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by

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(A PROGRESS REPORT)

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INTRODUCTION:

During the past 88 years of agricultural history in South Dakota, 38 have been years in which grasshoppers were present in above normal numbers. During 17 of these 38 years grasshoppers have been a serious pest of agricultural crops in South Dakota and neighboring states.* Many millions of dollars worth of cereal, forage and truck crops during each of these 17 years were destroyed by hungry hordes of the insects.

The impetus given soil conservation work and farm woodlot and shelterbelt plantings of trees in the past few years has brought about the realization that grasshoppers are far more than just a serious menace to growing vegetation. In areas where 'hoppers appear in outbreak numbers they are, through the destruction of growing plants, very definitely one of the major hazards of the soil itself.

Under dry conditions and a lack of vegetative cover the soil in restricted portions of South Dakota and other Great Plains states is subject to devastating erosion by wind. The dust storms of a few years ago, fences buried by drifting soil and eroded wastes where cultivation was attempted in once fertile prairies--all bear mute testimony to this statement.

Drought and improper treatment of the soil have been two of the important long-time factors in bringing about these conditions while grasshoppers have been one of the most important immediate factors.

Many fields, particularly of corn, have been completely denuded of vegetative cover as a result of grasshopper invasions. Small grain fields, especially if planted late in the spring or of a late maturing variety, occasionally have suffered a similar fate although usually not to the extent of complete removal of cover. In addition to the devouring of corn and small grain in certain areas, thus laying the fields bare to the winds, grasshoppers have hindered soil conservation efforts by the destruction of grass. Attempts to regrass badly blown areas in parts of the Great Plains have been repeatedly defeated by the ravages of grasshoppers which ate the grass shoots as fast as they came through the soil. Thus, grasshoppers, in certain areas, are recognized as one of the major problems of successful farming, soil conservation, and range and pasture management.

It has been known for some time that certain cultural methods help hold grasshoppers in check. This is accomplished in the following ways:

* The foregoing unpublished data was furnished the writer by G. I. Gilbertson, Entomologist, Extension Service, South Dakota State College, Brookings, S. Dak.

1. By exposure of eggs, in both broken and whole pods, to drying effects of sun and wind and to alternate freezing and thawing.

2. By making pods more subject to attacks by various biological enemies, including rodents and birds.

3. By mechanical destruction--actual breaking of eggs by machinery.

4. By discouraging egg-laying--fields tilled immediately after harvest, by subsurface tillage methods, plowing, etc., which contain no living vegetation and in which the soil is loose, are not nearly so acceptable from the standpoint of egg deposition as are untilled fields. "Stubbling in" a crop of small grain is a poor practice in grasshopper areas.

BRIEF STATEMENT OF TILLAGE RECOMMENDATIONS TO DATE:

For the past 10 years various tillage methods have been recommended to aid in the control of grasshoppers by the destruction of their eggs.

1. Plowing has been highly recommended with deep plowing (4 to 6 inches) apparently more effective than shallow plowing (2 to 2½ inches.)

2. The duck-foot cultivator has recently been acclaimed as the best shallow tillage implement for use in treating stubble fields.

3. Discing, both by means of the one-way disc (sometimes called the wheatland plow) and by regular method have been advised.

4. Harrowing, both spike and spring-tooth, have been recommended in certain instances, such as in alfalfa fields of several years standing.

It is generally conceded that certain types of tillage, completed late in the fall or early in the spring after the eggs have been laid and before they have hatched, will bring about a decrease in the number of grasshoppers produced on a given area. However, available data indicate that to date, no work has been done in evaluating different tillage methods on the basis of the actual numbers of young grasshoppers which emerge from the variously tilled areas.

The North Dakota Agricultural Experiment Station apparently has most nearly approached this as an ideal in studies of the effect of spring tillage methods on grasshopper populations. Their conclusions were based on a survey of the tilled areas and untreated check areas for numbers of young hoppers found per square foot after hatching had taken place.

It is significant to note that from the North Dakota studies this conclusion was drawn: "From the standpoint of spring tillage of land that is infested with grasshopper eggs it would appear that shallow tillage renders inadequate protection to the growing crops." Tillage practices have been employed against grasshopper eggs upon numerous occasions by individual farmers, but--with practically no knowledge of just what percentage of control might be expected of the various methods, nor at what season of the year the tillage was most effective.

