Influence of slash and burn and slash and mulch practices on insect pests in intercropped sorghum and maize in southern Honduras

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Abstract. Intercropped sorghum and maize in two diverse areas, foothills and coastal plains, in southern Honduras were sampled for insect pests in slash and burn and slash and mulch crop production systems. Severe insect damage to seedling sorghum and maize was observed in the foothills, whereas only low levels of damage were observed on young plants on the coastal plains. The fall armyworm, *Spodoptera frugiperda* (J.E. Smith), and *Metaponpneumata rogenhoferi* Moschler were the most prevalent insect pests. *S. frugiperda* infestations were highest on whorl stage maize with 3.7 and 6.0 larvae per plant in fields in the foothills and on the coastal plains, respectively, but at lower densities of 0.5 and 3.4 larvae per plant on whorl stage sorghum in the respective areas. Significantly lower numbers of *S. frugiperda* larvae were found on early whorl stage maize in unburned fields than in burned fields, with similar numbers on plants at this stage on the plains at the time of peak infestation. Numbers of neotropical cornstalk borer, *Diatraea lineolata* (Walker), were higher in sorghum stalks in burned fields than in unburned fields in the foothills; and sorghum damage by this pest was also somewhat greater in the burned fields. Crop residue destruction by burning may be of little value for control of *S. frugiperda* and *D. lineolata* infestations in intercropped sorghum and maize in southern Honduras.

Key words: Cultural control, fire.

Resumen. En el sorgo y maíz intercalados en laderas y valles en el sur de Honduras, fueron muestreados los insectos plagas en sistemas de producción de cultivos de corte y quema, y corte y mulch. En áreas de laderas se observaron daños severos por insectos a las plántulas de sorgo y maíz, mientras que en las zonas de valles se encontraron niveles bajos de daño por insectos. El gusano cogollero, *Spodoptera frugiperda* (J.E. Smith) y *Metaponpneumata rogenhoferi* Moschler, fueron los insectos plagas más comunes. Las infestaciones más altas de *S. frugiperda* se presentaron cuando el maíz estaba en plántula con 3.7 y 6.0 larvas por plántula en laderas y valles, respectivamente, pero a bajas densidades de 0.5 y 3.4 larvas por planta en sorgo en estado de plántula, en las respectivas áreas. Significativamente menor cantidad de larvas de *S. frugiperda* fueron encontradas en los estados tempranos de plántulas de maíz en plantaciones no quemadas que en plantaciones quemadas, con número similar de plantas en este estado en los valles al momento de la infestación pico. La cantidad de larvas de barrenadores neotropicales, *Diatraea lineolata* (Walker), fueron mayores en tallos de sorgo en campos quemados que en campos no quemados en laderas; y el daño provocado por esta plaga al sorgo fue mayor en campos quemados. Los residuos de cultivos destruidos por la quema pueden ser de poco valor para el control de infestaciones de *S. frugiperda* y *D. lineolata* en plantaciones de sorgo y maíz intercalado en el sur de Honduras.

Palabras claves: Control cultural, fuego.

INTRODUCTION

Most of the sorghum (90%) in Honduras is intercropped with maize (Hawkins, 1984). DeWalt and DeWalt (1982) and Silva *et al.* (1984) identified insect pests as a principal constraint to production of these crops in southern Honduras. A comparison of insect pest infestations on crops in the foothills and on the coastal plains in southern Honduras suggested that insects were more damaging in the foothills (Silva *et al.*, 1984). DeWalt and DeWalt (1982) mentioned the fall armyworm, *Spodoptera frugiperda* (J.E. Smith), and the "langosta" [a term used by farmers to recognize a group of larvae; this group was recently identified as a lepidopterous

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complex (Pitre,1988)] as important pests in sorghum-maize fields in the foothills around Pespire, Honduras. Koone and Banegas (1958) and Andrews (1984) reported *S. frugiperda* and the neotropical cornstalk borer, *Diatraea lineolata* (Walker), as pests on sorghum and maize in other areas of Honduras.

The objectives of this study were to identify the most frequently encountered phytophagous insect pests attacking the vegetative and reproductive structures of sorghum and maize intercropped in the foothills and on the coastal plains in southern Honduras, and to determine the effect of burning the stubble of the previous crop on the incidence and density of these species.

