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Soil Boron Application for the Control of Boron Deficiency in KwaZulu-Natal Avocado Orchards

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ABSTRACT

Soil boron (B) applications over two full growing seasons have been shown to be effective at correcting deficiencies and maintaining adequate leaf concentrations when applied at sufficient yet judicious application rates. In the range from 0 to 60g borax/m^2/year (applied as 3 split applications) uptake was limited and slow during the first 12 months, but increased dramatically during the second season.

Highest applications (60 and 40g/m^2/year) both resulted in severe toxicity symptoms appearing in January 1997, on a fairly heavy Inanda type soil. Applications of 10 and 20g/m^2/year were shown to be most effective rates, however the higher rate, which should be used with caution, would only be necessary for one season on old extremely deficient orchards, after which a lower rate could be used.

An application of 5g/m^2/year was shown to be inadequate to significantly raise leaf boron concentrations on this particular soil type and within the time span of the experiment, and is better suited to a maintenance dosage. Applications were most effective in younger orchards, where lower application rates were more effective.

In addition to correcting the deficiency, average fruit size were increased by 4% and raised yield by 10%. Further research is required, especially for other soil types.

INTRODUCTION

Orchard boron (B) requirements in South Africa have until recently been met by means of foliar sprays applied during flowering when the demand for B is at its greatest. It was believed that soil B applications caused toxicity and were deleterious to feeder root health. This restrained growers from using soil applications. More recently, B deficiency symptoms, which have for many years remained unrecognised were identified in Australia (Whiley *et al,* 1996), and found to be highly prevalent in South African avocado orchards. It was believed that foliar applications were not providing sufficiently for the high requirement of the entire tree, including the vitally important root system. Moreover, foliar applications are believed to be relatively ineffective except on younger foliage in that mature leaves, having a relatively thick cuticle, only allowing limited uptake into the leaf. Substantial amounts of foliar applied boron remain on the surface of the leaf, or are trapped in the cuticle where it falsely inflates annual leaf analysis values and leads growers into believing that the B status of the orchard is higher than it is in reality. In

addition, the limited uptake of sprays is likely to be largely localised to the leaf. Since B is probably poorly phloem translocated in avocado (unlike in many deciduous fruit trees), sprays do not cater for the needs of the entire tree, particularly the roots and developing fruit. This experiment aimed at determining at what rate toxicity would occur in the KwaZulu-Natal Midlands, thus providing a safety margin for the fairly high clay red soils typical of the area. Australian results served as a basis for planning the trial (A.W. Whiley, pers. comm.).

It should be noted that Jaganath and Lovatt (1995) in California recommend foliar application at the pre-bloom stage of flowering in combination with urea, rather than the current standard South African spray recommendation of spraying at 50% flowering.

MATERIALSAND METHODS

At Cooling Estate (Wartburg), trials were continued at two sites with trees of 2m and 5m canopy diameter in 1995. The former block of trees consists of 4 year old Hass trees (in 1995), and the other of 8 year old trees. Both blocks are on clonal Duke 7 rootstock growing in Hutton/Inanda soil form with sandy-clay texture (±35% clay). Trees have been treated with the following borax rates (m^2/year of soil surface beneath the canopy): 0g, 5g, 10g, 20g, 40g and 60g. Applications were split into 3 equal applications applied in January, April and September. The first application was made in September 1995. Monthly leaf samples were taken and analysed for B using the Azomethane-H method (Shahina *et al,* 1967). Fruit samples were taken in February, April and June, and analysed for B. Fruit size was determined gravimetrically at harvest in July 1996. Nature and onset of toxicity symptoms were recorded. To determine the soil B concentration, soil samples were taken from Everdon, Cooling and Baynesfield Estates, and soil B was determined using the hot water extraction method (Wear, 1965). It must be stressed that Australian research has shown that borax application rates are usually between about 5g/m^2 (sandier soils) to about 15g/m^2/year (heavy clay soils). The much higher rates included in this trial were purposefully used to experimentally induce toxicity symptoms.

RESULTS AND DISCUSSION

Results show that all soil B applications raised leaf B concentrations proportionally to the application rate (figures 1 & 2). Initial uptake during the first season appeared slow, particularly in older trees. It is possible that poor root growth reduced uptake, or B was held in the structural framework of the tree, thereby reducing translocation to the leaf. Younger trees responded somewhat more quickly (figure 2). No toxicities were noticed during the first season even at highest application rates, however, severe toxicities appeared in both 40 and 60g/m^2/year treatments in January, 1997. Toxicity symptoms appearing in the leaves, began as a necrotic area at the leaf apex (figure 5). Following this, necrotic spots developed on the leaf margin, moving slowly towards the leaf petiole (figure 6). Badly affected leaves senesced prematurely, turning yellow in colour and abscised.

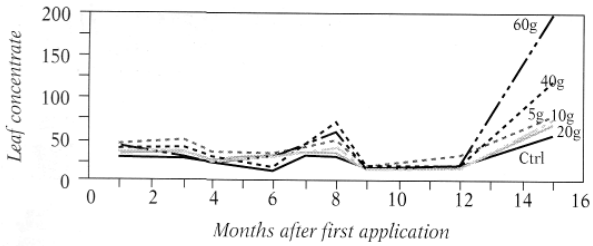

Figure 1
Effect of soil B application rate on leaf B concentration for older trees

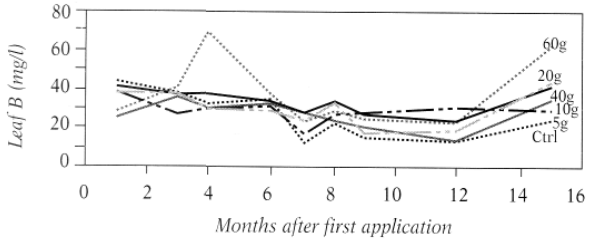

Figure 2
Effect of soil B application rate on leaf B concentration for younger trees

