INSECTICIDE TESTS IN THE CONTROL OF THE CORN EAR WORM

(HELIOTHIS OBSOLETA FAB.)

by

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INTRODUCTION

Importance of Pest

Economic entomologists have long recognized the corn ear worm as a most difficult pest to control. The protection of the husk to the worm renders it relatively inaccessible to predators, parasites, and insecticides. The larvae have a wide range of host plants. The adults migrate readily from one field to another. The females are capable of laying as many as 2000 eggs, the eggs being laid singly and generally only one on a plant (McColloch, 1915). These factors have made complete control of the insect difficult.

The corn ear worm was rated by Hyslop (1927) as the third most important insect pest in the United States. It is chiefly injurious to corn, cotton, tomatoes, beans, tobacco, and alfalfa. Phillips (1931) estimated that two percent of the value of the field corn crop, or about two million acres, was lost annually through the ravages of this pest. Damage to sweet corn is serious in the central and eastern states and occasionally in the western and northern states. In some parts of the southern states the ear worm is the prohibitive factor in the growing of sweet corn. The tomato growers around Norfolk, Virginia suffer annual losses of 20 to 25 percent of the crop. The annual damage to cotton was estimated by Hunter (1909) to be eight million dollars.

Smith (1919) summarized ear worm injury to corn and the resultant losses as follows:

1. The larvae of the first generation feed on the unfolding leaves of the young corn plants.

2. The developing tassels are next attacked by the larvae. A serious loss of pollen might result if this feeding habit were more frequent.

3. The larvae severe silks. This prevents fertilisation of the tip ovules and results in a nubbin.

4. The loss of kernels actually eaten may vary from one to twenty-five percent.

5. The smearing of the cob with excrement renders many ears of sweet corn unfit for food.

6. The openings of the ears serve as entrances for other insects and for molds. Taubenhaus (1920) stated that moldy ears may have pathogenic consequence if fed to live stock.

7. The kernels are loosened and shatter more easily due to the larvae tunneling through the germ.

It is a difficult matter to weigh in their proper proportion these sources of loss due to ear worm injury. In considering the total effect of the above injuries there can be little doubt that the corn ear worm is one of the major corn pests at the present time.

Object

This study was conducted for the purpose of investigating the efficiency of certain insecticides in the control of the corn ear worm on corn. The object was threefold:

1. To test the efficiency of certain insecticides and repellents.

2. To determine the efficiency of treatment when applied to the different stages of development of the ear.

3. To study the effect of time of planting in combination with the use of insecticides on the percentage of infestation.

This study was conducted at or near the field insectary of the Department of Entomology at Kansas State College. The data unless otherwise noted were taken during the summer of 1932. The work was done in connection with Project No. 9 of the experiment station entitled "The Corn Ear Worm and Other Insects Affecting Corn".

REVIEW OF LITERATURE

Because of the importance of the corn ear worm there has been considerable research on the life history and control of this insect. Due to the large number of papers written on the subject it was found necessary to limit the review of literature to the more important contributions on control and particularly on corn.

The corn ear worm was known in Ohio as early as 1845 (Webster and Molly, 1898). In 1879 Professor Comstock recommended the use of Paris green either with water or dry with flour as a means of destroying this insect on cotton (McColloch, 1924).

Beckwith (1889) advised the application of one part white hellebore to five parts lime or gypsum.

Alwood (1893) stated that some success could be obtained by applying a strong decoction of tobacco and whale oil soap with a sponge or cloth to the silks and outer ends of young ears immediately after the corn had passed the bloom. This was to be repeated after 10 days.

Lowe (1896) recommended the use of London purple, Paris green, and kerosene emulsion for control on tomatoes. The worms were to be destroyed on corn by cutting open the tips of the husks.

Bruner (1892) gave the following remedies: hand picking, attracting the moths by odor of syrup and drowning them, and attracting the moths by light to traps.

Rolf (1893) was of the opinion that poisoning was clearly out of reasoning in the control of the corn ear worm.

There are many other references that could be cited, but Forbes (1904) summed up the knowledge at that date with the statement: "The ear worm is uncontrolled by any means yet devised and tested."