MATERIALS AND METHODS

The study was conducted in 1987 in two agro-ecological locations (coastal plains and foothills) in the Department of Valle in southern Honduras approximately 13° 31' N, 87° 43' W. El Conchal is located on the coastal plains (approximately sea level) near the border of El Salvador. La Coyota is located nearby in the foothills at 52 m above sea level. The two locations are approximately 16 km apart. Fields in the foothills have low agricultural input compared to fields on the coastal plains (Silva *et al.*, 1984). Farmers on the coastal plains use more modern agricultural technologies than farmers in the foothills because land is more productive and therefore generates more income. Farmers on the coastal plains plant larger fields and can afford to rent a tractor to prepare the soil. After soil preparation they use ox-pulled plows to make seed furrows and plant by hand. Insecticides, herbicides (used to clear fields prior to planting) and fertilizers are used more frequently in this area.

Six fields were selected at each location. The stalks from the previous crop and/or weeds were slashed in all fields, and three fields at each location experienced slash and burn prior to planting. Pairs of burned and unburned (slash and mulch) fields (=treatments) were adjacent to one another on the coastal plains, but separated by 1 to 2 km in the foothills. The treatments were assigned at random and data were analyzed as a randomized complete block and means were separated using Duncan's (Duncan, 1955) multiple range test for data on the coastal plains and as a completely random design with means separated using F-test for data in the hills.

Sorghum and maize were planted on the coastal plains between May 27 and June 2, 1987, after the beginning of the rainy season. Seed of each crop (native varieties selected by individual farmers) were planted by hand in the same row (rows 116 cm apart) but in alternate hills (65 cm apart). In accordance with local practice, all fields (ca 0.7 ha) on the coastal plains were cultivated either by tractor or with ox-pulled plows, but fertilizers and herbicides were not used.

In the foothills, maize was planted May 26 and sorghum on July 2 in fields approximately 0.5 ha. Land cultivation is not common in this area, and although some chemical herbicides may be used, weeds usually are controlled manually. Seed were planted using a "chuzo" planting stick in rows 205 cm apart and in hills 97 cm apart in burned fields, but were planted in unburned fields in a pattern similar to that used on the coastal plains.

Seedling stage: Visual observations of crop plants (20 hills selected at random in each field) were used to determine insect densities and damage to seedlings. Crop seedlings were examined on three dates in June. Weeds bordering the fields were sampled at the same time for insects, using a wooden frame (1600 cm^2, the area within the frame). Four random samples were taken around each field. The frame was dropped to the ground, and plants within the frame were collected and identified by a plant taxonomist at the Paul C. Stanley Herbarium, Panamerican School of Agriculture (E.A.P.), Zamoramo, Honduras. All insects on the plants or knocked to the ground within the wooden frame were collected and identified. Plant growth stages were recorded on each sample date.

Whorl stage and reproductive stage: A destructive, whole plant sampling procedure (16 plants selected at random in each treatment on each sample date in each field) was used to determine the presence of insects infesting leaves, stalks and fruit (sorghum panicles and maize ears) and plant damage. Sampling was done from June 9 to November 26. Plants were pulled from the ground, and each leaf was separated to determine presence or absence of insects on the foliage. Stalks were dissected, and sorghum panicles and maize ears were examined thoroughly for insects. Lengths of stalk borer tunnels were measured at harvest. Insect larvae were collected and either identified immediately or reared on artificial diet (Nutri-Soy Wheat Germ Diet) in the laboratory if positive identification was uncertain. Adult Noctuidae were identified by a taxonomist specialist and voucher specimens were deposited in the museum at the E.A.P. and in the Mississippi Entomological Museum at Mississippi State University, Mississippi State, MS.

RESULTS AND DISCUSSION

Seedling stage: The first rain in the foothills occurred on May 20 and by May 22, weed seeds were germinating. The most common broadleaf weeds were *Amaranthus* sp. (probably *A. hybridus* L. or *A. viridis* L.), *Portulaca oleracea* L., *Melampodium divaricatum* (Rich. ex pers), *Ipomoea* sp. (probably *I. purpurea* (L.) Jacq.) and the most common grass *Ixophorus unisetus* (Presl) Schlecht. Although the abundance of weeds was not quantified, greater infestations appeared to be present around fields in the foothills than on the coastal plains, but no lepidopterous larvae were found on weed seedlings during the early sampling period.

