Chemical Protection of Sorghum Seeds and Seedlings from Insect Pests in Honduras[1,2]

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ABSTRACT

Seeds of *Sorghum bicolor* (L.) Moench, c.v. San Bernardo III, a photoperiod sensitive Honduran sorghum, was treated with furathiocarb 40 SD, methamidophos 60LC, chlorpyrifos 4EC and kerosene to evaluate the protection each provides against seed and seedling insect pests. The seeds were allowed to stand 24 h before planting in a small plot field test at El Zamorano, Honduras. Observations on missing and dead seed, seedling emergence, plant stand, plant height, number of leaves per plant and number of insects were made 5, 10, 15 and 20 days after planting. Fire ants [*Solenopsis geminata* (Fabricius)], white grubs (*Phyllophaga* sp.), fall armyworm [*Spodoptera frugiperda* (J. E. Smith)] larvae and termites (*Amitermes* sp.) were uniformly distributed throughout plots according to chi-square test. Furathiocarb provided the highest level of protection to the seeds and seedling plants during the 20 day post planting period; nevertheless, only about 50o/o of the seeds planted in the test area survived to establish a stand. Kerosene, often applied by resource poor farmers, and chlorpyrifos were comparable to furathiocarb in limiting number of seeds removed by ants during the first 5 days after planting, but plant stands were reduced significantly by other insect pests. Kerosene can be a low cost alternative for protection of seeds from ants. In this study, 94o/o of the untreated seed was missing or removed from where they were planted, presumably by ants. Phytotoxicity of methamidophos limited its evaluation.

INTRODUCTION

The area planted to sorghum, *Sorghum bicolor* (L.) Moench, by subsistence farmers in southern Honduras has increased but yield per hectare has decreased (44.1 metric tons in 1965-66 to 35.3 metric tons in 1977-78) due to low soil fertility, financial constraints and insect pest damage (DeWalt & DeWalt, 1982). Certain insect pests destroy seeds after planting and reduce plant stand. Subsistence farmers incur higher production expenses when additional seed is required for replanting or they may not replant due to the lack of seeds. Replanting also results in delayed maturity of the maize, which increases its vulnerability to mid-season drought and exposure to additional damage by late season insect pests, e.g. stalk borers, *Diatraea lineolata* (Walker) (Sequeira *et al.*, 1986).

Insecticides can effectively control some soil insect pests. Granular insecticides applied in the soil at planting are known to provide longer protection to seeds and seedlings than insecticides applied to the seeds (Metcalf, 1982). However, granular applications are more costly and require increased labor and special equipment (Dogger and Lilly, 1949). Additionally, residues of certain granular insecticides, especially chlorinated hydrocarbons may build up in the soil and may affect plant growth (Lange *et al.*, 1949). This is not as serious with the use of the short residual chemicals, i.e., organophosphate insecticides. As granular insecticides are costly and their application requires special equipment, subsistence farmers in developing countries seldom use them. However, seed treatment is often used, since it is an efficient means of protecting germinating seeds and seedling plants, even if the protection is not as long lived as with granular insecticides in the soil. Such applications require less insecticide, are less disruptive to the environment and are relatively inexpensive. However, there may be a high risk of dermal intoxication when the chemicals and seeds are hand mixed by the subsistence farmers.

The objective of this study was to compare the efficacy of four chemicals used frequently in Honduras as sorghum seed treatments. Protection provided to the seeds and seedling from insect pests during the first 20 days after planting was determined.

MATERIALS AND METHODS

This study was conducted at the Escuela Agricola Panamericana, 35 km east-southeast of Tegucigalpa, Honduras, during June 28 to July 17, 1986. Sorghum was planted in a pure stand. Seeds of the local variety San Bernardo III was treated with one of four chemicals. Chemicals were methamidophos (Tamaron®) 60 LC at 19 ml/kg of seed, furathiocarb (Promet®) 40 SD at 22 ml adhesive (packaged with Promet) + 11g insecticide/kg of seed, chloropyriphos (Lorsban®) 4 EC at 39 ml/kg of seed, and kerosene at 110 ml/kg of seed. The chemicals were mixed with sugar-water (added as adhesive) at the rate of 10 g sucrose/50 ml water per kilogram of seed. The seeds were then mixed the chemical solutions for 24h in glass containers after which they were immediately planted.

The field selected for the study was planted for the first time in 1985 with corn. Many large and small rocks were in the field, a condition similar to fields in southern Honduras, therefore the land was not prepared using machinery. Weeds were removed with herbicides and machete. Five treatments including a non-treated check were arranged in a randomized complete block design with four replications. Each treatment plot consisted of four rows, five meters long and 80 cm between rows; the middle two rows were utilized for sampling. Sorghum seeds were planted 7.5 cm deep (ca. depth used by subsistence farmers), using a digging stick (chuzo) in hills 50 cm apart. Ten sorghum seeds were placed in each hill.

