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Grasshopper eggs in grass roots

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DESTROY THE GRASSHOPPER EGGS

H. C. SEVERIN AND G. I. GILBERTSON

Grasshoppers did an immense amount of damage to farm crops in South Dakota in 1930 and 1931. If weather conditions are favorable during the coming winter and next spring, there is every reason to believe that 1932 will be another grasshopper year, but with the damaged territory considerably enlarged over that of 1931. A survey has shown that there are large numbers of grasshopper eggs in the soil at the present time in those areas where the grasshopper damage was severe during the past summer, while in the remainder of the State the number of eggs in the soil is, at times, sufficiently abundant to cause alarm. The natural enemies that feed on or within these eggs are not abundant this fall, and, therefore, every effort should be made by the farmer to destroy as many of the grasshopper eggs as possible.

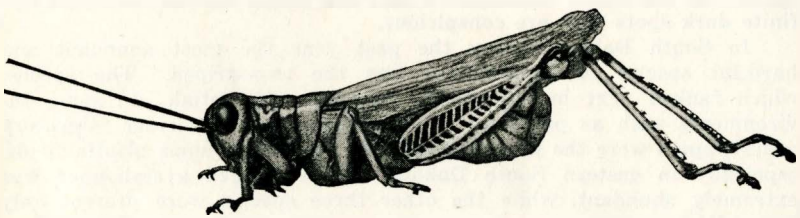

Fig 1.—Male differential grasshopper.
Enlarged 1½ times. After Milliken.

The Principal Injurious Grasshoppers

While the writers have found that 112 different species of grasshoppers live within the borders of South Dakota, ordinarily only four of these species ever increase in such numbers as to become exceedingly harmful. These four species are the two-stripped,[1] the differential[2], the red-legged[3] and the lesser migratory[4] grasshoppers. The two-stripped and the differential grasshoppers are robust of body and measure usually between 1 and 1¾ inches in length. The red-legged locust and the lesser migratory, on the other hand, have a

1 Melanoplus bivittatus (Say)
2 Melanoplus differentialis (Thomas)
3 Melanoplus femur rubrum (DeG.)
4 Melanoplus mexicanus (Sauss.)

body which is more slender and measures from ¾ to 1¼ inches in length.

The differential locust (Fig. 1) is usually of a bright yellowish-green color, unstriped, and more or less marked with black. In some specimens the black color is more extensive, while in a small percentage of the locusts it is the predominant color. The two-stripped grasshopper (Fig. 2) is yellowish or yellowish-brown in color but there are two bright yellow stripes extending lengthwise over the back from a position behind the eyes to the tip of the first pair of wings.

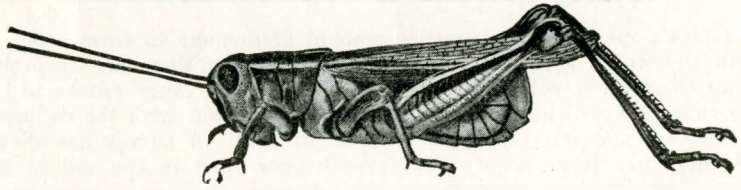

Fig. 2.—Male two-striped grasshopper.
Enlarged 1½ times. After Milliken.

The red-legged and the lesser migratory grasshoppers are quite similar in general appearance and size, but the males of the latter species have the end of the abdomen notched, while in the former this is not the case. In the red-legged grasshopper the first pair of wings are unspotted, or if dark spots are present, they are indefinite and small. In the lesser migratory locust the wings are marked with definite dark spots that are conspicious.

In South Dakota during the past year the most abundant and harmful species of grasshopper was the two-striped. The species which ranked next in importance was the differential. In some environments such as pastures, the red-legged and the lesser migratory grasshoppers were the important species. Again, in some alfalfa fields, especially in eastern South Dakota, the red-legged grasshopper was extremely abundant, while the other three species were present only in small numbers.

