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VERTEBRATE DAMAGE CONTROL RESEARCH

QUELEA BIRD PROBLEMS IN AFRICAN AGRICULTURE

1971 ANNUAL REPORT

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of

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Office of Agriculture and Fisheries
Washington, D.C.

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ABSTRACT*

Two trips were made to the African continent during 1971 under auspices of USAID and FAO. Objectives were: (1) to investigate the agricultural damage caused by Quelea quelea (red-billed weaver) and related species; (2) to evaluate various control techniques; and (3) to determine susceptibility of quelea to a number of chemical compounds. Aspects of the total problem were reviewed; basic information on distribution, reproduction, food habits, and damage was obtained from the literature and from knowledgeable workers. A number of recommendations pertinent to the problem are suggested.

Quelea has been reported to adversely affect the economy of 25 nations in Africa and has the distinction of being the most numerous and destructive avian species in the world. Crops damaged are millet, sorghum, rice, and wheat. The problem dates back to 1890, but has only recently received international attention.

Since 1950, many methods of quelea control have been devised and millions of birds have been destroyed. Aerial applications of high levels of very potent pesticides in roosting and nesting sites is the damage control method currently being used almost exclusively by many governments in Africa. Although heavy annual kills are made, they have not resulted in decreased populations, indicating that surplus birds are being harvested.

Part of the FAO-sponsored quelea project in Ft. Lamy, Chad, is involved in reducing hazards resulting from spraying lethal chemicals on roosting and nesting sites. Denver Center personnel cooperated with FAO in a search for better and safer toxicants. Quelea were quite sensitive to orally and dermally administered pesticides, and a number of compounds were suggested as the safest for each use.

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INTRODUCTION

Bird damage to agricultural crops has been a long-standing problem in many parts of the world. Although considerable effort has been expended in highly developed countries to solve local or regional bird damage problems, only recently has a significant effort been made in the developing nations. In Latin America, bird damage control activities have been initiated by the USDI-BSFW in conjunction with USAID, while in Africa, major research has been directed by the British, French, and Germans, through technical assistance programs, and more recently by FAO.

The red-billed weaver (Quelea quelea) or black-faced dioch has the distinction of being the most numerous avian species in the world and perhaps the most destructive. Damage reportedly caused by this species (hereafter referred to as quelea) dates back to 1890, but has received international attention only since about 1950. Quelea range over about 20% (2 million square miles) of the entire land area of Africa and affect the economies of 25 nations. Crops affected include millet, sorghum, rice, and wheat. The quelea is morphologically similar to the house sparrow (Passer domesticus), but weighs about 18 g, compared with 25 g for the house sparrow. The natural diet of quelea consists of small grass seeds, but when these preferred foods become scarce, enormous damage to crops can occur. However, damage in many areas is sporadic and not precisely predictable.

Since 1950, many methods of killing quelea have been used and hundreds of millions of birds have been destroyed. Explosives and aerial applications of toxic pesticides (such as parathion and fenthion) to roosting and nesting sites are techniques now being used. These control methods have not appreciably reduced population levels nor decreased crop damage (except in some local areas); thus a need for better control methods is indicated.

Present control techniques need refining and other methods of crop protection should be investigated and developed. Basic research on behavior, movements, damage, and more selective chemicals are also requirements for the future. FAO personnel headquartered at Ft. Lamy, Chad, have recently begun much of this basic research. Personnel of the Denver Wildlife Research Center cooperated with FAO by making two field trips to Africa (one by J.F. Besser in March 1971 and one by J.W. De Grazio and E.W. Schafer in November 1971). Major objectives of these trips were: (1) to learn more about the quelea problem by conferring with knowledgeable workers, (2) to determine the susceptibility of queleas to chemical agents, and (3) to evaluate promising chemical control agents in preliminary field trials.

Our impressions and findings are briefly summarized in this report. For much of this information, we are indebted to the following: J. Roy, P. Park, J. Jackson, L. Bortoli, FAO/Ft. Lamy, Chad; E. Buyckx, FAO/Rome; W. Meinzinger, German Control Team, Maidugari, Nigeria; G. Pope and P. Ward, Center for Overseas Pest Research, Tanzania; and M. Kassa and M. Gillot, Ministry of Agriculture, Morocco.

