Effect of Foliar Boron Sprays on Yield and Fruit Quality of Navel Oranges in 1998 and 1999[1]

Michael Maurer and James Truman

Abstract

A field study was designed to determine if foliar boron (B) sprays could increase fruit set and yield of 'Parent Washington' navel oranges (Citrus sinensis). Treatments consisted of two application timings (prebloom and postbloom) and five application rates 0, 250, 500, 750 and 1000 ppm B as Solubor. Leaf B levels had a significant response to both application timing and rate in 1998, but there were no significant differences in 1999. There were no significant difference in fruit quality or yield in either year.

Introduction

Boron (B) is a micronutrient that is often thought to be toxic to many crops, even at low concentrations in leaves. However, deficiency of B is equally serious, and may be a problem in Arizona citrus. Certainly, many symptoms of B deficiency are apparent in Arizona citrus. The effects of B deficiency on vegetative growth of citrus are well known, and occur when leaf B concentrations are less than 15 ppm. Some of these symptoms include translucent or water-soaked flecks on leaves and deformation of those leaves, yellowing and enlargement of the midrib of older leaves, death and abortion of new shoots, dieback of twigs, and gum formation in the internodes of stem, branches and trunk (Reuther *et al.*, 1968). Many of these symptoms are seen in Arizona. Furthermore, the supply of B needed for reproductive growth in many crops is more than that needed for vegetative growth (Mengel and Kirkby, 1982, Marschner, 1986; Hanson, 1991), and the same may be true in citrus. Boron appears to accumulate in citrus peel to a much greater extent than in the leaves, ranging in lemon from 1600 to 3500 $ug \cdot g^{-1}$ (Sinclair, 1984). Concentrations of B also may be higher in flower parts as well. It is entirely possible that Arizona citrus appearing to have adequate B for vegetative growth may exhibit deficiency symptoms during flowering, fruit set, and fruit maturation. In citrus, B deficiency leads to low sugar content, granulation and excessive fruit abortion (Reuther *et al.*, 1968) as well as rind thickening; symptoms that are seen regularly in fruit grown here in Arizona. Increases in fruit set from B have been reported on 'Redblush' grapefruit (Maurer and Davies, 1993) and 'Hamlin' oranges, but no response on 'Lisbon' lemons (Karim *et al.*, 1996).

Materials and Methods

A field study was initiated on a block of six-year-old 'Parent Washington' navel orange trees (*Citrus sinensis* L.) on a 'Carrizo citrange' rootstock located at the Cactus Lane, Bard Ranch north of Sun City, AZ. Treatment were arranged as a 2 (spray timings) X 5 (application rates) factorial experiment with 10 single tree replicates in a randomized complete block design. Treatment included two application timings of prebloom and post

---

1The authors would like to thank the Arizona Citrus Research Council for their support of this research. This is the final report for project 99-03 - Effect of Foliar Boron Sprays on Yield and Fruit Quality of Navel Oranges.

This is a part of publication az1178: "2000 Citrus and Deciduous Fruit and Nut Research Report," College of Agriculture and Life Sciences, the University of Arizona, Tucson, Arizona, 85721.

bloom and five boron (B) concentrations of 0, 250, 500, 750 and 1000 ppm. Applications were applied prebloom (11 March 1998 and 22 March 1999) and postbloom (28 May 1998 and 5 May 1999) with a handgun sprayer calibrated to deliver 200 gpa. Sodium borate (Solubor) was applied at rates of 0, 250, 500, 750 and 1000 ppm B. All treatments were applied with Activator 90 non-ionic surfactant at 0.1% v/v. Fruit weight, juice weight, percent juice, peel thickness, total soluble solids (TSS), titratable acidity (TA), and ratio(TSS:TA) were taken prior to harvest on 11 November 1998 and 1 December 1999 . Fruit samples consisted of 10 fruit/tree from four trees per treatment. Fruit were sectioned equatorially so that the peel thickness could be measured with a hand caliper and the juice extracted by hand with a Sunkist motor driven extractor. TSS was determines with a handheld temperature-compensating refractometer and TA by titration of a 25ml aliquot of juice using 0.3125 N NaOH to a endpoint of pH 8 on an autotitrator. Leaf tissue samples collected 28 October 1998 and 27 September 1999 and analyzed by a commercial laboratory for leaf B levels. Yield was determined by weighing and counting fruit that was harvested from each tree. Fruit were harvest on 12 November 1998 and on 21 December 1999.

