EFFECTIVE REPELLENCY CONCENTRATION OF BIRD SHIELD REPELLENT(TM) WITH METHYL ANTHRANILATE TO EXCLUDE DUCKS AND GEESE FROM WATER IMPOUNDMENTS

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Abstract: Laboratory studies were conducted to establish the effective repellency concentration (EC_R) of Bird Shield Repellent(tm) on mallard ducks *(Anas platyrhynchos)* and domestic geese for fresh water impoundments. Six concentrations of the repellent compound, ranging from 90 ppm to 2,890 ppm, were placed in small ponds in 2 aviaries and bird behavior monitored for 7 days. Concentrations $\leq$360 ppm did not limit either of the test species' activities (drinking or bathing) in the impoundments. Concentration $\geq$725 ppm precluded most activity after an initial exposure. Dissolved oxygen tended to decrease after an initial rise and pH increased slightly. Impoundments became discolored with higher concentrations of the repellents' methyl anthranilate precipitates in 24 hr.

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Key Words: birds, ducks, effective repellent concentration, geese, methyl anthranilate, repellent, water impoundments.

Use of anthranilates as bird repellents for a wide variety of applications has drawn considerable attention for almost 40 years. Morley Kare's patent, filed on June 6, 1957 and approved January 3, 1961, indicates that a number of years had been spent exploring this, as well as other compounds. Interest in Kare's work lay dormant until the early 1980's when several scientists began exploring its use for controlling birds at feed lots (Glahn et al. 1989; Mason and Arzt undated; Mason et al. 1983, 1985, 1991), lawns and parks (Mason and Clark 1987), horticultural crops (Askham and Fellman 1989), rice (Avery et al. 1993), field crops (Mason et al. 1993) and airports (Dolbeer et al. 1993).

Dolbeer et al. (1993) found that mallard *(Anas platyrhynchos),* laughing gull *(Larus atricilla),* and rock dove *(Columba livia)* use of impoundments in and around airports could be reduced, when 20 ml of ReJeX-iT™ TP250, a bird repellent with methyl anthranilate, was applied per m^2 of water surface. Unfortunately the compound "did not disperse uniformly over the water surface but tended to coalesce in globules...that the wind blew to the leeward side of the pond." In a second trial using 1g of ReJeX-iT™ AP-75 per liter of calculated pool volume, the same researchers found that the formulation "tended to form globules...on pool bottoms." (Dolbeer et al. 1993).

The inability to achieve an even distribution of the Re-JeX-iT™ formulations in aqueous solutions, as these trials demonstrated, is a function of the formulation; one that is easily predictable and identifiable (Askham 1992, Askham and Moore 1992). Methyl anthranilate (MA) is only slightly soluble in water (Budavari 1989). Encapsulating the MA in modified food starch complexes, as originally developed for livestock feed additives (Mason et al. 1988), does not compensate for the hydrophobic properties of MA. When encapsulated formulations are placed in aqueous solutions, the water soluble starches readily dissolve. This disassociates MA to freely disperse as oil globules that either precipitate to the bottom or coalesce on the surface. Combining surfactants with MA or Re-JeX-iT formulations to ameliorate this problem has been suggested but has not been found to be effective (Askham 1994).

Bird Shield Repellent™, using a patented formulation process that resolves this problem, has been proven to be effective when incorporated with water carriers and sprayed on plants to reduce bird damage to small soft fruit (Askham 1992, 1993; Askham and Moor 1992). Because the product was effective under these conditions, the concept of applying the formulation to water impoundments appeared to be the next logical step. Two questions, however, needed to be addressed. First, how much was needed to effectively keep targeted birds out of the water and second, what physical effects would the compound have on the aqueous physical environment?

MATERIALS AND METHODS

Nine mallard ducks *(Anas platyrhyncos)* and 5 domestic geese were obtained as part of the U.S. Corps of Engineers bird nuisance abatement program in Lewiston, Idaho and Clarkston, Washington along the Snake and Clearwater Rivers and were used as test subjects for this study. Each species was confined to separate 3.75 X 2.1 X 12.6 m (12.5 X 7.0 X 42 ft) wire enclosed outdoor aviaries at the E.H. Stephen Research, Teaching, and Extension Center at Washington State University, Pullman. All birds were fed whole wheat and lettuce *ad libitum,* which maintained their weight throughout the trials.

Water was impounded in 1.4 m diameter children's wading pools, with 0.3 m sides, placed equidistant from each other in each of the 2 aviaries. During the 2-week acclimation period prior to testing, each pool was filled daily with 190 L of water (the optimal amount for easy access and departure) and each bird's behavior recorded (e.g., number of times each bird drank from each pool while feeding or bathing).

Treatments consisted of randomly assigning 31 ml, 63 ml, 125 ml, 250 ml, 500 ml, and 1,000 ml of Bird Shield Repellent™ concentrate (25% vol./vol. active ingredient methyl anthranilate) into 2 of the 3 pools. The remaining pool was left untreated and designated as a control. Each test period was replicated 3 times and separated by a 7-day recovery or "buffer" period. Each flock's behavior was observed and videotaped periodically during the trial.

