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Plant Disease
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Boron Deficiency of Papaya

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Papaya plants can suffer from deficiencies of major and minor elements required for growth, including nitrogen, potassium, magnesium, iron, zinc, calcium, and boron. Deficiency symptoms associated with each element are distinct; therefore, growers can identify and correct the problem by applying the appropriate fertilizer.

Such deficiency diseases arise in particular environments and where plants receive insufficient care. In areas of high rainfall, elements leach through the soil profile and out of the root zone. In acidic soils, certain elements may become bound to clay particles and be unavailable to plants. Some soils are compacted, lacking in oxygen, and need to be aerated. Other soils are naturally deficient in certain elements, making it necessary to amend them with fertilizers.

A papaya fruit column showing typical symptoms of boron deficiency (photograph: Wayne Nishijima).

A distinctive deficiency disease of papaya in Hawai'i, which dramatically distorts the fruits, is caused by a lack of boron. Here we illustrate its symptoms and describe integrated practices to prevent and correct this abiotic, non-infectious disease.

Boron

Boron is a ubiquitous element in rocks, soil, and water. The basaltic rocks that erode to form the soils of Hawai'i contain about 5 ppm (parts per million) of boron (Woods 1994), while boron in soils derived from these rocks ranges in other places from about 2 to 100 ppm (Woods 1994). Some of the boron in soils also comes from decomposing organic matter. In areas of high annual rainfall, especially in sandy and rocky soils, boron leaches from soil profiles. During rainy or wet weather, therefore, plants may encounter long periods of low boron levels, resulting in acute boron-deficiency symptoms. Chronic boron deficiencies can also occur in soils that are usually dry, or in soils with a high pH. These conditions are common in deserts and in regions with dry seasons. In these areas, boron is tightly bound within the dry soil and cannot be taken up by plant roots.

Boron plays an important role in nitrogen metabolism, protein formation, cell division, and cell wall formation. It also helps to maintain a balance between sugars and starches in plants. Boron is also essential for pollination and seed production (Gupta et al. 1985). During transpiration, boron assists in the movement of potassium to the guard cells of leaf stomata, which help to regulate gas exchange and tissue hydration (Cakmak 1997).

Boron is a micronutrient, only required by plants in very small quantities, but it is nonetheless vital to the health of papayas and other tropical fruits. It cannot be replaced by any other element. The small quantities of boron needed must be available to satisfy the requirements of cell wall formation and other metabolic functions.

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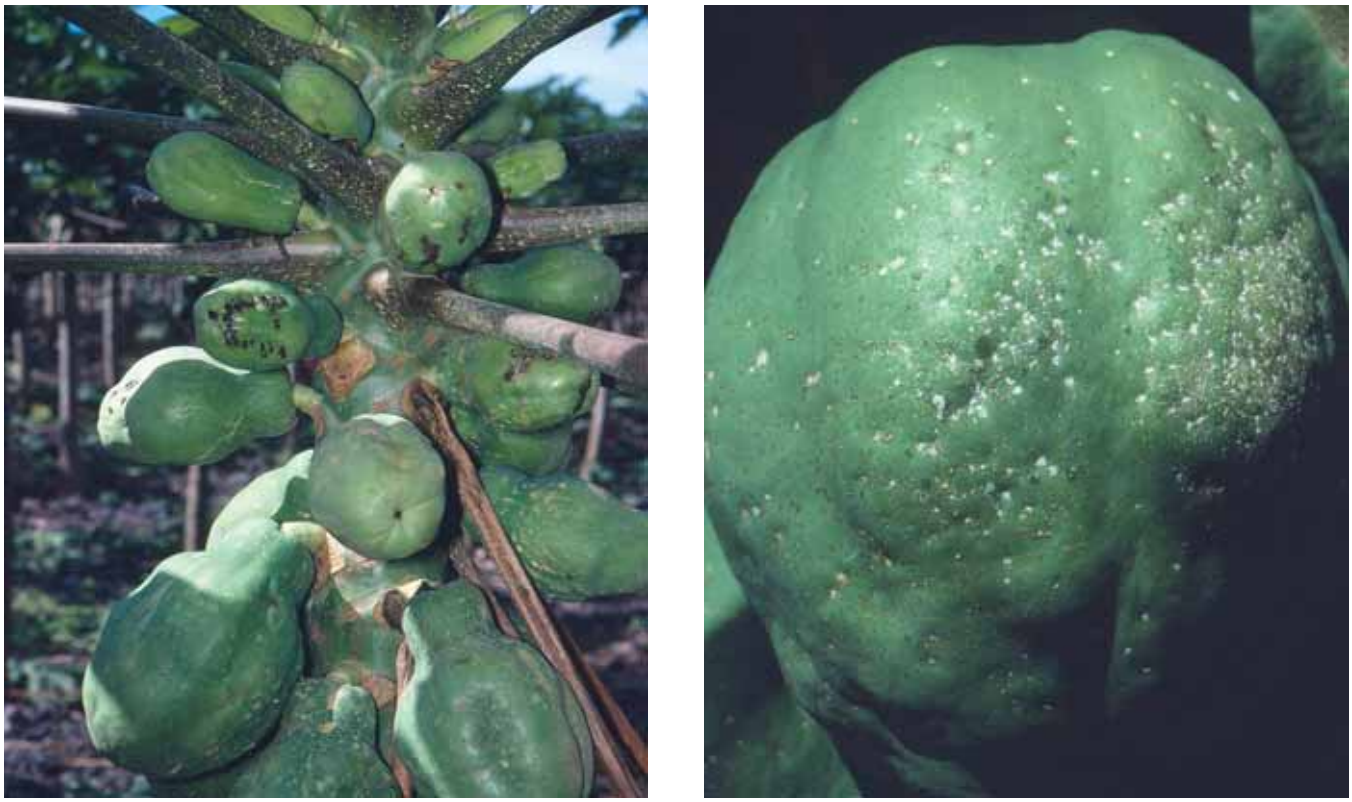
Symptoms

