THE DEVELOPMENT OF METHIOCARB FOR PROTECTING SORGHUM FROM BIRDS IN ETHIOPIA

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ABSTRACT

Red-billed quelea cause serious losses annually to ripening sorghum at the Ethiopian Sorghum Improvement Project research field at Melkassa in the upper Awash River Valley. This field has the only ripening sorghum in the area during the early dry season since local farmers stopped cultivating it because of quelea bird damage. Augmented by lethal control of nesting and roosting colonies, timely alternate band and spot spray applications of methiocarb (at rates of 1 to 4kg/ha) have played an important role in reducing losses to the valuable ESIP breeding lines and variety trials since 1977.

The purpose of this paper is to document the development and effectiveness of the chemical methiocarb [3, 5-Dimethyl-4-(methylthio)phenyl methylcarbamate--Mesurol^{R}] as a repellent to bird pests of sorghum in Ethiopia. This repellency is thought to occur due to an illness-induced conditioned aversion in birds eating treated grain (8,9). Methiocarb has been field tested in both West and East Africa with usually encouraging, but sometimes inconsistent results (1,2). Damage to sorghum by village weavers *(Ploceus cucullatus)*, red bishops *(Euplectes franciscanus)*, doves *(Streptopelia* spp.), and particularly red-billed quelea *(Quelea quelea)* has been a major concern at the Ethiopian Sorghum Improvement Project's (ESIP) Melkassa research station in the upper Awash Valley. Here ESIP breeds improved varieties of Ethiopian sorghum and tests imported varieties to expand production in the country.

The situation at Melkassa is different from traditional sorghum production in Ethiopia because no other sorghum is grown in the general area when ESIP crops are ripening in the early dry season (September-October). Moreover, testing thousands of breeding lines and varieties results in a

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relatively long (approximately 2 months) nonhomogenous period of grain vulnerability to birds. Further aggravating the situation is the fact that the ripening of sorghum coincides with the period of breeding and immigration of large numbers of both adult and juvenile quelea into the area (7). The gravity of the situation is underscored by the ESIP having recently spent more than Birr 26,000 to construct a 1.5-ha netting enclosure in which to grow their breeding lines (Brhane, pers. comm.). Thousands of cloth bags also have been used in the past to cover ripening sorghum heads. Less expensive, yet effective protection methods are needed.

MATERIALS AND METHODS

Trial Locations

Studies were conducted at the 17-ha ESIP research station at Melkassa (8°30'N, 39°15'E; elev. 1,500m) in the upper Awash River Valley of Ethiopia during 1977, 1978, 1979, and 1980. The station consists of small trial plots of several thousand breeding lines and varieties. Rainfall averages 820mm annually, falling primarily between July and September. During 1978, methiocarb also was applied to 2ha of irrigated sorghum at Melka Werer (9°15'N, 40°15'E) in the middle Awash Valley.

Application Techniques

Methiocarb was sprayed onto individual ripening heads in alternate 5 by 50 to 100m bands in each plot as they became susceptible to bird damage Similar alternate band application methods were employed in all years. The bands were separated by 1-m wide footpaths. The chemical was applied at rates of 1.0 to 4.0kg/ha with precalibrated hand pump backpack sprayers. Citowett or Rhoplex A-33 adhesives were used between 1978 and 1980 and applied at the rate of 60ml/100l of water (Table 1). During 1980, some of the field was spot-sprayed by spraying all susceptible heads in a 10-m radius of a pole which had been placed in an area of localized damage.

Efficacy Evaluations

Since the objective was to protect the entire field, untreated plots were not available. Efficacy was, therefore, based on pre- and post-application damage assessments, comparisons with losses during 1976 when the chemical was not used, and bird behavior observations. Preharvest damage assessments were made each year from 1976 to 1980; pretreatment assessments were made during 1979 and 1980. All assessments were visual estimations of the per cent loss to individual heads using regular random sampling as described by Jaeger and Erickson (6). Two sorghum heads were randomly

Table 1. Summary of the effectiveness of methiocarb as a bird* repellent on ripening sorghum at ESIP, Melkassa, Ethiopia, between 1976 and 1980

Year	% damage	Application rate (kg/ha)	Area (ha)	Adhesive	Rainfall (mm)
1980	14.2	1.0 and 1.5	14	Rhoplex	10.3
1979	22.1	2.5-3.0 and 1.0	15	Rhoplex	58.7
1978	5.7	4.0	17	Citowett	0
1977	< 2-3% after treatment; 23% before treatment	4.0	12	None	not recorded
1976	42.0	no treatment	12	None	not recorded

* Pest birds all 5 years: 99% red-billed quelea, 1% village weavers, doves, and red bishops

selected at regular 20-m intervals across each plot; independent visual estimates of bird damage to each head were made by two trained observers. Correction factors were applied for observer differences.