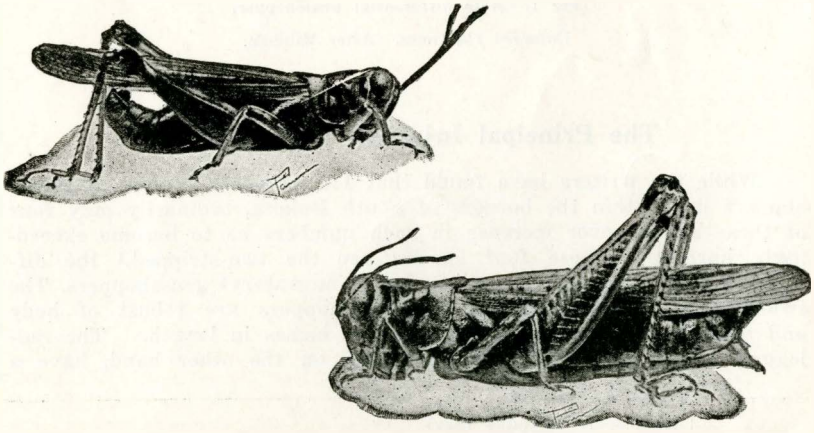

Fig. 3.—Lesser migratory grasshopper.
Above, adult male; beneath, adult female.
About twice natural size. After Walton.

Life Cycle of the Four Species of Injurious Grasshoppers

The four species of injurious grasshoppers discussed in this bulletin, lay their eggs in the ground and after egg-laying has been completed the locusts die. The eggs are deposited in masses or pods, the first pod being laid usually within two or three weeks after the female matures. Later, additional egg pods may be laid by the same female. The eggs remain unhatched over winter, but in the following spring as soon as it becomes warm, the eggs give rise to young hoppers (Fig. 4). These, while still enclosed in their egg membrane, make their way to the surface of the ground, where the membrane is shed. The

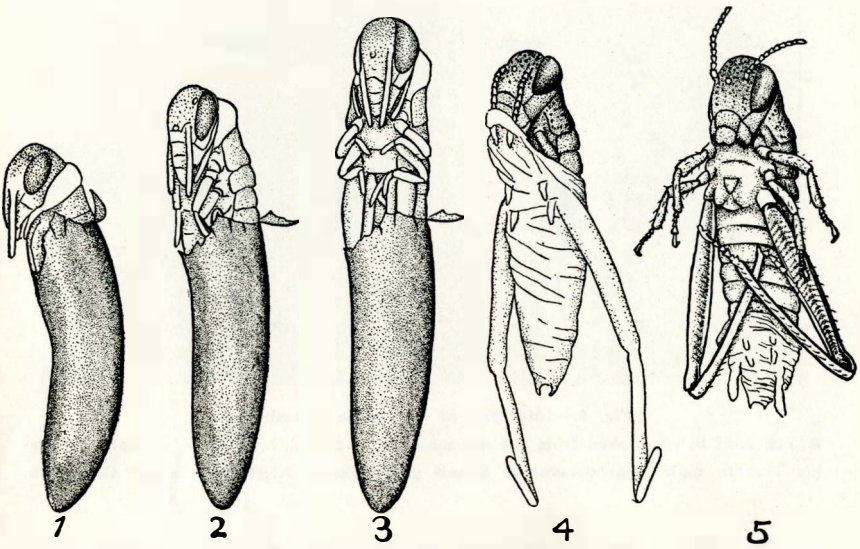

Fig. 4.—Successive stages in the hatching of a grasshopper. After Washburn.

young hoppers are now light in color and measure from ⅛ to 3/16 of an inch in length. In a short time the young hoppers become darker and less conspicious. Soon the young hoppers begin to feed. Feeding continues during the following week or ten days and at the end of this time, the insects shed their hard body covering, a process known as molting. The molting process is necessary, for without it the hoppers would be unable to grow. Immediately after the molting, the hopper increases in size and then another hard coating is secreted. Molting takes place four, five or six times during the life of our injurious grasshoppers, and after each molt the hoppers increase in size. Wings, which may be seen as mere traces on the body of the recently hatched

hopper, increase in size with each molt, but after the skin has been shed for the last time, the grasshopper acquires its full sized wings (Fig. 5). The grasshopper is now spoken of as an adult. Usually within seven to fourteen days such adults mate and shortly after, egg-laying begins.

