

Relationship Between Deformed-Fruit Disease of Papaya and Boron Deficiency

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ABSTRACT

Leaf samples collected from papaya trees with deformed fruits contained only about one-fourth as much boron as the leaves of healthy trees. Tomato and lettuce grown in soils collected from diseased fields developed typical boron deficiency symptoms. The disease was controlled by spraying

leaves of diseased trees with 0.25% borax or boric acid solution, or by applying 0.5 g borax around a diseased tree. Results indicate that this deformed-fruit disease of papaya is caused by boron deficiency.

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Three years ago, in Southern Taiwan, it was noticed that many papaya (*Carica papaya* L.) fruit were suffering from latex secretion and deformity (Fig. 1-A, B). The disease, which is called "Ki-rui" locally, affects all commercial cultivars, and is most serious in sandy areas and during the dry winter. The percentage of unmarketable papaya fruits sometimes reached as high as

100% in some areas. In this paper, we report the association of this previously undescribed disease of papaya with boron deficiency.

MATERIALS AND METHODS.—The number of papaya trees per treatment and replicates used was 4 × 2 and 10 × 5 for Experiments I and II, respectively. Leaves were sprayed six times with 0.25% borax (Na₂B₄O₇·10

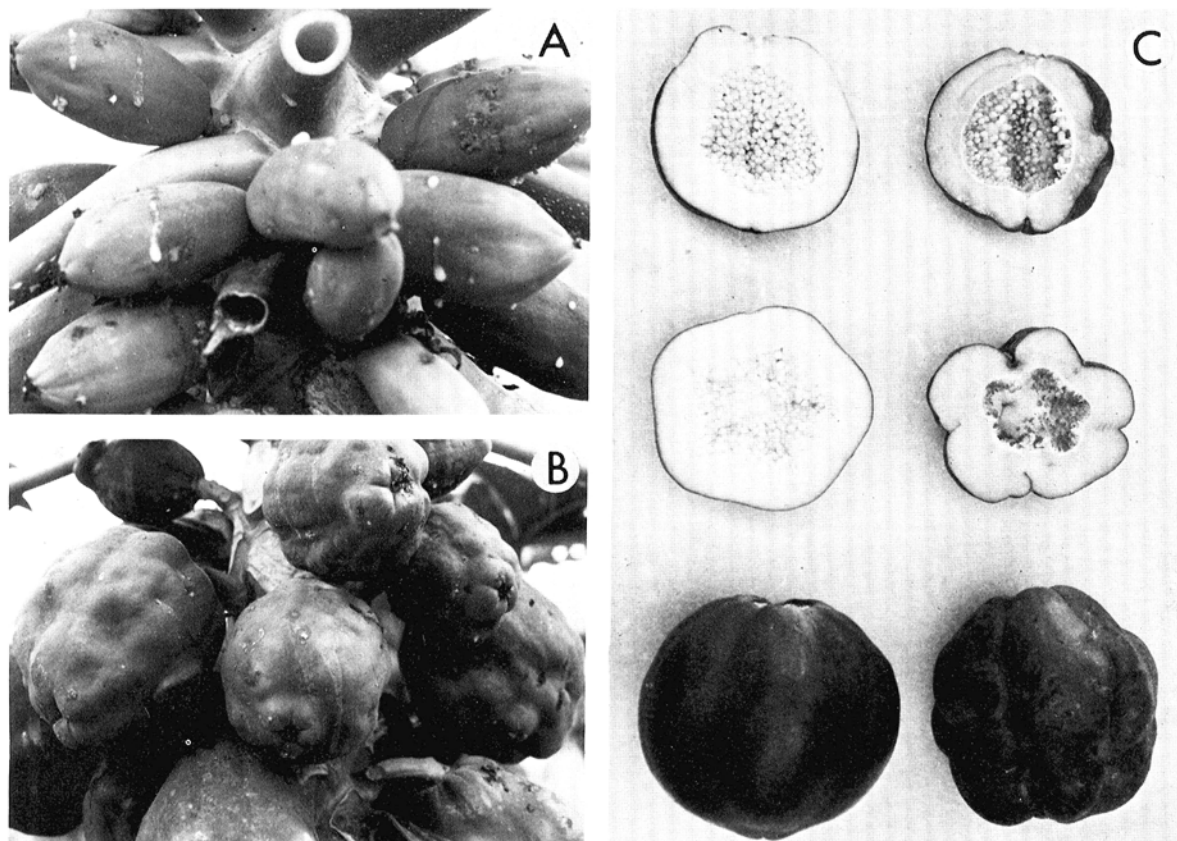


Fig. 1-(A to C). **A**) The early stage of deformed-fruit disease. Note the secretion of milky latex from affected fruits. **B**) The late stage of deformed-fruit disease. Note the roughness and deformity of the affected fruits. **C**) Internal and external appearance of normal fruits (left column), and deformed fruits (right column).

