PRESIDENT: There are two papers to be read this morning, one by Mr. Bechard on "Redwing Locusts and their control at Amatikulu" and the other is "The Problem of the Red Locust" by Mr. Lea and Dr. McMartin. I will ask Mr. Bechard to read his first, and then Mr. Lea to read his, and afterwards we will discuss the two together. Mr. Lea was sent down by Professor Faure from Pretoria to work in conjunction with the Sugar Experiment Station and with the Committee of this Association on this locust question.

Mr. Bechard read his paper, followed by Mr. Lea.

REDWING LOCUSTS AND THEIR CONTROL AT AMATIKULU

By R. M. BECHARD.

Red wing flyers first made their appearance in this district, on the 17th of December, 1933. The density of the swarms could be described as sparse as no more than two to three locusts could be said to occupy one cubic foot of space. The width of the swarm might have been in the neighbourhood of four miles. It would be rather hard to judge the length, but the time of flight occupied that day about five hours. As the locusts were reported four hours afterwards to have reached a distance of 45 miles South, the length could be estimated as between 40 and 50 miles.

This swarm did not settle in the district, but flyers continued to appear at irregular intervals, the first swarm that settled in the immediate neighbourhood was on the 20th of December. On the 16th of January the last swarm made its appearance and these locusts, despite all attempts at driving them away, remained in the district for eight days. It is hard to decide of the fate of this last swarm, but a considerable number appear to have died here. A large number of this last swarm appeared to be in a passive state as they could be approached fairly easily and seized with the fingers.

A large number of active, **passive** and dead locusts were collected. Active and passive ones were bred in captivity; out of fifty active females collected on January the 18th, three eventually died, killed by parasites, all three having a large dipterous larva in the cavity at the upper end of the Thorax. The larvæ pupated the same day they emerged from the host and in three days a large tachinid fly having five barbs on the last segment of the abdomen emerged. The fly was not identified.

Fifty **passive** females collected on the 17th and 18th January were also bred, of these twelve were found to be parasitised, nine by dipterous parasities of the same unidentified tachinid and three by a hymenoptera.

Some two hundred and fifty egg sacs were also carefully dug up, of these only eleven were observed to have been attacked by hymenopterous larvæ and one either accidentally or otherwise by a dipterous larvæ that unfortunately did not survive.

No case of blood fungus was observed in any of the three hundred odd adults disected. Most of the dead bodies picked up, certainly showed extensive signs of fungus growth but this was probably saprophytic.

As soon as a supply of hoppers was available, that is to say on the 14th of January, reaction tests were carried out, while field observations were afoot continuously, the following experiments, amongst others, being carried out:—

Experiment I.—

Arsenite of Sodium at 0.5% concentration as a spray and bait on 1st Instar locusts.

Six cages constructed of mosquito gauze on wooden frames 2 feet wide, 3 feet long and 3 feet high were used.

Three stools of cane were sprayed, using 100 cubic centimeter of 0.5% Sodium Arsenate and 5% molasses. These were covered with cages in the field and a large number of hoppers introduced.

In every case a 100% mortality was obtained in twenty four hours. Three stools were covered, locusts introduced and then sprayed with also 100% mortality in twenty four hours. It was therefore not possible to differentiate between spraying and baiting from this experiment.

Experiment II.—

Spraying and Baiting. Three stools were covered, locusts were introduced and after knocking them down these were sprayed taking care not to touch the leaves of the cane, in three days the number of survivors was very large at least 75% having escaped poisoning. Three stools were covered, again locusts were introduced and after being knocked down; the leaves of the cane only were sprayed and 100% mortality was obtained in twenty four hours.

Experiment III.—

Baiting in advance.—Six stools were sprayed with 0.5% Arsenite and 5% molasses. One sprayed and one unsprayed stool were covered and locusts of 1st Instar introductd. Stool 1a was covered immediately. 100% mortality after twenty-four hours.

Stool 2a was covered 24 hours afterwards, one untreated stool being covered at the same time. Mortality was high, probably 60%.

Stool 3a covered 48 hours afterwards mortality was low, about 15% on estimation.

Stool 4a Rainfall recorded 0.48 inches after 3a. Time after spraying 72 hours. Mortality negligible, at the outside 1%.

Experiment IV.—

Baiting with varying strength of Arsenite solution.

a.—0.5% Arsenite and 5% molasses stool covered with untreated stool—and a large number of 1st Instar locusts, introduced. Mortality 100% after 24 hours.

b.—0.25% Arsenite and 5% molasses. Stool covered and a large number of 1st Instar locusts, introduced. Mortality estimated at 36%.

