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Combined use of rodenticidal dust and poison solution against house-mice (*Mus musculus* L.) infesting a food store

By F. P. ROWE and A. H. J. CHUDLEY
Infestation Control Laboratory, Ministry of Agriculture, Fisheries and Food, Tolworth, Surbiton, Surrey

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INTRODUCTION

Laboratory and small scale field trials have shown that some measure of control over house-mouse (*Mus musculus* L.) populations living in dry environments could be achieved by surrounding water baits with a dust containing 1% warfarin [3-(α-acetonyl-benzyl-4-hydroxycoumarin)] (Rowe, 1957). The effectiveness of warfarin dust alone in controlling house-mice infesting the wall cavities of food stores was also demonstrated. Both methods have been used recently in an attempt to control a heavy infestation of mice living in the stacks of flour and the wall cavities of a large food store. Bait-boxes containing a water fount surrounded by 1% warfarin dust were placed around the bases of the stacks and in some of the air-lanes dividing stacks. More warfarin dust was laid at the ends of roof trusses and in wall crevices.

Monthly census baitings showed that mice infesting the walls were soon controlled, but that control of the mice living in the stacks was less rapid. It was considered that a quicker kill would have been obtained had the stacks been smaller (200–400 tons) and had the air-lanes been wide enough to allow a bait-box to be placed in each of them. It was also considered that replacing the water in the drinking founts with anticoagulant in solution (Rowe, 1961) might yield quicker results. A second trial against mice infesting a similar store is described below.

METHOD

The store chosen housed approximately 3000 tons of flour built in seventeen stacks measuring between $30 \times 30 \times 12$ ft. and $35 \times 30 \times 12$ ft. During the experiment a turnover of the stock was in progress, some flour stacks being dismantled and replaced by new ones.

An index of the degree of infestation by mice was obtained by test-baiting the stacks, wall ledges and machinery with wheat grains laid on bait trays. Three grains were placed on each tray and the number removed was recorded 24 hr. later; the number of grains was then made up to 3 per tray and the number missing again recorded after a further 24 hr.

Immediately after the first test-baiting was concluded the stacks were treated with poison placed in bait-boxes measuring $11\frac{1}{2}$ in. square (Pl. 1, fig. 1). Each box consisted of a hardboard base with two wooden sides nailed opposite each

other and a detachable hardboard lid. Shallow wooden battens were fixed across the two open ends of the base to prevent dust from spilling. The lid had a 3 in. diameter hole in the centre and rested on the wooden sides. A box was prepared by removing the lid and covering the base to a depth of approximately $\frac{1}{4}$ in. with 1 % warfarin dust. A small chick-fount—consisting of a 1 lb. jam jar and metal base—was partly filled with a solution of sodium warfarin and placed in the centre of the dust. The lid was then put back, the top of the jar projecting through the hole in the lid. The poison, a 0·005 % sodium warfarin/5 % sugar solution, was prepared by adding individual packets of the anticoagulant, contained in a diluent, to water containing 5 % of sugar. The solution was mixed in bulk in a pail and each fount three-quarters filled by immersing the fount-base and jar in the solution.

The flour stacks were supported off the floor on dunnage consisting of a lattice of wooden planks over an open network of bricks. Wherever possible the boxes were partially inserted between the bricks (Pl. 1, fig. 2) with the solid sides placed in line with the length of the stacks. Boxes laid in this manner were found to be less liable to be knocked accidentally than those which projected completely into the gangways.

One box was laid mid-way along each side of the five stacks situated at the ends of the store. Around each of the other twelve stacks an additional box was placed in the 2 ft. air-lane dividing it from its neighbour, the four boxes in the air-lanes being staggered. A further sixteen boxes, making a total of ninety-six, were distributed at eaves height at the gable ends of the store and on the floor in each corner of the building.

During the poison treatment test-baitings were carried out at intervals. At each test-baiting, and periodically between baitings also, the warfarin dust in the boxes was examined; more was added when required and footprints were erased. The chick-founts were also inspected and the poison solution topped up when necessary.

