GRASSHOPPER AND CRICKET REPELLENTS¹

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Much has been done to secure a bait with which to poison grasshoppers and crickets and as evidence of creditable results obtained, we have poison bran mash with various attractive agents enough to suit the conditions of most any locality as well as the fancy of any particular entomologist.

For several years there has been much trouble experienced by farmers in widely separated localities from grasshoppers and crickets cutting the bands of the sheaves while the grain is in the shock. In the case of grasshoppers this trouble could be prevented by poisoning the insects in question before the grain is cut but unless this procedure were practical for other reasons a more suitable remedy is to be desired. Since so much effort seems to have been necessary to secure a suitable attractive poison bait, it would naturally be expected that a suitable repellent could easily be found which might be applied to binder twine to prevent this damage. Since records on this subject are so rare and brief in Orthoptera literature, it seems desirable to include here all references which can be found.

Criddle. Report of Canadian Experimental Farms 1884-1904. Report of Entomologist, 1903. Page 174.

"Some damage was caused from locusts eating binder twine; very few had blue-stoned the twine, and we have now been able to demonstrate without a doubt that some brands of binder twine are much more subject to attack than others. Whether it is that certain brands are made of different materials or that they are looser than others, I cannot say; but the twine which was most attacked is very loosely twisted."

Howard. U. S. D. A., Div. Ent. Bul. No. 30, page 94.

"Insect injury to binding twine:- We have received several complaints of injury by crickets and grasshoppers to binding or binder twine, which we are informed is used for stacking small grain in the field, a remedy or preventive being desired. During May 1901, Mr. I. D. Sheaffer, Russell, Kansas, and Miss Annette Bowman, Moscow, Idaho, wrote in regard to such injury. These are only two of several complaints. In no cases have we received specimens of the insects, nor have we been able to suggest any substance that would kill the insects or deter them from attacking the twine that would not at the same time be dangerous to those handling it. Poisons, of course, could not be used, and sticky substances would also be objectionable, although of course, they would prevent injury by the insects." Gibson & Criddle. Canadian Department of Agriculture. Crop Protection Leaflet. No. 6. Page 3.

"Damage to Binder Twine In the Prairie Provinces considerable injury, some years, has been caused by locusts, as well as crickets, eating binder twine

when grain is standing in stocks. Some kinds of twine, as for instance thrt which is loosely twisted, has been more attractive to insects. We have used several mixtures to protect the twine from locust injury and the following has been found most useful.

Bluestone 1 pound
Water 6 gallons.

The balls of binder twine should be soaked in the solution for half an hour, and then dried thoroughly before using. The mixture, of course, is not intended to destroy locusts: it simply acts as a deterrent."

Washburn. Minn. Agric. Expt. Station. 1903. Press Bulletin No. 16, page 6.

"To prevent crickets and grasshoppers from eating binder twine in the fields: Soak balls of twine in a solution of 2 lbs. bluestone dissolved in 12 gallons of water, for half an hour and then dry it thoroughly. (H. Vane, in Canadian Report.)

It must be remembered that it is hard to dissolve bluestone; it should therefore be placed in the water quite a long time before the liquid is to be used.

A farmer here suggests soaking balls of twine in kerosene. This might be effective."

Being unable to locate the vague reference to Mr. H. Vane, the following explanation is offered through the courtesy of Mr. Criddle in a letter of recent date.

"The experiments conducted by Mr. H. Vane were undertaken with a view to protecting the binder twine from the ravages of locusts. Several substances were tested, including coal oil and salt, but the only one giving immunity was from soaking the balls of twine in a solution of Bluestone (Copper sulphate) and water.

I may say that the Bluestone solution was used by many of us and proved very satisfactory excepting for the fact that it had a tendency to weaken the twine. We found also, that it tended to clog in the binder but that it worked much better when thoroughly dried.

Mr. Vane is a farmer of these parts and has not published any information on the above subject."

During the past season, in order to obtain further information on this subject, a series of experiments was conducted in which one to two hundred sheaves were bound in the usual manner, with each of the several variously treated twines and exposed naturally in the field. A similar test was run in each of six widely separated localities from which trouble of this sort had been reported the previous season. Just before threshing, an examination was made for cut bands and not a single band was found cut in any locality, even of the untreated twine used as a check.

It was then decided to carry out some elimination experiments by some other method to determine if possible which of the ordinary repellents would probably be best for actual field application. The method of determining the relative value of the various repellents used was the same as described by Larrimer and Ford in a previous paper

on "Observation on the Attractiveness of Materials used in Grasshopper Baits." Small amounts of wheat bran were treated with the various repellents, these samples were exposed under natural conditions in the field, and the crickets and grasshoppers observed within six inches of the bran or feeding upon it, were recorded. In all cases the various samples were run in duplicate and interchanged frequently so that any variation of results might not be due to advantage of location. A pair of field glasses was used to make the counts since, by this method, accurate counts could be made with the observer stationed twenty or thirty feet from the bran samples and thus not disturb the crickets or hoppers which were being counted.

