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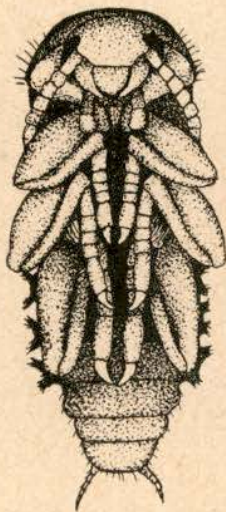
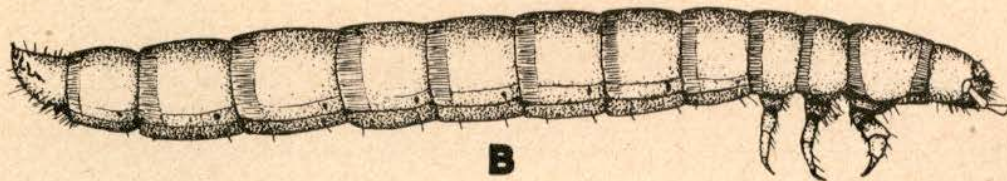


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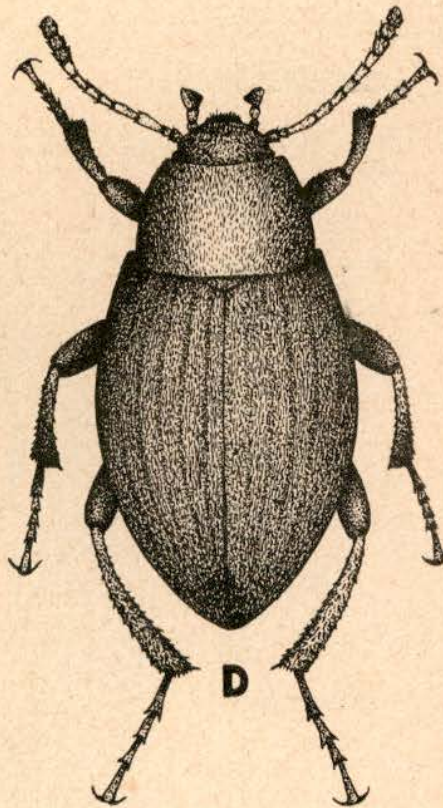
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The Plains False Wireworm and Its Control

M. H. SWENK



C



D

The plains false wireworm (*Eleodes opaca*): a, egg; b, larva; c, pupa; d, adult female beetle. Enlarged 4x. (Original.)

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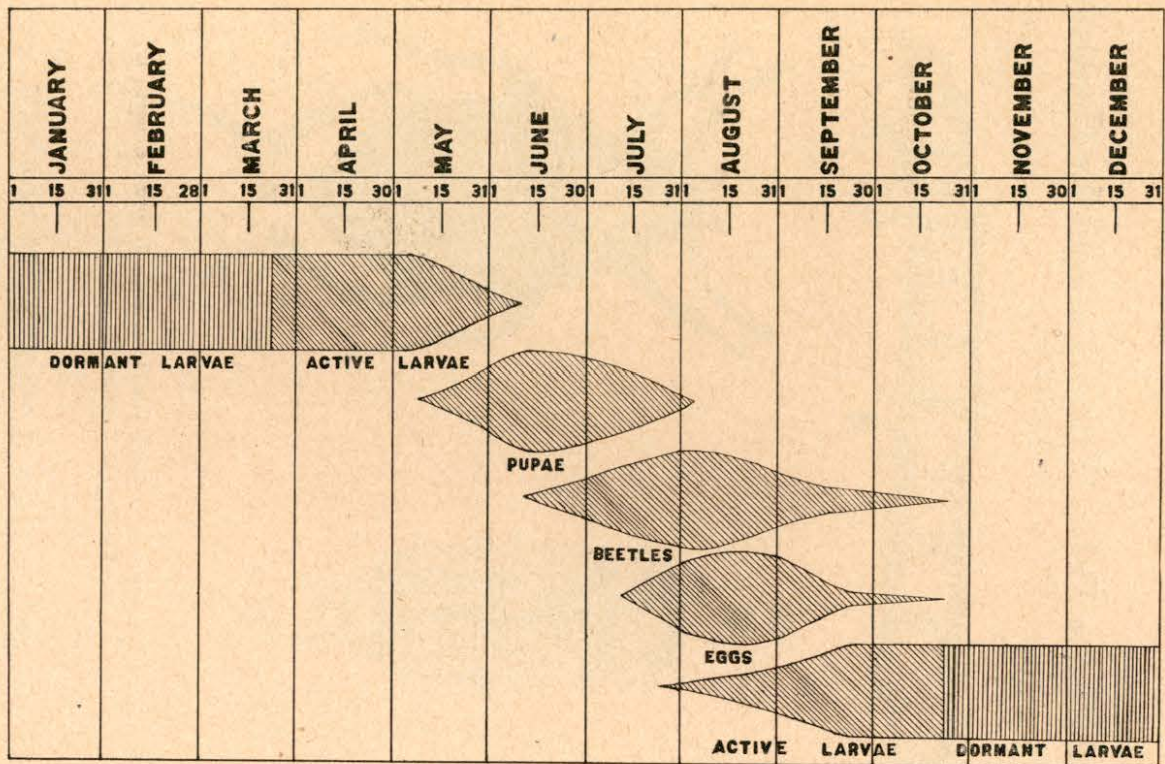