During the early part of the treatment the location of dead mice was recorded daily and during each test-baiting and at each examination of the boxes the store was searched for bodies. The numbers of mice found during the breaking down of stacks were also noted.

RESULTS

The test-baitings

Examination of past baiting records showed that the flour store had had a persistent mouse infestation for nearly 2 years prior to the reported experimental treatment. In the last 16 months of this period between March 1960 and July 1961, baits containing 0·025 % warfarin in medium oatmeal were distributed on the stacks at the rate of one bait per ton of flour. The results of test-baitings with wheat grains at approximately 3-monthly intervals during this treatment are given in the upper part of Table 1.

The average number of wheat grains removed at the test-baiting in July 1961 was 2438 or 44·8 % of the total grain laid. The warfarin/medium oatmeal baits were then removed and the boxes containing 1 % warfarin dust and a 0·005 % sodium warfarin and 5 % sugar solution were placed around the stacks. The results of three

further test-baitings done during the dust/liquid poison treatment are given in the lower part of Table 1. After 5 weeks' poison treatment, the number of grains missing was 132 (test-baiting 1) indicating that the mouse population had been reduced by approximately 95 %. Five weeks later the degree of control achieved

Table 1. *Test-baiting results for two different warfarin treatments against mice infesting stacks of flour*

Month of laying test-baiting	Number of wheat grains laid	Number of wheat grains removed (mean of two days)	Percentage removed
March 1960	10,248	3,369	32·9
June 1960	6,515	472	7·2
September 1960	5,070	1,459	28·8
January 1961	5,559	2,643	47·5
April 1961	5,385	2,173	40·3
July 1961	5,445	2,438	44·8
August 1961	5,439	132	2·4
September 1961	5,271	52	1·0
November 1961	5,763	3	0·1

Table 2. *Results of test-baiting*

Location of census points	Number of grains removed daily							
	Pre-treatment test-baiting 4. vii. 61–5. vii. 61		Test-baiting 1 9. viii. 61–10. viii. 61		Test-baiting 2 14. ix. 61–15. ix. 61		Test-baiting 3 22. xi. 61–23. xi. 61	
Stack A	158	247	62	63	6	14	0	0
B	64	135	0	3	2	1	0	1
C	31	60	0	4	0	4	0	0
D	141	240	1	3	0	0	0	0
E	152	214	2	4	7	22	0	0
F	203	266	0	0	0	0	0	0
G	113	192	0	7	2	0	—	—
H	181	224	0	0	—	—	0	0
I	—	—	—	—	6	0	0	0
J	165	170	0	16	0	0	0	0
K	181	196	0	0	0	0	0	0
L	144	189	0	6	0	0	4	0
M	81	142	14	24	11	16	1	0
N	—	—	—	—	0	2	0	0
O	73	117	—	—	—	—	0	0
P	138	169	20	32	4	4	—	—
Q	170	223	0	0	0	0	0	0
Wall ledges	46	49	3	0	0	0	0	0
Cased goods	0	2	0	0	0	3	0	0
Total	2041	2835	102	162	38	66	5	1
Mean of two days	2438		132		52		3	
Total number laid daily	5445		5439		5271		5763	

had risen to about 98% (test-baiting 2) and after a further 10 weeks (i.e. after the treatment had been in progress for 20 weeks) almost 100% control had been obtained (test-baiting 3). The test-baiting figures for the individual stacks, wall ledges and cased goods are given in Table 2.

Mouse activity at the bait-boxes

Footprints in the warfarin dust were recorded as either light, medium or heavy. They were designated light when only a few prints were visible, medium when prints were scattered over most of the dust and heavy when the dust had been trampled. Table 3 shows the numbers and intensity of visits to the boxes at intervals throughout the treatment.