Insect damage on crop seedlings in fields on the coastal plains was minor, whereas seedlings in the-foothills experienced heavy damage. Seedling damage was similar in burned and unburned fields. *S. frugiperda* and *Metaponpneumota rogenhoferi* Moeschler were the most prevalent insects damaging the crops during this early growth stage; however, a third lepidopterous species, *S. latifascia* (Walker), was also encountered at this time. Two of the fields in the foothills with early planted maize ultimately suffered 100% plant destruction and a third had 30% of the plants destroyed during their first week of development.

S. frugiperda and *M. rogenhoferi* were observed on the above non-crop vegetation surrounding the fields in the foothills by June 9 while the crop plants were seedlings (Figure 1). The numbers of *S. frugiperda* increased to 6.8 larvae per 1,600 cm^2 by June 23, whereas numbers of *M. rogenhoferi* larvae declined in samples from early June through late June. *M. rogenhoferi* was present on weeds until June 23, after which it was not found in the study fields. The data suggest that investigations are needed to determine if this species is univoltine and if it aestivates in this area of Honduras, in contrast to *S. frugiperda* which is active during most, if not all, of the crop growing season (Passoa, 1983; Pitre, 1988).

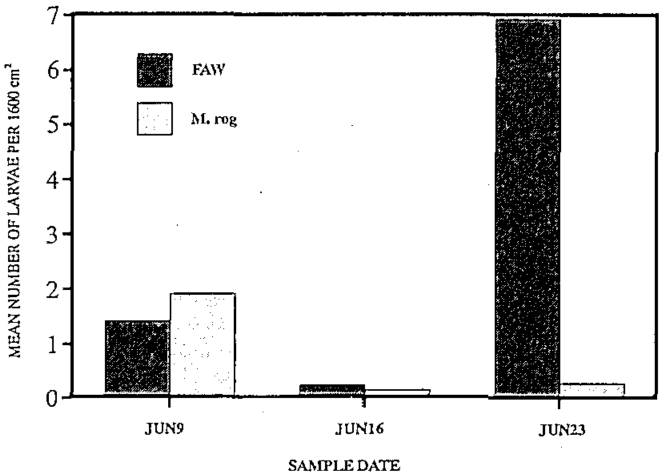

Figure 1. Mean number. of lepidopterous larvae [*Spodoptera frugiperda* (FAW) and *Metaponpneumata rogenhoferi* (M. rog.)] on 1,600 cm^2 of weeds bordering sorghum-maize fields in the foothills. La Coyota, Honduras, 1987.

The severity of lepidopterous larvae infestation on the crop seedlings in the foothills appeared to be related to the presence of weeds in and around the fields (Portillo et al., 1994). *S. frugiperda* infestations were higher on maize in fields with reduced weed control than in fields with weed control (Portillo *et al.*, 1997). The weeds were infested with high numbers of larvae 2-3 weeks after the plants emerged from the soil. The crops were damaged by late instar larvae, which apparently had developed through early instars on weeds that germinated before the crop seeds were planted, and subsequently dispersed to the crop plants. Weed management in sorghum-maize cropping systems is being investigated to determine the impact of this cultural practice in control of the langosta species.

Whorl stage: Populations of *S. frugiperda* on whorl stage crop plants generally were similar in the foothills and on the coastal plains (Figure 2A and Figure 2B). Infestations of maize plants in the burned fields in the foothills were higher on 4 of 6 sample dates than in unburned fields (Figure 2A). Burning could reduce natural enemy populations, thus increasing survival potential of this lepidopterous pest. The relationship of soil nutrients (as in burned fields) with sorghum and maize attractiveness to lepidopterous moths in planting systems in this area of southern Honduras, as well as that of defoliator pests and their natural enemies in slash and burned fields should be identified and would contribute to understanding the influence of burning practices on pest infestations.