GENERAL INFORMATION ON QUELEA AND RELATED SPECIES

Distribution

Quelea live almost exclusively in semi-arid savanna regions of Africa (Crook and Ward, 1968). The northern boundary of the quelea range encompasses all of the sub-Sahara region except the northern tiers of Mauritania and Senegal on the west through Sudan, Ethiopia, and Somali on the east, then south to the north of South Africa, and a northwest extension from southwest Africa. According to Hall and Moreau (1970) *Quelea quelea* is the most widespread of four major species, and brief descriptions of the habitat of each follow:

> *Quelea quelea*--black-faced dioch or red-billed weaver or quelea. Occupies dry areas; nests in trees and reeds; lives in colonies.
>
> *Quelea erythrops*--red-headed dioch or red-headed weaver. Occupies wetter areas; usually nests in reeds; lives in colonies.
>
> *Quelea cardinalis*--cardinal quelea. Ecologically intermediate; sympatric with *Q. quelea* in wettest areas and overlaps with *Q. erythrops* marginally; lives in colonies.
>
> *Quelea anomala*--bob-tailed weaver. Confined to clearings along rivers within Congo forests; nests in bushes and small trees; lives in small colonies.

Reproduction

Quelea breed during or near the end of the rainy season, which can vary in onset from September in west Africa through April in south Africa. In the Lake Chad-Ft. Lamy area, nesting begins in September and the period of reproduction is about 35 to 40 days. A nesting area may cover 4 to 300 acres and density of nests in single trees can vary from 100 to 2,000. Quelea usually nest only once per year; the male builds the nest inwhich the female lays an average of 2 or 3 eggs.

We observed a nesting area of about 10 acres in thorn trees (Acacia sp.) near Kauwa, Nigeria, where German scientists had recently completed a spray test with fenthion. At this site, there was an average of about 750 trees/acre, 130 nests/tree, and 2.5 young/nest. Thus, on this 10-acre area, 2.4 million young could have been produced (i.e., about 240,000/acre). With one adult male and female for each nest, the total population on the area could have been as high as 4.4 million birds.

Since breeding can apparently double the population, annual mortality of about 50% is to be expected (Crook and Ward, 1968). Nesting centers are always located near water, and therefore generally near productive areas for wild and cultivated grasses and grains (Pearson, 1965). Individuals will breed wherever habitat for establishing colonies is suitable. Nesting locations can vary from year to year (Ward, 1971).

Food Habits

Food habits of the quelea are similar to those of the American fringillid, the dickcissel (Spiza americana), which causes losses to cultivated grains in Latin America (Besser, et al., 1970). Both the quelea and dickcissel prefer grass and other small seeds over crop seeds, and it is only in those years or areas where and when preferred foods become scarce that major damage occurs. In the Lake Chad region, quelea feed on wild grasses such as Panicum, Echinocloa, Pennisetum, Setaria, and Oryza, and when these foods are scarce they may feed on sorghum, millet, rice, and wheat. In nonirrigated areas, wild and cultivated seeds mature at approximately the same time, thereby reducing crop damage. Scarcity of small seeds is usually caused by abnormally low rainfall, or little understood factors. Perhaps other seed-eating birds such as ruffs (Philomachus pugnax) or high numbers of seed-eating insects are competitors. During the nesting season, insects are eaten but make up only a small part of the diet (flying termites are taken at the beginning of the rainy season).

In a food preference test at Ft. Lamy, we found that quelea, when offered a choice of six foods--red milo (average seed weight--25 mg), white milo (49 mg), millet (9 mg), durham wheat (3.5 mg), white rice (2.2 mg), and Echinocloa (1 mg)--consumed about 98% of the millet, 50% of the Echinocloa, and negligible amounts of the remaining seeds. The average consumption of millet per bird per day was about 4 g. In field situations, damage can be much higher; quelea peck at the germ when grain is in the milk and dough stages, and knock to the ground as much as or more than they eat.

Damage Caused by Quelea and Other Species

Bird damage problems, species causing damage, weather conditions, crops affected, and time of damage are generally the same from Senegal in the west to Somali in the east. We obtained information on damage in this area from many sources and compiled the data in Tables 1 and 2.

TABLE 1. Bird damage to crops in Chad, Cameroon, Nigeria.

