New Protection Against Stored-Grain Insects

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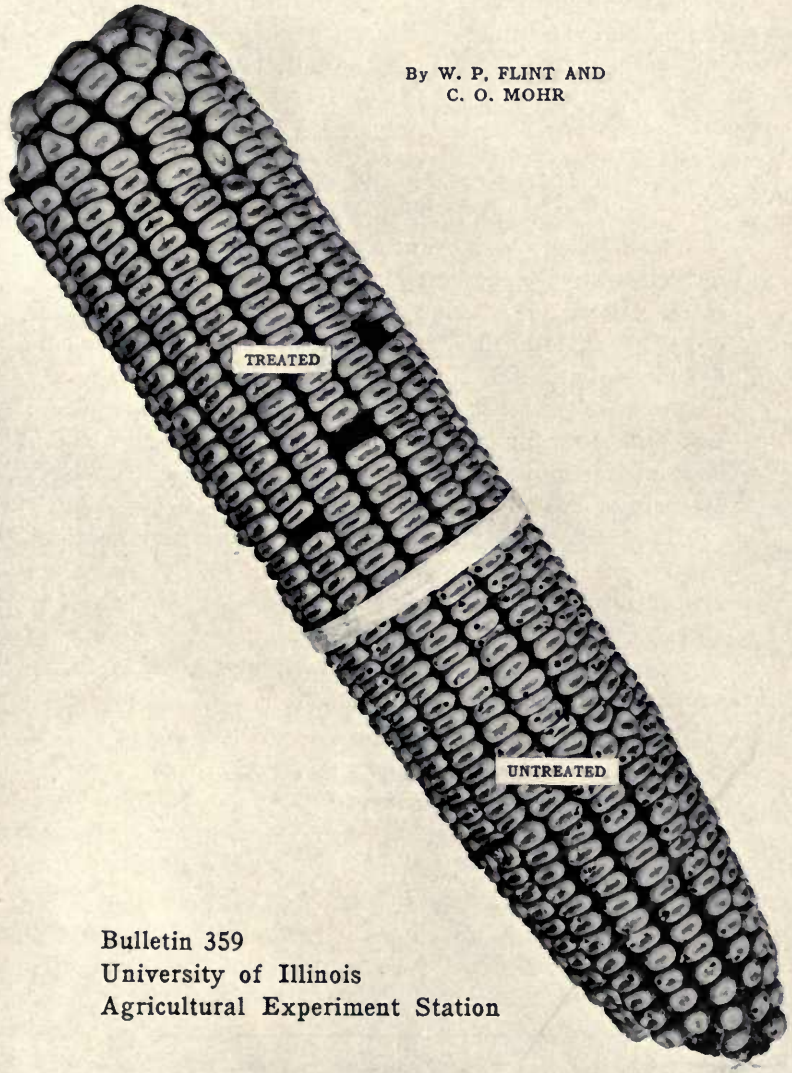

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Formula for Making Oil Emulsion to Protect Stored Corn From Insect Injury

A stock emulsion of boiled lubricating oil (homemade dormant oil emulsion) that has proved successful in protecting stored corn against insect damage and does not injure germination, is made by the following formula:

Light-grade lubricating oil..... 1 gallon
Water..... 1 quart
Potassium oleate..... 1 to 2 pounds, depending on the hardness of the water; very hard water requires the larger amount.

The light-grade lubricating oil required in the above formula will give the best results if it meets the following specifications: (1) specific gravity at 20° C., .87 to .93; (2) volatility at 110° C. for 4 hours not above 10 percent; (3) viscosity at 100° F., 90 to 150 seconds, Saybolt test.

To make the stock emulsion, boil the water, oleate, and oil together for 5 minutes, taking care not to burn the mixture; then pump it thru a spray pump at 150 to 250 pounds pressure or use an electric mixer.

The commercial oils mentioned in these investigations can be purchased thru dealers in insecticides. There are many commercial oils other than those used that may afford equally good protection against insect injury to stored grains, but obviously it was impracticable to attempt to include all in these tests.