McColloch (1916) made a study of lead arsenate as to the proper dilution and number of dustings. He found that the most efficient dust was three parts arsenate of lead and one part sulfur. Fifty percent lead arsenate was not sufficient. Sulfur was more effective as a carrier than flour or lime. It acted as a fungicide. The injury decreased as the number of dustings increased.

Headlee (1913) stated that dusts should be maintained throughout the green and succulent period of silking. Dusts properly placed and maintained would prevent 75 percent of the normal damage. A mixture of equal parts of lead arsenate and sulfur was better than 75 percent lead arsenate.

Dusting with 50 percent lead arsenate was also recommended by Phillips and King (1923) and Pellet (1924).

Haseman (1915) reported that powdered arsenate of lead reduced the injury from 75 percent to 35 percent. There was no marked results in an experiment in which one plot was sprayed with lead arsenate (1 pound to 50 gallons) and another was dusted with lead arsenate 15 percent. Three applications were made on each plot. In 1924 the experiment was repeated with two seedings, June 1 and June 26, using the same dilution as before. The control was not good enough to warrant the use of spray or dust on a large scale. The late seeded corn was damaged the most.

Richardson (1915) found that young worms were at the apex of the ear within twenty minutes after hatching. Very little feeding was done until the larvae were hidden by the husks. The efficiency of an insecticide would depend on its sifting downward.

Cartwright (1932) tried dusting with "Kubatox" every other day, with lead arsenate every other day, and desilking at three-day intervals. The dust was applied as soon as the silks appeared and continued until the ears were harvested. Kubatox gave no control, desilking was moderately effective, and lead arsenate was most satisfactory. On later grown field corn lead arsenate gave control from 60 percent to 80 percent depending on whether the dust was applied every day or every third day.

Ditman and Cory (1931) tested the effect of desilking at one, two, and three-day intervals. "Tangle foot" was also applied in some cases. About 80 percent of the ears in the checks were well fertilized. However, the results indicated that the treatment was not practical. It was evident that the source of ear infestation was not entirely from eggs laid on the silks. Fertilization was incomplete to a large degree in the ears from which silks had been cut every day. Over 50 percent of the ears were infested before silking and in addition a large number of young larvae ate their way through the tender growing husks rather than by entering through the silks. These two facts should partly explain the lack of complete control by stomach poisons dusted or sprayed on the silks. In a summary of the 1928 insecticide tests they reported that undiluted lead arsenate and barium fluosilicate gave the best control. Barium fluosilicate, however, caused considerable burning and interfered with pollination. The efficiency of lead arsenate decreased as the amount of the carrier increased. Pure lead arsenate gave the most promising results. No satisfactory repellents or attrahents were found. The dusts were superior to the sprays. The time required for young larvae hatching on the silks to enter the ear was found to vary from one-half hour to two and one-half hours.

Freeborn and Wymore (1929) tested the following materials: plain hydrated lime, one part lead arsenate and four parts hydrated lime, one part calcium arsenate and four parts hydrated lime, extra light sodium fluosilicate, commercial sodium fluosilicate diluted in equal parts with hydrated lime, caffeine 1½ percent solution in water, nicotine sulfate 1 to 500 in a .37 percent solution of aluminum sulfate, nicotine sulfate in a .37 percent solution of HCl, nicotine caseinate 1 to 50, nicotine caseinate 1 to 500, black pepper, and pyrethrum extract. Ten thousand ears of sweet corn of two varieties were tabulated as to their stage of development at time of treatment: silk, shoot plus, and shoot minus. Two treatments were made; one when 10 percent of the ears were in full silk, the second ten days later. Black pepper, extra light sodium fluosilicate, and pyrethrum extract gave the best protection. They observed that the larvae migrated from ear to ear. Loose silks which received the coating of dust or spray were not likely to be eaten. It was assumed that the sodium fluosilicate killed by contact or by producing an irritation which compelled cleaning.

Drake (1928) found that the most effective dust was one part lead arsenate or calcium arsenate and three parts sulfur

Ditman (1932) observed that the chief infestation was through the tips of the ears although occasionally larvae entered through the husks.

