PROTECCION DE PLANTAS

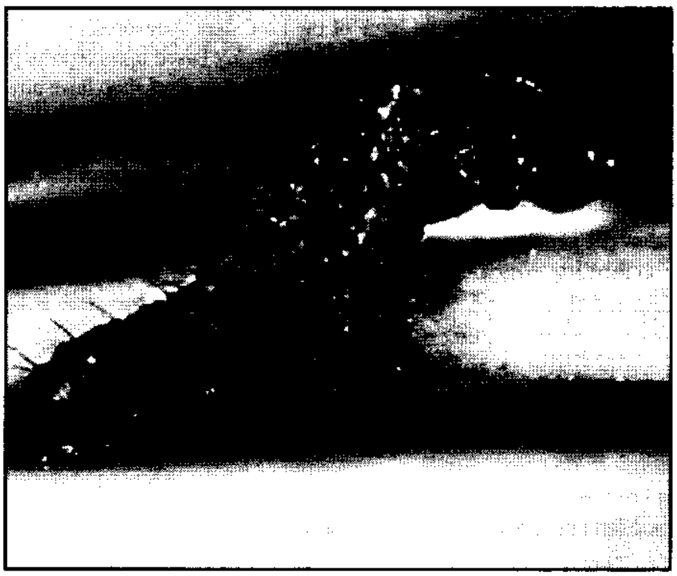
INSECTICIDES EVALUATED FOR CONTROL OF FALL ARMYWORM (LEPIDOPTERA: NOCTUIDAE) ON SORGHUM.

Mario Parada Jaco[1] and Henry N. Pitre[2]

[1] National Center for Agriculture and Forestry Technologies (CENTA), San Salvador, El Salvador, C.A.
[2] Mississippi State University, Mississippi State, MS 39762, USA.

RESUMEN

El gusano cogollero [*Spodoptera frugiperda* (J.E. Smith) (Insecta: Lepidoptera: Noctuidae)], es uno de los principales insectos que afectan el cultivo de sorgo en El Salvador. En vista de lo anterior, durante los meses de septiembre de 2001 y enero de 2002, se realizó una investigación en la estación experimental dos del Centro Nacional de Tecnología Agropecuaria y Forestal (CENTA), ubicado en el valle de San Andrés, departamento de La Libertad. El objetivo de la investigación fue determinar la efectividad de productos químicos, botánicos y biológicos para el control del gusano cogollero. Se utilizó un diseño de bloques completos al azar, con nueve tratamientos y cuatro repeticiones. Los tratamientos fueron: insecticida botánico (Agro-Inagor), Aceite de Nim, *Beauveria bassiana*, Virus de la Poliedrosis Nuclear (VPN), *Lufenuron*, *Teflubenzuron*, Agua azucarada, testigo relativo (*clorpirifos*) y testigo absoluto (sin aplicación). Los datos de mortalidad se obtuvieron 24 horas y cuatro días después de las aplicaciones. Los resultados muestran diferencias significativas entre tratamientos en los porcentajes de mortalidad de la plaga. Los insecticidas inhibidores de la quitina, lufeneron y teflubenzuron, mostraron mayor efectividad (superior al 90 por ciento) comparados con los otros tratamientos insecticidas, los cuales mostraron niveles de mortalidad inferior al 65 por ciento cuatro días después de su aplicación. El porcentaje de mortalidad obtenido en parcelas tratadas con chlorpyrifos fue de 63.3 por ciento durante el primer muestreo. La mortalidad fue superior en larvas de los primeros estadios, comparada con larvas de los últimos estadios. Los tratamientos con Neem, productos biológicos (*Beauveria bassiana* y el virus de la poliedrosis nuclear) y agua azucarada presentaron los más bajos niveles de mortalidad. Hubo diferencias significativas en el rendimiento del cultivo, sin embargo, dichas diferencias no siempre estuvieron relacionadas a los niveles de mortalidad presentados por los tratamientos insecticidas.



