RESPONSE OF APPLE CULTIVARS TO VARYING CONCENTRATIONS OF FOLIAR APPLICATION OF BORON UNDER THE AGRO-CLIMATIC CONDITION OF KALAM

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ABSTRACT

The purpose of study was to improve the quality and yield of three different apple cultivars for district kalam agro-climatic condition. The three cultivars were treated with four different concentrations of boron at pink bud stage. Statistical analysis revealed that boron application at (1.5%) concentration significantly improved fruit dimeter (8.01 cm), yield plant^{-1} (73.88 kg), firmness (5.39kg cm-^{2}). While on the other hand number of fruits kg-^{1} and the physiological disorder are significantly reduced with 1.5% boron application. Royal Gala was found with minimum bitter pit and fruit corking while increased yield plant^{-1}. Apple cultivar Jonica has maximum fruit diameter, fruit firmness, while minimum sun scald disorder. Apple cultivars Golden Smoothee has maximum TSS. The interaction of boron levels and apple cultivars was observed non-significant for all the parameters. It was concluded from the experiment that boron at rate of 1.5% significantly increased yield plant^{-1} while decrease, fruit firmness, titratable acidity, bitterpit, sun scald and fruit corking.

Keywords: Apple, Cultivars, Boron, Agro climatic condition

INTRODUCTION

Apple (*Malus domistica*) is a pome fruit belongs to family commonly known as "*Rosaceae*". Apple is unique and most famous fruit of genus *Malus* which is largely commercially cultivated all over the world. The origination of genus *Malus* is Eastern Turkey but progressively spread to Asia and Europe (Morgan and Richards, 1993) as well as Pakistan (Chuadhry and Malik, 1994).

For the improvement and development of plant boron is one of the 7th key micro nutrients (Gupta, 1979). Boron application has a limited range between lack and excess level. Therefore, it is difficult to be applied on a large-scale production because it should be

applied at optimum level (Marschner, 1997). Boron has a key role in improving the enzymatic activity and fruit quality like sugars, ascorbic acid and Total Soluble Solids acid ratio (Sing *et al.,* 2002). Boron also synergistically enhance calcium uptake to the fruits and protect the fruits from bitter pit and fruit corking disorders, therefore, optimal level of boron is necessary (John, 2016). Boron has a vital role in flowering and fruit formation (Nonnecke, 1989). As a micro nutrient boron has a major role in the development behavior of trees as well as in the yield. Boron maximize the germination of pollen grain and elongation of pollen tube thus increases the fruit set (%) and finally increase the yield (Abd.Allah, 2006). Boron also effected on flowering and fruiting. It maximizes fruit set, yield, fruit weight and total soluble solids. Boron showed their effect on all quality parameters. It has a key role in fruit set, maintaining integrity of cell, respiration rate, metabolic activities as well as nutrients uptake. (Naz *et al.,* 2012).

Boron also plays an important role in increasing the yield and quality (Magalhaes *et al.,* 1980). Boron helps in cell division, calcium uptake, nucleic acid synthesis, and transportation of carbohydrates (Bose and Tripathi, 1996). Deficiency of boron in plants affected the newly growing roots and leaves. The color of leaves converts to light green and become crumpled and frizzy. The translocation of phosphorus, starches, nitrogen and sugar also affected by boron deficiency. It also affects the synthesis of protein and amino acids (Stanley *et al.,* 1995). When leaves become thickened, curled or wilted and discoloration, cracking or decaying of fruits, tubers or roots is seem, so it is also the symptoms of boron deficiency (Tisdale *et al.,* 1985). When fruits are produce commercially it is particularly important to give sufficient level of boron for high yield formation, fruit quality, crop storability and stress tolerance (Wojcik *et al.,* 1999; Cakmak and Romheld, 1997; Khayyat *et al*., 2007).

Keeping in view the importance of boron in quality fruit production of apples and resistance against physiological disorders, the present experiment was planned with the following objectives.

- To study the effect of boron on yield and fruit quality of different apple cultivar under the agro-climatic condition of Kalam.
- To identify best level of boron against fruit corking, sun scald and bitter pit.
- To study the combined effect of Boron treatments and different apple cultivars on fruit attributes.

