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BORON EXCESS IN ROSES[1]

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Boron is an essential element for plant growth. It frequently is called a minor element, but a more appropriate term would be micro, since this element is essential in very small amounts.

Little concern is given to boron, since very small amounts are required by plants and very small amounts are found in soils or water. Further, deficiencies and excesses of micro elements are not common and cannot easily be detected visually. However, with the advent of tissue testing, the problem of micro element detection is much easier.

When an uncommon cultural problem develops, the typical approach is to search the literature for published information. It frequently is difficult to decide whether the problem is caused by disease, insects, spray burn, air pollution, nutrition problems, or a combination. Descriptions of plant symptoms in the literature are at best confusing and photographs may even add to the problem. Tissue tests as well as soil tests may aid in determining the nature of the problem.

In Minnesota

For 2-1/2 years a problem has plagued a commercial rose grower in Minnesota. Primary symptoms were abortion of small flower buds; development of lateral shoots, which bypassed the aborted bud; crippled immature leaves (Figure 1); along with marginal burning (necrosis) and dropping of older leaves (Figure 2). In searching the literature photographic and descriptive evidence pointed to two prime suspects: low level mercury damage or boron deficiency. The former was not considered possible,

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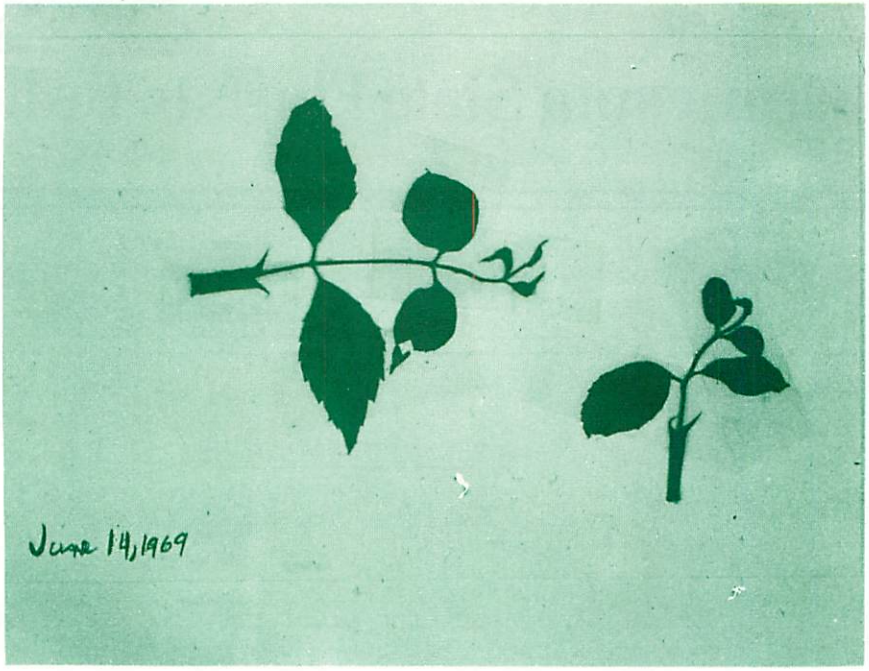