Bird Observations

Birds were mist-netted in the field at the time methiocarb was applied or for 1-week periods during the maturation period to determine age (by the extent of cranial pneumatization) (13), sex, and diet. General observations were made after methiocarb applications to determine the effectiveness and need for subsequent applications.

RESULTS AND DISCUSSION

1977

Twelve ha of short, early-maturing lowland varieties were treated with methiocarb over alternate 5-m bands at an application rate of 4 kg. Adhesive was not used. The first application was made when most grain in the hard-dough stage and was being attacked by thousands of predominantly juvenile quelea (92%, n = 236). The day methiocarb was applied, damage in the sprayed bands averaged 23.2% (n = 150) (Table 1).

The day after application (22 October) the number of quelea in the field greatly diminished and ESIP personnel reported no major damage for

another 3 weeks. Sick and dead birds were found in the plots for about a week (Brhane, pers. comm.). By mid-November, quelea were again feeding on the sorghum. However, harvesting had been delayed because of an international field day. Primarily adult quelea were collected at this time (97%, n = 154). These probably were birds which had arrived after methiocarb was applied and likely had no previous contact with the chemical. The young birds initially feeding on the sorghum appeared to be effectively repelled. Only 2 to 3% additional damage occurred. In 1976, without treatment, damage was 41.8% (n = 200).

1978

Methiocarb was applied at a comparable rate as in 1977 but the adhesive Citowett also was used. The 17-ha field was treated in 5-m alternate bands on three occasions at approximate 2-week intervals. ESIP again reported effective control; damage was only 5.7% (n = 200). However, fewer quelea were in the area because of successful, earlier control of three breeding colonies (estimated to contain over 7,000,000 adults and young) in the middle Awash River Valley. Quelea breed in this area during the rains and subsequently disperse into the cereal regions, including the Melkassa area, as crops ripen (7). Thus, the lighter damage recorded in 1978 probably was due to a combination of less quelea pressure, population suppression operations, and the chemical methiocarb.

In early 1978, one treatment of methiocarb also was applied over 2 ha of dry-season irrigated sorghum at ESIP's Melka Werer research field. Dosage rates were similar to the 1977 treatment at Melkassa. The chemical was only used as a temporary protection measure until sorghum heads could be covered with cloth bags. ESIP reported initial effective protection, but indicated quelea returned several days later and attacked the uncovered heads.

1979

One kg/ha of methiocarb, with Rhoplex adhesive, was again applied in alternate bands to approximately 7.7 ha of sorghum. Two quelea breeding colonies were located 1 to 1½km from the sorghum field, and an estimated 20,000 to 30,000 birds were attacking the earliest maturing varieties in mid-September before the field was treated. ESIP began spot spraying some of the susceptible plots in one section of the field with 2.5 to 3.0kg ai/ha; hundreds of dead quelea were found in the field.

The first alternate band application was made on 18-19 September. Most plots were in the flowering stage and only milky-stage heads were being damaged. Pretreatment damage assessments in the trial plots averaged 5.3% (n = 300) (Table 2). No dead or sick birds were found when the lower application rate of 1kg/ha was used.

Table 2. Damage assessments to individual plots of ripening sorghum before applying methiocarb and at harvest at ESIP, Melkassa, Ethiopia, during 1979 and 1980
All plots were treated with methiocarb.

Year	Plot	Area (ha)	No. heads examined		Avg % damage per plot	
			pretreatment	harvest	pretreatment	harvest
1979	1	2.1	70	70	14.4	39.6
	2	1.8	70	72	4.0	21.1
	3	1.7	70	70	2.0	11.5
	4	1.8	70	72	2.3	22.1
	5	0.4	70	20	0.4	1.9
Total/avg		7.8	350	304	5.3	22.1
1980	1	1.9	150	50	1.2	13.0
	2	1.2	50	50	0.8	7.3
	3	0.8	102	28	5.8	29.0
	4	0.8	152	50	9.5	18.0
	5	0.9	102	50	4.8	14.2
	6	1.0	150	50	4.0	6.2
	7	0.4	0	22	NA	9.6
	8	1.4	102	50	0.1	6.4
	9	1.4	0	50	NA	3.9
	10	2.0	0	50	NA	31.4
	11	2.0	0	50	NA	19.0
Total/avg		13.8	808	500	4.2	14.2

