A THIRD SERIES OF INSECTICIDE TESTS AGAINST THE ELEGANT GRASSHOPPER

By. J DICK.

In an account of insecticide tests against the elegant grasshopper, *Zonocerus elegans* Thnb., presented to this Association at last year's congress, attention was drawn to some disappointing results obtained from a brand of benzene hexachloride dusting powder which was stated by the makers to contain 2 per cent of the gamma isomer of benzene hexachloride. Further tests have now been carried out in an attempt at discovering why this material caused a significantly lower mortality than Bexadust. The latter contains 5 per cent. technical benzene hexachloride and is advertised as containing not less than 0.5 per cent. of the gamma isomer, the actual amount of this isomer being generally between 0.6 and 0.65 per cent.

In a preliminary trial, carried out in November 1949, sets of 100 hoppers of *Z. elegans* were dusted at a rate equivalent to about 12 pounds per acre with new samples of the two dusts and with dust which had been kept for a year in the original containers, eight replications being carried out for each treatment. The mortality after five days is shown in Table I, in which the powder stated to contain 2 per cent. of the gamma isomer is referred to as BHC 2 per cent.

TABLE I.

Mortality per hundred hoppers after five days.

Cage No.	Control.	BHC 2 per cent. old.	BHC 2 per cent. new.	Bexadust, old.	Bexadust, new.
1	1	36	78	100	100
2	1	43	65	100	100
3	3	19	67	99	100
4	2	11	79	99	100
5	2	48	76	100	100
6	5	40	59	100	100
7	5	51	70	100	100
8	1	41	77	100	99
Totals... ...	20	289	571	798	799

Significant difference between totals: 59.3 at 19 to 1.
80.0 at 99 to 1.

It will be noticed that the old Bexadust is just as effective as the new, while the old BHC 2 per cent. is significantly less effective than the new. However, the powders were not stored under controlled conditions and the following experiment was therefore designed to discover whether comparable results would be obtained when samples of the two dusts were allowed to age under the same conditions.

Samples consisting of 50 c.c. of each of the powders were spread out over an area of 400 sq. cm., giving a mean thickness of 1.25 mm., and were exposed to the atmosphere under the same conditions. The powder was stirred at weekly intervals to expose new surfaces, one sample of each material being kept for two months and another for one month.

Sets of 100 hoppers each were then dusted with the equivalent of about 12 pounds per acre of each of the exposed powders and with fresh samples of the same materials, six replications being carried out for each treatment. Figures showing the mortality two days and five days after dusting are given in Tables II and III respectively.

TABLE II.

Mortality per hundred hoppers after two days.

Cage No.	Control.	BHC 2 per cent., 2 mnths.	BHC 2 per cent., 1 mnth.	BHC 2 per cent., new.	Bexadust, 2 mnths.	Bexadust, 1 mnth.	Bexadust, new.
1	0	0	0	31	31	59	79
2	0	0	0	29	39	52	70
3	0	0	0	39	39	60	61
4	0	0	0	26	49	70	80
5	0	0	0	31	38	61	72
6	0	0	0	32	40	62	74
Totals ...	0	0	0	188	236	364	436

Significant difference between totals: 30.7 at 19 to 1.
41.3 at 99 to 1.

TABLE III.

Mortality per hundred hoppers after five days.

Cage No.	Control.	BHC 2 per cent., 2 mnths.	BHC 2 per cent., 1 mnth.	BHC 2 per cent., new.	Bexadust, 2 mnths.	Bexadust, 1 mnth.	Bexadust, new.
1	6	9	22	52	95	100	100
2	5	8	38	57	100	100	100
3	2	4	50	52	100	100	100
4	3	8	49	60	100	100	100
5	4	7	39	55	98	99	100
6	5	8	42	56	99	100	100
Totals ...	25	44	240	332	592	599	600

Significant difference between totals: 29.0 at 19 to 1.
39.1 at 99 to 1.

As far as the Bexadust is concerned, the mortality figures for the second day after treatment show that the lethal effect has been significantly retarded by exposure of the powder, especially by exposure for two months. However, the final mortality as shown by the figures for the fifth day after treatment is practically the same for the exposed and the new powder.

With the BHC 2 per cent. powder, on the other hand, the final mortality is significantly lower for

the exposed powder than for the fresh, the material exposed for two months not being significantly better than the control.

