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Simplification of GARDEN-PEST CONTROL

WEST VIRGINIA UNIVERSITY AGRICULTURAL EXPERIMENT STATION

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Simplification of GARDEN-PEST CONTROL

M. E. GALLEGLY and J. G. LEACH

Summary

The home gardener often is confused by the numerous preparations recommended for the control of garden pests. It is true that for the best control of all garden pests, several different fungicides and insecticides are necessary. If satisfactory control of all major pests could be obtained with a single mixture, however, much time, labor, and expense could be saved. In these experiments fifteen different mixtures were tested on tomatoes, potatoes, beans, and eggplants for their value as an all-purpose garden dust.

Dust mixtures containing the fixed copper compounds, tribasic copper sulfate and copper oxide, were no better than those containing zincb for control of potato late blight as shown by defoliation readings and yield. They were slightly better than zincb in control of tomato late blight fruit rot. There was no difference between copper oxide and tribasic copper sulfate in control of late blight. Effects of other foliage diseases of tomato and potato were masked by the severe late blight epidemic. Diseases of the bean and eggplant controllable by foliage fungicides were not encountered.

Lindane was not as effective as methoxychlor in control of leaf hopper and Mexican bean beetle injury. Both insecticides controlled flea beetles. Aphids were controlled by lindane but were not affected by methoxychlor. Since there was no aphid build-up in the plots, no advantage from use of lindane was seen. In addition, a slight off-flavor was encountered in tomatoes dusted with lindane.

The over-all results show that the dust combination of zineb and methoxychlor was best for control of the fungus and insect pests on the four vegetable crops. The tomato yield was slightly higher when the fixed copper materials were substituted for zineb. However, the gain was not large enough to compensate for the injurious effect of copper to other garden crops, i. e., cucurbits and beans.

It is believed that a completely satisfactory "all-purpose" garden dust is not yet practical because of the absence of a suitable aphicide, but that the home gardener should use the zineb-methoxychlor mixture and have on hand a suitable aphicide such as nicotine sulfate for use in case of an aphid build-up. This procedure would give satisfactory pest control with the minimum expenditure of money, time, and labor.

Introduction

Although much research has been done on the control of vegetable crop pests, little of it has been directed toward solving the special problems of the home gardener. Intensified truck farming has led to the development of special insecticidal and fungicidal combinations for individual crops and pests. However, a combination best for control of the pests of one crop may not be suitable for use on another. For example, DDT is excellent for control of potato insects, but it is not suitable for use on bean, cucumber, and tomato. Thus, the home gardener often is confused by the necessity of using several different fungicides and insecticides to control all his garden pests.

To control flea beetles he should dust with one material. To control late blight he should use another. He may need four or five different materials before the gardening season is over. In addition to the extra work and waste involved in cleaning up the duster and changing to another material, the total expense of the several mixtures may be considerable. Many of the gardeners and even the fungicide dealers do not understand the principles of a pest-control program sufficiently well to use the various materials efficiently. In numerous instances an insecticide has been sold to control a fungus disease, or a fungicide to control an insect.

If a gardener had one dust composed of a combination of certain insecticides and fungicides that control most of the major garden pests, much trouble and many mistakes would be eliminated. Little research has been done on such an "all-purpose" garden dust. Leach and Yount (2) tested combinations of a fixed copper, sulfur, DDT, and rotenone in an effort to devise such a dust. They found that the yields of vegetable crops in the tests usually were highest when the three-way combination of copper, DDT, and rotenone was used. They found, however, that certain crops were injured by copper and DDT. Since that time many new pest-control materials have been developed. The purpose of the experiments reported here was to test some of the newer fungicides and insecticides, singly and in combination, as an all-purpose garden dust.

Methods and Materials

Because it was impracticable to include all the vegetable crops grown in home gardens, four were selected. Each is subject to attack by troublesome diseases and insects in West Virginia. The potato and

tomato were selected because of their susceptibility to late blight, early blight, flea beetle, and leaf hopper injury. The bean was included because of the prevalence and destructiveness of the Mexican bean beetle. The eggplant was included because of its sensitivity for flea beetle and chemical injury.