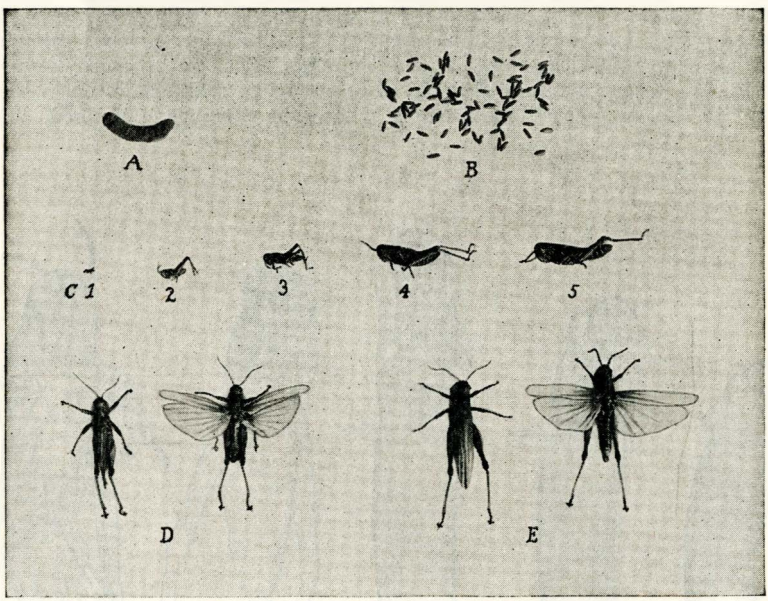

Fig. 5.—Life cycle of differential grasshopper.

A, egg pod; B, eggs taken from one egg mass; C, 1, 2, 3, 4, 5, stages of immature grasshoppers; D, male grasshoppers; E, female grasshoppers. After Severin and Gilbertson.

Not all the eggs of the same species of grasshoppers begin to hatch at the same time, and as it is to be expected, all of the young do not become adult at the same time. Further, the length of the adult life of the grasshoppers of the same species may vary considerably. Because of these facts, egg-laying in the two-striped, differential, lesser migratory or red-legged locusts may be spread out over a period of three months.

The time of hatching of the eggs of our four injurious grasshoppers varies with the species. The eggs of the two-striped grasshopper, for instance, will hatch from 3 to 4 weeks earlier than do the eggs of the differential locust. As a consequence, in a heavy outbreak of the two-striped and differential locusts, the adult hoppers in June, July and early August are predominately of the two-striped species. Later, as members of the two-striped species die and as more and more of the differential species mature, the complexion of the outbreak changes, for now the differential predominates in numbers.

How the Eggs are Laid

A grasshopper about to lay eggs, first makes a hole in the ground or among the stems or roots of plants, with her abdomen. For this purpose, the end of the body is provided with four curved, horny pointed structures, the ovipositor. The hole is made by pressing the tips of these processes against the ground and then alternately opening and closing the ovipositor. The abdomen is worked in this manner gradually downward and backward into the ground or among the stems or roots of plants (Fig. 6). When the abdomen has been forced into the ground as far as it will go, it is greatly elongated. A frothy liquid is now poured into the hole and into this fluid the eggs are placed, one at a time. The abdomen is gradually withdrawn from the hole as more and more liquid and eggs are added, and finally, after egg-laying has been completed, a mass of frothy material is secreted which is molded by the ovipositor as a plug to the hole and a cap to the egg pod. The dried liquid not only binds the eggs together but forms the envelope around the mass of eggs.

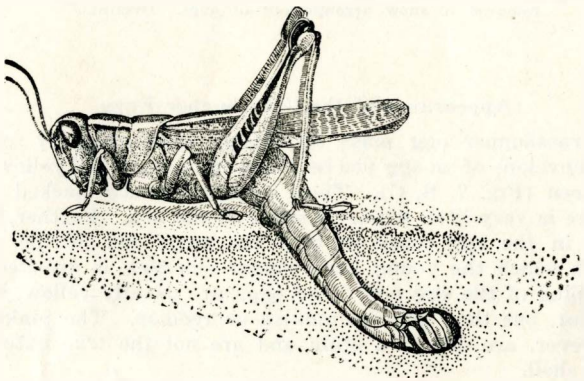

Fig. 6.—Two-striped grasshopper laying eggs. After Walton.

Appearance of Egg Pods

The egg masses or egg pods of the four species of grasshoppers discussed in this bulletin are cylindrical in shape and usually curved (Fig. 7). While the egg pods of even the same species of locust may vary considerably in size and shape, in general, those of the two-stripped and differential locusts are considerably larger than are those of the red-legged and lesser migratory grasshoppers. Most of the egg pods of the two-striped and differential species measure about an inch in length and 3-16 of an inch in diameter, while those of the red-legged and lesser migratory grasshoppers measure usually about ¾ of an inch in length and ⅛ inch in diameter. The outer envelope of the egg pods consists of a dried fluid to which soil particles, small stones or portions of rootlets adhere.

