CONTROLLING BLACKBIRDS AND STARLINGS AT WINTER ROOSTS USING PA-14

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ABSTRACT

The only EPA-registered chemical for lethal control of winter roosting blackbird (Icterinae) and European starling (Sturnus vulgaris) populations is Compound PA-14 Avian Lethal Agent (PA-14). Between 1978 and 1987, 39 PA-14 spray operations, 15 by helicopter and 24 by ground-based spray systems, have been conducted at 33 winter roosts in Kentucky, Tennessee, and Alabama. In-roost bird mortality for the aerial operations have been poor, averaging only 4% of the pretreatment roost populations or 114,000 birds killed per spray operation. Although very labor-intensive, a ground-based sprinkler system application method has proven much more successful, averaging 67% in-roost bird mortality for 17 spray operations or 287,000 birds killed per operation. A much less labor-intensive ground-based spray system using a pivotal water cannon and chemical injector pump is presently being developed and tested. Results of 7 test sprays conducted in 1986 and 1987 showed an average 57% in-roost bird mortality (203,000 birds killed per spray operation) and investigations into the bird control uses and limitations of this system are continuing.

INTRODUCTION

Blackbirds and starlings often establish large winter roosts in urban and rural areas of the Midsouth. These roosts are often objectionable from agricultural, health, aesthetic, and nuisance standpoints. Public concern over these roosts has increased during the past 20 years, prompting Federal personnel involved in animal damage control research to intensify efforts to develop improved lethal control techniques for roosting birds.

The only EPA-registered chemical for lethal control of roosting blackbirds and starlings is Compound PA-14 Avian Lethal Agent (a-Alkyl[C11-C15]-omega-hydroxypoly[oxyethylene]), a non-ionic surfactant with excellent wetting characteristics. When applied to birds, PA-14 allows water to penetrate and saturate the feathers so that with low temperatures (<7°C) and sufficient precipitation (>1.3 cm of rainfall) the birds die from hypothermia.

From the time PA-14 was registered as a lethal bird control agent in roosts in 1974 through February 1978, 25 PA-14 spray operations involving 63.1 million blackbirds and starlings at 21 roosts in Kentucky and Tennessee have been conducted by state and federal agencies (Garner 1978). PA-14 was applied exclusively by helicopter, and reductions of birds at individual roosts ranged from 0 to 99%. The purpose of this paper is to review and summarize the results of all the PA-14 operations conducted after February 1978 and to discuss the advantages, disadvantages, and limitations of aerial and ground-based application methods.

PA-14 APPLICATION TECHNIQUES

The use of PA-14 is regulated by the U. S. Dept. of Agriculture, Division of Animal and Plant Health Inspection Service, Animal Damage Control program (ADC), following guidelines set forth by the U. S. Department of the Interior (U. S. Department of the Interior 1976).

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Application is limited to certified applicators under the approval and guidance of a management representative of the ADC program. Most PA-14 applications have been cooperative efforts with state agencies coordinating the operational aspects of the roost treatment. Local communities have provided manpower and expenses for purchase of PA-14, making the applications, and disposing of dead birds. The federal government has provided biological evaluations and on-site technical assistance.

PA-14 has been applied to roosting blackbirds and starlings by helicopter and by ground-based sprinkler system (Stickley et al. 1986). A third application technique, using a ground-based pivotal, single-nozzle water cannon, is presently being developed and tested (Heisterberg and Hager In Prep.).

The success of PA-14 spray operations, as measured by the percent of the roosting birds killed, is dependent on: 1) the effective delivery of the chemical to the birds; 2) at least 1.3 cm of rainfall (natural or artificial) falling on the birds shortly after chemical delivery; and 3) accurate prediction of a nightly low temperature of $<7^{\circ}C$. In most cases, aerial applications have relied on natural rainfall (Garner 1978), and ground-based applications on artificially produced rainfall (e.g., Stickley et al. 1986). Aerial application relying on natural rainfall requires an accurate weather forecast in time to assemble the manpower and equipment needed to spray a roost before impending rain and cold temperatures. Ground-based applications relying on water from a nearby (<600 m) fire hydrant and a fire truck to pump water through the spray system have precluded the need for natural rainfall.