Experiment V.—

Mechanical attraction.—Six cages were used, these were counter baited with a pot of water grass and a small stool of cane. The bait material was placed on a petri dish. It was desirable, however, to see if the sun position had any effect on the preference of the hoppers to bait as it had been noticed previously that the general trend was for the hoppers to congregate on the side of the cages facing South.

The experiment was therefore duplicated, the bait being placed alternately South and North of the counter baits used. For quick results the bait was poisoned with 3% of its own weight of Sodium Arsenite and saturated with water—200 locusts of 1st Instar were then introduced. Mortality was low in every case so experiment was continued for 72 hours and final results recorded.

1a Bran mash placed North of counter bait 12%
1b Bran mash placed South of counter bait 12.5%
2a Saw Dust placed North of counter bait 9%
2b Saw Dust placed South of counter bait 11%
3a Mill Bagasse placed North of counter bait 19%
3b Mill Bagasse placed South of counter bait 20.5%

Bagasse having proved somewhat more satisfactory. Experiment Va. was conducted with a view of superimposing a colour reaction to the mechanical attraction (a) refers to all experiments where the bait was placed North of the counter bait and (b) where bait was placed South of counter bait:—

Experiment Va.—

Bagasse as carrier.—Repeated with colour reaction in 24 hours poisoned with potassium cyanide at 0.5% concentration.

4a uncoloured 17%
4b uncoloured 17.5%
5a coloured yellow 18%
5b coloured yellow 17.5%
6a coloured medium green..... 42%
6b coloured medium green..... 41%

Experiment Vb.—

Colour Reaction.—Six different shades of green were made, bagasse as medium poisoned with 0.5% Potassium Cyanide, Southern exposure was adopted, counter baited in each case by one pot of water grass and one pot of cane leaves. Shades varying from decidedly blueish green to nearly yellow.

Mortality from 27% in the Blueish range increasing to 51% on a Yellowish Green and back to 18% where the colour was decidedly yellow.

Experiment VI.—

Mechanical attraction.—Six cages were used counter baited by means of the same leaves, water grass and cane. Bait was disposed in Southern exposure in every case and poisoned with 0.5% Cyanide, the shade approaching water grass was imitated:—

100 locusts 1st Instar

introduced.

1.—Mill Bagasse Moistened—mortality 46%.
2.—Very coarse bagasse produced by Laboratory Mill—mortality 43%.
3.—Wood straw—mortality 87%.
4.—Plane shavings—mortality 85%.
5.—Maize husks—mortality 78%.
6.—Maize husks torn to shreds—mortality 72%.

Experiment VII.—

Tests of Olfactory Reaction.

Cages were counter baited by means of water grass and cane as above. Bait was coloured green by means of picric acid and methylene blue in the same way as above, poisoned by means of 0.5% Potassium Cyanide solution. Wood straw was used—200 hoppers 2nd Instar, were introduced. The scents used were as follows:—

5 drops lemon essence.
5 drops orange essence.
5 drops raspberry essence.
5 drops oil of Citronella.
5 drops alcoholic extract of water grass.
1 drop lacquer thinner (amylacetate).
5 drops vanilla essence.
5 drops oil of winter green.
5 drops oil of eucaliptus.
3 drops menthol.
small quantity of pineapple juice.
small quantity of mango juice.

All essences were shaken in one litre of water and 10 millilitres were used for moistening 100 grams of bait.

Mortality in the case of citronella was 100%. Lemon came second with 96%, all others between 85 and 92%.

Experiment VIIa.—

Part of the above experiment was repeated using varying quantities of Citronella oil.

1.— 1 drop in 1 litre—mortality 90%.
2.— 3 drops in 1 litre—mortality 97%.
3.— 5 drops in 1 litre—mortality 100%.
4.— 7 drops in 1 litre—mortality 99%.
5.—10 drops in 1 litre—mortality 81%.
6.—15 drops in 1 litre—mortality 70.5%.

Conclusion:—The experiment indicates that locusts react to some extent to olfactory stimuli but is not conclusive, other observations showing that locusts do not travel any distance to the scents used, but seem to stay longer where a strong scent has been diffused.

Experiment VIII.—

Tests of Gustatory Reaction.

Six solutions were made. Cages were baited and counter baited as above using wood straw and Cyanide (Citronella oil was used, five drops in 1 litre of poisoned material).