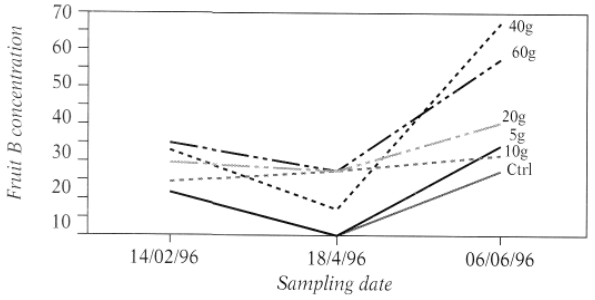

Figure 3
Effect of soil B application rate on fruit B concentrations in older trees

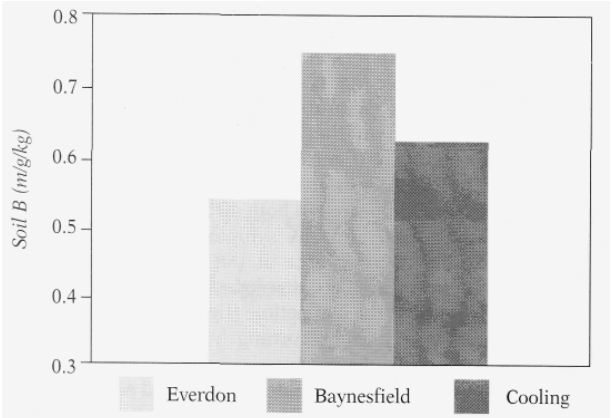

Figure 4
Soil B concentrations for avocado growing areas in the KwaZulu-Natal Midlands

Figure 5
Early warning signs of B toxicity

Figure 6
Advanced stage of B toxicity

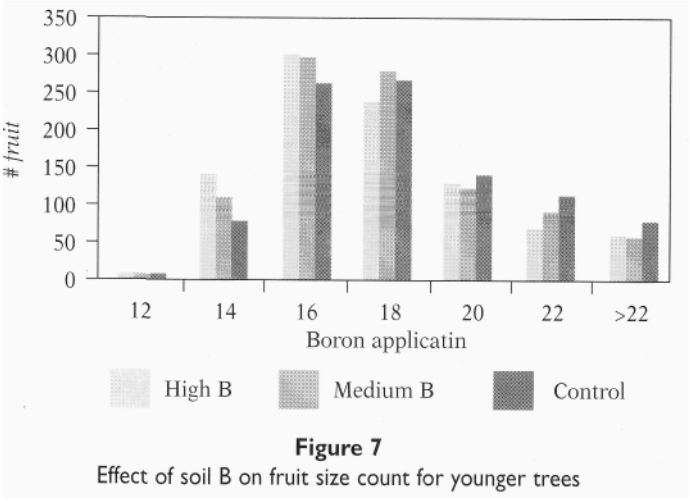

Figure 7
Effect of soil B on fruit size count for younger trees

It appears that the time of greatest uptake and accumulation of B occurred from late December to February, after which leaf concentrations decreased markedly. This is likely to occur as a result of good feeder root health during this time, which accommodates rapid uptake of B to emerging flushes and developing fruit. It follows that most effective application would be during this time. B concentrations also increased from the end of April to mid June, however increases during this time were not as great.

Analysis of fruit tissue for B indicated that applications were reaching the fruit where it is required for fruit growth. All soil applications increased fruit B concentrations.

An increased average fruit size was noted in the younger trees. In the experiment involving older trees, no increase in fruit size or yield could be established because of the high variability of tree yield within the treatments, however, the experiment will be continued for the next season.

Results show that soil applications are effective at controlling B deficiency in the avocado in the KwaZulu-Natal Midlands. It should be noted that soils in this region are extremely deficient in B and contain on average less than 1mg/kg (determined using the hot water analysis). Soil analysis is recommended particularly under arid conditions, where leaching of B is unlikely to occur. Under dry conditions, margins of toxicity are likely to decrease dramatically and toxicity could easily be induced by only slight over-application.

Average fruit size between the control and highest application was increased by 4%. This amounted to a 10% increase in yield, or at the planting density used, increased yield by 2 t/ha. It should be noted that in addition to the increase in yield per hectare, the value of the crop was increased as a result of increased fruit size. In particular, increases were noted in the larger fruit sizes (figure 5) viz. count sizes 14 and 16. It should be noted that although figure 5 indicates 'High B' as resulting in the largest fruit size, higher applications do not simply imply better yields. In this case, it was higher applications that resulted in leaf B concentrations rising to levels of sufficiency, i.e. 50mg/kg. Therefore, growers are advised to raise leaf B concentrations to this

recommended norm to experience noted improvements in yield.

CONCLUSIONS

Soil B applications have been shown to be successful at increasing leaf B concentration to the desired level of ±50mg kg^{-1}. When used at judicious and carefully monitored rates, this is possible without any deleterious effects. Applications also increase fruit size and yield. Conservative application is advised. Where severe deficiencies occur, the use of an experienced horticultural consultant in deciding on heavier application rates, is recommended. For correcting severe deficiencies, the greater the application the quicker the deficiency can be rectified, however the risk of toxicity is greatly increased. At this stage, an application rate of greater than 20g borax/m^2/year is not recommended under any circumstances. A rate between 10 and 15g borax/m^2/year (divided into three applications) is probably safe for soils with more than 35% clay, especially in years of above average rainfall. However, the rate should be reduced for lighter textured soils, where at least four applications per year are suggested. If other boron fertilizers are used, rates must be adjusted according to the boron concentration of the fertilizer compound.

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