November 1976

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The Red-billed Quelea (*Quelga quelaa*), because of its widespread destruction of grain crops throughout its range in Africa, is one of the most studied and written about granivorous bird species. Less publicized are more local bird pests in Africa which may be equally Important. The Village Weaver, (*Ploceus cucullatus*), for example, is a pest in many countries, while some other Ploecids with limited destructive habits create local problems. Significant crop losses also occur where there are large populations of Golden Sparrows (*Passer luteus*), House Sparrows (*Passer domesticus*), Red Bishops (*Euplectes oryx),* Doves (*Streptopelia* spp.), Glossy Starlings (*Lamprotornis chalybaeus*), Parakeets (*Psittacula* spp.), and some waterfowl (Mackworth-Praed and Grant, 1952; Pans Manual No. 3, 1974; Park, 1974).

Crop losses from local bird pests were reported in early February 1975 to the Sudan Plant Protection Bird Control Unit of the Ministry of Agriculture. A mechanized farm scheme in Khartoum North had large concentrations of Red Bishops roosting in maize and feeding on an early-maturing wheat variety (Mexicana). Small flocks of Golden Sparrows and House Sparrows also were present. Bird damage was clearly visible, especially at the corners and along the edges of the ripening wheatfields.

Ground spraying with Queletox (60% a.1. Fenthion) on roosts of the Golden and House Sparrows was conducted along hedge rows of acacia (*Acacia mellifera*) located at the north end of the farm. Although the spray killed large numbers of roosting birds, damage continued as the wheat matured. Pilot field trials were thus organized to test the effectiveness of other crop protection techniques. Because birds fed throughout many blocks of wheat which matured at different periods, it was felt that several different experiments could be conducted without Interfering with each other. The control techniques Included an acoustical repellent, a chemical repellent, a chemical frightening agent, and a trap. The experiments, conducted from February 7 through February 23, 1975, were not designed as an integrated control operation.

MATERIALS AND METHODS

Study Site

Kfouri's farm, where testing was done, borders the Blue Nile River and a large industrial site. The farm consists of a dairy on the north side of the Nile, and an irrigated crop scheme of maize, wheat, and lucerne adjacent to the industrial area north of the dairy (Fig. 1). Two varieties of wheat were grown: 87.75 ha of Giza 155 and 228.48 ha of early-maturing Mexicana. The lucerne and maize were utilized for the dairy operation; the wheat was grown for human consumption with a small portion held for seed.

Bird Numbers and Movement Pattern

After leaving their roost each morning, the Red Bishop population (10,000-15,000 birds) normally splits Into 3-4 feeding flocks, while the Golden Sparrow and House Sparrow populations segregated into about 15 feeding flocks (100-200 birds per flock). The flocks fed on the early-maturing Mexicana wheat located between two canals - Halenko and Wad Gas (Fig. 1).

Acoustical Repellent

The Av-Alarm sound system has been used to repel fruit-eating birds in North America (Brown 1974, Mendal 1974, Palmer 1970). Little work, however, has been done with Av-Alarm to protect cereal crop schemes.

The Av-Alarm can produce many different sound combinations. To determine those sounds most likely to repel birds, one TAV generator and three speakers were mounted on the front of a Land Rover for use as a mobile unit. This enabled quick movement to different feeding flocks of pest birds upon which a wide range of sounds could be tried. When a certain sound appeared effective, individual feeding flocks were followed to determine its repeatability as a repellent stimulus.

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Two Av-Alarm ST series TAV-100A generator units and six 30-ohm speakers were used in the field trial. The units were placed alongside a road (Fig. 1) facing east into field 8/9 Wad Gas (Mexicana variety) from January 9 - February 24. Units were installed on 3-meter-high steel platforms placed 75 meters apart and 175 meters from each end of the 425 x 150 meter trial site. Each unit was fitted with three speakers and timed to operate alternately. After four days of testing six different "sounds," two were selected and used for the duration of the trial (Table 1). Each unit was adjusted to produce one of the two "sounds." Speaker height from ground level, speaker distance from the generator, and speaker direction were varied during the next six days to determine optimum placement.