Two hundred locusts of the 2nd Instar were introduced and mortality observed in twenty-four hours.

1.— 5% Molasses.
2.—10% Molasses.
3.— 5% Sugar.
4.—10 grains of quinine Hydrochloride in 100 millilitres.
5.— 5% Epsom Salt.
6.— 5% Common Salt.

The mortality in every case was 100%.

Experiment repeated and mortality observed by baiting at 10 a.m. and observing at 4 p.m. with again a mortality of 100% in every case.

Experiment IX.—

Lasting effect of sprays and effect on vegetation.

Six stools of cane were each sprayed with the six different mixtures. Each day one each of the stools differently treated was covered together with an untreated stool one hundred millilitres of spray was used on each stool using a house atomiser. This was sprayed into the cane stool which stood about 30 inches high. A fair number of 1st Instar locusts were introduced into each cage after covering.

1.—0.25% Sodium Arsenite and 5% Molasses + Citronella oil 5 drops per litre.

	Mortality	Rainfall
1st Day	100%	Nil.
2nd Day	70%	Nil.
3rd Day	20%	Nil.
4th Day	Nil.	1.13in.

Cane withered in twenty-four hours.

2.—0.5% Sodium Arsenite and 5% Molasses + Citronella oil 5 drops per litre.

	Mortality	Rainfall
1st Day	100%	Nil.
2nd Day	60%	Nil.
3rd Day	No death	Nil.
4th Day	No death	1.13in.

Cane withered in twenty-four hours.

3.—0.5% Sodium fluosilicate and 5% Molasses + Citronella oil 5 drops per litre.

	Mortality	Rainfall
1st Day	90%	Nil.
2nd Day	Nil.	Nil.
3rd Day	Nil.	Nil.
4th Day	Nil.	1.13in.

Cane withered in twenty-four hours.

4.—1.0% Sodium fluosilicate and 5% Molasses + Citronella oil 5 drops per litre.

	Mortality	Rainfall
1st Day	90%	Nil.
2nd Day	Nil.	Nil.
3rd Day	Nil.	Nil.
4th Day	Nil.	1.13in.

Cane withered in twenty-four hours.

5.—0.5% Calcium Arsenate and 5% Molasses + Citronella oil 5 drops per litre.

	Mortality	Rainfall
1st Day	100%	Nil.
2nd Day	100%	Nil.
3rd Day	100%	Nil.
4th Day	90%	1.13in.
5th Day	30%	.28in.
6th Day	60%	Nil.

Cane fresh to end of experiment.

6.—1.0% Calcium Arsenate and 5% Molasses + Citronella oil 5 drops per litre.

	Mortality	Rainfall
1st Day	100%	Nil.
2nd Day	100%	Nil.
3rd Day	100%	Nil.
4th Day	95%	1.13in.
5th Day	60%	.28in.
6th Day	80%	Nil.

Cane fresh to end of experiment.

Experiment X.—

Testing Adhesive properties of carrier.

The poison chosen was Calcium Arsenate at 0.5% concentration. Four stools were sprayed with each of the various mixtures using a hundred millilitres per stool; these were left for two days then one stool of each was covered at the same time as one untreated stool and a large number of 1st Instar locusts were introduced.

This was repeated daily for four days and the mortality observed.

No. 1.—0.5% Arsenate + 5% Molasses + Citronella oil 5 drops per litre.

	Days after Spraying	Mortality	Rainfall
Stools covered and locusts introduced	3	100%	.68in.
do do	4	100%	.52in.
do do	5	90%	Nil.
do do	6	100%	Nil.

No. 2.—0.5% Arsenate + 10% Molasses + Citronella oil 5 drops per litre.

	Days after Spraying	Mortality	Rainfall
Stools covered and locusts introduced	3	100%	.68in.
do do	4	90%	.52in.
do do	5	100%	Nil.
do do	6	100%	Nil.

No. 3.—0.5% Arsenate + 5% Water Glass + Citronella oil 5 drops per litre.

	Days after Spraying	Mortality	Rainfall
Stools covered and locusts introduced	3	100%	.68in.
do do	4	100%	.52in.
do do	5	80%	Nil.
do do	6	10%	Nil.

No. 4.—0.5% Arsenate + 1% Water Glass + Citronella oil 5 drops per litre.

	Days after Spraying	Mortality	Rainfall
Stools covered and locusts introduced	3	100%	.68in.
do do	4	100%	.52in.
do do	5	80%	Nil.
do do	6	50%	Nil.