For directions for applying the emulsion to ear corn, see back cover page

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New Protection Against Stored-Grain Insects

By W. P. Flint, Chief Entomologist, Illinois Natural History Survey, and C. O. Mohr, Assistant Entomologist

So heavy and sure is attack by grain moths and beetles that corn cannot be stored without protection for more than one season without its being severely injured. Even with present methods of caring for grain, the measurable loss runs constantly above the million-dollar mark in many states and into several millions in each of the Southern states. A greater, unmeasurable loss is due to the early sale of grain forced by present short-time controls, for one may not hold grain more than a season except by constant vigilance, frequent fumigation, and some loss in spite of great care.

Seed corn kept in storage in the usual ways is always subject to injury by certain of the grain-infesting moths and oftentimes by weevils and beetles. As a result of five years' experimental work it has been found that some of the oil emulsions developed for the control of orchard insects will protect seed corn from stored-grain insects. This method may also be applied for the protection of corn stored for feed. Protection is sure, safe, and enduring, as shown by the way in which the treated corn has been protected against injury when subjected to severe exposure to insect pests and the successful germination of the corn thereafter.

This publication is a statement of the results obtained in tests with corn. A later publication will give the result of applying oil emulsions to other grains. The information will be made available as soon as a series of experiments now under way is completed.

Insects causing damage to stored grain are mainly larvae of moths or adults and larvae of beetles. Among the most destructive are the rice weevil and Angoumois grain moth. The adults of these two insects fly freely and the larvae develop inside the seed, destroying it completely. The Cadelle, the granary weevil, the confused flour beetle, the Mediterranean flour moth, and the saw-toothed grain beetle frequently cause severe damage to stored seed and feed corn.

Drawbacks to Protective Methods Now in Use

At the present time a number of methods are employed to prevent damage to stored seed and feed corn. One of the most effective

is that of thoroly cleaning out all storage rooms, bins, or buildings before the grain is stored and placing only clean corn in storage.

The method generally employed where infestations have become established is fumigation by hydrocyanic acid gas, carbon bisulfid, ethylene oxid, or other chemicals. Fumigations are effective if the building is made properly gas-tight, the right dosage of the chemicals is used, and exposure is maintained for a sufficiently long period at the proper temperature and humidity. Fumigation is always rather expensive and has the disadvantage of not giving protection from reinfestation; that is, a room used for the storage of seed corn may be fumigated and all corn-infesting insects killed, but by the next day or week other insects may be reintroduced into the room, making it necessary to fumigate again within a short time.

Treatment with heat protects stored corn when proper equipment and conditions can be provided. If seed corn is to be so treated, care must be taken that the temperature does not rise above 135° F. or fall below 120° F.; that the temperature is maintained for approximately six hours; and that the corn does not contain less than 12 percent or over 20 percent moisture.

Thus present methods of preventing insect damage to seed and feed corn have not been entirely satisfactory. An attempt was therefore made to find a method for protecting seed corn, and possibly stored feed corn, that would be less expensive than other methods, would give protection over a longer period, and would require the minimum amount of skill and equipment for applying.

New Methods Given Severe Test

The conditions under which the tests herein described were made were as severe as possible.

Ears of corn were treated by being dipped in certain oil emulsions. In one test the ears were dusted with calcium fluosilicate dust. Five to ten ears were treated with each material. These ears were then placed on flat screen-bottomed trays that allowed insects to have access to the corn from all sides. These trays were kept in rooms where hundreds of thousands of Angoumois grain moths were being reared in connection with work on one of the egg parasites, the Angoumois grain moth being used to supply the eggs for rearing this parasite which is later liberated in the field where it attacks the eggs of a number of other insects. Not only was the Angoumois grain moth present in these rooms in excessively large numbers, but moderate numbers of