Table 3. *The number and intensity of visits by mice to the bait-boxes at intervals during the poison treatment*

Date	Interval between inspections (days)	Intensity of footprints			Number of bait-boxes entered (out of 96)
		Light	Medium	Heavy	
5. vii. 61–6. vii. 61	1	11	10	1	22
6. vii. 61–20. vii. 61	14	28	24	29	81
20. vii. 61–21. vii. 61	1	26	10	0	36
21. vii. 61–9. viii. 61	19	32	14	5	51
9. viii. 61–10. viii. 61	1	4	0	0	4
10. viii. 61–13. ix. 61	34	25	1	0	26
13. ix. 61–14. ix. 61	1	1	0	0	1
14. ix. 61–4. x. 61	20	18	2	0	20
4. x. 61–5. x. 61	1	0	0	0	0
5. x. 61–16. x. 61	11	41	11	2	54
16. x. 61–6. xi. 61	21	33	9	0	42
6. xi. 61–21. xi. 61	15	28	5	0	33
21. xi. 61–22. xi. 61	1	0	0	0	0

After 24 hr. 22 of the 96 boxes had been entered by mice. All but one of them had footprints of light or medium intensity. A further inspection 2 weeks later showed that all but eight boxes had by then been entered. Further inspection on 2 consecutive days in each month from late July until mid-September showed that there was a progressive decrease in the number of visits by mice to the boxes. Single inspections in mid-October and early November indicated some renewal of activity, but 80% of the footprints were recorded as light, and no mice entered the boxes at all during 24 hr. from 21 to 22 November—the period of the final test-baiting.

Dead mice recovered

Two dead mice were found 4 days after the beginning of the treatment and 48 during the 1st month; 15 more bodies were found during the remaining 10 weeks of the treatment. Of the 63 dead mice recovered outside the stacks, 48 were found on the floor close to or between stacks, 10 on the tops of stacks, 2 at the base of the inner wall of the store, 2 beneath boxes placed at eaves height, and 1 underneath

machinery. It is probable that many more mice died, for during the dismantling of two of the flour stacks 34 bodies were found. A few recently killed mice found in nests in the centre of one stack showed that at least some of the animals living furthest away from the boxes were visiting them.

DISCUSSION

The test-baiting figures in Table 1 show that, although the poison treatment using cereal/warfarin baits was fairly successful in its early stages, poison baitings between September 1960 and July 1961 proved less effective and the mouse infestation actually began to increase. The greatly improved control obtained when solid warfarin bait was replaced by the bait-boxes containing poison dust and liquid is clear from the lower part of Table 1. The effectiveness of the latter treatment may also be compared with that of the similar one mentioned earlier, where plain water was used instead of the poison solution. The control achieved with the dust and poison solution after 5 weeks' treatment was 95 %—compared with only 85 % after 9 weeks with dust and plain water bait. The supposition that the increased rate of kill in the former treatment was due in part to consumption of the poison solution is corroborated by the fact that patches of dust were found from time to time on the rim of the fount bases.

The experience of both trials showed that the dust/liquid method of poisoning mice requires fairly constant attention and regular maintenance of the baiting points. It was found necessary to top up some of the drinking founts after the treatment had been in progress for only 5 weeks and all were replenished to a varying extent over the next 3 months. After 1 month also, it was noticeable that the poison solution in some of the founts had become slightly cloudy; and after 3 months mould growth was sufficiently advanced to warrant cleansing of the jars and founts. Another difficulty encountered was the need during turn-over to move a number of the boxes from dismantled to new stacks. It was found, however, that with care this could be done with little spilling of the poison solution.

A field trial of the usefulness of the dust/liquid baiting technique against mice living in colder and less dry conditions than encountered hitherto has also been attempted. The turn-over of the stocks caused the trial to be abandoned but the result obtained—a 65 % reduction of the mouse population after 5 weeks' treatment—suggests that the method is less effective under these circumstances. Although an additional bait such as whole wheat placed in the boxes might help to attract the mice more regularly to the baiting points, the dust/liquid baiting method would seem to be most effectively used as an alternative or additional form of control to cereal warfarin baits against mice living in relatively warm environments where alternative drinking supplies are intermittent or non-existent.