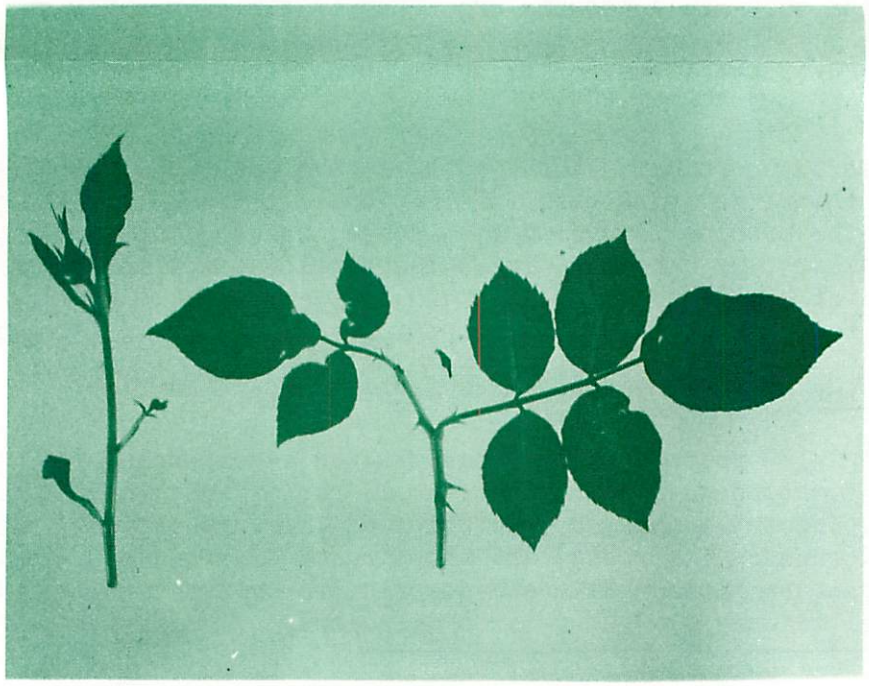

Figure 1. Rose leaves of cultivar Forever Yours showing malformed leaves and aborted buds, attributed to Botrytis.