Williams (1923) found that dusting with arsenical powders was not practical for use on large fields in Ohio.

Haseman (1915) stated that opening the ears at the tips at "shooting time" gave a lower percentage of worms.

Cultural Control

Cultural control should be a part of any attempt to control the corn ear worm. The insect overwinters in the soil in the pupal stage. If the pupae are exposed to climatic changes through late fall or early spring plowing, many of them will be destroyed. This in turn will reduce the early infestation. However, the adults migrate readily from one field to another so this method of control would have to be conducted on a wide scale.

Perhaps the most important factor in cultural control is the time of planting. From a study of four standard varieties over a period of ten years, 1909 to 1919, McColloch (1924) stated that the best time to plant corn in Kansas was from April 15 to May 1, both for yield and ear worm injury. By planting at this time, the third brood which causes the most damage may be avoided.

Phillips and King (1923) showed that the percentage of loss with corn silking at the most favorable time was only one-fifth to one-half as great as at other periods.

Cultural control reduced the injury from 17 to 5 percent.

In Louisiana, Bradley (1924) found that corn planted between May 12 and June 2 showed a heavier infestation than earlier planted corn.

Headlee (1910) at Manhattan, Kansas, reported three full broods and a partial fourth which did not mature. These observations were during 1909. The dates of emergence were as follows: First brood, June 8 to July 19; second brood, July 19 to August 21; third brood, August 21 to October 13, and the fourth brood after October 13.

Resistant Varieties

Attempts have been made to breed strains of sweet corn resistant to the ear worm and some success has been reported. Collins and Kempton (1917) made a study of four protective characters of husks to determine their effect on infestation. The characters studied were: distance which husks extend beyond tip of ear thus increasing the distance of larval travel; thickness of husk cover, texture of husk, and husk leaves. For the most part low damage was correlated with all of these morphological characters, but the greatest correlation was in the prolongation of the husks.

Cartwright (1930) reported that the length of the shuck was important but varietal resistance was negligible to the corn ear worm.

Phillips and Barber (1931) found husk protection an important factor in reducing corn ear worm damage. The most effective husk extended five inches beyond the cob and was tightly wrapped about the ear.

Freeborn and Wymore (1929) found long husks to be no protection in their experiment. Of the protruding ears 32.75 percent were not infested, while the immunity rate of all the ears of the controls was 32.9 percent.

Other Crops

Since Heliothis obsoleta Fab. attacks other crops, a few papers will be listed under each. This insect is known as the cotton boll worm, tomato fruit worm, and tobacco bud worm as well as corn ear worm.

Morrill (1926) reported that 7,500 acres of tomatoes were dusted using calcium arsenate and a fungicide. The dust was distributed from an airplane in a swath 140 feet wide. From 4 to 12 pounds of dust were used per acre depending on the size of the plants. In the undusted fields the damage was 40 percent, 48 percent and 76 percent as compared to 4, 14, and 24 percent in the dusted fields. The damage from the dusted plants was largely from later hatched worms.

Watson (1919) recommended spraying tomatoes with 3 pounds of arsenate to 50 gallons of water. Two pounds of lime were to be added to prevent burning. The first treatment was to be made when the fruit was the size of a marble.

For control on tobacco Quaintance (1898) recommended sprinkling poisoned corn meal in the bud, using one quart of corn meal and one-half teaspoonful of Paris green. This was to be applied frequently.

Watson (1919) recommended dusting the buds with undiluted arsenate, or mixing it with two or four times its bulk of hydrated lime.

Sherman (1930) reported the results of airplane dusting in the control of the cotton boll worm. Cotton dusted with 5 to 6 pounds of calcium arsenate per acre successfully controlled the boll weevil but not the boll worm. Boll worm damage was without exception heaviest in the dusted areas in 1927 and 1928. This might have been due to the killing of the predators of the boll worm.

Larrimer (1922) and Smith (1927) reported that the corn ear worm damaged alfalfa. Poison bran mash was recommended for control.