The first methiocarb spray appeared very effective in repelling quelea. Birds completely abandoned the field for almost 10 days. Subsequent treatments were made only in areas of heavy damage or to varieties of special value; and the birds again abandoned these areas. Damage at the time of harvest (31 October) averaged 22.1% (n = 304). Most of this damage was in single application areas of the field. Flocks of about 2,000 adult and juvenile quelea continued feeding on some of the late maturing varieties, but the quelea population in the area was greatly reduced from mid-September levels due to successful aerial avicide sprays to breeding colonies in mid-October. An untreated 66-ha sorghum field at the Netlie State Farm near lake Zwai 70km away from Melkasa, also adjacent to a large quelea breeding colony, was completely destroyed by the birds. As at Melkassa, farmers in the vicinity of the Netlie State Farm are unable to grow sorghum due to the quelea problem.

1980

Methiocarb (1 kg/ha) was first applied in mid-September, 3 to 4 day after the onset of quelea attacks. Feeding pressure was intense from severa thousand quelea coming from a nearby nesting colony. All quelea collectec in the field were adults (n = 138); 63% were males. Their diet consistec mainly of ripening sorghum and wild grass seeds of *Setaria*, *Panicum*, *Echinochloa*, and wild sorghum. They began feeding in plots whereth earliest maturing varieties were reaching the milky stage. Many of the varieties in the other plots were not yet susceptible to damage. Methiocarb was applied in alternate bands and to localized areas where damage was starting or beginning to spread. Only susceptible heads were sprayed (approximately one out of three), considerably reducing the amount of chemical (2.65 kg) used.

'The reduction of quelea in the field following application' was not as dramatic as seen in previous years. This probably was due to the low application rates. Very few sick or dying birds were seen. Damage in the treated plots was estimated at 4.2% (Table 2). On the evening of 18 September, a nearby nesting colony was successfully sprayed with toxicants. During the following 3 weeks, only a few quelea were sighted in the field.

A second methiocarb application (1½ kg/ha) was made between 10 and 14 October when thousands of quelea again began attacking the sorghum. These, presumably, were immigrating birds (79% juveniles, n = 1,018) from September breeding areas. Severe damage was occurring, mainly on plots where late varieties were ripening. Considerably fewer birds were feeding on plots of drying grain of the lower plots (Fig. 1). Alternate band spraying began on the upper plots and was continued throughout the field. There was no attempt to spot spray as the entire field was now susceptible and damage was widespread. Most damage occurred before the chemical was applied. A total of 19.5 kg of methiocarb was used for the second application.

The results of the second application were more impressive than the first, likely due to lack of rainfall (compared to 10.3 mm during first application) and to the higher application rate. The number of quelea in the field greatly diminished during the first 4 postapplication days as depicted by the daily decrease in the number of birds collected (Fig. 1). All birds were killed with toxiciants at the night roost on the evening of 14 October and no further damage was reported. Damage was assessed at 14.2% over the entire field prior to harvest.