Results and Discussion

Leaf B levels were significantly different between timing of application and rate of application in 1998 (Table 1). Leaf B levels were significantly higher for postbloom applications (140 ppm B) compared to the prebloom applications (130 ppm B). In addition, there was a significant rate effect with the 750 and 1000-ppm B rates significantly higher than the other treatments. However, there was no interaction between application timing and rate. All leaf B levels were in the high range (100-200 ppm) for citrus (Tucker et al., 1995). The difference between application timings can be attributed to leaf development stage at the prebloom application. There were no significant differences in leaf B levels in 1999 (Table 2). Fruit weight, fruit number and average fruit size taken at harvest was similar for treatments in both years (Table 1 and 2). Likewise, fruit weight, juice weight, percent juice, peel thickness, total soluble solids, titratable acidity and ratio were similar for all treatments in 1998 and 1999 (Table 3 and 4).

The results of this experiment indicate that foliar prebloom and postbloom applications have impact on navel oranges. Although, increases in fruit production to prebloom foliar B sprays have been reported on ‘Hamlin’ oranges (Karin et al., 1996) and high levels of B resulted in an increase in fruit production on ‘Redblush’ grapefruit (Maurer and Davies, 1993) the two years of this study have not produced similar increases in production. One possible explanation is that the ‘Hamlin’ orange and ‘Redblush’ grapefruit are seeded cultivars that need pollination to set fruit. Navel oranges are set parthenocarpically and therefore do not need stimuli of pollination to set fruit. Although previously reported, cooler than normal temperatures in the spring of 1998 may have contributed to an optimum fruit set (Maurer and Taylor, 1999) this no longer appears to be the case. The failure of navel oranges to respond to prebloom foliar B sprays is similar to those reported on ‘Lisbon’ lemons (Karim et al., 1996).

Literature Cited

Hanson, E.J. 1991. Movement of boron out of tree fruit leaves. HortScience. 26:271-273.

Karim, M.R., G.C. Wright and K.C. Taylor. 1996. Effect of foliar boron sprays on yield and fruit quality of citrus. 1996 Citrus Research Report. University of Arizona, College of Agriculture, Tucson, AZ, Series P-105.

Marschner, H. 1986. Mineral nutrition of higher plants. Academic Press, San Diego, CA.

Maurer, M.A. and F.S. Davies. 1993. Use of reclaimed water for irrigation and fertilization of young ‘Redblush’ grapefruit trees. Proc. Fla. Hort. Soc. 106:22-30.

Maurer, M. and K. Taylor. 1999. Effect of foliar boron sprays on yield and fruit quality of navel oranges. 1999 Citrus and Deciduous Fruit and Nut Research Report. University of Arizona, College of Agriculture, Tucson, AZ, Series P-117.

Mengel, K. and E. A. Kirkby. 1982. Principles of plant nutrition. International Potash Institute. Bern, Switzerland.

Reuther, W., L.D. Batchelor and H.J. Webber. 1968. The citrus industry - Volume 2. University of California Division of Agriculture, Oakland, CA.

Sinclair, W.B. The biochemistry and physiology of the lemon and other citrus fruits. University of California, Division of Agriculture and Natural Resources. Publication No. 3306. Oakland, CA.

Tucker, D.P.H., A.K. Alva, L.K. Jackson and T.A. Wheaton. 1995. Nutrition of Florida Citrus Trees. University of Florida, SP 169.

Table 1. Prebloom and postbloom boron spray applications effects on leaf B levels, fruit weight, number and size of navel oranges, 1998.