Chemical Repellent

Methiocarb [3,5 dimethy]-4-(methylthio) phenol methylcarbamate], trade name Mesurol^{R}, has been used as an experimental bird repellent on several crops (DeGrazio, 1972; Guarino, 1972; Crase and DeHaven, 1976). In late 1974, small trials undertaken in the Sudan with methiocarb sprayed on wheat, barley, and sorghum showed promise with repeated treatments, but the need for a good spreading/sticking agent to enhance coverage and chemical retention was Indicated (Martin & Jackson, 1976).

Two separate methiocarb trials were conducted for this experiment. In the first, two ha of Mexicana wheat (site 1) were treated with 6.0 kg active ingredient (a.i.) methiocarb in 292 1 of water per ha with 0.03% AGRAL 90 (ICI)wetter and spreading agent. Half of this plot was sprayed using motorized backpack sprayers; the other half, with a Unimog-mounted 608 1 capacity Holden UG-8 sprayer equipped with 100 m of high pressure hose. The weather during application was clear and hot but with gusty winds. The wheat was treated during the early milk stage just as bird damage started. An adjacent 2 ha plot of Mexicana wheat was used as an untreated control. Treated and control plots were separated by a 3-meter-wide access path.

The second site consisted of .82 ha of Giza wheat that was sprayed with the Unimog-mounted sprayer using the same formulation as at site 1. Two .82 ha untreated plots were located adjacent (one on each of two sides) to the treated plot.

Chemical Frightenlng Agent

Avitrol (4-aminopyridine) is a chemical frightening agent that produces a "series of flock alarm reactions in those birds ingesting a sufficient quantity" (Avitrol Corporation 1973). In some cases the pest birds will not return to the feeding site for 3-6 weeks or longer, but repeated baitings are often required.

After bait preference trials at Kfouri's using wheat, millet, and sorghum offered to Red Bishops, Golden Sparrows, and House Sparrows for 3 days, millet seed appeared preferred and was treated with 1.0% (a.i.) Avitrol using 1.0% milk as a sticker. Treated seed was mixed in four different ratios with untreated seed (1 part treated to 200, 100, 50, and 25 parts untreated, respectively), and one ratio was set at each of four bait sites located in areas where birds regularly fed during early morning hours. Millet seed (0.5 kg) was spread evenly on the ground (Fig. 1). Also, two V-shaped wooden troughs (1m x 12cm x 2cm), described by Palmer (1970), were baited with 0.5 kg of millet seed and placed in a bushy acacia, located on the south-west edge of the Halenko Canal. Little of the bait was eaten the first morning after baiting, but on the second morning about 70% (345 g) of the bait was taken; nearly complete acceptance was noted on the third morning.

Trapping

A modified Australian crow (MAC) trap (Palmer, 1970) was placed in the morning flight path of a 3-6 thousand bird feeding flock of Red Bishops at the south end of Wad Gas field number 9 for 18 days. Groups of 100-200 Golden Sparrows also were feeding in the nearby areas. Ten Golden Sparrows and Red Bishops were placed in the trap as decoys; acacia branches were placed on top of the trap for perch sites. Water and millet seed were provided in the trap and on the ground around it. After 18 days, the trap was moved to a site used mainly by House Sparrows.

Damage Assessment

An unpublished report of the damage assessment technique and results was written by R. G. Allan (1976). Random samples of 100 grain heads were scored at predetermined locations within each test plot. Visual estimates of percent damage were made by comparing sample heads with a photographic standard.

RESULTS AND DISCUSSION

Acoustlcal Repel lent

Damage assessment In the Av-Alarm plot indicated about a 15% loss in field number 8 compared to a 5% loss in field number 9 (Fig. 2). Although damage was evenly distributed throughout both plots (Fig. 2), damage was greatest close to the sound units. If they were effective, the opposite would be true.

Av-Alarm appeared to have a good initial repelling action on all three pest species and on other birds flying over the treatment area for about the first four days. But during the 4th to 6th days, Red Bishops and House Sparrows began feeding consistently a long the field edges. Small flocks of birds would glide into the field and fly out immediately if the Av-Alarm unit came on before they descended below the top of the wheat. The sound was also effective if it came on as the birds moved among feeding sites, but the birds would soon settle down and begin feeding again. Between the 6th and 9th days both Red Bishops and House Sparrows fed throughout the field in flocks of 100-200 birds, and the sound had little or no apparent effect.

