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Grasshoppers, Cutworms and Army Worms and their Control by Poisoned Bran Mash

A. Ford

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EXTENSION CIRCULAR NO. 38

MARCH, 1922

**Grasshoppers, Cutworms and Army Worms and
Their Control by Poisoned Bran Mash**

COMMUNITY BAIT MIXING BEE
IN WESTERN SOUTH DAKOTA

EXTENSION SERVICE
SOUTH DAKOTA STATE COLLEGE
BROOKINGS

DIGEST

1. Grasshoppers, cutworms, and army worms are South Dakota's most injurious insects. These pests cause a large annual loss to the growing crops of the state. Pages 1 and 2.

2. All parts of the state are subject to attacks from any of these pests, a fact which shows the necessity of every farmer availing himself of information relative to the best known means of controlling them. Page 2.

3. The use of poisoned bran mash is the best known means of controlling grasshoppers and army worms, and under certain conditions is an effective means of reducing losses due to cutworms. Pages 2 to 6.

4. Different baits have been tried under various conditions and the one recommended herein we believe is the best for South Dakota conditions. Page 4.

5. All bait should be mixed and applied according to directions if maximum results are to be expected. Pages 3 to 6.

6. Poisoned bran mash costs very slightly over a cent a pound (labor excluded) making the cost of treatment about 11 cents per acre per application when used against grasshoppers and about 17 cents per acre when used against cutworms and army worms. Pages 6, 10, 13 and 15.

7. When correctly applied, there is no danger of stock poisoning from the use of poisoned bait. Pages 5 and 6.

8. Poisoned bait will effectively control cutworms that travel on the surface of the soil but is not effective against those species that travel beneath the surface. Pages 14, 15 and 16.

9. For the control of all outbreaks of migratory insect pests, community cooperation is absolutely essential to the success of any measures that may be applied. Page 16.

Grasshoppers, Cutworms, and Army Worms and Their Control by Poisoned Bran Mash

A. L. FORD
Extension Specialist in Entomology

INTRODUCTION

Were it possible to accurately estimate in dollars and cents the average annual loss caused by grasshoppers, cutworms, and army worms to the growing crops of South Dakota, the figure arrived at would be a staggering one. These three pests cause a greater average annual damage than any other three insect pests in the state. Natural conditions here are such that we may expect outbreaks from any of these three in any part of the state for many years to come. Being situated in this manner, it behooves every farmer in South Dakota to be prepared to fight these pests should they appear in damaging numbers.

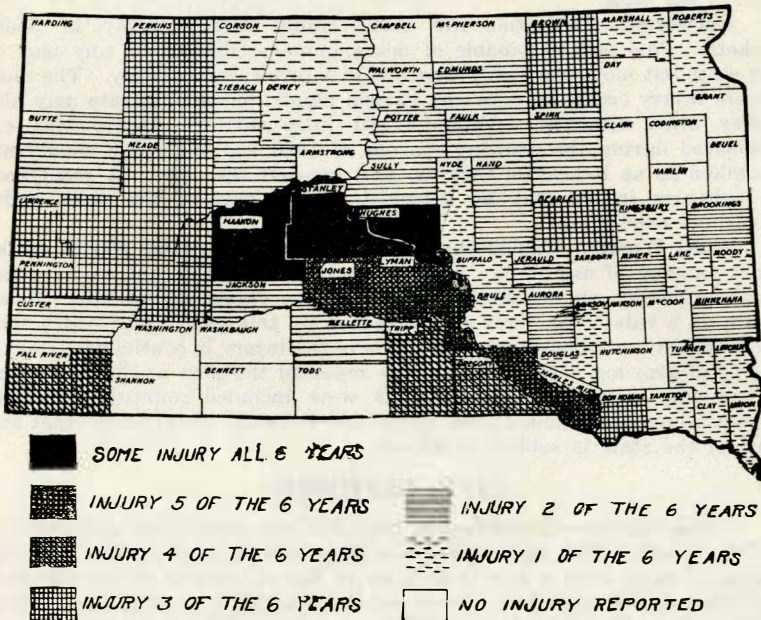


FIGURE 1.—The above map, which was compiled from the records on file in the state entomologist's office, shows the counties in the state reporting one or more serious grasshopper infestations during the various years for the period 1916 to 1921 inclusive. This does not necessarily mean that the entire county was infested as indicated for a particular year, but that at least one community in that county reported serious grasshopper damage during that year.—Original.

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Poisoned bran mash has proved to be the best known means of controlling grasshoppers and army worms, and under certain conditions, it is an effective way of greatly reducing losses due to cutworms. Since these three pests are the most serious in South Dakota, one can easily see that this poisoned bait is probably the most important insecticide used in the state.

