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**NON-ARSENICAL STOMACH POISONS FOR
GRASSHOPPER CONTROL**

W. L. THOMPSON

Grasshoppers, as a rule, are not a serious pest of citrus trees over three or four years old. During the fall of 1931, they did severe damage in some orange groves in the central part of the State. Due to recent legislation prohibiting the use of arsenicals in citrus groves, except under special permission, it was necessary to make some tests of non-arsenical stomach poisons to control these pests.

The grasshopper doing the most damage was the "Bird Grasshopper", *Schistocerca americana*. It is one of our largest grasshoppers, long and slender, a powerful flier, and very active, especially on sunny days. It is evidently a sun-loving insect, as the trees were most severely damaged on the sunny side.

The grasshoppers used for the following experiments were collected from one of the infested groves. Wire screen cages, 12"x14"x18", were used in the dusting, spraying, and a few of the bait tests. The majority of bait tests were made in cages of the above size but having no bottoms. In each test, potted citrus plants were put into the cage, or the bottomless cages were placed over young citrus trees in the nursery. In almost every case the tests were started the day after the grasshoppers were collected.

Kalo, a material made up of 96 percent sodium silicofluoride, gave very good results when used in a bran mash. *Kalo* used at the rate of 3 pounds to 50 pounds of bran, 1 gallon of syrup and approximately 10 grapefruit, gave a 100 percent kill in two

to three days. A wire screen cage six feet square and six feet high was placed over a three year old orange tree and the above bait applied on the tree and ground. There were 80 grasshoppers used in this experiment. In three days, 79 of the grasshoppers were dead. The results of this experiment seemed to justify a field test.

In the field test, the following formula was used.

TEST 52—*Field Test.*

Kalo, 3 pounds, Bran, 50 pounds, 1 gallon syrup, grapefruit, 15, water enough to make a stiff mash. This material was applied to four acres of Temple oranges about eight years old. Approximately two large handfuls of bait was applied on and around the east and south sides of each tree, since the most damage was being done there. Most of the grass and weeds had been killed by cultivation. This bait was applied between six and seven o'clock in the evening.

Before application of the bait, an approximate average of thirteen grasshoppers would fly from each tree when the foliage was disturbed. After four and one-half days, observations were made to determine the effect of the bait. An approximate average of two grasshoppers per tree was observed, or about an eighty-four percent kill. Many trees had no grasshoppers on them, the number ranging from zero to five per tree. A few dead hoppers were found under the trees but due to the fact that so much dead grass was on the ground, it was difficult to find them.

The far side of the same grove, ten rows removed from the treated section, was used as a check. There was no decrease in the number of grasshoppers in this section of the grove during four and one-half days.

The above observations were made from one to two-thirty o'clock in the afternoon when the grasshoppers were very active.

Sodium fluoride, used at the rate of 1 pound to 20 pounds of bran and 2 quarts of syrup, gave a 100 percent kill in three to four days. The combination gave better results than using 2 pounds of sodium fluoride to 20 pounds of bran, since a kill of only 90 percent was obtained after six days. It is quite probable that 2 pounds of sodium fluoride per 20 pounds of bran is distasteful to the grasshoppers.

Sodium fluoride, mixed with oat-meal and syrup, gave only a 40 percent kill in six days. Sodium fluoride, as well as the Kalo, should be sifted through a fine screen before it is mixed with the bran as both of these materials are more or less lumpy.

Kalite, a dust containing 18 percent sodium silicofluoride, gave a kill of 100 percent in six days when the plants *and grasshoppers* were both dusted; but when only the plants were dusted, the kill was but 55 percent in six and one-half days and ninety-nine percent of the leaves were eaten off the plant. *Kalite* did not stick well on the citrus leaves, but when a mixture of 3 parts of *Kalite* to 1 part talc was applied, the adhesive qualities seemed to be improved. Two different tests were made where five grasshoppers were placed under a small wire screen and the *Kalite* dusted over them and on the boards where they had to crawl. No food was under these screens. After 48 hours all the grasshoppers were dead and in the checks none. Whether the grasshoppers died from the poison eaten when cleaning themselves or whether it passed into the body through other channels, was not determined.

