THE EFFECT OF CERTAIN INSECTICIDES ON THE GERMINATION AND GROWTH OF ONIONS

II. INSECTICIDES APPLIED TO THE SEED[1]

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INTRODUCTION

In 1949, it appeared that the recommended calomel seed-treatment did not satisfactorily control the onion maggot, *Hylemya antiqua* (Meig.), in seedling onions in the interior of British Columbia. Because of this, and its excessive cost, an investigation of the control of this pest with some of the newer insecticides was initiated in 1950. Analyses of yield data showed significant differences between various treatments. These differences were not all directly attributable to the attack of the maggots, since some treatments produced yields almost twice as great as others with almost similar percentage damage. The lower yields appeared to occur where insecticides had been applied either directly to the seed or to the seed trench.

To investigate this point, germination tests, the results of which are presented below, were conducted in the greenhouse during the winter of 1950-51. Further tests were conducted in the laboratory throughout the summer of 1951.

METHODS AND MATERIALS

The chemicals investigated were wettable powders of DDT, toxaphene, BHC, chlordane, Aldrin, and dieldrin; emulsible concentrates of aldrin and dieldrin; and powdered calomel (mercurous chloride). These were applied in three ways:—

Stirring in slurries of wettable powder. Onion seeds were treated with a 25 per cent. concentration of actual insecticide in water for each of the following: DDT, Toxaphene, BHC, chlordane, aldrin, and dieldrin. The seeds were stirred into the slurry for 5 minutes and the mixture was then poured through a 20-mesh copper screen to drain off the excess liquid. The seeds were placed on paper towelling to dry and were agitated periodically by means of a glass rod to prevent them from adhering to one another, so that none of the chemical coating might be removed in separating the seeds.

Dipping in emulsions. The seeds were stirred into a 5 per cent. emulsion of each of aldrin and dieldrin for 1 minute, the mixture was then poured through a 20-mesh copper screen and the seeds were placed on paper towelling to dry.

Coating seed with dry powder. The seeds were first soaked in water for 5 minutes, and then mixed with an equal weight of calomel. When as much of the calomel as possible had adhered to the seeds, they were separated from the powder by screening. This procedure is commonly recommended for controlling the onion maggot.

In the greenhouse the seeds were grown in 8-inch flower pots and each of the 10 treatments was replicated 5 times. Each replicate (*i.e.*, 10 pots) was set up as a randomized block.

Seeding was done by hand, 100 seeds per pot. These were sown in concentric circles with about half an inch between seeds and about the same distance between circles.

The first germination count was made 8 days after the first seedlings began to appear. Two additional counts were made at intervals of 10 days. Although daily recording might have given higher counts the germinations obtained by the above method indicated those seedlings that had grown beyond the period when food was supplied by the seed. The count at which the maximum number of plants was recorded was considered the total germination for the treatment.

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Throughout the growing period the plants were checked periodically for toxicological symptoms. Conclusions were based on comparisons involving three aspects of growth: the root and leaf systems, the average green weight per plant, and the average dry weight per plant. The average green weight per plant was determined by carefully removing all plants from the pots after allowing the soil to become slightly dry, and then washing the clinging soil from the plants by immersing them in warm water. After the excess moisture had been removed they were weighed as a group for each pot and the average weight per plant was calculated. The average dry weight per plant was obtained by placing the plants in a warming oven at 80°C. until a constant weight was obtained.

In the laboratory tests wettable powders and emulsions were applied to seed of a different lot from that used in the soil tests. In this series, samples of ½ oz. of onion seed were treated with either a 25 per cent. concentration of actual insecticide in water from a wettable powder or a 5 per cent. emulsion from an emulsifiable concentrate. The following numbers of ounces of actual insecticide adhered to one pound of onion seed:

DDT (w.p.)	3.5
BHC (w.p.)	4.0
aldrin (w.p.)	2.5
dieldrin (w.p.)	2.1
chlordane (w.p.)	4.1
toxaphene (w.p.)	4.1
aldrin (emul.)	0.16
dieldrin (emul.)	0.07
calomel (approx.)	16.0

Germination tests were conducted periodically to determine whether storage of the chemically treated seeds in an open glass container affected germination. Four tests were completed in all. In the first three, single lots of 25 seeds were placed in 10-cm. petri dishes on two thicknesses of No. 1 filter paper and covered. The filter paper was moistened daily so that the quantity of water could be better controlled. Germination counts were begun on the fourth day after the seeds were set out and continued daily for the following 12 days. The fourth test was similar to the previous three except that it was initiated 110 days after treatment and consisted of 5 replications. In addition to the germination counts observations were made periodically on development of the seedlings, colour, and general vigour of the plants.

