Proc. Fla. State Hort. Soc. 110:136-138. 1997.

PRELIMINARY FINDINGS ON THE EFFECTS OF FOLIAR-APPLIED UREA AND BORON ON PLANT NUTRITION, FRUIT SET AND YIELD OF AVOCADO TREES[1]

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Additional index words. 'Lula', 'Booth 7', rocky soil, leaf nutrition, flower nutrition, *Persea Americana.*

ABSTRACT

Fifty-year-old 'Booth 7' and 'Lula' avocado (*Persea Americana* Mill.) trees were used to investigate the effect of foliarly applied urea and boron (B) on leaf and inflorescence nitrogen (N) and B contents, and crop yields. The urea trial included soil application of 100 lb N per acre per year (non-urea sprayed control), 10 Ib per acre of urea-N applied foliarly plus 90 Ib soil-applied N per year, and 20 Ib per acre of urea-N applied foliarly plus 80 Ib soil applied-N per year. Applications of urea were made during fruit set and early development. These preliminary data show that urea-N treatments increased leaf N 8-57% but there were no differences in N concentration in leaves among treatments sampled 28 days after application. Foliar application of urea increased fruit yield of 'Booth7' but decreased fruit yield of 'Lula''. Boron treatments consisted of two rates of B (1 or 2 Ib B/acre) and a non-sprayed control. Boron at the 1 Ib B/acre and 2 Ib B/acre rates increased leaf and inflorescence B concentration of B of 'Lula'' and 'Booth 7' 4 weeks after application. There was a trend for trees treated with B to have greater crop yields than non-sprayed controls. Preliminary results suggest foliarly applied urea and B affect leaf and inflorescence content of these nutrients and may influence crop yields.

Foliarly-applied urea has been used as a supplement to soil-applied nitrogen fertilizer to improve tissue N content, fruit set and yields in a number of crops; however, research on foliar application of urea for avocado has lead to conflicting results. Abou Aziz *et al.,* (1975) reported foliarly-applied urea increased avocado fruit set, fruit yield, size, and weight. Foliar-applied ^{15}N-enriched urea on avocado showed substantial uptake of N and urea-N was translocated from leaves to developing fruit (Zilkah *et al.,* 1987). However, Nevin *et al.*, (1990) reported uptake of ^{14}C enriched urea by avocado leaves was physiologically insignificant (<7% of the total urea applied). Regardless of these findings, some avocado growers in south Florida are applying N fertilizer foliarly. This project was designed to better understand effects of foliar-applied urea on avocado trees under Florida production conditions.

Boron is one of essential elements for plant growth. Ten roles of boron in plant nutrition have been listed by Parr and Loughman (1983). Numerous studies have investigated the effect of B on flowering and fruit set (Faust, 1989; Hanson and Breen, 1985). Boron deficiency causes 'blossom blast' in which flowers wilt, die and persist on fruit trees (Faust, 1989). Foliarly applied B increased fruit set of 'Italian' prune trees (Hanson and Breen, 1985), hazelnuts (Shrestha *et al.,* 1987) and sour cherry (Hanson, 1991); however, foliar B applications on pear (Degman, 1953) and apple (Bramlage and Thompson, 1962) showed no or inconsistent effects. Robbertse *et al.*, (1990) reported foliarly-applied B (1000 ppm) on avocado increased the boron concentration of the leaves significantly, but did not affect pollen tube growth or fruit set. Boron deficiency is not considered to be a major problem for avocado in Florida because it is frequently a component of most commercially available micronutrient fertilizer mixes. However, the requirements of avocado for B and the role of B in avocado growth and development are still not well understood. The nutrient range for healthy avocado leaves has been estimated to be 40-50 ppm in Florida (J. Crane, University of Florida, personal communication) and 50-100 ppm in California (Goodall *et al.,* 1981). Shear and Faust (1980) suggested that temperate tree fruit crops should be considered B deficient if leaf B concentrations are <15-20 ppm.

The objective of this study was to evaluate effects of foliar application of low-biuret urea and boron during flowering on leaf and flower nutrition, fruit set and yield of 'Booth 7' and 'Lula' avocado trees.