Treatment Timing	Rate	Leaf B level (ppm dry wt.)	Fruit weight (lb.)	Fruit number (no.)	Fruit size (lb.)
Prebloom	0	123	186	505	0.377
Prebloom	250	125	159	426	0.383
Prebloom	500	130	139	374	0.378
Prebloom	750	135	204	564	0.372
Prebloom	1000	140	168	502	0.352
Postbloom	0	128	133	344	0.396
Postbloom	250	133	162	455	0.373
Postbloom	500	140	156	441	0.371
Postbloom	750	140	124	342	0.375
Postbloom	1000	163	150	406	0.383
Significance					
Timing		+	NS	NS	NS
Rate		*	NS	NS	NS
Timing*Rate		NS	NS	NS	NS

NS, +, * Nonsignificant or significant at P≤ 0.10 or 0.05, respectively.University of Florida, SP 169.

Table 2. Prebloom and postbloom boron spray applications effects on leaf B levels, fruit weight, number and size of navel oranges, 1999.

Treatment Timing	Rate	Leaf B level (ppm dry wt.)	Fruit weight (lb.)	Fruit number (no.)	Fruit size (lb.)
Prebloom	0	115	198	379	0.53
Prebloom	250	110	182	362	0.50
Prebloom	500	123	182	346	0.53
Prebloom	750	142	237	489	0.49
Prebloom	1000	119	186	392	0.49
Postbloom	0	115	165	311	0.55
Postbloom	250	128	190	372	0.53
Postbloom	500	133	188	373	0.51
Postbloom	750	115	155	304	0.52
Postbloom	1000	135	182	366	0.52
Significance		NS	NS	NS	NS

NS = Nonsignificant

Table 3. Prebloom and postbloom boron spray applications effects on fruit weight, juice, percent juice, peel thickness, total soluble solids (TSS), titratable acid (TA) and ratio (TSS/TA)of navel oranges, 1998.

Treatment Timing	Rate	Fruit weight (g)	Juice weight (g)	Percent juice (%)	Peel thickness (mm)	TSS (%)	TA (%)	Ratio (TSS:TA)
Prebloom	0	1735	766	44	5.5	9.9	0.77	12.8
Prebloom	250	2010	921	46	5.8	9.7	0.75	13.1
Prebloom	500	1792	823	46	5.4	9.7	0.83	11.8
Prebloom	750	1815	821	45	5.8	9.8	0.76	12.9
Prebloom	1000	1644	742	45	5.2	9.8	0.74	13.4
Postbloom	0	1917	882	46	5.5	9.2	0.83	11.1
Postbloom	250	1875	868	46	5.3	9.6	0.79	12.2
Postbloom	500	1718	788	46	5.3	9.8	0.85	11.6
Postbloom	750	1802	816	45	5.6	9.4	0.78	12.4
Postbloom	1000	1927	890	46	5.5	9.7	0.75	13.0
Significance		NS	NS	NS	NS	NS	NS	NS

NS = Nonsignificant.

Table 4. Prebloom and postbloom boron spray applications effects on fruit weight, juice, percent juice, peel thickness, total soluble solids (TSS), titratable acid (TA) and ratio (TSS/TA)of navel oranges, 1999.

Treatment		Fruit weight	Juice weight	Percent juice	Peel thickness	TSS	TA	Ratio
Timing	Rate	(g)	(g)	(%)	(mm)	(%)	(%)	(TSS:TA)
Prebloom	0	2281	1001	44	5.4	9.5	0.57	16.6
Prebloom	250	2345	1053	45	5.3	9.0	0.64	14.1
Prebloom	500	2212	989	45	5.3	9.1	0.65	14.2
Prebloom	750	2197	986	43	5.2	9.2	0.63	14.6
Prebloom	1000	2199	969	44	5.2	9.5	0.58	16.5
Postbloom	0	2230	1029	46	5.0	8.7	0.65	13.4
Postbloom	250	2289	1032	45	5.1	9.3	0.51	18.5
Postbloom	500	2365	1058	45	5.1	8.9	0.57	15.7
Postbloom	750	2348	1071	46	5.1	8.9	0.63	14.3
Postbloom	1000	2286	1009	44	5.6	9.2	0.55	16.9
Significance		NS	NS	NS	NS	NS	NS	NS

NS = Nonsignificant