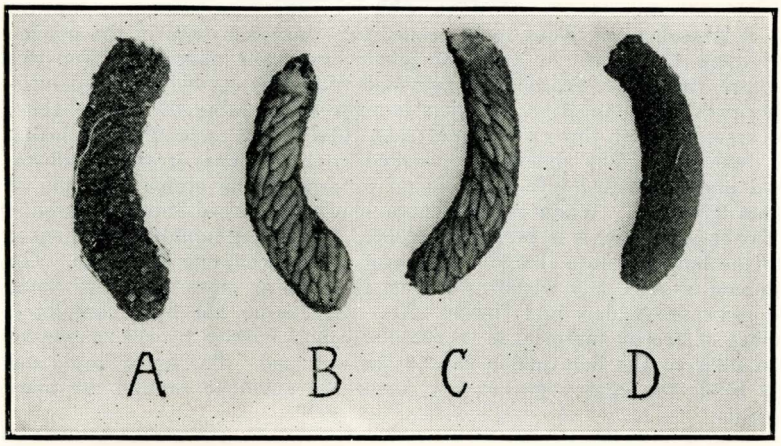

Fig. 7.—Egg pods of two-striped grasshopper.
A, D, egg pods with envelope unbroken; B, C, egg pods with one face of envelope removed to show arrangement of eggs. Original.

Appearance of the Grasshopper Eggs

If a grasshopper egg mass be broken open carefully, or if one face of the envelope of an egg pod be removed, many small yellowish eggs are to be seen (Fig. 7, B, C). These eggs are neatly packed together, so that there is very little waste of space in the pod. Further, the eggs are placed in the egg mass so that the same end of the egg, the end through which the young grasshopper emerges, is directed toward the top or plug of the egg pod. The eggs are usually yellow, brown or gray in color, but they may be pinkish or reddish. The pink and red colors, however, are due to a stain and are not the true natural color of the egg shell.

Each egg of the two-striped and differential grasshopper is more or less oval in shape, slightly curved, about 3-16 of an inch in length and not quite 1-16 of an inch in diameter (Fig. 8). As development proceeds and the young hoppers form, the eggs become more plump but they increase their length little if any.

The eggs of the red-legged and lesser migratory grasshoppers are smaller than those of the species discussed, but in shape and color they all resemble each other closely.

Total Number of Egg Pods and Eggs Laid by One Grasshopper

The number of eggs in a grasshopper egg pod depends upon the size of the pod and upon the species of locust that laid it. In the largest egg masses of the two-striped and differential grasshoppers, we found as high as 130 eggs per pod, while in the largest egg masses of the red-legged and lesser migratory species we found as many as 40 eggs.

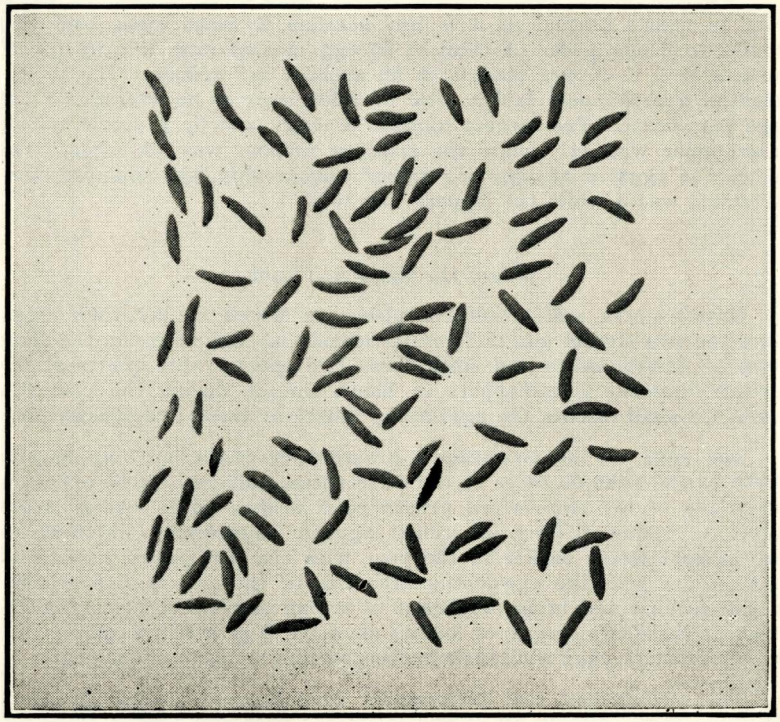

Fig. 8.—Eggs found in one egg pod of the two-striped grasshopper.