These crops were planted together in blocks 30 feet long. The tomato plants were set 3 feet apart in the row and 6 feet from the potato row. The rows of the other vegetables were 3 feet apart. To minimize effects from dust drifts, 9-foot alleys surrounded the blocks. Potato seed pieces were planted 10 inches apart in the row, beans 6 inches, and eggplants 2 feet. The certified Cobbler potato seed was planted May 24; Marglobe tomato plants were transplanted May 25; Giant Stringless Green Pod beans were planted May 24; and Black Beauty variety eggplants were transplanted June 20. The trials were conducted in the Tygart Valley near Huttonsville, West Virginia at an altitude of about 2,500 feet.

The dust mixtures were prepared according to our specifications by the Miller Chemical Corporation of Charles Town, West Virginia. The basic ingredients were zineb (zinc ethylene bisdithiocarbamate) and methoxychlor (dimethoxy diphenyl trichloroethane). Zineb was used as the fungicide because of its ability to control late blight of potatoes and tomatoes and numerous other foliage diseases. Two fixed copper compounds commonly used in the garden were included for comparison with zineb. Methoxychlor was used as the insecticide for control of flea beetle, leaf hopper, tomato horn worm, and Mexican bean beetle. Methoxychlor is effective in control of the same insects that are controlled by DDT and also will control the Mexican bean beetle. Methoxychlor also is practically nontoxic to most plants and in this respect differs from DDT. However, aphids are not controlled by methoxychlor but may increase because of the insecticidal action of methoxychlor against certain aphid parasites. For this reason lindane, the purified *gamma* isomer of benzene hexachloride, was used as an aphicide in some of the dust mixtures. These five materials are relatively nontoxic to warm-blooded animals and thus do not leave harmful residues on edible green vegetables.

The dust mixtures and their ingredients are listed below. The per cent of concentration of each active ingredient is given in parenthesis following the compound. The percentages of tribasic copper sulfate and copper oxide refer to the amount of metallic copper. Those of zineb, methoxychlor, and lindane refer to the amount of active compound. The dilutent for each mixture was pyrophyllite.

Zineb (6.5) and methoxychlor (5)
 Tribasic copper sulfate (7) and methoxychlor (5)
 Copper oxide (7) and methoxychlor (5)
 Zineb (6.5) and lindane (1.5)
 Tribasic copper sulfate (7) and lindane (1.5)
 Copper oxide (7) and lindane (1.5)
 Zineb (3.2), tribasic copper sulfate (4), and methoxychlor (5)
 Zineb (3.2), copper oxide (4), and methoxychlor (5)
 Zineb (3.2), tribasic copper sulfate (4), methoxychlor (5), and
 lindane (1.5)
 Zineb (3.2), copper oxide (4), methoxychlor (5), and lindane (1.5)
 Zineb (6.5), methoxychlor (5), and lindane (1.5)
 Tribasic copper sulfate (7), methoxychlor (5), and lindane (1.5)
 Copper oxide (7), methoxychlor (5), and lindane (1.5)
 Methoxychlor (5) and lindane (1.5)
 Zineb (3.2) and tribasic copper sulfate (4)
 Control (none)

The dusts were applied with one-quart Hudson (Admiral) dusters at the approximate rate of fifty pounds per acre. Because of their consistency, some of the mixtures inadvertently were applied at slightly heavier rates than others. Each block or miniature garden was considered a replicate and was dusted with one of the mixtures. Each treatment was randomized and replicated five times. The dusts were applied at weekly intervals for fifteen applications.

At various times during the season the plants were examined and rated for disease and insect injury. Flea beetle, leaf hopper, and bean beetle injury was rated as slight, moderate, severe, or very severe. Amount of defoliation of tomato and potato was measured in percentage after the method of Horsfall and Barratt (1). The percentages reported in the following tables are the averages of five replicates. The defoliation percentages were subjected to analysis of variance.