Crop	Species	Severity	Damage period
Millet	quelea, others*	Moderate	Sept. 15 - Oct. 30
Wheat - irrigated	quelea, *Ploceus* sp.	Variable	Feb. - April
Rice - nonirrigated - 1st crop	*Ploceus*, quelea, others	Variable	Sept. - Dec.
Rice - irrigated - 2nd crop	*Ploceus*, quelea, others	Variable	April - June
Red and white sorghum - dry season	quelea, *Ploceus*, *Lamprotornis* sp.	Variable	Dec. - March
**Red sorghum - wet season	quelea, *Ploceus*, *Lamprotornis*	Variable	July - Oct.

*Golden sparrow.
**Damage occurs to earliest maturing varieties.

TABLE 2. Bird damage in other African countries.

Country	Crops damaged
Senegal	Rice, sorghum (dry season)
Mauritania	Rice
Mali	Rice - irrigated (occurs every year)
Dahomey	Corn
Sierra Leone	Upland rice
Niger	Millet
Liberia	Upland rice
Tunisia	Wheat, olives
Morocco	Wheat, rice, sunflowers, olives
Sudan	Wet and dry season sorghum (wet damaged most heavily), rice, millet
Ethiopia	Sorghum, millet, rice
Somali	Sorghum, millet, rice
Tanzania	Rice, wheat
Malawi	Rice
Kenya	Wheat
S. Africa	Wheat
Swaziland	Rice

Often, quelea attacks on grains begin at the flowering stage (Mallamaire, 1959), and continue on to the milk, dough, and hard stages of ripeness. According to Crook and Ward (1967), the most serious economic losses in Africa occurred in millet and sorghum. However, they stated that more attention had been given to rice and wheat because of research promoted by governmental programs and intensive farming.

Irrigation programs are being developed by FAO and others in various parts of the continent, and it is conceivable that bird damage in some of these areas may become a limiting factor. Presently, except in Sudan and Senegal, only small acreages are being irrigated where quelea are pests.

Other species implicated in crop damage in the Lake Chad area, but not present in numbers as great as quelea, are Ploceus sp. (weavers), Euplectes sp. (weavers), and Lamprotornis sp. (glossy starlings). The golden sparrow (Passer luteus) causes problems in the northern range of the quelea. In Tunisia, the Spanish sparrow (Passer hispaniolensis) is a pest on wheat (Bortoli, 1969) and damages millet in the Sudan. Ploceus is also implicated in damage to upland rice in Sierra Leone, Liberia, and Senegal. Apparently, there are only minor problems with Psittid (parrot) flocks. Quelea are considered serious pests to rice in Tanzania and Malawi also. Bird damage control is being practiced in Morocco and experimental research studies, including laboratory and field tests, are being planned or are underway. Parathion, DDVP, phosdrin, and mevinphos sprayed on roosting and nesting sites have received and will continue to receive the most attention. A brief summary of bird problems in Morocco can be found in Table 3.

TABLE 3. Bird damage in Morocco.

Crop	Species	Damage Period
Wheat (most severe problem)	Passer domesticus and P. hispaniolensis	Feb. - June
Rice	Passer domesticus and P. hispaniolensis	Aug. - Oct.
Sunflowers	Passer domesticus and P. hispaniolensis	May - June
Olives	Sturnus vulgaris and Turdus sp.	Nov. - Feb.

Control Methods

Efforts to control damage by quelea have included (and still include) the use of sticks, cans, rattle gourds, drums, and fireworks to haze flocks, and the use of guns, explosives, flame throwers, jellied gasoline, and contact poisons for control of the population. Many of these methods are obviously of limited effectiveness. As an example, contact poisons have been used to kill hundreds of million quelea in a single year, yet there has not been an appreciable change in the status of the quelea problem.

Aerial Sprays

Aerial application at high levels of very potent pesticides, parathion and fenthion, in roosting and nesting sites, is the method being used almost exclusively by African governments. Birds are often quite difficult to kill, as they take flight and evade the spray in dusk and dawn sorties. In addition, birds are often protected by the vegetation in more hazardous nighttime control operations. The large number of low density roosts add to the problem of control.

Fenthion is being used in Sudan, Nigeria, and east African countries, parathion in OCLALAV* countries and South Africa. Both parathion and fenthion are being used on roosting and nesting sites. Treated roosting sites have varied from 5-25 acres but nesting sites up to 220 acres have been sprayed. In Nigeria, helicopter application of 1/2 gal/acre of 37.5% fenthion has produced 100% control in nesting sites. In the Sudan, similar results were obtained with 3 gal of 25% fenthion/acre. OCLALAV countries are using 3 gal of 25% parathion/acre, and some with favorable results. The best time to spray during the nesting season is when eggs are in the nest or when young first fledge.

