T H E S I S

GRASSHOPPER BAIT EXPERIMENTS WITH AN ANALYSIS OF THE DATA BY THE VARIANCE METHOD

Submitted by

Frank T. Cowan

In partial fulfillment of the requirements
for the Degree of Master of Science

Colorado Agricultural College
Fort Collins, Colorado

April 30, 1932

COLORADO AGRICULTURAL COLLEGE

- - -

GRADUATE WORK

April 30 1932

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Frank T. Cowan ENTITLED GRASSHOPPER BAIT EXPERIMENTS WITH AN ANALYSIS OF THE DATA BY THE VARIANCE METHOD BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE MAJOR SUBJECT ENTOMOLOGY

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Grasshopper Bait Experiments with an Analysis of the Data by the Variance Method.

INTRODUCTION

The work reported in this paper was undertaken to determine the most efficient grasshopper bait for Colorado. In making this determination the cost of the bait was to be considered, as well as the percentage of kill obtained under actual field conditions.

HISTORICAL REVIEW

Grasshoppers have been a menace to the agricultural world since biblical times. Perhaps no other insect has caused such universal crop damage over such a long period of time, as have grasshoppers. The literature on these insects is enormous and the writers thereof almost innumerable. Grasshoppers have always been, and probably always will be, among the most important insect pests that man will have to combat.

Colorado has had her share of grasshopper troubles in her relatively brief span of years. However, the literature on these outbreaks is not all available. The following information was found in letter files dating from 1900 to 1910. It shows that outbreaks occurred from 1900 to 1903 in the Arkansas and Platte Valleys. This outbreak apparently reached the peak in 1902. Again from 1908 to 1912 grasshoppers were in outbreak numbers in the same localities. This outbreak also extended over much of northern Colorado. It reached the peak in 1910 and gradually subsided to 1912. Jones (6) recorded a partial outbreak in 1913 and 1914, which probably reached its peak in 1915. Again Jones (7) reported outbreaks in the San Luis Valley, Las Animas, El Paso and Logan counties in 1916,'17 and'18. Outbreaks were also recorded by Jones in Mesa, Montrose, Garfield and Delta counties in 1918. Corkins (1) recorded an outbreak of Disosteira longepennis Thos. in Pueblo, Fremont and El Paso counties in 1921. Again in 1922 and '23 Corkins (2&3) recorded a severe outbreak in the Fort Morgan section. The outbreak, which reached its peak in 1931, began building up about 1928 over practically all of eastern Colorado. Last year it was necessary to fight the pests in practically every county east of the mountains in order to avoid total or partial destruction of crops. More than 40,000 sacks of bran, 34,000 quarts of sodium arsenite, as well as some crude arsenic and Paris green were used. More than $55,000 was spent to finance the campaign in Colorado. Some damage was done to crops in spite of all the control work, altho on the whole, this damage was small compared to what it probably would have been had no control been carried out. In scope of territory included the infestation of 1931 is probably the worst outbreak in this state since 1900. For the most part the important outbreaks have occurred on the eastern slope with only one or two of major importance on the western slope. No attempt has been made to estimate the amount of damage done by these outbreaks but the cost to the farmers in crops lost and funds spent in combating the hopper has been enormous. In a campaign such as was waged during 1931, where thousands of dollars were involved, it is felt that a saving of a few cents on the formula by cutting out one or more ingredients, is certainly worth while. Also any increased kill resulting from a more efficient bait is likely to save thousands of dollars in crops.

The present "Standard Bait" has been developed over a long period of years. Many workers, not all of them entomologists, have had a hand in this development. According to Langford (8) C. V. Riley tells of using flour and Paris green as early as 1877. Luggar of Minnesota is credited with being the first man to use bran, arsenic and molasses as a combination, in 1895. Norman Criddle, then a farmer in Manitoba, first used horse manure and Paris green in 1903. This mixture has since been known as "Criddle Mixture" and its use has been wide spread. F. C. Milliken of Kansas developed the use of oranges and lemons in grasshopper bait in 1913-14, while Parker and Seamans of Montana developed amyl acetate to replace the citrus fruits in 1920. Molasses has apparently been in good usage for a long while altho the controversy between beet and cane molasses has come to the front in more recent years. Its value in the mixture is probably due to its odor and sweetness. It was also used in years past to stick the arsenic to the bran. Corkins (4) in his work in Colorado in 1923 found that one quart of sodium arsenite to the 100 pounds of bran was a very good substitute for the 5 pounds of crude arsenic or Paris green, which had previously been used. For the most part each state has its own grasshopper mixture and few of them coincide in every respect, but the "Standard Bait", as given below, has been accepted as such by most workers.

Standard Bait for Grasshopper Control

Bran (free from shorts)...........	100 pounds
Crude arsenic or Paris green......	5 pounds
or	
Sodium arsenite (8# material).....	1 quart
Molasses (beet or cane)...........	2 gallons
Amyl acetate......................	3 ounces
Salt..............................	5 pounds
Water(depending on coarseness of bran.........................	10-15 gallon

From results of work which was started about 1924 by Stewart Lockwood and R. L. Shotwell, of the U. S. Bureau of Entomology, and J. R. Parker of the Montana Experiment Station*, it was felt that the Standard Bait contained at least two ingredients, the salt and amyl acetate, that might possibly be omitted. It was proven more or less definitely, that salt is not an attrahent when the bait

* Unpublished notes.

is used on alkali soil by Parker of Montana, and also by Criddle of Canada. Whether this was true for Colorado conditions was not known prior to this year. There has always been some controversy between beet and cane molasses as an attractor in baits and from the work done by Lockwood it appeared that cane molasses was the better of the two. Again, however, Lockwood did his work in Montana under admittedly different conditions than exist in Colorado. There has also been some doubt as to the efficiency of the amyl acetate as an attractor, in baits under existing conditions here. Amyl acetate is very volatile and it is doubtful if the low concentration of the liquid as used in grasshopper baits would have any attrative qualities for the insects after being exposed for a short time to the hot, dry atmosphere existing in the state during most of a grasshopper season.