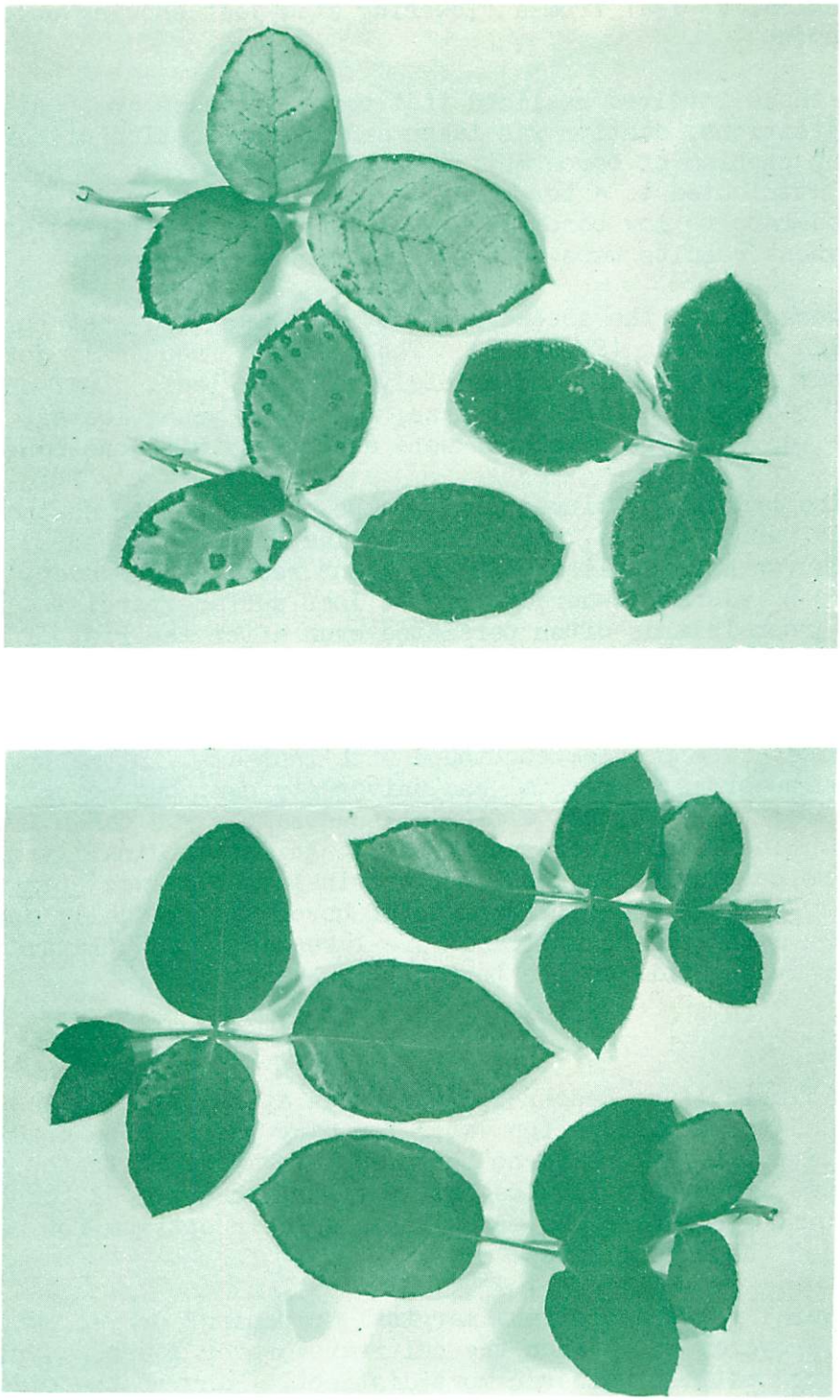

Figure 2. Rose leaves of cultivar Forever Yours showing symptoms of boron excess.

so boron deficiency was the more likely cause. Tissue tests made from young leaves (first five-leaflet leaf from a flowering stem just showing color) revealed a low level of boron.

Since those involved realized that boron excesses are easily created by improper applications, caution was taken and an application of boric acid was made. The apparent problem of boron deficiency disappeared. Some months later the symptoms, which were attributed to a boron deficiency again appeared. A tissue test again showed a moderate to low boron level. A second boron (borax) application was made. But no apparent results were seen and the problem continued.

Some weeks after the second application a marginal leaf burn on the older foliage began appearing (Figure 3). These leaves frequently developed peculiar green islands of pigment in a completely yellowed leaf. Leaf drop was severe. The problems of bud abortion, shoot bypass, malformed young leaves, and marginal necrosis on older leaves with green islands were associated with one cause: boron deficiency.

When the problem continued plant pathologists confirmed that the problems of aborted buds, shoot bypass, and malformed leaves were caused by Botrytis (Figure 1). Control measures were applied with excellent results. However, the marginal leaf burn and green islands powdered over the leaf surface persisted (Figure 2, 3). These dark green islands often persisted even after the rest of the leaf was completely dried.

A commercial fertilizer with boron (17 pounds borax/ton) was applied over a 6-month period. The problem continued with increased intensity. Leaf specimens were sent to numerous commercial and university men, but no one seemed to have a solution. After many months, a final tissue sample was taken from old and young leaf tissue. The results were unexpected. An extraordinarily high boron level now existed. The conclusion was that the original problem was Botrytis, not boron deficiency. Further, the applications of boron had gradually accumulated to an excess or toxic level in the soil and were taken up by the plant. Table 1 shows the boron levels during this entire period.

In Colorado

In the Floriculture Research Greenhouses at Colorado State University boron has been added to the irrigation water for many years. The traditional levels were at 0.4 to 0.8 p.p.m. There is no boron in the water. With the addition of CO_2 to the greenhouse atmosphere for the past 6 years, the rate of boron application has been 0.8 p.p.m. This rate was established as near optimum for year-round carnations produced under these conditions.

For several years a distinct marginal "ripening" or yellowing pattern was observed on roses grown at CSU. When the cultivar Forever Yours was planted in 1966, the leaf "ripening" pattern was even more distinct. Many of the older cultivars such as Red Delight and Tropicana showed marginal burning on older leaves without the green islands illustrated in Figures 2 and 3. Commercial rose growers from other areas and from Colorado observed that this "ripening" pattern was in some ways different from theirs. We recognized that we were injecting nutrients in the irrigation water for the culture of carnations and that possible more potassium and/or boron was being added than roses required. Tissue tests for the major elements in 1968 indicated that potassium was not high.