Other Control Methods

The effectiveness of scaring methods, the only method of protection available to villagers, is unknown. For small crop fields, patrolling may be highly effective, while on large crop fields, which are inadequately manned, the exercise given the birds may only increase their appetite. They may even feed less on the noncrop seeds usually present on the soil surface.

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*OCLALAV is an anti-locust and bird control group that operates in the semi-arid savannah countries of Africa.

OCLALAV countries, with the exception of Chad and Cameroon, are still using explosives. Workers in Mali and Mauritania are poisoning watering holes in dry areas with phosdrin, which, if used improperly, could be a hazard to nomadic cattle and other animals (however, phosdrin is very rapidly decomposed in water with a half-life in water of about 6 hours).

We found that quelea responded well to the chemical frightening agent, 4-aminopyridine. Vocal distress displays, both in the air and on the ground, lasted for periods of up to 5 hours. However, preliminary field trials using sorghum baits in March, in an area where quelea were largely feeding on Echinochloa, and another trial using millet where quelea were damaging sorghum, were discouraging. It was apparent that baits and baiting methods will require more research. Quelea may indeed be difficult to bait by conventional broadcast baiting methods, but they should not escape being affected if a portion of the crop they are damaging is sprayed with the chemical. Spraying with a frightening agent may be of special use for grain sorghum, a crop reported to be heavily damaged. (Note--the more bird-resistant brown-seeded varieties were not seen in the few fields visited, but they may provide a partial solution.)

Perhaps the most encouraging results obtained in March were repellent tests on quelea. None of the 20 birds tested took measurable amounts of millet treated with 0.1% methiocarb, and they preferred untreated millet to 0.01%-treated at a 9 to 1 ratio. It appears that quelea will probably be able to detect (and, hopefully, avoid) levels of methiocarb as low as 30 ppm, which is only slightly above the tolerance level being sought for fruits consumed by humans. It was noteworthy that higher levels (1,000 ppm) produced immobilization of quelea for relatively long periods (up to 3 hours).

EVALUATION OF NEW CONTROL AGENTS

The major purpose of the November trip was to evaluate potential new chemical control agents on quelea.

Methods and Materials

Twenty compounds that are highly toxic to house sparrows and red-winged blackbirds (Agelaius phoeniceus), or are registered or are in the process of registration in the U.S. for bird damage control, were selected for testing on Quelea quelea. Of the compounds listed in Table 4, fenthion and parathion have been used in the U.S. as oral and dermal toxicants on a variety of avian species, but are no longer used;

methiocarb is a highly active avian immobilizing agent and repellent; 4-aminopyridine is a lethal fright-producing agent; CL 47676 and CL 17092 are being used as oral and dermal toxicants for starlings (Sturnus vulgaris); and α-chloralose is a moderately active immobilizing agent for avians. All other compounds are commercial or experimental insecticides with high avian toxicity and were evaluated on quelea using the following procedures:

Oral toxicity

Propylene glycol solutions of each chemical were gavaged into quelea using a 50 µl syringe (Hamilton 705-LT) equipped with a 21 ga. 1-inch needle (B-D-Yale) that had a 1.5-inch length of polyethylene tubing (0.030 inch id x 0.048 inch od - Intramedic) attached on the end. The proper length of the tubing was determined by measuring the distance from the back of the oral cavity to the esophageal opening of the proventriculus. This procedure guarantees that the dosing medium will be introduced at approximately the same location in the gastrointestinal tract of each bird. Solutions were prepared so that the exact µl dose to be administered could be calculated by multiplying the bird weight in grams times two. Thus, the volume of solution delivered to a bird was directly related to its weight. Dosing was at 1/4-10 g intervals with two birds at each level. After dosing, birds were held individually in nylon-net cages for 1 to 2 hours of observation. Birds surviving after the initial observation period were banded with colored and numbered bands and released into an outdoor 7 x 7 x 7-ft wire cage. Observations continued periodically for 4 days, and the survivors were then released. Brief descriptions of the oral dosing techniques used can be found in DeCino, et al. (1966) and Schafer, et al. (1967).