MATERIALS AND METHODS

Two experiments were conducted in a 4.4-acre orchard planted with 50 year-old 'Booth 7' and 'Lula' avocado (*Persea Americana* Mill.) trees at the Tropical Research and Education Center, Homestead, Florida. Trees were spaced at 25 ft x 50 ft on a Krome very gravely loam (loamy-skeletal, carbonatic, hyperthemic lithic Udorthents). There were six rows of trees with 25 trees per row. The orchard was split into two 3-row blocks: one was used to investigate the effect of foliar applications of urea and the other was used to investigate the effect of foliar boron. Four plots of two to four trees of 'Booth 7' alternated with three plots of four 'Lula' trees in each row.

Foliar urea experiment. The urea experiment consisted of three treatments: 1) non-sprayed control: soil application of 100 Ib N/acre/yr as regular fertilize ($8N\text{-}3P_2O_5$ - $9K_2O$); 2) 10 Ib N/acre/yr urea as foliar application plus 90 Ib N/acre/yr soil applied-N; and 3) 20 Ib N/acre/yr as foliar application plus 80 Ib N/acre/yr applied-N. Regular dry fertilizer were broadcasted under tree canopy on Feb. 1997. Liquid low-biuret urea (20% N, 0.1% biuret, Unocal Corp., Brea, CA) was used for foliar applications. Urea was applied to the foliage when "Booth 7" fruit were less than 0.5 inch in diameter and "Lula" fruit were about 1 inch in diameter and a new vegetative flush was maturing on both cultivars (25 April 1997). Twenty leaves were sampled prior to urea application and 4 days and 28 days after foliar application from each plot. The leaves were washed with 1 % detergent (liqui-Nox), rinsed several times in tap water, dipped in 1% HCI for 20 seconds followed by rinses in distilled water, dried at 76 C for 48 h, and ground in a Whiley mill to pass through 40-mesh sieve. The concentration of N in the ground leaf

sample was analyzed using the Kjeldahl procedure (Hanion *et al.,* 1995).

Table 1. Foliar B application timing for 'Lula' and 'Booth 7' avocado.

Cultivar	Stage of reproductive growth	Date of application
Lula	full bloom and new flush emerging	27 Feb. 1997
	fruit set	26 March 1997
Booth 7	flower bud swelling and panicle emerging	27 Feb. 1997
	full bloom	26 March 1997

Foliar boron experiment. A soluble boron fertilizer (20.5% B, Solubor, Borax Inc.) was used for foliar applications. Treatments consisted of B at two rates (i.e., 1 Ib and 2 Ib) and water as a control at different stages of inflorescence and fruit set for 'Lula' and 'Booth 7' trees (Table 1). Twenty leaves and flowers were taken from each plot 4 and 8 weeks after the first foliar application. Samples were processed as described for urea experiment. The ground leaf and flower samples were ashed at 500°C for 6 h. Concentrations of B were determined by an Inductively Coupled Argon Plasma Spectroscopy (ICPES).

Fruit was harvested and yield was recorded on a tree basis during November 1997.

RESULTS AND DISCUSSION

Foliar urea experiment. None of trees used for the experiment showed symptoms of N deficiency. Concentrations of N in leaves sampled from non-sprayed control plots averaged 1.67% and 1.39% for 'Booth 7' and 'Lula' trees, respectively. An optimum N leaf concentration for avocado leaves range between 1.7-2.0% in Florida (Koo and Young, 1977; Young and Koo, 1976; Young and Koo, 1977). Foliar application of urea at the 10 Ib N/acre or 20 Ib N/acre rates increased N concentration in leaves sampled 4 days after foliar application (Fig. 1). Leaf N increased 8-32% for "Booth 7" and 16-57% for 'Lula'. However, leaf N concentrations sampled 28 days after application showed no differences among treatments. The results suggest there was rapid" translocation of urea-N from the leaves to other parts of tree. Klein and Zilkah (1986) reported up to 85% of applied urea was taken up by the avocado leaves within 2 to 5 days. Results from Zilkah et al. (1987) showed 22.0% of foliar-applied urea-N was translocated to fruit after 38 days. There are trends for crop yields to increase with urea application rates for 'Booth7' trees. In contrast, fruit yields for urea-treated 'Lula' trees were about half of those compared to non-treated trees. Perhaps urea was phytotoxic to small 'Lula' fruit; although no signs of fruit or leaf phytotoxicity were observed during the course of the experiment (Fig. 1). There was a trend for 'Lula' crop yields to be less than those for 'Booth 7'. This may be due to the alternate bearing habit typical of avocado trees.

