Effects of Plant-Growth-Regulating Substances on Control of Erwinia amylovora by Streptomycin and Terramycin

A recent report of ours (*1*) demonstrated the value of the addition of indole-3-acetic acid to an antibiotic spray formulation for the control of fireblight (causal agent, *Erwinia amylovora*) in potted 1-yr-old apple trees (var. Jonathan).

The presence of 100 ppm of indole-3-acetic acid in the antibiotic spray formulation that contained 250 ppm each of streptomycin and terramycin and 1 percent each of methyl cellosolve and Carbowax 4000 increased control markedly in apple shoots inoculated subepidermally 24 hr after application of the spray.

Experiments were continued to determine whether this phenomenon was peculiar to indole-3-acetic acid. Figure 1 suggests that ethyl indole-3-acetate is equally as effective as indole-3-acetic acid; in companion experiments this high degree of effectiveness was obtained with ethyl indole-3-acetate at 50 ppm.

Furthermore the current report presents information which indicates that this property of increasing the efficacy of antibiotics is not unique to indigenous substances but also appears to be a function of a diverse group of nonindigenous substances that possess plant-growth-regulating properties.

One or more members of the known

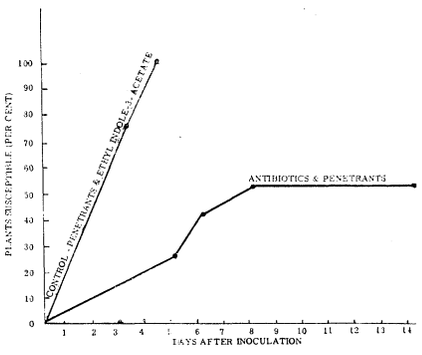

Fig. 1. Effect of indigenous growth-regulating substances (indole-3-acetic acid and indole-3-acetate) on control of *E. amylovora* by antibiotics (250 ppm of streptomycin and 250 ppm of terramycin) and penetrants (1 percent each of methyl cellosolve and Carbowax 4000). Antibiotics + penetrants + indole-3-acetic acid (100 ppm) = 0. Antibiotic + penetrants + ethyl indole-3-acetate (100 ppm) = 0.

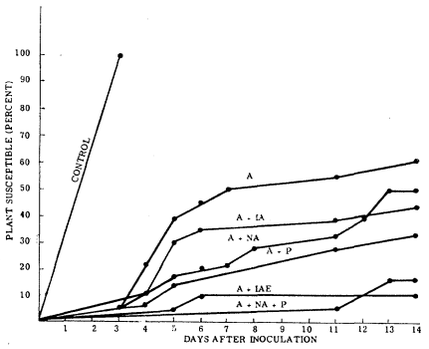

Fig. 2. Effect of indigenous and nonindigenous growth-regulating substances on control of *E. amylovora* by antibiotics (318 ppm of streptomycin and 32 ppm of terramycin) and penetrants (1 percent each of methyl cellosolve and Carbowax 4000). *Control,* no treatment; *A,* antibiotics; *A + IA,* antibiotics + indole-3-acetic acid (100 ppm); *A + NA,* antibiotics + naphthyl acetamide (20 ppm); *A + P,* antibiotics + penetrants; *A + IAE,* antibiotics + ethyl indole-3-acetate (50 ppm); *A + NA + P,* antibiotics + naphthyl acetamide (20 ppm) + penetrants.

nonindigenous groups of growth-regulating substances were tested. Included were α-naphthaleneacetic acid, naphthyl acetamide, β-naphthoxyacetic acid, *p*-chlorophenoxyacetic acid, 2,4,5-trichlorophenoxypropionic acid, 2,3,5-triiodobenzoic acid, α-cyano-β-2,4-dichlorophenylacrylic acid, maleic hydrazide, *p*-chlorophenyl tetradecyl ether, 2,4-dichlorophenyl tetradecyl ether, *N*-*m*-tolyl phthalamic acid, and 2,2-dichloropropionic acid.

Most of the afore-mentioned materials demonstrated activity similar to that obtained with indole-3-acetic acid and its ethyl ester. However, the necessity for high concentrations, and/or the phytotoxicity that was encountered in some instances limits the practicability of a number of these materials as adjuvants in antibiotic spray formulations for the control of *E. amylovora* in apples.

Perhaps one of the most promising nonindigenous materials evaluated in experiments to control *E. amylovora* with antibiotic sprays was naphthyl acetamide. This is illustrated graphically in Fig. 2.

Naphthyl acetamide is effective at a lower concentration than either indole-3-acetic acid or ethyl indole-3-acetate. Further, foliage-modification effects on apples are less pronounced with naphthyl acetamide at a concentration of 20 ppm than they are with indole-3-acetic acid and ethyl indole-3-acetate at 100 and 50 ppm, respectively.

The value of methyl cellosolve and Carbowax 4000 in increasing disease control is well demonstrated in this experiment, as it was in previous investigations (*2*).

In an effort to elucidate the mechanism(s) by which growth-regulating substances increase the disease-control properties of antibiotics, *in vitro* studies on both solid and liquid media were made. Using the agar diffusion-filter-paper-disk-technique, we found no enlargement of the zone of inhibition when the plant-growth-regulating substances were added to the antibiotic solutions. Furthermore, with the standard tube-dilution-technique, it was impossible to decrease the minimum inhibitory concentration of the antibiotic by the addition of plant-growth regulators.

From these results it has been concluded, tentatively, that the enhanced disease control is not the result of an effect of growth-regulating substance on the pathogen per se and, therefore, it reflects some host-plant reaction to the growth-regulating substance.

Certain reported effects of auxins on plant tissues may provide some insight into the mechanism(s) involved. Among these are (i) increased water uptake (*3, 4*) and (ii) increased permeability of cell membranes (*5*), both of which might facilitate the inward and internal movement of the antibiotic; and (iii) increased metabolic rate (aerobic respiration) (*6*), which may speed maturation of tissues. The significance of an increase in rate of maturation has been demonstrated in greenhouse and field experiments in which it has been observed repeatedly that actively growing apple shoots are more susceptible to infection than are shoots that have terminated or reduced their vegetative activity.

Experimentation to determine the exact nature of the enhanced disease control obtained with antibiotic and plant-growth-regulator combinations is still in progress.

D. D. Hemphill
R. N. Goodman
Department of Horticulture,
University of Missouri, Columbia

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