Pre and post planting soil samples were taken 3 days before planting and at 5-day intervals to day 20 after planting. For the pretreatment samples ten soil samples, each measuring 20 x 20 cm, were taken at random from the field using a 20 cm wide hoe to a depth of 10 cm to determine the complex of insects present. Soil samples were taken on four dates after planting. Each samples was 8 cm in diameter and was centered over four consecutive hills per plot. A total of 64 samples were taken for each treatment. The following data were taken: 1. number of seeds missing, 2. number of non-germinated seeds, 3. number of seedlings emerged, 4. number of dead plants, 5. plant height (soil line to lowest point in the whorl), 6. number of leaves per plant, and 7. identity and number of soil insect pests present in each hill. Percent seedlings emerged, percent seeds missing and percent dead seeds were calculated. Arcsin transformations of the percentage data were used for analysis. The data were analyzed using analysis of variance and the means were separated by Duncan's multiple range test.

RESULTS AND DISCUSSION

Ants [*Solenopsis geminata* (Fabricius)], white grubs (*Phyllophaga* sp.), fall armyworm [*Spodoptera frugiperda* (J. E. Smith)] larvae and termites (*Amitermes* sp.) were the insects most commonly found in the field. A chi-square test applied over sample dates showed that these insects were uniformly distributed in all treatment plots. Ants and fall armyworms moved into and out of the small treatment plots or reinfested the plots maintaining a uniform distribution throughout the test period, even in the presence of insecticides. We can only assume that the insecticides killed insects in the test plots and that treatment differences were attributed to the chemicals applied to the seeds, although a reduction in insect pest populations was not observed in the insecticide treatment plots.

Examination of individual hills 5 and 10 days after planting revealed that significantly more untreated seed than treated seed was missing (Table 1). As few other herbivores were observed, ants were considered responsible for most seed removal. During the first five days after planting, 87o/o of the untreated seeds was removed, whereas 13 to 29o/o of the seeds with chemical treatments was removed. Ants continued to carry away seeds from all treatments for 10 days after planting, and at 10 days significantly fewer chemically-treated seeds (14-54o/o) were missing than untreated seeds (94o/o missing). Furathiocarb (14o/o seed missing after 10 days) and chlorpyrifos (33o/o) provided good protection followed by kerosene (53o/o), and methamidophos (54o/o).

Table 1. Effect of chemical treatment on sorghum seed survival. El Zamorano, Honduras, 1986.

Treatment		Percent ± SEM seeds missing on days after planting		Percent ± SEM dead seed on day 5
Material	Form[1]	5	10	
Furathiocarb	40 SD	13 ± 2 a[2]	14 ± 5 a	1 ± 1 a
Kerosene	L	14 ± 1 a	53 ± 16 a	1 ± 1 a
Chlorpyrifos	4 EC	21 ± 4 a	33 ± 6 a	3 ± 3 a
Methamidophos	60 LC	29 ± 14 a	54 ± 12 a	19 ± 4 b
Untreated	—	87 ± 8 b	94 ± 4 b	0 ± 0 a

1/ SD = seed dust, L = liquid, LC = liquid concentrate, and EC = emulsifiable concentrate.

2/ Means in a column followed by the same letter are not significantly different at P=.05 level by Duncan's multiple range test.

Most of the seeds emerged by day 4 after planting and soil moisture was adequate for good plant growth during the study period. The number of non-germinated seeds observed on day 5 indicated that percent dead seeds ranged from 0 to 3o/o for untreated seeds and seeds treated with furathiocarb, kerosene and chlorpyrifos to 19o/o for seeds treated with methamidophos. These data indicate that methamidophos was phytotoxic at the dosage applied.

Plant stand establishment data, based on the number of surviving seedlings, showed that furathiocarb consistently protected the sorghum seeds and seedlings better than the other treatments throughout the first 20 days after planting and resulted in a significantly better stand establishment (Table 2). On day 5 after planting, the number of emerged plants was significantly higher for treated seeds compared to untreated seeds, with highest numbers (75-87o/o) of plants surviving in plots planted with seeds treated with furathiocarb, kerosene or chlorpyrifos. The furathiocarb, chlorpyrifos and kerosene seed treatments provided some protection to the seeds and seedlings during the 20 day period following planting, but furathiocarb was significantly better than kerosene and chlorpyrifos. However, percent surviving seedlings in all treatments declined from 5 to 20 days after planting, indicating a gradual loss of plants due in part to insect feeding damage. Plant stand on day 20 after planting was 58o/o for furathiocarb, 28o/o for kerosene, 26o/o for chlorpyrifos, 7o/o for methamidophos and 3o/o for untreated seeds. The destruction of seedlings was caused principally by the fall armyworm. Direct observations in the field on July 5-10 indicated that fall armyworm larvae fed like cutworms. Any systemic activity or contact with insecticide in the soil might influence insect feeding damage on seedling plants. White grubs and termites had little effect in this study.