J. R. Parker*, working with lesser migratory grasshoppers kept under controlled laboratory conditions, obtained as high as 15 egg masses from a single female. The grasshoppers used in his experimental work were collected in the field early in August, and undoubtedly had already laid some eggs. Parker concluded from his work that "it seems reasonable to believe that vigorous females may have a potential capacity of 20 egg pods."

Parker further found that the egg pods of his lesser migratory locusts each contained from 12 to 36 eggs and averaged 25. Under favorable laboratory conditions, therefore, it should be possible for a single female lesser migratory grasshopper to lay about 500 eggs. Undoubtedly few grasshoppers, if any, of this species ever produce such a large number of eggs under field conditions.

M. J. Hatten of the State College of South Dakota, after studying the egg-laying habits of the differential locust, furnished the writers with the following unpublished data:

*Parker, J. R., 1930. Some effects of temperature and moisture upon Melanoplus mexicanus mexicanus Sauss. and Camnula pelucida Sc. Mont. Exp. Sta. Bul. 223. pp. 96-98.

"Fifteen female grasshoppers caged under field conditions, which were as nearly normal as it is was possible to make them, each laid from 2 to 6 egg pods. A total of 56 egg masses were laid by the 15 females or 3 11-15 egg masses on an average per female. The 15 differential grasshoppers laid a total of 3,694 eggs or an average of 246 eggs per locust. The largest number of eggs laid by a single female grasshopper was 441, while the smallest number was 108 eggs. The number of eggs in an egg pod varied considerably, the smallest number found was 8 while the largest was 153."

Where the Eggs Are Laid

Grasshoppers select suitable places in which to lay their eggs. Since the two-striped and differential locusts lay their eggs in the same kinds of environments and since these two species were the most important economic grasshoppers in South Dakota during the past few years, we shall discuss the egg-laying habits of these two species only.

The eggs of the two-striped grasshopper begin hatching several weeks earlier than do those of the differential, and, as is to be expected, the young of the two-striped grasshopper become adult several weeks before any adult differential locusts appear. Egg-laying, likewise, begins several weeks earlier in the year with the two-striped locust, but later in the year the egg-laying activities of the two species overlap. In late August and in September it is not an unusual sight to find females of these two species of locusts clustered together in a small space and laying their eggs with their bodies touching or nearly touching.

The two-striped and differential grasshoppers prefer succulent plants as food. Nearly all of our cultivated field and garden crops are eaten, and in addition the leaves of many trees and shrubs, and many succulent weeds are eagerly devoured. Some plants, such as cane, for instance, are almost immune, especially after the cane gets to be a foot or more tall. Many of our native grasses are also immune.

Both the two-striped and differential grasshoppers prefer grassy areas for egg-laying purposes, but such areas are always near and usually border the preferred foods, such as corn, small grains, alfalfa and sweet clover. Buffalo sod, if it is available, is preferred over all other grasses for egg-laying, but western wheat grass, gama grass, pigeon grasses, and a host of other species may also be used (Fig. 8). Fields of corn, small grain and alfalfa are usually bordered by a grass strip and if such fields were badly damaged by grasshoppers, the strips of grass serve as ideal places in which the hoppers may lay their eggs. Comparatively few eggs are laid in clean corn, clean grain stubble or clean alfalfa, but if such fields are weedy with grasses, many egg pods may be laid among the roots and underground portions of the stems of these grasses (see frontispiece). Alfalfa plants in thin stands may attract the egg-laying grasshoppers, and in such cases the egg masses are usually placed among the stems near the crown of the plants. In alfalfa fields the grassy edges of bare spots surrounding ant hills are ideal places in which the hoppers may also lay eggs, and in such areas the egg pods may be as abundant as they are in the sod strips next to corn, grain, alfalfa or sweet clover.

