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Quality attributes and shelf life of onion in response to application of boron

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Abstract
An investigation was performed at the experimental field of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K) during Rabi 2015-16 and 2016-17 to find out the effect of different levels of boron on quality attributes and shelf life of onion. The experiment was tested in Randomized completely block design with three replications. Four levels of boron viz., boron (B), B_0 (control or no zinc), B_1 (0.500 kg ha^{-1}), B_2 (1.000 kg ha^{-1}) and B_3 (1.500 kg ha^{-1}). The observations were recorded on quality attributes from 10 randomly selected samples of each treatment while observations regarding shelf were carried out after storage of 10 kg bulbs in each treatment for three months. Pooled analysis revealed that maximum values for quality traits like protein content (12.31 percent), vitamin C content (13.16 mg 100^{-1}g), T.S.S (13.18 ^{o}Brix), pyruvic acid (7.59 µmol g^{-1}) and dry matter content (15.01 percent) were recorded with B_3 (1.500 kg B ha^{-1}) treatment followed by B_2 (1.000 kg B ha^{-1}). Significantly lower values of total weight loss (30.62 percent), physiological weight loss (13.37 percent), sprouting (8.54 percent) and rotting (8.71 percent) were observed with B_3 (1.500 kg B ha^{-1}).

Keywords: Onion, TSS, pyruvic acid, total weight loss and zinc

Introduction
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crop cultivated extensively in India. It is the most widely cultivated species of the genus *Allium*, belongs to family Alliaceae. An umbel-like inflorescence composed of white or greenish-white small flowers, grows at the tip of the stem. The fruits are capsules, which contain black flat seeds. The edible bulb can grow up to 10 cm in diameter; it is composed of several overlapping layers on a central core. The edible portions of the bulb are the enlarged leaf bases and compact stem. The predominant flavor component results from activity of the enzyme alliance in broken or crushed tissue, yielding the volatiles allyl propyl disulfide and methyl propyl disulfide (Malik, 1994) [15]. It is one the most important character which increases the taste of food (Kumar *et al*., 2010). In India, it is treated as most important export oriented vegetable, exporting to the tune of 13, 58,193.00 mt of rupees 2, 87,713.00 lakhs during 2015 – 2016 (Anonymous, 2016) [5]. It is a cool season vegetable crop but is among the most widely adapted vegetable crops. Onion is cultivated under an area of 4121.51 ('000 ha) with a production of 79867.21 ('000 mt) in the world (Anonymous, 2015) [6]. In India, onion is being grown in an area of 1225.21 (000' ha) with production of 20991.34 (000't) and the productivity is 17.30 t ha^{-1} which is low (Anonymous, 2017) [3]. Productivity of onion were higher in the case of Turkey (34.3 t ha^{-1}) followed by Brazil (26.1 t ha^{-1}) and China (25 t ha^{-1}). Due to lower yields, though India has the highest area under onion, it stands second in the production of onion in the world. Hence, there is a lot of potential for increasing the production of onion by improving the yields. In Kashmir it is grown under an area of 950 ha and produces 24250 (t) with a productivity of 25.4 (t ha^{-1}) (Anonymous, 2015) [4]. India is also the largest exporter of onion and hence, it is crucial to improve the yield and quality for enhancing the export level, so that it helps in earning foreign exchange for the exchequer of the country. In India onion is mostly cultivated during rabi (60 percent) followed by 20 percent each in kharif and late kharif seasons. Productivity could be increased by use of suitable varieties, balanced nutrition, optimum water management as well as need based plant protection measures. Among the many constraints for low productivity in onion, imbalanced nutrition is the main limiting factor.

Fertilizers offer the best means of increasing yield, quality and maintaining soil fertility. In addition to nitrogen, phosphorus, potassium and sulphur, Boron is essential for normal growth and production of sound and healthy vegetables. Boron has been linked with initiation and development of growing points, movement of sugars and starches to developing parts, movement of nutrient elements within the plant, formation of plant hormones affecting growth, root growth and health of fleshy roots, flower and fruit set and quality and flavour of vegetables (Vitosh *et al*., 2001) [25]. Boron is one of the important micronutrient for onion production and is essential for cell division, nitrogen and carbohydrate metabolism, protein formation and water relation in plant growth (Brady, 2010) [7]. It is essential for cell wall formation. It also maintains balance between sugars and starch in plant body. It increases the growth of primary and lateral roots. Although it is quickly taken up from the soil, it is relatively immobile in the plant. Young leaves develop yellow and green mottling. Older leaves become yellow and undergo dieback. Light yellow lines appear and develop into ladder-like transverse cracks on the upper surfaces of older leaves. They become brittle and deep green in colour. Plants can be stunted or distorted. Soils with higher clay and organic matter content adsorb higher contents of boron than medium textured soils containing low organic matter. Most of the soils (fine as well as coarse textured) are considered to be low in available boron as it has been reported that < 0.50 mg Kg^{-1} boron is not sufficient for optimum plant growth (Reisenaure *et al*., 2008) [19]. Boron deficiency has been observed in soils with low organic matter contents (Valk *et al*., 2009) [24]. Soils of Jammu and Kashmir are mostly dominated by Lithic or Topic Udorthents (Sidhu *et al*., 1999) [20]. These soils have already been reported to be deficient in boron (Mondal, 2002) [17]. The soils of Himalayas were found very low in boron (Khatri and Ghimire, 1992) [12]. Application of boron improves quality of onion (Manna *et al*., 2014) [16]. Therefore, the objective of this work aims to investigate the quality attributes and shelf life of onion in response to application of boron.

