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SUMMARY OF METHIOCARB TRIALS AGAINST PEST BIRDS IN SENEGAL

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INTRODUCTION

Several species of granivorous birds are responsible for damage to cereal crops in Senegal. Palearctic migrants, such as ruffs *(Philomachus pugnax),* godwits *(Limosa limosa),* and waterfowl damage newly sown rice seed or germinating plants. The main pests to ripening cereals are the red-billed quelea *(Quelea quelea),* black-headed weavers *(Ploceus melanocephalus),* village weavers *(P. cucullatus),* and golden sparrows *(Passer luteus).* Starlings *(Lamprotornis chalybaeus),* bishops *(Euplectes* spp.), parakeets *(Psittacula kramerii),* and doves *(Streptopelia* spp.), are often locally abundant pests.

The communal roosting and nesting habits of only two of these approximately 10 species, quelea and golden sparrows, makes them susceptible to the mass destruction techniques almost universally employed by regional and national African bird control organizations. Such techniques may be applicable to large bird concentrations but usually are not economical for protecting small cereal schemes nor ecologically advisable when these bird concentrations install in marshes. Therefore, a main emphasis of the UNDP/FAO Quelea Project research has been to evaluate alternate methods of protecting cereal crops, one method of which is the use of chemical repellents. This paper summarizes the results of work conducted in Senegal between 1975 and 1977 in which the chemical methiocarb (3,5 dimethyl-4-(methylthio)- phenol methylcarbamate; Mesurol), was applied as a seed dressing immediately prior to sowing and to the heads of maturing cereals. Some of the results reported herein have previously been published and are cited when appropriate in the text but are included for completeness. Methiocarb has been an effective, broad-spectrum, and non-lethal repellent to many bird pests in several countries (Guarino 1972; Crase and DeHaven 1976; Calvi et al. 1976.)

METHODS

Trial sites and application procedures: Trials were conducted throughout Senegal during both the wet and dry seasons in cooperation with and at the field stations of government production schemes (SAED), private companies (BUD), and agricultural research organizations (ISRA and WARDA). An attempt was made in all trial sites to have separate and distinct plots of the same variety in the same state of maturity and subject to comparable bird pressure. In sites in which the plots were planted specifcally for the trial, a test design with replication and randomization was used (Ingram 1976). However, some of the trials were, by necessity, conducted within the constraints imposed by the cooperating organization. Therefore, there were some single plot demonstrations which, if taken together, could represent replication.

Methiocarb was applied at rates of 1.0 - 6.5 kg/ha to maturing sorghum, millet, and rice in individual plots ranging in size from $400m^2$ to replicate plots totalling 10 ha (Table 1). Treated and untreated plots were independent and separated physically by vegetationless bands at least 0.5 m wide and/or visually by colored flags mounted on poles just above cereal head height. Applications to ripening crops usually were made under the supervison of a pesticide specialist and with either motorized or pressurized backpack sprayers. Depending on the trial circumstances, methiocarb was applied from one to three times during the 30 - 35 day maturational period. Initial applications were made 7 - 10 days after flowering, and any subsequent applications were made during the milk or soft dough stages. Triton CS-7 or AE adhesives always were employed at rates of 60 ml to 100 1 of water for ripening crops.

The rice seed-dressing trials occurred in the Senegal River Valley. In all of these trials, methiocarb was applied at 0.25% - 0.83% (by dry-seed weight) to non- and pre-germinated seed in 3-5 liters of water and mixed with the seeds on a canvas or in a barrel mixer. Seeds then were spread on the canvas for about 30 minutes to allow the water to evaporate before being sown by hand in flooded fields or drilled by a tractor in dry fields. The sowing rate was 100 or 120 kg of pre- or non-germinated rice seed/ha.

I-Kong-Pao variety seed was used in all trials. In the melon seed trial, 3 kg of seeds/ha were mechanically sown, with 406 seeds drilled each 15 cm using Stanhous seed spacing drills pulled behind tractors.

Bird counts and damage observations: Observations of bird feeding patterns were made to support the weekly damage and final yield estimates. The methodology varied among the trials, but it involved identifying the species present and quantifying their numbers counting those landing or those flushed at regular 15-, 30-, or 60-minute intervals. In some trials the species composition of feeding flocks also was obtained. The observations were made at regular intervals throughout each trial, usually from concealed locations along the perimeter of the plots. Birds were watched primarily during their morning and afternoon feeding periods but occasionally at mid-day or at night (for observing waterfowl feeding behavior on sown rice seeds). The order of these observations was reversed on alternate days in trials containing replicate plots.