All PA-14 spray operations on roosting birds were begun after sunset, and were usually completed by 2:00 a.m. All spray operations have used the registered application rate of 187 l PA-14/ha (20 gal PA-14/acre). For aerial applications, PA-14 heated to around 50-70°C was mixed with 70% water and 5% isopropyl alcohol to prevent freezing of spray equipment, and enough solution was applied to achieve the 187 l PA-14/ha application rate. For the sprinkler system applications, heated PA-14 or heated PA-14 mixed with 30% water was educted (using an in-line foam eductor) or injected (using a chemical injector pump) into a multi-standpipe, low-water volume (760-1890 l/min [200-500 gal/min]) sprinkler system at a 0.7% PA-14 application rate. For the water cannon application technique, a chemical injector pump injected heated PA-14 into a single standpipe, high-water volume (760-4540 l/min [200-1200 gal/min]) spray system at a 0.4% application rate. Immediately following the application of PA-14 through the ground-based spray systems, additional water was applied until a 2.5 cm coverage of the spray area was achieved. For more detailed descriptions of the aerial and sprinkler system techniques, see the PA-14 label use instructions (U.S. Department of the Interior 1985). For more information on the water cannon application technique, contact the senior author.

Methods used to evaluate in-roost bird mortality and percent of the roost population killed differed between the aerial and ground-based PA-14 application techniques. For most of the aerial treatments in-roost kill was considered to be the difference between pretreatment counts of flightlines entering the roost the evening of treatment and posttreatment counts of flightlines exiting the roost the morning after treatment. This difference was divided by the pretreatment count and multiplied by 100 to determine the percent in-roost kill. No attempt was made to determine the species composition of the in-roost kill for the aerial treatments. For most of the ground-based treatments in-roost kill was determined by counting all carcasses, by species, found in randomly selected

1-m^2 plots and extrapolating this count to the area of the kill (Stickley et al. 1986). The percent roost kill was then determined by dividing the in-roost kill by the sum of the in-roost kill and the estimated number of birds exiting the roost the morning after treatment, and multiplying by 100. After most operations a follow-up roost count was made within 2 weeks of treatment.

Many ground-based PA-14 applications and some aerial applications did not cover the entire area occupied by roosting birds. Thus, any comparisons of percent kills as a result of different application methods must be based on the area treated, not on the entire roost area. To achieve this we had to assume that the pretreatment bird density determined for the overall roost area was representative of the pretreatment bird density for the area treated. The percent kill in the treated area (efficacy) was then achieved by dividing the density of the bird kill determined for the treated area (birds killed per ha treated) by the pretreatment bird density determined for the entire roost area (birds/ha), and multiplying by 100.

RESULTS OF SPRAY OPERATIONS

From 1978 through 1987, 15 aerial PA-14 treatments and 24 ground-based PA-14 treatments were made at 33 winter roost sites in Kentucky, Tennessee, and Alabama. Of the 33 sites, 28 (85%) were in urban areas and 5 (15%) in rural areas. In-roost bird mortality varied according to application technique, area of roost treated, and pretreatment density of

Table 1. Results of aerially applied PA-14 winter roost treatments, 1978-1987.

A Roost site[a]	B Treatment date	C Pretreatment roost population	D Roost area (ha)	E Pretreatment bird density (birds/ha)	F Area treated (ha)[b]	G Birds killed in roost	H Birds killed per ha treated	I % of roost population killed in roost	J Efficacy[c] (%)
Winter 1977-78									
Somerville, TN	03/02/78	3,400,000	7.4	459,000	7.4	0	0	0	0
Winter 1978-79									
Bowling Green, KY[d]	01/04/79	2,400,000	2.9	828,000	1.9	160,000	84,000	7	10
Fayetteville, TN IA	01/12/79	800,000	3.4	235,000	3.4	0	0	0	0
Fayetteville, TN IB	01/23/79	1,000,000	3.4	294,000	3.4	100,000	29,000	10	10
Collierville, TN	02/20/79	3,200,000	2.9	1,103,000	2.9	200,000	69,000	6	6
Winter 1979-80									
Fayetteville, TN IIA	01/22/80	2,300,000	3.6	639,000	0.8	0	0	0	0
Fayetteville, TN IIB	01/30/80	2,900,000	3.6	806,000	3.6	1,100,000	306,000	38	38
Fayetteville, TN IIC	02/08/80	768,000	3.6	213,000	3.6	e	e	e	e
Milan, TN	02/07/80	1,250,000	4.0	312,000	4.0	0	0	0	0
Winter 1980-81									
Jefferson City, TN	02/10/81	267,000	1.2	222,000	1.2	0	0	0	0
Winter 1981-82									
Lewisburg, TN IA	02/02/82	3,900,000	2.4	1,625,000	2.4	40,000	17,000	1	1
Winter 1982-83									
Estill Springs, TN I	01/21/83	2,500,000	3.6	694,000	3.6	0	0	0	0
Memphis, TN I	02/04/83	2,250,000	2.3	978,000	2.3	0	0	0	0
Winter 1984-85									
Lewisburg, TN IB	01/30/85	1,800,000	2.4	750,000	2.4	0	0	0	0
Winter 1986-87									
Estill Springs, TN II	01/09/87	1,600,000	5.7	281,000	5.7	0	0	0	0
Mean		2,022,000	3.5	629,000	3.2	114,000	36,000	4	5
Total		30,335,000	52.4		48.6	1,600,000			