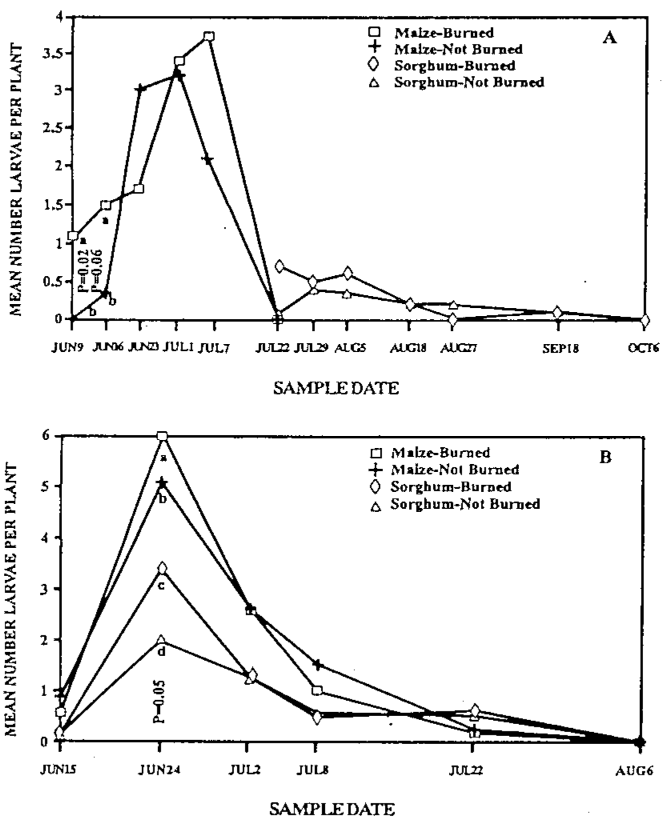

Figure 2. Mean number of *Spodoptera frugiperda* larvae per sorghum or maize plant in burned or unburned fields in the foothills [A] at La Coyota and on the coastal plains [B] at El Conchal, Honduras, 1987.

S. frugiperda larvae were not found on maize after July 7. Numbers of this species on sorghum remained below 0.6 larvae per plant, but larvae were found on the crop until late September. The late-planted sorghum provided a suitable host for *S. frugiperda* in mid-to-late season.

Peak infestations by *S. frugiperda* larvae on whorl stage sorghum and maize on the coastal plains occurred June 24 (Figure 2B), when maize averaged 11 leaves and sorghum 9 leaves per plant. The number of *S. frugiperda* larvae per plant was higher on maize in the burned fields (6.0 larvae/plant) than in unburned fields (5.1 larvae/plant). This same relationship was observed on sorghum (3.4 larvae in burned fields, 2.0 in unburned). The *S. frugiperda* infestations on both crops on the coastal plains declined to near zero by August 6 even though sorghum remained in the whorl stage until early November.

Reproductive stage: As maize initiated reproduction (July 8 on the coastal plains and July 22 in the foothills), *S. frugiperda* larvae moved from the foliage to the developing ears. Infestations of maize ears by *S. frugiperda* larvae in the foothills and on the coastal plains were similar (0.3 larvae/ear) in burned and unburned fields (Table 1). *D. lineolata* larvae appeared to be in greater numbers than *S. frugiperda* larvae in the ears over the sample period. However, maize ears in fields on the coastal plains were infested more heavily by *S. frugiperda* than *D. lineolata* larvae on July 22. The number of *S. frugiperda* larvae per ear was 0.6 in burned and unburned fields; whereas, the infestation by *D. lineolata* was 0.1 larvae per ear on this sample date in burned and unburned fields. Numbers of *D. lineolata* larvae in maize ears were similar in burned (0.6 larvae/ear) and unburned (0.7 larvae/ear) fields in the foothills, as well as on the coastal plains (0.1 larvae/ear) on August 5.

Stalk stage: The number of *D. lineolata* larvae increased markedly on whorl stage sorghum foliage in the foothills by September 18, after which numbers decreased (Figure 3A). The infestation in sorghum stalks peaked by October 6 (Figure 3B), indicating that the larvae moved from feeding sites on leaves in the whorl to the stalk, where the most serious damage can occur. Numbers of borers in sorghum stalks generally declined from October to mid-to late November.

Table 1. Number of fall armyworm, *Spodoptera frugiperda*, and neotropical cornstalk borer, *Diatraea lineolata*, larvae per maize ear. Valle, Honduras, 1987.[1]

		S. frugiperda		*D. lineolata*	
Location	Date	Burned	Unburned	Burned	Unburned
Hills	July 22	0.1	0.3	0.4	0.1
	July 29	0.5	0.4	0.9	1.1
	August 5	0.5	0.3	0.6	0.7
Plains	July 22	0.6	0.6	0.1	0.1
	August 5	0.0	0.0	0.1	0.1
Mean		0.3	0.3	0.6	0.7

[1] Differences between burned and unburned fields for each insect species at each sample date were not significant at P=0.05 level using F test.

