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Bud Break in Pecan following Boron Toxicity[1]

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Additional index words. Carya illinoensis

Abstract. **Boron was soil applied to pecan trees (*Carya illinoensis* (Wang) K. Koch) at the rate of 0, 12.5, 25.0, 50.0, or 100 g per tree. Boron toxicity increased with B applied. Bud break the following spring was advanced in relation to B applied and toxicity incurred.**

Pecan bud break has been shown to be advanced following apparent freeze injury during the preceding fall (3). The results confirmed our observations that bud break in pecan is often advanced following injury or stress conditions. Chandler et al. (2) reported similar observations for fruit trees in general. In this paper we report bud break of pecan following injury from excessive B during the preceding growing season.

'Cherokee' pecan trees were planted Jan. 8, 1975, on the Southeastern Fruit and Tree Nut Research Station as 1-yr-old whips on 3-yr-old rootstocks. Spacing was 4.6 × 4.6 m. The soil was subsoiled to a 60 cm depth and limed with dolomitic limestone to pH 6.5 prior to planting. Fertilization was 1122 kg of 5N–4.3P–12.4K per ha during dormancy plus 0.5 kg of 10N–4.3P–8.3K per tree in June. The experimental design was a randomized complete block replicated 5 times with 4 trees per plot. The original objective was to study the effect of insecticides on control of pecan bud moth, *Gretchena bolliana* (Slingerland). However, during shoot elongation, the foliage became chlorotic and leaflet size was suppressed and often straplike. Varying degrees of shoot dieback and defoliation occurred. This disorder invalidated the original objective of the study.

Leaflet analysis (May 30) suggested the disorder was due to B deficiency. Boron in the leaflet ranged from 4 to 11 ppm and varied inversely with the severity of the disorder. As a result, a study was initiated to observe the effects of B on the disorder. Boron as sodium borate was applied to the soil on June 6, 1975, at rates to give 0, 12.5, 25.0, 50.0, or 100.0 g of elemental B on a 9m^2 area around each tree.

By mid-June a second cycle of shoot growth had developed from the original shoots, or buds on the whip had broken and grown. Except for occasional leaflets, the new leaflets were of normal color and size regardless of the B treatment. However, by July 10, trees receiving 50 g or more of B began to show B toxicity symptoms (1) on the foliage of the old shoots and later on the foliage of the new shoots. Toxicity symptoms intensified as the season progressed. One tree receiving 100 g of B died. Toxicity symptoms were recorded by tree on Oct. 23, 1975.

We anticipated that injury from excessive B might advance the time of bud break the following spring. Thus, date of bud break by tree was recorded in 1976 from Mar. 3 until bud break had occurred on all trees, Mar. 25.

Advancement of bud break in 1976 was related to the amount of B applied and the degree of toxicity occurring in 1975 (Fig. 1). We propose that bud break advancement was not a result of B as such but simply a response to injury associated with toxicity. An injury hypothesis is supported by other results

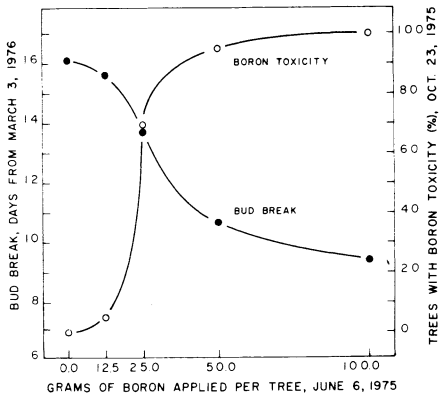

Fig. 1. Bud break in pecan as a function of B applied to the soil and B toxicity. Bud break effect was statistically significant at the 1% level.

(3) which showed that bud break in pecan was advanced on apparent freeze-injured trees and by our observations that bud break on injured pecan trees is often advanced whether it be from winter injury, partially broken limbs, trunk damage from farm implements, or other factors. Possibly, injury or stress prevents the tree from entering maximum rest.

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Determination of Moisture in Walnut Seeds by Near-infrared Spectrophotometry[1]

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Abstract. **A method is described for the rapid determination of percent water in walnut seed by use of near-infrared spectrophotometry.**

Percent water in a shipment of walnuts is estimated by taking a sample of the nuts and determining the moisture in the seeds on a Cenco Moisture Balance[3] (CMB). The sample is chopped, distributed evenly on a balance pan, and dried under an infrared lamp. Percent moisture is read directly on a 0–100 scale. With this procedure, about 30 min is required to prepare and analyze one 5 g sample. Thus, although the procedure is dependable, only a few samples, representing many hundreds of tons of walnuts, can be analyzed per day. Therefore, a faster method of estimating moisture percent would be useful.