In Foreign Countries

Heliothis obsoleta bears a bad reputation in some of the British colonial possessions. In India it is a serious pest, attacking large numbers of plants and many of the crops throughout that country, apparently being less inclined to concentrate on any one than it is in America. Rice, hemp, poppy, pulse, indigo, beans, peas, and cotton are all badly injured.

This insect was first described as a pest in Queensland by Tyron in 1889. The food plants there are maize, cotton, tobacco, cape gooseberry, rosella, peas, and snap dragons. Tyron (1923) stated that lead arsenate was not effective in controlling it.

Garman and Jewett (1914) reported that it was a serious pest in orchards of New Zealand. It also had this same fruit eating habit in South Africa.

Dunlap (1923) mentioned that the corn ear worm was a pest of maize in British Honduras and was controlled by a mixture of starch and arsenic.

Newman (1928) reported it feeding on tomatoes, stone fruit, apples, and wheat in West Australia.

Benson (1926) recorded it as an important pest of tomatoes in Queensland but it was controlled by spraying the fruit at ten-day intervals from the time it was formed until it was full grown. Lead arsenate, 4 pounds to 100 gallons of water, was used.

Jones (1915) stated that it was an important pest of corn in Porto Rico.

In Gandzha, Rekach (1928) recorded over 100 food plants

MATERIALS

Sprays and Dusts

The following materials were used in the experiment: powdered lead arsenate, calcium arsenate, sodium fluosilicate, barium fluosilicate, calcium fluosilicate, Kalite, pyrethrum dust, plain gypsum, black pepper, oil of wintergreen, Pyrocide No. 20, and Volck.

Preparation

Orchard Brand arsenate of lead was used. It was tested at full strength, 75 percent and 50 percent. Sulfur was used for the diluting ingredient.

Calcium arsenate was mixed with an equal weight of superfine sulfur dust.

Commercial sodium fluosilicate was first used but an extra light, fluffy form was substituted in the later work on field corn. The latter form apparently causes less injury by burning. This may be due to there being less concentration of the material at any one place when the fluffy form is used.

Barium fluosilicate was secured from the Sherwin-Williams Products Company. It contained 90 percent barium fluosilicate and 10 percent sulfur.

The calcium fluosilicate was purchased from the Victor Chemical Works. It contained not less than 15 percent active ingredients.

Kalite is a commercial product recommended for the control of the tomato fruit worm. It contains 18.5 percent sodium fluosilicate.

Undiluted pyrethrum dust was used.

Plain gypsum was tested because it has been commonly recommended as a carrier for insecticide dusts.

Ordinary black pepper was used full strength to test the prevalent idea that it reduces corn ear worm injury.

It had been noticed by D. A. Wilbur, assistant professor of entomology at this college, that while testing certain essential oils as attrahents to the moth oil of wintergreen had a decided repelling affect. Oil of wintergreen was mixed with powdered lead arsenate, gypsum, and sulfur, and used as a dust to test its value as a repellent. It was used at the following dilutions:

Oil of wintergreen	10 cc. with gypsum	12 oz.
Oil of wintergreen	20 cc. with gypsum	12 oz.
Oil of wintergreen	5 cc. with lead arsenate	12 oz.
Oil of wintergreen	10 cc. with sulfur	12 oz.

This oil was also used as a salve by mixing 115 cc. with 16 oz. of vaseline.

Pyrocide No. 20 is extract of pyrethrum. It was purchased from the Pearson-Ferguson Company.

A two percent emulsion of Ortho Volck was prepared. This material was used because of its supposed ovacidal value. The dilution with Pyrocide was 1 part Pyrocide to 250 parts 2 % Volck and 1 part Pyrocide to 500 parts 2 % Volck.

Equipment

A pint jar with a hole cut in the lid and a screen inserted was used to apply the dusts. An opening of one and three-eights inches was first tried but it permitted an excess of dust to be shaken from the can. A diameter of one and one-eighth inches gave more satisfactory results.