DISTRIBUTION IN THE STATE

Grasshoppers.—During the past six years (1916 to 1921 inclusive) reports show that practically all parts of the state, with the exception of a few scattering localities east of the Missouri River, have been visited by one or more serious grasshopper outbreaks. During the seasons of 1916, 1917, and 1918, much of the trouble occurred in the central and eastern parts of the state, but during the three years from 1919 to 1921 inclusive, the bulk of the damage has occurred either adjacent to or west of the Missouri River. From all present indications, the pest is on the increase in the western part of the state. With a year or two of favorable conditions, however, the trouble may again appear throughout the eastern part of the state.

Cutworms.—Cutworms are corn's worst insect enemy in South Dakota. This pest is capable of doing immense damage in any part of the state but more especially where corn is grown extensively. The most severe injury occurs to corn and garden plants, but small grain may also suffer when attacked. Although but little cutworm injury was experienced during the growing seasons of 1920 and 1921, this should not be taken as an indication that the pest has left the state. A recurrence of cutworm injury may be expected in any part of the state under favorable conditions.

Army Worms.—Considering the state as a whole, army worms do the least damage of any of the three pests here discussed, but when severe local outbreaks are considered, they must be placed in the lead. Small grain as a rule is the first crop attacked by this pest, after which they may migrate to adjacent cornfields where the injury is continued. During the 1920 growing season 15 counties reported the pest as doing damage to growing crops. Among these 15 were included counties as widely separated as Minnehaha, Clark, Butte, and Shannon, which shows that any part of the state is subject to attack.

LIFE HISTORIES

Grasshoppers.—Grasshoppers have but one generation each year in South Dakota. The eggs, which are deposited in late summer or early fall in pods of from a few to as high as 130 (according to the species), pass the winter unhatched. These hatch during May or early June giving rise to tiny wingless hoppers which shed their skins five times before becoming mature winged grasshoppers. Maturity is reached under ordinary conditions in from six to eight weeks after hatching from the eggs. Egg laying starts usually in late July and may continue until the first frosts in the fall.

Cutworms.—Cutworms pass through four distinct stages during the year, namely the egg, worm, pupa, and moth. The moths, which are very commonly seen about our lights at night, during the summer months, deposit their eggs in late summer or early fall, choosing grassy or weedy

places for this purpose. Most of the eggs of our South Dakota species are glued singly or in clusters to the stems of vegetation of any kind. The eggs hatch in about two weeks and the resulting young worms feed until cold weather on any succulent roots which may be available, when the half grown worms enter hibernation deeper in the soil. The following spring these worms resume feeding.

There are many species of cutworms in South Dakota that are of real economic importance and their life-cycles vary markedly. Some have more than one generation per year while others may winter in the pupal, egg, or even in the moth stage itself. It is believed, however, that most of our cutworms have a life-cycle similar to the one described above.

Army Worms.—Like the cutworm, the army worm passes through an egg, larval, pupal, and moth stage, but this insect has two complete generations each year in South Dakota. Hibernation takes place in the partly grown worm stage and possibly as a moth, but reliable information regarding the latter is still uncertain. In the spring, after resuming feeding, the worms pupate in the soil, and give rise to moths usually in June. These moths seek low places rank with vegetation in which to deposit their eggs. Each female moth is capable of laying from six to eight hundred eggs which hatch into tiny green worms during July. These reach the damaging stage during the last of July or the first part of August. At maturity the worms transform to pupae which later give rise to a second generation of moths. The worms which hatch from the eggs laid by this generation of moths become partly grown by the time cold weather sets in and hibernate as such.

POISONED BRAN MASH

Ingredients.—Poisoned bran mash is made up of a mixture of wheat bran, white arsenic (refined or crude) or paris green, cheap molasses, and water. Recently the addition of a small amount of amyl acetate (banana oil) to the mixture has been thoroughly tested and we believe makes a more effective bait. Apparently this is a haphazard lot of materials to be mixed together, but there is a reason for each separate ingredient. In the first place, there must be a body material that will carry the poison and at the same time be palatable to the pest under consideration. It must not be prohibitive in price and still it must be a substance which is readily available to the average farming community. Wheat bran has proved to be the ideal material to use. There must be a poisoning element present and either white arsenic (refined or crude) or paris green is best for this purpose. White or very finely ground crude arsenic is recommended in preference to paris green as it is much cheaper. Lead arsenate should not be used in this bait as it is necessary to use it twice as strong as the above mentioned poisons which makes its cost prohibitive. There must be some attracting agent to draw the hoppers from the green crop to the bait and ordinary blackstrap molasses has proved to be excellent for this purpose. It acts as an attracter, a sweetener, an adhesive, and prevents too rapid drying of the mash. Amyl acetate, or banana oil, adds but little to the cost of the bait and during 1921 its presence in the mash gave better kills than did the bait not containing this material. The water simply adds weight and succulence.