Materials and Methods

The present investigation entitled "Quality attributes and shelf life of onion in response to application of boron" was carried out during Rabi 2015-16 and 2016-17 at Vegetable Experiment Farm, Division of Vegetable Science, SKUAST-K, Shalimar. Soil of the experiment area was sandy loam having pH of 7.61; available NPKS 288.83:15.71:155.95:26.23 kg ha^{-1} with low boron content (0.41 ppm).The treatment consists of four levels of boron (0,. 500, 1.000 and 1.500 kg ha^{-1}) by adopting RCBD with three replications. The solubar (21.5%) as source of boron as per the treatments was applied at the time of transplanting. The recommended full dose of phosphorus, potassium and half dose of nitrogen were applied as basal dose while the remaining nitrogen was applied as top dressing at 30 days after transplanting. The seedlings of seven weeks old were transplanted at a spacing of 15×10 cm2. All the recommended package of practices was adapted uniformly to all the treatments to raise a good onion crop of cv. Yellow Globe. Data were recorded on five bulbs per replication and estimated for Vitamin C (mg/100g), protein content (%), total soluble solids (^{0}Brix), pyruvic acid content (μmoles of g^{-1}) and dry matter content (%). Ascorbic acid (vitamin C) was estimated by 2, 6-dichlorophenol-indophenol dye by visual titration method (A.O.A.C, 2000) [1]. The protein content was calculated by multiplying a factor 6.25 (protein factor) with total nitrogen content in bulbs. Total nitrogen content in bulbs was determined by Kjeldahls method as outlined by Tandon (1993) [23]. TSS were analysed by Hand Refractrometer, pyruvic acid (μmoles of g^{-1}) by Ketter and Randle (1998) [11] and dry matter content (%) composite samples of 100 g were taken from each treatment and subjected to sun drying followed by oven drying at 60 ºC to a constant weight. The dried material was weighed and recorded as dry matter content in percent.

Storage quality of onion

After curing 10 kg bulbs from each treatment were kept in perforated plastic crates keeping lower crates empty and stored in a well ventilated conditions at room temperature for a period of 90 days (3 months). The physiological weight loss, sprouting percent and rotting percent during storage were recorded after each month and total weight loss was then calculated by following formulas.

$$\text{PWL (\%)} = \frac{\text{Initial weight} - \text{final weight}}{\text{Initial weight}} \times 100$$

$$\text{Sprouing (\%)} = \frac{\text{No. of sprouted bulbs}}{\text{Total No. of bulbs}} \times 100$$

$$\text{Rotting (\%)} = \frac{\text{No. of rotted bulbs}}{\text{Total No. of bulbs}} \times 100$$

Total weight loss % were recorded by sum of PWL (%), Sprouing (%) and Rotting (%).

The data recorded on various parameters were subjected to statistical analysis as per the procedure suggested by Gomez and Gomez (1984) [9].

Result and discussion

Effect of boron on qualities attributes of onion

Pooled data presented in Table 1 revealed that protein percent, vitamin C (mg $100g^{-1}$), TSS (°Brix), pyruvic acid (umol g^{-1}) and dry matter percent responded significantly to varying levels of zinc. Application of boron at the rate of 1.500 kg ha^{-1} (B_3) recorded higher values for protein content (12.31 percent), vitamin C content (13.16 mg 100^{-1}g), T.S.S (13.18 ºBrix), pyruvic acid (7.59 μmol g^{-1}) and dry matter content (15.01 percent). This might have been due to increased sugar transport and production of carbohydrates during photosynthesis. Boron is needed for the production of uracil, a pre-curser of uridine-diphosphate-glucose (UDPG), an essential enzyme for the production of sucrose. Similar findings have been reported by Sliman *et al*. (1999), Manna (2013) in onion. Similarly Ryabykh and Chuprikova (1989) and Paithankar *et al.* (2004) reported in tomato and Vyas and Khandwe in soya bean (2013).