Kaolith, made up of 94.26 percent sodium aluminum fluoride, applied as a spray, gave only a 20 percent kill in six days, and approximately ninety-nine percent of the leaves of the plant were eaten. The adhesive qualities of this material is very poor on citrus. By adding 1 percent of Penetrol, a sulfonated oil, a kill of 70 percent was obtained in five and one-half days and 80 percent in eight and one-half days.

Copper carbonate baits and sprays gave only fair results. Copper carbonate at the rate of 16 pounds per 200 gallons of water, 50 pounds of sugar and 10 gallons of syrup, gave only a 36 percent kill in seven days. When the amount of copper carbonate was raised to 25 pounds with the same amount of the above ingredients, a kill of 80 percent was obtained in five days and 100 percent in seven days. After six and one-half days, approximately fifty percent of the leaves of the plants had been eaten and on the checks, ninety-nine percent. Copper carbonate in a bran mash was tested in amounts from 2 pounds to 9 pounds to 50 pounds of bran with syrup and grapefruit. The syrup was increased from four quarts to six quarts to make the bait more attractive, but the kill was not increased. In one test, copper carbonate, used at the rate of 5 pounds to 20 pounds of bran and 2½ quarts of syrup, gave a 100 percent kill in five days.

A 5-5-50 Bordeaux mixture gave a 60 percent kill in five days and 80 percent in ten days. A combination of a 5-5-50 Bordeaux mixture and arsenate of lead at the rate of 4 pounds to 100 gallons of water gave only a 64 percent kill in seven days.

Neither bichloride of mercury nor strychnine gave any results as a poison for grasshoppers.

ARTIFICIAL CONTROL OF GRASSHOPPERS (SCHISTOCERCA AMERICANA)

Test No.	Applications	No. Specimens	% Dead	Days	% Dead	Days	% Dead	Days	% Dead	Days
Dusts										
1.	Kalite—Plants and grasshoppers dusted.	20	80	2½	84	3½	84.6	4½	100	6½
2.	Kalite—Plants and grasshoppers dusted.	15	86	2½	86.6	3½	86.6	5½	100	6
3.	Kalite—Plants and grasshoppers dusted.	20	60	2½	80	3½	100	4½	55	6½
4.	Kalite—Plants dusted only.	20	5	2½	20	3½	40	4½	90	6½
5.	Kalite 3 parts, Talc 1 part—Plants and grasshoppers dusted.	19	84.6	2½	84.6	3½	90	4½	60	6½
6.	Kalite 3 parts, Talc 1 part—Plants and grasshoppers dusted.	20	85	2½	95	3½	100	5½	35	6½
7.	Check for tests 1, 2 and 5.	20	5	2½	5	3½	10	4½	60	6½
8.	Check for tests 3, 4 and 6.	20	5	2½	25	4½	25	4½	35	6½
Sprays										
9.	Kaolith—4 lbs. per 100 gallons.	20	10	2	20	4	20	5½	20	6
10.	Kaolith—4 lbs. per 100 gallons plus Penetrol 4%.	20	60	2½	65	3½	70	5½	80	8½
11.	Arsenate of Lead—2 lbs. per 100 gal.	20	10	2½	30	4½	65	5½	85	10
12.*	Arsenate of Lead—2 lbs. per 100 gal.	80	13.7	2½	22.5	4½	27.5	5½	37.5	12
13.	Arsenate of Lead—2 lbs. per 100 gal. plus Bordeaux 5-5-50.	25	16	2	60	4½	52	5	64	7
14.	Bordeaux Mixture 5-5-50.	20	15	2½	1	4½	60.5	5½	80	10
15.	Copper Carbonate 16 lbs., Sugar 50 lbs., Syrup 10 gal., Water 200 gal.	25	4	2½	1	5	24	5	36	7
16.	Copper Carbonate 25 lbs., Sugar 50 lbs., Syrup 10 gal., Water 200 gal.	25	36	2½	5	5	80	5	100	7
17.	Check for test 9.	20	5	2½	5	3½	10	4½	60	6½
18.	Check for test 10, 11, 12, and 14.	20	5	2½	25	4½	35	6½	85	10
19.	Check for test 13, 15, and 16.	25	0	2	4	3½	8	4½	32	7
Baits										
20.	Sodium fluoride 2 lbs., Oatmeal 20 lbs., Lemons 4.	20	5	2	5	3	10	4	40	6
21.	Sodium fluoride 2 lbs., Bran 20 lbs., Syrup 2 qts., Lemons 4.	20	35	2½	85	3½	85	4½	90	6½
22.	Sodium fluoride 1 lb., Bran 20 lbs., Syrup 2 qts., Grapefruit 5.	20	85	2½	95	3½	100	4½	90	6½
23.	Sodium fluoride 2 lbs., Bran 50 lbs., Syrup 1 gal., Grapefruit 15.	25	92	2	100	3	100	3	100	6½
24.	Paris Green 1 lb., Bran 20 lbs., Syrup 2 qts., Lemons 4.	15	80.9	2	95	3	100	4	100	6½
25.	Kalite 1 part, Bran 9 parts, Syrup 2 qts., Lemons 4.	20	0	2½	0	3½	10	4½	25	6½