Then, too, Parker and Lockwood both used what is commonly called the "Pan Bait" method in testing these materials. In this method the fresh baits were placed on shallow pans or boards and set in a row upon the ground. These baits were changed every half hour to assure their attractiveness and counts were made every 10 minutes of the grasshoppers coming to those baits to feed. There are many chances for error in this method of experimentation and actual poisoning under field conditions is not simulated.

MATERIALS

For the above reasons it was decided to test a series of baits under an improved plot method and under Colorado conditions.

The following baits were used in these experiments and will be referred to later in this paper by the numbers designated below.

Bait No. 1	Bran arsenic water or Basic Formula.				
" " 2	Basic formula plus cane molasses.				
" " 3	"	"	"	beet	"
" " 4	"	"	"	cane molasses and amyl acetate.	
" " 5	"	"	"	beet molasses and amyl acetate.	
" " 6	"	"	"	salt.	
" " 7	"	"	"	cane molasses, amyl acetate & salt.	
" " 8	"	"	"	beet molasses, amyl acetate & salt.	
" " 9	Purina sweet roughage plus arsenic, amyl acetate and water.				
" " 10	Basic Formula plus salt and amyl acetate.				
" " 11	Dried beet pulp plus amyl acetate, salt, arsenic and water.				
" " 12	"Delicious Hopper" Bait. Product of the Raven Honey Dew Mills, Omaha, Nebraska. Formula unknown.				

It will be noted from the above list of baits that each so-called attractor has been taken separately and in combination with each other except amyl acetate. This one was not used alone in any bait. By comparing the efficiency of each bait with Bait No. 1, or the basic formula, it can readily be shown whether or not any of the attractors are of enough value to warrant the added expense of using them in the bait which will finally be recommended for Colorado. Then, too, it is possible to compare each bait with every other bait on the list and thereby determine which one might be expected to yield the best results. It will also be noted that Baits 7 and 8 are what have been termed above as "Standard Formulae" that is, they contain all the ingredients in combination which are used separately or in combination with each other in the other baits. All baits except Nos. 9, 11 and 12 were mixed according to the following formula.

Bran.....................	100 pounds
Sodium arsenite...........	1 quart
Molasses (when used)......	2 gallon
Salt (when used)..........	5 pounds
Amyl acetate (when used)..	3 ounces
Water.....................	14 gallons

In all baits having bran as a carrier for the poison a coarse material entirely free from shorts and middlings was used. This type of bran absorbs a large amount of water, scatters well when broadcast, and thereby is not dangerous to livestock and birds.

The sodium arsenite or poison ingredient, is a liquid containing 8 pounds of arsenic to the gallon. It mixes readily with water and stays in solution. Both the cane and beet molasses were of the cheap grade commonly sold for stock feed.

The following analysis was supplied by the chemist of the Great Western Sugar Company factory at Fort Collins.

	Beet %	Cane %
Moisture....................	23.45	28.47
Dry substance...............	76.55	71.53
True sugar..................	42.54	29.98
Raffinose...................	3.85	----
Ash on original.............	13.25	12.64
Invert sugar................	.38	20.28
Apparent sugar..............	52.	50.

Common table salt was used in all baits containing that ingredient. The amyl acetate contained in the formula was a technical grade.

Bait No. 9 was included in the list on recommendation of the Purina Mills of Denver. Large quantities of this product have been sold for grasshopper bait in the past in Colorado and other states, and it was thought advisable to include it in the list of baits to be tested. It contained, according to the analysis tag, cottonseed meal, wheat bran, ground grain screenings, molasses and 2% iodized salt. The material is very finely ground and for this reason it is hard to mix and scatter, having a tendency to "ball up" and fall in lumps when spread in the field. Materials which do not spread or "flake out" well in scattering are dangerous to livestock and for this reason alone the material cannot be highly recommended for grasshopper baits.

Bait No. 11 contained dried beet pulp as a carrier for the poison. This material was included in the list of baits because it has been highly recommended this past year as a substitute for bran. In price dried beet pulp compares rather favorably with bran since it is more bulky and can be spread over a relatively larger acreage. It is capable of absorbing almost twice as much water as coarse bran, an important item in dryland poisoning, altho it is a little harder to mix since the water is not taken up so readily. In spreading value it compares favorably with coarse bran since there is no tendency toward "balling up" and each particle falls separately when broadcast. There should be absolutely no danger to livestock with this material, altho it appears that birds might possibly pick up more of it since it is made up of larger particles than the bran. However, there is no data to substantiate this statement.

Bait No. 12 consisted of a commercial bait manufactured by the Raven Honey Dew Mills of Omaha, Nebraska. It is supposed to contain all ingredients necessary for successful hopper poisoning except the water. No formula was furnished by the makers of this bait.

METHODS

The method used in gathering ~~this~~ these data has been in use for a number of years by workers in the Bureau of

Entomology, especially Larrimer and Shotwell*, and else-

* Unpublished notes.

where. It is, however, particularly well adapted to the comparison of grasshopper baits under actual field conditions.

Description of plots. - In this particular set of experiments square 1/4 acre plots were used. These plots were laid out with stakes, usually on the day preceding the placing of the baits. Where possible alfalfa land having a succulent growth of vegetation and an abundance of hoppers, was chosen. The plots were staked out in straight rows with an alley 10 feet wide on each side of the plots. These alleys were left as a barrier to help prevent migration from one plot to another and were not poisoned.

Method of scattering the baits. - On the morning of the first day of the experiment the baits, which were to be tested, were taken to the plots and scattered in the approved manner of broadcasting grasshopper baits. This usually took place between the hours of 6:10 a.m. and 7:30 a.m. with special emphasis placed on getting the baits out at an air temperature of 65 degrees F., the minimum temperature at which grasshoppers feed. The hoppers were allowed to feed on the baits until about 3:00 o'clock in the afternoon of the same day, when a quantity of them were swept into cages and brought into the college for observation. By making the sweepings at the time of day above mentioned ample time was allowed the hoppers to feed on the baits, but not enough time had elapsed so that the ones eating the bait had become logy from the effects of the poison.