Hart et al. (2) found that % moisture in grain seeds could be determined by near-infrared spectrophotometry (NIRS) of methanol extracts. Subsequently, this method was applied to soil samples by Bowers and Smith (1). Keyworth (3) demonstrated that absorbance at 1940 nm is proportional to water

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[3]Trade names are used to identify equipment or material used, and do not imply endorsement of the product.

concn from 0 to 2.45%. However, samples containing more than 2.45% water could be analyzed by diluting them with dry methanol to reduce the water content to the optimum range. With this adaptation, moisture from 5 to 61% was measured. Dry methanol was used in the reference cell.

The purpose of our study was to adapt the NIRS method to determination of moisture percent in walnut seeds.

The 20 g samples were prepared from seed lots ranging in moisture from 3 to 30%. The seeds were placed in a Waring Blendor containing 100 ml of absolute methanol to obtain a range of 0.25 to 4% water. Both standards and samples were scanned from 1300 to 2100 nm, was rinsed with additional methanol to recover all of the sample, and the final volume was adjusted to 250 ml. The flask was then stoppered and weighed to calculate the weight of methanol used. A portion of the slurry was centrifuged in a capped tube for clarification. The clear supernatant liquid was decanted into an Erlenmeyer flask which was then sealed, and the sample was analyzed spectrophotometrically. Preparation of the sample required about 10 min.

A Beckman DK-2A ratio-recording spectrophotometer was used to measure absorbance. The optical system was designed for double beam operation. With dry methanol placed in both the reference and sample cells, and the instrument adjusted for 100% transmission, absorbance of the methanol was eliminated. Then when a mixture of methanol and water was placed in the sample cell, only the absorbance of water was measured. The scale from 0.0 to 1.0 was used.

Standards were prepared by adding known amounts of water to 100% methanol to obtain a range of 0.25 to 4% water. Both standards and samples were scanned from 1300 to 2100 nm, and the absorbance of the samples was compared with the standard peaks (Fig. 1).

Absorbance at 1940 nm was too strong to be useful in measuring the normal range of % water in the diluted samples. However, the peaks at 1440 nm were strong and included the entire range of % water with good resolution (Fig. 1). Absorbance of the samples was compared with absorbance of the standards at 1440 nm, and % water was determined (Table 1). For samples with low % water, 1940 nm was useful.

In 4 trials, a correlation coefficient of 0.999 was obtained between absorbance and % water in the standards with $Y = 0.003 + 0.0607\ X$ (Fig. 2).