In all trials, damage was evaluated prior to the first treatment, at weekly intervals, and at harvest by scoring randomly or previously selected heads (whose stalks had been marked prior to the first application) as attacked or not attacked and by estimating the percent damage to these heads. The latter was accomplished either visually, by measuring the length of damage relative to the total length of the head (Manikowski and DaCamara-Smeets 1979), or by counting or weighing the grains. At harvest the yields from individual heads or from sampling units of 0.5 or 1.0 m^2 were determined. The grain was removed either manually or, when possible, using automatic threshers. In the seed dressing trials, plants were counted in 50 - 200, 625-cm^2 sampling units, which were oriented throughout the plots at the time of sowing. In the melon trial, 1000 drilling sites/plot were scored for the presence of melon plants. Sampling comprised observing 10 consecutive drilling sites at each of 100 stations located at 60 m intervals along the length of the rows. Birds were shot or mist-netted from in or around the trial sites or from their roosts for determination of food habits. More detailed procedures for the individual trials are given in the original Quelea Project reports available from FAO Rome.

RESULTS AND DISCUSSIONS

Seed dressing trials: Seed dressing applications of methiocarb at 0.25% - 0.83% by seed weight resulted in a greater amount of rice plants in four of the six trials and 8 of the 10 plots in which it was applied. From 1.1 - 2.2 times more seedlings and 1.0 - 4.5 fewer birds were counted in treated than untreated plots (Table 2). Under properly supervised agronomic conditions, which was the situation during both of the trials at Nianga, the differences in the number of plants and the rice yield at harvest were significant ($P<0.05$) (Ruelle and Bruggers 1979). Although statistical significance relative to differences in plant numbers did not occur in any of the trials at Boundowm, the methiocarb application resulted in at least a 39% increase in their numbers (Bruggers and Ruelle 1977) and more plants in five of the seven plots for two years.

Agronomic and cultural practices greatly influenced the results of the trials at Boundowm. Much of the scheme was only being developed at the time of these trials, so that considerable differences existed among plots relative to land preparation, drainage, and soil salinity. Similarly, many of the farmers were resettled war veterans or nomads with little, if any, experience in rice farming.

Ruffs were the main pests in all trials and accounted for 75% of the more than 9000 birds which frequented the plots during the trial at Nianga in 1976. Their numbers annually swell in the Senegal River Valley from about 10,000 in September to more than 200,000 during December and January (Treca 1976). Whistling tree ducks and godwits very frequently ate newly sown rice. Nearly all other species of birds identified and collected from the rice fields during these trials had eaten insects or wild seeds almost exclusively (Ruelle and Bruggers 1979).

Dead birds were found only in the trial at Boundowm when methiocarb was applied at 0.83% (Bruggers and Ruelle 1977). At the lower application rates 0.25 - 0.50% no sick or dying birds were collected. Besser (1973) has suggested using 0.10% treatments to reduce damage by red-winged blackbirds *(Aeglius phoencius),* which have a R_{50} = 0.08% (Shumake et al. 1976).

Almost no damage occurred to melon seeds *(Cucumis melo)* following 0.75% seed dressing; most of the pest birds left the farm after the application. Only three birds per 15-minute interval were counted throughout the entire 9.5 ha. Not surprising under the circumstances, the number of drilling sites containing plants for each 10 sampling stations was nearly identical in the treated (8.4 $\pm$ 1.6) and untreated plots (8.9 $\pm$ 1.2) ($P>0.05$) and was not statistically significant. Heavy row damage of 3-4 seeds per consecutive drilling hole had occurred in another plot in September just prior to the methiocarb application.

The birds responsible for the damage to the seeds in September were not fully identified. Behavioral evidence suggested crested larks *(Galerida cristata),* the most abundant species. They followed the rows while feeding, but never were observed digging out or splitting exposed seeds. Sparrow larks *(Eremopterix leucotis)* and Senegal plovers*(Vanellus senegallus)* also were seen frequently in the plots; but, as with crested larks, examination of the stomach contents showed only insects and wild seeds. No sick or dead birds were reported.

