bed at least 2 years but can still have salable plants at the end of 3 years if for some reasons we do not move them sooner.

When plants are moved to the field, we level and compact the beds, then set the plants right on top of the soil through old sawdust placed to a depth of 5 to 6 inches on top of the soil. We use Rain Bird sprinklers in the propagation bed with a 1/8 inch or 5/32 inch orifice with adjustable screw spreader. The Rain Bird sprinkler must have 50 to 60 psi pressure to operate and mist properly, although we ordinarily have no problem with water pressure, we do maintain a booster pump We also have a diesel-powered back-up for the propagation and irrigation system.

Our entire operation also includes the propagation of a few muscadine grapes. In addition, we have a pick-your-own operation that includes peaches, blueberries and grapes. We find that the sequence works out well as the peaches can be picked first, followed by the blueberries and then the grapes. Our propagation and plant sales are done at other times of the year.

We feel that satisfied customers are important. We encourage them to buy at least two cultivars of blueberries for good crop set.

MICROMAX — MICRONUTRIENTS FOR IMPROVED PLANT GROWTH[1]

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Abstract: A 3^5 factorial set of treatment combinations were developed to study the effects of iron, manganese, copper, boron, and zinc on growth and development of container nursery stock A computer was used to select 1/3 of the treatment combinations for the study and data analysis

Interactions were noted between iron and copper, iron and manganese, and copper and boron Plant growth and quality increased or decreased as the micronutrient ratios shifted This study revealed that the ratio among the micronutrients was a more important consideration than the rate of a particular micronutrient

In 1957, Matkin, Chandler, and Baker (3) wrote "since micronutrients are required in such minute amounts by plants and are natural components of peat, soil, fertilizer, and water, it is improbable that a soil mix would develop micronutrient deficien-

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cies." Since that time, many studies have been conducted to improve the physical and chemical aspects of container growing (2,4,5,6,7,8). In general, with each improvement in the conditions in the container, i.e. total pore space, air space, carbon: nitrogen ratio, and media structure and components, improved plant growth and quality has been achieved. Likewise, with each advancement in the understanding of container nutrition growth has improved. These improvements in plant growth and quality have come in steps as successive limiting factors have been removed. There are probably many more limiting factors to be discovered and removed before maximum plant growth in containers can be achieved.

In 1969, Whitcomb (7) showed that as N,P,K rates were increased, higher rates of Perk (a micronutrient fertilizer manufactured by Wilson & Toomer Fertilizer Company, Jacksonville, FL) also had to be increased to achieve maximum growth with the physical and cultural conditions imposed on the plants at that time.

METHODS AND MATERIALS

Based on these studies and observations of plant responses to micronutrients in many nursery situations, a 3^5 factorial study with 2 replications for each species was begun in 1977. Iron, manganese, copper, boron, and zinc were used at rates which were thought to be near optimum. Each rate of each micronutrient studied was reduced by ½, and doubled to achieve the 3 levels of each element in the study. Since a complete 3^5 factorial has 243 treatment combinations, a computer was used to select the 81 treatment combinations likely to provide the most useful data to understand the micronutrient interactions.

Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and molybdenum were held constant for all treatments. N, P, K were supplied by Osmocote 18-6-12, Ca and Mg by dolomite, and molybdenum by sodium molybdate at rates of 14 lbs, 8 lbs, and 0.09g cu yd. (8.3 and 4.7 kg/m^3 and $1.17 g/m^3$) respectively. The growing medium was a mix of 2 parts ground pine bark, 1 part Canadian peat, and 1 part washed concrete sand. Micronutrient sources were ferrous sulfate, manganese sulfate, zinc sulfate, copper sulfate, and sodium borate.

Recently rooted liners of *Pyracantha* 'Watereri' (*P. coccinea* 'Lalandii × *P. crenulata* 'Watereri') were planted into one gallon (3.8l) containers on May 12, 1977. Plants were grown in full sun under sprinkler irrigation for 5 months and evaluated for height, fresh top weight, and stem caliper.

One-year old *Rhododendron* 'Hinodegiri' were planted on June 9, 1977 and were grown until July 12, 1978 under 30%