PURPOSE OF THE STATION TILLAGE PROJECT:

The South Dakota Station project was undertaken in an attempt to evaluate various tillage methods from the standpoint of destruction of grasshopper eggs and the prevention of egg deposition. The author wishes to emphasize at the outset that the project was set up on a five year basis. Work was begun in the fall of 1939. This progress report, then, is not to be considered as a statement of final results of the experiment. The figures, consequently, are subject to change from year to year and probably will change with the compilation of additional data. In the case of each of the various tillage methods investigated, the figures given for percentage control should be considered as approximations backed by experimental evidence. The material is presented at this time in order to give farmers, soil conservation personnel and any other interested organizations or individuals a chance to use the information obtained thus far in the experiment.

Because of the hazards of grasshoppers to soil conservation, an attempt is being made to determine what practice is best to use from the following standpoints: grasshopper control, soil conservation, and moisture conservation.

ACKNOWLEDGMENTS:

To George I. Gilbertson, Extension Entomologist and H. C. Severin, Experiment Station Entomologist, go acknowledgments for aid in setting up the experiment and for valuable suggestions relative to methods of procedure.

For reasons previously stated the Soil Conservation Service is intensely interested in the problem. The author wishes to acknowledge the valuable cooperation given by the Soil Conservation Service without which the rapid and relatively inexpensive progress on this project could not have been made. In particular, he wishes to acknowledge the services of Dan E. Cass, Project Manager, Winner-Dixon S.C.S. Demonstrational Area; Elmer J. Lund, District Conservationist, Hecla S.C.S. District; Rex Bankert, Assistant Agronomist, Hecla S.C.S. District; Eugene Swift, Assistant Conservationist, and J. T. Paulson, Project Manager, Huron S.C.S. District and Demonstrational Area. Edgar C. Joy, Project Supervisor, Soil Conservation Service, Brookings, S. Dak., has given valuable assistance in each of the areas mentioned and to the project as a whole.

The Soil Conservation Service has assisted in the following ways:

1. Farmer cooperators were already signed up and in each instance where tillage methods were tested the farmers have entered into the work with splendid spirit.

2. Various tillage implements owned by the Soil Conservation Service were made available for use at whatever time they were needed. In such cases the farmer cooperator furnished the power for pulling the implements.

3. Supervision of tillage operations was given by the leaders of the several soil conservation areas.

In addition to these services the leaders, because of their knowledge of the grasshopper situation on their respective areas, were able to aid materially in the location of experimental plots.

PROCEDURE:

In the fall of 1939 a grasshopper egg survey was conducted in each area where tillage studies were later carried on in order to locate the most suitable place for experimentation.

Before an experiment could be set up several conditions were considered necessary:

1. To have the experimental plots on land where actual field tillage could be studied and to have the land be of uniform character (soil composition, contour, etc.) Small grain stubble fields were selected in most instances.

2. A uniform deposition of grasshopper eggs over the area used for study.

3. An average of at least one egg pod per square foot, a higher average number being more desirable because the results then could be considered more accurate.

When a suitable location was found the land was measured and staked in strips of various widths. The strips were then labelled for specific kinds of tillage. Check strips, where no tillage was done, were left at intervals.

The following spring, before any young grasshoppers had hatched, emergence cages were placed on the experimental plots. These cages were so constructed that each one covered exactly three square feet of soil. The cages were examined at regular intervals after the eggs began to hatch and the young grasshoppers were counted and removed.

At the end of the hatching season the percentage of emergence of young grasshoppers and the percentage control offered by the tillage methods were computed. The figures obtained for the check areas were considered to be 100 percent emergence, or no control. The natural enemies of grasshopper eggs, climatic factors, etc., were considered to be constant for each experiment. Any differences, then, were considered to be occasioned solely by the different tillage methods employed. This gave a direct comparison between the tillage practices themselves as methods of grasshopper egg destruction.

TILLAGE EXPERIMENTS IN THE WINNER AREA:

Two experimental areas were set up in the Winner-Dixon S.C.S. Demonstration Area. The soil type on the areas was Boyd silt loam, a heavy gumbo soil.

Area No.1 - L. T. Wilcox, operator; A barley stubble field, from which a crop was harvested in 1939, was chosen. Strips 200 feet in width were tilled as indicated below with certain strips left untilled for use as check plots. In the spring of 1940, prior to the hatching of any grasshopper eggs, the emergence cages were placed on the experimental plots. Emergence of young grasshoppers was subsequently recorded. The following percentages of control were indicated by this experiment.