"Psychological jamming" from Av-Alarm according to Stewart (1974) "Interferes with indicator sounds that might alert the birds to imminent threats." Regardless of the method, however, Av-Alarm was ineffective in repelling birds after four days in this trial. The most effective initial results came from separating the three speakers of each unit by about three meters and placing them on poles driven into the ground approximately 30 cm above the wheat. The center speaker, when mounted close to the top of the *wheat in a horizontal position (normal position is vertical), produced an echo effect.* The degree of sound change, when manipulating the speakers, was easily perceived by a person in the wheat field. To the human ear, at least, a given "sound" emitted from a speaker is modified depending upon the distance between ear level and the top of the wheat. We have no way of knowing if the birds were reacting to the same sounds heard by a person in the field, although the hearing range of most birds does fall well within that of humans (Frings and Slocum, 1958; Fitzwater, 1970; Stewart, 1974).

Chemical Repel lent

Site 1. Damage assessment indicated approximate losses of 6.0% in the methiocarb-treated plot and 4.0% in the untreated plot. Bird counts, made in the control and treatment test plots (0700-0800 hours every 2 days) one week before and three weeks following the application of methiocarb, indicated the presence of early morning feeding flocks of Golden Sparrows and House Sparrows. Few Red Bishops fed in the area. A count was made by visually estimating the flock size while walking through the test plots on a predetermined route. The total average of birds in the treatment and control plots was 60 Golden and 40 House Sparrows per count day. The numbers of birds in the treatment and control plots did not differ significantly.

Site 2. Damage assessment (Allen, 1976) revealed a loss of about 5.0% and 4.5% in the two control plots and 4.8% in the treated plot. Bird counts were made every two days, one week before and three weeks following treatment between 0800-0900 hours, in the same manner as described for site 1. An average of 70 Red Bishops and 45 House Sparrows were counted each day in the control plot. In the treated plot an average of 50 Red Bishops and 30 House Sparrows were observed per count.

One of the most important factors influencing the action of a bird repellent is the coverage and adhesion of the chemical to the target site (Martin and Jackson, 1976). This often requires an adjuvant with excellent wetting and sticking properties. The Agro 90 adjuvant used in this trial was a good wetting agent but a poor sticker. Host of the methiocarb remained on the wheat for only 3-5 days (at a level visible with a 10 power hand lens). The wheat was vulnerable to damage for about 14 days.

Chemical Frightening Agent

Acceptance of the Avitrol-treated bait was excellent at all bait sites. Effects of the chemical were noted within 5-15 minutes after a flock of birds began feeding. Affected birds did not, however, react as expected, and no immediate flock dispersal reaction was observed. Individual reactions from ingesting treated bait ranged from spasmatic paralysis with slight chirping to short hopping-flights followed by spasmatic paralysis and chirping. Of the several hundred affected birds throughout the trial, only two birds made prolonged spiralling flights with good vocalization, but even these two birds did not stimulate a flock alarm reaction. The birds did not feed at the bait sites for 11 days following treatment, and one flock of Red Bishops (400-600 birds) changed their morning feeding area the day after treatment. After the 11th day, Golden Sparrows and House Sparrows began feeding on the wheat and weed seeds at the bait sites, but not on the millet seed.

It appears that the Avitrol did induce an aversion to the bait sites and surrounding areas by causing the birds to move to new feeding areas 200-300 m away. Golden Sparrows were the first to accept feed at the bait sites. Their feeding action tended to attract House Sparrows first and then Red Bishops. Generally Red Bishops did not feed at the bait sites unless Golden Sparrows were already feeding. Red Bishops were most cautious.

Trapping

No Red Bishops or Golden Sparrows were caught in the MAC trap, and only a few individuals investigated the trap. However, at the other trap site, over a 14-day period, 284 House Sparrows were trapped.

CONCLUSIONS

Av-AIarm

The Av-Alarm sound system proved ineffective in this study. Stewart (1973,1974) indicates that augmentation with other devices, such as the gas cannon, gunfire, aerial bombs, and electronic hiss, or certain Av-Alarm accessories, may enhance the degree of control. There are, however, many limiting factors, even for experimental use of sound devices in the Sudan. Easy access to each unit on a daily basis must be maintained, especially when theft is a problem. Batteries must be serviced and recharged on schedule. Deep mud often precludes the use of roads for 3-4 days at a time. The expense and availability of replacement parts and batteries must be considered. Augmentation with other devices would further compound the problem. Thus, even if it had worked, it would not be practical.

