LITERATURE CITED

1. RUEHLE, GEO. D. Outstanding potato late blight control in Florida with a new organic fungicide combined with zinc sulfate. *Plant Disease Reporter* 28: 242-245. 1944.
2. WALTER, J. M. Control of Gray Leaf Spot of Tomato. *Market Growers Journal*, pp. 19-29. 1948.
3. WALTER, J. M. Unpublished data.

FERTILIZER-INSECTICIDE COMBINATION FOR ARMYWORM, MOLE-CRICKET AND WIREWORM CONTROL

D. O. WOLFENBARGER
Florida Agricultural Experiment Stations
Sub-Tropical Experiment Station
Homestead

and

E. G. KELSHEIMER
Florida Agricultural Experiment Stations
Vegetable Crops Laboratory
Bradenton

Interest in combining insecticides with fertilizers is much greater than it was four years or more ago. The significance of this lies in combining field operations in order to save labor. The idea of combining insecticides with fertilizers is closely associated with the development of the new organic insecticides. The potentialities of combining insecticides with fertilizer appear extensive, but it is well to recognize our dearth of knowledge in the matter.

Factors for Consideration

The objective of an insecticide-fertilizer combination is to control soil inhabiting insects and to provide for the nutritional requirements for the plants treated all in one operation. This operation may not be as simple as it appears. The use of two materials involves many factors which must be considered before widespread successful performances will be secured.

It is assumed, for purposes of this discussion that the kind, amount and other factors regarding the fertilizer are known. This leaves the problems of mixing, compatibility, and results to be discussed. Definite entomological factors to be considered include the following: insect to be controlled, insects that may increase after the application of an insecticide, compatibility of the insecticide and the fertilizer, reactions and interactions of the soil with the insecticide-fertilizer combination.

The authors have observed the effectiveness of insecticide-fertilizer combinations for mole crickets, cutworms, white grubs, ants, earwigs, chinch bug, and wireworms. Mole crickets, cutworms, earwigs, and chinch bug are recognized as surface feeders. Less insecticide per acre is needed for control of surface feeding insects than for insects which forage beneath the surface, such as wireworms and white grubs. Although the amount of insecticide is given on the acre basis for both surface and subterranean feeding insects, the third dimension, depth, requires increased amounts of the toxicant for subterranean insects.

It is recommended that the use of an insecticide-fertilizer combination be governed by the insect problem involved. There is waste, and a possibility of achieving harmful results, in applying the insecticide-fertilizer combination indiscriminately in the hope of getting some benefits unless a problem exists. If one has a soil surface or subterranean insect problem and if the

timing of the fertilizer application may coincide with the need for an insecticide, the two may be combined and used with a saving of labor and equipment.

Insecticides Mixed with Fertilizer

The newer insecticides tested with fertilizer include DDT, chlordane, benzene hexachloride, toxaphene, lindane, aldrin, parathion, and dieldrin. Some insecticides are more useful for certain insects than for others. A number are, however, equal in effectiveness on a number of insects, hence, become competitive.

The user may mix whatever insecticide he may desire with fertilizer. The Department of Agriculture, State of Florida, however, has regulations governing the combinations of chlordane, DDT, benzene hexachloride, and lindane mixed for sale (Florida Commercial Fertilizer Law, Chap. 576, Florida Statutes, 1949, Sec. 576.09, Tech. Reg. No. 5).

Mixing the Components

Combining insecticides with fertilizers has been accomplished by simple mechanical mixes. Most mixing is done by formulators, manufacturers, or dealers, although it may be done by hand. The insecticidal material is usually added to the fertilizer and stirred thoroughly by hand or by machines. Some industrial processes permit mixing the insecticides and the different fertilizer components simultaneously. No differences have been recognized in the manner of mixing.

Rate of Mixing and Application

Confusion and dissatisfaction may result unless some knowledge and attention is given to the amount of insecticide, in terms of active ingredient, used.

A mix of one pound active ingredient of chlordane and of DDT per 200 pounds of fertilizer applied per acre gives commercial control of mole crickets, chinch bugs, earwigs, cutworms, and will reduce ant populations.

