African Journal of Microbiology Research Vol. 6(11), pp. 2682-2685, 23 March, 2012
Available online at http://www.academicjournals.org/AJMR
DOI: 10.5897/AJMR11.1163
ISSN 1996-0808 ©2012 Academic Journals

Full Length Research Paper

Investigating the effect of boron spray on yield nutrient content, texture and brix index of apple (*Sheikh Amir Variety*) in Shirvan region

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Accepted 10 November, 2011

The influence of late-season boron (B) application on the bud B concentration and fruit set was studied in apple (*Sheikh Amir Variety*). The experiment was carried out on 10-year-old trees Shirvan region of Iran. In order to study the effect of boron on some characters of apple Sheikh Amir Variety fruits an experiment was conducted during 2010 and 2011 seasons cropping season in apple orchard at Shirvan region. The experimental design in this research was randomized complete block design (RCBD) with four replications. The treatment were comprised of two levels of pre-harvest foliar application of nutrients T_1 = Control (water foliar application), T_2 = Acid boric foliar application (0.51 g/tree). Obtained results in this research showed that foliar application on boron as pre-harvest had significant effect on dry weight, texture, Prix index and B concentration of apple fruits (*Sheikh Amir Variety*). Highest amount of all characters was obtained in T_2 (foliar application of boron) and minimum amount of these properties were recorded in control treatment.

Key words: Apple, boron, brix index, dry weight, fruit quality.

INTRODUCTION

Have long been known boron is an essential micronutrient in plants that is often deficient in most soils because most of the boron in the soil is adsorbed to clay minerals, hydrous metal oxides, and organic matter in soils. Most pome fruit orchards need some fertilizer, lime or a trace element to achieve and maintain optimum tree growth and fruit production. Boron deficiency is a common trace element disorder of apples. It may be found in all districts and soils but is usually worst on granite soils. The tree response to foliar application of nutrients may be inconsistent (Weinbaum et al., 1988). In fruit and nut trees, B deficiency often results in decreased seed set even when vegetative symptoms are absent (Nyomora et al., 1997). The major role of B in fruit trees involves fruit set. It is essential for reproduction, aids in the formation of pollen germination and pollen tube growth (Faust, 1989). Application of B sprays is often used to ensure that sufficient amounts of B are available for flower fertilization, fruit set, and early fruitlet development (Stover et al., 1999; Nyomora et al., 1999; Stampar et al., 1999; Solar et al., 2001). Early research indicated that B is necessary for flower bud formation (Kamali and Childers, 1970) and pollen tube growth (Dickinson, 1978). Boron sprays after bloom increased fruit set and yield of the apple cultivar Elstar (Wojcik et al., 1999). Sprays at the pink flowering stage increased flower cluster and early-season leaf B concentrations of apple Scarlet Gala (Peryea et al., 2003).

In another research Perica et al. (2001) stated that application of B prior to flowering increased fruit set of olive Manzanillo. Foliar applications of B before full bloom or after harvest increased fruit set and fruit yield of Conference pear (Wojcik and Wojcik, 2003). Late season foliar spraying is an effective method of supplying B to flower buds, leaves and flowers apple (Zude et al., 1998) and influences fruit set and yield of almond (Nyomora et

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Table 1. Chemical analysis of soil.

Zn	Fe	B	Ca	P	K	N	EC	pH
Mg l^{-1}	Mg l^{-1}	PPM	Meq l^{-1}	PPM	PPM	Meq l^{-1}	mS/Cm	-
1.615	0.03	0.45	6.75	27.05	665	0.027	2.12	7.68

Table 2. Analysis of variance on Dry Weight, Texture, Acidity, Brix and content of B in apple fruit.