* Screen cage, 6 ft. x 6 ft. x 6 ft. over three year old tree.

ARTIFICIAL CONTROL OF GRASSHOPPERS (SCHISTOCERCA AMERICANA)—Continued

Test No.	Applications	No. Specimens	% Dead	Days	% Dead	Days	% Dead	Days	% Dead	Days
Baits (Continued)										
26.	Kalo 2 lbs., Bran 50 lbs., Syrup 1 gal., Grapefruit 10.	25	96	2	100	3				
27.	Kalo 3 lbs., Bran 50 lbs., Syrup 1 gal., Grapefruit 10.	25	100	2						
28.	Kalo 4 lbs., Bran 50 lbs., Syrup 1 gal., Grapefruit 10.	25	96	2	96	3	100	4		
29.	Kalo 3 lbs., Bran 50 lbs., Syrup 1 gal., Grapefruit 10.	25	100	2½						
30.	Kalo 3 lbs., Bran 50 lbs., Syrup 1 gal., Grapefruit 15.	25	96	2	100	3				
31.	Kalo 3 lbs., Bran 50 lbs., Syrup 1 gal., Grapefruit 15.	80	25	1	50	2	97.5	3		
32.	Strychnine 10 gr., Bran 20 lbs., Syrup 2½ qts., Lemons 4.	25	0	1½	8	4½	12	5½		
33.	Bichloride of Mercury 1-200, Bran 20 lbs., Syrup 2½ qts., Lemons 4.	25	4	2	8	5	24	7		
34.	Copper Carbonate 5 lbs., Bran 20 lbs., Syrup 2½ qts., Lemons 4.	25	80	3	100	5				
35.	Copper Carbonate 3 lbs., Bran 50 lbs., Syrup 4 qts., Lemons 10.	25	20	1½	68	3½	72	4½	76	5½
36.	Copper Carbonate 4 lbs., Bran 50 lbs., Syrup 4 qts., Lemons 10.	25	24	1½	52	3½	76	4½	96	5½
37.	Copper Carbonate 5 lbs., Bran 50 lbs., Syrup 4 qts., Lemons 10.	25	20	1½	64	3½	80	4½	88	5½
38.	Copper Carbonate 6 lbs., Bran 50 lbs., Syrup 5½ lbs., Lemons 10.	15	46.6	2	53.3	3	73.3	4	86.6	6
39.	Copper Carbonate 7 lbs., Bran 50 lbs., Syrup 5½ qts., Lemons 10.	15	53.3	2	66.6	3	66.6	4	86.6	6
40.	Copper Carbonate 8 lbs., Bran 50 lbs., Syrup 5½ qts., Lemons 10.	15	53.3	2	86.7	3	86.6	4	93.3	6
41.	Copper Carbonate 9 lbs., Bran 50 lbs., Syrup 5½ qts., Lemons 10.	15	33.3	2	60.6	3	86.6	4	86.6	6
42.	Copper Carbonate 6 lbs., Bran 50 lbs., Syrup 6 qts., Grapefruit 15.	15	33.33	2	53.33	3	80	4	86.6	7
43.	Copper Carbonate 7 lbs., Bran 50 lbs., Syrup 6 qts., Grapefruit 15.	15	46.66	2	66.66	3	80	4	80	7
44.	Copper Carbonate 8 lbs., Bran 50 lbs., Syrup 6 qts., Grapefruit 15.	15	40	2	66.66	3	66.66	4	93.33	7
45.	Checks for tests 42, 43, and 44.	15	6.66	2	13.33	3	20	4	26.66	7
46.	Checks for tests 20, 21, 24, and 25.	20	5	2½	5	3½	10	4½	60	6½
47.	Checks for test 22.	20	5	2½	25	4½	35	6½	85	10
48.	Checks for tests 23, 26, 27, and 28.	25	0	2	4	3				
49.	Checks for tests 29, 33, and 34.	25	0	2½	4	3½	8	4½	32	7
50.	Checks for tests 30, 31, 32, 35, 36, and 37.	25	0	2½	4	3½	8	4½	12	5½
51.	Checks for tests 38, 39, 40, and 41.	30	3.3	2	9	3	15.1	4	24.2	6