MATERIALS AND METHODS

The experiment entitled 'Response of apple cultivars to varying concentrations of foliar application of boron under the agro-climatic condition of Kalam' was carried out at Kalam Swat, (Summer Station Kalam) in 2016. The research experiment was design according to the randomized complete block design (RCBD) with two factors that is replicated three times. Factor A contain four treatments of boron in which boric acid is taken as a source of boron which would be applied as a foliar spray on three apple cultivars which is taken as factor B.

The experiment details are given below:

FACTOR A: Apple Cultivars
C_1: Golden Smoothee.
C_2: Jonica.
C_3: Royal Gala

FACTOR 2: Boron Level
T1: Control
T2: 0.5%
T3:1.0%
T4: 1.5%

The experiment was conducted at (KSS) Kalam Summer Station. Kalam is located at an altitude of 2100 m, (North 35° 29' 15.8" East 72° 34' 26.6") above sea level. The area has a typical dry temperate zone climate. In winter the weather become very cold and temperature fall below 0° C. Summer start from June and ends in October.

Statistical Procedure

To Analysis of Variance (ANOVA) all the data will be added and used the procedure suitable for RCBD with two factors arrangement. Least Significance Differences (LSD) test for these analyses used to compare the means. Statistix 8.1 is used as statistical package (Jan *et al*., 2009).

RESULTS AND DISCUSSION

Fruit Diameter (Cm^2)

Fruit diameter was significantly varied in different apple cultivars. Maximum fruit diameter (8.58 Cm) was recorded in apple cultivar Jonica followed by fruit diameter (8.05 Cm) noted in apple cultivar Golden Smoothee while the minimum fruit diameter (7.16 Cm) was observed in apple cultivar Royal Gala. (Table 1)

Tariq *et al*. (2007), reported the similar results of increased fruit size in sweet oranges a result of zinc and boron combine application. Our results can be co related to the findings of Rawat *et al*. (2010), who stated that boron has regulatory effect on plant metabolism due to which the size of guava fruit significantly increased as a results of boron application. Fruit diameter vary with different apple cultivars. Ahmad *et al*. (2013). Marinda *et al*. (2015), stated that it is because of genetic make-up of different apple cultivars. Wojick *et al*. (1999) also stated that the fruit setting and yield increased in apple trees by the foliar application of Boron before flowering. The fruit diameter enhanced with the application of Boric acid. Muhammad, (2012).

Numbers of Fruits Kg^{-1} (Kg)

The detection of mean data showed that maximum no. of fruits per kg^{-1} (5.95) was observed with-out boron application followed by (0.5%) and (1.0%) of boron that is (5.79) and (5.59) respectively, however as the concentration of boron was increased no. of fruits kg^{-1} was reduced. Minimum no. of fruits kg-1 (5.24) was recorded with (1.5%) of boron. (Table 1)

No. of fruits kg^{-1} was the main reason for poor yield. No. of fruits was reduced by boron foliar application. Rawat *et al*. (2010), found that guava fruit size increased as a results of boron application. Wojcik *et al*. (1999), Aziz *et al*. (2001), noted that the positive effect of boron on fruit weight as a results of increasing cell division, cell enlargement and transportation of organic food. The fruits treated with boron has lower number of fruits per kilogram which might be due to the increased size and weight as a results of boron application as compared to control. Wojcik *et al*. (1999). Fruits kg^{-1} changes with different apple cultivars. Ahmad *et al*. (2013). Marinda *et al*., (2015) noted that the changes in apple cultivars is because of its genetic make-up.

Yield $Plant^{-1}$ (kg)

Regarding mean for apple cultivars. Maximum yield $plant^{-1}$ (81.25kg) was recorded in apple cultivar Royal Gala followed by yield $plant^{-1}$ (61.08kg) in apple cultivar Jonica while minimum yield $plant^{-1}$ (58.50kg) was observed in apple cultivar Golden Smoothee. According mean of boron. Maximum yield $plant^{-1}$ (73.88kg) was noted with (1.5%) of boron followed yield $plant^{-1}$ (68.44kg) and (65.11kg) with (1.0%) and (0.5%) of born respectively, however the minimum yield $plant^{-1}$ (60.33kg) was recorded in control. (Table 1)

Our findings are in lined with the results of sing *et al*. (2006), who stated that boron significantly increased yield in strawberry. Our results also in line with Kami. (2011), who observed that boron application in combination of some cultural practices increased yield in grapes cultivars. Naz *et al*. (2012), reported the similar increase in tomato because of boron application which might be due to the key role of boron in maintaining respiration rate metabolic activities, nutrients uptake as well as sustaining the cell integrity. Ahmad *et al*. (2013), stated that yield plant^{-1} vary with different apple cultivars. It might be due to the genetic make-up of different apple cultivars. Marinda *et al*. (2015).