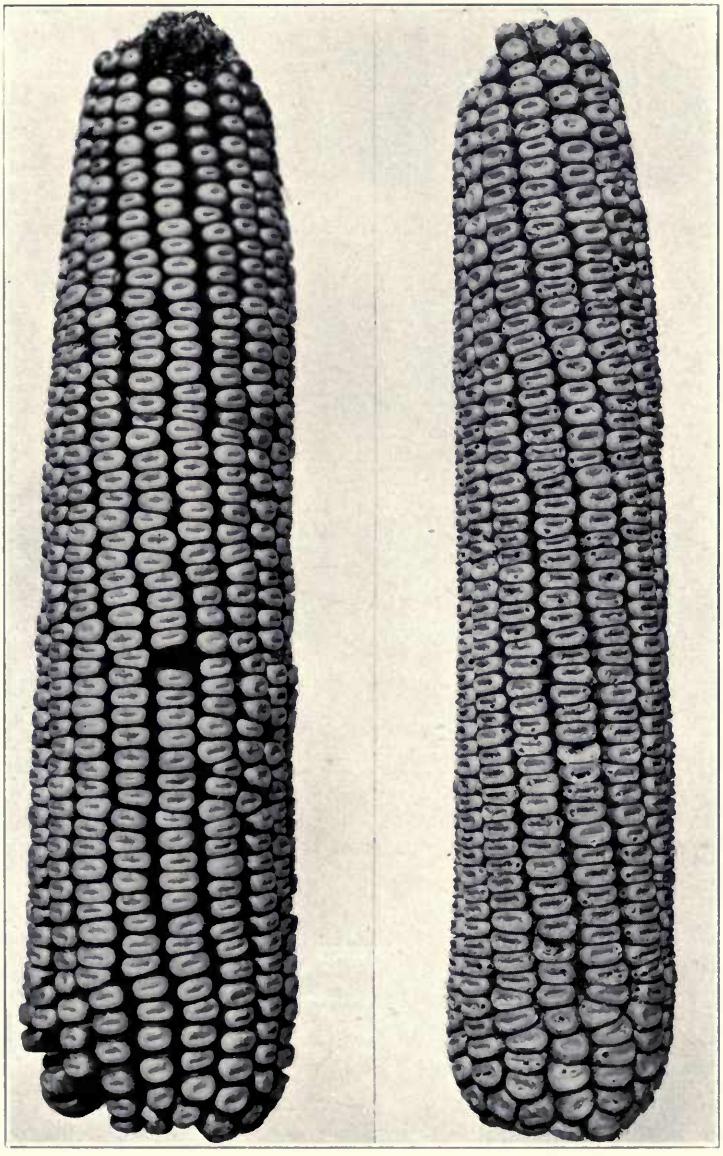

FIG. 1.—EXPOSED SIDE BY SIDE FOR FIVE MONTHS IN MOTH ROOM

The ear on the left was dipped into a commercial dormant spray oil (Dendrol) diluted in the proportion of 1 part of oil to 10 parts of water. This oil gave excellent protection but injured the subsequent germination of the corn. Note holes in ear at right, which was not treated.

