

Lindane for Wireworm Control

wireworms affecting certain vegetable and field crops controlled with lindane seed treatment

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Control of wireworms affecting certain vegetable and field crops now appears possible by means of an inexpensive method of treating the seeds with lindane before planting.

Soil fumigants or residual chemicals are satisfactory controls, but some are costly and others may build up large amounts of chemicals in the soil. In addition, certain chemicals may be carried into plant tissues as toxic residues or off-flavors, thus reducing the marketable value of the produce.

Seed treatment cannot entirely supplant the use of these other wireworm control methods. It is, however, an effective and practical means of control if the effective dosage does not injure the seeds of a crop and if wireworms are attracted to the seed zone during germination.

The pure gamma isomer of benzene hexachloride, or lindane, is used in the treatment of the seed. It is available as 25% wettable powders, and as a 75% powder especially for seed treatment. Although technical grades of benzene hexachloride that have characteristic musty odors are effective they should not be used, as they are more likely to injure germinating seeds.

Fungicides can be safely combined with lindane to form a combination insecticide-fungicide treatment. During studies made at the Experiment Station, the following fungicides used with lindane had no apparent adverse effects: Arasan, Ceresan M, Phygon, Semesan, Spergon, and yellow cuprous oxide.

Seed Treatment

Seeds can be treated with lindane and fungicides in several ways:

1. A measured dosage of chemical in dust form can be applied in rotating mixers, such as diagonal barrels, cement mixers, or other open containers.

2. After the dry dust is applied, one-quarter pint to one-half gallon of water—the amount used depends upon the kind of seed—can be sprayed on each 100 pounds of seed during the mixing process. A compressed air sprayer can be used for this purpose.

3. The chemicals can be applied to the seed in the form of solutions or as suspensions of wettable powders. Compressed air sprayers, spray treaters, or

slurry treaters are all effective for this process.

Of the different methods used in treating seed with lindane and fungicides, liquid applications are most satisfactory and adaptable because of the greater adherence of the chemicals to the seed, increased safety to the operator, and equal or better insecticidal effectiveness.

Dosage of lindane for seed treatment has to be considered for each crop. Not only does lindane affect the germination of some kinds of seed more than others, but also its insecticidal efficiency varies with different crops. For example, lindane is used at the rate of two to four ounces of 25% lindane to 100 pounds of seed for baby lima beans, but at 16 ounces of the same mixture for sugar beets.

The dosage of fungicide depends upon the chemical to be used and upon the kind of seed to be treated.

The tolerances of different kinds of seed to lindane vary markedly. Injury from dosages greater than those suggested in this article may include delay or reduction in germination, stunting of the plants, nonabsorption of the cotyledons in the case of certain bean varieties, and reduction in seedling weight. Insecticidal efficiency also varies with dosage. For this reason, the dosage suggested for a particular crop is based upon the maximum amount of lindane the seeds will tolerate and the minimum amount necessary to seriously affect or kill wireworms. In view of these facts, the tolerances for different kinds of seeds in relation to insecticidal efficiency are discussed below.

Sugar Beets

Sugar beets are relatively tolerant of lindane seed treatment. Tests have indicated that 16 ounces of a 25% lindane formulation, or 5.33 ounces of 75%, may be applied to 100 pounds of seed without injurious effects. In one test a dosage of 32 ounces did not injure the seed, but 40 ounces caused a delay and a reduction in total germination.

In a field experiment, 16 ounces of 25% lindane to 100 pounds of seed killed 93% of the wireworms within the seed area and increased the number of plants per foot of row from 0.69 plant, where the seed was untreated, to 1.63 plants, where the seed was treated. One seed

treatment in another field test not only increased the plant stand but also reduced the population of wireworms—those worms not passing through a 16-mesh screen—by half, and in addition, affected wireworms that came in contact with the old seed balls for two months afterward.

Laboratory and field tests indicated that a dosage higher than 16 ounces of 25% lindane to 100 pounds of seed was not necessary for wireworm control, but that a reduction to eight ounces decreased control.

Length of storage may be an important factor. Sugar beet seed treated with 16 and 32 ounces of 25% lindane to 100 pounds of seed lost about one half of its insecticidal effectiveness to wireworms when stored for 10 months in nonsealed jars. Seed stored under similar conditions for 15 months caused a two- to three-day delay in emergence and a reduction in total emergence.

With spray or slurry treaters, fungicides, such as Arasan, Ceresan M, or Phygon, can be applied at the same time as the insecticide.

Thousands of pounds of sugar beet seed have been treated during the past two years with lindane or lindane-fungicide combinations, and good control has been obtained.

Baby Lima Beans

Baby lima beans can be successfully treated with a dosage of two to four ounces—by weight—of 25% lindane to 100 pounds of seed. The higher dosage may cause occasional delay in germination, but in most field plantings no permanent injurious effects occur.

Lindane can be combined with Arasan or Spergon and applied to the seed as dry mixtures or as suspensions. If applied dry, it is advantageous to use 75% lindane at 1.33 ounces with the necessary fungicide, and to spray one-quarter to one-half pint of water—to 100 pounds of seed—on the seed as it is mixed. If applied as liquids in a spray or slurry treater, 1.33 ounces of 75% lindane—per 100 pounds of seed—can be combined with the wettable fungicides—used at manufacturer's recommendations.

The two to four ounce dosage men-

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tioned above was found to seriously affect or to kill from 75% to 90% of the wireworms in the vicinity of the treated seed within three to four weeks after planting.