Firmness (Kg Cm^{-2})

The detection of the mean showed that fruit firmness (6.14kg cm^2) was recorded in apple cultivar Jonica followed by fruit firmness (5.71k g cm^2) was noted in apple cultivar Golden Smoothee, however the minimum fruit firmness (3.50k g cm^2) was recorded in apple cultivar Royal Gala. Regarding mean for boron treatments. Maximum fruit firmness (5.34kg cm^2) was noted in control followed by fruit firmness (5.18 kg cm^2) and (5.04kg cm^2) with (0.5 %) and (1.0%) of boron respectively. When the concentration of boron levelss was increase fruit firmness was reduced. The minimum fruit firmness (4.94kg cm^2) was recorded with (1.5%) of foliar application of boron. (Table 1)

Our results are in line with the findings of Khalifa *et al*. (2009), who noted that foliar application of boric acid and calcium chloride applied in two consecutive year significantly increased fruit firmness in anna apple fruit Our findings can also be co related to the results of Khalij *et al*. (2017), whose stated that boron and calcium foliar application significantly affected the fruit firmness in Asian pear fruit. Sing *et al*. (2006), obtained the similar results of increased fruit firmness in strawberry fruit because of boron and calcium application alone or in combination and further stated that it might be due to cellular turgidity, strength of cell wall and cell to cell contact. Higher levels of pectin in cell wall might be the reason for maximum firmness in the fruits treated with boron. Khalij *et al*, (2016). Ahmad *et al*. (2013), noted that firmness changes with different apple cultivars. This changes in apple cultivars is due to the genetic make-up of different cultivars. Marinda *et al*, (2015).

Table 1: Fruit diameter (Cm^2), number or fruits Kg^{-1}, yield $plant^{-1}$ (Kg) and firmness (Kg Cm^{-2}) of apple cultivars as affected by boron levels.

	Parameters			
(Factor A) Apple Cultivars	**Fruit diameter (Cm^2)**	**Number or fruits Kg^{-1}**	**Yield $plant^{-1}$ (Kg)**	**firmness (Kg Cm^{-2})**
Royal Gala	7.16c	5.50 a	81.25 a	3.50 c
Jonica	8.58a	5.69 a	61.08 b	6.14 a
Golden Smoothee	8.05b	5.74 a	58.50 c	5.71 b
LSD (P≤0.05)	0.1383		1.1852	0.1433
(Factor B) Boron Levels				
0	7.77 b	5.95 a	60.33 d	4.99 c
0.5%	7.98 a	5.79 ab	65.11 c	5.04 bc
1.0%	7.97 a	5.59 b	68.44 b	5.18 ab
1.5%	8.01 a	5.24 c	73.88 a	5.34 a
LSD (P≤0.05)		0.2901	1.3685	0.1655
Interaction at LSD (P≤0.05)				
Cultivars × Boron	---	---	---	---
Significance	NS	NS	NS	NS

Means followed by same letters are statistically different using LSD test at 5% Significance levels.

Bitter Pit (%)

Maximum percent of bitter pit (22.33%) was noted in cultivar Jonica followed by bitter pit (13.08%) in apple cultivar Golden Smoothee. while minimum percent of bitter pit (7.41%) was noted in apple cultivar Royal Gala. Maximum percent of bitter pit (23.22) % was noted in control followed by bitter pit (16.88%) and (11.55%) with (0.5%) and (1.0%) of boron respectively, while minimum percent of bitter pit (5.44%) was noted in (1.5%) of boron. Maximum percent of bitter pit (35%) was noted in apple cultivar Jonica in control which is closely related to bitter pit (28.33%) with (0.5%) of boron followed by bitter pit (22.33%) in apple cultivar Golden Smoothee without boron application, however minimum percent of bitter pit (2.66%) was noted in apple cultivar Royal Gala in (1.5%) of boron. (Table 2)

Bitter pit is the occurrence of brown spot on skin and in flesh it may be caused due to deficiency or in appropriative movement within the plant as calcium is not vary mobile in the plant. Jeremy Bright (2005). The decrease of bitter pit affected fruits in the trees treated with boron application might be due to the facts that boron has involved in the movement of calcium with in the plant tissue. Anonymous (2012). Ahmad *et al*. (2013), noted that bitter pit physiological disorder varies with different apple cultivars. This change is due to the genetic make-up of different apple cultivars. Marinda *et al*., (2015).