FIG. 1. Diagram showing life-history of the plains false wireworm in Nebraska. (Original.)

THE PLAINS FALSE WIREWORM AND ITS CONTROL

BY M. H. SWENK, STATION ENTOMOLOGIST

The last three crops of winter wheat, and especially the crop of 1922-23, have been seriously injured in southwestern Nebraska, and especially on the dry land farms of Cheyenne, Kimball, Banner, Morrill, Garden, Deuel, Keith, Perkins, and Hitchcock Counties, by an abundance of hard-bodied, cylindrical, shining waxy yellow, soil-infesting larvae (cover illustration, *b*). These greatly resemble wireworms and are often mistaken for them, but they differ conspicuously in being more active and having well-developed, club-shaped antennae, long and stout front legs, and a less flattened body with a distinctly upturned tip. These larvae destroy the planted seed in the fall and eat off the roots of the young plants both in the fall and in the spring. In some cases the damage done amounts to the practical ruination of the crop. This pest was undoubtedly no small factor in helping to cause the large acreage of abandoned wheat in the spring of 1923 in some of our western counties. It is known as the plains false wireworm (*Eleodes opaca*).

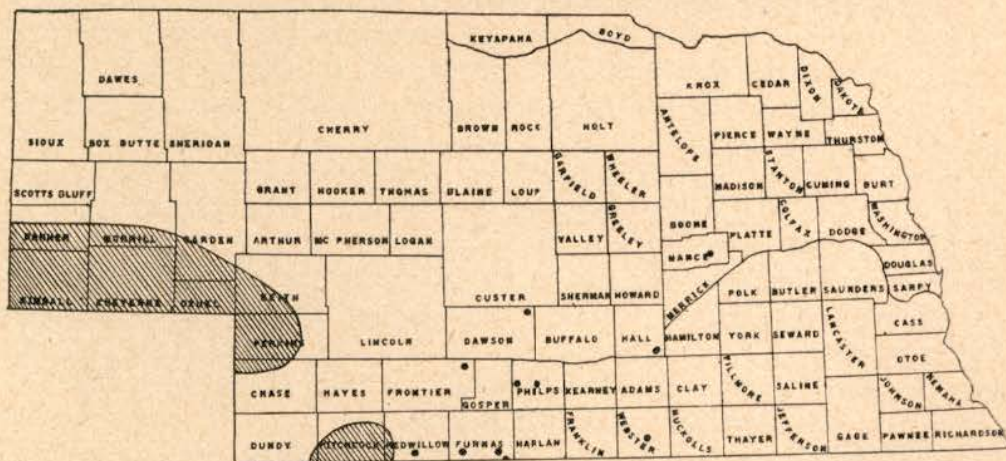


FIG. 2. Area in which the plains false wireworm seriously injured the winter wheat crop of 1922-23 and the two preceding crops (shown by shading) and localities outside of this area in which this pest has done serious injury to winter wheat some time during the past fifteen years (shown by dots). (Original.)

The plains false wireworm occurs abundantly over the greater part of the Great Plains area of the United States, in Montana, the Dakotas, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, New Mexico, and Texas. In Nebraska it is to be found over the entire state, very abund-

antly westwardly but only commonly eastwardly. It occurs in small numbers eastward, even into Iowa. North of the United States it apparently extends for an undetermined distance into central Canada.