Ripening crops - dry season: The results obtained from applying methiocarb to ripening cereals varied depending on the application rate, the particular crop, its season and maturation process, the bird species present and their numbers, and the season. The yield data for all these trials are presented in Table 3. One application of 6.5 kg ai to millet early in the 1975 dry season gave some protection to millet, which in most years at the ISRA Center is eaten by birds (Deuse pers. comm). Although 90% of the treated and 100% of the untreated heads incurred some bird damage, a greater percentage of the treated (75%) than untreated heads (12%) sustained less than 10% loss. Likewise, treated heads weighed nearly twice as much (4 g vs 2.19 g). These results suggest that birds tasted and rejected the treated grain. The birds usually flew over the treated area, despite its proximity to the roost, to feed in the untreated plots.

Two applications of 1, 2 and 3 kg ai applied at the end of the 1976 dry season to ripening millet at the same research center were completely ineffective deterrents to the birds. The millet was subject to very intensive attack, which began just after heading, from a resident bird population comprised initially of bishops and golden sparrows; but the numbers of quelea progressively increased (Fig 1). Within three days of the application, 50-100% of the heads in all plots were completely denuded, and most of it was devoured before it reached the early milk stage (Table 4). At harvest mature grain was found only at the base of the head where it was surrounded by a leaf. Flowers and 0.5-1.0 mm grain was found in the crops of the birds.

Such acute damage is characteristic of the end of the dry season, a period in the sahel when natural food supplies are scarce (Ward 1965). At this time starvation is the most likely ultimate cause of death (Ward 1973) for the postulated 56% annual mortality rate in quelea (Jones 1976). During the dry season an agricultural research station is in effect an oasis for birds, providing a predictable supply of water and food. As such it attracts large numbers of birds from the surrounding countryside. More than 300 birds often were seen trying to drink from a small leak in an irrigation hose or faucet. It is unlikely that the 6 mm of overhead irrigation two to three times a week in these trials influenced their outcome.

Ripening crops - wet season: Sorghum: During the normal growing season, 2.5 kg of methiocarb provided excellent protection to ripening sorghum at Darou. Optimum conditions existed throughout the trial. Only 5.7 mm rain fell, and at the time of application the wind speed was only 2.5 km/hr. Significant differences ($P<0.05$) in all yield parameters were obtained at harvest, with treated and untreated areas sustaining 4% and 67% damage, respectively, heads in these areas averaged 49.4 g and 15.8 g (Bruggers 1976). No bird damage had occurred prior to the initial application. Although these differences undoubtedly were accentuated by a shift of at least part of the bird population to the untreated area, the results do demonstrate repellency. Presumably wild grass seed also was available as an alternate food source for at least some of the "repelled" birds.

Thirteen species of birds were observed in the trial site, of which village, black-headed, and buffalo weavers *(Bubalornis albirostris),* starlings, and green pigeons *(Vinago waalia),* caused the most damage. Village and buffalo weavers ate an average of 0.33-0.50 g of crop each feeding period (Table 4) and shattered considerably more grain. Three-and-one-half times more birds were counted in the untreated than treated plot. Based on the time some individuals spent feeding on treated heads, bishops and *Ploceus* spp. appeared to be the most affected by the repellent; and Senegal parrots *(Poicephalus senegallus),* the least. Some tasting and rejecting of treated heads seemed to occur.

Rice: Rice always suffers heavy losses to birds in the Senegal River Valley, the habitual range of quelea in Senegal. Two attempts to protect rice in different years on the WARDA Research Station near Richard Toll gave contrasting results. In the first attempt in August 1975, two applications of 2.0 ad 2.5 kg/ha were made to 0.8 of 1.5 ha of ripening rice (variety IR 442). The applications were made when the rice was in the flowering and late milk stages. The different rates reflect the difficulty of walking a uniform speed in flooded fields. The two plots were separated by a two m - wide path and three red flags mounted above the rice along the path. An adjacent 0.05 ha plot was covered with nylon fishnet for comparison.

Birds began attacking the rice prior to grain formation, so that at the time of the first application, one or two flowers already were missing on the damaged panicles. After one week, 5% of the treated heads and 15% of the untreated heads were damaged. The second application followed 36 mm of rain, coincided with a period of secondary heading, and occurred with 11% and 26% damage in the treated and untreated plots, respectively. At harvest and after 72 mm more rain and an influx of *Ploceus* weavers, damage in the two plots was 23% and 46%. Treated panicles averaged 2.05 g versus 1.91 g for untreated ones, and yields from 0.5 m^2-sample units (n = 10) in the respective plots also were greater (206 ± 84 g vs 149 ± 50 g ($P<0.05$)). The yield from the plot protected by nets was 201 ± 45 g.