Dermal toxicity

Dermal toxicity was determined using solutions as described above, but with acetone instead of propylene glycol. The syringe size was the same; however, application was made through a 21-ga., 1-inch needle with a blunt tip. The area treated was the featherless skin area covering the pectoralis muscles, immediately ventral to the wing joint. The solution was applied over an area about 1/2 inch in diameter, and acetone was rapidly evaporated by artificial movement of air. Holding and observation procedures were the same as for oral dosing. A brief summary of this dosing technique is contained in Schafer, et al. (1969).

Results

Acute Oral Toxicity

All compounds except for two (CL 47676 and α-chloralose) exhibited a high degree of oral toxicity to quelea (Table 4). These data were compared with acute oral rat data and compounds were ranked according to quelea and rat toxicity (Table 5). An additional attempt was made to determine those compounds having both high toxicity to quelea and low toxicity to rats. One compound, BAY 75546, was rated very high because its toxicity to quelea was 2.42 mg/kg and to rats, 1750 mg/kg. Four other compounds appearing to have considerable mammalian safety and high oral quelea toxicity were BAY COE 3675, BAY HOL 0574, fenthion, and BAY COE 3664. These studies suggest that if quelea are to be killed by oral ingestion, these five compounds should be investigated in further detail.

The main purpose for this series of tests was to compare the toxicity of these 19 compounds to quelea with similar data gathered for house sparrows. This phase will require additional studies so that current tests on house sparrows can be concluded. It does appear, however, from incomplete data that: (1) quelea are about twice as sensitive to these chemicals as house sparrows treated under similar circumstances, (2) the variation in quelea response (0.5 to 5 times that of house sparrows) may preclude an accurate forecast of quelea toxicity from data gathered on house sparrows, and (3) there may be a much closer relationship in susceptibility to toxicants between quelea and red-winged blackbirds than between quelea and house sparrows.

Acute Dermal Toxicity

Eleven of 18 chemicals administered dermally to quelea possessed high toxicity to this species (<10 mg/kg, Table 6). Of the 11, 2 possessed outstanding activity considering avian and mammalian toxicity (BAY COE 3644 and fenthion), while 2 others were moderately active (BAY COE 3675 and BAY 93820). The remaining compounds, because of low avian toxicity or high mammalian toxicity, were of passing interest.

As was the case with oral toxicants, a comparison of quelea and house sparrow dermal toxicity will be delayed until the house sparrow data are gathered and analyzed. However, it appears that essentially the same conclusions will be reached. Quelea are about two times as sensitive as house sparrows to the chemicals tested, but variation between chemicals is 0.3 to 6 times greater. At this time, we have no opinion as to the applicability of red-winged blackbird data to quelea.

TABLE 4. Results of toxicity tests conducted on *Quelea quelea*—Ft. Lamy, Chad.

DRC No.	Chemical	Company	Acute LD_{50} (mg/kg) Oral	95% CL	Dermal	95% CL	Oral rat LD_{50} mg/kg
142	BIDRIN	Shell Chemical Corp. 110 W. 51st St. New York, N.Y. 10020 U.S.A.	1.33	NC	1.33	NC	19
632	FENTHION	Bayer Farbenfabriken Leverkusen, Germany	1.33	NC	1.78	1.00-3.16	230
736	METHIOCARB	Bayer Farbenfabriken Leverkusen, Germany	4.21*	NC	100	56.2-178	100
1143	DEMETON	Bayer Farbenfabriken Leverkusen, Germany	1.33	NC	1.78	1.00-3.16	7
1150	PARATHION	Monsanto Chemical Co. 800 N. Lindbergh Blvd. St. Louis, Mo. 63166 U.S.A.	1.78	1.00-3.16	1.78	1.00-3.16	6
1324	COUMAPHOS	Bayer Farbenfabriken Leverkusen, Germany	3.16	1.78-5.62	7.50	NC	84
1327	4-AMINOPYRIDINE	Avitrol Corp. 725 Nat'l Bank Tulsa Bldg. Tulsa, Okla. 74103 U.S.A.	5.62	3.16-10.0	>100	—	20
1329	DASANIT	Bayer Farbenfabriken Leverkusen, Germany	0.24	NC	0.42	NC	6