HISTORY

The adult beetle of the plains false wireworm was made known to science and given a name just 100 years ago, in 1823, by the entomologist Thomas Say, from specimens collected by him along the Missouri and Arkansas Rivers while a member of the Major Long expedition to the Rocky Mountains in 1819-1820. Later it was found to occur commonly among the native plains grasses, but until 1908 was not known to be connected in any way with injuries to cultivated crops. In the fall of that year, however, some of the newly-sown winter wheat fields of southern Furnas and Red Willow Counties of Nebraska were seriously injured by wireworm-like larvae collecting in the drill rows in great abundance and gnawing or devouring the planted seed. Similar injuries were noted in western Kansas at the same time. These larvae proved to be the pest under discussion, which later was named the plains false wireworm. It is entirely probable that this insect had caused injuries in the winter wheat fields of Nebraska and Kansas prior to 1908 but that the trouble had been attributed to true wireworms or to some other insect pest.

Since 1908 this pest has been more or less injurious in Nebraska and Kansas every year, and the damage seems to be steadily increasing. Injury by the pest was discovered in the fall of 1909 in Furnas, Phelps, and Hall Counties, Nebraska, and it did a slight amount of damage to winter wheat in Kansas in both 1909 and 1910. In the fall of 1911 there was a well-marked outbreak in western Kansas, resulting in the destruction of several thousand acres of wheat. The winter wheat crop of 1914-15 was injured in several localities of both Kansas and Nebraska, the trouble in Nebraska being chiefly in Phelps County. Injury to the winter wheat crop of 1916-17 took place in Cheyenne and Frontier Counties, Nebraska, and to the crop of 1917-18 in Cheyenne and Webster Counties, Nebraska, many localities in central and western Kansas, and parts of Oklahoma and northwestern Texas. The crops of 1918-19 and 1919-20 were not much injured in Nebraska, but in the fall of 1920 began the present outbreak which has caused serious losses in the last three crops of winter wheat.

INJURY

The plains false wireworm is native to this region. Originally it probably fed on the roots and seeds of our plains and prairie grasses and weeds. But with the breaking up of the native sod land and the planting of cultivated grains the insects were forced to adjust themselves to

these new plants for food. This they seem to have accomplished very quickly and successfully. The principal injury takes place in the fall immediately after the wheat is seeded. The larvae attack the planted seeds at once and devour many of them or so gnaw them that germination cannot take place, resulting in a reduced or thinned stand. If the fall is dry, as in 1922, so that the grain lies in the soil for several weeks without sprouting, the injury is greatly intensified, and the planting may be wholly lost. After the seed has germinated the injury is less severe, but usually does not stop. The larvae then cut off the young plants just above the seed, or later attack the roots and underground stem, gnawing them so severely that the plant succumbs. Even in the spring, after the wheat plants have made considerable growth, the larvae burrow in the underground stems, sometimes severing them, resulting in either the stunting or the death of the plants.

Altho winter wheat has been far more injured by the plains false wireworms than any other cultivated crop, largely because it is planted at the time when the larvae are approaching full growth and are at the most voracious period of their lives, they also freely attack spring wheat, oats, barley, corn, and sorghums where these are planted on ground where the winter wheat had been destroyed the previous fall. In lieu of cultivated crops these larvae will feed on the roots of certain grasses or even of certain weeds, such as bindweed.

In its adult stage this insect is a dull black, oval-shaped, flattish-backed beetle, two to three-fifths of an inch long by about one-half as wide, with some very fine pale hairs arranged to form vague stripes down the back (cover illustration, *d*). These beetles are unable to fly, but crawl about very actively at night, spending the hot, bright part of the day hiding under suitable shelter. They have the habit, when disturbed, of stopping and elevating the rear end of their body, at the same time excreting a pale yellow oily liquid that has a strong and offensive odor. Because of this habit they are sometimes called "circus beetles," or "skunk beetles." In the wheat fields they hide in abundance under the wheat shocks and around the stacks after harvest, and at such times may do slight injury to wheat heads in the shock or stack, especially if the grain becomes damp. The natural food of the beetles, however, is the leaves of various available plants, such as wheat, corn, alfalfa, Russian thistle, evening primrose, smartweed, the kernels and chaff of grains, manure, dead insects, etc. These insects are not as yet to be regarded as seriously harmful in the adult stage.