RESULTS

Germination in Soil

A 5 per cent. emulsion of aldrin or dieldrin appeared to retard by 10-15 days the germination of the seeds planted in soil, aldrin seeming to be more harmful than dieldrin. In addition to the delay, the percentage germination was significantly low for both of these treatments (Table I). Although there was a significant decrease in the percentage germination of seed treated with BHC, no delay was evident. Toxaphene and dieldrin wettable powder treatments produced results similar to those for BHC. The percentage germination for the treatments is shown in Table I.

No significant differences were present between the remaining treated and the untreated series.

Effect of Storage on Germination

The effects of storing the chemically treated seeds in an open-topped glass container are shown in Tables II and III. In seeds tested immediately after treatment, germination was delayed by all chemicals except BHC. Tests begun 30 and 80 days after treatment did not exhibit this condition; however, in tests begun 110 days after treatment a marked delay in germination occurred for each treatment.

In the seeds stored 0 to 80 days, the percentage germination was highly significantly low for aldrin emulsion and significantly low for dieldrin emulsion; all the other treatments had similar germination to that of the untreated seeds. For seeds stored 110 days all treatments caused delay in germination; significant differences appeared as early as the second day

TABLE I.

Percentage germinations, in pots, of onion seed treated with various insecticides

Treatment	Ounces of actual insecticide adhering to one pound of seed	Germination	
		Total[1]	Percentage
Chlordane, 40 per cent. wettable powder	4.1	120	24.0
Untreated		117	23.4
Aldrin, 50 per cent. wettable powder	2.5	103	20.6
DDT, 50 per cent. wettable powder	3.5	91	18.2
Calomel, 100 per cent. dry powder	16 (approx.)	90	18.0
Dieldrin, 50 per cent. wettable powder	2.1	87	17.6
Toxaphene, 40 per cent. wettable powder	4.1	73	14.6
BHC, 50 per cent wettable powder	4.0 (BHC)	52	10.4
Dieldrin, 5 per cent. emulsion	0.07	41	8.2
Aldrin, 5 per cent. emulsion	0.16	19	3.8

[1]Difference necessary for significance: 5 per cent. level, *27.2*.

after germination commenced (Table III). By the second day DDT wettable powder. BHC wettable powder, and aldrin emulsion each caused significantly lower germination than aldrin, dieldrin, and toxaphene wettable powders. Chlordane wettable powder and dieldrin emulsion were not significantly different from either of these groups. However, by the twelfth day of germination, DDT, BHC, toxaphene, aldrin emulsion, and dieldrin emulsion treatments each gave significantly low counts.

Characteristics of Growth in Soil

Periodical observations indicated that plants grown from treated seed did not differ from those from untreated seed, except those from seed treated with BHC or chlordane. Plants grown from BHC-treated seed were stunted and stocky, the leaf portion being two to four times thicker than in the untreated plants. Within a week after germination these plants exhibited chlorosis, and necrosis was developing. Several such plants were removed from the soil, all showing the following characteristics: short, stubby, primary roots; no secondary root system; no root hairs; and little or no bulb. Later examination proved that the roots from all plants grown from BHC-treated seed had similar symptoms. Plants grown from seed treated with chlordane appeared to have larger root and leaf systems than those of the checks.

The treatments did not cause significant differences in either the average green weight or the average dry weight of the onion plants. As a result of reduced germination, however, the grand total of green and dry weights was significantly reduced by treatment with BHC, toxaphene, aldrin emulsion, or dieldrin emulsion.

TABLE II.

Germination counts, in petri dishes, of treated onion seed after storage for 0, 30, and 80 days in open-topped glass containers.

Treatment	Ounces of actual insecticide adhering to one pound of seed	Germination counts at 1, 6, and 12 days for 25 seeds								
		0 Days' Storage			30 Days' Storage			80 Days' Storage		
		1	6	12	1	6	12	1	6	12
Chlordane, 40 per cent. wettable powder	4.1	6	23	24	10	22	22	4	19	24
Untreated		10	22	22	17	22	22	15	25	25
Aldrin, 50 per cent. wettable powder	2.5	0	23	24	9	19	21	3	15	20
DDT, 50 per cent. wettable powder	3.5	2	21	21	9	22	23	5	15	22
Dieldrin, 50 per cent. wettable powder	2.1	0	22	23	14	23	23	9	18	21
Toxaphene, 40 per cent. wettable powder	4.1	0	21	22	11	21	21	8	16	20
BHC, 50 per cent. wettable powder	4.0 (BHC)	17	24	24	10	16	20	6	14	22
Dieldrin, 5 per cent. emulsion	0.07	0	16	18	8	10	12	6	15	21
Aldrin, 5 per cent. emulsion	0.16	0	7	10	0	2	4	0	1	2

Growth Characteristics in Petri Dishes

The toxicological symptoms observed in the seedlings grown in petri dishes from treated seeds were more pronounced. As the petri dishes were covered to maintain moisture content, fumigation may have been a factor. The relative sizes of the seedling plants for these tests are shown in Fig. 1.