Although several formulas for poisoned bait are used by the various states, we believe the following one is the best suited for grasshopper control in South Dakota. The bait used for army worms and cutworms varies slightly from this, which is explained later in this publication.

Wheat bran, 25 lbs.

White arsenic (refined or crude) or paris green, 1lb.

Cheap molasses, 2 qts.

Amyl acetate, $\frac{3}{4}$ oz.

Water, about $3\frac{1}{2}$ gal.

Several variations from this formula have been used with varying degrees of success in several of our western states and should be taken into consideration. Where good clean sawdust is available, it may be mixed 50-50 with the wheat bran and this mixture used as the body material with good results. Where the best paris green is obtainable its strength can be cut down to three-quarters or even one-half of a pound for each 25 pounds of bran, still leaving sufficient killing power to give satisfactory results. Where absolutely pure white arsenic is available, the amount used may be reduced from one pound to three-quarters of a pound, without much lowering of its efficiency and the same holds true of crude arsenic in the very fine powdered form. Where crude arsenic is in a rather coarse crystalline form, its rate in the mash must be increased Salt used at the rate of one pound for each 25 pounds of bran is strongly recommended by some entomologists as it apparently adds to the effectiveness of the mash under semi-arid conditions not as an attracting agent, but because hoppers are very fond of it and will consequently consume more of the salty bait. Because of the excellent results with salt in Montana and in Canada, we believe it should be considered in South Dakota, although we have thus far found no benefit from its use. Good kills in grasshopper and cutworm control work have been reported from the use of nothing but poison, bran, and water; but also some failures have resulted from the use of this mixture. Amyl acetate should in no case be used stronger than here recommended as it may repel rather than attract insects at greater strengths. Under average South Dakota conditions, we believe the formula given above will bring maximum results against grasshoppers. Variations from this formula (described above) might well be used in cases of emergencies where certain ingredients are not available at the time they are needed.

Proper Mixing of the Ingredients.—There is nothing more important in the entire process of preparing and applying poisoned bran mash than a correct and thorough mixing of the ingredients in their proper proportions. Where a small amount of poisoned mash is to be mixed, a tight wagon box, an old water tank, or a concrete floor can be used nicely. After spreading the bran out in a layer about a foot deep, sprinkle the dry powdered poison over it by means of a fine sieve at the rate prescribed in the above formula. Thoroughly mix the poison through the bran by shoveling it completely over at least eight or ten times. Absolutely thorough mixing while dry insures a uniformly poisoned mash and is of paramount importance.

Having thoroughly mixed the poison through the bran, in a separate container, such as a tub or a barrel, mix the wet ingredients together, using about $3\frac{1}{2}$ gallons of water, 2 quarts of blackstrap molasses, and three-fourths of an ounce of amyl acetate for each 25 pounds of bran.



FIGURE 2.—Mixing poisoned bran mash in an ordinary tight wagon box.—Original.

Stir this concoction vigorously and moisten the dry ingredients by sprinkling the solution over the poisoned bran while it is again shoveled over or shaken through a scoop fork. The mash is now ready to be applied to the infested fields.

Where large amounts of poisoned bait are desired, as in case of community poisoned bait mixing bees (see cover plate), any kind of a barrel concrete mixer will nicely mix one-half sack of bran per batch. The slower the machine is turned the more thorough will be the dry mixing. This type of machine cannot be used for mixing the wet ingredients with the dry as the entire mass seems to "ball up" without mixing. In this case the dry mixture can be resacked directly from the machine and mixed wet by hand. When a large "drum" concrete mixer is available, both the dry and wet mixing can be done if the machine is cut down to a very slow speed. Some little difficulty is often experienced in getting the wet mash to run out of the machine freely but this can be overcome by hitting the drum a few blows with a wooden mallet.

It has been found that mash which has been allowed to stand in a wet condition until a slight fermentation has been set up, brings, as a rule, better results than the fresh mash. The mash should not be left in a wet condition long enough for it to heat and mold, however, as this is not only detrimental to its effectiveness, but also hinders its application to infested fields because of the caking which usually takes place with molding.