LIFE-HISTORY

There is but one generation of the plains false wireworm each year. The adult beetles which are the parents of this pest are to be found commonly in the fields throughout the state from middle June to middle September. They reach their maximum abundance in eastern Nebraska

during middle and latter July, and in western Nebraska during latter July and early August. A few may be found in the field by June 10th, and a few may be found surviving in the field until as late as October 23rd, but these scattering individuals are of no great economic importance. Each adult beetle will live for two to three months, and, in the case of some individuals of exceptional vitality, for even four months. A month to six weeks after emergence the beetles mate, and a few days later the females begin to lay their eggs. The egg-laying varies from ten days or two weeks to as long as eight weeks, but averages about a month. Eggs are laid about three days in every four, on the average seven or eight at a time, tho occasionally three or four times that number, and the total number of eggs laid by each female beetle during her life varies from 25 to 400, averaging about 100 eggs. In general, eggs are being deposited from early July to October, mostly during the month of August.

The eggs are laid in cavities in the soil at a depth usually varying from one to five inches. Each egg is ovaliform, unsculptured, glistening white when first laid but changing to a creamy yellow before hatching, and measures from one twenty-third to one-eighteenth of an inch long by one-fiftieth to one-fortieth of an inch wide (cover illustration, *a*). A sticky secretion covers the egg when it is laid, causing particles of soil to adhere to it. Eggs laid in July and August will hatch in 6 to 10 days, while those laid in September or later require longer to hatch, up to 19 days. The newly hatched larvae are only about one-ninth of an inch long, but they at once begin a comparatively rapid growth, so that by the coming of frosts most of them are nearly fully grown, measuring from four-fifths of an inch to about an inch in length. In this stage they spend the winter buried at no great depth in the soil in a more or less dormant condition. Early the following spring they resume activity and usually undergo one molt (the tenth molt since hatching) before the final (eleventh) prepupal molt. Altogether the larval period covers about 300 to 350 days. Before pupating the larva constructs a spherical cell in the soil from a half inch to two inches beneath the surface and enters into a quiet prepupal period for about a week before changing to the pupal stage. The pupa is whitish and measures from one-half to three-fifths of an inch long by one-seventh to two-ninths of an inch wide (cover illustration, *c*). Pupation begins in western Nebraska about the middle of May, while in eastern Nebraska it begins a little earlier if the spring is warm and later if the spring is cool, and larvae continue to pupate for three weeks or a little more before all have entered that stage. The pupal period lasts from 8 to 20 days, averaging 11 days. Thus pupae are to be found in most seasons during the greater part of the months of May, June, and July.

NATURAL ENEMIES

False wireworms and their beetles are occasionally parasitized by a braconid (*Perilitus eleodis*) and by a flesh-fly (*Sarcophaga eleodis*) but the real efficiency of these parasites is doubtful. The false wireworms are attacked by two fungous diseases (*Sporotrichium globuliferum* and *Metarrhizium anisoplae*) and are also subject to a bacterial disease, which appears first as a small red spot on the body that enlarges, finally encircling the body, the larva succumbing shortly afterward. These larvae are also markedly cannibalistic. Birds of various kinds, especially blackbirds, feed readily upon the false wireworms and their pupae, whenever they are exposed by cultivation or heavy rains. The hard bodies and offensive oily secretions of the beetles of the false wireworm make them distasteful to most birds, and they are eaten but very little by them. However, the white-rumped shrike, crow, bronzed grackle, red-headed woodpecker, western mocking bird, burrowing owl, and upland plover are known to eat them, sparingly at least.

CONTROL

Treating the seed. One of the first questions usually asked concerning the control of false wireworms is whether the seed wheat can be treated by any substance that will not materially injure its germinating ability but yet will prevent the worms from attacking it, or else will kill them if they do attack it. The answer to this question is, briefly, that false wireworms, like true wireworms, are very hardy and resistive larvae, and that no substance is now known which, when applied to the seed grain, will either deter the false wireworms from injuring it or successfully poison them, and which is at the same time satisfactory to use from the standpoint of not injuring the germination of the seed, not causing the seeder to clog, and being within practical limits as to the expense for material and labor of the seed treatment.