Sun Scald (%)

Mean data regarding apple cultivars. Maximum percent of sun scald (7.66%) was recorded in apple cultivar Golden Smoothee followed by sun scald (5.50%) in apple cultivar Royal Gala, while minimum percent of sun scald (4.33%) was observed in apple cultivar Jonica. Maximum percent of sun scald (8.88%) was noted in control followed by sun scald (7.00%) and (4.88%) with (0.5%) and (1.0%) of boron respectively, while minimum percent of sun scald (2.55%) was noted with (1.5%) of boron. (Table 2)

Sun Scald occur when the fruits are directly exposed to sun rays at high temperature in winter season. Anonymous (2005), stated that the calcium deficient fruits are highly susceptible to sun burn. As calcium is not vary mobile in plants and boron plays in important role in the movement of calcium chloride in the plants therefore the fruits treated with boron foliar application has been noted with less percent of sun scald disorder. Sun scald varies with different apple cultivars. Ahmad *et al*, (2013). Marinda *et al*. (2015), stated that it might be due to the genetic make-up of different apple cultivars.

Fruit Corking (%)

Mean data exhibited that maximum percent of fruit corking (8.66 %) was noted in apple cultivar Golden Smoothee followed by fruit corking (5.25%) in apple cultivar Jonica, while minimum percent of fruit corking (3.33 %) was noted in appple cultivar Royal Gala. Maximum percent of fruit corking (10.44%) was noted in control followed by fruit corking (6.44%) and (3.77%) with (0.5%) and (1.0%) of boron respectively, while minimum percent of fruit corking (2.33%) was noted with (1.5%) of boron. Maximum percent of fruit corking (17.66%) was recorded in apple cultivar Golden Smoothee in control followed by fruit corking (9.66%) with (0.5%) of boron and which is closely related to apple cultivar Jonica that has (8.00%) fruit corking in control, however

minimum percent of fruit corking (1.66%) was noted in apple cultivar Royal Gala with (1.5%) of boron. (Table 2)

Julie Dart (2004) stated that internal or external cork may be caused due to deficiency of boron. He further stated that nutrient deficiency can be caused due to water logging and vary dry soil where the roots are unable to absorb nutrients and the symptoms develop on fruits and leaves. Kevin R. Day (1998) also confirmed that boron deficiency is the reason for external and internal cork. Jeremy Bright (2005) also confirmed our result that boron deficiency caused internal and external cork. Physiological disorder fruit corking changes with different apple cultivars. Ahmad *et al*, (2013). Marinda *et al.* (2015), noted that the change in inter cultivars is because of its genetic make-up.

Table 2: Bitter pit (%), sun scald (%) and fruit corking (%) of apple cultivars as affected by boron levels.

	Parameters		
(Factor A) Apple Cultivars	**Bitter pit (%)**	**Sun scald (%)**	**Fruit corking (%)**
Royal Gala	7.41 c	5.50 b	3.33 c
Jonica	22.33 a	4.33 c	5.25 b
Golden Smoothee	13.08 b	7.66 a	8.66 a
LSD (P≤0.05)	1.6505	0.9776	0.8239
(Factor B) Boron Levels			
0	23.22 a	8.88 a	10.44 a
0.5%	16.88 b	7.00 b	6.44 b
1.0%	11.55 c	4.88 c	3.77 c
1.5%	5.44 d	2.55 d	2.33 d
LSD (P≤0.05)	1.9059	1.1289	0.9514
Interaction at LSD (P≤0.05)			
Cultivars × Boron	---	---	---
Significance	NS	NS	NS

Means followed by same letters are statistically different using LSD test at 5% Significance levels.

Conclusion

On the basis of my study it is concluded that Boron foliar application at the rate of 1.5% significantly increased yield plant^{-1}, firmness while decreased no. of fruits kg^{-1}, bitter pit, fruit corking and sun scald. While showed maximum fruit diameter, firmness, with minimum sun scald disorder was recorded in apple cultivar Jonica while minimum bitter pit and fruit corking incidence was observed in apple cultivar Royal Gala.

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