[a]Roman numerals indicate individual roost sites; capital letters distinguish different treatments at the same site.
[b]In most cases area treated was not measured but was assumed to be the entire roost area.
[c]Column H x 100/Column E.
[d]PA-14 applied by helicopter followed by water from fire hoses.
[e]No information.

Table 2. Results of PA-14 winter roost treatments using the ground-based sprinkler system, 1983-1987.

A Roost site[a]	B Treatment date	C Pretreatment roost population	D Roost area (ha)	E Pretreatment bird density (birds/ha)	F Area treated (ha)	G Birds killed in roost	H Birds killed per ha treated	I % of roost population killed in roost	J Efficacy[b] (%)
Winter 1982-83									
Manchester, TN IA	01/10/83	325,000	0.5	650,000	0.4	251,000	628,000	77	97
Manchester, TN IB	01/21/83	93,000	0.5	186,000	0.4	72,000	180,000	77	97
Lawrenceburg, TN I	02/09/83	286,000	1.5	191,000	1.5	242,000	161,000	85	84
Lawrenceburg, TN II	02/18/83	99,000	0.3	330,000	0.3	68,000	227,000	69	69
Lawrenceburg, TN III	02/18/83	500,000	1.2	417,000	1.0	154,000	154,000	31[c]	37
Winter 1983-84									
Russellville, KY IA	01/09/84	1,300,000	3.1	419,000	1.4	895,000	639,000	69	100+[d]
Russellville, KY IB	01/29/84	230,000	1.4	164,000	1.4	213,000	152,000	93	93
Somerset, KY I	02/19/84	165,000	0.7	236,000	0.7	154,000	220,000	93	93
Somerset, KY II	02/23/84	345,000	1.6	216,000	1.3	228,000	175,000	66	81
Russellville, KY II	03/12/84	270,000	0.6	450,000	0.3	203,000	677,000	75	100+[d]
Winter 1984-85									
Somerset, KY III	01/30/85	541,000	4.5	120,000	2.0	127,000	64,000	23	53
Scottsboro, AL	02/19/85	628,000	1.8	349,000	1.4	408,000	291,000	65	83
Winter 1985-86									
Somerset, KY IV	01/16/86	591,000	2.4	246,000	2.1	516,000	246,000	87	100
Memphis, TN II	01/23/86	325,000	0.8	406,000	0.8	201,000	251,000	62	62
Manchester, TN II	01/25/86	1,896,000	2.4	790,000	1.6	496,000	310,000	26	39
Winter 1986-87									
Huntsville, AL II	01/29/87	737,000	1.3	567,000	1.0	591,000	591,000	80	100+[d]
Cave City, KY I[e]	01/29/87	95,000	0.6	158,000	0.6	62,000	103,000	65	65
Mean		496,000	1.5	347,000	1.1	287,000	298,000	67	80[f]
Total		8,426,000	25.2		18.2	4,881,000			

[a]Roman numerals indicate individual roost sites; capital letters distinguish different treatments at the same site.
[b]Column H x 100/Column E.
[c]Temperature dropped below freezing and spray turned into ice particles.
[d]Efficacy exceeded 100% because the average pretreatment bird density in the kill area exceeded the overall pretreatment bird density in the roost.
[e]A water cannon placed in a different part of the roost site was operated simultaneously with the sprinkler system.
[f]When determining mean efficacy, those individual efficacies exceeding 100% were considered to be 100%.

Table 3. Results of PA-14 winter roost treatments using the ground-based water cannon, 1986-1987.