Time of seeding. Our data show that the young, growing plains false wireworms are present in the fields from late July to late September, but that the principal injury to the seeded wheat is caused by the nearly grown worms between the middle of September (15th to 22nd) and the middle of October (16th to 24th). For this reason the early seeded fields are as a rule the ones most seriously injured. After the middle of October the activities of these pests diminish greatly, so that much injury could doubtless be avoided by seeding the winter wheat about the middle of October. However, it must be borne in mind that such late seeding does not yield as well as wheat seeded in September or early October, and in ^{western} Nebraska, where the Hessian fly is not a problem, if seeding conditions are favorable enough to promise prompt germination, it is ordinarily desirable that the fields be seeded in August and early September. But if, on the other hand, the weather is so

dry that it seems probable that the seed will lie for some time in the soil without germinating, subjected all the time to the attacks of the false wireworms, it is then advisable to delay the seeding. The greatest fall injury by false wireworms comes in those years when the season has been dry, allowing the soil to become dry and loose, so as to enable the active false wireworms to work thru it easily and to concentrate in the drill rows, where they can gradually consume the entire seeding of non-germinating wheat.

Effect of tillage and cropping on infestation. In the area of infestation in Cheyenne, Kimball, Banner, Morrill, Garden, Deuel, Keith, and Perkins Counties (fig. 2), summer fallowing is generally practiced, so that each year many of the fields in this area are not cropped. The idea is to work such fields sufficiently during the summer to keep down plant growth and conserve moisture. If fields are really thoroly summer tilled they are made comparatively unattractive for the beetles, because they do not provide food and shelter for them, and such fields usually receive comparatively few eggs. The stirring of the soil also has a tendency to destroy such eggs as are placed in it. Consequently these fields are usually not heavily stocked with young false wireworms when the winter wheat is seeded in them, usually late in August or early in September. But if the fields are merely plowed and not further cultivated during the summer, so that clumps of volunteer wheat and oats and large numbers of Russian thistles spring up in the fields, they then become highly attractive to the beetles, which concentrate in such fields and lay their eggs there so that they are well infested with young larvae when the wheat is seeded. In a large number of cases the winter wheat that was badly injured or destroyed in this area in the fall of 1922 and spring of 1923 had been sown in ground that during the summer of 1922 was uncropped but which produced a growth of volunteer grain, weeds, and grasses. Next to the uncropped ground, the most injury probably comes in winter wheat sown in sod land that was broken in the spring or early summer, in time to grow up to weeds and invite the egg-laying beetles.

Other things being equal, the greatest injury by false wireworms is likely to occur on lands cropped continuously to wheat. Rotation with corn, oats, barley, sorghum, and other crops is helpful in keeping these flightless beetles dispersed and not allowing them to concentrate and settle in the wheat fields. Still, instances have come to notice of wheat that was sown on ground that had been continuously planted to corn for several years and yet was seriously injured by this pest.

Where the false wireworms have destroyed the winter wheat in the fall, the question frequently arises as to whether it would be safe to re-seed the field to spring grain. Our data show that in western Nebraska the bulk of the false wireworms resume active feeding in the spring about the middle or the third week in March (15th to 28th) and

continue in full force until the first week in May (3rd to 7th). A few continue to feed until the middle of May or later (15th to 23rd). If the seeding of the spring wheat or other small grain crop can be delayed until latter April it stands an excellent chance of escaping serious injury providing it germinates promptly. However, as with late seeded winter wheat, spring wheat seeded as late as latter April is likely not to yield as well as earlier seeding. Otherwise, where this false wireworm has destroyed the crop in the fall, plowing the ground about the middle of May and planting to corn would probably be the best procedure. If the season is very backward the larvae may not have begun pupation extensively by the middle of May, but in some seasons many of the larvae will have pupated by this time, and the plowing or listing of infested fields during middle or latter May will destroy large numbers of the delicate pupae by breaking up the protecting earth cells and exposing them to the elements and their natural enemies, or by crushing them. In an infested field thus plowed or listed, from 80 to 95 per cent of the pupae will be destroyed. Sorghum, Sudan grass, millet, and other forage crops, as well as potatoes, can also be used following winter wheat destroyed in the fall.