Pasture land bordering corn, small grain, alfalfa, sweet clover or other succulent grasshopper food is attractive to the female grasshoppers for egg-laying purposes. However, most of the egg pods will be deposited within a strip 50 feet wide of the pasture land immediately bordering the corn, small grain, alfalfa or sweet clover. Beyond this area, some egg masses will be found in the pasture sod but they become scarcer the farther away from the succulent food we go. At a

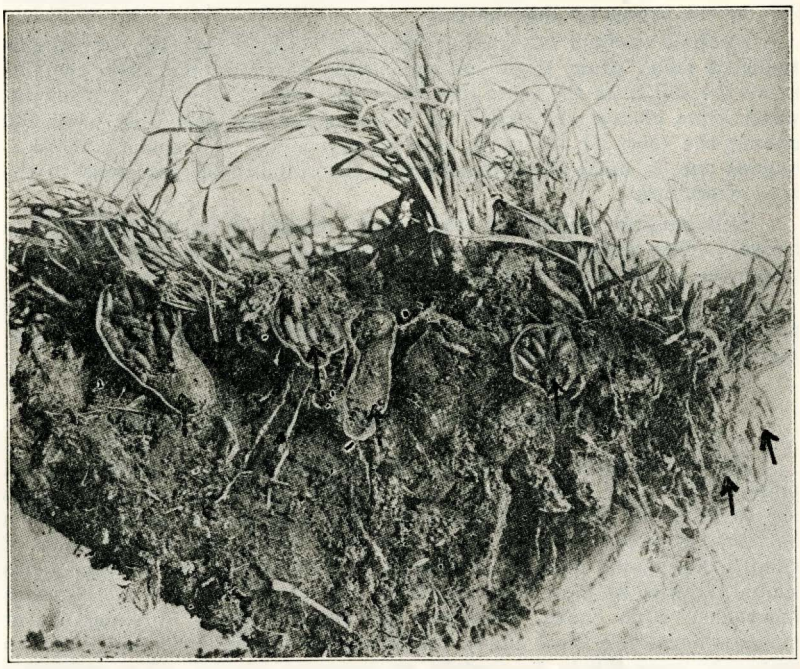

Fig. 8.—Clump of gama grass showing grasshopper egg pods among the stems and roots. (After Severin and Gilbertson.)

distance of 150 feet from the succulent food, the number of egg pods is negligible. Many succulent weeds found along roadsides, or in draws, may serve as food for large numbers of the two-striped and differential grasshoppers, but the eggs are laid in largest numbers in the favored grasses close by.

How to Find the Egg Masses

A sharp garden spade, trench spade or garden trowel may be used for digging when a person wishes to look over his farm for grasshopper eggs. Such areas as are likely to contain egg pods in large quantity should be examined first, and later, less likely areas should be gone over. When sod, clumps of grass or bare soil is dug up for examination purposes, it is not necessary to dig deeper than two inches beneath the surface, for the egg masses are all to be found within two

inches of the surface. The grass or sod should then be pulled apart and the soil should be carefully crumbled away from the stems and roots. If egg masses are present, the intact or broken-up pods or the eggs are readily exposed.

To locate the eggs or egg pods quickly, the sod or soil should be cut away with a sharp spade or trowel, care being exercised not to cut deeper than about an inch. It may be necessary to brush away the loose soil to expose the eggs or egg masses. Most of the egg masses will be cut across by this method.

Another method of finding the eggs quickly in corn or stubble fields of small grain is to pull up clumps of grass, and then crumble away the soil from the roots and lower portions of the stems. However, when grass clumps are pulled up, some of the egg pods that were laid among the roots of the grass may remain in the soil, and as a consequence one is liable to underestimate the number of egg pods in the area examined.

Still another method of finding egg masses is by scraping with a trowel. This method can scarcely be used in sod land, but in areas in which the plants are few in number, it is excellent.

To locate the egg masses that may be laid among the underground portions of stems of alfalfa plants, a combination of digging and scraping will give the best results.

HOW TO DESTROY GRASSHOPPER EGGS

Before attempting to destroy grasshopper eggs, a farmer should make a thorough investigation of his farm and learn where the eggs are to be found in largest quantity. Not only should an examination be made of weedy or grassy corn and cane fields, but stubble fields of small grain should also be investigated. Alfalfa and sweet clover fields should likewise be gone over carefully. The grassy borders of the fields mentioned, ditch banks, roadsides, and those portions of a pasture or meadow bordering these fields should receive careful attention, for such areas are very likely to contain an immense number of grasshopper egg pods.