Bishops, quelea, and *Ploceus* weavers were the main pests in the trial; but their feeding behavior varied according to the time of day and the maturation stage of the rice (Fig 2). In the morning, during the flowering and early milk stages, red bishops *(Euplectes orix)* were the most prevalent species, comprising a resident population of about 200 individuals or 45% of the total number of birds seen feeding in the fields. They fed on rice and weeds growing along the irrigation dikes. Small flocks of 10-20 individuals of quelea began frequenting the scheme during the late flowering stage and were 30% of the feeding population during the dough stage. They also stopped to feed during the evening while returning to a roost in the nearby sugar cane. Most birds shot immediately upon alighting in the rice had crops containing weed seeds, but those leaving the plots had eaten rice. By the end of August when the rice was in the dough stage and with the onset of nesting, quelea were no longer important pests.

The feeding behavior of black-headed and village weavers was somewhat different but also appeared related to their breeding condition. Black-headed weavers were only occasionally seen in the rice scheme after the onset of nesting in early September. Of 13 nestlings collected on 18 September from six nests located along the irrigation ditches, all had been fed insects and only two rice - one grain each. Village weavers were, however, the major pests during the late maturation stage, when they were beginning to construct nests but had not yet laid eggs. Based on data collected during 1975 in The Gambia and 1976 in Mali, this feeding pattern would be expected to at least partially shift to an insect diet as nesting progressed. In The Gambia, 48% of 156 adults of both sexes returning to a nesting colony from an adjacent sorghum field were carrying grasshoppers. Similarly, 100% of 38 nestlings collected from a colony in western Mali had been fed exclusively insects (Ruelle pers. comm.). These observations may have phenological implications for reducing crop losses.

In 1977 an attempt was made to duplicate the positive results obtained in 1975 but by using a technique of alternate band application (Besser pers. comm.). Again in cooperation with WARDA but under less than ideal conditions, three replicate 0.25-0.50 ha plots were laid out using boundary flags in adjacent 1.0-3.0 ha fields of three varieties of seed production rice (Taching Native, Thin Thou Way, IR 442). Six kg of methiocarb was applied to one-third of the area in alternate bands of 2.3 m treated and 7.7 m untreated, giving an overall rate of2kg/ha. Equivalent-size untreated plots also were marked out at the opposite end of each field. Each variety began ripening in successive weeks. More than 71 mm of rain fell during the trial.

Although some repellency occurred during the first 7-10 days, overall, methiocarb did not effectively reduce losses. After two weeks 23%, 36%, and 75% of the rice had been eaten in the three treated plots and 59%, 78%, and 92% in the corresponding untreated plots, with harvest figures from 38%-100% loss in treated and 93-100% in untreated. The intermediary areas of the fields between plot boundaries also were completely eaten. The lower treated figures are somewhat misrepresentative, since they included a considerable number of undamaged flowering secondary heads. WARDA did not harvest the fields.

As during 1975 the damage was caused by red bishops, quelea, and *Ploceus* weavers. A daily feeding population from 200-500 birds early in the trial to 2000-3000 as the crop reached the milk and soft dough stages was observed. Bishops again were the most prevalent during the early maturation stages and quelea later on. Similarly, quelea again came from a one-two million bird nesting colony in the sugarcane at Richard Toll.

The test failed for several other reasons in addition to the large numbers of birds. Considerable amounts of attractive weed seed were present in and along the borders of the rice. There was extensive heterogenity in the maturation rate of the rice within each trial plot, as well as among the different varieties; the latter resulted in an extended two-month vulnerability period. Finally, the birds were in starving condition, due to the almost non-existent rains in the region and the lack of natural foods. Unlike the 1975 trial, when most birds had eaten wild seeds and only fed briefly in the rice before returning to their evening roost, in 1977 large numbers of quelea fed or remained in the immediate vicinity of the rice fields throughout the day. The WARDA fields were in effect an oasis; conditions were similar to those occurring with dry season cropping, and heavy losses to birds resulted.

CONCLUSIONS

The increasing development of cereal production in Africa and the role played by birds as depredators of these crops requires developing more effective protection methods. Methiocarb, which is thought to cause a conditioned aversion reaction in affected birds (Rodgers 1974) to which quelea are highly sensitive (R_{50}= 0.015%) under laboratory conditions (Shumake et al. 1976), perhaps can play an important role in an integrated approach to reducing bird damage. The problem is to determine its repellent form under field conditions encountered in Africa. The following conclusions are applicable primarily to using methiocarb in Senegal.