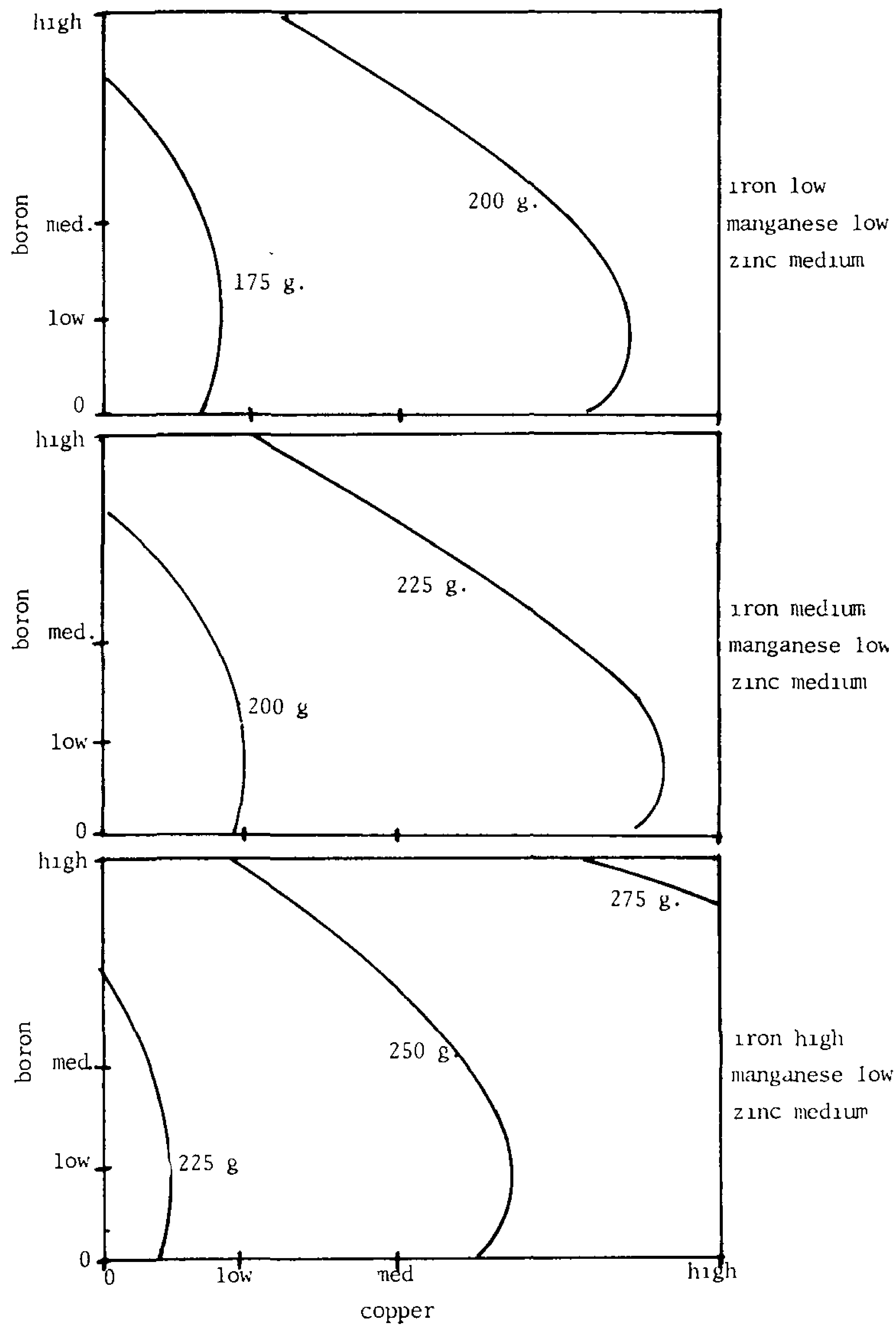

Figure 1. Fresh top weight (grams) response of pyracantha to combinations of micronutrients in containers· low iron (top), medium iron (center), high iron (bottom) The greatest top weight was achieved when the high boron and high copper levels were used with the high iron