Method of gathering the hoppers. - It is felt here that some space should be devoted to the methods employed in making the sweepings. An ordinary insect sweeping net, containing a paste-board cylinder, having a capacity of approximately 3 pints, with a screen bottom and lid, was used in gathering the hoppers. The paste-board cages were placed inside the net with the lid removed and held in place with a rubber band. As soon as enough grasshoppers had been gathered the lid was replaced and the entire cage removed from the net. Each carton bore a number corresponding to the number of the plot from which the hoppers were taken. By using this paste-board cage it was not necessary to handle the hoppers individually and much of the mechanical injury, which otherwise would have occurred, was avoided.

All sweepings were made near the center of the plots and the chances of gathering hoppers which might have migrated in from other plots was lessened. No particular number of hoppers was captured from any plot altho it was the aim to capture at least a hundred. The number varied however, with the degree of infestation from 36 to as high as 317, but, since the kill obtained was computed on a percentage basis the total number caged did not matter.

Immediately after the sweepings from all plots had been completed the cartons,containing the hoppers, were brought in to the college where they were dumped into large screen cages for observation. These large cages consisted of a 1x2 framework of yellow pine lumber on which was fastened ordinary 12 mesh wire window screening. They were 2x2x2 feet in size, having an open bottom and a top of wire screen, half of which was hinged to form a door or lid, so that entrance could be gained into the cage. The bottom of the cage was formed of a 2 inch layer of fine sand. The hoppers were fed daily on fresh alfalfa. In all 26 of these cages were used. They were supplied by the State Entomologist's Office.

Tabulation of notes. - On the first day, that is, approximately 24 hours after the hoppers had been brought in, each cage was examined and the dead hoppers removed. The number removed was recorded on a card especially made up for the purpose. This process was repeated each day for four days. On the fourth day following the time the sweepings were made, all hoppers left alive in the cage were also removed and their number recorded. The total number caged was then computed by adding the total number of dead hoppers to the total left alive at the end of the experiment. From this number and the total number dead the percentage of kill was computed.

Interpretation of notes. - In order to determine the number of hoppers dying from unavoidable mechanical injury from the poisoned plots a check cage of unpoisoned hoppers was run with each series. The percent which died in the check was taken of the total number caged of each plot because it was felt that this number probably would have died had they not been allowed to eat the poison bait. The number which was obtained by taking the percentage dead in the check of the total caged from each plot was subtracted from the total dead from that particular plot and the percentage of kill computed by dividing the corrected number of dead in the cage by the total caged.

This might best be explained by taking Series No. 1 as an example from the daily notes. It will be noted that the bait used in Series No. 1 was scattered on August 11, 1931, between the hours of 6:10 and 7:00 a.m. The temperature range for the time the bait was being scattered was 58 degrees F. to 67 degrees F. Sweepings were made from these plots about 3:00 p.m. of the same day. The first counts of dead hoppers were made during the afternoon of August 12. Take for example Bait No. 1. On the first day, or August 12, there were 7 dead hoppers taken from the cage. On the second day, or August 13, 57 hoppers were removed. On the third day 10 and on the fourth day 6, or a total for the test of 80. Also, on the fourth day it was found that there were still 31 hoppers left alive. Adding this number to the total dead, or 80, it is found that the total caged was 111. However, during this same test there were 141 hoppers caged in the check and 20 or 14.8% of these died. It was therefore assumed that equally as large a percentage died in cage No. 1 from unavoidable mechanical injury and it seemed reasonable to believe then that this 14.8% should be taken into account in computing the final percentage of kill. Therefore, 14.8% of 111 is 16 and 80 minus 16 gives 64 or the total in cage No. 1 that actually died from the poison. The percentage of kill is then computed by dividing 64, the corrected number dead in the cage, by 111, the total caged, and it is found that the actual percentage of kill from the poison bait in Bait No. 1, Series No. 1, was 57.6%.

DAILY RECORDS

Below is given in tabulated form the results of the experiments as recorded on the daily record sheets.

Table 1.

Series 1.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	7	57	10	6	80	16	31	64	111	57.6
2	50	67	7	1	125	21	17	104	142	73.2
3	29	56	10	1	96	19	34	77	130	59.2
4	19	42	5	1	67	12	14	55	81	67.9
5	19	43	4	2	68	12	12	56	80	70.
6	9	15	2	2	28	8	24	20	52	38.4
7	29	12	2	0	43	8	11	35	54	64.8
8	33	44	6	3	86	16	24	70	110	63.6
9	8	24	8	2	42	14	52	28	94	29.7
10	19	37	5	0	61	15	41	46	102	45.
11	17	36	13	2	68	13	22	55	90	51.1
12	22	40	5	1	68	14	25	56	93	60.2
Chck	1	5	7	8	21		120		141	14.8

Aug. 11, 1931. Time 6:10 - 7:00. Temp. 58 - 67.
Sunny, warmed up fast.
West Ft. Collins Oil Field on Evans Place.
Hoppers plentiful. *Femur rubrum* and several species not of economic importance.

Table 1 continuted

Series 2.

Bait	Number Dead: 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	16	62	5	1	84	12	44	72	128	56.2
2	22	47	2	0	71	9	23	62	94	65.9
3	18	52	6	3	79	11	40	68	119	57.1
4	11	63	5	0	79	9	20	70	99	70.7
5	24	135	7	1	167	17	18	150	185	81.
6	10	49	13	2	74	12	59	62	133	46.6
7	13	67	10	2	92	11	24	81	116	69.8
8	16	33	14	5	68	12	65	56	133	42.1
9	6	35	5	5	51	11	64	40	115	34.7
10	8	32	10	6	56	9	42	47	98	47.9
11	9	60	13	2	84	12	43	72	127	56.6
12	12	32	9	5	58	8	31	50	89	56.1
Chck	0	3	4	3	10	97		107		9.3

Data same as Series 1.

Table 1 continued.