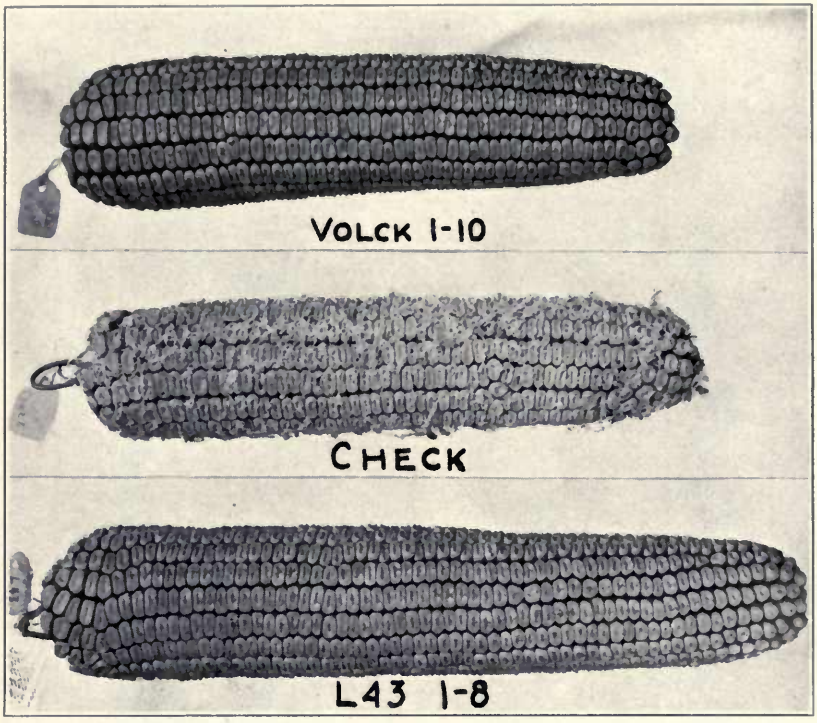

FIG. 2.—TREATED AND UNTREATED EARS KEPT IN MOTH ROOM FOR SIX MONTHS

The ear at the top was treated with commercial summer spray oil (Volck) diluted 1 part of oil to 10 parts of water. The lower ear was treated with a commercial summer spray oil (L-43) diluted 1 to 8. The ear in the center was left untreated. Both these oils gave excellent protection and permitted normal germination.

the Indian meal moth were also present, and considerable numbers, at times rather large numbers, of the granary weevil, the rice weevil, the confused flour beetle and the saw-toothed grain beetle. The rooms were kept at a temperature of 75° to 85° F. and a humidity of approximately 40 to 50 percent.

The corn was allowed to remain in the trays for a number of months. In no test was the period less than five months. After this period, the ears were shelled and grains of corn from the ears of each treatment were mixed together to make a composite sample, and one thousand to five thousand kernels from each treatment were carefully examined for infestation by insects.

Untreated ears were always handled in the same way as the treated ears and were examined and counts made in the same manner. At various times during the course of the treatment and at the conclusion of each test, a number of grains were removed from the treated and untreated ears and were tested for germination, these tests being carried on by the Department of Agronomy.

Three Oils Prove Worth

The first series of tests reported herein were made during 1928-29. They were based on results of tests made in earlier years, and are

TABLE 1.—RESULTS OF FIRST SERIES OF TESTS IN TREATING SEED CORN ON THE EAR WITH OILS, DUST, AND ACID: OCTOBER, 1928–FEBRUARY, 1929

Treatment	Total grains	Infested grains	Infested grains
	No.	*No.*	*perct.*
Homemade oil emulsions			
Homemade boiled lubricating oil emulsion (1-10)	4 002	12	.3
Homemade boiled lubricating oil emulsion (1-20)	3 816	549	14.4
Commercial oils			
Volck (1-10)	3 910	109	2.8
Oil formula L-200 (1-10)	4 111	776	18.9
Oil formula L-263 (1-10)	3 816	767	20.1
Cresylic acid in light, refined mineral oil (1-10)	4 015	0	0
Calcium fluosilicate dust	3 806	3 557	93.5
Check (untreated corn)	3 670	3 670	100.0

TABLE 2.—RESULTS OF GERMINATION TESTS ON SEED CORN AFTER COMPLETION OF TREATMENTS SHOWN IN TABLE 1
(40 kernels tested from each treatment)

Treatment	Germination			Dead
	Strong	Weak	Total	
	perct.	*perct.*	*perct.*	*perct.*
Homemade oil emulsions				
Homemade boiled lubricating oil emulsion (1-10)	80	13	93	7
Homemade boiled lubricating oil emulsion (1-20)	20	20	40	60
Commercial oils				
Volck (1-10)	30	40	70	30
Oil formula L-200 (1-10)	63	30	93	7
Oil formula L-263 (1-10)	5	28	33	67
Cresylic acid in light refined mineral oil (1-10)	73	10	83	17
Calcium fluosilicate	32	18	50	50
Check (untreated corn)[1]	..	..	..	..

[1]The check was 100 percent infested and no uninjured kernels could be obtained from it for a germination test.