Danger in Carelessness.—All arsenicals used in poisoned bait are poisonous to humans and domestic animals. Because of this, too much care cannot be exercised in the handling and mixing of these materials. The poison should at all times be kept well labeled and out of reach of children. After mixing, all vestiges of spilled mash should be cleaned up

as it is very palatable to domestic animals, especially poultry. Where small amounts of the poisoned bait are left over, it should not be thrown out, but immediately buried. In case the bait is mixed several hours before sowing, it should be labeled POISON and either sacked or well covered in a manner that makes it absolutely inaccessible to poultry. Where the poisoned bait is applied to an infested field in the correct manner, there is practically no danger to livestock or poultry and very few wild birds are killed. To avoid the danger of poisoning stock, the bait should always be broadcast thinly. Incidentally this method of sowing will give a higher insect kill. There is only one place where the bait should not be used and that is about the poultry yard, as young chicks have been known to pick up enough of it to make them sick or even kill them.

Cost.—The cost of poisoned bran mash outside of the labor involved in mixing and applying is very low. Under the present prices (1921) poisoned bait can be prepared according to the above formula for between one and one and a quarter cents per pound. For grasshoppers 10 pounds per acre per application is recommended and for cutworms and army worms about 15 pounds per acre. From this it can be readily seen that the cost of materials is not an important factor.

POISONED BRAN MASH AS A CONTROL FOR GRASSHOPPERS

Poisoned bran mash is the best known means of controlling the grasshopper. Its effectiveness against this pest is not miraculous, but where properly used, it is absolutely effective. To obtain satisfactory results a number of points are essential and must be followed or the outcome will always be variable. Grasshoppers, once they get a start, are very hard to check. Because of this it is important to start poisoning early in the season. Often the young hoppers, which hatch in May and early June in South Dakota, are found concentrated near their hatching grounds in certain spots of the fields, or along certain fence rows, roadsides, or banks. When this condition exists it is an ideal time to get busy with the poisoned bait.

Method of Applying the Bait.—The poisoned bait may be applied by a person on foot, sowing it much the same as seed from a pail or other container, but where the nature of the ground permits, a much faster way of spreading the bait is from a moving wagon or even an automobile. The ordinary end-gate seeder can also be used to good advantage in this work. It distributes the bait more uniformly than can be done by hand and will cover nearly twice as much ground per hour as a man on foot. The only objection to the end-gate seeder is that the mash will not work down readily in the machine and because of this it is necessary to station a man at the seeder either feeding it a handful at a time or else keeping the mash punched down with some sort of a probe. For ordinary infestations 10 pounds of the moist mash per acre is recommended but where the infestation is unusually severe the rate should be increased somewhat.

Time of Day to Apply the Bait.—Recent investigations show that hoppers under fair weather conditions have but one strong feeding period each day and that comes in the morning. Because of this the bait should be applied early in the morning in order that it be in a moist, palatable

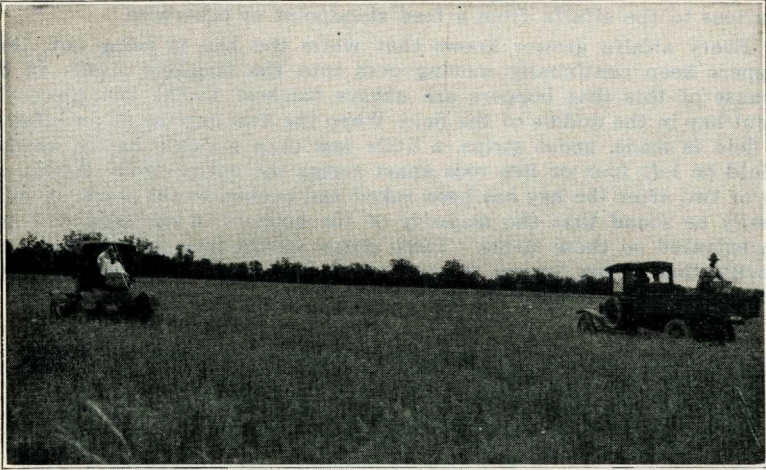


FIGURE 3.—Broadcasting poisoned bait in alfalfa by auto and motor truck. This outfit covers from 30 to 35 acres per hour.—Original.

condition during the maximum feeding period. When nights are very moist and dewy, the bait often can be sown in the evening and will remain moist all night, resulting in an excellent kill. On the other hand, the heat which the soil absorbs during the day often causes the moist bait to dry before morning, a condition which will always cause failure. We believe the best results can be obtained by applying the bait early in the morning. Bait should not be applied previous to a rain as rain greatly reduces its effectiveness, but excellent results can be obtained by sowing the mash on the wet ground immediately following a rain at any time of the day. Under such conditions the mash remains moist for a considerable time, thus giving the hoppers a much longer feeding period.