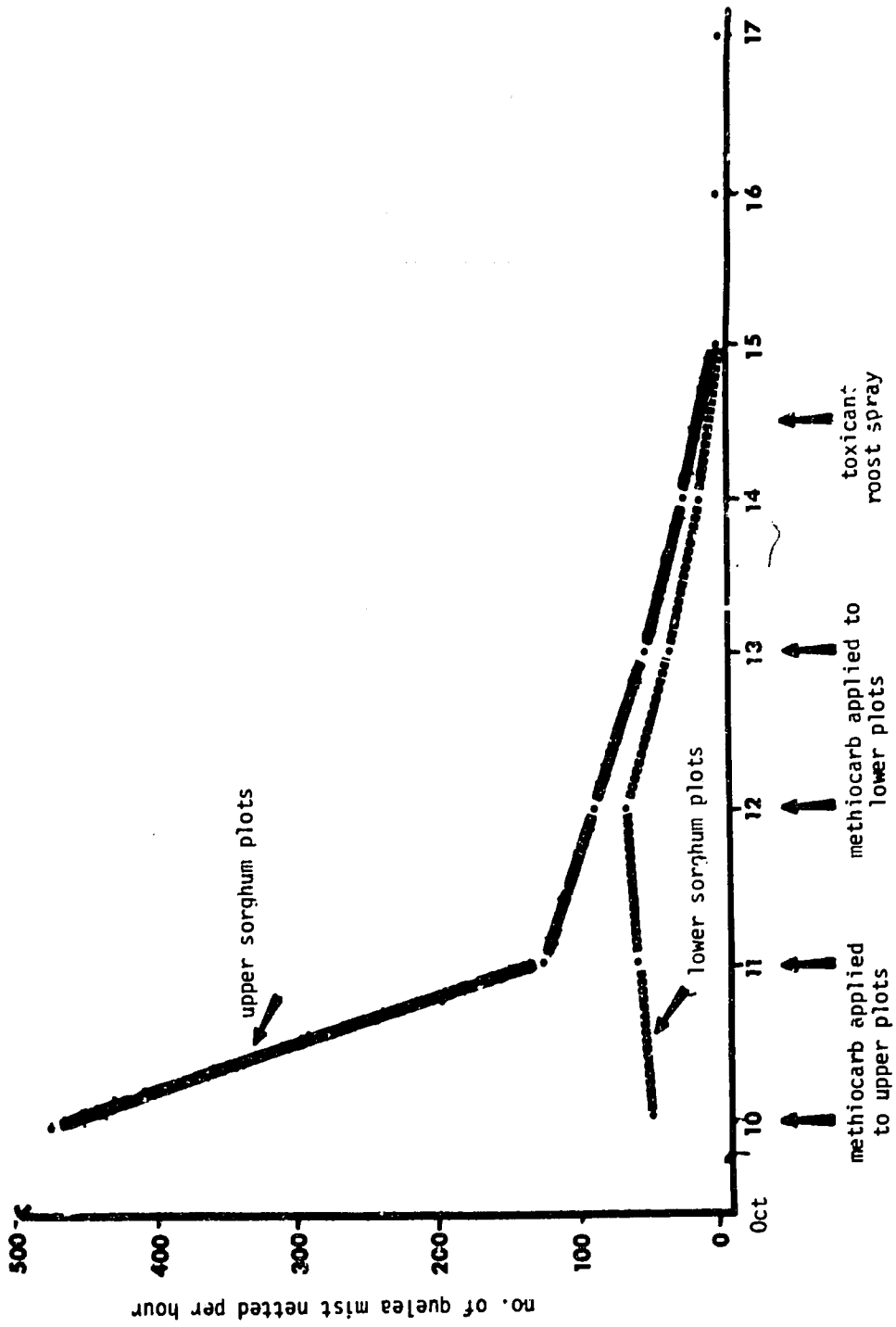

Fig. 1. Relative numbers of quelea collected in the sorghum fields in relation to methiocarb treatment dates at Melkassa Ethiopia during 1980

CONCLUSIONS

Increasing sorghum production in Ethiopia, particularly on high-value breeding plots, necessitates effective crop protection methods against pest birds. Methiocarb is being increasingly used in Africa and providing more consistent protection against pest birds in certain situations (2). In Ethiopia the use of methiocarb is probably limited by cost (Birr 60/kg) to high-value crops such as these grown on research fields and seed multiplication schemes. It probably is not applicable over the main rainfed sorghum growing regions due to cost and logistic constraints of treating areas of several hundred or thousand ha. Aerial application techniques have not yet been adequately evaluated and spraying small tracts within these large areas may only deter birds to neighboring fields and redistribute damage. Methiocarb may be most appropriate in crop damage situations where the pest species, for behavioral reasons, may not be susceptible to population reduction techniques.

The circumstances at ESIP Melkassa, however, are particularly appealing for using methiocarb because (a) high-value varieties and breeding lines are involved, (b) sorghum has exposed grains so that birds ingest the chemical, (c) rainfall usually is minimal, reducing the likelihood of the chemical being washed from the grain, and (d) the fields are isolated temporally and spatially from other cereals but are surrounded by abundant wild seed to attract birds repelled from the field. Although entire fields can be sprayed, alternate band or spot applications to areas being damaged are economically and logistically preferable and oftentimes just as effective (2).

Methiocarb is a safe chemical when applied at normal, repellent use levels of 1 to 3 kg/ha. The heavy quelea mortality in some of these demonstrations occurred because the individual sorghum heads were sometimes sprayed until dripping. However, quelea and several other species which are secondary pests to African cereals are very sensitive to concentrations as low as 0.015% to 0.133% (11, 12). Initial decomposition also is rapid; a 2-kg/ha application (with an adhesive) to sorghum in Senegal had a half-life of 6 to 7 days and residues of < 3.5 ppm after 20 days (4). Methiocarb is registered in the U.S. for use on several agricultural crops at higher residue levels of 15 to 25 ppm (10). Even more rapid decomposition would be expected at the 1,500-m elevation in Ethiopia because carbamates readily decompose under ultraviolet light (3, 5). Augmentation of methiocarb with population reduction techniques provides a good crop protection strategy for the situation at Melkassa.

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