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Interaction of 2,4-D, Ethephon and Morphactin on Pepper and Zinnia

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SYNOPSIS: Seedlings of *Capsicum frutescens* L. and *Zinnia elegans* L. were treated with 1 and 100 ppm 2,4-dichlorophenoxyacetic acid (2,4-D), 100 and 10,000 ppm (2-Chloroethyl) phosphonic acid (ethephon), and 10 and 1000 ppm methyl ester of 2-chloro-fluorenol-9-carbonic acid [morphactin (chlorofluorenol)]. Low concentrations of the materials applied singly had minor effects while morphactin and 2,4-D in combination modified morphological development in various ways. Ethephon did not seem to cause interactive effects when applied with 2,4-D and (or) morphactin. High concentrations of each material applied singly modified plant morphology of pepper and zinnia and inhibited growth of zinnia.

INDEX DESCRIPTORS: Pepper, Zinnia, 2,4-D, Morphactin, Ethephon, Pollution, Growth Regulators.

The growth regulators 2,4-D and ethylene are air pollutants damaging many species of plants (1,2,4). Other growth regulating chemicals are likely to become recognized air pollutants.

The interactive effects of pollutants have been classified as additive, synergistic, or antagonistic (5). Sherwood and Rolph (3) found ozone markedly reduced 2,4-D phytotoxicity, which suggests that certain chemicals may be applied to plants to prevent or reduce damage from air pollutants. The purpose of the research reported here was to investigate the effects of 2,4-D, ethephon, and morphactin upon pepper and zinnia plants when applied singly; and to determine their interactive effects when applied in combination. Such information could help identify characteristics of plant damage from any of these chemicals as pollutants, and indicate whether one chemical might provide protection to the plant from another chemical.

2,4-D, ethephon[3] and morphactin[4] were used as separate applications, in combination with one other chemical, and with all three together; 2,4-D was applied at 1 and 100 ppm by volume, ethephon at 100 and 10,000 ppm, and morphactin at 10 and 1000 ppm. The lower concentrations of each chemical were used in combination treatments. All concentrations of chemicals including the control were formulated in a 50% ethanol solution and applied as a mist to *Capsicum frutescens,* 'Red Hot Cayenne' and *Zinnia elegans,* 'Yellow Canary' seedlings.

The experimental design was a split plot with whole plots composed of species of plants, and sub plots composed of the various chemical treatments. There were four replications with each sub plot containing four plants. The potting soil was loam with native fertility sufficient to grow the plants without added nutritive elements. Plants were grown in a greenhouse with minimum night temperature of 65°F and with day temperature about 75°F but occasionally ranging up to 85°F. Plants were treated when in the third true leaf stage.

TABLE 1. HEIGHT OF PEPPER AND ZINNIA PLANTS THREE WEEKS AFTER TREATMENT WITH GROWTH REGULATORS

Treatment	*Zinnia* cm	*Pepper* cm
Control	68.7a[1]	13.6a
2,4-D 1 ppm	48.3b	13.6a
2,4-D 100 ppm	18.8c	6.7b
Ethephon 100 ppm	65.0a	13.1a
Ethephon 10,000 ppm	23.4c	6.9b
Morphactin 10 ppm	54.7a	13.9a
Morphactin 1,000 ppm	45.9b	15.2a
Ethephon 100, Morphactin 10, 2,4-D 1 ppm	45.1b	13.8a
Ethephon 100, 2,4-D 1 ppm	44.5b	14.2a
Morphactin 10, 2,4-D 1 ppm	47.0b	15.1a
Morphactin 10, Ethephon 100 ppm	58.4a	12.7a

[1] Treatments within a column and followed by a common letter are not statistically different (5% level, Duncan's Multiple Range).

2,4-D at 1 ppm caused plant distortion for 10 to 15 days after treatment, but new growth appearing after this period seemed to develop normally. Stems of plants treated with 100 ppm 2,4-D were curved and twisted, and the plants were rigid; apical growth was arrested and some growing points were killed. There was little recovery from the high concentration of 2,4-D, even after 30 days.

Morphactin at 10 ppm had no observable effect on the plants. Morphactin at 1000 ppm caused epinasty and discoloration of leaves and distortion of the apex of zinnia plants, and prevented flower development but not initiation. On pepper, 1000 ppm morphactin also caused epinasty, and leaves were small and underdeveloped. Plants of both species displayed small leaves and tended to grow prostrate rather than remain upright. Treated pepper plants were twisty and viney although total length (height) was comparable to control plants.

Ethephon at 100 ppm had little effect except that treated zinnia plants bloomed sooner than did control plants. At 10,000 ppm, ethephon stunted the plants, but with little or no disfiguration. Leaves were smaller and plant height was less than in control plants (Table 1), but the dwarfed plants seemed healthy. New growth developing 5 to 6 weeks after treatment was normal.

The mixture of ethephon and morphactin at low concentrations had little effect on plant development. Plants treated

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[3] Supplied by AmChem Products, Inc., Ambler, Penn., as "Ethrel."

[4] Supplied by Vero Beach Laboratories, Vero Beach, Fla., as "Bay 102614."

with low concentrations of 2,4-D mixed with ethephon showed typical effects of 2,4-D but there was no visible evidence of ethephon effect.

The morphactin and 2,4-D combination had very noticeable effects. Apical growth of both species was distorted and stunted; some leaf veins were light green to yellowish. Pepper leaves were rippled, whereas leaves of zinnias were epinastic, narrow and some were fused with other leaves. Treated zinnia plants were only about two-thirds as tall as control plants one month after treatment while treated and control pepper plants were similar in height (Table 1).

The 2,4-D, ethephon and morphactin combination exhibited profound effects similar to those of the morphactin-2,4-D mixture. Leaves were fused together in both zinnia and pepper but more so in pepper than zinnia. Treated zinnia plants were only about two-thirds the height of the control, and treated pepper plants were about the same height as control.

Results indicate that growth regulators applied purposely to crops may magnify phytotoxicity of air pollutants, such as 2,4-D. Predicting the phytotoxic effects of a growth regulator-pollutant such as 2,4-D thus should include the possibility of agricultural chemicals applied to the crop modifying the effects through interaction. Perhaps other growth regulators might hold promise for reducing phytotoxicity of air pollutants.

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