvial region of India.

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