Absorbance = 0.003 + (0.067) (%H_2O); therefore

$$\%\ H_2O = \frac{\text{absorbance} - 0.003}{0.0607}$$

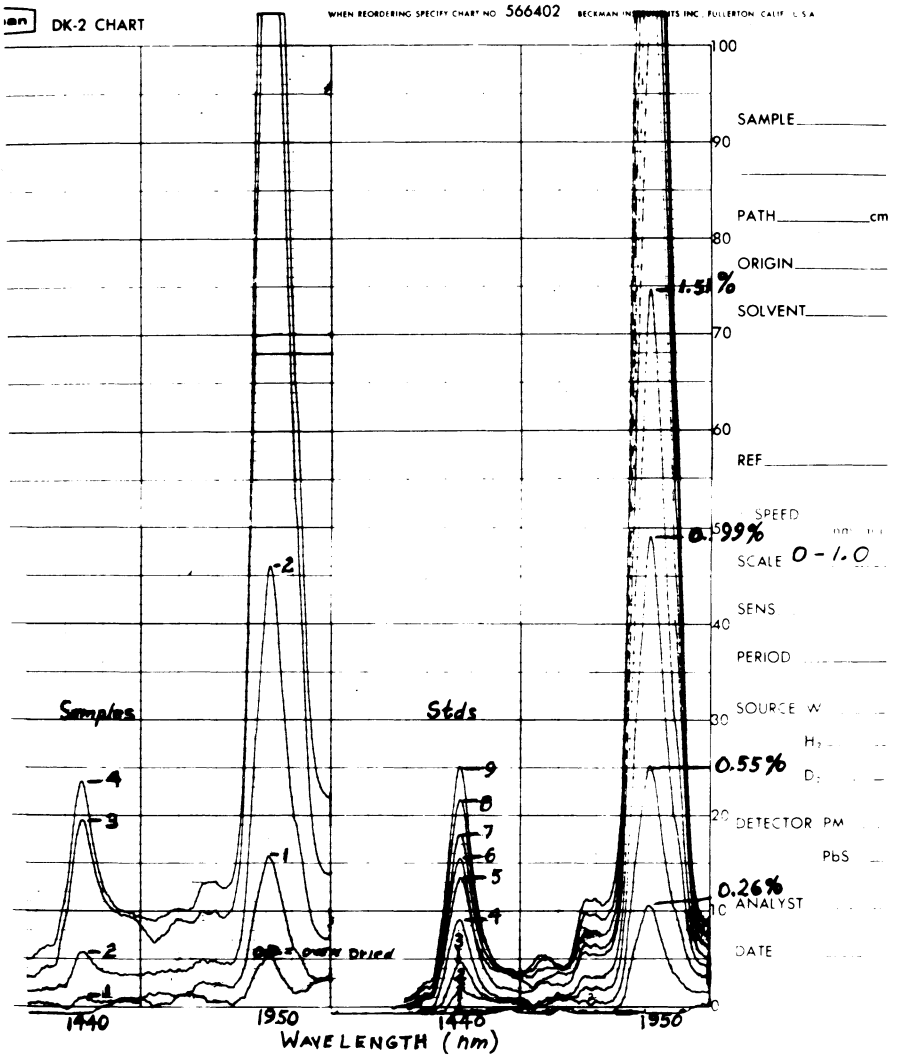

Fig. 1. NIRS analysis of wt % water in methanol standards and walnut seed samples from 1300 to 2100 nm.

Knowing the % water in the methanol extract, one can calculate % water in the seed sample by determining the weight of water extracted from the seeds. The weight of water in the extract ($gH_2O(E)$) is given by the following equation:

$$gH_2O(E) = (\%\ H_2O(E))(\text{wt MeOH})$$

substituting absorbance for % H_2O gives:

$$gH_2O(E) = \frac{(\text{absorbance} - 0.003)(\text{wt MeOH})}{0.0607}$$

and % water in the seeds (% $H_2O(S)$) is given by:

$$\%\ H_2O(S) = \frac{(\text{absorbance} - 0.003)\ (\text{wt MeOH})}{(0.0607)\ (\text{Sample wt})}$$

Table 1. Absorbance at 1440 nm of standard methanol-water mixtures and walnut seed extracts.[z]

Standards			Methanol extracts of seeds		
Sample	% H_2O	Absorbance	Sample	% H_2O[y]	Absorbance
1	0.26	0.015	1	0.02	0.38
2	0.55	0.025	2	0.058	1.04
3	0.99	0.055	3	0.195	3.12
4	1.51	0.095	4	0.235	3.74
5	2.00	0.135			
6	2.49	0.155			
7	2.97	0.180			
8	3.54	0.220			
9	4.02	0.255			

[z]See also Fig. 1.

[y]Calculated from absorbance using standards as reference.

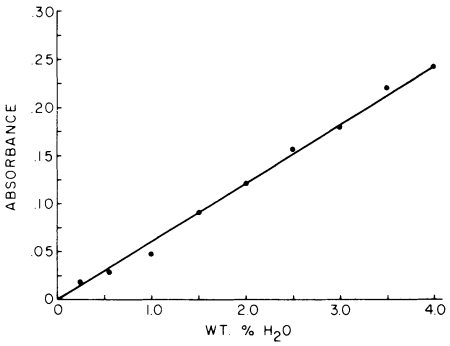

Fig. 2. Standard curve for absorbance versus wt % water in methanol as determined by NIRS at 1440 nm.

Nine samples of walnut seeds containing a range of moisture levels were divided into 2 lots each. One lot was analyzed by NIRS, the other with the CMB. There was close agreement between the % H_2O found by NIRS and that found by the CMB method (Table 2). The differences reflect errors in calculating % H_2O in the methanol extracts from the regression equation $Y = 0.003 + 0.0607 X$, predicted values for absorbance from % H_2O in the standards being both higher and lower than the observed results. Furthermore, the relationship between X and Y may be curvilinear when the range of X is extended. Thus, a small error is introduced by assuming a straight line within the limits of the X values used.

The NIRS method is rapid, and repeatable results are easily obtained. At least twice as many samples can be analyzed per unit time with NIRS as with the CMB procedure. With NIRS the limiting factor is the initial grinding-extraction. Time could be saved by utilizing several blenders.

Table 2. Percent water found in duplicate lots of walnut seeds as determined by NIRS vs. CMB.