Series 3.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	12	29	11	4	56	13	50	43	106	40.5
2	14	40	3	3	60	11	29	49	89	55.
3	18	73	11	3	105	19	50	86	155	55.4
4	5	40	4	2	51	9	19	42	70	60.
5	14	36	2	3	55	9	17	46	72	63.8
6	6	22	5	3	36	7	20	29	56	51.7
7	6	36	1	4	47	7	6	40	53	75.4
8	46	41	7	1	95	13	8	82	103	79.6
9	21	21	3	1	46	12	47	34	93	36.5
10	14	70	5	4	93	15	31	78	124	62.9
11	6	26	3	5	40	12	54	28	94	29.7
12	11	46	7	3	67	12	28	55	95	57.8
Chck	1	3	5	8	17		120		137	12.4

Aug. 25, 1931. Ti e 6:45 - 7:45 a.m. Temp. 64 - 72.
Bright, warmed up quickly.
Place same as No. 2

Table 1 continued.

Series 4.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	14	34	4	3	55	2	36	53	91	58.2
2	13	48	8	6	75	2	19	73	94	77.6
3	19	63	16	3	101	2	29	99	130	76.1
4	19	40	8	1	68	2	41	66	109	60.5
5	34	50	8	5	97	3	36	94	133	70.6
6	22	40	5	1	68	2	47	66	115	57.3
7	17	42	5	6	70	2	40	68	110	61.8
8	24	48	6	4	82	2	23	80	105	76.1
9	12	32	6	6	56	2	45	54	101	53.4
10	28	43	7	7	85	3	50	82	135	60.8
11	9	57	13	7	86	3	61	83	147	56.4
12	23	77	11	14	125	4	69	121	194	62.3
Chck	0	1	0	1	2		103		105	1.9

Data same as No. 3

Table 1 continued.

Series 5.

Bait	1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	5	34	74	7	120	51	43	69	163	42.3
2	9	46	100	5	160	58	25	102	185	55.1
3	14	83	114	22	233	85	41	148	274	54.
4	19	59	77	11	166	62	32	104	198	52.2
5	11	37	58	9	115	44	28	71	143	49.6
6	7	39	71	4	121	42	15	79	136	58.
7	4	28	63	6	101	36	14	65	115	56.5
8	3	18	121	9	151	51	14	100	165	60.6
9	7	35	63	13	118	54	55	64	173	36.9
10	2	13	78	7	100	34	8	66	108	61.1
11	4	26	85	14	129	49	27	80	156	51.2
12	6	33	43	5	87	32	15	55	102	53.9
Chck	0	1	12	21	34		75		109	31.1

Aug. 31, 1931. Time 7:10 - 8:40. Temp. 68 - 68.
Cool and cloudy all day.
Place N.W. Douglas Reservoir.
Second cutting alfalfa left standing. Heavy in spots. Most of sweeps made in heavy alfalfa. Hoppers abundant, mostly <u>Femur rubrum</u> adult.

Table 1 continued.

Series 6.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	6	45	71	8	130	19	31	111	161	68.9
2	32	55	122	5	214	26	9	188	223	84.3
3	11	80	66	14	171	25	47	146	218	66.9
4	27	59	89	15	190	25	27	165	217	76.
5	30	122	125	14	291	36	26	255	317	80.4
6	11	69	111	10	201	29	47	172	248	69.3
7	8	37	84	20	149	24	56	125	205	60.9
8	10	49	114	7	180	25	36	155	216	71.7
9	7	42	40	7	96	17	52	79	148	53.3
10	3	27	49	5	84	12	20	72	104	69.2
11	12	24	89	9	134	19	31	115	165	69.6
12	24	83	61	7	175	23	22	152	197	77.1
Chck	2	2	12	9	25		191		216	11.5

Data same as No. 5

Table 1 continued.

Series 7.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	44	32	1	0	77	12	12	65	89	73.
2	36	27	4	2	69	12	14	57	83	68.6
3	97	38	8	3	146	25	35	121	181	66.8
4	71	41	6	9	127	28	76	99	203	48.7
5	68	67	23	8	166	29	38	137	204	67.1
6	9	37	12	3	61	17	60	44	121	36.3
7	9	21	4	3	37	8	21	29	58	50.
8	28	41	8	2	79	16	35	63	114	55.2
9	24	57	5	5	91	24	79	67	170	39.4
10	19	33	1	3	56	14	43	42	99	42.4
11	15	47	17	4	83	21	65	72	148	48.6
12	38	49	11	2	100	21	48	79	148	53.3
Chck	0	9	9	5	23		147		170	14.0

Sept. 5, 1931. Time 6:30 - 7:30. Temp. 66 - 78.
Bright, warmed up quickly.
Place same as in Nos. 5 & 6.

Table 1 continued.

Series 8.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	64	34	3	3	104	23	14	81	118	68.6
2	54	36	2	1	93	22	23	71	116	61.2
3	52	64	2	4	122	27	19	95	141	67.3
4	37	47	10	2	96	23	33	73	119	61.3
5	44	54	9	0	107	25	21	82	128	64.
6	19	31	2	0	52	16	29	36	81	44.4
7	31	46	12	5	94	23	26	71	120	59.1
8	29	46	7	4	86	20	16	66	102	64.7
9	21	28	4	3	56	18	36	38	92	41.3
10	23	32	10	2	67	20	35	47	102	46.
11	16	18	11	2	47	16	38	31	85	36.4
12	32	38	7	4	81	26	56	55	137	40.1
Chck	0	13	14	8	35		147		182	19.2

Data same as No. 7.

Table 1 continued.

Series 9.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	67	67	10	---	144	33	21	111	165	67.2
2	86	45	15	---	146	33	20	113	166	68.
3	103	44	10	---	157	35	21	122	178	68.5
4	75	52	11	---	138	34	33	104	171	60.8
5	83	29	7	---	119	26	12	93	131	70.9
6	74	43	9	---	126	29	22	97	148	65.5
7	54	33	9	---	96	25	31	71	127	55.9
8	61	35	6	---	102	24	19	78	121	64.4
9	42	21	6	---	69	20	30	49	99	49.4
10	60	43	9	---	112	28	30	84	142	59.1
11	41	36	19	---	96	25	33	71	129	55.
12	70	28	16	---	114	26	18	88	132	66.6
Chck	4	11	15	---	30		122		152	19.7

Sept. 9, 1931. Time 6:30 - 7:30. Temp. 64 - 72.
Bright, warmed up quickly.
West of Wellington Oil field 1 mile. Second cutting alfalfa left standing.
Heavy in spots. Sweeps made in heaviest vegetation.

Table 1 continued.