The symptoms produced by BHC were the most pronounced. Chlorosis was present from the time of germination of the seeds until the death of the plants. The length of the sprout in BHC-treated seed did not exceed ½ inch, even 10-12 days after germination. On the other hand, in the untreated series, the young plants had dark-green leaves, secondary roots and root hairs, and small bulbs; and the leaf had begun to straighten from the "loop stage."

Other treatments that caused some difference in the development of the seedlings were chlordane wettable powder, toxaphene wettable powder, and aldrin emulsion. The seedlings of chlordane-treated seed exhibited a lack of root hairs, slight chlorosis, and a thickening at the neck of the bulbs. The two other treatments caused exactly opposite conditions: seedlings from toxaphene-treated seed had poorly developed root hairs, whereas those from aldrin emulsion-treated seed had root hairs that were longer and more abundant than those of the untreated seedlings.

TABLE III.

Germination counts, in petri dishes, of treated onion seed after storage for 110 days in open-topped glass containers.

Treatment	Ounces of actual insecticide adhering to one pound of seed	Germination counts at 2, 4, 6, 8, 10, and 12 days for 125 seeds					
		2[1]	4	6	8	10	12[1]
Chlordane, 40 per cent wettable powder	4.1	19	50	80	97	102	104
Untreated		118	121	123	124	124	124
Aldrin, 50 per cent. wettable powder	2.5	29	52	81	91	108	109
DDT, 50 per cent. wettable powder	3.5	6	33	67	86	95	100
Dieldrin, 50 per cent. wettable powder	2.1	30	68	91	97	102	105
Toxaphene, 40 per cent. wettable powder	4.1	27	50	73	86	89	93
BHC, 50 per cent. wettable powder	4.0 (BHC)	11	27	36	75	88	98
Dieldrin, 5 per cent. emulsion	0.07	18	39	65	79	85	87
Aldrin, 5 per cent. emulsion	0.16	2	5	12	22	29	35

[1]Difference necessary for significance, 5 per cent. level:
second day, 16.9,
twelfth day, 23.6.

DISCUSSION

Although the percentage germination of the onion seed used in soil was far from satisfactory, the potential rates of germination of treated and untreated seeds were similar. The germination for untreated seeds averaged only 24 per cent., which is far below that required for commercial seed. Nevertheless, the germination of seed treated with BHC wettable powder, dieldrin wettable powder, toxaphene wettable powder, a 5 per cent. emulsion of aldrin, or a 5 per cent. emulsion of dieldrin was significantly lower than that of the checks. In the last two treatments it is thought that germination was not retarded by the insecticides themselves, but by the liquid solvent used in the emulsion concentrate. If this be so it could either act as a mechanical barrier to the moisture necessary to produce germination or have a lethal effect on the embryo within the seed.

Germination tests conducted in petri dishes substantiated the results obtained for treated seeds used in soil, this seed giving almost 100 per cent. germination in the checks. Here again the germination of seeds treated with BHC, toxaphene, a 5 per cent. emulsion of aldrin, or a 5 per cent emulsion of dieldrin was significantly lower than for the checks. However, for one additional treated series, that of DDT, germination was significantly lower than for the checks.

Throughout the series of tests to determine the effect of storage on chemically treated seeds there was a delay in germination of all treated