DRC No.	Chemical	Company	Acute LD_{50} (mg/kg) Oral	95% CL	Dermal	95% CL	Oral rat LD_{50} mg/kg
1339	CL 47676	Cyanamid International P.O. Box 400 Princeton, N.J. 08540 U.S.A.	31.6	17.8-56.2	—	—	1500
1347	CL 17092	Cyanamid International P.O. Box 400 Princeton, N.J. 08540 U.S.A.	—	—	42.1	NC	>1500
2538	AZODRIN	Shell Chemical Corp. 110 W. 51st St. New York, N.Y. 10020 U.S.A.	1.33	NC	4.21	NC	22
3533	α-CHLORALOSE	K & K Laboratories 121 Express St. Plainview, N.Y. 11803 U.S.A.	56.2**	NC	—	—	400
4226	BAY 75546	Bayer Farbenfabriken Leverkusen, Germany	2.42	NC	>100	—	1750
4241	BAY 93820	Bayer Farbenfabriken Leverkusen, Germany	0.75	NC	1.33	NC	75
4917	CARBOFURAN	FMC Corp. Niagria Chem. Div. Middleport, N.Y. 14105 U.S.A.	0.42	NC	100	56.2-178	5
5527	BAY COE 3664	Bayer Farbenfabriken Leverkusen, Germany	2.42	NC	2.42	NC	375

TABLE 4. (Continued)

DRC No.	Chemical	Company	Acute LD_{50} (mg/kg) Oral	95% CL	Dermal	95% CL	Oral rat LD_{50} mg/kg
5528	BAY COE 3675	Bayer Farbenfabriken Leverkusen, Germany	0.75	NC	2.42	NC	175
5529	BAY HOL 0574	Bayer Farbenfabriken Leverkusen, Germany	5.62	1.78-17.8	75.0	NC	>1000
5569	CYOLANE	Cyanamid International P.O. Box 400 Princeton, N.J. 08540 U.S.A.	1.78	1.00-3.16	10.0	5.62-17.8	30
5781	BAY 50519	Bayer Farbenfabriken Leverkusen, Germany	4.21	NC	5.62	3.16-10.0	4

*ED_{50} immobilization with recovery 2.42 mg/kg.
**ED_{50} immobilization with recovery 13.3 mg/kg.

TABLE 5. Comparative toxicity of compounds tested on *Quelea quelea*—Ft. Lamy, Chad (quelea oral vs. rat oral)

Rank by quelea toxicity (oral) mg/kg		Rank by rat toxicity (oral)		Combined rank*	
DASANIT	0.24	BAY 75546	1750	BAY 75546	214
CARBOFURAN	0.42	CL 47676	1500	BAY COE 3675	69
BAY 93820	0.75	BAY HOL 0574	>1000	BAY HOL 0574	53
BAY COE 3675	0.75	α-CHLORALOSE	400	FENTHION	51
AZODRIN	1.33	BAY COE 3664	375	BAY COE 3664	46
BIDRIN	1.33	FENTHION	230	BAY 93820	29
DEMETON	1.33	BAY COE 3675	175	CL 47676	14
FENTHION	1.33	METHIOCARB	100	COUMAPHOS	7.9
CYOLANE	1.78	COUMAPHOS	84	DASANIT	7.4
PARATHION	1.78	BAY 93820	75	METHIOCARB	7.0
BAY 75546	2.42	CYOLANE	30	CYOLANE	5.0
BAY COE 3664	2.42	AZODRIN	22	AZODRIN	4.9
COUMPHOS	3.16	BIDRIN	22	BIDRIN	4.9

TABLE 5. (Continued)

Rank by quelea toxicity (oral) mg/kg		Rank by rat toxicity (oral)		Combined rank*	
BAY 50519	4.21	4-AMINOPYRIDINE	20	CARBOFURAN	3.5
METHIOCARB	4.21	DEMETON	7	α-CHLORALOSE	2.1
4-AMINOPYRIDINE	5.62	DASANIT	6	DEMETON	1.6
BAY HOL 0574	5.62	PARATHION	6	4-AMINOPYRIDINE	1.1
CL 47676	31.6	CARBOFURAN	5	PARATHION	1.0
α-CHLORALOSE	56.2	BAY 50519	4	BAY 50519	0.3

$$\text{*Combined rank} = \left(\frac{\text{Quelea } LD_{50} \text{ Parathion}}{\text{Quelea } LD_{50} \text{ Chemical}}\right) \times \left(\frac{\text{Rat } LD_{50} \text{ Chemical}}{\text{Rat } LD_{50} \text{ Parathion}}\right), \text{ PARATHION} = 1.0$$

One item was of extreme interest. The ratio of oral LD_{50}'s to dermal LD_{50}'s with quelea was different than expected. Past experience with most other species indicated a 3 to 5 fold difference between oral and dermal toxicity (considering only those compounds that are quickly absorbed), but in quelea this ratio approached unity on a number of occasions. It is entirely possible that this phenomena may be due, at least in part, to the fact the quelea skin is thinner than that of many other species.