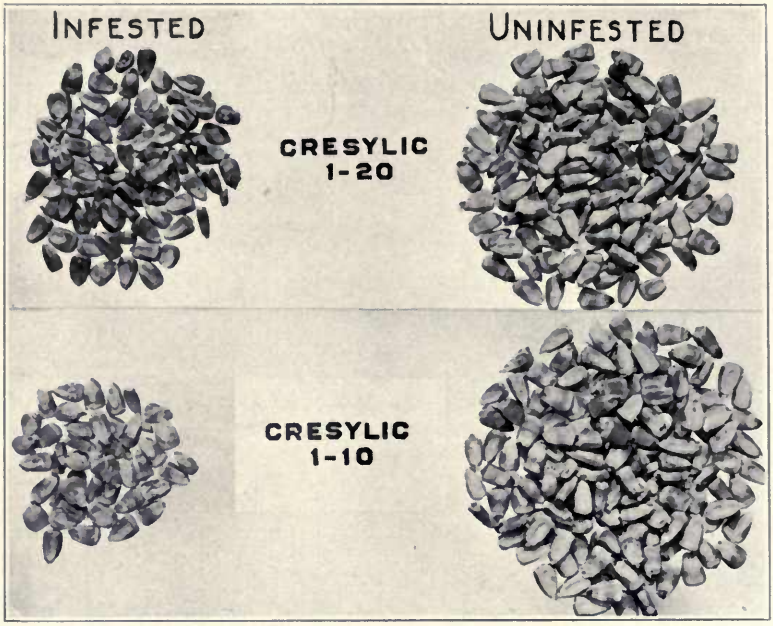

FIG. 3.—EFFECT OF CRESYLIC ACID IN TWO DILUTIONS
The stronger solution (1 to 10) gave the better protection but injured germination.

here recorded as showing some decidedly useful trends. The following materials were used:

Homemade boiled lubricating oil emulsion (with potassium oleate, see inside of front cover page)
Three commercial oils
Cresylic acid (1 part to 10 parts of light, refined mineral oil)
Calcium fluosilicate dust

The liquid preparations were applied by dipping the ears slowly enough to permit thoro penetration; the dust was applied by rolling and working it into the ears. The protection afforded by these treatments is shown in Table 1; the germinating powers of the treated seed are shown in Table 2.

Seed treated with the homemade boiled lubricating oil emulsion in the 1-to-10 dilution (1 part of emulsion to 10 of water) and that treated with two of the commercial oils (Volck and L-200) showed good germination and was well protected. These materials were therefore retained for a second set of tests. Cresylic acid injured the

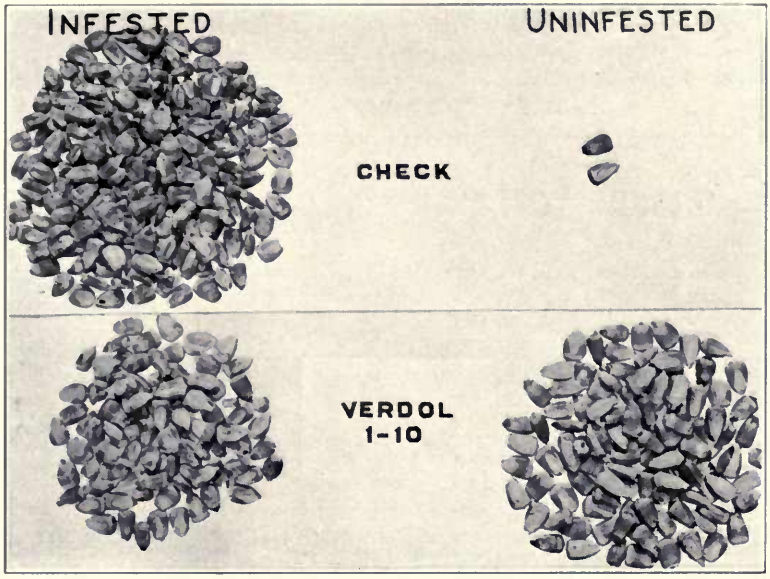

FIG. 4.—SOME TYPES OF COMMERCIAL OIL EMULSION DO NOT GIVE SUFFICIENT PROTECTION

After six months' exposure in the moth room about 45 percent of the treated kernels were infested. All but 2 of the 200 untreated kernels were infested.

seeds, but gave such excellent protection that weaker solutions of it were tried in the second series in the hope that it might give satisfactory protection and cause less injury to the germinating powers of the corn. Calcium fluosilicate dust, commercial oil formula L-263, and the 1-to-20 dilution of the homemade boiled lubricating oil emulsion failed to prove at all promising and were eliminated from the tests.