A knapsack pressure sprayer with a cone-shaped nozzle was used for the sprays. The nozzle was borrowed from Dr. Phillips of the Bureau of Entomology. It was made by Dr. R. C. Smith while he was working with Dr. Phillips on the corn ear worm. The nozzle was inserted into the tips of the ears and the silks were thoroughly covered with the spray.

Some difficulty was encountered in mixing the oil of wintergreen with the carriers. A ball mixing machine was unsatisfactory because of a tendency of the material to cake on the sides of the mortar. An atomizer and a flour sifter gave better results. The sifter was placed over a gallon can. A hole in the side of the can gave entrance to the nozzle of the atomizer. As the dust sifted down into the can, the oil was sprayed upon the particles, thoroughly impregnating the material. This method was too slow to be of practical value. A quicker method would be to add the oil directly to the carrier and sift the material several times.

The Pyrocide and Volck were mixed by vigorously stirring the two together. This spray was used immediately after it was prepared. Care was taken to maintain a uniform pressure in the spray tank.

Sulfur was used as a carrier for the dusts.

EXPERIMENT

Experimental Plots

1. Time of Planting Plots. Time of planting is an important factor in the control of the corn ear worm. The date of planting may be more effective in limiting infestation than the use of insecticides (McColloch, 1924). Because of this fact a series of plantings of corn were made. Plot 1 was planted April 15. It contained three varieties of sweet corn, Country Gentleman, Adam's Early, and

Stowell's Evergreen, and one variety of field corn, Kansas Sunflower. This last variety was not included in the insecticide tests but was saved for infestation counts in regard to time of planting. Each variety included two rows fifty feet long. Two grains were planted in each hill with the hills one foot apart. The hills were thinned to two or three stalks. Additional plots were planted on the following dates;

Plot 2 on April 29.

Plot 3 on May 13.

Plot 4 on May 27.

Plot 5 on June 10

Plot 6 on June 24.

These plots were identical with plot 1.

2. Oil of Wintergreen Plots. Two additional plots were planted for the oil of wintergreen tests. Plot 7, planted June 6, consisted of thirteen rows of sweet corn of the Country Gentleman variety, and plot 8, planted June 7, consisted of nine rows of Pride of Saline field corn.

3. Field Corn Plots. A convenient field of corn located across the road from the alfalfa insectary was selected for further investigation. It was a cross of Reed's Yellow Dent and Kansas Sunflower planted May 1.

Method of Tagging Ears

All ears that were to be treated were tagged and numbered. This made it possible to keep an accurate record of the stage of development, applications of insecticide, and infestation of each ear.

Method of Applying Materials

1. Time of Planting Plots. The usual procedure in the attempted control of the corn ear worm is to apply a poisonous dust or spray to the silks of the ear. To determine the importance of the stage of development of the ear at time of treatment, all the potential ears in plot 2 were tabulated as to their stage of development at the time of the first treatment. Freeborn and Wymore's method of classifying of the ears was followed.(Freeborn and Wymore, 1929).

   a. Shoot minus stage included from the formation of the ear bud to the time the cob developed.

   b. Shoot plus stage included from the shoot minus until the silks appear.

   c. Silks. With the silks present.

Plot 2 was divided into six sections and the following insecticides used:

Section A was dusted with pure lead arsenate.

Section B was dusted with 50 percent calcium arsenate.

Section C was dusted with pyrethrum dust.

Section D with commercial sodium fluosilicate.

Section E was dusted with 50 percent lead arsenate.

Section F was saved for a check.

The first dusting was made when the silks began to appear. It was repeated every other day until the ear was harvested at the "roasting ear" stage. At the time the ears were harvested, the corn ear worm infestation was noted and the infested ears were graded according to the degree of infestation. The average number of applications varied from five to nine depending on the stage of the ear when the dust was first applied. In all cases the applications were made at two-day intervals. The dust was applied to the silks and tip of the ear, or in the case of immature ears directly on the shoots.

Plots 3, 4, 5, and 6 were treated similarly to plot 2 as soon as each in turn reached the proper stage of development. Plot 1 had silked out before the materials were ready for use and it was not included in the experiment.