A Roost site[a]	B Treatment date	C Pretreatment roost population	D Roost area (ha)	E Pretreatment bird density (birds/ha)	F Area treated (ha)	G Birds killed in roost	H Birds killed per ha treated	I % of roost population killed in roost	J Efficacy[b] (%)
Winter 1985-86									
Nashville, TN I	01/31/86	465,000	7.6	61,000	1.3	201,000	155,000	43	100+[c]
Nashville, TN II	02/21/86	9,000	0.3	30,000	0.3	9,000	30,000	100	100
Winter 1986-87									
Huntsville, AL I	01/03/87	489,000	1.5	326,000	0.9	289,000	321,000	59	98
Cave City, KY I[d]	01/29/87	272,000	1.9	143,000	1.3	122,000	94,000	45	66
Franklin, KY I	02/10/87	1,009,000	3.2	315,000	1.4	309,000	221,000	31	70
Franklin, KY II	02/12/87	638,000	3.2	199,000	1.3	193,000	148,000	30	74
Memphis, TN III	02/24/87	342,000	1.5	228,000	1.1	301,000	274,000	88	100+[c]
Mean		461,000	2.7	186,000	1.1	203,000	178,000	57	87[e]
Total		3,224,000	19.2		7.6	1,424,000			

[a]Roman numerals indicate individual roost sites.
[b]Column H x 100/Column E.
[c]Efficacy exceeded 100% because the average pretreatment bird density in the kill area exceeded the overall pretreatment bird density in the roost.
[d]A sprinkler system placed in a different part of the roost site was operated simultaneously with the water cannon.
[e]When determining mean efficacy, those individual efficacies exceeding 100% were considered to be 100%.

roosting birds (Tables 1, 2, and 3). In-roost bird mortality for the aerial treatments was poor, averaging only 4% of the pretreatment roost populations (average 114,000 birds killed per spray operation). In contrast 17 sprinkler system sprays and 7 water cannon sprays averaged 67% and 57% mortality (average 287,000 and 203,000 birds killed per spray operation, respectively) of the pretreatment roost populations, respectively. After adjustment of bird kill figures for roost area treated, the percent kill in the treated areas (efficacy) averaged 87% for water cannon sprays, 80% for sprinkler system sprays, and 5% for aerial sprays (Tables 1, 2, and 3).

Follow-up roost counts conducted 1-14 days after PA-14 spray operations generally showed a further decline in bird numbers than that attributable to the in-roost kill the night of treatment. This decline from pretreatment roost populations averaged 27% for aerial operations, 84% for sprinkler system operations, and 59% for water cannon operations. Five of the 33 (15%) roost sites treated (Lawrenceburg, TN I, II, and III, Nashville, TN II, and Memphis, TN III) were completely abandoned within 1 week of treatment. Ground-based treatments were used at all 5 sites. Obviously, some of the birds exiting the roost the morning after treatment did not return to the sprayed roost. Whether these birds died away from the sprayed roost because of the residual effects of the chemical or abandoned the sprayed roost because of the conduct of the spray operations is unknown.

Species affected by the sprinkler system and water cannon spray operations and their mean percentages in the overall kill were: common grackle (Quiscalus quiscula) -- 49%; starling -- 23%; red-winged blackbird (Agelaius phoeniceus) -- 19%; brown-headed cowbird (Molothrus ater) -- 8%; and rusty blackbird (Euphagus carolinus) -- 1%. Dead nontarget birds were noted in only 5 of the 24 ground-based spray operations. With the exception of the Nashville, TN I water cannon spray, total numbers were small: 3 northern cardinals (Cardinalis cardinalis), 4 northern bobwhites (Colinus virginianus), 2 American robins (Turdus migratorius), and 1 white-throated sparrow (Zonotrichia albicollis). In the Nashville, TN I spray operation, an estimated 2700 robins were killed (1% of the total bird kill). No data on nontargets killed were obtained for the aerial operations.

A number of factors influenced the success of the different PA-14 application techniques. Insufficient rainfall immediately after PA-14 application accounted for most aerial spray failures. Other relatively minor problems affecting the success of aerial sprays included flushing of birds during chemical application, equipment breakdown and freezing, and difficulty in delineating the area to be treated. The major factor reducing the success of the ground-based application techniques was an inability to treat the entire roosting area. The sprinkler system covered an average of 73% of the roosting areas (average 1.1 ha treated) and the water cannon covered an average of 41% of the roosting areas (average 1.1 ha treated). Flushing of birds during PA-14 application also appeared to be an occasional problem with the use of the sprinkler system and a more pronounced problem with the water cannon.

Equipment and materials expense (1987 prices) to treat 1 ha of roost averaged $1025/ha for aerial application and $670/ha for the ground-based application techniques. This assumes that the average $10,000 cost of a ground-based sprinkler or water cannon spray system is prorated over a 20-year operating life during which 6 spray operations/winter (1.2 ha/operation) are conducted. Labor to conduct the spray operations averaged about 15 person-hours/ha sprayed for aerial sprays, 217 person-hours/ha sprayed for sprinkler system sprays, and 25 person-hours/ha sprayed for water cannon sprays.