In the second series of tests (Tables 3 and 4) the homemade boiled lubricating oil was tried in a 1-to-15 dilution as well as in the 1-to-10 dilution. In addition to Volck and commercial oil formula L-200, two other commercial oils (L-43 and Verdol) were tried.

Of the materials used in this second series, the homemade boiled lubricating oil emulsion in the 1-to-10 dilution, commercial oil formula L-43, and Volck protected over 95 percent of the corn treated with them and gave satisfactory germination. The untreated corn was completely riddled by moth infestation. Cresylic acid and two of the commercial oils (Verdol and L-200) proved unsatisfactory.

TABLE 3.—RESULTS OF SECOND SERIES OF TESTS IN TREATING SEED CORN ON THE EAR WITH OILS AND ACIDS: 1929
(Period of exposure to insects 7 months)

Treatment	Total grains	Infested grains	Infested grains
	No.	*No.*	*perct.*
Homemade oil emulsions			
Homemade boiled lubricating oil emulsion (1-10)	4 133	182	4.4
Homemade boiled lubricating oil emulsion (1-15)	4 092	1 239	30.3
Commercial oils			
Volck (1-10)	4 012	117	2.9
Oil formula L-43 (1-10)	3 771	78	2.1
Oil formula L-200 (1-10)	3 527	1 591	45.1
Verdol (1-10)	3 945	1 769	44.8
Cresylic acid (1-10)	3 909	843	21.6
Cresylic acid (1-15)	4 024	1 536	37.9
Carbolic acid (1-99)	3 900	3 824	98.1
Check (untreated corn)	4 133	4 098	99.2

TABLE 4.—RESULTS OF GERMINATION TESTS ON SEED CORN AFTER COMPLETION OF TREATMENTS SHOWN IN TABLE 3
(100 kernels tested from each treatment)

Treatment	Germination			Diseased	Dead
	Strong	Weak	Total		
	perct.	*perct.*	*perct.*	*perct.*	*perct.*
Homemade oil emulsions					
Homemade boiled lubricating oil emulsion (1-10)	76	23	99	42	1
Homemade boiled lubricating oil emulsion (1-15)	71	26	97	All moldy	3
Commercial oils					
Volck (1-10)	89	7	96	16	4
Oil formula L-43 (1-10)	78	12	90	32	10
Oil formula L-200 (1-10)	73	11	84	39	16
Verdol (1-10)	76	8	84	All moldy	16
Cresylic acid (1-10)	0	1	1	All moldy	99
Cresylic acid (1-15)	25	3	28	All moldy	72
Cresylic acid (1-20)	53	18	71	All moldy	29
Check (untreated corn)[1]	0	0	0	..	..

[1]This untreated corn was so badly damaged by insect attack that it failed to germinate.

In the third and final test of materials, begun in January, 1930, and ended in May, when germination tests were made, the materials that had previously proved satisfactory were used as well as two new ones, potassium oleate and Dendrol.

TABLE 5.—RESULTS OF THIRD SERIES OF TESTS IN TREATING SEED CORN ON THE EAR WITH OILS AND POTASSIUM OLEATE: 1930
(Period of exposure to insects, 5 months)

Treatment	Total grains	Infested grains	Infested grains
	No.	*No.*	*perct.*
Homemade oil emulsions			
Homemade boiled lubricating oil emulsion (1-10)	1 065	200	18.8
Homemade boiled lubricating oil emulsion (1-8)	1 143	103	9.0
Commercial oils			
Volck (1-10)	1 135	35	3.1
Volck (1-12)	1 365	200	14.7
Oil formula L-43 (1-10)	1 002	217	21.6
Oil formula L-43 (1-12)	1 000	288	28.8
Dendrol (1-10)	1 000	5	.5
Potassium oleate (1-10)	1 130	487	43.1
Unprotected check	1 000	1 000	100.0
Protected check[1]	1 000	0	0

[1]This corn was protected from infestation by fine-mesh screen cages, but otherwise it was subjected to the same conditions as the treated corn.