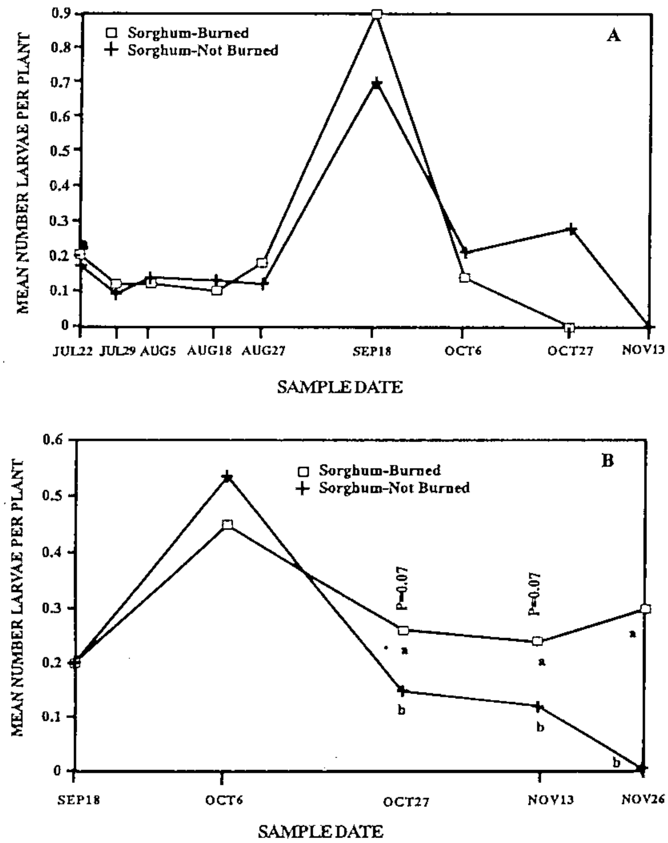

Figure 3. Mean number of *D. lineolata* larvae on sorghum foliage [A] and in stalks [B] in burned or unburned fields in the foothills. La Coyota, Honduras, 1987.

D. lineolata larvae were present on whorl stage foliage of sorghum plants on the coastal plains early in the growing season (Figure 4A). The infestation peaked in number of larvae per plant on September 25, after which numbers declined by early November. This reduction in number of borer larvae on foliage corresponds to the observed increase in stalk infestation after September 25 (Figure 4B). The infestation of borers in stalks increased through October to a high level (0.4 larvae per plant) on November 18 in burned and unburned fields.

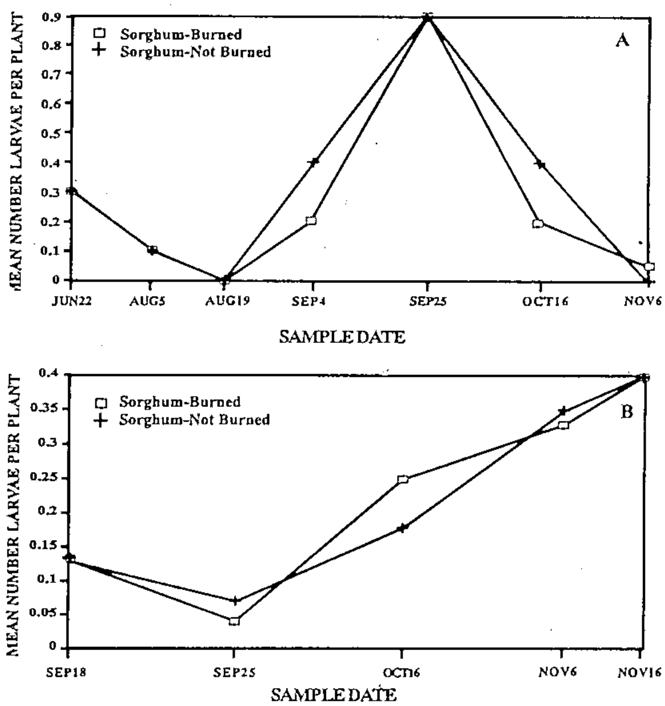

Figure 4. Mean number of *D. lineolata* larvae on sorghum foliage [A] and in stalks [B] in burned or unburned fields on the coastal plains. El Conchal, Honduras, 1987.