Poisoning the adult beetles. One of the most promising methods of direct control of the plains false wireworms is the poisoning of their adult beetles with poisoned bran mash. The adult beetles of the plains false wireworm are very fond of moist wheat bran, preferring it in fact to fresh green food. Even when the bran is prepared in the form of a poisoned bait, such as is now so extensively used for poisoning grasshoppers, it seems to lose nothing of its attractiveness for these beetles, since they will eat it quite readily when there is an abundance of fresh, unpoisoned food. They are frequently attracted to it from a distance of two or three feet. Consequently it seems altogether likely that these beetles could be destroyed on a large scale by poisoning operations, as the related false wireworm beetle, *Eleodes hispilabris*, was destroyed in Idaho in 1921 and 1922. However, it must be stated that the extensive control of the plains false wireworm by poisoning the beetles has never been actually tested out, so far as the writer is aware.

In the Idaho tests the best results were obtained by using a bait prepared by mixing, dry, twenty-five pounds of coarse wheat bran and one pound of Paris green, and then adding three-fourths of an ounce of amyl acetate in enough water to make a stiff mash. This formula may well be used in the present Nebraska outbreak. White arsenic is apparently not a satisfactory substitute for Paris green in this case, because of distinctly inferior efficiency.

As has already been pointed out, the adult beetles of the plains false wireworm begin to appear in the fields early in June, become common toward the end of that month, reach their greatest abundance during

late July and early August, and are largely gone by the middle of September. Eggs are being laid from early July on, but chiefly during August. Since the purpose in poisoning the adult beetles is to kill them before they have been able to lay their eggs for the next generation, it follows that the poisoned bait must be used early in the season, before the egg-laying season is well under way. As the period between the emergence of the beetles and egg-laying is only four to six weeks, it is evident that poisoning operations should begin just as soon as the beetles become sufficiently abundant in the field to make it profitable, and that these operations should continue at least until the heavy egg-laying period begins. In other words, *the poisoned bait should be spread during July, and especially during the latter half of that month.*

During the month or more between emergence and egg-laying the adult beetles feed voraciously. They crawl about over the ground very actively in the evening and early morning, and on cloudy days, so can hardly fail to soon encounter even a very thinly spread poisoned bran bait. To spread the poisoned bait thickly or in lumps or heaps is to run some risk of poisoning birds, so should be scrupulously avoided. The bait should, therefore, be broadcast thinly, in the late afternoon or evening, around the daytime hiding places of the adult beetles, such as around the grain shocks or the stacks of grain or straw in the wheat fields, about the clumps of volunteer grain or grass, along the piles of Russian thistles collected along fences, along the roadsides, over waste or weedy land, and in the vicinity of any other daytime retreats of the beetles.

When crawling about, if the beetles encounter a furrow, rut, path, or other similar depression or smooth place, they are likely to follow along for some distance before climbing out or crossing over. This habit was taken advantage of in the Idaho tests against *E. hispilabris* by plowing furrows 100 to 300 yards apart across beetle-infested fields, and along their edges, and spreading the poisoned bran mash lightly in the furrow so that the wandering beetles could not fail to find it. The bait continued to be attractive to these beetles even after it had dried out, and unless rains occur it should be effective for several days after having been spread. The poisoned beetles do not die at once, but it requires several days for the effects of the poison to be evident, just as is true in poisoning grasshoppers with the poisoned bran bait. Ten days after spreading the poisoned bait many dead beetles should be in evidence, especially along the baited furrows, if that method has been used.

In evenly broadcasting the poisoned bran bait over a field to destroy false wireworm beetles, it need not be spread more heavily than one would spread it for grasshoppers; that is, the above formula should make enough bait to cover several acres. The cost will be about twenty-five or thirty cents an acre for materials, at present prices.

But it is often not necessary to cover the whole of a field. If the furrow method is used, fields can be treated for much less. A trough, attached to the back of a wagon that straddles the furrow, can be used to facilitate rapid thin spreading. Fifty pounds of mash should treat a mile of furrow. The poisoned bran mash should never be spread thickly, for that is not only unnecessarily wasteful, but, as above stated, dangerous to bird life.

It is not probable that in most cases a single season of poisoning the adult beetles will accomplish complete control of the pest, but it should greatly reduce the injury for the following year, and, if followed by a second poisoning, complete control should be secured. However, when the poisoned bait is applied painstakingly and persistently by each individual, and coöperatively over a large area, fairly effective control should be possible in one season.

[2M-July 1923]