Controlling Grasshoppers in Alfalfa.—All alfalfa fields in localities subject to grasshopper outbreaks should be watched very closely during May and early June, when the young hoppers normally hatch. Should the young hoppers be found swarming out of the ground in certain places, these places should be immediately baited, the mash being sown fairly thick. If the entire field is uniformly, but not too heavily infested, good results can often be obtained by waiting until after the first cutting of alfalfa is made before baiting the field. Grasshoppers in South Dakota in a normal year do not cause serious damage to the first cutting of alfalfa as they are usually only half grown at this time. It is a thoroughly established fact that grasshoppers will take the bait better where there is a lack of vegetation, which accounts for the fact that they are more easily poisoned immediately following the cutting. This fact should not discourage farmers from poisoning in standing alfalfa when no other method can be used, as very satisfactory kills are obtained in most cases. When standing alfalfa is baited it is

absolutely safe to feed to livestock as hay. The mash when broadcast does not stick to the foliage but falls to the ground and is in no way injurious to the alfalfa from a feed standpoint or otherwise.

Every alfalfa grower knows that while the hay is being cut, the hoppers keep continually moving over into the standing stuff. It is because of this that hoppers are always thickest in the last piece of uncut hay in the middle of the field. When the first cutting of an infested field is made, uncut strips, a little less than a sickle bar in width, should be left four or five rods apart across the entire field. Within a day or two after the hay has been raked and bucked to the stack, it will usually be found that the majority of the hoppers in the field will be concentrated on these strips. These strips should then be baited quite heavily, thus giving control for the entire field by the actual baiting of not more than one-twentieth part of it.

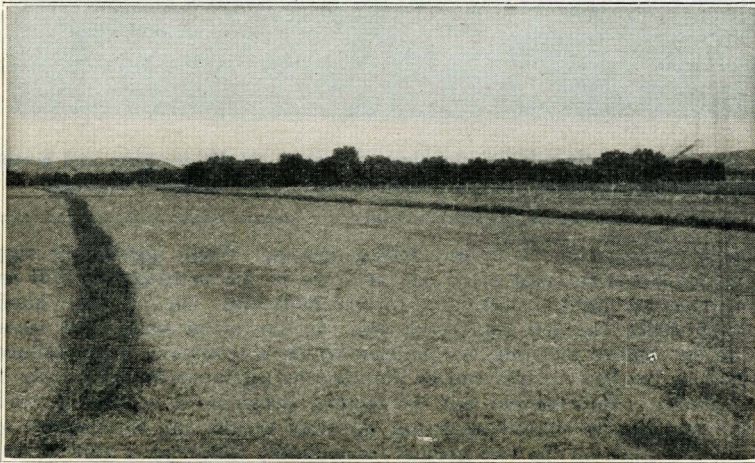


FIGURE 4.—Standing strips of alfalfa left when the first crop is cut. The young hoppers concentrate on these strips and may then be poisoned with a minimum amount of bait and labor.—Original

When ready for the first cutting of alfalfa a little investigating will often save much trouble. Examine the entire field before going in with the mowers. If hoppers are found only in certain spots or along certain sides of the field, as is often the case, these infested places should not be cut until last. Always cut away from the infested spots as the hoppers will move but slowly from uncut to cut alfalfa. In this way they can be kept from spreading, thus making it possible to thoroughly bait the infested areas before they have moved elsewhere.

When the surrounding prairies dry up in midsummer, the activities of the hoppers should be closely watched. If they move in on the previously poisoned alfalfa, it may necessitate re-poisoning the edge or edges at intervals. Where the hoppers take flight and "drop in" on a

previously poisoned field, as occurred in some places in western South Dakota in 1921, there is nothing to do but repositon. This point is not as important as it may appear as most of the hoppers, which we as South Dakotans have to deal with, are not the migratory kind and seldom move far by wing.

It has been noticed that cane is not as subject to grasshopper injury as other cultivated crops. It is usually the last crop to be attacked by the pest. Where grasshoppers are accustomed to move in on alfalfa from the prairie, a strip of cane several rods wide planted between the infested grasslands and the alfalfa will often do much toward checking the forward movement of the pest. It is also claimed by some, and is probably true, that better kills can be secured by the use of baits in cane because of the grasshopper's apparent lack of fondness for this crop which results in a more greedy devouring of the bait.

Controlling Hoppers in Small Grain and Flax.—Grasshoppers are more easily poisoned in small grains and flax than in standing alfalfa. The method corresponds closely to that described under grasshopper control in alfalfa, except that in case of small grains and flax the poisoning has to be done in the standing crop. The keynote here is to

poison early in the season before the hoppers have spread over the entire field. Grasshoppers seldom hatch uniformly over a cultivated field because the female hoppers deposit but few eggs in loose ground. Most of the hoppers hatch from the hard, unplowed edges and move in on the crop as they grow. If done in time (late May or early June) a serious outbreak in small grains and flax can often be "nipped in the bud" by simply poisoning the edges two or three times at intervals of five or six days while the young hoppers are hatching.