TABLE 6.—RESULTS OF GERMINATION TESTS ON SEED CORN AFTER COMPLETION OF TREATMENTS SHOWN IN TABLE 5
(100 kernels tested from each treatment)

Treatment	Germination			Dead
	Strong	Weak	Total	
	perct.	*perct.*	*perct.*	*perct.*
Homemade oil emulsions				
Homemade boiled lubricating oil emulsion (1-10)	81	14	95	5
Homemade boiled lubricating oil emulsion (1-8)	77	14	91	9
Commercial oils				
Volck (1-10)	87	6	93	7
Volck (1-12)	78	10	88	12
Oil formula L-43 (1-10)	81	14	95	5
Oil formula L-43 (1-12)	77	17	94	6
Dendrol (1-10)	43	11	54	46
Potassium oleate (1-10)	70	17	87	13
Unprotected check	7	6	13	87
Protected check	88	8	96	4

Three materials in this third test gave excellent results, as shown by the data in Tables 5 and 6:

Homemade boiled lubricating oil emulsion in the 1-to-8 and the 1-to-10 dilutions

Commercial oil formula L-43 in the 1-to-10 and 1-to-12 dilutions

Volck in the 1-to-10 dilution

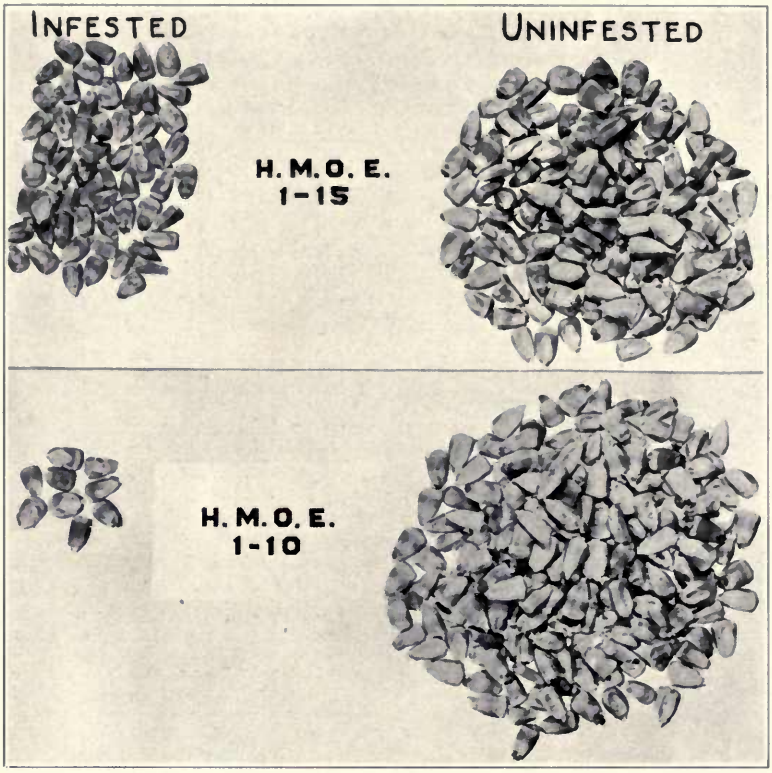

FIG. 5.—EFFECT OF DIFFERENT DILUTIONS OF HOMEMADE OIL EMULSIONS

The 1-to-10 dilution of boiled homemade lubricating oil emulsion made with potassium oleate gave good protection and did not injure germination. The 1-to-15 dilution was too weak to protect against infestation.

Each of these substances protected 80 percent or more of the corn, while pests riddled 100 percent of the untreated corn, and each permitted a germination of over 90 percent. Two, the homemade emulsion in the 1-to-10 dilution and L-43 in the 1-to-10 dilution, permitted a germination of 95 percent of the kernels, equalling that of the untreated corn.