Foliar boron experiment. No trees showed symptoms of B deficiency during the course of the experiment. However, leaves sampled 3 weeks before B applications were 23.0 ppm and 21.45 ppm for "Booth 7" and 'Lula', respectively. This is substantially lower than estimates for Florida avocado leaves (J. Crane, University of Florida, personal communication) and those reported in California (Goodall *et al*., 1981). Boron applied at

the 1 lb B/acre and 2 lb B/acre rates significantly increased B leaf concentration 4 weeks after foliar application for 'Lula' (Fig. 2). 'Booth 7' did not have a new flush for the first sampling. 'Lula' leaf B concentrations decreased for all treatments 8 weeks after application (Fig. 2). However, leaf B was significantly greater 1 lb/acre and 2 lb/acre treatment rates than non-sprayed controls. Reduced leaf B concentrations 8 weeks after application may be due to dilution caused by the leaf expansion of maturing leaves.

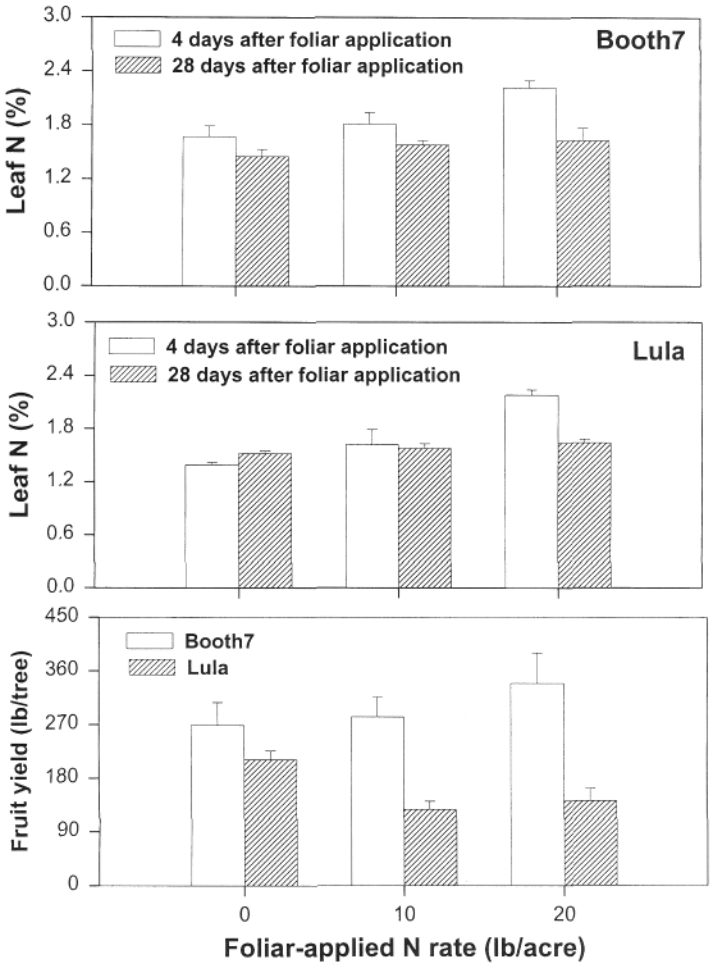

Figure 1. Effect of foliar urea application on leaf N concentrations and fruit yields of 'Booth 7' and 'Lula' avocado. Bar represents the standard error of the mean.

Foliarly-applied B significantly increased B concentrations in 'Booth 7' and 'Lula' inflorescences 4 weeks after application (Fig.3). Boron concentrations in inflorescences were about 1.5-12.1% higher than that in leaves.

There was a trend for increased crop production of 'Booth 7' and 'Lula' trees treated with B compared to nonsprayed controls (Fig. 3). The yield responses to boron were somewhat similar to those 'Lula' trees treated with foliar urea, and these responses

were less than those of 'Booth 7'.

Summary. Foliarly applied urea increased foliar uptake of N within 4 days for 'Booth 7'' and 'Lula' trees. Decreased N concentrations 28 days after application suggests N from urea-treated leaves was translocated to other plant parts (e.g., wood, developing fruit). Foliar applications of B increased leaf and inflorescence concentrations for both cultivars compared to non-sprayed controls. Foliar application of urea increased fruit yield of 'Booth 7' but decreased fruit yield of 'Lula''. Foliar B applications tended to increase crop yields compared to non-sprayed controls.