No. 5.—0.5% Calcium Arsenate + 1% Starch + Citronella 5 drops per litre.

	Days after Spraying	Mortality	Rainfall
Stools covered and locusts introduced	3	100%	.68in.
do do	4	100%	.52in.
do do	5	70%	Nil.
do do	6	30%	Nil.

No. 6.—0.5% Calcium Arsenate + 2% Starch + Citronella oil 5 drops per litre.

	Days after Spraying	Mortality	Rainfall
Stools covered and locusts introduced	3	100%	.68in.
do do	4	100%	.52in.
do do	5	75%	Nil.
do do	6	25%	Nil.

Numerous other experiments were carried out on baiting methods, exposure, etc., but were mostly inconclusive. It was, however, apparent that the best bait carrier was the vegetation itself, more especially so if erect and of a herbaceous nature. Molasses having proved satisfactory as a thickener and adhesive, and being plentiful was chosen for this purpose, 7% concentration was considered the best concentration to facilitate suspension. Although it was difficult to conclude the presence of any olfactory sense a certain amount of evidence, showed that the locusts were somewhat inclined to linger where citronella was present; this scent was therefore chosen as a secondary attractant.

Calcium Arsenate, being the only poisoning medium that left the cane unaffected, was chosen, the lasting effect and toxicity also being satisfactory.

The locusts by that time, February the 2nd, having started to collect, the results of the various baiting and spraying experiments were combined and the following spray tried under field conditions.

2 lbs. Calcium Arsenate.
2 gallons Molasses.
½ ounce Citronella oil.

diluted to 44 gallons with water.

Locusts which had started to collect on the edge of one cane field in their 1st instar were sprayed with the above spray. The mortality was excellent but no estimation of actual percentage was deduced; on the 3rd of February an isolated swarm was sprayed 80 yards away from the nearest swarm, the sprayed swarm was kept under observation on the 4th, none moved and by the afternoon of the 4th, twenty hours after spraying there were no survivors.

On the 5th inst. the experiment was repeated on 1st instar hoppers isolated from the nearest swarm by ninety five yards with similar results. On the 6th, 2nd instar locusts were sprayed on grass, the nearest other patch being one hundred and fifteen paces away. These were treated in the morning, visited continuously on the 7th and 8th and by mid-day of that date there were no survivors. Since then to date, a total of 248 swarms of all stages have been destroyed in the same way with 3,240 gallons of spray mixture and the results have been excellent. On the whole, it has never been found necessary to return more than twice to the same swarm and this mostly in the early days.

The present technique is as follows:—

2½ lbs. of Calcium Arsenate are stirred into two bottles of water to a thin cream. The cream is then poured into two gallons of molasses stirring well, a half ounce of citronella oil is added; this is sufficient to make forty gallons of spray for locusts of 4th instar and over.

Those of 1st and 2nd instar are treated with 2 lbs. of Arsenate for the same quantity of spray. It is sometimes found more convenient to make to two and a half gallons for transport to fields and this concentrate diluted sixteen times for actual spraying.

The concentrate keeps well but the thin solution should be made alkaline with two ounces of fresh lime to prevent damage to cane, if kept for any length of time.

While spraying a certain amount of stirring is necessary to keep the Arsenate in suspension.

The Arsenate used is in the form of the fine powder usually used for dusting fruit trees against Coddling Moth and contains 36 to 42% Arsenic Oxide 0.5% to 1.0% Soluble Arsenic and 12 to 15% of free lime.

Method of application.—Swarms are treated by spraying around them about three paces and gradually working in on the swarm itself, all vegetation being fairly well covered by a mist. The actual practice is to use a pump with extension bend so as to spray up and well into the stool of cane or grass. This practice and method of approach ensures that the swarm does not migrate from the poisoned zone and good mortality results. Locusts in 4th and 5th instar may take as long as 4 days to die, specially if in a moulting condition; they, however, are disinclined to travel when in this condition, and fair mortality was always registered.

Since writing it has been possible by the above method to destroy all hoppers on these estates two hundred acres of which, were very badly infested and five times that area moderately so.

Two large swarms of flying locusts, in the sexually immature stage have also been successfully dealt with and destroyed.

Experiments on a field scale were afoot to try and stem a threatened invasion of unmolested fields on a front of 1,000 yards.

This was moderately successful; the cane having been sprayed previously with sodium arsenite, the vegetation had been destroyed, but all locusts crossing were successfully dealt with and destroyed with the calcium arsenate bait placed in advance on the unmolested cane.