Another major expense frequently associated with roost sprays was carcass removal. The stench and attraction of flies to decaying carcasses frequently lasted 3-4 months making roost cleanup necessary at sites located near human habitations. Dead birds were buried by bulldozing at 8 sites, picked up by hand and hauled off at 3 sites, and raked into newly dug trenches and buried at 1 site. Burying birds by bulldozing generally required removal of much of the roost vegetation and cost an average of about $620/ha. Picking birds up by hand approximated 150 person-hours for each 100,000 carcasses removed plus hauling and dumping expenses. At roosts where carcasses were not buried or removed, attempts to mask the stench with lime or deodorizing sprays were unsuccessful.

DISCUSSION AND MANAGEMENT IMPLICATIONS

All PA-14 roost treatments must first be approved by a management representative of the ADC program, U. S. Dept. of Agriculture. Once a site is approved, the advantages and disadvantages of the different application techniques are discussed with the local officials responsible for financing the operation, and recommendations are given as to which application technique best fits their needs. Because of problems with predicting suitable weather conditions, the helicopter application method has seldom been used in recent years. The ground-based application techniques have been used much more frequently, although they also have their limitations. The necessity of a nearby water source (fire hydrant) and restrictions on the area that can be treated in 1 setup are the primary ones. The water source can also be a pond or stream; however, such a source has only been used on 1 previous water cannon spray application.

Presently the sprinkler system can cover up to 1.6 ha and the water cannon 1.4 ha. With larger feeder lines and more standpipes the area covered by the sprinkler system could be increased to about 3 ha. To cover such an area, a fire hydrant capable of delivering water at 3785 l/min would be required. With 2-3 water cannons operating in sequence or in tandem, the area sprayed by the water cannon system in 1 night could be increased to 3-4 ha. The feasibility of expanding either of these systems, however, remains to be fully investigated.

The ground-based sprinkler and water cannon spray systems have advantages and disadvantages. The multi-standpipe sprinkler system can be better tailored to fit the area sprayed than the single standpipe water cannon. The sprinkler system can also be operated with lower volumes of water than the water cannon and may be better suited for use in roosts where hydrant output is <1890 l/min and the area to be treated is >0.8 ha. Birds appear to flush less during operation of the sprinkler system as opposed to the water cannon, although the effect that this phenomenon has on overall kill has yet to be established. The major advantage of the water cannon is that it can be set up and tested the day of treatment, requiring only about 25 person-hours/ha sprayed to erect, test, spray, and disassemble compared with 217 person-hours/ha sprayed for the sprinkler system. Kill efficacy for the water cannon was also slightly higher than for the sprinkler system (average 87% versus 80%), but this was based on a relatively small sample of only 7 water cannon sprays. The water cannon can also be used in roosting vegetation up to 20 m high compared with a maximum 13.7 m for the sprinkler system.

Follow-up roost counts conducted 1-14 days after PA-14 treatment indicated that some surviving birds leaving the sprayed roosts the morning after treatment were not returning to the sprayed roosts on subsequent nights. Within 2 weeks after treatment the average percent decreases from pretreatment roost numbers attributable to the in-roost kills were an additional 23% for the aerial operations (from 4% to 27%), 17% for the sprinkler system operations (from 67% to 84%), and 2% for the water cannon operations (from 57% to 59%). Much of this decrease is probably attributable to surviving birds avoiding the spray site either because of dead birds in the roost or conduct of the spray operations. Spring migration could also account for some of the reduction in bird numbers at roosts sprayed in late February and March as roosts generally begin to break up at this time. Some of the decrease may also be attributable to residual kills occurring away from the roost; however, such kills are likely to take place only when rainfall and cold temperatures occur within several days of the sprays. Such weather conditions after sprays have occurred, but their overall effect on those birds sprayed with PA-14 that survived the night of the spray cannot be quantified.

The recently developed ground-based PA-14 application methods represent a vast improvement in the control of roosting blackbirds and starlings. However, the success of these methods must be tempered by the fact that only a small percentage of roosts have a nearby water source for operation of the systems. For example, ADC State Directors in Tennessee and Mississippi estimate that only about 20% of the problem winter roosts in Kentucky, Tennessee, Mississippi, and Alabama, where lethal control is the preferred alternative, can be sprayed with the water cannon or sprinkler system. This equates to an average 6-8 PA-14 spray operations per winter being conducted in these 4 States in future years. Until lethal roost control toxicants with less restrictive requirements for operational use can be developed, however, the ground-based PA-14 application methods offer the ADC management biologist the best tools available for controlling winter-roosting blackbirds and starlings.

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