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Evaluation of methyl anthranilate and activated charcoal as snow goose grazing deterrents

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Because greater snow geese (*Chen caerulescens*) damage grain crops and turf grass throughout the eastern United States, repellents are being sought. In the present experiment, 12 0.4-ha study plots were treated with methyl anthranilate (Rejex-It AG-36®, 3.4 kg a.i.), an aqueous slurry of activated charcoal (Anjan-activaid®, 3.4 kg a.i.), or left unsprayed, as a control. Both methyl anthranilate and activated charcoal significantly reduced feces within plots for 16 days post-treatment compared to unsprayed plots. Methyl anthranilate and activated charcoal appear to be promising candidate repellents to deter grazing by snow geese.

Keywords: Anjan-activaid, charcoal, *Chen caerulescens*, goose, methyl anthranilate, Rejex-It, repellent

Populations of greater snow geese (*Chen caerulescens*) have increased in recent years throughout the eastern United States (Gauthier and Bedard, 1991). As a result, crop depredations occur more frequently on migration and wintering areas along the East Coast (Atlantic Flyway Council, 1981). Unlike Canada geese (*Branta canadensis*), that mainly damage crops in the autumn (Heinrich and Craven, 1990), damage by snow geese is most severe in late February and early March during premigratory fattening (Ankney, 1977). Rye, winter wheat, and turf grass are severely grazed, compromising the principle reasons for planting these crops, i.e. nitrogen fixation and protection of soil from wind erosion (Mason, Clark and Bean, 1993). In addition, geese are a vector for the transmission of agriculturally important pathogens and parasites (e.g. soybean cyst nematode; Mason *et al.*, 1993), and even farmers without substantial goose damage to crops express concern over visits by flocks to their fields.

Existing management strategies include hunting and harassment, planting unattractive cover and lure crops (Owen, 1978, 1990; Gauthier and Bedard, 1991), and using auditory and visual repellents (e.g. Conover and Chasko, 1985; Knittle and Porter, 1988; Heinrich and Craven, 1990; Mason *et al.*, 1993; Mason and Clark, 1994b; Taylor and Kirby, 1990; Timm, 1983). However, use of these techniques is limited by cost, logistics, and/or effectiveness. These limitations have stimulated efforts to develop chemical repellents that are effective, economical, and ecologically safe. Two candidate repellents are methyl anthranilate (CAS# 134–20–3) and activated charcoal (CAS# 64365–11–3). Methyl anthranilate is a human and livestock food flavoring that stimulates avian trigeminal chemoreceptors (Mason, Adams and Clark, 1989). Cummings *et al.* (1991) found that methyl anthramilate repelled grazing Canada geese. Activated charcoal repels passerines in laboratory feeding trials, apparently because it absorbs organic substances in the gut (Mason and Clark, 1994a). Both substances are inexpensive and approved by the U.S. Food and Drug Administration as human food or drug additives (e.g. Barnhart, 1989; Mason *et al.*, 1989).

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Materials and methods

Study plots

Twelve plots, each 0.4 ha in size, were selected in Cumberland and Salem Counties, New Jersey, USA. Selection criteria were: (a) evidence of goose activity, e.g. feces, foot prints, feathers, grazing damage; (b) agronomic similarity, e.g. planting date, crop, barriers to the wind. Winter wheat (*Triticum aestivum*) was planted in six plots, and Kentucky blue grass (*Poa pratensis*) was planted in the remaining six. The corners of each plot were marked with a 0.5-m tall survey stakes.

Chemicals

Anjan-activaid®, a product containing 140 mesh activated charcoal (particle size 106 μm) and a small amount of proprietary binder was provided by Pickenhagen Partners (Geneva-Versoix, Switzerland). Rejex-It AG-36®, a product containing encapsulated methyl anthranilate was provided by PMC Specialties Group (Cincinnati, Ohio, USA). For application, both substances were mixed into an aqueous solution containing 10% Wilt-Pruf® (Wilt-Pruf Products, Inc., Essex, Conn., USA). Below, products are referred to in terms of their active ingredients, methyl anthranilate and activated charcoal, respectively.

