Evaluation of thiram and cinnamamide for protection of maize seeds against multimammate mice, *Mastomys natalensis*, in Tanzania

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ABSTRACT. Farmers in Tanzania consider rodents to be the major vertebrate pest of maize, especially at planting and seedling stages and annual losses are high. We evaluated the potential of two seed-dressing compounds, thiram and cinnamamide, as rodent repellents to protect maize against damage by multimammate rats, *Mastomys natalensis*. In laboratory tests, the two compounds showed a strong repellent effect against *M. natalensis* and thus the potential to protect maize seeds. The two compounds were evaluated in maize fields using Randomized Complete Block Design (RCBD) with three replications. The results show that these repellents are effective for protecting maize seeds against multimammate rats in the field, but in locations with high population of *Tatera leucogaster*, seedlings are still damaged after emergence. Therefore, in such locations, other control measures, including application of rodenticides just before seedling emergence may be necessary.

KEY WORDS : cinnamamide, economic loss, *Mastomys natalensis*, repellents, *Tatera leocogaster*, thiram, seed predation.

INTRODUCTION

In Tanzania, farmers consider rodents to be the main vertebrate pest (LEIRS et al., 2003). It has been estimated that the annual economic loss due to rodents in maize fields may amount to 42.5 million dollars (MULUNGU, 2003), a loss that may be preventable by poisoning and trapping (STENSETH et al., 2001). However, poisoning and trapping techniques are frequently ineffective, environmentally hazardous and socially unacceptable or uneconomic (MYLLYMÄKI, 1987). Thus alternative methods to prevent rodent damage are needed.

The deterrence approach to rodent control is not new (NOLTE & BARNETT, 2000, CAMPBELL & EVANS, 1985), although emphasis on chemical repellents as a means of reducing damage by rodents and other animals has increased in recent years. The need for materials to protect maize at planting and seedling stage is generally recognized (NGOWO et al., 2003). Ideal repellent seed dressing would prevent rodents from damaging the seed (SIMMS et al., 2000). The toxic effect on rodent should be minimal; otherwise they will act as rodenticides and basically create vacant space that will attract other rodents. Moreover, the repellents must not have phytotoxic effects that would reduce germination rates (NOLTE & BARNETT, 2000, MYLLYMÄKI, 1987, CAMPBELL & EVANS, 1985).

Preliminary laboratory studies from a wide range of botanic and synthetic repellents suggest that dressing maize seeds with thiram and cinnamamide can reduce damage to seeds by multimammate rats, *M. natalensis*. In general, repellents may be classified as either primary or secondary, according to their site of activity in the target species (ROGERS, 1978). Primary repellents provoke instantaneous responses through taste, olfaction, or irritation of the buccal cavity. Secondary repellents produce distressing effects after eating (e.g. gastrointestinal malaise or other illness) which, if associated with a novel cue, may cause the subject to develop a conditioned aversion to a given food (GILL et al., 1995). Some repellent compounds have both primary and secondary activity (GILL et al., 1994). For example, the cinnamamide used in the current study is considered bitter and does not smell good (GILL et al., 1995). Thiram has a a bad strong smell which probably has olfactory repellence in rodents. The present study, therefore, reports the results of field tests with thiram and cinnamamide.

MATERIAL AND METHODS

Study locations

Two field experiments were conducted in December, 2002 and March, 2003 in Chunya (South -west Tanzania) and Mikese - Morogoro, (Eastern Central Tanzania), respectively, during the maize cropping seasons. In Chunya, maize is planted in November or December depending on the onset of rainfall, while in Mikese, it is planted in March. Initial trapping was carried out for three

consecutive nights one week before ploughing using 300 and 200 Sherman live traps per night at Mikese and Chunya, respectively, in order to determine the species composition and abundance. Therefore, there were a total of 900 and 600 trapping nights for Mikese and Chunya, respectively. The traps were placed in 100 x 100m grids, on 10 trap lines, 10m apart, each with 10 trapping stations also 10m apart. Peanut butter mixed with maize bran was used as bait. Traps were inspected each morning and captured animals were identified and counted according to species.

In both locations, the experimental set up was a Random Complete Block Design (RCBD) with three replications. The replicates were 70 * 70 m maize fields. Untreated seeds were planted in three control plots at each site. All plots were 100m apart. Other cultivated maize plots surrounded the experimental plots. In Chunya, only thiram was used to treat maize seeds. At Mikese, thiram and cinnamamide were used for seed dressing separately and each was, tested in three individual fields. Maize seeds (STAHA variety is commonly used by farmers in the study areas) not formally treated with chemicals (fresh from a farmer) were used in this study. Eighty grams of maize seeds were mixed thoroughly with 0.8 grams of the respective chemical repellent (i.e. thiram and cinnamamide). The treated seeds were left in the laboratory for 24 hours before planting and thereafter were planted in rows, 90cm apart and 60cm between planting holes, with three seeds per planting hole.

