THE ACCEPTANCE BY BOBWHITE QUAIL OF RODENT BAITS DYED AND TREATED WITH ZINC PHOSPHIDE

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Rodent damage to forest tree plantations and orchards is a common economic problem throughout much of the United States. Several species of rodents cause losses by consuming tree seeds, by girdling stems of seedlings and saplings, and by excavating and eating roots. These depredations have occasionally been extensive and sufficiently severe to require control of the nuisance species. The control method chosen generally was determined by economic feasibility and its effectiveness in reducing damage. The problems of losses of non-target species of wildlife, and the longterm effects of the rodent control program on the ecosystem were given secondary or negligible consideration. Endrin, for example, was widely used for control of pine mice *(Microtus pinetorum)* in orchards and gardens despite its persistence in the ecosystem and its nonspecific toxic effects.

Today, however, widespread public and professional concern exists over the dangers of pesticides to wildlife, and ultimately to man. "Safety" for non-target species is now a primary factor governing the selection of a metho- for controlling any nuisance animal population. Unfortunately, the search for safe, economical and efficient methods for animal control has produced few successes. Particularly is this true for wild rodent control in forest plantations, where damage may be widespread in areas of good wildlife habitat and crop value per acre relatively low.

One such agent, meeting the requirements of economic feasibility and effectiveness, and reputedly of low hazard to non-target species, is grain treated with 1.5 percent by weight of zinc phosphide (USDI 1968). This material, applied at a rate of 7-10 pounds of grain per acre, is recommended for controlling small rodents in largescale damage situations. While zinc phosphide is highly toxic to all forms of wildlife, its reported "safe" quality for non-rodents is due to its disagreeable odor and the dark coloration it imparts to the bait vehicle. It is registered by the U. S. Department of Agriculture and by many state departments of agriculture for controlling rodents in fields and around homes and gardens. As other rodenticides, particularly those with persistent life in nature, are discontinued from use, the utilization of zinc phosphide may show an increase.

However, disquieting reports of losses to wildlife in areas treated with zinc phosphide continue to occur. A most recent case involved a control program in Tennessee on 10,000 acres of Virginia pine *(Pinus virginiana)* where zinc phosphide on dyed crackd corn *(Zea mays)* was used to reduce populations of prairie voles *(M. orchragaster)*. Public claims of extensive losses to wildlife in this case were not substantiated, but neither were they conclusively disproven. Available evidence, however, suggested that wildlife losses were negligible. A report by the National Pest Control Association (1967) refers to incidences of poisoning of ducks, pheasants and domestic stock by zinc phosphide, and stresses the potential hazard of this chemical to wildlife. Janda and Bosseova (1970) note without elaboration that wheat *(Triticum aestivum)* dyed red and treated with 2.5 percent zinc phosphide was readily eaten by pheasants *(Phasianus colchicus).*

These conflicting opinions and statements about the hazards of zinc phosphide treated grain baits suggested a need for more information about the reaction of wildlife to the introduction of this poison into the environment. This paper reports on a study made to determine the repellency to bobwhite quail *(Colinus virginiana)* of zinc phosphide combined with black dye and shape alternation of oats *(Avena sativa)*, the bait vehicle.

EXPERIMENTAL METHODS

Four bait materials were tested: (1) whole oat groats dyed black, (2) lightly rolled oats dyed black, (3) whole oat groats dyed black treated with a 1.5 percent of zinc phosphide, and (4) undyed oat groats treated with zinc phosphide.

A series of four sets of experiments were conducted to test the repellency of the various bait treatments. These experiments were conducted as follows:

Experiment I: Five quail in each of five cages were provided the opportunity to choose between whole oat groats dyed black and undyed oats in separate feeders. Each day for four days the weight of each type eaten by the birds was determined. A similar experiment using dyed vs. undyed rolled oats was conducted with a separate group of 25 birds.

Experiment II: Five quail in each of five cages were presented daily 25 grams of dyed and 25 grams of undyed oat groats mixed and scattered on the wooden floor of their 4′ by 4′ pen. The residual grain was carefully retrived and weighed at the end of each day for four days. Again this experiment was repeated testing dyed vs. undyed rolled oats with a different group of 25 birds.

Experiment III: Ten birds were placed in each of five outdoor pens measuring 10′ x 12′. The floor of these pens contained moderately dense stands of natural vegetation and approximated areas normally used by wild quail. A total of 420 grams each of dyed and undyed whole oats were scattered in each pen. One bird from each pen was sacrificed each day, their crops removed, and the number of kernels of each biat type in each crop was counted.

Experiment IV: Five birds in each of five outdoor pens were adapted to milo and lespedeza in feeders. Feeders were removed after 10 days and approx. 250 grams each of milo and lespedeza were scattered in the pens. The following five days exposure another 100 grams of milo were added to replenish the food supply. Survival of the birds was the criterion used to determine the repellency of the bait. The experiment was repeated using dyed poisoned oats in five pens for five days and a control group of five pens with no oats.

Statistical analysis utilized a paired t-test for experiments I-III. The results of experiment IV were not subjected to statistical analysis. The Kolmogorov-Smirnov two-sample test was used to detect differences in trends in utilization over time.

To avoid bias due to learning, no individual quail was used twice in separate experiments.

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RESULTS

The repellent attribute of black dye on oat kernels was readily apparent under conditions of free choice of bait placed separately in troughs. Oats dyed black, both whole and lightly rolled, were eaten in significantly lesser amount ($p=0.01$) than were their undyed counterparts (Table 1). Whole oat groats were eaten in lesser amounts than rolled oats, but the experimental method did not permit valid statistical comparison of differences between these treatments.