Symptoms of a severe boron deficiency are most evident in fully grown plants. Unlike nitrogen, boron in not readily transported throughout the plant. For this reason, symptoms of boron deficiency first appear in the shoot apical meristem and in fruits. The meristem is where new leaves develop within the apical bud; when boron is lacking, new growth may emerge deformed (Shorrocks 1997). In non-fruiting papaya plants, the young leaves become distorted, brittle, and claw-like. Mature plants are dwarfed and fruit set is severely reduced. Affected fruits tend to be seedless and poorly developed or absent, to ripen unevenly, and to have low sugar content. Young fruits may secrete latex. The surface of fruits on severely affected plants may be covered with lumps. Most of the seeds in the seed cavity fail to germinate. If symptoms appear on young fruits, the fruits may not develop to full size (Wang and Ko 1975). Under adverse conditions, farmers in Hawai'i in the past have experienced losses of close to 100 percent of their crop due to this deficiency disease (Nishina 1991), so it is of economic importance to correct it with the appropriate protocols.

Leaves of boron-deficient papaya plants may be deformed and bunchy at the apical meristem. They also may be excessively brittle and claw-like (photograph: Wayne Nishijima).

As the papaya fruits enlarge, the symptoms of boron deficiency may become more severe (photograph: Wayne Nishijima).



Latex may bleed from boron-deficient papaya fruits (photographs: Wayne Nishijima).

Diagnosis: Sampling Soils and Plant Tissues

To identify a boron deficiency from plant tissue, collect leaf samples from both healthy and symptomatic plants so their boron content can be compared. Ensure that the leaf samples are the same age and from the same position near the apical meristem. If the tissues of symptomatic plants have less boron, it indicates a possible boron deficiency. Samples of soil can also be tested to measure the level of boron present.

Management

To correct a boron deficiency, the right amount of the element must be applied to the soil or plant leaves. Too much boron can severely damage or kill a plant, but too little boron will not resolve the deficiency (Gupta et al. 1985). Do not re-apply boron to a treated plant for at least 3 months, as this much time is required to see the effects of a treatment. Fertilizers containing boron vary in the solubility of the element, and application equipment may need continuous agitation to keep the product from settling to the bottom. Carefully read and follow the instructions for products containing boron. The following are general treatment guidelines.

- Feed papaya at least twice per year with a fertilizer designed for papaya. It should contain all of the minor elements, including boron. Even if papaya fertilizers containing boron are applied regularly, however, boron-deficiency symptoms may still develop.
- To correct a boron deficiency in papaya, spray foliage or drench the soil with a 0.25% Borax or boric acid solution. Three months later the fruits will develop normally, if the deficiency has been corrected. When mixing and applying Borax, agitate the container to keep the product in suspension. Alternatively, apply 0.5 g Borax around the base of a papaya plant (Wang and Ko 1975). If this amount fails to solve the deficiency, up to 5 g Borax per plant may be applied. You

may also apply a drench to the root systems of symptomatic plants using a water-soluble form of boron, such as Solubor®. For a mature papaya plant, apply a mixture of 2 to 4 ounces of Solubor® combined with 4 to 5 gallons of water. Foliar spray applications of water-soluble boron can correct a boron deficiency more rapidly than root (soil-drench) applications.

- Other fertilizer products with boron include Granubor® and Soluble Trace Element Mix (S.T.E.M.). The solubility of the boron contained varies among these products.
- Irrigate plants fertilized with granular or powdered boron so the roots can take up the boron-containing water.
- Recognize that boron deficiency is more common in very wet or dry areas, or in sandy or rocky soils. These areas may require more frequent boron applications.

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