In choosing the following materials as fairly representative of the various groups of the common repellents, the availability and cost was of course an important consideration. Soap, gasoline, sulphur, aloes, creosote oil, furniture polish, nitrobenzine, nicotine sulphate, auto oil, kerosene and copper sulphate were each mixed with small samples of wheat bran and these exposed in the center of card board discs twelve inches in diameter and cross marked with black lines to facilitate counts. These discs were placed in a tract of uncultivated land grown up to weeds, uniformly but not heavily, infested by grasshoppers and crickets.

Melanoplus femur-rubrum was by far the predominating species of the grasshoppers present but some *M. atlantis*, *M. differentialis*, *Disosteira carolina*, *Encoptolophus sordidus*, *Scudderia furcata*, *Orchelimum vulgare*, and a species of *Conocephalus* were also taken. The species of crickets taken in the counts were *Gryllus assimilis pennsylvanicus* and *Nemobius fasciatus*. Wet bran was used as a check and since black strap molasses has been found to be one of the best attractive agents, samples of bran treated with the standard strength of this material were included as an additional basis of comparison.

The bran samples were moistened with the various materials mixed in the following strengths. The liquid repellents, black leaf 40 excepted, one part repellent to four parts water; powdered aloes or sulphur, one tablespoonful to one pint water; copper sulphate, a saturated solution in water; black leaf 40, one tablespoonful to one pint of water; soap, either Ivory or fish oil, as strong a solution as possible in cold tap water. It was not practical to run all of the materials at one time, but four series were run on the following inclusive dates Series 1, August 23 to 25; Series 2, August 31 to September 1; Series 3, September 21 to 22; Series 4, October 5 to 8.

In Series 1, fresh samples were used for August 23 and 24 and those

used on the 24th were left in position over night and used on the 25th. In series 2, 3, and 4, the original samples used on the first day of each series were left in position at night and run for the entire period. The total number of crickets and grasshoppers for each material and each series is indicated in Table 1.

Table I.

Series	Crickets				Grasshoppers			
	1	2	3	4	1	2	3	4
Soap		743	64	225		364	829	881
Black Strap	1667	286	12	118	593	243	232	503
Water	922	203	10	137	609	214	348	392
Gasoline	948				499			
Sulphur				145				347
Aloes		370	13			161	191	
Creosote Oil	1031				390			
Furniture Polish	780				427			
Nitrobenzine			6				133	
Nicotine Sulphate		175		66		155		161
Auto oil	573				347			
Kerosene	345	146	6	31	372	193	72	160
Copper Sulphate		68	3	10		157	32	70

The most remarkable feature of the whole experiment is not the discovery of a first rate repellent but the relative unconcern with which both crickets and grasshoppers ate the bran even when heavily treated with materials commonly regarded as repellents and especially the almost unbelievable fondness shown for soap. This is shown, not only by the record of counts made, but was especially noticeable while the experiment was in progress. In the case of Series 4, practically the entire sample of bran treated with soap was consumed by the end of the fourth day. This peculiarity of taste was noted as soon as soap was added to the series and subsequently extreme care was taken to make sure that it was the result of an actual liking for the soap and not due to a possible slip in technique. It might be stated that a later field test proved the value of soap not only as an attractive substance when used in the preparation of poison mash but by its use as an ingredient, the mechanical condition of the mash was improved considerably.

To determine the effect of soap on the hoppers when no poison was used, one lot was confined in a screen cylinder cage and fed green corn and bran treated with soap. A check lot was fed on green corn alone and the death rate in the check was more rapid than in the case of the soap fed lot. Another season it is intended to give this a thorough test and also determine if possible, just what ingredient of soap is so attractive.

As for repellents, the copper sulphate is easily the most promising, kerosene coming second. It was noted during the progress of the experiment that while some few hoppers and crickets were counted near or on the bait treated with copper sulphate, it was very rarely indeed that any feeding was done. This was also true to a less extent in the case of kerosene.

By a comparison of the counts and influenced somewhat by the behavior of the hoppers as otherwise noted during the progress of the experiment, the various materials can be listed in order of their repellent qualities, as follows, the most repellent being placed last: soap, black strap, water, gasoline, sulphur, aloes, creosote oil, furniture polish, nitrobenzine, nicotine sulphate, auto oil, kerosene and copper sulphate. Since the first three and the last two mentioned were run in three series together, it is interesting to note the total results as shown in Table II.

Table II

Series	Crickets					Grasshoppers				
	Soap	Black Strap	Water	Kerosene	Copper Sulphate	Soap	Black Strap	Water	Kerosene	Copper Sulphate
2	743	288	203	146	68	364	243	214	193	157
3	64	12	10	6	3	983	244	348	78	35
4	225	118	137	31	10	881	503	392	160	70
Total	1032	418	350	183	81	2228	990	954	431	262

MR. J. J. DAVIS: In connection with the attractiveness of soap to grasshoppers, it may be of interest to state that Mr. Leach, who has been working with insecticides for the control of the Japanese beetle, has found that soap added to arsenate seemingly has an attraction for that insect.

PRESIDENT WILMON NEWELL: The next paper is by T. J. Headlee.