	Lot								
Method	1	2	3	4	5	6	7	8	9
NIRS	2.0	2.3	3.6	4.0	10.9	18.9	25.4	29.3	29.5
CMB	2.2	2.4	2.6	3.0	10.5	18.7	25.6	29.3	29.1

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Yield, Fruit Size, and Chlorosis of Grapefruit on 10 Rootstocks[1]

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Additional index words. Citrus paradisi, foot rot, calcareous soil

Abstract. **Grapefruit trees (*Citrus paradisi* Macf.) budded on Karna Khatta and sour orange were most productive in a test including 10 rootstocks. Karna Khatta, sour orange, and Yuzu were tolerant, 'Orlando' tangelo and 'Ortanique' tangor were intolerant of calcareous soil. Trees on Karna Khatta were more susceptible to foot rot than trees on sour orange.**

The performance of 9 citrus species and hybrids as rootstocks for grapefruit was compared with sour orange, the standard rootstock used in commercial groves in southern Texas as part of a series of tests (2, 7, 9). One long-term and 2 short-term tests were conducted between 1963 and 1974. Nucellar CES #3 'Redblush' grapefruit was budded in a nursery in 1962 for the long-term and 1 short-term test on sour orange, (*C. aurantium* (L.); 'Ortanique' [probable hybrid of *C. sinensis* (L.) Osbeck × *C. reticulata* Blanco]; 'Scarlet Emperor', 'Soh Siem', and 'Sanguinea' mandarins (*C. reticulata* Blanco); 'Orlando' tangelo (*C. paradisi* × *C. reticulata*); Assam lemon [*C. limon* (L.) Burm. f.]; Karna Khatta (probable hybrid of rough lemon, *C. jambhiri* Lush.); Yuzu (putative *C. ichangensis* × *C. reticulata* var. *austera* hybrid); and C58-229 [Rangpur lime (*C. reticulata* var. *austera* hyb.?) × Troyer citrange (*Poncirus trifoliata* (L.) Raf. × *C. sinensis*)]. Karna Khatta and sour orange seedlings in pots (15 cm diam with a 2 soil:1 peat:1 perlite mixture) were budded in 1968 with nucellar CES #3 'Redblush' and old-line 'Webb Redblush' grapefruit; 'Valencia' sweet orange, *C. sinensis* (L.) Osbeck; and 'Fairchild' mandarin hybrid [*C. reticulata* × (*C. reticulata*)] for the second short-term test.

Trees budded in 1962 were planted in the field at 2 sites in Feb. 1963. Six trees of each of the 10 rootstock-scion combinations were planted at Weslaco, Texas, on deep, sandy loam soil (pH 7.3, EC of saturation extract 0.37 millimhos/cm) in a randomized complete block design, with single-tree plots and 4.7 × 7.6 m spacing for the long-term performance test. A short-term test for chlorosis with an equal no. of trees, except for the C 58-229 rootstock where only 3 trees were used, was planted at the same time at Monte Alto, Texas, on calcareous, sandy loam soil containing 5% $CaCO_3$ in the top 30 cm, and 20% $CaCO_3$ at the 1 m-level (pH 8.2, EC of saturation extract 0.73 millimhos/cm). Spacing and design were the same as at Weslaco.

The second short-term test, 8 single-tree replications of 4 scion cultivars on Karna Khatta and sour orange rootstock, was planted in 1969 on sandy, loam soil (pH 7.2, EC of saturation extract 1.25 millimhos/cm) at Monte Alto. Design, spacing, and grove care were as in the other tests. Grove care included 3 to 4 insecticide sprays, 4 to 7 irrigations with Rio Grande River water (700–1,200 ppm total salts), and 1 application of 150 kg/ha of N per year.

Most of the trees in the first short-term chlorosis test on calcerous soil at Monte Alto were removed 18 months after planting. Trunk circumferences were determined and trees were rated for chlorosis (Table 1). Only 2 of 6 trees on 'Orlando' rootstock survived and they were severely chlorotic. Trees on 'Ortanique' and 'Sanguinea' were also chlorosis-prone. Trees on sour orange, Karna Khatta, and Yuzu were only mildly chlorotic. The largest trees were on Karna Khatta and sour orange rootstocks, the smallest on 'Sanguinea' and 'Ortanique'.

Three trees on some rootstocks were left in the test plot. A 30-fruit sample was collected from trees on sour orange and Karna Khatta in Feb. 1968 when they were 6 years old. Fruit circumference was 33.3 cm; fruit wt 490 g; rind thickness 6.4 mm; juice content 55.1%; total soluble solids 9.1%; total acids 1.02%; and Brix-acid ratio 8.91 for trees on sour orange rootstock. Values for trees on Karna Khatta were

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