Procedure

Study plots were assigned to six pairs on the basis of proximity and vegetation type (wheat or grass). Pairs were then assigned to group 1 or 2 (n = 3 pairs/group), and within pairs, one plot was assigned to the treatment condition, while the other was assigned to the control condition. A transect was established diagonally across each plot, and its length was measured. The mean transect length (± standard error) was 92.5 ± 2.7 m. All goose feces within 0.3 m of the transect midline were removed.

All plots were visited at 7-day intervals for 2 weeks pre-treatment and at 4-day intervals for 24 days post-treatment. During each visit, an observer walked each transect and collected all goose droppings within 0.3 m of the midline. Sampling visits to each plot lasted approximately 20 min, and occurred between 0630 and 0900 h, prior to the arrival of geese. After collection, droppings were returned to the laboratory, placed in a drying oven at 37°C for 72 h, and then weighed. Weights were taken as measurements of goose activity within plots (e.g. Mason and Clark, 1994b).

On the day of treatment, a Solo Model 410 Backpack Mist Blower was used to apply methyl anthranilate or activated charcoal slurries at a rate of 3.4 $kg^{-1}ha$ to the treatment plots in groups 1 and 2, respectively. A 10% aqueous solution of Wilt-Pruf® only was applied to the control plots. Control plots were sprayed first, followed by application of activated charcoal. Methyl anthranilate was applied last, because decontamination of the equipment following exposure to this substance required more extensive cleaning than was practical under field conditions. Between each application, all equipment was thoroughly rinsed with warm water.

For methyl anthranilate, residue analyses were performed by coating glass slides (75 × 25 mm) with a slurry of methyl anthranilate on the day of treatment, and then placing the coated slides at the midpoint of the feces collection transect in one of the treated plots. Beginning on the day of treatment, four slides were retrieved at 4-day intervals throughout the post-treatment period. The purpose of the analyses was not to precisely quantitate the amount of methyl anthranilate applied to foliage. Rather the data provided an index of the presence or absense of the compound. For activated charcoal treated plots, slides were coated with slurry on the day of treatment and visually examined for qualitative differences at 4-day intervals throughout the post-treatment period. No quantitative analyses were performed.

Analysis

Field test. Mean post-treatment feces weight per m of transect were calculated for each plot and then evaluated in a three-factor analysis of variance (ANOVA; Keppel, 1973) with repeated measures over measurement times and plots. The independent factor was group (i.e. repellent). Turkey *post-hoc* tests (Winer, 1962) were used to isolate significant differences among means.

Residue analysis. Methyl anthranilate residue concentrations were determined by standard spectrographic techniques (Clark and Shah, 1993). Briefly, each slide was immersed in 100 ml of methanol for 5 days. At the end of this period, the methanol samples were sonicated for 30 min and the sonicated solutions passed through a 5-μm filter to remove the methyl anthranilate encapsulation materials. Filtered solutions were assayed for methyl anthranilate content by ultraviolet spectroscopy. Ultraviolet absorbance was measured at 300 nm, with pure methanol assayed as the control. Standards were prepared using the methods of Clark and Shah (1993).

Results

Field test

There were significant differences among measurement times ($F = 4.3$; 5, 30 df; $P < 0.005$) and between plots ($F = 31.7$; 1, 6 df; $P < 0.002$). There were also significant interactions between group and visits ($F = 3.9$, 5, 30 df; $P < 0.008$), and among group, visits and plot ($F = 3.0$; 5, 30 df; $P < 0.03$; *Figure 1*). Post-hoc interpretation of the three-way interaction showed that, overall, feces weights per transect meter were significantly less in both methyl anthranilate and activated charcoal treated plots (Ps < 0.05, *Figure 1*). In addition, the effects produced by activated charcoal were slightly less durable than those produced by methyl anthranilate ($P < 0.05$). Relative to control plots, the effects of treatment were substantially diminished 16 days post-treatment.