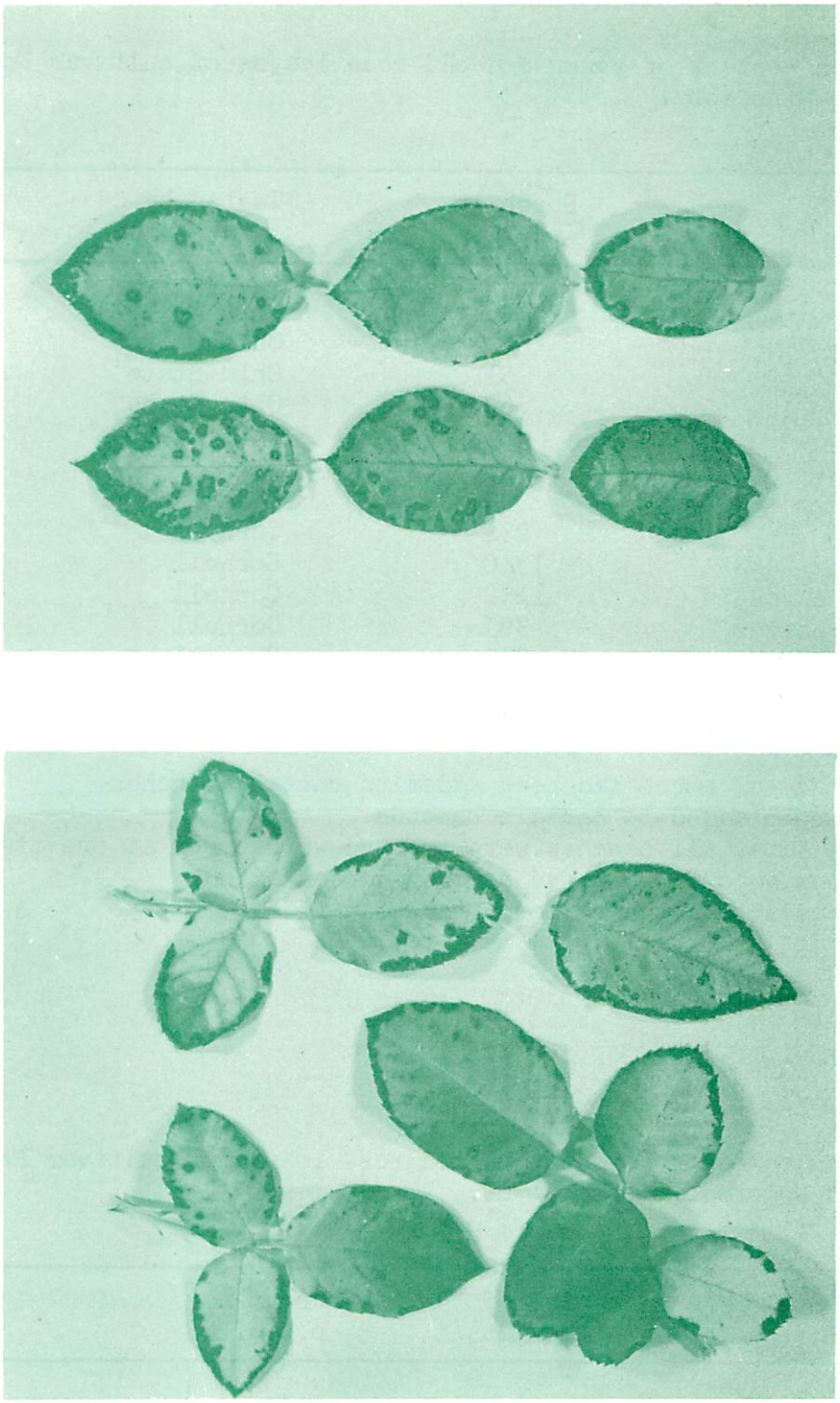

Figure 3. Rose leaves of cultivar Forever Yours showing advanced stages of boron excess symptoms. Note yellowing and development of green islands of pigment which persist after the leaves turn yellow and dry.