Controlling Hoppers in Corn.—Grasshopper injury in corn is as a rule secondary. The hoppers usually leave some other cultivated crop or weed patch when it is cut or entirely consumed by the pest, and move into the corn because of lack of palatable food elsewhere. For this reason, corn can be protected by keeping adjacent infested crops well poisoned. Once the hoppers have gained access to a cornfield, the ordinary

FIGURE 5.—Corn badly damaged by grasshoppers.—Original.

poisoned bait is still effective but if modified slightly it is perhaps more efficient. When mixing bait for application in standing corn, if the amount of water is doubled, a sticky, sloppy mash results. When this is thrown forcibly among the tops of the corn plants, much of it sticks to the leaves where the hoppers cannot help but find it. Some care should be exercised in feeding corn fodder that has been previously poisoned in this manner, but if a close examination does not reveal any old, dried and caked mash adhering to the leaves or in the axils of the plants, it is perfectly safe for feeding purposes.

Results to be Expected.—Poisoned bran mash is not miraculous in its results when used against grasshoppers, but nevertheless, it is thoroughly effective on all crops grown in South Dakota. One regulation application (10 pounds per acre) should kill around 70 percent of the hoppers, and the person using it can consider his results as satisfactory

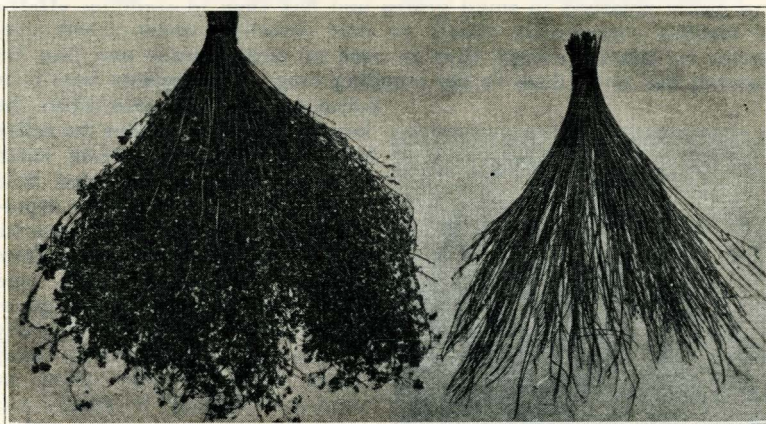


FIGURE 6.—At the left 100 stems of alfalfa from a poisoned field. At the right 100 stems from an unpoisoned field.—Original

if the kill approaches this figure. The writer has seen as high as 98 percent of the hoppers of a heavy infestation killed by one application and again he has seen as low as 50 percent killed. Occasionally a report of complete failure comes in, but usually the cause has been failure to follow directions or the use of adulterated poison. Do not expect the hoppers to fall dead immediately upon eating the poisoned bait. It takes from one to five days after feeding on the bait for the maximum kill to take place. Results obtained should not be judged until four or five days after the application of the bait has elapsed. Although the hoppers may appear perfectly normal and healthy for several days after feeding on the mash, they consume very little green food between the times of poisoning and death.

Necessity of Community Cooperation.—Where entire communities are infested, as is usually the case, unsystematic poisoning by individuals here and there will not bring the desired results. The larger the



FIGURE 7.—Dead hoppers in an alfalfa field four days after applying poisoned bait.—Original.

unit poisoned, the better and more permanent will be the results. Where one man poisons diligently and his neighbors with infested land do not, that individual is at the mercy of his neighbors' hoppers as soon as their crops are cut, because then the pests will move to new fields in search of food. Where farmers in an infested community cooperate in this matter, the work is not only made much more effective, but the cost of the material is greatly reduced since the price on large amounts of arsenic and molasses as well as the other ingredients is much cheaper than the price charged where small amounts are purchased.

Suggestions for Grasshopper Control Campaign.—When it is apparent in the spring that grasshoppers are going to do considerable damage during the approaching growing season, meetings of the residents of the infested territory should be called. At these meetings the farmers should each report the number of acres of crops they wish to protect and with the aid of the county agent, who in turn has been informed on the subject by the Extension Service at the State College, they should calculate the amount of materials needed and send in a pooled order. This can be obtained at wholesale prices as the county commissioners are authorized to provide for its purchase after they have been petitioned for such aid by 15 or more of the freeholders of the county. The county agent merely acts as the party between the commissioners and the farmers, in other words, he is the purchasing agent appointed by the county commissioners. These materials can then be given to the farmers at cost, resulting in a considerable saving over retail prices. Where local druggists or other dealers will furnish the ingredients necessary at somewhere near reasonable prices, it is always advisable to support the local enterprise.