1. Most bird problems to newly sown rice in the Senegal River Valley could be avoided by proper preparation and management of the rice schemes by insuring that sowing is completed in late August before the arrival of the palearctic migrant pest species. When, for various reasons, this time schedule cannot be met, methiocarb seed applications of 0.25-0.50% can reduce losses. It would be advisable to treat the seeds prior to germination, since post-germination mixing can damage the developing radicle. Furthermore, soaked seeds apparently lose from 15-60% of the chemical before being sown (Cunningham 1975). Therefore, hand sowing or mechanically drilling dry, treated ungerminated seed, as at Nianga, into the fields is preferable.

2. The results of these trials also show that methiocarb can reduce bird damage to grain crops, although the results have been more inconsistent. It is probable that two or three applications of 5-6 kg ai are necessary to achieve any damage reduction when trying to protect dry-season crops at research stations or flood-recession sorghum planted by farmers in the Senegal River Valley. The likelihood of success also diminishes as the dry season progresses and the natural food (weed seeds) becomes more scarce, the situation at Bambey in 1977. At these high rates and application frequencies, the economics and practicality become important considerations. The technique of edge, alternate-band or spot application over large areas using ground spraying equipment needs to be evaluated, as this would reduce costs.

During the normal cropping season, one or two applications of 2-3 kg ai/ha can protect crops. This happened at Darou and Richard Toll in 1975 when the birds were not "starving" and when the population was not so large as to overwhelm any repellent effect.

3. From field observations it appears that species such as the golden sparrow and, in particular, red bishops and *Ploceus* weavers might be more sensitive to methiocarb than other species; such observations require laboratory verification. In many repellent trials in which bishops are pests, such as at Richard Toll during both 1975 and 1977, damage during the first one or two weeks usually is greater in untreated than treated plots.

In two methiocarb trials in the Sudan, contrasting results were obtained. Both trials involved house sparrows *(Passer domesticus)* and golden sparrows but in different population sizes. In a trial at Shambat Institute in the presence of 800-1500 birds, damage to treated and untreated sorghum was 32% and 85%, and to treated and untreated wheat and barley, 30% and 60%, respectively (Martin and Jackson 1975). The results of another trial two months later, also in the environs of Khartoum, were inconclusive (Martin 1976). Only 100 birds were counted in the area daily, and only minimal damage of 4-6% was determined for all the trial fields.

4. The insecticidal effect of methiocarb may inadvertently play an important role in reducing crop damage by birds. An insect-free field would presumably be less attractive to species such as village and black-headed weavers, which often eat insects and rely heavily on them to feed their nestlings. A shift by the adults from insects to grain and the subsequent use of the field by the fledglings would appear to be quite easy and not unexpected.

In the successful trial at Darou (Bruggers 1976), the insectivorous species also left the treated bands following methiocarb applications which killed earwigs *(Forficula* spp.) that were on the heads. By reducing the number of birds in the fields, the social stimulation associated with the feeding behavior of gregarious species is minimized, and the total number of birds from which the crop must be protected also is reduced. It is easier to move a population of pest birds before it becomes too large or established in a particular feeding area.

5. The possible effect of adhesives masking repellency (Hermann and Kolbe 1971) has not yet been evaluated satisfactorily. Recent evidence suggests that this may in-

deed occur at least in high ratios of repellent to methiocarb (Besser pers. comm.). The variation in types and amounts of adhesives/adjuvants may be one of the reasons for the inconsistent results which have characterized repellent trials on grain crops. Nonetheless, the results of the trials in Senegal do show that repellency can occur when adnesives are used, and that they probably are necessary under conditions of rainfall or aerial irrigation.

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TABLE 1: Criteria used to test methiocarb as a bird repellent in Senegal between 1975 and 1977.