Treatment	df	Dry weight	Texture	Acidity	Brix	B
Replication	3	5.87^{ns}	1.14^{ns}	0.003^{ns}	10.59^{ns}	75.28^{ns}
Foliar application	1	2.58^{**}	0.50^{**}	0.0009^{**}	23.70^{**}	7203.58^{**}
Error	3	0.0005	0.006	0.0006	0.02	0.005
%CV	-	0.13	3.54	5.88	0.89	0.19

ns, * and **, Non-significant, significant at 5% and 1% probability levels, respectively.

al., 1997). Foliar B application often promotes fruit set and yield of different fruit species, but response to B application seems to be related to different factors, like species, cultivar, and nutrient status. The experiment is designed to investigate the relative effects of foliar application of acid boric on yield and quality characteristic of fruits apple (*Sheikh Amir Variety*) in Shirvan region.

MATERIAL AND METHODS

This experiment was conducted during 2010 and 2011 seasons cropping season in an apple orchard at Shirvan region. The site lies at longitude 57°54, and latitude 37°27 and the altitude of the area is 1047 m above sea level. The soil characteristics of apple orchard is loamy clay soil in texture, pH = 7.64 and EC = 2.12 m S/Cm (The soil properties has shown in Table 1). The experimental design in this research was randomized complete block design (RCBD) with four replications. The treatment were comprised of two levels of Pre-harvest foliar application of nutrients T_1 = Control (water foliar application), T_2 = Acid boric foliar application (0.51 g/tree). Apple trees (*Malus domestica*) in a private orchard at Shirvan region, having 10 years old, grown in loamy clay soil, spaced 4x4 m, under drip irrigation system, similar in growth and received common horticulture practices, were selected for this investigation. The total B application rate in all treatment was 0.51 g/tree (0.56 kg/ha) which is the recommended B maintenance rate (Smith, 2002). All selected trees for this research were healthy, nearly uniform in growth vigour and fruiting. All trees had received regularly the same common cultural practices already give to the tree. Selected trees were sprayed 3 times at full bloom, after fruit set (fruit diameters 3 cm) and four weeks after fruit set (Shahin et al., 2010). Foliar sprays were applied using a hand pressure sprayer. Each treatment was surrounded with two rows as guard trees. The treatments were arranged in a randomized complete block design with three replicates for each treatment and three trees per each replicate. The following parameters were determined in the seasons of the study are dry weight, fruit firmness, total soluble solids, acidity and fruit concentration of B. Total soluble solids were determined using a hand refractometer, percentage of titratable acidity in fruit juice was determined according to AOAC, (1995), total soluble solid / total acidity ratio were calculated and total sugar in the fruit pulp tissues were also determined by phenol sulfuric method according to (Dubois et al., 1956).Samples at twenty leaves from the middle part of the shoots according to Chuntanaparb and Cummings (1981) were randomly selected from each replicate. Fruits were harvested at maturity stage (the first week of June) from each tree of various replicates and yield was recorded as a number of fruits/tree and weight in Kilograms. Samples of 10 randomly mature fruits from each experimental unit were used for measuring various fruit quality attributes. For measuring B content, fruit samples were collected after harvesting time then washed, oven dried ground and extracted with wet acid digestion method and analyzed for elemental content of B by Atomic Spectrophotometer, model-2380 (Jones and Case, 1990). Total Acidity was estimated as malic acid according to A.O.A.C (2011). The data were analyzed using SAS software; mean comparison was done using Duncan Multiple Comparison at 5% probability level.

RESULT AND DISCUSSION

Dry weight

Data clearly were shown that (Table 2) dry weight of fruit apple was influenced by using Acid Boric. Higher and lower dry weight of fruit were obtained from application of Acid Boric (T_2) and control (T_1) treatments, (16.38 and 15.87) respectively as shown in Table 3. This result showed that foliar application of boron as preharvest timing increased dry weight of apple fruits 3.11%. Obtained results confirmed that earlier findings of Wojcik et al. (1999) he noted that boron sprays after bloom increased fruit set and apple yield. Yield may increase following foliar B application even for trees that exhibit leaf B concentrations within the desirable range (Chaplin et al., 1977; Wojcik, 1999). Faust (1989) stated that a major effect of B nutrition in fruit trees is its role in fruit set. Early research indicated that B is necessary for flower bud formation (Kamali and Childers, 1970). Another scientists in different researches showed that boron applications increase fruit set in Italian prune (Hanson and Breen, 1985; Hanson, 1991). Boron requirement for reproductive growth in plants has long been recognized. Gauch and Dugger (1954) cited over 70

Table 3. Mean comparison for dry weight, texture, acidity, brix and content of B and in apple fruit.