In organized grasshopper control work, the community grasshopper bait mixing bee has proved to be a success. In handling the mixing of the bait in the community in this manner, all materials are hauled to some central point where they are mixed under experienced supervision

by members of the community. In this way all bait used is known to be mixed absolutely right and will bring more efficient results. Furthermore, the mixing bee instills a community spirit that is so essential in any organized work of this sort.

POISONED BAIT AS A CONTROL FOR ARMY WORMS

The true army worm is an offender that is either known or has been heard of by practically everyone. To the average person the army worm appears as a very active striped cutworm. The full-grown worm is nearly naked, smooth, longitudinally striped, and about one and one-half inches in length. In general color the worms vary from greenish, through brown to nearly black. There is a dark stripe running the full length of the body along each side and a similar but broader dark stripe running down the center of the back. The dark strip along the back usually has a fine, light colored, broken stripe running down its center. The color of the body between the dark stripes varies from greenish to reddish brown.

Importance of Watchfulness.—It is impossible to state what particular years are favorable for army worms as they have been known to be serious both in wet and dry years and following both mild and severe winters. All that can be truthfully said along this line is that any part of South Dakota is subject to attack any year, except that the same piece of ground is seldom attacked by this pest during two



FIGURE 8.—Army worms at work on millet.—After Cook.

succeeding years. The attack usually comes during the last part of July or the first part of August. The time to keep careful watch is during the two weeks period previous to the last of July. As a rule army worms start from low places where vegetation is rank. In 1920 a great many outbreaks started in haled-down oats that had made a rank second growth brought on by late June and July rains.

Correct Use of Poisoned Bait for Army Worms.—For army worm control the poisoned bait used varies slightly from that used for grasshoppers. The amyl acetate is not necessary and paris green seems to give very slightly better results than refined white arsenic. Several highly reputable entomologists have recently advocated that molasses is not necessary in poisoned bait against army worms or cutworms. We believe that better results will be secured if some molasses is used in the bait and are recommending its use at the rate of one quart to each 25 pounds of bran used. In cases of emergency, where molasses cannot be secured when desired, we would suggest that poisoning proceed without the molasses. For army worms the bait is applied exactly as described under grasshopper control, except that it should be applied at the rate of about 15 pounds per acre and during the late afternoon or early evening instead of in the morning. This point is of the greatest importance in army worm control since the worms work only in the evening or at night and the mash should be before them in a moist and palatable condition during their feeding period. This can only be accomplished by applying the bait in the late afternoon or early evening.

Where an army of young worms is discovered before they have spread, the infested piece of ground should be baited quite heavily. The young worms will take the bait just as readily as the older ones. This practice will usually prevent a pending outbreak with very little work and material. In case the worms are moving every night, first determine as closely as possible the location of their "front line" then, in the late afternoon or early evening, broadcast a swath of the poisoned bran mash two or three rods in width directly in their path. This will stop the average mass of moving worms. Where the infestation is unusually severe, it may become necessary to use the poisoned bait in connection with trenches. To construct a trench, plow as deep a furrow as possible, throwing the furrow slice toward the field to be protected, then drag a heavy log back and forth in the furrow until a fine dust is formed. This type of trench can be used only when the soil is dry. When the soil contains much moisture a fine dust cannot be secured and under these conditions the use of trenches is not recommended. The dusty ditch will check the advance of the worms so that they can be baited with the poisoned mash in the trench. The worms while caught in the trench and thus deprived of food will make for the poisoned bait in an almost ravenous manner.

In case the worms are in small grain which is about ready to be cut, the grain should be immediately cut and shocked. It has been found that the worms do very little damage to shocked grain but will strip the heads of grain that is left on the ground in bundles. Often it pays to cut infested grain a trifle green to avoid army worm damage

but this must be left to the judgment of the individual. In case grain too green for cutting is infested, the entire field should be treated with poisoned bait. It will be found that a single application of the bait will give an excellent kill within 24 hours.

Army worms do some damage to corn, but they usually enter it from surrounding grain fields. In corn, if the poisoned bait is thrown high when sowing, so that at least part of it will fall in the curl of the plant, it will be found more effective than when it is all simply broadcast on the ground.



FIGURE 9.—Army worms killed as a result of eating poisoned bran mash.—After Knight.

POISONED BAIT AS A CONTROL FOR CUTWORMS

Cutworms are universally known in South Dakota, consequently they need no description here. Our cutworms include many species which are much alike in appearance, but there is considerable variation in habit among them. Most of them are surface travelers, but some species travel through the soil beneath its surface. This variation in habit has much to do with their control by poisoned bait as will be explained later.