These results suggest either that the BHC 2 per cent. powder is more readily decomposed than the Bexadust, or that the gamma benzene hexachloride content of the former is not as high as it is claimed to be. A rough estimate of the total benzene hexachloride content of the two powders was arrived at, as described below, and would appear to explain the anomalous results.

Weighed samples of the two powders were heated to about 300°C. for two hours. This was thought to be sufficient to drive off practically all the benzene hexachloride, which has a boiling point of 218°C. at atmospheric pressure. After being allowed to cool, the samples were weighed again. The Bexadust was found to have lost 6.09 per cent. (by weight) on heating, while the other BHC powder had lost only 3.32 per cent. The decrease in weight would include a certain amount for loss of moisture, but this amount would probably be nearly the same for the two powders, which had been stored under the same conditions. As far as Bexadust is concerned, the loss in weight is consistent with the stated benzene hexachloride content.

When the powders were heated, the benzene hexachloride was given off as a white cloud of smoke. It was noticed that the smoke given off by the Bexadust was considerably greater in quantity than that given off by the other powder. If the gamma isomer content of this powder is 2 per cent., the total benzene hexachloride content should be between 15 and 20 per cent., and the loss of weight on heating should be considerably greater than the figure obtained. It would appear, therefore, that this powder is considerably lower in benzene hexachloride content than it is claimed to be.

The results of the tests against the elegant grasshopper would then be explained as follows. Even after exposure to the atmosphere for two months, Bexadust still contained sufficient active material to kill practically all the hoppers. The other powder, however, containing less active material at the start, no longer contained enough to be effective after two months.

In the course of these observations a certain amount of information was collected on the nature of the diluents used in the preparation of the two benzene hexachloride powders. This information does not now appear to have much bearing on the results of the mortality tests; nevertheless it is summarised here for reference.

The inert carrier used in the preparation of Bexadust is stated to be talc. Its specific gravity, after heating to remove the benzene hexachloride, was found to be 2.64. Information on the carrier used in the other material not being available, the substance was analysed by Mr. Beater, and it was found to contain silica (as SiO_2) 58 parts, and alumina (as Al_2O_3) 31 parts per hundred, these figures being consistent with the composition of a clay of the kaolin type. The specific gravity of this carrier was found to be 2.56.

Microscopic examination of the two powders was carried out by dusting equal quantities of each on to glass slides and measuring the diameter of all particles in the field of view, the slide being moved until 1,000 particles had been measured for each sample. The results are tabulated in Table IV. The figures for the smallest particles may be inaccurate, as particles may have been present which were too small to be observed under the magnification used.

TABLE IV.

Range of particle size in carriers.

Diameter of particles in microns.	Number of particles BHC .2 per cent.	Number of particles Bexadust.
Up to 0.35...	31	16
0.35 to 0.70	117	33
0.70 to 1.05	374	102
1.05 to 1.40	171	82
1.40 to 1.75	106	77
1.75 to 2.10	56	71
2.10 to 2.45	35	68
2.45 to 2.80	23	95
2.80 to 3.15	24	122
3.15 to 3.50	35	154
3.50 to 5.25	16	94
5.25 to 7.00	7	47
7.0 to 10.5	3	18
10.5 to 14.0	2	9
14.0 to 17.5	—	4
17.5 to 21.0	—	2
21.0 to 24.5	—	2
24.5 to 28.0	—	1
28.0 to 31.5	—	1
31.5 to 35.0	—	1
35.0 to 42.0	—	1
Mean diameter in microns ...	1.57	3.33

Thiophos and Aldet Insect Powders.

A test was also carried out to compare the toxicity to *Z. elegans* of Aldet insect powder and Thiophos (Parathion) agricultural dusting powder with that of Bexadust. Aldet insect powder is stated to consist of 5 per cent. DDT and 2.5 per cent. benzene hexachloride in a talc carrier. It probably contains about 0.3 per cent. of the gamma isomer of benzene

hexachloride. The Thiophos dust used contained 1 per cent. Parathion (o, o-diethyl o-p-nitrophenyl thiophosphate).

Sets of 100 hoppers were dusted with Aldet insect powder, Thiophos and Bexadust, at a rate equivalent to 12 pounds per acre, eight replications being carried out for each treatment. Figures showing the mortality after one day and after five days respectively are given in Tables V and VI.

TABLE V.

Mortality per hundred hoppers after one day.