Table 1. Boron content of young and old rose leaves of cultivar Forever Yours from Minnesota.

Age of leaves	Boron in p.p.m.	Tested by	Date
Young	15	Ohio State	8/15/67
Young	23	Ohio State	9/28/67*
Young	51	Ohio State	1/5/68 **
Young[1]	63	Ohio State	4/19/68
Young[2]	40	Ohio State	4/19/68
Young	50	Cornell	9/26/68***
Old	98	Cornell	9/26/68
Young	234	Cornell	2/28/69
Old	1340	Cornell	2/28/69
Edges of old leaves	1180	Cornell	4/15/69
Center of old leaves	305	Cornell	4/15/69
Edges of young leaves	895	Cornell	4/15/69
Edges of young leaves	280	Cornell	4/15/69

* Reagent grade of boron had been added to certain benches.
** Borax had been added to certain benches.
*** After this date, all benches were treated with boron at one time or the other.
1 Samples from a bench where no boron had been added.
2 Samples from a bench where boron had been added.

Table 2. Boron content of young and old rose leaves of cultivar Forever Yours from Colorado, April, 1969.

Source	Age of leaves	Boron in p.p.m.	Tested by
CSU	Young	152	Penn. State Univ.
CSU	Old	450	Penn. State Univ.
CSU	Young	136	Cornell Univ.
CSU	Old	380	Cornell Univ.
Commercial	Young	151	Cornell Univ.
Commercial	Old	505	Cornell Univ.

In April 1969, Harold Wilkins visited Colorado and observed these foliar symptoms at the research facility and at a commercial firm. He thought these symptoms were caused by boron excess, since the symptoms were similar to those in Minnesota. Tissue samples of young and old leaves were sent to John W. White at Pennsylvania State University and to James W. Boodley at Cornell University. Table 2 shows the boron content of leaves from plants showing the senescence or "ripening" pattern illustrated in Figures 2 and 3. Other nutrients, both macro and micro, were considered adequate, though not excessive in these tissue samples.

While toxic levels of boron in old leaves are not known, it appears that rose plants translocate accumulated boron to old leaves when this nutrient is in more than ample supply. White (4) has observed a range of boron in most commercial rose leaf tissue samples from 28 to 55 p.p.m. If this level is assumed normal for young rose leaves, the young leaves from Colorado in these tests contained three times as much boron as needed.

Boron toxicity is well described by Laurie and Kiplinger (2). According to their bulletin, "Culture of Greenhouse Roses," "First symptom is a distinct browning of the teeth of the leaflets of oldest leaves, the rest of the leaf remaining green. Next, irregular brown intravenal spots appear closely associated with the marginal burning. Spotting is quickly followed by chlorosis, the leaflets often falling separately, leaving the midrib attached to the plant."

Kamp and Pokorny (1) published similar boron toxicity symptoms and added that older leaves often had small spots of dark green powdered over the surface of intravenal areas. These green areas often persist after the rest of the leaf is dried up. Boron excess symptoms that have been described and those observed in this study are easily confused with the symptoms and photographs published by Oertli (3) for magnesium deficiency. However magnesium levels of 0.25 to 0.38 per cent were considered adequate in the tissues included in Table 2.

This paper was compiled to show how difficult a cultural problem can be and how many people can be involved. Further, it is published as a warning <u>that very little of some micronutrients can cause a great deal of trouble</u>. <u>Boron should not be added to roses unless it is needed</u>. If "boron hunger" is suspected, confirm this suspicion with tissue analysis. Probably no more than 0.25 p.p.m. or boron should be added to roses on a regular basis.

If boron excess is suspected, confirm it with tissue analysis. If boron accumulates in the young leaves and stem to 100 p.p.m. or more, steps should be taken to reduce boron available to the plants.

<u>Literature Cited</u>

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