Series 10.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	57	36	11	--	104	35	17	69	121	57.
2	76	34	8	--	118	38	14	80	132	60.6
3	77	56	8	--	141	47	23	94	164	57.3
4	74	32	11	--	117	39	19	78	136	57.3
5	43	11	5	--	59	19	6	40	65	61.5
6	67	26	6	--	99	33	15	66	114	57.8
7	48	27	10	--	85	29	18	56	103	54.3
8	68	21	9	--	98	34	21	64	119	53.7
9	42	5	4	--	51	21	24	30	75	40.
10	42	21	6	--	69	27	26	42	95	44.2
11	57	19	7	--	83	32	28	51	111	45.9
12	54	17	4	--	75	27	18	48	93	51.6
Chck	7	13	23	--	43		107		150	28.6

Data same as No. 9.

Table 1 continued.

Series 11.

Bait	Number Dead 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	31	64	5	8	108	21	17	87	125	69.6
2	42	73	6	4	125	23	8	102	133	76.6
3	29	58	6	5	98	18	8	80	106	75.4
4	45	59	4	5	113	21	10	92	123	74.7
5	45	47	4	7	103	20	12	83	115	72.1
6	32	62	9	4	107	20	12	87	119	73.1
7	44	61	5	3	113	23	24	90	137	65.6
8	43	54	4	5	106	20	12	86	118	72.8
9	12	21	0	2	35	9	20	26	55	47.2
10	13	55	4	5	77	17	21	60	98	61.2
11	18	65	12	17	112	26	39	86	151	56.9
12	25	52	3	6	86	18	22	68	108	62.9
Chck	1	7	6	11	25		122		147	17.0

Sept. 12, 1931. Time 6:45 - 7:45. Temp. 63 - 69.
Bright, clear, warmed up quickly.
Otherwise same as Nos. 9 & 10.

Table 1 continued.

Series 12.

Bait	Number Dead. 1st. day	2d. day	3d. day	4th. day	Total dead	Total dead from handling	Total alive	Total poisoned	Total caged	Percent dead
1	30	63	3	1	97	22	4	75	101	74.2
2	41	68	2	6	117	27	7	90	124	72.5
3	51	78	5	3	137	31	6	106	143	74.1
4	42	58	3	1	104	24	10	80	114	70.1
5	48	29	3	2	82	19	8	63	90	70.
6	44	81	2	1	128	29	7	99	135	73.3
7	43	44	3	3	93	24	17	69	110	62.7
8	43	53	3	1	100	24	12	76	112	67.8
9	5	15	2	2	24	8	12	16	36	44.4
10	28	57	6	1	92	25	24	67	116	57.7
11	11	36	5	5	57	14	10	43	67	64.1
12	28	46	1	8	83	20	10	63	93	67.7
Chck	1	1	6	15	23		84		107	21.4

Data same as on No. 11

Ecological data. - In summing up the data relative to the time of day of poisoning, temperature, location of plots, etc., it will be noted that the baits were scattered early in the morning. The earliest recorded time of starting this operation being 6:10 a. m. and the latest 7:10 a. m. Approximately one hour was consumed in scattering the baits in every instance. The temperature at the beginning of operations varied from 58 degrees F. on Aug. 11 as the minimum, to 68 degrees F. on Aug. 31 as the maximum. The temperature at the time the baits were all scattered varied from 67 degrees F. on Aug. 11 to 78 degrees F. on Sept. 5. All temperatures at the beginning of operations were at or near 65 degrees F. or the minimum feeding temperature for grasshoppers. All temperatures at the close of scattering operations were below 80 degrees F. or the optimum feeding temperature. Temperature readings were made at approximately 3 feet above the surface of the soil. No soil surface readings were made.

It will also be noted that three widely separated locations were used for plots and two sets of two series each were run at each location. Series 1 to 4 inclusive were run on a farm just west of the Fort Collins oil field on the north side of the Cheyenne highway leading past Terry Lake. Series 5 to 8 were conducted north and west of Douglas Reservoir about one mile. Series 9 to 12 were conducted on a farm lying one mile west of the south end of the Wellington oil field. All plots were laid out in alfalfa fields where a good succulent growth of alfalfa and a heavy infestation of hoppers occurred in combination.

The species of grasshoppers present varied somewhat altho for the most part Melanoplus femur-rubrum was the most abundant. M. differentalis and M. bivittatus were also numerous. There were also present several species belonging to the sub-family Oedipodinae which are not considered of economic importance. Their numbers were not great, however. All of the experiments this year were conducted with adult hoppers.

RESULTS

Stastical analysis of the data. - In the analysis of the data generalized probable error was calculated for the entire experiment in order to reduce the chance errors. The Variance Method* was employed as it allows the errors

*This is sometimes called "Students" generalized probable error formula.

due to replicates and treatments to be removed from the experiments. The remaining error, which is due to chance, was considerably reduced as shown by a comparison with the Deviation of the Mean Method*. In the latter, it is

* Devised by H. K. Hayes, Univ. of Minn.

possible to remove only the error between treatments. It is obvious that a small chance error means more precision in the experiments and this in turn increases the reliability of the results obtained. Due to the fact that this type of analysis has been little used in entomological work, it seemed desirable to give all steps in the calculation.

<u>Calculation of the probable error</u>. - The formula employed and the step by step analysis are given below.

$$P.E. = 0.6745 \sqrt{\frac{MN\ (\sigma_T^2 - \sigma_R^2 - \sigma_g^2\ )}{(M-1)\ (N-1)}}$$

M = number of baits tested (in this case 12).

N = number of replications of each bait (also 12).

σ_T^2 = squared standard deviation or variance of all the "kills" of all the baits in the tests.

σ_R^2 = variance of the means of the baits.

σ_g^2 = variance of the mean of the replicates.

The percentage of kill for all baits in all the tests, the average kill for each bait and the average for each replicate are given in Table No. 2

Table 2.