INGREDIENTS OF MATERIALS USED

Kalite	{	Sodium silicofluoride.....	18.0%
		Sulfur.....	19.0%
Kaolith	{	Inert ingredients.....	62.0%
		Sodium aluminum fluoride.....	94.26%
Kalo	{	Inert ingredients.....	5.24%
		Sodium silicofluoride.....	96.0%
		Inert ingredients.....	4.0%
		Sodium fluoride—active ingredients.....	90-95%
		Arsenate of lead—active ingredients.....	98%
		Copper—active ingredients—Metallic copper.....	18%

OBSERVATIONS OF TREATED PLANTS EXPOSED TO GRASSHOPPERS

	Leaves eaten			
Kalite $\frac{3}{4}$, Talc $\frac{1}{4}$, dusted on plants and grasshoppers	5%	after	6 $\frac{1}{2}$	days
Kalite dusted on plants and grasshoppers.....	1%	"	6 $\frac{1}{2}$	"
Kalite dusted on plants only.....	99%	"	6 $\frac{1}{2}$	"
Kaolith, sprayed on plants only.....	99%	"	6 $\frac{1}{2}$	"
Lead arsenate, 2 lbs.....	90%	"	6 $\frac{1}{2}$	"
Check.....	99%	"	6 $\frac{1}{2}$	"
Strychnine Bran Bait.....	99%	"	6 $\frac{1}{2}$	"
Kalo Bran Bait.....	1%	"	6 $\frac{1}{2}$	"
Sodium fluoride bran bait.....	1%	"	6 $\frac{1}{2}$	"
Copper carbonate spray.....	50%	"	6 $\frac{1}{2}$	"

Out of 200 grasshoppers that were not exposed to poison, only six parasites were observed. The parasites were tachinid flies.

Sodium fluoride and Kalo gave the best results and were the most economical. Both of these materials compare with the kill obtained by using Paris green bran bait in like amounts. No burning of foliage was observed when sodium fluoride or Kalo were used in the bran bait, which was thrown on the plants. Copper carbonate gave only fair results, unless used in rather large amounts.

The table on page 9 gives in detail the results of the various experiments.

DR. HERBERT OSBORN ADDRESSES ENTOMOLOGICAL SOCIETY

On April 2 the members of the Florida Entomological Society and visitors were treated to an illustrated lecture on the "History of Entomology in the U. S. and Canada." Dr. Osborn showed lantern slides of most of the early entomologists and spoke briefly of the work of each.

The speaker was introduced by Dr. P. H. Rolfs who has recently returned from Brazil. Three other former students of Dr. Osborn were present, Drs. E. W. Berger, Wilmon Newell, and A. N. Tissot.