Preliminary Tests of Feeding Value

In preliminary tests conducted by the Animal Husbandry Department of the Illinois Station, the feeding of treated corn to some

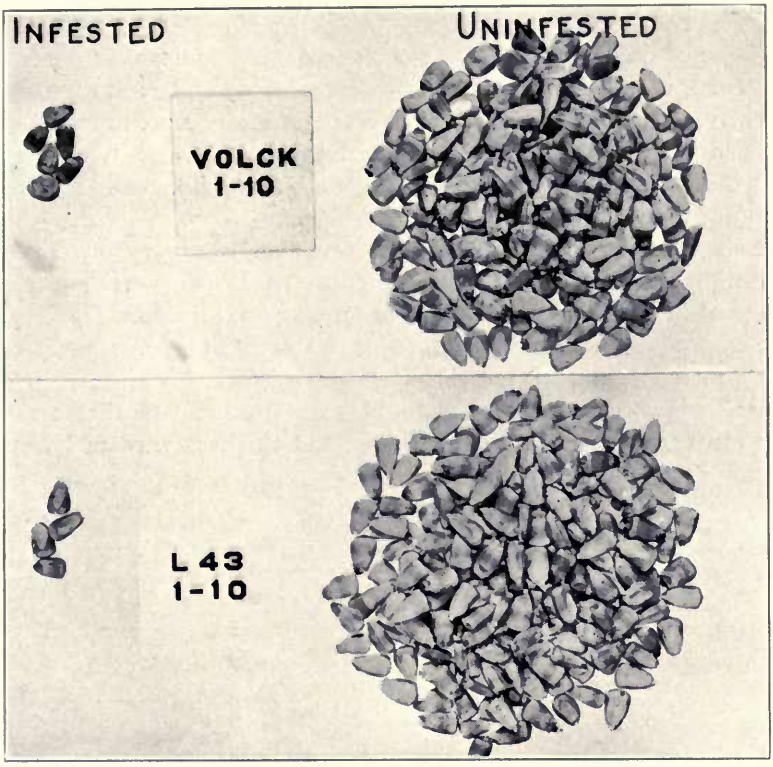

FIG. 6.—ALMOST COMPLETE PROTECTION WAS AFFORDED BY CERTAIN TYPES OF COMMERCIAL OIL EMULSIONS

After six months' exposure in the moth room only 6 of this composite sample of 200 grains treated with Volck were found infested. Of the 200-kernel sample of the grains treated with L-43, only 4 were found infested.

farm animals (in this case corn treated with Dendrol) produced no injurious effects on the animals, and the corn was just as palatable as untreated corn.

Three different oil emulsions were also tested by being fed to rats. Five times the amount of emulsion that an animal would obtain from treated ear corn was mixed with the ration. Some injurious effects resulted in these tests. In the case of tests with highly refined oils, only a slight effect on the rats was noted.

It seems improbable that treated corn would cause any injury to horses, cattle, hogs, or chickens, but further tests are necessary.

Summary

Some of the common oil emulsions and miscible oils now generally used for spraying fruit trees will protect ear corn dipped in these mixtures from attack by many of the insects that injure stored grain.

Seed corn treated with commercial emulsions made from highly refined oils was effectively protected from insect injury and the germination of the corn was not affected.

Boiled homemade lubricating oil emulsion was very effective in protecting ear corn against damage by insects. When potassium oleate was used in such emulsion, germination was not injured.

Some of the commercial miscible oil orchard sprays gave very good protection but injured germination.

Preliminary feeding tests would seem to indicate that treated corn can be fed to horses, cattle, hogs, and chickens without harmful effect.

Treating Ear Corn to Prevent Insect Damage

To treat small amounts of ear corn, mix the required amount of oil emulsion in water at the rate of 1 gallon of emulsion to 10 gallons of water. Approximately 1 quart of this diluted oil emulsion will treat a bushel of corn.

A tub or convenient small tank can be used. Place the corn to be treated in slatted crates or ordinary bushel baskets. Dip corn and container in the liquid; remove immediately and place on a drain board which will permit the excess liquid to run back into the dipping tank. Slatted crates are better containers for this purpose than bushel baskets as the crates are more open and will permit a quicker dipping and draining.

After being dipped, the corn should be thoroly dried and then stored without any more handling than is absolutely necessary. It apparently is the thin film of oil which surrounds each kernel that protects the corn from insect injury, and if the corn is handled, this film is broken and the corn rendered liable to injury.

For directions for making the oil emulsion see inside of front cover page.