Bait No. / Rep. No.	1	2	3	4	5	6	7	8	9	10	11	12	Ave. of Rep.
1	57.6	73.2	59.2	67.9	70.0	38.4	64.8	63.6	29.7	45.0	51.1	60.2	56.7
2	56.2	65.9	57.1	70.7	81.0	46.6	69.8	42.1	34.7	47.9	56.6	56.1	57.0
3	40.5	55.0	55.4	60.0	63.8	51.7	75.4	79.6	36.5	62.9	29.7	57.8	55.6
4	58.2	77.6	76.1	60.5	70.6	57.3	61.8	76.1	53.4	60.8	56.4	62.3	64.2
5	42.3	55.1	54.0	52.2	49.6	58.0	56.5	60.6	36.9	61.1	51.2	53.9	52.6
6	68.9	84.3	66.9	76.0	80.4	69.3	60.9	71.7	53.3	69.2	69.6	77.1	70.6
7	73.0	68.6	66.8	48.7	67.1	36.3	50.0	55.2	39.4	42.4	48.6	53.3	54.1
8	68.6	61.2	67.3	61.3	64.0	44.4	59.1	64.7	41.3	46.0	36.4	40.1	54.5
9	67.2	68.0	68.5	60.8	70.9	65.5	55.9	64.4	49.4	59.1	55.0	66.6	62.6
10	57.0	60.6	57.3	57.3	61.5	57.8	54.3	53.7	40.0	44.2	45.9	51.6	53.4
11	69.6	76.6	75.4	74.7	72.1	73.1	65.6	72.8	47.2	61.2	56.9	62.9	67.3
12	74.2	72.5	74.1	70.1	70.0	73.3	62.7	67.8	44.4	57.7	64.1	67.7	66.5
Average kill	61.1	68.2	64.8	63.3	68.4	55.9	61.4	64.3	42.1	54.8	51.8	59.1	59.6 General mean

$\overline{X}$ = General mean of all baits = 59.6

T = Kills of individual baits.

$\sigma_T^2 = \frac{S(T)^2}{MN} - \overline{X}^2 = \frac{531,470.36}{144} - 3,552.16 = 3690.76 - 3552.16$

$\sigma_T^2 = 138,60$

R = Mean kill of all baits.

$\sigma_R^2 = \frac{S(R)^2}{M} - \overline{X}^2 = \frac{43,249.70}{12} - 3552.16 = 3604.14 - 3552.16$

$\sigma_R^2 = 51.98$

g = Mean kill of the replicates

$\sigma_g^2 = \frac{S(g)^2}{N} - \overline{X}^2 = \frac{43,046.93}{12} - 3552.16 = 3587.24 - 3552.16$

$\sigma_g^2 = 35.08$

Substituting in the formula.

$P.E. = .6745 \sqrt{\frac{12x12(138.60 - 51.98 - 35.08)}{(12-1) \quad 12-1)}}$

$P.E. = .6745 \sqrt{\frac{144x51.54}{121}} = .6745 \sqrt{61.83}$

P.E. = .6745 x 7.831

P.E. = 5.282

P.E. of a single determination in percent of the general

mean = $\frac{5.282 \times 100}{59.6} = \frac{528.20}{59.6} = 8.86$

P.E. for the mean of each bait = $\frac{8.86}{\sqrt{12}} = \frac{8.86}{3.46} = 2.56$

P.E. for each bait = $\frac{2.56 \times \text{ave. for bait}}{100}$

Determination of significance. - The probable error in itself has little value unless it can be used to determine whether or not there are some real differences between baits. This difference is calculated after the manner suggested by Goulden (4).

P.E. of a difference $= \sqrt{a^2 + b^2}$ *

*While this formula disregards correlation, it was believed that no correlation existed between the order of treatments.

Where a = P.E. of one treatment

b = P.E. of another treatment

$$\text{Significance of difference} = \frac{\text{Difference}}{\text{P.E. of Difference}}$$

In Table 3 in the column Diff/P.E. all baits showing a significance over Bait No. 1 are underscored. All baits marked with plus sign are better than Bait No. 1, but not significantly better. All baits showing a minus sign, except those followed by a star, are not as good as Bait No. 1, but the difference is not significant. Those marked by a star are signficantly worse.

In order to establish an elimination level all baits are compared with Bait No. 5, the one showing the highest average percent of kill, and are arranged accordingly in Table 4.

Table No. 3

Comparing each bait with Bait No. 1

Bait No.	Average kill for bait	P. E. of Difference	Difference	Difference/P. E.
1	61.1 ± 1.56			
2	68.2 ± 1.75	± 2.34	+7.1	3.
3	64.8 ± 1.66	± 2.27	+3.7	+ 1.62
4	63.3 ± 1.62	± 2.24	+2.2	+ .98
5	68.4 ± 1.75	± 2.34	+7.3	3.12
6	55.9 ± 1.43	± 2.11	-1.2	- .56
7	61.4 ± 1.57	± 2.20	+ .3	+ .13
8	64.3 ± 1.65	± 2.27	+3.2	+1.40
9	42.1 ± 1.08	± 1.89	- 19.0	-10.05*
10	54.8 ± 1.40	± 2.09	- 6.3	- 3.01*
11	51.8 ± 1.33	± 2.04	- 9.3	- 4.55*
12	59.1 ± 1.51	± 2.17	- 2.0	- .92

Table No. 4

Establishing elimination level.

Bait No.	% Kill and P.E.	P.E. of Diff.	Difference	Diff./P.E.
5	68.4 ± 1.75			
2	68.2 ± 1.75	2.47	.2	.08
3	64.8 ± 1.66	2.41	3.6	1.49
8	64.3 ± 1.65	2.40	4.1	1.70
4	63.3 ± 1.62	2.38	5.1	2.14
7	61.4 ± 1.57	2.35	7.0	2.97
1	61.1 ± 1.56	2.34	7.3	3.12
12	59.1 ± 1.51	2.31	9.3	4.02
6	55.9 ± 1.43	2.25	12.5	5.55
10	54.8 ± 1.40	2.24	13.6	6.07
11	51.8 ± 1.33	2.19	16.6	7.58
9	42.1 ± 1.08	2.05	26.3	12.82

SUMMARY

In Table No. 3 all baits are compared with Bait No. 1 the basic formula. It will be found that only two baits, Nos. 2 and 5, show a significant difference over Bait No. 1. There are, however, four other baits, Nos. 3, 4, 7 and 8, which are better than Bait No. 1, but the difference is not significant. Of the remaining baits Nos. 6 and 12 are not as good as Bait No. 1 but again the difference is not significant, while Baits No. 9, 10 and 11 may be said to be significantly worse.