		trial plots							
		treated		untreated					
Crop and Site	Date	No.	Size (ha)	No.	Size (ha)	Application	kg ai/ha	Water (liter/ha)**	Sprayer or Mixing Method
SEED DRESSING									
Rice-moist, pre-germinated-Boundowm	Sept 76	2	1.50	2	1.50	1	0.53 & 0.83%	—	On canvas, hand sown.
Boundowm	Oct 77	4	1.00-2.00	4	1.00-2.00	1	0.25%	—	Barrel mixer, hand sown.
-dry, non-germinated Nianaga	Nov 76	1	9.00	1	0.75	1	0.60%	—	On canvas, hand sown.
Nianaga	Dec 76	2	0.50	2	0.50	1	0.25%	—	On canvas, seed driller.
Melon-dry, non-germinated-Sebikotane	Oct 77	1	7.50	1	2.00	1	0.75%	—	Barrel mixer, seed driller.
RIPENING GRAIN									
Millet-Bambey	Feb 75	1	0.04	1	0.15	1	6.50	110	Pulval pressurized sprayer.
-Bambey	Apr 76	3	0.04	2	0.04	2	1.0, 2.0, & 3.0	75	Holder atomizer.
Sorghum-Darou	Oct 75	1	0.22	1	0.17	1 & 2	2.60	65	Holder atomizer.
Rice-Richard Toll	Aug 75	1	0.80	1	0.70	2	2.0 & 2.5	50 & 65	Pulval pressurized sprayer.
-Richard Toll	Aug 77	3	0.25 & 0.50	3	0.25 & 0.50	3	2.00	60	Solo atomizer

* The entire plots were treated except at Richard Toll, Aug 77, when treated ½ the area in alternate bands with 6 kg ai in each band.
** For seed dressings a methiocarb-water slurry (3.5 liters) was mixed with 100 kg of dry seed. Water evaporated before sowing.
*** % active ingredient by dry seed weight.

TABLE 2: Results of rice and melon seed-dressing trials with methiocarb in Senegal between 1975-1977. Statistical significance ($P < 0.05$) exists between means at each site followed by different superscripts.

Trial Sites	plots	number of plant samples	number of birds/obs. interval*	avg. numbers of birds/obs. interval	avg. numbers of seedlings ($\bar{x} \pm SD$) sample site
RICE SEED					
Boundowm (11-29 Sep 76)					
East - treated	1	100	12	17	9.7±12.7a
- untreated	1	100	12	49	6.9± 6.7a
West - treated	1	100	31	1	5.8± 7.4a
- untreated	1	200	31	2	6.9± 8.8a
Nianaga (13-30 Nov 76)					
- treated	1	54	159	10	10.4±11.1a
- untreated					
(9 Dec 76/14 Jan 77)	1	54	159	43	5.9± 8.1b
- treated (avg)	2	50	109	3.2	21.5±20.8a
- untreated (avg)	2	50	109	7.2	9.8±11.3b
Boundowm (28 Sep-13 Oct 77)**					
- treated (avg)	4	100	31	6.2	5.5± 5.9a
Seye	1	100	31	2.7	10.2± 7.6
Cisse	1	100	31	1.5	4.7± 4.6
Sy	1	100	31	1.8	1.5± 1.7
Diop	1	100	31	2.0	5.2± 3.9
- untreated (avg)	4	100	31	27.6	4.2± 5.0a
Seye	1	100	31	10.5	6.2± 5.3
Cisse	1	100	31	7.9	5.6± 5.7
Sy	1	100	31	5.6	1.5± 1.9
Diop	1	100	31	3.6	3.2± 3.8
MELON SEED					
Sebikolane (7-18 Oct 77)					
- treated	1	1000	24	1.5	6.4± 1.6a
- untreated	1	1000	24	1.5	8.9± 1.2a

* number of observation days: Boundowm East (3) and West (6) 1976. Nianga 1976 (11) and 1977 (12); Boundowm 1977 (13); Sebikolane 1977 (5).

** data from the individual farmers. (Seye, Cisse, Sy, Diop).

TABLE 3: Summary of yields and principal bird pests in methiocarb trials conducted in Senegal from 1975-1977.

Trial location	No. plots	No. heads sampled at harvest/plot	Yields or % damage	Avg. no. birds/obs*	Main pest species
MILLET					
Bambey (15/2-4/3/75)					
- treated	1	25	4.61g/head	not recorded	*P. luteus, P. griseus, E. orix* resident during trial.
- untreated	1	37	2.19g/head		200-300 total in small feeding flocks.
Bambey (26/4-26/5/76)					
- treated	3	50	93-100%	21-52	*Q. quelea* (30%), *P. luteus* (53%) *E. orix* (23%)
- untreated	1	50	100%	18	roost population of 1000-3000 birds.
SORGHUM					
Darou (13/10-4/11/75)					
- treated	1	1200	4%-49.4g/head	12.5	*P. cucullatus* and *P. melanocephalus. L. chalybaeta, V. wasiia, B. albirostris, Ploceus*
- untreated	1	900	67%-15.6g/head 15.8g/head	44.5	from breeding colony of 500-1000 birds.
RICE					
Richard Toll (8/8-18/9/75)					
- treated	1	68	2.05g/head 206± 54g/0.5m²	136	*E. orix, Q. quelea,* and *Ploceus* spp.
- untreated	1	72	1.91g/head 149± 50g/0.5m²	209	
Richard Toll (19/8-12/9/77)					
- treated	3	200	38%, 63%, 75%	23-87	*Q. quelea* (80%), *Ploceus* spp. (5%), *E. orix* (15%); 600-2000 birds each period all from pre- or nesting colonies.
- untreated	3	200	93%, 100%, 100%	63-78	