SUMMARY

1. A food store infested with house-mice (*Mus musculus* L.) was treated with boxes containing 1 % warfarin dust surrounding a solution containing 0·005 % sodium warfarin and 5 % sugar. The boxes were placed around the bases of the

stacks, in the air-lanes between stacks and at eaves height at the gable ends of the store.

2. Census baitings with counted numbers of wheat grains showed that the mouse population was reduced by about 95 % after 5 weeks of the poison treatment and by almost 100 % after 20 weeks.

3. The field trial suggests that the combined use of rodenticidal dust and poison solution baiting points is a useful additional method of controlling *M. musculus* and is most effectively employed against mice living in warm, dry environments.

Thanks are expressed to our colleague Mr E. W. Powell, who co-operated in this work.

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EXPLANATION OF PLATE

Fig. 1. Bait-box containing 1 % warfarin dust surrounding a 0·005 % sodium warfarin/5 % sugar solution.

Fig. 2. Bait-box with lid removed placed at the base of a flour stack.

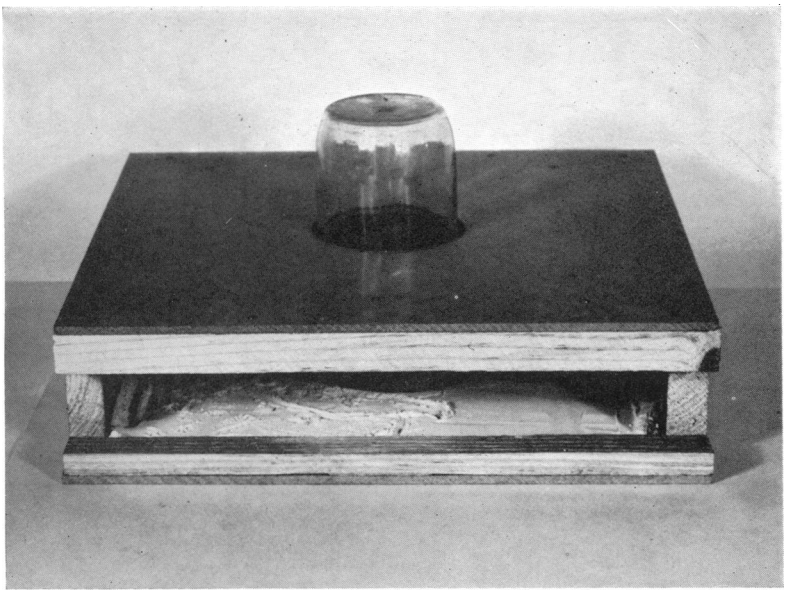

Fig. 1

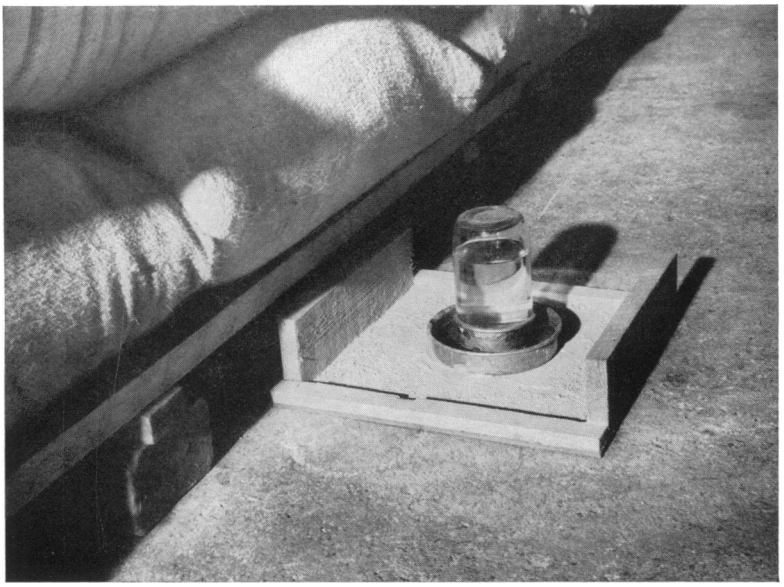

Fig. 2