2. Oil of Wintergreen Plots. Plots 7 and 8 were used to determine if oil of wintergreen might be of value as a repellent. Plot 7 was divided into five sections

and treated as shown in Table IIIa. Approximately 80 percent of the ears were in silk at the time of the first dusting. The ears were harvested at the roasting ear stage. Only the silks and tips of the ears were dusted. In plot 8 the application was by rows. The dusts used in plot 7 were repeated. In addition oil of wintergreen in vaseline base was applied to strips of burlap. These strips were fastened to the stalks so that they touched the ears. The ears were harvested when the corn had fully matured and hardened.

Method of Measuring Results

The later plantings of corn in the vicinity of Manhattan frequently have every ear infested with one or more corn ear worm larvae. Because of this fact it was necessary to devise an additional method of recording the injury besides using the percentage of infestation. The percentage of infestation might be one hundred percent in each of two plots, but the actual amount of injury in one could be far greater than in the other.

Ears were selected ranging from no infestation to extreme cases where the larval feeding extended over practically the entire ear. The ears were arbitrarily divided into six classes with class 0 for those ears with no infestation to class 5 for the extreme type. (See Fig. 1) The average degree of injury was found by the following procedure: Each class was multiplied by the number of ears in that class. The sum of the products was divided by the total number of infested ears. The quotient was the average degree of infestation. This method was originated by Dr. R. H. Painter.

Fig. 1. Class of Injury.

EXPLANATION OF RESULTS

Pure lead arsenate gave the best control of the insecticides tested on sweet corn. Fifty percent calcium arsenate gave better control than 50 percent lead arsenate. The commercial sodium fluosilicate caused severe burning of the husks. Pyrethrum dust gave the poorest control. Larvae were observed crawling through this dust with no apparent effect resulting.

TABLE I

Comparison of Efficiency of Insecticides Tested on Sweet Corn

Insecticide	Number of ears	Ears infested	Total	Ave. class of infestation	Percentage of infestation
Lead arsenate 100%	168	32	52	1.62	19.1
Lead arsenate 50%	130	47	78	1.66	36.1
Cal. arsenate 50%	129	34	62	1.82	26.4
Sodium fluosilicate	106	41	75	1.90	38.6
Pyrethrum dust	151	69	125	1.81	45.8
Check	175	118	215	1.82	67.5

In Table II the insecticides show better control where the first application was made prior to the silk stage. With the exception of calcium arsenate the infestation was further reduced by making the first application while the ear was in the shoot minus stage. Pyrethrum gave only 10 percent control when applied to silks but when the dusting started in the shoot minus stage gave 60 percent control. This may have been due to the pyrethrum acting as a repellent and preventing the moths from laying eggs on the silks. If it was applied after the eggs were laid it would have little effect on the hatching of eggs or on the newly hatched larvae. The results given in this table show the importance of applying dusts at an early stage in the development of the ear. Ditman and Cory (1931) state that approximately 50 percent of young ears were infested with larvae before silking. This fact may explain many reported failures of insecticides to control the corn ear worm.

Oil of wintergreen (see Table IIIa and IIIb) gave little promise of being of value in controlling the corn ear worm under the methods used. The infestation was reduced from 84.1 percent to 58.2 percent when the oil was used with lead arsenate. This is probably due to the insecticidal action of the lead arsenate. However, more frequent application might give better results. When

TABLE II

Comparison of Infestation in Silk, Shoot plus, and Shoot minus Ears

Date Plant-ed	Insecticide		Ear	Total No Ears	Ears Infest-ed	Total	Ave. Class Infesta-tion	Percent. Infesta-tion
April 29 to June 24	Lead Arsenate	100%	Silk	72	21	37	1.76	29.1
	Lead Arsenate	50%	"	65	26	43	1.65	40.-
	Cal. Arsenate	50%	"	55	20	39	1.95	36.3
	Sodium fluosilicate		"	46	26	54	2.07	56.5
	Pyrethrum dust		"	54	33	60	1.82	61.1
				292	126	233	1.85	43.1
	Lead Arsenate	100%	Shoot+	42	7	10	1.45	16.6
	Lead Arsenate	50%	"	35	13	20	1.54	37.1
	Cal. Arsenate	50%	"	27	4	5	1.25	14.8
	Sodium fluosilicate		"	25	10	19	1.90	40.-
	Pyrethrum dust		"	39	20	31	1.55	51.3
				168	54	85	1.57	32.1
	Lead Arsenate	100%	Shoot-	54	4	5	1.25	7.4
	Lead Arsenate	50%	"	30	8	15	1.87	26.6
	Cal. Arsenate	50%	"	47	10	18	1.80	21.2
	Sodium fluosilicate		"	35	5	5	1.-	14.3
	Pyrethrum dust		"	58	16	34	2.12	27.6
				224	43	77	1.79	18.3
	Check			175	118	215	1.82	67.5