* Observations: Bambey (10 days - 62 intervals); Darou (8 days - 64 intervals); Richard Toll 75 (10 days - 33 intervals); Richard Toll 77 (depending on the plot, from 8-15 days and 64-174 intervals)

TABLE 4: Summary of food habits of Ploceid weaver species collected from trial sites during methiocarb trials in Senegal 1975-1977.

	Quelea quelea	Passer luteus	Lonchura cucullata	Ploceus cucullatus	Euplectes orix	Ploceus melanocephalus	Bubalornis albirostris
MILLET							
Bambey - Apr 75							
no. birds sampled	53	61	6	7			
% eating cereal	100	100	50	71			
avg. wt (g) and range	0.59	0.23	0.08	0.55			
of crop and stomach contents	(0.01-2.09)	(0.02-0.80)	(0.03-0.30)	(0.01-1.22)			
SORGHUM							
Darou - Oct 75							
no. birds sampled				9			5
% eating cereal				89			100
avg. wt (g) and range				0.40			0.31
of crop and stomach contents				(0.14-0.61)			(0.10-0.75)
RICE							
Richard Toll - Aug 75							
no. birds sampled	26			5	40	10	
% eating cereal	12			100	33	80	
avg. wt(g) and range	0.14			not	0.19	not	
of crop and stomach contents	(0.01-0.88)			weighed	(0.01-1.49)	weighed	
Richard Toll - Aug 77							
no. birds sampled	147			2	31		
% eating cereal	45			100	71		
avg. wt(g) and range	0.12			0.37	0.10		
of crop and stomach contents	(0.01-0.28)			(0.34-0.40)	(0.01-0.31)		
TOTALS							
no. birds sampled	226	61	8	28	71	10	5
% eating cereal	54	100	50	87	49	80	100
avg wt(g) and range	0.23	0.23	0.08	0.45	0.15	not	0.31
of crop and stomach contents	(0.01-2.09)	(0.02-0.80)	(0.03-0.30)	(0.01-1.22)	(0.01-1.49)	weighed	(0.01-0.73)

*Collection dates: Bambey 75 (29 and 30/4, 19 and 26/5). Darou 75 (29 Oct), Richard Toll 75 (5, 13, 14, 18, 20 and 25 Aug), Richard Toll 77 (31/8 and 1, 2, 6, 8, and 9/9).