	Approximate Control
For fall tillage (completed October 20 & 21, 1939)	
Moldboard plowing (Not recommended in central or western S. Dak.)	100%
Regular discing	90%
One-way discing (wheatland plow)	85%
Cut-away-disc discing	36%
For spring tillage (Completed April 8 & 9, 1940)	
Sub-surface cultivation (duckfoot type)	90%
Regular discing	83%
Regular listing	Below 10%

Area No.2 - L. T. Wilcox, operator: This experiment was set up within a patch of Western wheatgrass adjoining a barley stubble field. The Soil Conservation Service at Winner classified the cover as "Western wheat grass sod on blow soil accumulated over native sod." The land was what might be considered to be moderately sodded, that is, the grass was of such a density as to make it an ideal spot for grasshopper egg deposition. Egg pods were found to average 11.8 per square foot over the plots as a whole. Four tillage strips each 25 feet wide, and two check strips each six feet wide, were marked off and on October 21, 1939, the tillage was completed. Tillage methods and approximate percentages of control were as follows:

Fall Tillage:

Field Number	Treatment	Approximate Control
1	One-way discing (wheatland plow)	96%
2	Regular listing	100%
3	Double discing	100%
4	Moldboard plowing	95%

This experiment was undertaken with the full realization that except in possible special instances this type of treatment of native sod would not be recommended in an area subject to severe wind erosion. It was completed with the hope that in non-soil-blowing areas the information might prove to be useful from the standpoint of treatment of headlands and roadsides.

Comments on the Winner Experiments:

The author feels that recommendations for the use of one type of tillage over another are not necessary because the figures given for the two experiments would seem to indicate the relative merits of the tillage methods tested. With these figures the farmer may choose from his available implements the method he wishes to use. In making his choice he should not fail to consider the tillage method from the standpoint of producing a field which will not be subject to soil blowing. The method chosen should be in keeping with good soil and moisture conservation practices if possible. Fall tillage is recommended over spring tillage in the case of any of the methods tested thus far.

TILLAGE EXPERIMENTS IN THE HECLA AREA:

The soil in this area is of light sandy nature and in places it is similar to the Valentine (Nebraska) sand. Under certain conditions it is subject to severe wind erosion.

Area No. 1 - Anton Fangen, owner: The first experiment was set up in a wheat stubble field, six miles south of Hecla, S. Dak. The average egg pod deposition was found to be 3.6 pods per square foot. The field had been harvested by the use of a binder and was later shock threshed. The stubble was approximately 8 inches high. The tillage (one way disc [wheatland plow] treatment) was done on September 25, 1939, the date upon which the egg survey was made. The soil was tilled to a depth of 3 to 4 inches. In an examination of the soil immediately following the tillage treatment numerous egg pods were found to have been broken, the eggs scattered and turned to the surface. The entire field, about 20 rods wide, was tilled and planted to rye with the exception of a small area which was left as a check plot, one-half of which was left untreated and one-half tilled but not planted. Results were as follows:

Treatment	Approximate Control
One-way discing (wheatland plow) not planted	59.42%
One-way discing followed by drilling of rye in fall of 1939	67.53%

It is interesting to note that in this case the additional operation of drilling in rye following the tillage treatment increased the destruction of eggs by 8.11 percent; all other conditions were alike for the two plots.

Area No.2 - Lee Horseth, owner: The plots were situated in a field of idle land as of 1939. Vegetative cover on this field consisted principally of foxtail, sunflowers, smartweed, lamb's quarter, sweet clover and scattered wild lettuce. The tillage test strips were approximately 14 feet wide by 100 feet long and were separated by check strips four feet in width. An average of 4.66 egg pods per square foot was found on the plots. The tillage was done on December 5, 1939. Results were as follows:

Treatment	Approximate Control
Moldboard plowing, about 8 inches deep, walking plow	100%
Plowing with moldboard removed, about 8 inches deep, walking plow	No control
Tandem discing, double, 2 to 3 inches deep	50.11%

Comments on the Hecla Experiments:

It would seem apparent from this experiment that plowing light sandy soil, especially to a depth of 8 inches, with the moldboard removed from the plow, does not disturb the surface layer of soil sufficiently to damage grasshopper egg pods. It is the author's opinion that this type of tillage might prove more effective in an effort to discourage egg deposition, in certain areas, by loosening the soil somewhat and by killing fall vegetation. It should in such cases be done immediately following harvest. This would then be similar to subsurface tillage in its effect upon vegetation. Depending upon weather conditions, additional treatments, in order to keep the land free of living vegetation, may or may not be necessary.

Here again the relative merits of the tillage methods tested are shown by the percentage control figures. Farmers should consider soil-blowing hazards in their choice of implements. Fall plowing in this particular area is not recommended because of the hazard thus produced in such a light sandy soil.

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