In wireworm control on potatoes, on the highly alkaline Perrine marl soils, 4.3 pounds chlordane, active ingredient, in 1500 pounds of fertilizer per acre gave 82 percent control. Aldrin, at 2.2 pounds active ingredient in 1500 pounds of fertilizer per acre gave 88 percent control. The combinations were applied as the potatoes were planted, in bands, two inches wide, two inches at each side, and one inch below the row.

Experimental results showed that chlordane and aldrin applied broadcast gave more effective control, pound for pound of active ingredient per acre, than the same materials applied with fertilizer. Wireworm control reported by Pepper, et al, (1949) showed similar results where benzene hexachloride was applied. Neither benzene hexachloride nor lindane can be recommended for use on potatoes nor on soil where potatoes will be grown, because of the objectionable off-flavor in the tubers.

Inclusion of 0.5 pound of actual chlordane per 50 gallons of starter solution on tomatoes has been reported by growers as giving satisfactory wireworm and cutworm control.

Chlordane, DDT, benzene hexachloride, and lindane are useful on lawns, golf courses, and among ornamental shrubs and trees for chinch bugs, mole crickets, and certain other insects at the rate of one pound active ingredient per acre.

Plant Injury, Seed Germination and Growth

Chlordane has been used in amounts up to 50 pounds of active ingredient per acre on seedbeds on Bradenton sandy loam soil without any injurious effects to cabbage, lettuce, tomato, eggplant, and pepper. Benzene hexachloride at

two and one-half and five pounds of five percent gamma-isomer content per 50 gallons of starter solution, as used on tomatoes, injured tomato plants. DDT has been safe to plants in soil applications at dosages up to 200 pounds per acre. Aldrin has been safe to potato plants up to four pounds active ingredient per acre in combination with fertilizer.

TOXIC INSECTICIDE RESIDUES OF VEGETABLES

J. W. WILSON
Florida Agricultural Experiment Stations
Central Florida Experiment Station
Sanford

The hearings conducted by the Food and Drug Administration on chemicals used for pest control in fruit and vegetable production were completed in late September. It is expected that tentative tolerances will be announced during the early spring of 1951. The promulgation of these tolerances is of primary interest to every one connected with fruit and vegetable production, from the grower to the distributor and manufacturer of pesticides. These hearings and the restrictions on the amounts of insecticides to be tolerated on fruits and vegetables have served to focus attention upon the means of avoiding excessive residues. It is generally conceded that the use of insecticides is absolutely essential in the economic production of market-acceptable fruits and vegetables. Entomologists' efforts are directed toward developing effective means of insect control which require a minimum amount of poisonous insecticides.

When a new chemical is under investigation as a possible insecticide it is necessary to conduct a lengthy and detailed study of the chemical before it is released for experimental trial. Among the factors which are studied during the preliminary investigations are: (1) the effectiveness of the chemical against several different types of insects, (2) the reaction of plants to the chemical, that is, whether or not plants are injured by the material under a variety of conditions, (3) the compatibility of the chemical with other insecticides and fungicides, and (4) the acute and chronic toxicity of the chemical to small animals and man. If the chemical still shows promise after the preliminary investigations it is released for experimental trials under a wider range of weather conditions against a large number of insects on many crops. After it has passed these tests the chemical is ready to be placed on the market for general use. Thus the development of a new insecticide is a long and expensive process. We may then define the ideal insecticide as one which has a high toxicity to a wide range of insects, will not injure plants, can be readily mixed with other insecticides and fungicides, has an optimum degree of persistence and is not toxic to human beings. The insecticides which have come into use in recent years have many of the desirable characteristics of an ideal insecticide, but most of them are highly toxic to human beings. For this reason these insecticides must be used cautiously in order to avoid injury to those who apply the insecticides and those who consume the treated vegetables.

If the necessary precautions are observed the possibilities of acute poisoning are rather remote. But the possibilities of chronic poisoning, resulting from the consumption of foods contaminated with small quantities of cumulative poison over a long period of time, are of great