Cage No.	Control.	Bexadust.	Aldet.	Thiophos.
1	0	14	43	82
2	1	27	19	83
3	1	17	40	84
4	0	15	36	86
5	2	25	32	80
6	1	22	26	76
7	0	25	26	75
8	1	16	56	71
Totals	6	161	278	637

Significant difference between totals: 64.0 at 19 to 1.
87.1 at 99 to 1.

TABLE VI.

Mortality per hundred hoppers after five days.

Cage No.	Control.	Bexadust.	Aldet.	Thiophos.
1	2	100	100	100
2	5	100	100	100
3	4	100	100	100
4	4	100	100	100
5	6	100	100	100
6	3	100	100	100
7	5	100	100	100
8	7	100	100	100
Totals	36	800	800	800

Significant difference between totals: 6.8 at 19 to 1.
9.3 at 99 to 1.

These figures show that Thiophos is more rapid in its action, Aldet being intermediate in this repsect between Thiophos and Bexadust. The final kill obtained after each treatment, however, was the same, each insecticide causing a mortality of 100 per cent. of the hoppers.

As Thiophos is toxic to man, and can be absorbed through the skin, the makers advise that the following precautions should be taken when it is being applied:—

Do not get on skin, in eyes, or on clothing.

Wear protective clothing and goggles.

Do not breathe dust or vapours; wear a respirator.

Keep away from food or food products.

Wash hands, arms and face after handling and before eating or smoking.

Acknowledgement.

My thanks are due to Mr. B. E. Beater for analysing and determining the specific gravity of materials used as carriers in the benzene hexachloride dusts tested.

Summary.

An account is given of a number of laboratory tests on insecticides against the elegant grasshopper. Disappointing results obtained with a particular make of benzene hexachloride powder are explained as probably being due to this material not having as high a content of the gamma isomer as is claimed for it. In one experiment Bexadust (a powder containing 5 per cent. technical benzene hexachloride), Aldet (a powder containing 5 per cent. DDT and 2.5 per cent. technical benzene hexachloride) and Thiophos dust (a powder containing 1 per cent. parathion) each killed all the hoppers.

Experiment Station,
South African Sugar Association,
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The PRESIDENT wished to know if the two benzene hexachloride insecticides mentioned in the paper were of local manufacture. Apparently a good deal depended on the length of time benzene hexachloride was stored, and this was a serious drawback when one wanted to use it, perhaps, very occasionally. It was remarkable that of the four forms of benzene hexachloride, only one, the gamma form, was useful as an insecticide. All four had the same chemical composition in the sense that their molecular constructional differences could not be shown on paper, for being differences in the spatial arrangement of the atoms around the benzene nucleus, they could only be explained with solid models.

Dr. DICK replied that both of the benzene hexachloride insecticides were of local manufacture. He did not think that benzene hexachloride decomposed very rapidly on storing. The Bexadust form kept well for a year and was then nearly as effective as the new material. Even when exposed to the atmosphere for two months, it was still effective, but the other material could not stand exposure to the same extent.

The four forms of benzene hexachloride known showed differences in specific gravity and in boiling point.

Mr. BECHARD asked whether the insecticides were applied to the hoppers, or their food, or to both.

Dr. DICK said that both grasshoppers and their food were dusted. The substances used were all contact insecticides, but while benzene hexachloride was a stomach poison as well, it was usually employed as a contact insecticide, which meant that one had to hit the insect with it. This was quite easy to do in the field. The hoppers were dusted shortly after they had hatched out, when they clustered together in little groups in the early morning and in the evening. It was a simple matter to apply one puff of dust to each group, and this was all that was required.

Mr. BECHARD considered that there was less chance of the insecticide deteriorating if it was in the form of a material that was always being used by farmers such as "Dubble Benhex."

Dr. Dick stated that this substance was designed as a dip for animals, but, while he had not tested it on these insects, the active agent was the same benzene hexachloride, and it would probably be as effective in this liquid form.

The PRESIDENT pointed out that as the boiling point of benzene hexachloride was 218°C., it must be volatile to some extent, as glycerine, which had a similar boiling point, was slightly volatile at ordinary temperatures.

He enquired to what extent D.D.T. was volatile. This substance, being much more complicated in chemical constitution, he would not expect to be as much so as benzene hexachloride.

Dr. DICK considered that D.D.T. was not volatile to the same extent. The residual effect of D.D.T. used as a spray seemed to last a long time. He had had some beds in the native compound painted with this spray, and could still see the deposit of white powder two years later.