Seeds treated with furathiocarb produced significantly taller plants than the untreated (Table 3). Plants from furathiocarb treated seeds developed normally and had almost three times the number of leaves per plant compared to plants receiving no seed protection. Seed treated with furathiocarb also protected plants from leaf damage which resulted in more leaves than the untreated, but these differences were not significant due to the variability in untreated samples. Furathiocarb protection of seeds and seedlings from insect pest

Table 2. Effect of chemical seed treatment on sorghum stand establishment. El Zamorano, Honduras, 1986.

Treatment		Percent ± SEM live plants on days after planting			
Material	Form[1]	5	10	15	20
Furathiocarb	40 SD	87 ±3 a[2]	71 ± 12 a	63 ± 3 a	58 ± 5 a
Kerosene	L	86 ±1 a	33 ± 15 ab	44 ± 11 ab	28 ± 11 b
Chlorpyrifos	4 EC	75 ±7 a	43 ± 7 a	27 ± 10 b	26 ± 11 b
Methamidophos	60 LC	39 ±17 b	34 ± 10 ab	18 ± 8 b	7 ± 3 b
Untreated	—	13 ±8 c	3 ± 2 b	9 ± 1 b	3 ± 1 b

1/ SD = seed dust, L = liquid, LC = liquid concentrate, and EC = emulsifiable concentrate

2/ Means in a column followed by the same letter are not significantly different at P=.05 level by Dunca's multiple range test.

Table 3. Effect of chemical seed treatment on sorghum plant development 20 days after planting. El Zamorano, Honduras, 1986.

Treatment		Mean no. ± SEM of leaves/plant	Mean ± SEM plant height (cm)[2]
Material	Form[1]		
Furathiocarb	40 SD	5 ± 0.4 a[3]	6 ± 0.3 a
Kerosene	L	4 ± 0.5 a	5 ± 0.5 ab
Chlorpyrifos	4 EC	3 ± 0.9 a	4 ± 0.9 ab
Methamidophos	60 LC	3 ± 0.8 a	4 ± 1.2 ab
Untreated	—	2 ± 1.0 a	2 ± 0.6 b

1/ SD = seed dust, L = liquid, LC = liquid concentrate, and EC = emulsifiable concentrate.

2/ Plant height measured from soil line to bottom of whorl.

3/ Means in a column followed by the same letter are not significantly different at P=.05 level by Duncan's multiple range test.

damage allowed the plants to develop more than plants in the untreated plots.

CONCLUSIONS

Of the four chemical treatments evaluated in this study, furathiocarb provided the greatest protection to the seeds and seedlings from damage by insect pests. This protection during seed germination and early plant development permitted successful stand establishment. Kerosene and chlorpyrifos provided some protection to the seeds and seedlings, but were generally less effective than furathiocarb. Methamidophos was phytotoxic at the dosage applied.

Based on these results and the price and availability of the chemicals evaluated, kerosene can be selected for further testing as a seed treatment for protection of seeds in areas where ants remove seeds. Kerosene costs less than the other chemicals, is easy to apply to the seeds, is not highly toxic, and is commonly found in rural households where it is used for illumination and cooking. Kerosene and furathiocarb should be evaluated in on-farm trials in order to validate the results of the present study prior to developing recommendations for use by sorghum farmers. Cost of the insecticide may be a constraint to its use by resource poor farmers. Although furathiocarb proved to be the most effective seed treatment in this study, only about 50o/o of the seeds planted in the test area survived to establish a stand by day 20 after planting. This indicates that a substantial proportion of seeds and seedlings is lost to phytophagous insects or other causes, even when the seeds are treated with a chemical insecticide prior to planting. This may partially explain why subsistence farmers commonly plant 10 to 20 seeds per hill. The loss of seeds and reduction in plant population is sufficient to achieve desired plant stand in areas where insects are damaging to seeds and seedlings. Good stand establishment and greater growth of plants protected in the seed and seedling stages by effective seed treatments probably translates into improved plant yield. The magnitude of insect damage to sorghum seeds and the severe reductions of plant stand observed in this trial suggest that field surveys should be made to determine the extent of early season losses in the different sorghum production areas of Central America.

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