Residue analysis

There was no evidence that the encapsulation matrix

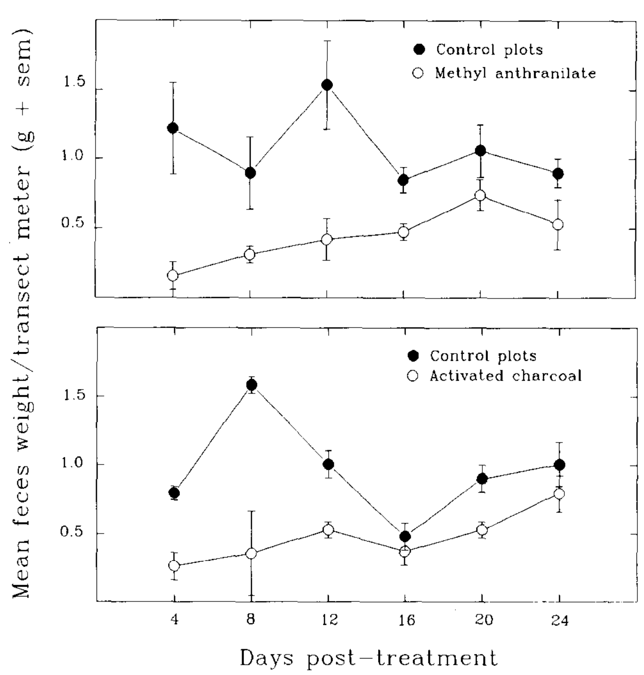

Figure 1. (Top) Mean feces (g/transect m) in control plots and plots treated with methyl anthranilate. (Bottom) Mean feces (g/transect m) in control plots and plots treated with activated charcoal. Capped vertical bars represent standard errors of the means

interfered with the absorption spectrum of methyl anthranilate. Residue analyses showed that the mean concentration of methyl anthranilate on the day of treatment was 3.475 mg slide. At the end of the post-treatment period, the concentration had declined only slightly to 2.353 mg slide. Charcoal particles appeared to be approximately as dense on slides collected at the end of the post-treatment period as they were on the day of treatment.

Discussion and management implications

The results suggest that both methyl anthranilate and activated charcoal reduced snow goose activity in treated plots. Although grazing damage was not evaluated directly, lower feces weights in treated plots probably reflect lower levels of damage to wheat and blue grass (Mason and Clark, 1994b). Such findings are consistent with previous work. For example, methyl anthranilate is broadly repellent to avian species (Mason, Clark and Shah, 1991), and Cummings *et al.* (1991) reported that it repelled grazing Canada geese. Likewise, there is mounting evidence that small particulates such as activated charcoal are repellent to birds in the laboratory (Mason and Clark, 1994a), in outdoor aviaries (Dolbeer and Ickes, in press), and possibly, in the field (Mason, pers. obs.).

Apart from effectiveness, *per se*, both methyl anthranilate and activated charcoal may be relatively easy to commercialize as goose repellents. Already, methyl anthranilate has been registered with the Environmental Protection Agency as a bird repellent for use in selected applications (P. Vogt, PMC Specialties Group, pers. commun.). Although no similar attempt has been made to register activated charcoal, this material has several properties that make it very attractive. Unlike other bird repellents, activated charcoal has no odor or flavor, and it is metabolically and environmentally inert. Large-scale field evaluations of both methyl anthranilate and activated charcoal appear to be warranted. Also, efforts should be directed towards the development of more durable formulations of these substances. Snow goose damage occurs from January to March (Mason and Clark, 1994b). Although birds do not habituate to the presentation of anthranilate derivatives (Mason, Arzt and Reidinger, 1983) or activated charcoal (Mason, pers. obs.), the formulations tested in the present experiment were only effective for 15–20 days. Farmers would need to reapply repellents at least 4–6 times during the winter for effective control of grazing. This level of effort would be both impractical and expensive.

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