Sorghum in burned fields in the foothills had a higher number of *D. lineolata* larvae than sorghum in unburned fields late in the growing season. Similar differences between treatments were observed for stalk damage (measured as cm of tunneling within stalks) by this pest. In early December, sorghum in burned fields had 14.2 cm tunnel damage per stalk; whereas, sorghum in unburned fields had 9.3 cm (P=0.1, Figure 5). The burned fields in the foothills had not been planted with maize or sorghum the previous year. Thus, we cannot associate the burning of infested sorghum or maize stalks with a reduction in numbers of diapausing *D. lineolata*. Plants in burned fields appeared to have less stress than those in unburned fields due to low soil moisture and probably were more attractive to moths and more suitable hosts for insect development. On the coastal plains, damage to the sorghum plants was similar for burned (6.1 cm stalk tunnels) and unburned fields (7.1 cm) (Figure 5). Although burning was associated with larger numbers of *D. lineolata* larvae in sorghum in the foothills, this practice of burning crop residues did not increase infestation of this pest on sorghum in fields on the coastal plains. Fields on the coastal plains apparently did not suffer from water stress as much as those in the foothills. Trabanino *et al.* (1990), investigating the soil inhabiting phytophagous arthropods in sorghum and maize fields in southern Honduras, reported that soil moisture was significantly higher in fields on the coastal plains than in the foothills. It seemed that plant suitability for insect development was similar for burned and unburned fields on the coastal plains.

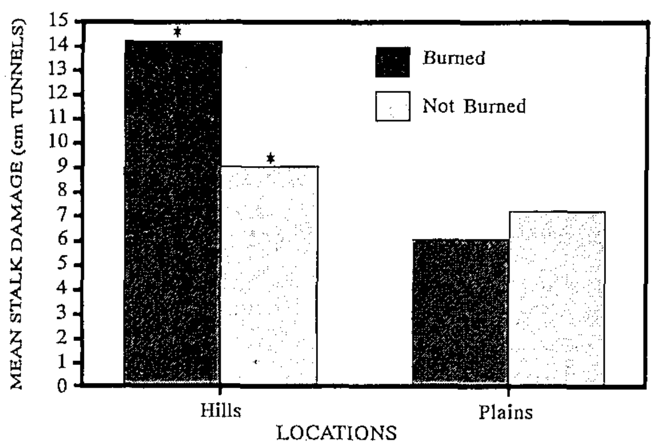

Figure 5. Damage (cm tunneling per stalk) to sorghum at harvest by *D. lineolata* larvae in burned and unburned fields in the foothills at La Coyota and on the coastal plains at El Conchal in Honduras. 1987 (*Treatment means were significant at P=0.1 level using F test.)

Pest Management: Early planted, photoperiod sensitive sorghums are not likely to escape infestations by the insect pests normally encountered on whorl and stalk stages in southern Honduras. The practice of planting early may not be an effective insect pest control measure with the photosensitive sorghums. However, late plantings may experience less damage by *D. lineolata*. The late plantings may be delayed in development, thereby providing a less attractive or suitable plant for some insects, e.g., *D. lineolata* (Castro, unpublished). Planting date may be more important for *S. frugiperda*, as early plantings will be in advanced stages of plant development at time of maximum infestation. The suitability of the photosensitive sorghums for *S. frugiperda* development is reduced as the plant matures (Castro, unpublished). However, since seedling and early whorl pests constitute a major constraint to production, late are delayed planting may result in less crop damage by avoiding large, early season pest infestations.

Effective control measures for *D. lineolata* have been reported to include crop rotation, crop residue destruction, early planting, and good soil fertility (King and Saunders, 1984). In the present study, burned fields in the foothills not planted with sorghum or maize the previous season had higher infestations of *D. lineolata* larvae than unburned fields which were planted with the crops the previous season. Adult *D. lineolata* may have infested the burned fields from nearby fields. This suggests that crop rotation may be of little value for reducing *D. lineolata* infestations in sorghum in southern Honduras. A similar situation may exist for *S. frugiperda* as this insect is known to fly over long distances (Sparks, 1979), and may invade the crop fields from surrounding areas (Pitre, 1988; Portillo *et al.* 1991).

The application of granular insecticides into the whorl until flowering may reduce the number of *D. lineolata* larvae moving from the whorl to the stalk (Mihm, 1985). However, the extended vegetative period of photosensitive sorghums would make this practice expensive and prohibitive to resource poor farmers.

The timely application of an effective insecticide may significantly reduce numbers of these pests on sorghum, reduce damage to the stalks, and improve crop yield. Farmers generally use backpack sprayers with high water volume per application for general distribution of the chemical over the plants. This may be a problem in areas where water is scarce. Additionally, these broadcast spray applications may cause increased mortality of natural enemies. Insecticides applied directly into the whorl can be more effective and economical.

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