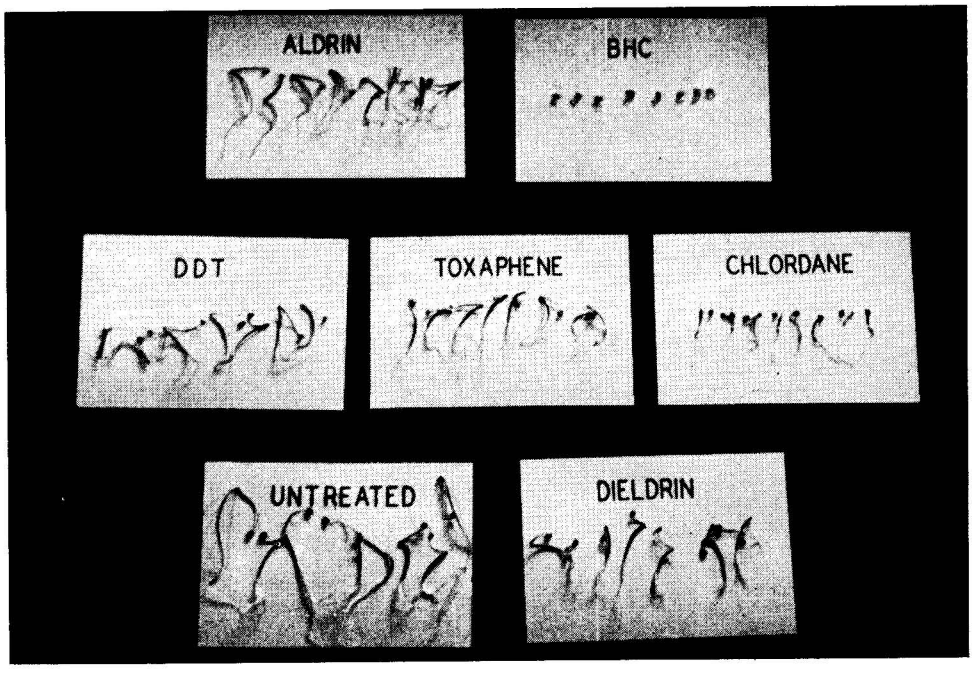

Fig. 1.—Growth produced by onion seeds treated with various insecticides and kept for 12 days in covered petri dishes after initial sprouting.

seeds except those treated with BHC. In this instance, the germination of seeds stored 0 days was similar to that for the checks. As the period of storage increased, the initial germination of the BHC-treated seeds decreased so that by 110 days after treatment all treated seeds had the same delay in germination.

Growth was apparently unaffected by the treatment of seed except in the case of BHC. In this treatment, although germination was significantly reduced, there were sufficient plants to observe its effect. Necrosis developed early, a factor found also by McLeod (1946) in his investigation on onion maggot control. J. R. Douglass and F. H. Shirck, U.S. Department of Agriculture, Twin Falls, Idaho (personal communication), found that wettable powder of lindane or chlordane applied to the seed trench at 0.46 or 1.4 pounds of active ingredient per acre, respectively, caused severe reduction in the onion stand; lindane caused 96.7 per cent. reduction, and chlordane 47.0 per cent. Although no serious effect on germination was observed for chlordane-treated seeds in the Kamloops tests, the necks of the bulbs were enlarged and chlorosis and necrosis appeared about the tenth day in the petri-dish tests.

SUMMARY

1. Germination of onion seed was adversely affected when the seed was treated with a wettable powder of DDT, BHC, dieldrin or toxaphene, or a 5 per cent. emulsion of aldrin, or a 5 per cent. emulsion of dieldrin. The solvent is suspected of being the toxic factor in the case of aldrin and dieldrin emulsions.

2. Growth of the onion plants, once the seed germinated, was not seriously affected by any of the treatments except that with BHC.

3. Storing of chemically treated onion seed in open glass dishes did not further seriously affect the eventual percentage germination, but it did delay germination.

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Reference

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OBSERVATIONS ON THE STUDY OF BEETLES IN BRITISH COLUMBIA

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The study of the beetles or any other group of organisms in an area like British Columbia that was originally peripheral to the world centres of scientific study falls somewhat naturally into several periods. First there is a period of exploration, during which specimens are collected by itinerant scientific collectors and brought back to the centres of scientific activity where they are studied and reported upon. Eventually, however, itinerant collectors give way to resident collectors and the endemic study of the fauna gets under way. For long, however, the endemic collectors remain dependent on outside aid, and it is only gradually that fully endemic studies backed up by fully equipped museum and library facilities become established.

In British Columbia the first of the three periods in the study of the beetles was unusually transitory. The first beetles were not collected until about twenty-five years after the first specimens had been collected in the Oregon Country to the immediate south. In British Columbia, the first specimens to be taken seem to have been collected about the year 1859 to 1861 by the naturalists attached to the Anglo-American Northwest Boundary Commission. Dr. John L. LeConte of Philadelphia, the leading American student of the Coleoptera in the third quarter of the last century, records *Cicindela longilabris* Say and *Cupes serrata* LeC. in 1861 from "Camp Kootenay."[1] With lack of precision that is characteristic of the coleopterological work of the period, he failed to notice whether the "Camp Kootenay" referred to was the east crossing of the international border by the Kootenay River in Montana or its west crossing in Idaho. In either event, the specimens were as likely to have been taken on one side of the boundary line as on the other.

John Keast Lord, the British naturalist with the Commission in his *Naturalist in Vancouver Island and British Columbia,* 1866, refers to collecting beetles at least twice: once (Vol. II, p. 109) near Palouse-Falls in Washington, once (Vol. II, p. 123) along Slesse (Selece) Creek, a tributary of the Chilliwack River near Chilliwack. His list of 94 species of beetles published in an appendix[2] to his book, contains no intimation of localities. While some of the species listed probably were collected in British Columbia, others were not, and Lord is known to have travelled overland all the way from San Francisco to the Canadian border. His book shows him, moreover, to have been preoccupied with the vertebrates.

The real beginning of the scientific study of British Columbian beetles began with a collection made probably

1 New species of Coleoptera inhabiting the Pacific district of the United States. Proc. Acad. Nat. Sci. of Philadelphia 1861, pp. 338-359.