During 1948 and 1949, large amounts of baby lima beans were treated with lindane; good wireworm control was obtained with no adverse effect on stand or final yields.

Large Lima Beans

Large lima beans are more sensitive to lindane damage than baby lima beans. Of the large types, Fordhooks are more easily damaged than standard limas. A dosage of two ounces of 25% lindane to 100 pounds of seed appears to be effective and comparatively safe for standard limas, but may cause a delay in emergence and a reduced total emergence of Fordhooks.

Lindane and fungicides are applied to large limas in the manner suggested for baby lima beans.

Field trials on standard limas were conducted in San Diego County during 1949. In five fields, beans treated with three ounces of 25% lindane and four ounces of Spergon per 100 pounds of beans were compared with nontreated seed. Where wireworms were absent, only a slight increase—but no decrease—in stand was recorded. In the two fields where wireworms were abundant a three to four times increase in stand occurred and an increase in final yields.

Although thousands of pounds of large limas were treated successfully with lindane during 1949, it is suggested that until more information is available the maximum dosage be held to two ounces of 25% lindane—0.66 ounce of 75%—per 100 pounds of standard limas, and that Fordhooks be treated with a one-ounce dosage of the same material on an experimental basis. Although these low dosages do not affect or kill wireworms as rapidly as higher dosages, they appear to give adequate wireworm protection in most instances.

Other Crops

The tolerances of other bean varieties to lindane vary, but in general are as tolerant or more tolerant than baby lima beans. Of the varieties tested, pink beans, kidney beans, and Tendergreen beans are more tolerant than Stringless Pole Blue Lake and Giant Stringless Green Pod.

A dosage of two ounces of 25% lindane per 100 pounds of beans—1.33 ounces of 75%—is safe on the bean varieties which have been investigated and should be used until further investigations can be made upon the tolerances of individual varieties.

A satisfactory dosage for milo seed is

four ounces of 25% lindane to 100 pounds of seed—1.33 ounces of 75%. During 1949, a large-scale treatment with 1.33 ounces of 75% lindane—to 100 pounds of beans—with Phygon paste at the equivalent rate of two ounces of Phygon XL to 100 pounds of seed—gave adequate wireworm protection, controlled *Pythium* seed decay, and reduced seed-borne *Fusarium moniliforme* infection.

Tests conducted in the Davis area during 1949 indicated that four ounces of 25% lindane to 100 pounds of seed will control the wireworm, *Limonius clypeatus*, without plant injury. In the greenhouse, dosages of eight to 16 ounces of the same formulation gave only temporary delays in germination. Ceresan M combines successfully with lindane. Both dust and slurry treatments are satisfactory.

Lindane seed treatment has been used to a limited extent on a number of other crops. Except for sugar beets, certain bean varieties, milo, and barley, where adequate field trials have been made, the dosages are based upon greenhouse trials, laboratory trials, and limited field tests. For this reason treatments of the other seeds should be restricted to small acreages. Tentative dosages for these crops are included in the tabulation below.

Cautions and Suggestions

Growers and others desiring to treat seed with lindane are referred to the schedule below which may have to be modified for certain crops as additional information is secured. These tentative recommendations should be used cautiously, as local climatic and soil conditions, varietal differences, and other variables may influence seed injury.

The amount of lindane suggested for a particular crop should be carefully

measured, as greater amounts may cause injury to germination.

Applying lindane to seeds is a method of obtaining a stand, and although it may give protection from wireworms until the plants are established, it may have to be repeated at each planting. In the case of certain crops, less treated seed is usually required than is ordinarily planted in wireworm infested areas.

Only limited amounts of dry dust will adhere to most types of seeds. For this reason, sticking the lindane or fungicides on the seed by applying water to the dry dusts, or using spray or slurry treaters, will often insure better results.

With dry applications of fungicides, the use of 75% lindane will prevent diluting the fungicide, and thus secure better protection. Seed first treated with non-wettable powders should not later have wet applications of lindane. With spray or slurry treatment, the 75% lindane should be used, together with a wettable form of the required fungicide.

Only seed of high germination, with good vigor, should be treated with lindane. Poor seed may suffer greater injury.

In the absence of adequate information, it is suggested that seed be treated not over six weeks before planting. What effect prolonged storage has on germination has not been definitely established.

Lindane seed treatment may partially protect seed from attacks of the seed corn maggot, but the degree of protective value is not fully known. Two ounces of a 40% wettable powder of chlordane applied to 100 pounds of Fordhook lima bean seed by means of a slurry treater was found of value in this regard. In a test conducted at Gilroy during 1949, the amount of injury to the cotyledons was reduced from 69% on the untreated beans to 2% on the seed treated with chlordane, without affecting germination. Such a chlordane treatment, however, should be used only experimentally.

Seed treated with lindane should never be used as food for either human or domestic animals.

Operators handling these chemicals should wear respirators, should wash thoroughly with soap and water following exposure, and should change clothing daily. Lindane may cause a skin rash if handled continuously.

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Crop	Dosage of lindane expressed in ounces per 100 pounds of seed	
	25% material	75% material
Sugar beets . . .	16	5.33
Cotton	8	2.66
Tomato	8	2.66
Corn	4	1.33
Peas	4	1.33
Okra	4	1.33
Milo	4	1.33
Barley	4	1.33
Cucumbers . . .	4	1.33
Cantaloupes . .	4	1.33
Beans, except		
large limas . .	2 to 4	0.66 to 1.33
Standard		
lima beans . .	2	0.66
Wheat	1 to 2	0.33 to 0.66
Fordhook		
lima beans . .	1 to 2	0.33 to 0.66