Such areas as are infested with grasshopper eggs should be disked and harrowed in the fall after the first heavy frosts have killed off nearly all of the grasshoppers. If disking and harrowing is done before the grasshoppers have been killed off by cold weather, a large number of eggs may still be laid, which otherwise might have been destroyed by disking and harrowing.

Since the egg pods are to be found in the first two inches of surface soil, it will not be necessary to tear up the ground to a depth greater than two inches. The object of disking and harrowing is to bring the egg masses or eggs to the surface of the ground where they may be exposed to the drying action of the wind and sun, or to the attacks of numerous animal enemies, such as birds, rodents, insects and and their larvae, etc.

The effect of disking should be studied by the farmer. If a single disking and harrowing brings a large number of eggs and egg pods to the surface of the ground, further disking and harrowing should not be repeated until about 10 days have elapsed. If, however, a single

disking does not do the desired work, and this will probably be the case in sod, then a double disking followed by harrowing is necessary. After intervals of 10 days the disking and harrowing treatment should be repeated, until either the ground freezes or until no live or plump eggs or live egg masses are brought to the surface.

A field that is infested with grasshopper eggs should be disked not only lengthwise but later it should be disked crosswise as well.

Several Diskings are Necessary

In disking certain kinds of sod land that contains a large number of egg masses, the disks may cut out only narrow strips of sod over which they pass and leave between these strips, unbroken or undisturbed sod. This undisturbed sod will contain large numbers of egg pods, and, therefore, later diskings and draggings are necessary to cut out and break up this sod.

In the process of disking and dragging, many egg pods are brought to the surface, and many of these pods will be found to be uninjured. Others, on the other hand, will be found broken, usually crosswise, and in many instances the pods will have been worked so that the eggs will be found scattered over or through the soil. It is surprising to find that only a small number of eggs are either broken or crushed through disking or harrowing.

In hot dry weather the intact egg pods that were brought to the surface of the ground through disking and harrowing dry out within 48 hours. So dry do they become during this time that when one rubs them between the fingers they break up into a powder. The broken egg pods and the scattered eggs brought to the surface of the ground dry up even faster under these conditions.

In cloudy cool weather, a correspondingly longer period of time will be necessary to destroy the eggs.

Shallow plowing, and by this we mean plowing not deeper than 2½ inches, will do much towards destroying grasshopper eggs, provided this is followed by thorough disking and dragging. Here again, intervals of 10 days should elapse between successive diskings and draggings.

Deep plowing has for its purpose the burial of the eggs to such a depth where the young, when they hatch, will not be able to make their way through the soil to freedom. The degree of success which this treatment will give will depend upon the following conditions:

a. the depth to which the eggs are buried.
b. the character of the soil, whether sandy or otherwise.
c. the thoroughness with which the soil has been packed at the time of hatching of the grasshopper eggs.

Since corn land is not usually plowed, we recommend that such land, if infested with eggs, be thoroughly disked and harrowed late in the fall whenever possible. Grain stubble, if it is not disked and harrowed in the fall, should be deeply plowed in the fall and thoroughly disked and harrowed early in the following spring. In this connection it should be remembered that sandy soils are not as difficult for young hoppers

to work through as are heavier soils and, therefore, the same treatment of two different soils may give quite different results. Sandy soils should, therefore, be plowed as deeply as possible.

Sod land, even though deeply plowed, disked and dragged, is difficult to compact sufficiently to prevent many of the young hoppers from working through it when they hatch in the spring. Since rains and snows would aid materially in compacting such plowed, disked and harrowed sod, it would be advisable to work the sod land in the fall.

Available data on the efficiency of deep plowing for the control of grasshopper eggs have by no means disclosed its superiority over disking. In the case of sod land that is infested with grasshopper eggs, we are inclined to favor disking and dragging as heretofore discussed, instead of deep plowing followed by disking and harrowing. We do this, first, because we know that by exposing the eggs to the wind and sunshine the eggs are destroyed, and second, because compacting of plowed soil is to some extent dependent upon rains and snows, two uncertain but highly important factors.