It will be noted in Table No. 4 that all baits which rank above Bait No. 1 contain molasses either alone or in combination with amyl acetate or salt or both. Of the two baits which show a significance over Bait No. 1, Bait No. 2 contains cane molasses alone while the other, Bait No. 5, beet molasses and amyl acetate. This would tend to show that amyl acetate is necessary when beet molasses is used, since Bait No. 3, which contained beet molasses alone, ranked third in the rating as shown in Table No.4. The reverse, however, is true when cane molasses is used since Bait No. 2, which contained only cane molasses out-ranked Bait No. 4, which contained cane molasses and amyl acetate. Of the two "Standard" formulas Bait No. 8, containing beet molasses, outranked Bait No. 7, the cane molasses bait. Amyl acetate was present in both of these

baits. It would seem then that amyl acetate may be an attractor when used with beet molasses, but when combined with cane molasses it has little or no value.

All baits containing salt ranked lower than those which did not. Bait No. 6 ranked below the basic formula of bran, arsenic and water. Baits No. 7 and 8 were the only ones in which salt was used in combination with molasses that ranked above Bait No. 1. This was probably due to the presence of the molasses since Bait No. 10, which contained amyl acetate and salt ranked far below the basic formula. This would indicate that salt is not an attractor and might well be left out of grasshopper baits for use under Colorado conditions. This agrees with the work done by Parker, Criddle and others.

Baits No. 9 and 12 each contained some bran and since both ranked far down the list it would indicate that their value is in direct proportion to the amount of bran present. Bait No. 11 had dried beet pulp as a carrier for the poison and from its rank in relation to the bran baits, it would appear that as a substitute for bran the dried beet pulp is not entirely satisfactory. This bait, however, contained salt and amyl acetate, and no additional molasses, which might account to some extent for its failure to rank higher. It would seem then that there is no substitute for bran in grasshopper baits, unless dried beet pulp in combination with molasses should give the desired results. It is suggested that the pulp be carried at least another year in experimental work before it is cast aside.

CONCLUSIONS

It is shown by the ranking of the different baits in Tables 3 and 4, and from the summary, that cane molasses might be used alone as an attractor in grasshopper baits with good results, but it seems from the results of this years experiments, that it is advisable to add amyl acetate to baits when beet molasses is used.

It is definitely shown that salt is not an attractor under Colorado conditions, and might well be left out of the formula.

It is shown also that there is no substitute for bran, but it appears that dried beet pulp might have possibilities.

Since cane molasses is more expensive in Colorado than beet molasses, it would be inadvisable to recommend that material over the local product. The following formula based on data as herein presented is therefore recommended for this state.

Coarse bran..................	100 pounds
Beet molasses...............	2 gallons
Amyl acetate technical......	3 ounces
Sodium arsenite.............	1 quart
Water.......................	10-14 gallons

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GRASSHOPPER BAIT EXPERIMENTS WITH AN ANALYSIS OF THE DATA BY THE VARIANCE METHOD

Abstract

INTRODUCTION

The purpose of the experiments reported on in this paper was to determine the most efficient and most economical grasshopper bait for Colorado.

HISTORICAL REVIEW

Grasshoppers are ~~an~~ important pests to agricultural crops practically the world over. Perhaps no other single pest of crops has been so destructive over a long period of time as they.

In Colorado it is shown that several major outbreaks have occurred since 1900 with the outbreak of 1931 being one of the most wide spread and destructive in the entire period. Over 40,000 sacks of bran, 34,000 quarts of sodium arsenite, as well as some crude arsenic and Paris green, were used in last year's campaign. Over $55,000 were expended last year in an effort to protect crops from the ravages of these insects, and even so some damage was done. In a campaign the size of the one conducted in 1931 the saving of a few cents on each 100 pounds of bran mash mixture means the saving of thousands of dollars. Also the added efficiency which might be gained by adding to or detracting from the bait might mean thousands of dollars in crops saved.

It has been shown that the present "Standard Formula", as given below, was worked out for the most part by men outside of

Colorado and therefore not necessarily adapted to Colorado conditions.

Standard Formula

Bran	100 pounds
Arsenic or Paris green	5 pounds
or	
Sodium arsenite	1 quart
Molasses	2 gallon
Amyl acetate	3 ounces
Salt	5 pounds
Water	10 - 14 gallon

MATERIALS

The following baits were tested over a series of 12 replications in an effort to obtain the most efficient as well as the most economical bait under Colorado conditions.

Bait No. 1 Bran, sodium arsenite and water (Basic formula)

Bait No. 2 Basic formula plus cane molasses

" " 3 " " " beet "

" " 4 " " " cane molasses and amyl acetate

" " 5 " " " beet molasses and amyl acetate

" " 6 " " " salt.

" " 7 " " " cane molasses, amyl acetate & salt.

" " 8 " " " beet molasses, amyl acetate & salt.

" " 9 Purina sweet roughage plus arsenic, amyl acetate and water.

" " 10 Basic formula plus salt and amyl acetate.

" " 11 Dried beet pulp plus amyl acetate, salt, arsenic and water.

" " 12 "Delicious Hopper" Bait. Product of the Raven Honey Dew Mills, Omaha, Nebraska. Formula unknown.

All baits were mixed according to the following formula.

Bran	100 pounds
Sodium arsenite	1 quart
Molasses (when used)	2 gallon
Amyl acetate " "	3 ounces
Salt " "	5 pounds
Water	14 gallon

It will be noted from the above list of baits that each so-called attractor in the "Standard Formula" has been tested separately and in combination with each other except amyl acetate. This one ingredient was not tested alone because of a shortage of equipment. In addition to testing the attrahents in the "Standard Formula" baits No. 9, 11 & 12 were added in order to determine if possible whether or not there is a substitute for bran.