Treatment	Dry Weight	Texture	Acidity	Brix	B
	(Kg)	-	(pH)	-	(ppm)
Control	15.87b	2.18b	5.07a	15.22b	23.75b
Acid Boric	16.38a	2.40a	4.48b	16.76a	50.58a

Test mean followed by similar letters in each column, are not significantly different at the 5% level of probability.

references that reported boron effects on pollen germination, or on flowering and fruiting of plants.

Brix Index and texture

Obtained results in this research showed that boron had significant ($P < 0.01$) effect on Brix index of apple fruits as shown in Table 2. Main compression in Table 3 shows that maximum amount of Brix index (16.76) resulted from acid boric foliar application and lower Brix index (15.22) was measured from control treatment (T_1). Results in this part showed that using boron in fertilizer program of apple orchard increased Brix index of apples about 9.18% as compeer to control treatment. Similar to our results Isarangkul Na Ayutthaya (2000) showed that application of boron during flowering increased the carbohydrate content in shoots and fruit. This may be party explained by the facy that calcium-boron with sorbitol were sprayed only once.

Regarding the effect of foliar application of Boron on texture of apple *(Sheikh Amir Variety*) fruits an increase in texture of fruit was observed by acid boric spray treatment as compare to control. Observed result showed that boron treatment had significant effect on texture of fruits as shown in Table 2, and mean comparison data in Table 3 were shown using acid boric spray as a pre-harvest, increased texture of fruits 9.16% in compare to control treatment. Clarkson and Hanson (1980) proposed that by forming crosslinks in pectin, boron protects Ca in the cell wall. Results that supported this idea came from Yamanouchi (1970) and Yamauchi et al (1986), who found that boron deficient cell walls of tomato contained less calcium. We could hypothesize that the hydroxyl H-bonding and borate ester formation may pull carboxylate groups of polymers into close proximity and allow calcium or magnesium binding by the polymers. Brown and his group (1994), who reported fraction and boron in cell walls of squash and tobacco, and by their survey of 14 plant species (1996) showing very close correlation between the uronic fraction, pectin sugars, and boron content of the plant.

Boron content

Boron content of apple fruit was affected significantly by boron spray as shown in Table 2. Maximum amount of Boron was measured in T_2 (acid boric foliar application) with mean of 50.58 and minimum amount this nutrient was recorded in control treatment (T_1) with mean of 23.75 respectively. Using boron increased concentration of B in comparing to control 53.04% as shown in Table 3. In field application of boron fertilization of (Dramlage, 1993) apple trees, as the soil treatment or by spray application (before after bloom), increased the boron concentration in apple fruits comparing with the control. Recently, Peryea et al. (2003) conducted a trial on 'Scartlet Gala /EMLA26 apple trees and concluded that applying half or the entire annual B maintenance rate in a spray at the pink flowering stage increased flower cluster and early season leaf B concentrations. The improving of fruit quality in response to application of nutrients was supported by Ahmed and Morsy, (2001); Younes-Randa (2002) and Fawzi and Abd Al-moneim (2004).

Conclusion

Obtained results from this research showed that foliar application of acid boric had good effects on quality and quantity characters of apple fruits such as yield, texture, total soluble solids, and fruit concentration of B. Among these characters boron concentration in fruits apple affected with acid boric spray at three times of full bloom, after fruit set (fruit diameters 3 cm) and four weeks after fruit set and boron spray increased concentration of this element in apple about 53% in comparing to control (Spray water). Boron is essential for plant growth and development, and adequate boron nutrition of cultivated plants can be of great economic importance. So levels of boron in plant tissue should be monitored to determine the effectiveness of boron application strategies and the change in soil boron availability. Therefore, the close attention to B levels is important because both low and high concentrations cause poor fruit quality. Low B results in short storage life with the fruit having a higher susceptibly to storage breakdown and fruit deformities. High B results in a higher incidence of internal disorders such as watercore and internal breakdown.

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