Assessment of crop damage

Crop damage assessment was carried out at seedling stage, 10 days after planting. We used a non-stratified systematic row sampling technique to assess damage as described by MWANJABE & LEIRS (1997) and MULUNGU et al. (2003). The sampling units were maize rows; four rows apart, leaving out the two outer rows. The assessor walked along maize rows across the plot, counting seedlings at each hole. Since three seeds had been planted per hole, we calculated the difference between observed and expected number of seedlings based on two assumptions, viz. the germination is 100% and other factors remain constant. The difference, therefore, was expressed as percentage damage.

Data Analysis

The data were analyzed in a general linear model with maize seed damage as the dependent variable and treatment as the factor interest, with field (and for thiram also site) as random factor (SAS, 1990). The damage data were subjected to Analysis of Variance (ANOVA) (SAS, 1990). The data were analyzed according to the following statistical model at each location :

$Y_{ij} = \mu + R_i + A_j + (RA)_{ij}$

Where :

Y_{ij} = Differences in maize seed damage

μ = Overall mean of maize seed damage

R_i = Replication effect

A_j = Treatment effect

$(RA)_{ij}$ = Experimental error

Since thiram was tested in both locations, the combined analysis was done by using the following model :

$Y_{ijk} = \mu + R_i + L_j + (RL)_{ij} + A_k + (LA)_{jk} + (RLA)_{ijk}$

Y_{ijk} = differences in maize seed damage due location different

μ = Overall mean of maize seed damage due to location difference

R_i = Replication effect

L_j = Location effect

$(RL)_{ij}$ = Main plot error

A_k = Treatment effect

$(LA)_{jk}$ = Location and treatment interaction effect

$(RLA)_{ijk}$ = Experimental error

RESULTS AND DISCUSSION

The effect of seed dressing on maize seed depredation at Mikese is shown in Table 1. The results show that there were highly significant differences (F = 203.5, df = 2, p = 0.001) between treated and untreated plots at Mikese : the treated maize seeds were less predated compared to untreated maize seeds. For Chunya, the results were not significantly different (F = 1.42, df = 1, p = 0.36) between treated and untreated maize seeds.

TABLE 1

The effect of dressing with Thiram and Cinnamamide on maize seed depredation by rodents in Mikese, Morogoro and Chunya, Mbeya, Tanzania

Treatments	Locations	
	Mikese	Chunya
Control	52.10 ± 3.51^a	38.4 ± 9.03^a
Thiram	27.53 ± 4.55^b	46.8 ± 3.24^a
Cinnamamide	26.41 ± 1.13^b	-

Means followed by the same letter are not significantly different from one another at the 95% probability level.

In Chunya, the amount of rainfall was low and erratic, causing sporadic germination. During the evaluation, the distribution and amount of rainfall was an important factor that influenced rodent damage to maize seed germination (MULUNGU, 2003). Therefore, rodent damage to seeds and seedlings appeared to depend on the duration of germination, particularly in Chunya. Similar observations were reported by KEY (1990) on the effect of rainfall on maize damage by squirrels during the seedling stage. In areas with erratic rainfall germination is sporadic and hence, seeds and seedlings were available at intervals spreading over several days. We compared depredation of untreated seeds with maize seeds treated with thiram in Chunya and Mikese. The results show that depredation of untreated maize seeds at both locations did not differ significantly (F = 5.05, df = 1, p = 0.09), suggesting that the extent of rodent damage to untreated and treated seeds was similar. However, the interaction between treatment and location was significantly different (F = 20.86, df = 1, p = 0.01). This suggests that thiram treatment at Mikese was more effective in preventing rodent damage than at Chunya.

The differences between these two locations were probably due to the rodent species present. In Chunya, two rodent species, *Tatera leucogaster* and *M. natalensis*

TABLE 2

Rodent species composition at Mikese and Chunya (one week before planting).

Locations							
Mikese				**Chunya**			
Species	Captured individuals	Trap nights	Composition (%)	Species	Captured individuals	Trap nights	Composition (%)
Mastomys natalensis	688	900	98.01	*Mastomys natalensis*	287	600	93.79
Tatera leucogaster	10	900	1.42	*Tatera leucogaster*	19	600	6.21
Lemniscomysspp	4	900	0.57	-	-	-	-

were most abundant (Table 2) and both predated on maize seeds and seedlings. In this location, maize seedlings were cut, probably by *T. leucogaster*.

Similar observations were reported in India where *T. indica* caused damage to seedlings immediately after germination (RAO, A.M.K.M. personal communication). Therefore, in locations with high populations of *T. leucogaster* much higher damage will be expected in addition to that caused by *M. natalensis*. The initial trapping before planting indicated that the population of rodents at Mikese was dominated by *M.natalensis* (98%) while at Chunya, it was composed of *M. natalensis* (93%) and *T. leucogaster* (6%). Other species occurred in relatively low numbers. At Mikese, therefore, there were fewer depredations of seedlings in treated plots, most probably due to the absence of *T. leucogaster*. The discrepancies between these two locations suggest that it is unlikely that a single repellent will be effective against all seed and seedling depredating rodent species. The results suggest that thiram and cinnamamide are effective against *M. natalensis* after seedling emergence and that they can protect damage to maize seeds and seedlings in the absence of *T. leucogaster*.

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