Poisoned Bait for Cutworm Control. Poisoned bran mash can be used effectively against those cutworms that travel from plant to plant on the surface of the soil. All of the injury cannot be prevented by this means, but it can often be reduced to a point where it might well be called negligible. It should be kept in mind that many of our cutworms are among the most difficult insects to control, in fact some species are still running rampant in spite of the fact that much investigative work has been done with their practical control in view.

The poisoned bait which gives the best results against cutworms is the same as that recommended for use against the army worm. The bait is applied as recommended for grasshoppers except that the rate should be increased to 15 pounds of the moist mash per acre. Always apply the bait in the late afternoon or early evening for the army worms. Some entomologists recommend mixing the mash rather wet so it will be distributed in lumps about the size of small marbles.

When Poisoned Bait Will Control Cutworms.—Often our cutworms become so numerous that they assume the army worm habit and move off across fields in huge armies in search for food. Under these conditions they can be just as readily controlled by the poisoned bait as the true army worm. This condition often occurs in small grain, the worms moving in from adjacent hay or grasslands and taking the young grain clean as they advance. As much as six or eight rods along one entire side of the field may disappear in a single night's operation. To stop such a forward movement of cutworms, first determine the line that marks the farthest advance of the worms by examining the infested fields in the late afternoon, as it is at this time that the worms are becoming active in preparation for their night's "offensive." Having determined this, poisoned bait should be broadcast in the evening for about two rods on both sides of this line, thus making the treated strip about four rods in width along the entire front on which the worms are working. Should additional worms continue to come from the grass or hay lands and advance on the cultivated crop, it will be necessary to repeat the operation.

Almost every corn grower is familiar with the damage that cutworms can do to young corn in May and early June. In this case the worms are usually well distributed through the field and do not move in armies as described above. They are also much harder to control with poisoned bait than when they are moving, however much damage can be avoided by the use of the bait in corn. When corn land is being plowed in the spring and many cutworms are seen going over with the furrow slice, it is almost a certainty that there will be cutworm trouble. After the corn is planted and up, a most careful watch should be kept for cutworm injury. If hills of young corn are found to have been recently cut off, the offending worm or worms can usually be found by scraping the soil away from the cut hill to the depth of a few inches. As soon as this injury appears, the damage can be considerably reduced by the application of poisoned bait to the infested portions of the field in the late afternoon or early evening. This will not give perfect control, but many times will save replanting and will allow the corn to safely escape early frosts in the fall which often "nip" replanted corn on account of its late start.

Cutworms may be classed as among the worst insect pests of the garden due to the fact that they may cut off any of our garden plants but more especially young cabbage, tomatoes and sweet corn. Here again poisoned bran mash can be used to excellent advantage. Where cutworms are doing damage in the garden, they can often be completely stopped by broadcasting liberal amounts of the above prescribed bait in small pellets over the garden in the evening. Poultry should not be given the run of the garden for some time after baiting as they may

suffer ill effects. Where the worms are cutting off such plants as cabbages and tomatoes, this may be prevented to a large degree by placing a small pinch of the bait at the base of each plant. If this is repeated two or three times about two days apart most of the damage will be prevented.

GENERAL CONSIDERATIONS

It should at all times be kept in mind that community cooperation is absolutely essential when dealing with grasshoppers, army worms, and migrating cutworms. An infestation of any of these three pests creates a strictly community problem, not an individual one. To cooperate further in insect pest control, the South Dakota State Legislature, during the session of 1921, passed an insect pest law (House Bill No. 25), which applies more especially to grasshoppers but in case of the most serious emergencies, may also be used in obtaining aid in army worm and cutworm control. The law in brief is as follows: In case it is evident that there will be great loss of crops, due to grasshoppers or other serious insect pests, 15 or more resident freeholders of the county may petition the county commissioners of said county to provide for the purchase of materials for making poisoned bait to be used in the county where necessary. The commissioners may or may not provide for this purchase as they choose. The county agent, where one exists, or a competent agent appointed by the commissioners, shall determine when and where poisoning is necessary in the county. When a person in the infested community refuses to poison and thereby jeopardizes his neighbors, the county may poison his infested land for him and the expense thereof be extended to his tax rolls for the following year.

Where counties are in such a financial condition that it is felt that it is impossible for the county to furnish these materials, no matter how badly they are needed, the situation can be nicely handled with very little cost to the county by the creation of a revolving fund by the county commissioners. This fund is used to purchase materials in large amounts for making the poisoned bait. The county can obtain these at the much lower wholesale prices and then give them to the farmers of their county at cost plus freight charges. In this way the county can help its farmers with very little cost to itself. This also instills a cooperative community spirit into the work that is necessary in the control of such pests as these under consideration.