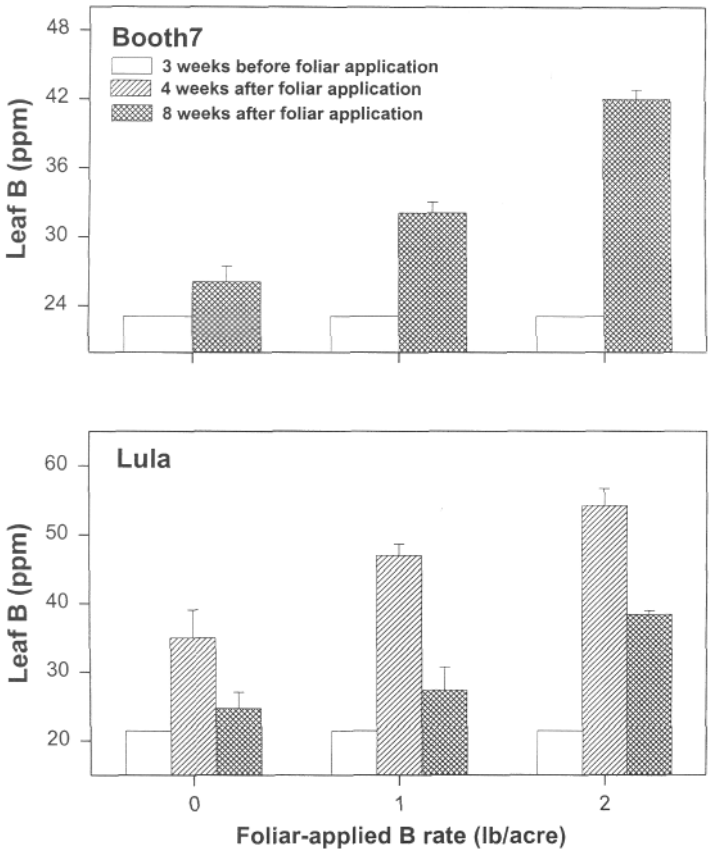

Figure 2. Effect of foliar B application on leaf B concentrations of 'Booth 7' and 'Lula' avocado. The vertical line at each data point is the standard error of the mean.

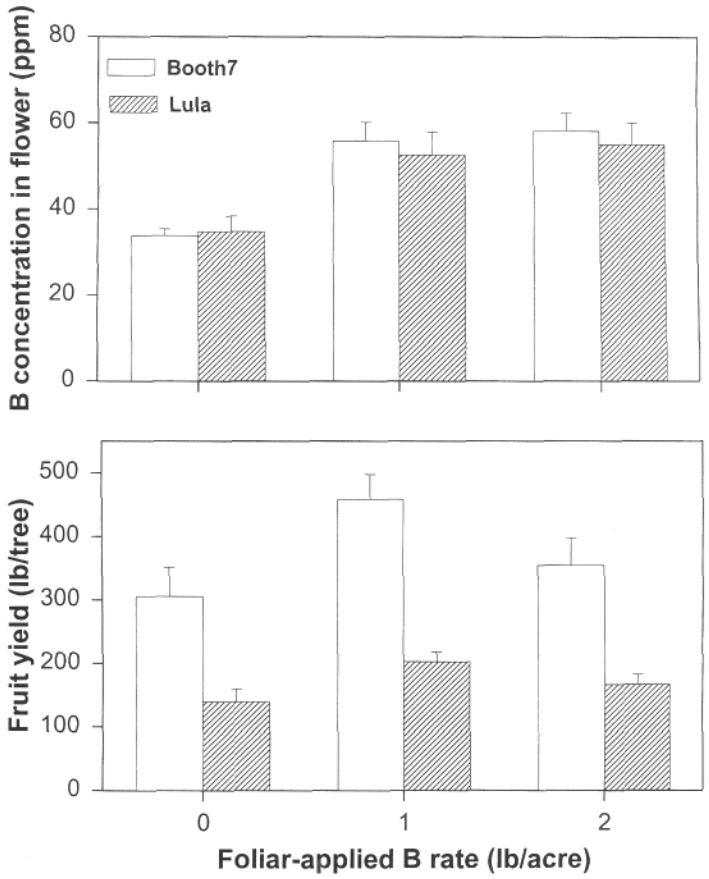

Figure 3. Effect of foliar B application on B concentrations in flowers and fruit yields of 'Booth 7' and 'Lula' avocado. The vertical line at each data point is the standard error of the mean.

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[1]Florida Agricultural Experiment Station Journal Series No. N-01481.