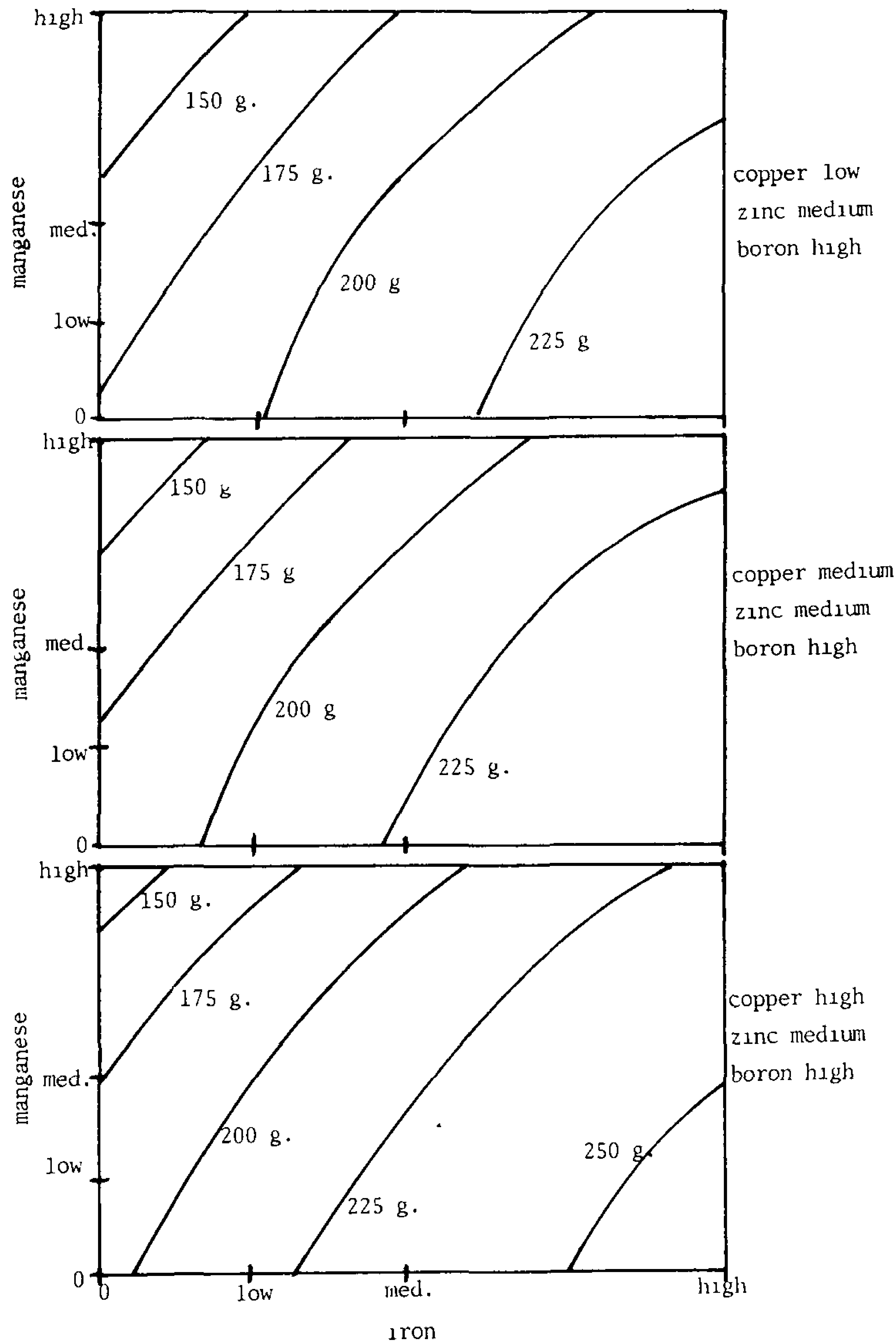

Figure 2. Fresh top weight (grams) response of pyracantha to combinations of micronutrients in containers, low copper (top), medium copper (center), and high copper (bottom) The iron and manganese levels gave about the same top weight response at the low and medium level of copper, however, top weight increased when the copper was increased to the highest level

shade. The azaleas were evaluated for visual grade twice, once in February following leaf drop by some treatments and at termination and for flowering and fresh top weight.

RESULTS AND DISCUSSION

Interactions between iron and copper, iron and manganese, and copper and boron were significant for both pyracantha and azalea. Response of the two species to the various micronutrient levels was similar, thus only two of the response surfaces of pyracantha are presented. Computer plotted response surfaces showed that fresh top weight of pyracantha increased significantly as iron increased from the low to the high rate but the maximum top weight was achieved (275 grams) only when the high boron and high copper rates were also present and manganese was at the low rate (Figure 1). Zinc had little influence on plant response, suggesting that even the lowest rate used was sufficient. Fresh top weight of pyracantha was similar for the low and medium rates of copper with the various combinations of iron and manganese; however, top weight increased with the combination of the high rate of copper and iron, low rate of manganese and the high rate of boron (Figure 2). In all cases, maximum growth was obtained only when manganese was at the low rate. This is in agreement with Epstein (1) who noted that high rates of manganese can cause iron deficiencies due to a competition for functional sites on iron binding compounds. Maximum plant growth response to copper was obtained only when boron was at the highest rate tested.

Figure 3. Azaleas grown with high rates of copper and boron and low manganese and high iron (left), medium iron (center), and low iron (right). Leaf retention and color and flower numbers and overall plant quality were increased by increased rates of iron, but only if manganese, boron, and copper were at the correct level.

Visual plant response was usually more distinct on azaleas than pyracantha in that few foliar deficiency symptoms developed on the pyracantha. During the winter azaleas with high iron and copper and low manganese rates held their leaves and retained a dark green foliage color, whereas plants with high rates of manganese dropped many leaves. Visual plant quality increased as iron level increased and manganese was low and copper and boron rates were high (Figure 3).

The proportions of micronutrients suggested by these data were used to make an experimental micronutrient fertilizer. After considerable testing and some further adjustments in the micronutrient sources and ratios, the commercial product, 'Micromax'[3], was developed.

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