METHODS

All baits were scattered early in the morning at or near an air temperature of 65 degrees F. This temperature was chosen because it has been demonstrated that grasshoppers are not active below that point. One-fourth acre plots having an alley 10 feet wide on each side, were staked out on the day preceeding the actual poisoning operations. These alleys were intended as a barrier against possible migration between plots and were not poisoned. Grasshoppers were collected from all plots on the afternoon of the same day that the baits were scattered. A specially designed cage placed inside an insect sweeping net was used in making the collections. No special number of grasshoppers was taken from each plot, altho the aim was to capture at least 100. This number varied, however, with the degree of infestation from 36 to 317. All sweepings were made near the centers of the plots to further exclude the possibility of migration from other plots. Alfalfa land having a succulent growth and an abundance of hoppers was chosen for the plots.

As soon as the sweepings were completed the hoppers were brought in to the college and dumped into large wire screen cages for observation. All dead hoppers were removed each day for four successive days from the cages and their number recorded. On the fourth day all hoppers remaining alive were removed and their number recorded. By adding this total of the dead and live hoppers the total number caged was computed. A check cage of unpoisoned hoppers was carried with each series, to determine the total which died in all cages from unavoidable mechanical injury. The percentage of dead in the check cage was then taken of the total caged from each of the poison plots and subtracted from the total number of dead hoppers from each of those plots. From this corrected number the actual percentage of kill for each bait was computed by dividing the corrected number killed by the total caged.

RESULTS

In analizing the data a generalized probable error was calculated for the entire experiment to reduce the chance error. The Variance Method was employed since it allows the errors due to replicates and treatments to be removed. The remaining error which is due to chance was considerably reduced thereby.

The formula used is given below.

$$P.E. = .6745 \sqrt{\frac{MN\ (\sigma_T^2 - \sigma_R^2 - \sigma_q^2\ )}{(M-1)\ (N-1)}}$$

In which

M = Number of baits tested.

N = Number of replications of each bait.

$\bar{X}$ = General mean of all baits.

σ_T^2 = Squared standard deviation or variance of all the "kills" of all the baits in the test.

σ_R^2 = Variance of the means of the baits.

σ_g^2 = Variance of the means of the replicates.

$$\sigma_T^2 = \frac{S(T)^2}{MN} - \bar{X}^2 = \frac{531,470.36}{144} - 3552.16 = 138.60$$

$$\sigma_R^2 = \frac{S(R)^2}{M} - \bar{X}^2 = \frac{43,249.70}{12} - 3552.16 = 51.98$$

$$\sigma_g^2 = \frac{S(g)^2}{N} - \bar{X}^2 = \frac{43,046.93}{12} - 3552.16 = 35.08$$

Substituting in formula.

$$P.E. = .6745 \sqrt{\frac{144(138.60 - 51.98 - 35.08}{121}}$$

$$P.E. = .6745 \times 7.831$$

$$P.E. = 5.282$$

P.E. of single determination in percent of general mean.

$$P.E. = \frac{5.282 \times 100}{59.6} = \underline{8.86}$$

P.E. of mean for each bait $\frac{8.86}{\sqrt{12}} = 2.56$

P.E. for each bait = $2.56 \frac{\text{average for bait}}{100}$

P.E. of difference = $\sqrt{a^2 + b^2}$

where a = P.E. for one treatment

b = P.E. for another treatment

Below is given all baits compared with bait No. 1, the basic formula.

Bait	Average kill for bait	P.E. of Difference	Difference	Difference/P.E.
1	61.1 ± 1.56			
2	68.2 ± 1.75	±2.34	+7.1	<u>3.</u>
3	64.8 ± 1.66	±2.27	+3.7	+1.62
4	63.3 ± 1.62	±2.24	+2.2	+ .98
5	68.4 ± 1.75	±2.34	+7.3	<u>3.12</u>
6	55.9 ± 1.43	±2.11	-1.2	- .56
7	61.4 ± 1.57	±2.20	+ .3	+ .13
8	64.3 ± 1.65	±2.27	+3.2	+1.40
9	42.1 ± 1.08	±1.89	-19.0	-10.05*
10	54.8 ± 1.40	±2.09	- 6.3	- 3.01*
11	51.8 ± 1.33	±2.04	- 9.3	- 4.55*
12	59.1 ± 1.51	±2.17	-2.0	- .92

In the column Difference/P.E. all baits which are underscored show a significant difference over Bait No. 1. All baits marked with plus sign are better, but not significant. All baits marked with a minus sign are not as good as Bait No. 1 but again the difference is not significant. Those marked with a star might be said to be significantly worse than Bait No. 1.

In the table given below all baits are compared with Bait No. 5 the highest ranking bait, in the list,and an elimination level established.

Bait	%Kill and P.E.	P.E. of Diff.	Difference	Difference/P.E.
5	68.4 ± 1.75			
2	68.2 ± 1.75	±2.47	.2	.08
3	64.8 ± 1.66	±2.41	3.6	1.49
8	64.3 ± 1.65	±2.40	411	1.70
4	63.3 ± 1.62	±2.38	5.1	2.14
<u>7</u>	<u>61.4 ± 1.57</u>	<u>±2.35</u>	<u>7.0</u>	<u>2.97</u>
1	61.1 ± 1.56	±2.34	7.3	3.12
12	59.1 ± 1.51	±2.31	9.3	4.02
6	55.9 ± 1.43	±2.25	12.5	5.55
10	54.8 ± 1.40	±2.24	13.6	6.07
11	51.8 ± 1.33	±2.19	16.6	7.58
9	42.1 ± 1.08	±2.05	26.3	12.82

SUMMARY

It is shown that of all the 12 baits tested only two, Baits No. 2 and 5 are significantly better than Bait No. 1. Baits No. 9, 10 and 11 might be said to be significantly worse.

It is also shown that beet molasses is benefited as an attractor when amyl acetate is added. The reverse is true for cane molasses.

Salt is shown to be detrimental to the formula under Coloardo conditions.

It is also shown there is no substitute for bran but that dried beet pulp has possibilities.

The following formula based on the data given is recommended for Colorado.

Bran (free from shorts)........	100 pounds
Sodium arsenite(8 # material)..	1 quart
Molasses (beet)................	2 gallon
Amyl acetate(Technical)........	3 ounces
Water..........................	10 - 14 gallons

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