Quail fed a mixture of dyed and undyed oats scattered on the wooden floor ofheir 4′ x 4′ cage discriminated readily between the baits, strongly favoring undyed oats in their diet. Differences between consumption of the two baits were highly significant for both whole and rolled oats (Table 2). Again, quail fed rolled oats consumed greater quantities of both dyed and undyed than did those given whole oats. Rolled oats did not accept dye as uniformly as did whole oats, and were generally lighter and more varied in color. Alteration of the shape of the oats by light steam rolling obviously did not serve as a deterrent to feeding and, in fact, appeared to increase its utilization.

Birds presented whole oat groats in outdoor pens under simulated field conditions demonstrated a preference for undyed kernels ($p=0.01$) (Table 3). Differences in mean number of kernels consumed were proportionately less than in previous experiments, and the data showed some trend toward an increase in consumption of dyed grains on the 4th day. This may have reflected the decreased availability of undyed kernels. The supply of undyed kernels was replenished and the previous pattern of consumption resumed.

In the last set of experiments the quail were exposed for the first time to baits treated with zinc phosphide. Prior to their exposure to the poisoned grain, they were adapted to feeding on milo and lespedeza. These seeds were readily available and represented foods which are moderately to heavily used by wild quail when available. This experiment was designed to simulate natural field conditions which should exist if a rodent control program were initiated during the autumn season. After about ten days acclimatization to the feed grains in outdoor pens, the quail were presented the poisoned, dyed oats in a concentration about 10 times the rate used in rodent control programs. Twenty-three quail survived ten days exposure in excellent condition. One bird consumed 18 grains of bait and died early on the first day. One other quail died on the fifth day. No oats were in the crop.

To further examine the repellency of dye and poison on oats, the experiment was repeated using undyed grain with poison in one set of five pens, and dyed grains with poison in another set. This test was run for five days. No bird in any treated pen expired, and all appeared healthy and vigorous at the conclusion of the experiment. Two birds in a control set of five pens died from cannibalism, but no losses occurred after the culprit was removed.

DISCUSSION

Under the experimental conditions described whole oat groats dyed black were least consumed by quail, and appear to be the most satisfactory bait vehicle for the application of zinc phosphide. Zinc phosphide applied to the oat kernels also served as a deterrent to feeding. Only two deaths occurred in nearly 500 bird-days exposure to dense concentration of oat groats treated with 1.5 percent by weight of zinc phosphide. We conclude from these data, that zinc phosphide treated oat groats pose relatively low hazard to bobwhite quail if distributed at recommended rates during a period of reasonable food abundance for quail.

We do not conclude that this bait is safe for all non-rodent species of vertebrates. Its high degree of toxicity, and its non-specific nature obviously pose some hazard to all vertebrates which may encounter it. Substantially more

TABLE 1

CONSUMPTION OF EXPERIMENTAL BAITS FROM FEEDERS BY CAGED BOBWHITE QUAIL

Day	Amount of bait consumed in grams[1]			
	Oat Groat[2]		Rolled Oat[2]	
	Dyed	Undyed	Dyed	Undyed
1	0.6	19.3	3.7	154.9
2	1.5	70.6	11.8	194.4
3	1.8	113.2	28.5	225.6
4	2.3	97.5	22.9	202.5
$\bar{x}$	1.6	75.2	16.7	194.4

[1]Each value represents total food of each type consumed in all cages each day (Oat groats-5 cages, 25 quail; rolled oats-5 cages, 25 quail).

[2]Differences highly significant for 25 paired observations (p=0.01).

TABLE 2

CONSUMPTION BY QUAIL OF EXPERIMENTAL BAITS MIXED AND SCATTERED ON CAGE FLOOR.

Day	Amount of bait consumed (grams)[1]			
	Oat Groat[2]		Rolled Oat[2]	
	Dyed	Undyed	Dyed	Undyed
1	3.3	38.2	39.7	95.3
2	7.3	111.6	49.9	111.6
3	3.8	100.6	78.4	115.4
4	14.4	113.9	76.4	110.2
$\bar{x}$	7.2	91.1	61.1	108.1

[1]See Table 1

[2]Differences highly significant for 25 paired observations (p=0.01)

TABLE 3

CONSUMPTION BY QUAIL OF DYED AND UNDYED OAT GROATS MIXED AND SCATTERED IN OUTDOOR PENS.

Day	Amount of bait consumed (kernels)[1]	
	Dyed	Undyed
1	2	104
2	32	93
3	52	238
4	221	207
5	268	428
6	45	1s1
7	95	241
8	22	26
9	69	126
10	100	180
$\bar{x}$	90.6	180.4

[1]Each value represents total number of kernels consumed by 5 quail (1 per pen) sacrificed at the end of each day. Differences highly significant for 50 paired observations (p=0.01).

experimentation needs to be done to improve and/or determine its repellency to other species. The search for species-specific poisons, and other chemical and cultural methods for preventing rodent damage to forests should be intensified. Nevertheless, when damage problems are severe and rodent control is deemed necessary, the rodenticide described above which is known to be economical and effective, affords some measure of safety to bobwhite quail.

LITERATURE CITED

Janda, J., and Marie Bosseova 1970. The toxic effect of zinc phosphide baits on partridges and pheasants. J. Wildl. Mgmt. 34(1):220-223.

National Pest Control Association 1967. Zinc phosphide. Technical Release 17-67. 6p.

U. S. Dept. of Interior 1968 (revised). Characteristics of common rodenticides (for rats and mice). Wildlife Leaflet 337.