Discussion

Quelea are quite sensitive to orally and dermally administered pesticides and a number of compounds are suggested as the safest for each use. Since priorities dictate that the most readily available compounds be used, it would seem extremely important to replace the pesticides currently used to poison quelea (phosdrin-oral and parathion-dermal) with better or less hazardous compounds. Fenthion would, for the present, be the compound of choice. This should not deter an effort to find compounds with less hazardous properties and compounds that would be economically feasible to use under the difficult sub-Sahara climatic conditions.

RECOMMENDATIONS

Chemical Studies

1. The use of parathion and phosdrin as quelea control chemicals should be curtailed as soon as is practical and be replaced with safer compounds.

2. Techniques to reduce the volume of pesticide necessary to kill roosting or nesting quelea should be continued and emphasized, with special attention to the use of microdroplets or vapor.

3. Residue levels on treated vegetation and birds should be determined in order to more closely define the hazards to man and animals.

4. Inhalation toxicity levels for compounds in which there is a definite interest should be determined on quelea.

5. Alternate means of damage control with repellents and fright-producing agents should be investigated further.

TABLE 6. Comparative toxicity of compounds tested on *Quelea quelea*—Ft. Lamy, Chad (quelea dermal vs. rat oral)

Rank by quelea toxicity (dermal) mg/kg		Rank by rat toxicity (oral)		Combined rank*	
DASANIT	0.42	BAY 75546	1750	BAY COE 3664	47
BIDRIN	1.33	CL 17092	>1500	FENTHION	38
DEMETON	1.78	BAY HOL 0574	>1000	BAY 93820	17
BAY 93820	1.33	BAY COE 3664	375	BAY COE 3675	22
FENTHION	1.78	FENTHION	230	CL 17092	>10
PARATHION	1.78	BAY COE 3675	175	BAY 75546	<5.2
BAY COE 3664	2.42	METHIOCARB	100	BIDRIN	4.9
BAY COE 3665	2.42	COUMAPHOS	84	DASANIT	4.2
AZODRIN	4.21	BAY 93820	75	BAY HOL 0574	>3.9
BAY 50519	5.62	CYOLANE	30	COUMAPHOS	3.3
COUMAPHOS	7.50	AZODRIN	22	AZODRIN	1.5
CYOLANE	10.0	BIDRIN	22	DEMETON	1.2
CL 17092	42.1	4-AMINOPYRIDINE	20	PARATHION	1.0

TABLE 6. (Continued)

Rank by quelea toxicity (dermal) mg/kg		Rank by rat toxicity (oral)		Combined rank*	
BAY HOL 0574	75.0	DEMETON	7	CYOLANE	0.9
CARBOFURAN	100	PARATHION	6	METHIOCARB	0.3
METHIOCARB	100	DASANIT	6	4-AMINOPYRIDINE	<0.6
4-AMINOPYRIDINE	>100	CARBOFURAN	5	BAY 50519	0.2
BAY 75546	>100	BAY 50519	4	CARBOFURAN	<0.1

*Combined rank = $\left(\frac{\text{Quelea } LD_{50} \text{ Parathion}}{\text{Quelea } LD_{50} \text{ Chemical}}\right) \times \left(\frac{\text{Rat } LD_{50} \text{ Chemical}}{\text{Rat } LD_{50} \text{ Parathion}}\right)$, PARATHION = 1

6. New compounds should be sought which will minimize hazard to mammals and avian predator populations and yet are economically feasible.

7. Investigations into the feasibility of using reproductive inhibitors for quelea should begin as soon as long-term population control tools are proved necessary.

We believe that the FAO quelea project has a good start, and with proper guidance and the technical expertise of the FAO team, Items 1, 2, and 3 under Chemical Studies can be accomplished if given the proper amount of time. The development of Item 1 can also be greatly enhanced by close cooperation with the German team in Nigeria, who have recently obtained some valuable information on ultra-low-volume applications of fenthion with helicopters.