TABLE 1. The mineral content of leaves from diseased and healthy papaya trees

Source of sample	% (dry weight basis)						μg/g					
	Ca	K	Na	Mg	P	Al	B	Ba	Cu	Fe	Mn	Zn
Diseased trees	3.23	1.70	0.04	1.20	0.26	201.66	14.02	4.22	16.40	210.18	98.88	30.61
Healthy trees	3.49	1.01	0.04	1.26	0.27	201.66	52.89	3.40	16.64	174.03	99.34	41.61

TABLE 2. Control of deformed-fruit disease of papaya by foliar spray with 0.25% borax solution

Treatment	Diseased plants (%)		Diseased fruits (%)	
	Expt. I	Expt. II	Expt. I ^a	Expt. II ^b
Treated with borax	0	2	0	0.07
Control	100	100	100	83.91

^aThe total number of fruits counted was 106 and 71 for treated and nontreated trees, respectively.

^bThe total number of fruits counted was 1,446 and 1,700 for treated and nontreated trees, respectively.

H₂O) solution once every 10 days. Data were taken three months after the first treatment, and all fruits, except those with deformity at the beginning of the spray program, were counted.

Leaf samples were taken from six healthy and six diseased papaya trees, and their mineral contents were analyzed by International Minerals and Chemical Corporation, Libertyville, Illinois, U.S.A.

Lettuce and tomato used as indicator plants were established in 10-liter plastic containers containing soils collected from two fields with the disease problem, and from one field free from the disease. Each container contained one plant and each treatment consisted of six plants.

RESULTS.—Symptomatology.—Only fruits were affected. Leaves and stems of the trees appeared to be normal. In the early stage of symptom development, secretion of a milky latex occurred at 1-5 locations on a fruit during the evening (Fig. 1-A). Later, the latex turns brown. Sometimes the latex secretion occurred more than once from the same location. At the late stage of disease development, the fruit surface became rough and lumpy

(Fig. 1-B). Most seeds in the seed cavity of the affected fruit are abortive or poorly developed (Fig. 1-C). If symptoms begin when fruits are very small, most do not develop to full size.

Etiology and control.—Among the minerals analyzed, the greatest difference in mineral content between healthy and diseased tissues was in boron (Table 1). The diseased tissue contained only about one-fourth the concentration of boron of the healthy leaf tissue.

Both lettuce and tomato grown in soils collected from diseased fields developed typical boron deficiency symptoms (1). Terminal leaves of lettuce were distorted and had necrotic margins. Tomato leaves just below terminal growth were stiff and brittle. Tomato plants also looked bushy because of proliferation of the laterals. Lettuce and tomato plants grown in soil collected from the healthy field were normal.

Three months after treatment with 0.25% borax solution, all papaya fruits (except one) which developed on previously diseased trees were normal (Table 2). However, in the control 100 and 83.91% of fruits in Experiment I and II, respectively, were deformed. Boric acid at the same concentration as borax was also effective in controlling the deformed-fruit disease of papaya. Results also showed that spraying leaves of diseased trees only once with 0.25% borax solution, or applying 0.5 g borax around a diseased tree, was sufficient to control the disease. Based on our recommendation, several papaya growers in Taiwan have successfully controlled the deformed-fruit disease in their own fields by foliar application of borax solution.

DISCUSSION.—No insects were found to be associated with the deformed-fruit disease of papaya. Neither was a disease-spreading pattern observed in the fields. Its frequent occurrence in sandy soils and prevalence during the dry winter indicated that deficiency of nutrients might be a possible cause of the disease. Tissue analyses showed that the boron content in the leaf samples of diseased trees was much lower than that in the healthy trees. Tomato and lettuce grown in soils collected from the diseased field exhibited typical boron deficiency symptoms. These suggested that the deformed-fruit disease of papaya is caused by boron deficiency. This assumption was confirmed by the field tests which demonstrated that the application of borax or boric acid to diseased trees prevented the fruits from developing deformity. Our results indicate that the observed fruit deformity of papaya was due to deficiency of boron.

Boron deficiency also caused deformity of apple fruits, but without latex secretion (2). Apple trees also show the symptoms of dieback and rosetts when they are deficient in boron, whereas no symptoms appear on leaves and stems of papaya trees suffering from boron deficiency.

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