TABLE IIIa

Results of Oil of Wintergreen Tests

on Sweet Corn

Materials Used	No. of Appli-cations	Total No. of Ears	Infest-ed Ears	Total	Ave. Class of Infes-tation	% of Infes-tation
Oil of Wintergreen 5 cc. Lead Arsenate 12 cc.	1	55	32	67	2.09	58.2
Oil of Wintergreen 10 cc. Gypsum 12 oz.	3	61	51	107	2.09	83.6
Oil of Wintergreen 20 cc. Gypsum 12 oz.	1	59	38	82	2.16	64.6
Oil of Wintergreen 10 cc. Sulfur 12 oz.	3	83	62	125	2.01	74.7
Check		69	58	132	2.27	84.1

Results of Oil of Wintergreen Tests

on Field Corn

Materials Used	No. of Appli-cations	Total No. of Ears	Infest-ed Ears	Total	Ave. Class of Infes-tation	% of Infes-tation
Oil of Wintergreen 5 cc. Lead Arsenate 12 oz.	1	49	43	73	1.69	87.6
Oil of Wintergreen 10 cc. Gypsum 12 oz.	3	35	34	67	1.97	97.1
Oil of Wintergreen 20 cc. Gypsum 12 oz.	1	32	31	66	2.13	96.9
Oil of Wintergreen 10 cc. Sulfur 12 oz.	3	34	32	67	2.09	94.1
Oil of Wintergreenl15 cc. Vaseline 16 oz.	1	40	40	74	1.85	100.
Check		61	58	113	1.95	95.1

applied directly on young larvae it seemed to have a very irritating reaction causing them to twist and squirm in an effort to free themselves from the dust. The oil volatilizes rapidly and soon loses its effectiveness.

The following materials gave practically no control: Volck 2 percent, black pepper, and plain gypsum (see Table IV). Sodium fluosilicate gave the best control of any of the materials tested on field corn. The husks are slightly burned, but the corn was not affected. By using three applications a control of 37 percent was obtained.

Pure lead arsenate and barium fluosilicate were next, each with approximately 30 percent control with three applications. The barium fluosilicate also caused some burning to the husk and silk but not as much as the sodium fluosilicate.

Lead arsenate 75 percent compared very favorably with the undiluted arsenate. Three applications gave 26 percent control. The slight percentage of control gained, however, by using the pure form would not pay for the difference in cost.

The first two plantings of Kansas Sunflower had a lower percentage of infestation than the later plantings. This agrees with McColloch's recommendation to plant field corn before May 1. The increased yield of the later plantings is probably due to the irrigation given these plots.

TABLE IV

Comparison of Efficiency of Materials Tested on Field Corn
Corn Ear Worm Insecticide Tests
(Field Corn West of Insectary)