Item 4 could be accomplished in Ft. Lamy with existing personnel, but would require a very large expenditure of time to obtain and calibrate equipment and conduct tests. This work could more easily be done by experts in Europe or the U.S.

Item 5 can probably be best solved by providing either USAID or FAO-supported experts and/or consultants on TDY to conduct initial field evaluations of candidate chemicals during damage situations.

Item 6 and 7 would almost certainly have to be done outside the FAO project, because of limited project facilities and manpower. Project personnel already lack time to conduct many of the basic studies that will lead to a fuller appreciation of the quelea problem, and alternative means to solve it. Items 6 and 7 could perhaps be initially conducted using species other than quelea as indicators. At the Denver Center, we are exceptionally well equipped to do such studies on a contract basis with USAID or FAO.

Biological Studies

1. The best bait for quelea should be determined and the acceptance of such widely used, specific, or attractive baits as small-particle cracked corn, or rape and sesame seed should be checked in field crops, staging areas, other feeding sites, and in roosts and nesting areas. The discovery of a well-accepted bait in crops is a must if chemical frightening agents and oral toxicants are to be applied in an economical and safe way.

2. Brown-seeded sorghums should be checked for bird resistance, and, if found resistant, food from these sorghums should be checked for palatability.

3. The value of conventional frightening methods used to move roosts in the U.S. should be established for those African roosts adjoining isolated crop fields.

4. Damage appraisals to establish the vulnerability of various crops, the seasons of bird damage, the severity of bird damage, and percentage of damage caused by quelea (or quelea-like birds) and other birds (starlings, doves, etc.) should begin as soon as possible. Although a gigantic task, the scarcity of quantitative data on damage is perhaps the most regrettable aspect of the 15 years of research and operation in damage control in Africa. This work will have to be done over a period of years and, for most economy, a part of it could be pursued while gathering biological data and conducting field tests in methods of control. Reports on negative damage are almost as important as positive reports.

5. Reasons for the variation in damage between years should be determined. Rainfall patterns are believed to be the key. Other factors resulting in the scarcity of preferred small seeds should also be investigated.

6. Food taken by queleas before major damage seasons should be checked to find a possible food item that indicates impending serious damage.

7. Populations of queleas should be delimited. Morphology appears to be the best tool at present. Movements of subpopulations could possibly be defined by color-marking various colonies of nesting birds with different dyes.

Items 1, 3, 4, 6, and 7 may be areas in which the Denver Center can contribute to studies underway or proposed. A USAID position headquartered at Ft. Lamy or another suitable location, in cooperation with FAO, would bolster the present FAO staff and expedite research activities.

ACCOMPLISHMENTS

Personnel of the Denver Wildlife Research Center have cooperated with UNDP/FAO and others by making two field trips to Africa (one by J.F. Besser in March 1971 and one by J.W. De Grazio and E.W. Schafer in November 1971). In particular, rapport has been established with FAO personnel headquartered at Ft. Lamy, Chad.

Through the literature and discussions with knowledgeable workers, basic information on the total problem of quelea damage to cereal crops has been obtained. This includes data on distribution, reproduction, food habits, damage caused by quelea and other species, and past and present control methods. Quelea damage in most areas is sporadic and not precisely predictable. They prefer grass and other small seeds, and it is only in those areas where and when preferred foods become scarce that major damage occurs.

Different organizations in Africa have tried many methods of damage control; one method being used almost exclusively is contact sprays on roosting and nesting sites. One important phase of research is to replace hazardous pesticides being used with better and less hazardous compounds. In caged tests at Ft. Lamy, dermal and oral toxicity tests were conducted on quelea using a number of potential compounds, of which some are currently being used in U.S. bird damage control programs. From these tests we found that a good relationship exists between quelea, red-winged blackbirds, and house sparrows; the house sparrow can be used to predict dermal quelea toxicity while the redwing can be used to predict oral toxicity to quelea.

The chemical frightening agent 4-aminopyridine produced excellent responses from the quelea in the laboratory, but in preliminary field trials in sorghum fields, quelea acceptance of sorghum-treated baits were discouraging. It is apparent that much research on baits and baiting will be required. Encouraging results were obtained with a repellent compound, methiocarb. Very low levels were repellent to quelea; this finding may result in application of repellent sprays on crops being damaged.

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