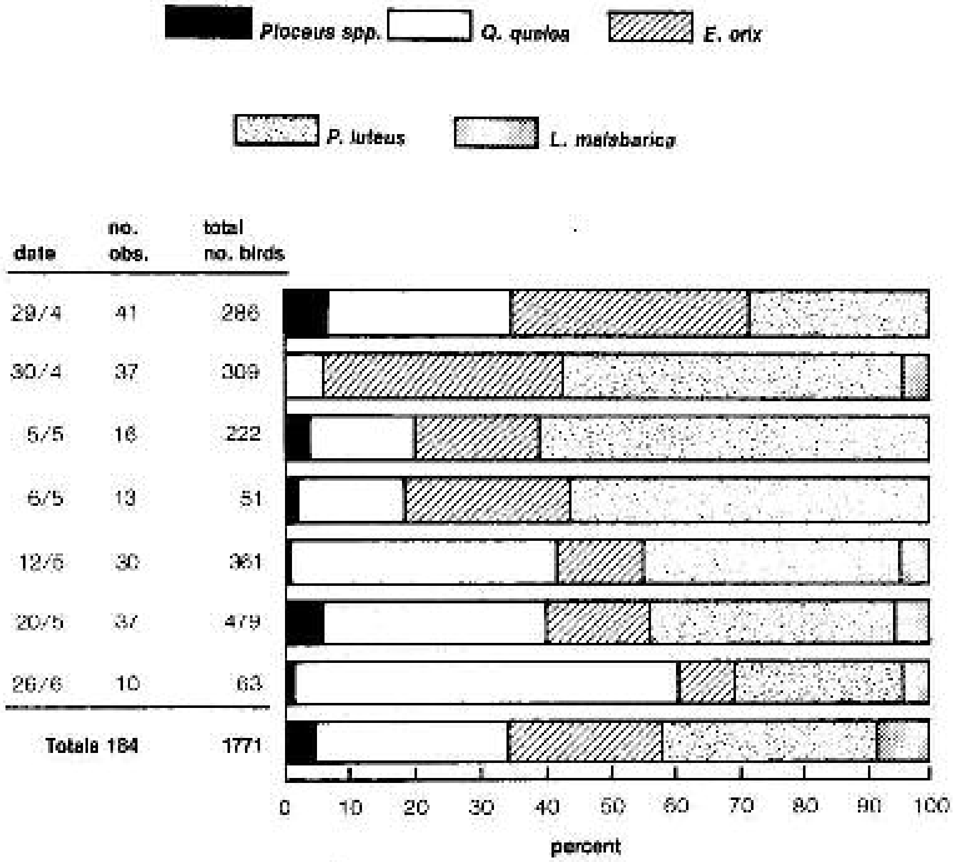

FIGURE 1. Changing proportions of Ploceid species feeding on dry season millet (1976).

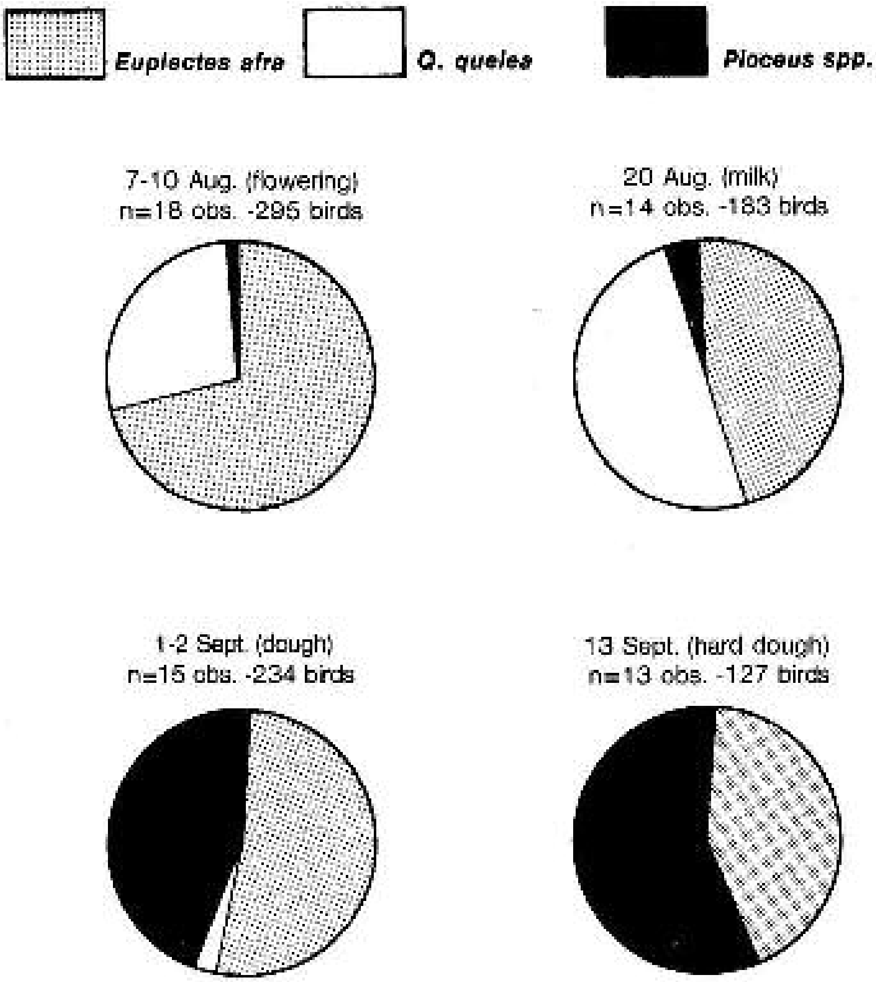

FIGURE 2. **Changing proportions of Ploceid species feeding on wet season rice (1975).**