The beans were picked four times. The weights of the four pickings for each replicate were totaled and converted to tons per acre. The tomatoes were picked eight times. In addition to the ripe fruit, the rotted fruit was weighed. The yield of ripe fruit was converted to tons per acre, and the amount of fruit rot was converted to percentages. The potatoes were dug October 23, and the total yields were converted to bushels per acre. Eggplant yields were not recorded because of the late planting. All yield data were subjected to analysis of variance.

Only a few diseases and insects were in the plots, but those present were extremely destructive. Mexican bean beetles were abundant and

damaged the beans severely. The potato and tomato were damaged by the flea beetle, the leaf hopper, early blight, and late blight. The eggplant was injured by the flea beetle. Temperature (60°-70° F. at night) and moisture (98-100 per cent humidity at night) were favorable for development of late blight throughout the growing season. As a result, the effects of other diseases on the tomato and potato were masked by an extremely severe late-blight infection.

Experimental Results

Beans. Of the bean pests that may be controlled by fungicides or insecticides, only the Mexican bean beetle was present in the plots. As shown in Table 1, dust mixtures in which methoxychlor was used as an insecticide were best for control of beetle injury. When methoxychlor was used, the beetle injury was slight; when lindane was used alone, it was moderate to severe. The injury was severe when no insecticide was used. The three fungicides had no apparent affect on the amount of beetle injury. Methoxychlor eliminated the injury caused by the bean beetle larvae, but it did not effectively prevent injury caused by the adult or "hard-shell" form. The slight beetle injury on the methoxychlor plots was caused by the adult beetle. Typical symptoms of Mexican bean beetle injury are shown in Figure 1.

The yield was increased when the insecticides methoxychlor and lindane were used. It was slightly greater from plants dusted with

TABLE 1. MEXICAN BEAN BEETLE INJURY AND YIELD OF BEANS DUSTED WITH VARIOUS FUNGICIDE AND INSECTICIDE COMBINATIONS.

DUST MIXTURE	BEAN BEETLE INJURY	YIELD (TONS PER ACRE)
Zin. + Meth.	slight	7.3
Trib. + Meth.	slight	6.6
CuO + Meth.	slight	6.9
Zin. + Lin.	severe	6.1
Trib. + Lin.	moderate	6.4
CuO + Lin.	moderate	6.9
Zin. + Trib. + Meth.	slight	7.1
Zin. + CuO + Meth.	slight	5.9
Zin. + Trib. + Meth. + Lin.	slight	6.4
Zin. + CuO + Meth. + Lin.	slight	7.0
Zin. + Meth. + Lin.	slight	6.9
Trib. + Meth. + Lin.	slight	6.1
CuO + Meth. + Lin.	slight	6.7
Meth. + Lin.	slight	7.5
Zin. + Trib.	severe	6.0
None	severe	5.4
LSD		
19:1		1.0
99:1		1.3

FIGURE 1. Mexican bean beetle injury typical of that on plants that were not dusted with an insecticide. Note that both larvae and adults are feeding on the undersurface of the leaf.

methoxychlor than from those dusted with lindane. In addition to the increased yields, the quality of the beans from plants dusted with methoxychlor was better than that from plants that received no insecticide. There was no apparent difference in yield when either of the three fungicides was used. The over-all results show that the zinc-methoxychlor mixture is satisfactory for control of beetle injury and for yield. None of the other mixtures was superior, but a few were inferior.

Potato. As shown in Table 2, flea beetle injury was controlled by both methoxychlor and lindane. However, only methoxychlor controlled leaf hopper injury. Both flea beetle and leaf hopper injury was severe when no dust was applied and was moderate when the zinc-tribasic, without an insecticide, was applied. Thus, it was evident that methoxychlor is necessary to control flea beetles and leaf hoppers

TABLE 2. INSECT INJURY, DEFOLIATION, AND YIELD OF COBBLER POTATOES
DUSTED WITH DIFFERENT FUNGICIDE AND INSECTICIDE MIXTURES.