Methiocarb

Although methiocarb did not appear effective in controlling damage at either of the two test sites, the low number of birds feeding in the test area makes it difficult to draw a valid conclusion. Use of a sticker would have prolonged the life of the repellent and might have provided increased protection even though the bird numbers were low.

Avitrol

Avitrol-treated bait was successful in moving pest species from a feeding location in wheat, but the birds merely moved to new territory 200 m away. Perhaps several swaths of bait applied by air over larger areas would have been more effective.

MAC trap

Trapping with MAC traps under different conditions and in different locations should be evaluated. The MAC trap Has been used effectively against House Sparrows by Royal (1969) and by Palmer (1970) for trapping House Finches (*caryodacus mexlcanus)*, Starlings (*Sturnus vulgaris),* and Cedar Waxwings (*Bombycilla cedrorum).* Palmer indicates that “trap placement sometimes is so critical that a move of several meters may make a significant difference in the trap's capturing capabilities.”

Indications are that in the Sudan Golden and House Sparrows can be trapped in certain locations. Red Bishops were attracted to other members of their flock caught in mist nets. Perhaps a meens of attracting them to the trap needs further investigation.

ACKNOWLEDGEMENTS

I thank Mr. Armia Magar, General Manager of Kfouri's farm, for use of his cereal production acreage for experimental purposes. Mr. Alfred Abdulla, field supervisor at Kfouri's farm spent many early morning and late evening hours assisting in the operation of the field work. I also thank Dr. Sidney Young and R. G. Allan for their assistance in damage assessment and for the analysis of data. K. M. Ahmed, I. E. Keir, H A. Farrag, M. H. Zein, S. H. Ali, and Y. M. Ahmed assisted in all phases of field operations.

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Table 1. Control Settings of Av-Alarm Generators Used in Study

	Unit 1	Unit 2
Time on	.35 min	.2 min
Time off	.35 min	.5 min
Burst/sec.	1	4
Pitch	high	low
Burst on	yes	yes
High level	yes	yes
Volume	maximum	maximum