Table 1: Effect of different levels of boron quality parameters of onion

Boron	Vitamin C mg 100g^{-1}	Protein (percent)	TSS (^{0}Brix)	Pyruvic acid (µmol g^{-1})	Dry matter (percent)
B_0	12.13	11.67	12.06	6.86	14.22
B_1	12.62	11.89	12.36	7.23	14.52
B_2	12.95	12.13	12.64	7.41	14.82
B_3	13.16	12.31	13.18	7.59	15.01
C.D($p \leq 0.05$)	0.21	0.15	0.16	0.24	0.11
S.E (m)	0.07	0.05	0.05	0.08	0.038

Effect of boron on storage qualities of bulb

Pooled data presented in Table 2 and fig. 1 depicted that treatment B_3 (1.500 kg B ha^{-1}) recorded Significantly lower values of total weight loss (30.62 percent), physiological weight loss (13.37 percent), sprouting (8.54 percent) and rotting (8.71 percent) were observed with B_3 (1.500 kg B ha^{-1}) after 3 months of storage as compared to lower levels of boron, while control (B_0) recorded significantly maximum values for total weight loss (35.39 percent), physiological weight loss (15.74 percent), sprouting (10.11 percent) and rotting (10.54 percent) of onion bulbs. This might be possible due to lower moisture loss from bulbs due to thickening of cell wall and formation of pectic network between boron and RG- II there by reduced physiological weight loss, rotting and sprouting of bulb. It may also be due to cell wall synthesis and lignifications according to Loomis and Durst (2012) [14], forming intramolecular or intermolecular bonds. This may be due to the effects of boron on membranes and cell walls. Many studies have shown that boron helps to maintain membrane stability (Yamouchi *et al.*, 1986) [26]. Yamouchi *et al.* (1986) [26]. reported that boron deficiency actually induced a reduction in the amount of calicum associated with the pectin fraction of leaf cell walls. They found 67 percent of the total boron in the cell wall fraction of tomato leaf tissues and suggested that boron may function in cell wall metabolism by maintaining the calicum-pectin association. The favourable effect of boron on storability of onion bulbs might be possible from negative correlation between boron uptake and total weight loss as per Singh and Tewari (1996) [21], Chennsiri *et al.* (1995) [8], Smriti *et al.* (2002) and Alphonso (2007) [2] in onion. Similarly Jeanine *et al.* (2003) [10] and Mushtaq *et al*. (2015) [18] reported in tomato.

Table 2: Effect of different levels of boron Storage parameters of onion

Boron	Physiological weight loss (percent)	Sprouting (percent)	Rotting (percent)	Total weight loss (percent)
B_0	15.74	10.11	10.54	36.39
B_1	15.09	9.47	9.68	34.24
B_2	14.49	8.89	9.21	32.59
B_3	13.37	8.54	8.71	30.62
C.D($p \leq 0.05$)	0.54	0.37	0.26	1.77
S.E (m)	0.18	0.12	0.09	0.59

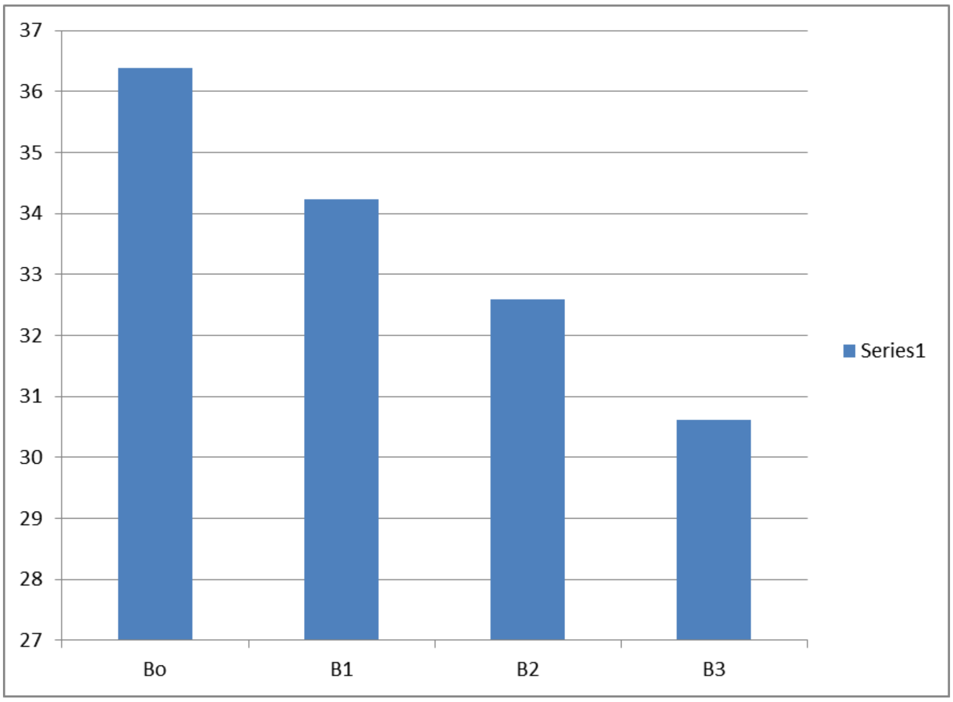

Fig 1: Effect of different levels of boron on total weight loss (percent).

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