Insecticide Used	No. of Applica-tions	Class of Infestation 0	1	2	3	4	5	Total No. Ears	Ears Infest-ed	Total	Ave. Class Infes.	% of Infes.
(Pyrethrum 1-250 Volck) 2%	1	5	56	14	5	1	-	81	76	103	1.35	93.8
" " 2%	3	9	45	12	2	0	1	69	60	80	1.33	86.9
(Pyrethrum 1-500 Volck) 2%	1	2	35	24	3	-	-	64	62	92	1.48	96.9
" " 2%	3	13	41	8	1	-	-	63	50	60	1.2	79.3
Black Pepper	1	6	57	13	-	-	-	76	70	83	1.18	92.1
Ba. Fluosilicate	3	20	37	7	2	-	-	66	46	57	1.24	69.6
Volck 2%	3	3	44	16	2	1	-	66	63	86	1.36	95.4
Lead Arsenate 100%	1	19	49	10	1	-	-	79	60	72	1.2-	75.9
Lead Arsenate 100%	3	20	44	4	-	-	-	68	48	52	1.08	70.6
Lead Arsenate 75%	1	18	38	12	1	0	-	69	51	65	1.27	73.9
Lead Arsenate 75%	3	15	41	4	-	-	-	60	45	49	1.08	75.-
Kalite	3	14	41	12	3	-	-	70	56	71	1.32	80.-
Ca. Arsenate 50%	3	10	36	14	1	1	-	62	52	71	1.36	83.8
Na. Fluosilicate (fluffy)	3	20	31	2	-	-	-	53	33	35	1.06	62.2
Ca. Fluosilicate	1	10	45	12	2	-	-	69	59	75	1.27	85.5
Plain Gypsum	3	0	45	21	2	-	-	68	68	93	1.37	100.-
Ca. Fluosilicate	3	8	44	18	1	-	-	71	63	83	1.31	88.7
Check	-	0	34	26	5	2	-	67	67	111	1.65	100.-
Check	-	2	33	30	5	2	-	72	70	116	1.65	97.2
Check	-	1	39	32	5	1	-	78	77	122	1.58	98.7
Ave. for check								217	214	349	1.63	98.6

TABLE V

Results of Time of Planting on the Percentage of Infestation

Date Planted		No. of Ears	Infested Ears	Total	Ave. Class of Infestation	% of infestation
Apr. 15	Kansas Sunflower	48	18	26	1.44	37.5
Apr. 29	Kansas Sunflower	38	18	23	1.28	47.3
May 13	Kansas Sunflower	48	42	72	1.71	87.5
May 27	Kansas Sunflower	81	71	119	1.67	87.6
June 10	Kansas Sunflower	74	73	147	2.01	98.6

CONCLUSIONS

1. Pure lead arsenate was the most effective of the dusts tested on sweet corn.

2. Commercial sodium fluosilicate severely burned the husks of the sweet corn.

3. Fifty percent lead arsenate was not sufficient.

4. The control of the ear worm on field corn would hardly be sufficient to warrant the use of insecticides because of the labor involved in applying the materials.

5. The sprays used were not as satisfactory as the dusts, both from the standpoint of ease of application and control.

6. The results obtained by using 75 percent arsenate of lead on field corn compared very favorably with that of the pure lead arsenate.

7. Oil of wintergreen was not effective as a repellent under the methods of application used in the tests.

8. The results indicate that the stage of development of the ears at the time of the first treatment was an important factor in determining the percentage of control secured by an insecticide.

9. The results show a definite and rather uniform lag in the percentage of control secured by the use of insecticides below that of the checks regardless of the

time of planting. (See Fig. 2)

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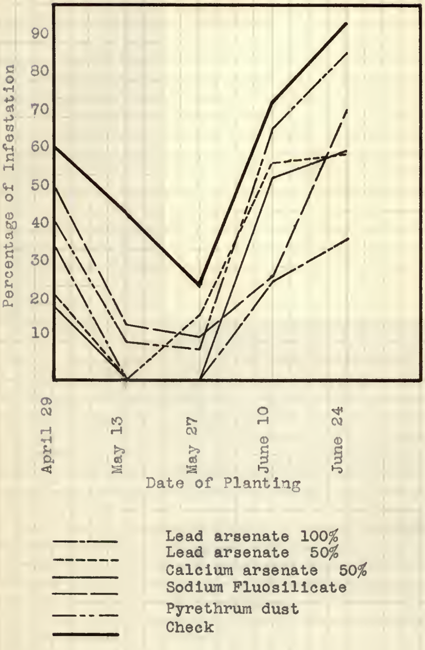
Fig. 2. Comparison of Efficiency of Insecticides Tested on Sweet Corn



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