Effects of Stimulatory and Inhibitory Levels of 2,4-D, Iron, and Chelate Supplements on Juvenile Growth of Field Beans

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SOME growth regulators stimulate plant growth at low concentrations but inhibit growth at high concentrations. Most reports on the effects of 2,4-dichlorophenoxyacetic acid (2,4-D) on plants deal with inhibitory aspects of herbicidal concentrations (8). Juvenile beans have been used extensively in studies of the herbicidal effects of 2,4-D (1, 3, 4), but few studies deal with stimulatory concentrations on young bean plants.

Taylor (5, 6) was among the first to report an increase in soybean plant dry weight from low rates of 2,4-D in nutrient solutions. Weaver (7) applied 2,4-D aqueous solution to the leaves of young red kidney beans and soybeans at rates of 0.001, 0.01, and 0.1 grams actual chemical per square yard. All treatments, measured 31 days after application, reduced plant weight and delayed pod appearance. Swanson (4) reported significant increase in cambial activity in young red kidney beans with the lethal rate of 0.1% aqueous foliar-applied 2,4-D sprays. Leonard (3) reported that aqueous solutions of the triethylamine salt of 2,4-D (150 ppm) slightly increased fresh weight of bean plants 14 days after application to seedling plants.

Wort (9, 10) reported that foliar-applied composite dusts or sprays containing a high concentration of 2,4-D and micronutrients increased the early growth and ultimate yield of several crop plants, including beans. The herbicidal and injurious effects of 2,4-D sprays and dusts were decreased or completely eliminated by previous, simultaneous, or subsequent foliar application of salts of iron or copper.

This study was designed to extend available data on 2,4-D by determining stimulatory levels as well as herbicidal concentrations. It was of additional interest to determine the effects of foliar-applied iron, chelate iron, and a chelating agent on plant growth when applied in varying combinations with stimulatory and herbicidal concentrations of 2,4-D. This report presents data showing that each of the three supplements markedly affected the response of young bean plants to both low and high concentrations of 2,4-D.

MATERIALS AND METHODS

Plant Material
A single source of Sutter Pink beans (Phaseolus vulgaris) was used in greenhouse studies. Seeds were germinated in sterile sand. After 7 days, 2 uniform plants were transplanted into vermiculite-filled plastic containers, bottom-perforated to provide drainage. The transplanted seedlings were initially irrigated with half-strength Hoagland's (1) Solution No. 1, except that the source of iron was FeEDTA. Thereafter they were regularly irrigated with full-strength Hoagland's solution and flushed occasionally with distilled water.

Spray Treatments
In all experiments, plants were spray treated at 12 to 14 days of age, when the shoots were still in the tight bud stage and the primary leaves were fully expanded. Dimethylamine salt of 2,4-D containing 41.2% acid equivalent plus manufacturers added surfactant was used in all the experiments.

The supplements included FeSO₄ at 1500 ppm of Fe, EDDHA (ethylenediamine di-o-hydroxyphenylacetic acid) at 1500 ppm, and FeEDDHA (ferric iron chelated with EDDHA) at 1500 ppm of Fe. FeEDDHA and EDDHA supplement spray solutions were prepared in advance of treatment time from the sodium salt adjusted to pH 7.0. FeSO₄ solutions were prepared immediately prior to application to minimize oxidation of Fe²⁺ to Fe³⁺. The FeSO₄ solutions were pH 4.9.

Sprays containing 2,4-D alone and with various supplements were applied as a fine mist to run-off, covering all aerial parts of each plant, including upper and lower leaf surfaces. Contamination of the root medium was prevented by shielding the vermiculite in the pot.

Plants were weighed before and after treatment to determine the amount of solution remaining on the plants after run-off ceased. Plants sprayed with 1/2, 1, 5, 10, or 100 ppm 2,4-D solutions, respectively, received approximately 1/2, 1, 5, 10 or 100 μg. of 2,4-D.