DUST MIXTURE	INSECT INJURY		DEFOLIATION AFTER PLANTING		TOTAL YIELD
	FLEA BEETLE	LEAF HOPPER	70 DAYS	80 DAYS	
			per cent	per cent	
Zin. + Meth.	Slight	None	5.1	46.7	351
Trib. + Meth.	Slight	None	5.1	61.8	299
CuO + Meth.	Slight	None	5.4	52.4	297
Zin. + Lin.	Slight	Moderate	3.9	40.9	349
Trib. + Lin.	Slight	Moderate	5.4	71.2	284
CuO + Lin.	Slight	Moderate	5.4	56.0	337
Zin. + Trib. + Meth.	Slight	None	3.3	46.7	354
Zin. + CuO + Meth.	Slight	None	4.5	46.7	328
Zin. + Trib. + Meth. + Lin.	Slight	None	3.3	43.1	366
Zin. + CuO + Meth. + Lin.	Slight	None	4.8	48.9	329
Zin. + Meth. + Lin.	Slight	None	5.1	39.6	359
Trih. + Meth. + Lin.	Slight	None	3.6	52.4	358
CuO + Meth. + Lin.	Slight	None	3.9	49.0	384
Meth. + Lin.	Slight	None	67.6	97.3	210
Zin. + Trih.	Moderate	Moderate	4.2	56.0	272
None	Severe	Severe	86.5	99.7	129
LSD					
19:1			4.2	24.4	71.2
99:1			5.6	32.5	94.7

on potato even though the fungicides have a slight repellent action.

Yield was slightly greater when both insecticides, methoxychlor and lindane, were used with a fungicide than it was when only methoxychlor was used with the same fungicide. This may be due to the aphid control received from lindane, even though there was no obvious build-up of the insect in the plots.

Although late blight control, as measured by per cent defoliation and yield, generally was greater when zineb was used in the dust mixture than it was when tribasic or copper oxide was used, the difference was not significant. The highest yield was obtained from the three-way combination of copper oxide, methoxychlor, and lindane. This yield, however, was not significantly better than that from the two-way combination of zineb and methoxychlor.

Tomato. Flea beetle injury on tomato was controlled by dust mixtures containing either methoxychlor or lindane. Since aphids were not abundant in the plots, there was no advantage from use of lindane.

Data in Table 3 show the amount of defoliation and fruit rot caused by late blight, total yields, and yields of salable fruit. Defoliation control was best when zineb was in the dust mixture. Also the total yields (salable fruit plus rotted fruit) were greater from zineb. The fixed copper fungicides, however, controlled late blight fruit rot better than did zineb. The combinations in which zineb and a fixed

TABLE 3. TOMATO LATE BLIGHT CONTROL RECEIVED FROM DIFFERENT DUST MIXTURES AS MEASURED BY THE AMOUNT OF DEFOLIATION, FRUIT ROT, AND YIELD.

DUST MIXTURE	DEFOLIATION 85 DAYS AFTER TRANS- PLANTING	FRUIT ROT	YIELD (TONS PER ACRE)	
			TOTAL	SALABLE
	per cent	per cent		
Zin. + Meth.	24.2	62.3	6.7	2.8
Trib. + Meth.	35.5	54.9	4.4	2.0
CuO + Meth.	34.3	43.3	5.4	3.1
Zin. + Lin.	25.0	62.7	6.4	2.5
Trib. + Lin.	33.3	40.9	5.8	3.5
CuO + Lin.	34.4	42.5	6.4	3.6
Zin. + Trib. + Meth.	26.3	47.0	6.7	3.5
Zin. + CuO + Meth.	29.8	40.1	8.3	5.0
Zin. + Trib. + Meth. + Lin.	30.5	44.5	7.6	4.2
Zin. + CuO + Meth. + Lin.	30.0	46.6	5.6	2.9
Zin. + Meth. + Lin.	31.2	72.3	5.1	1.5
Trib. + Meth. + Lin.	31.0	37.9	7.3	4.6
CuO + Meth. + Lin.	36.2	42.1	5.6	3.4
Meth. + Lin.	72.2	85.9	1.0	.1
Zin. + Trib.	29.2	59.4	6.3	2.6
None	75.2	100.0	.4	0.0
LSD				
19:1	7.3	10.9	2.0	1.4
99:1	9.7	14.5	2.6	1.9