FIGURE 1

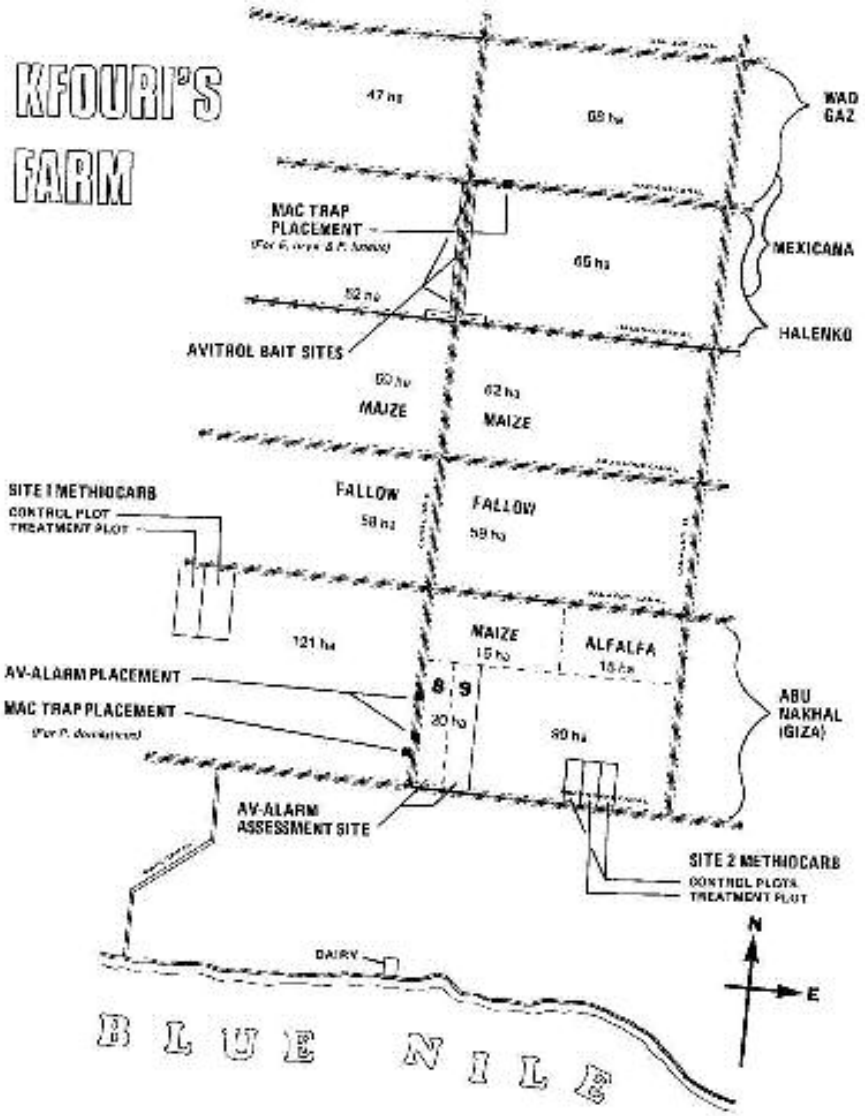
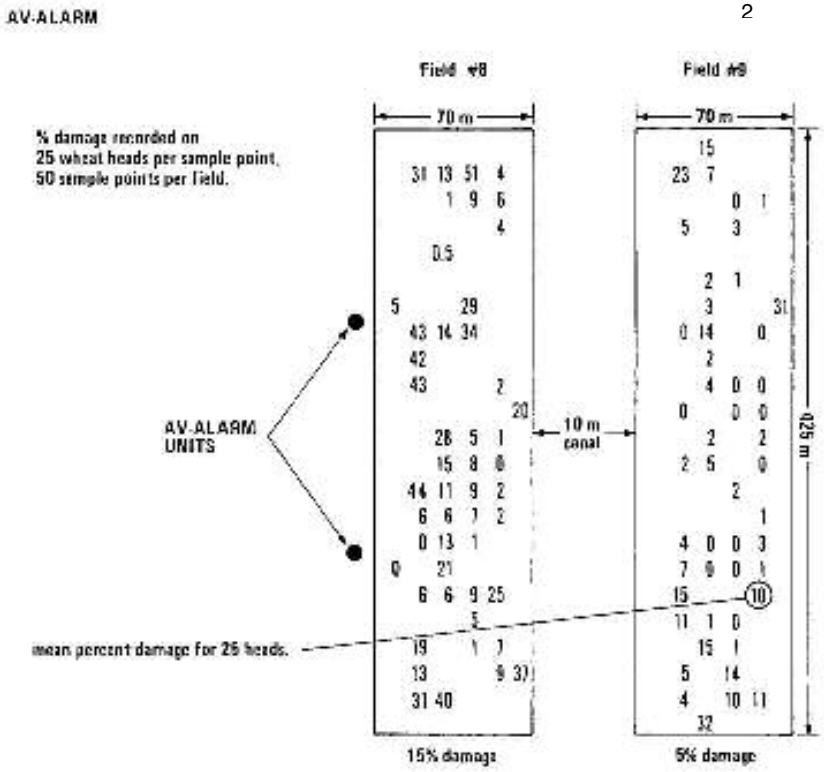

KFOURI'S FARM
47 ha
69 ha
WAD GAZ
MAC TRAP PLACEMENT
65 ha
MEXICANA
52 ha
HALENKO
AVITROL BAIT SITES
MAIZE
62 ha
MAIZE
SITE 1 METHOCARB
CONTROL PLOT
TREATMENT PLOT
FALLOW
58 ha
FALLOW
58 ha
121 ha
MAIZE
15 ha
ALFALFA
15 ha
AV-ALARM PLACEMENT
MAC TRAP PLACEMENT
8, 9
20 ha
89 ha
ABU NAKHAL (GIZA)
AV-ALARM ASSESSMENT SITE
SITE 2 METHOCARB
CONTROL PLOTS
TREATMENT PLOT
N
E
DAIRY
BLUE NILE

FIGURE 2


AV-ALARM
Field #8
Field #9
70 m
70 m
% damage recorded on
25 wheat heads per sample point.
50 sample points per field.
AV-ALARM
UNITS
10 m
canal
625 m
mean percent damage for 25 heads.
15% damage
5% damage