Impoundment use was determined, in addition to periodic television monitoring, by the amount of soil deposited from the feet of the birds in the pool bottoms and the number of feathers floating on the water of each pool. Water samples were taken from the top, middle, and bottom of each pool and evaluated for color, odor, pH, and dissolved oxygen (DO_2). Dissolved oxygen and pH data were compared with those developed for similar concentrations under controlled temperature, light, and airflow conditions. A t-test was used to determine differences in treatment.

RESULTS

No changes in the test subjects' body weight or overall physical health were noted during the trial. One female successfully hatched 3 ducklings during the sixth week of captivity. All birds were released to a private pond at the end of the summer.

During the initial 2-week acclimation period prior to the trials and again during each buffer period between treatments, every pool appeared to be used with the same frequency by both ducks and geese. Both species, however, preferred drinking from pools closest to their food sources when food was placed in the aviaries each day. During the pre- and buffer-periods both species could be easily herded through the ponds by the technicians. Twenty-four hr post-treatment, however, all of the birds avoided the treated pools and continued to avoid the pools when disturbed for the remainder of the trial period. No carry-over treatment effects were noted after the repellent was removed from the pools and filled with fresh water during the buffer periods.

None of the birds were affected by the 3 lowest concentrations (31 ml, 63 ml, and 125 ml/190 L water; 90 ppm, 180 ppm, and 360 ppm, respectively). No differences were noted in the frequency in which either species of birds used either the treated or control pools during each of these replicates. Concentrations of 250 ml, 500 ml, and 1,000 ml/190 L water (727 ppm, 1,445 ppm, and 2,890 ppm, respectively) curtailed all pool use. Significant differences ($P = 0.01$) were recorded between the number of times both test species used the untreated pools and the treated pools. After an initial head dunking or drink, all of the birds avoided pools treated with the high concentrations for the remainder of each trial period.

Bird Shield Repellent(tm) concentrations remained uniform throughout each pool. Olfactory comparisons of samples taken from each of 3 levels (top, middle, and bottom) were consistent for all concentrations throughout each 7-day trial period. No significant differences in pH changes were noted between control and treated samples; pH increased about 1.0 in both. Dissolved oxygen concentration increased rapidly from approximately 2.7 mg/L to 7.9 mg/L during the first 24 hr after the pools were treated with each concentration. After the initial increase, dissolved oxygen levels decreased about 1-3 mg/L depending on repellent concentration. Dissolved oxygen concentrations increased slightly (approximately 0.8 mg/L) throughout the comparative trial under controlled temperature, light, and air flow conditions. A uniform brown precipitate or residue developed throughout the water within 24 hr post-treatment in all but the lowest treatment. None precipitated to the bottom of the pools nor coalesced on top of the water as noted in previous trials on other formulations (Dolbear et al. 1993).

DISCUSSION

Concentrations of 90 ppm, 180 ppm and 360 ppm of Bird Shield Repellent (tm) did not alter the use of 190 L water impoundments by either mallard ducks or domestic geese. Behavioral changes, such as the number of times each bird drank from the pools while feeding or bathing, were not statistically different between treated and untreated water sources. Bird Shield Repellent(tm) concentrations of 727 ppm, 1,445 ppm, and 2,890 ppm altered both bird species' behavior immediately. After an initial 2-3 tries, drinking shifted from treated pools to the untreated pools and did not change throughout each of the trial periods. Bathing similarly shifted from the treated to the untreated pools. When forced to move (herded) in the aviaries, both species avoided crossing water treated with all concentrations. No changes in feeding behavior, including intake, were recorded throughout the trial period.

Odor remained consistent throughout each pool for each treatment for the 7-day treatment periods. The pH was not significantly different between treated pools and comparative controlled temperature, light, and air flow trials. Dissolved oxygen concentrations increased dramatically during the first 24 hr after all treatments, then decreased slightly over the following 6 days. While the water became somewhat discolored, none of the MA precipitated to the bottom of the pools or coalesced on the surface as noted in previous trials with other formulations (Dolbeer et al. 1993).

These data suggest that MA concentrations of 0.089 g/L are needed to achieve repellent efficacy with mallard ducks and domestic geese when formulated as Bird Shield Repellent™. The practicality of using these concentrations will depend, in part, upon economic and social necessity. High impact zones, such as airports and sewage treatment filtration ponds, appear to be viable candidates.

Data have not been developed on Bird Shield Repellent's(tm) longevity in water under differing environmental conditions, such as low temperatures and overcast skies. These trials indicate, however, that the repellent formulation is effective, under ambient summer conditions with light winds and temperatures in excess of 30° C for at least 7 days.

The effective repellency concentration (EC_r) of Bird

Shield Repellent ™ with MA appears to be ≥727 ppm in standing pools of water. The data also indicate that both pH and dissolved oxygen concentrations may be increased. Further testing in larger impoundments under less confined conditions, and under differing climatic conditions, appears warranted.

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