copper were used controlled fruit rot as well as did the combinations where a fixed copper alone was used as the fungicide. The amount of salable fruit was greater when the fixed coppers were used than it was when zineb was used. The difference, however, was significant in only one case. The lower yield from the zineb plots was due to the poorer control of fruit rot by zineb. Yields from dust combinations containing both zineb and a fixed copper were as high as those from combinations containing a fixed copper as the only fungicide. A healthy cluster of tomato fruit and a cluster completely rotted by the late blight fungus are shown in Figure 2.

Discussion

The over-all results reported herein show that the dust combination of zineb and methoxychlor was best for control of the insect and fungus pests of the bean, potato, tomato, and eggplant. The fixed copper compounds, tribasic copper sulfate and copper oxide, were equal to zineb in control of potato late blight. Late blight defoliation of tomato was best controlled by zineb, but fruit rot was best controlled by the fixed copper compounds. Thus, yield of salable fruit was slightly higher from plants dusted with the copper materials than from

FIGURE 2. (A) Late blight fruit rot from plants that were not dusted with a fungicide. (B) Healthy fruit from plants dusted with zineb.

plants dusted with zineb. Lindane was not as effective as methoxychlor in control of leaf hopper and Mexican bean beetle. Both methoxychlor and lindane controlled flea beetle injury. Methoxychlor does not control aphids, but lindane does. Since there was no build-up of aphids in the plots, no advantage from use of lindane was observed.

Although the vegetable crops included in these trials were representative, other crops are grown in home gardens and must be considered in the development of garden dusts. In addition to the four crops tested, many insects on asparagus, beets, crucifers, carrots, celery, sweet corn, cucurbits, lettuce, peas, peppers, and turnips are controlled by methoxychlor with no apparent injury to the plants. Similarly, zineb will control many of the diseases of these crops with little or no injury to plants. The fixed copper fungicides, however, sometimes are injurious to certain of the vegetable crops, i. e., cucurbits, beans, and tomatoes. Also, certain of the crops are injured by other insecticides, for example, DDT.

Although certain insects may not be controlled as well by methoxychlor as by certain specific insecticides, i. e., Mexican bean beetle by rotenone and leaf hoppers by DDT, the difference is usually small. Since methoxychlor will give satisfactory control of several insects that ordinarily cannot be controlled, unless two or more insecticides are used, it is ideal for use in a garden dust mixture. Likewise, zineb, under some conditions, may not be as good as the copper fungicides in control of potato and tomato late blight. On the other hand, zineb can be used effectively against the diseases of other vegetable crops.

Therefore, it appears that zineb and methoxychlor are almost ideal for control of most garden insect and disease pests. In addition, they are nontoxic to vegetable crops and are relatively nontoxic to man. The mixture, however, will not control aphids, which often are extremely destructive. These insects can be suitably controlled by lindane. It was present in some of the dust mixtures. However, lindane has been reported to impart an off-flavor to certain crops. A very slight off-flavor was observed on the lindane-dusted tomatoes. For this reason lindane should not be included in a garden dust unless further tests prove it to be acceptable. Other aphicides now on the market have certain limitations such as lack of stability in dust form, toxicity to certain crops, and injuriousness to man. It appears that a completely "all-purpose" garden dust is not yet possible. However, this can be approximated with the use of a zineb-methoxychlor combination and by having on hand an aphicide such as nicotine sulfate or parathion to use in case of an aphid build-up. The former material,

however, is unstable, the latter is likely to be injurious to man during application and may leave poisonous residues on plants unless proper precautions are taken. It may be possible to use lindane two or three times during the growing season without imparting an off-flavor to the garden crops.

The dust mixture of methoxychlor and zineb is now being recommended by the West Virginia Agricultural Extension Service. It is on the market under various trade names. The names and the amount of active ingredients are listed on all packages.

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