ABSTRACT

Research was conducted at the National Center for Agriculture and Forestry Technologies Experimental Station Number 2 located in the San Andres Valley, Department of La Libertad in El Salvador, Central America during September, 2001 through January, 2002 to determine the effectiveness of certain chemical, organic, and biological insecticidal products for control of the fall armyworm, *Spodoptera frugiperda* (J.E. Smith) on sorghum. Insecticide spray was applied to whorl stage sorghum and plants were examined 24 hours and 4 days after application to determine larval mortality. Results showed significant differences in effectiveness of the different insecticide treatments. The chitin inhibitor insecticides, lufenuron and teflubenzuron, appeared to be more effective (greater than 90% mortality) compared with the other insecticide treatments with less than 65% mortality by day 4 after application. Percent mortality in chlorpyrifos plots was 63.3% at this time. Mortality was greater for larvae at a younger stage of development than when they were in a mature stage. The treatments with Neem, biologicals (*Beauveria bassiana* and nuclear polyhedrosis virus) and sugar water had the lowest levels of mortality. Yields among treatments also showed significant differences, however the differences did not always appear to be directly related to levels of fall armyworm activity.

The fall armyworm, *Spodoptera frugiperda* (J.E. Smith), is an economic pest of sorghum in El Salvador (Guzman et al., 2001). This pest is widespread and its importance varies depending on the plant growth stage when infested. The two larval stages feed on the button surface of new leaves, leaving characteristic feeding marks resembling windows. Young plants that are damaged can recover from some defoliation (King and Saunders, 1984). Eventually, the larvae migrate into the whorl of the plant, where cannibalism often results in a reduced population so that only one or two larvae may be found per plant. When plants in very early stages of development are infested with large numbers of larvae, the plants may not survive. Fall armyworm larvae may also damage flowers, tassels and grain.

Farmers use highly toxic chemical products like parathion, methamidophos and methomyl, among others, to combat this pest. The excessive use of these chemicals has induced some levels of chemical resistance in this pest. Thus, there is need to determine more effective chemical products that would also result in reduced levels of environmental contamination. This would encourage the increased usage of effective biological insecticides that are specific for this pest. To achieve this goal, it is necessary to validate known technologies from other countries, and determine which practices should be recommended and adopted by farmers in El Salvador. This technology should emphasize practices that reduce environmental contamination and are economically and socially acceptable. The objective of this research was to determine the effectiveness of certain chemical, organic, and biological insecticides for control of fall armyworm on sorghum.

MATERIALS AND METHODS

Research was conducted at the National Center for Agriculture and Forestry Technologies Experimental Station Number 2 located in the San Andres Valley, Department of La Libertad in El Salvador, Central America. Nine treatments were arranged in sorghum plots in a randomized complete block with 4 replications of each treatment. Treatments were identified as follows: 1. botanical (organic) insecticide (Agro-Inagor), 2. Neem oil, 3. *Beauveria bassiana* (fungus), 4. nuclear polyhedrosis virus (NPV), 5. lufenuron, 6. teflubenzuron, 7. sugar water, 8. chlorpyrifos, and 9. untreated control. The sorghum variety was RCV (M-35585 x CX 3541 Crosses 31) BK-5-2-2-3-1-1-1-BK). Plots were 6 rows by 6m long with rows separated by 0.7m and plots by 2m. Plant density was 10 plants per meter of row on average. The level of foliage damage and infestation by fall armyworm was determined to indicate the need for insecticide application. This was determined by a random sampling of 100 plants in border rows of treatment plots. An infestation level of 30% or more was used to determine the need for insecticide application.

Insecticides were applied in the morning except for the biological materials that were applied in late afternoon (to avoid sunlight) with a backpack sprayer. The sugar water treatment consisted of dark sugar in 4 gal of water. The botanical insecticide from Agro-Inagor does not have a label indicating active ingredients. The label makes reference only to the type of insects that it controls, including armyworms. This product was applied at 285 ml per 4 gal of water. Neem acquired commercially, was applied at 30 ml of product per gal of water. The microbiological insecticides, *Beauveria bassiana* and NPV were applied at 1 kg per hectare. Lufenuron, which inhibits the synthesis of insect chitin, was applied at 120 ml per hectare. Teflubenzuron (from the benzoil group), also an insecticide that inhibits the synthesis of chitin, was applied at 150 ml per hectare. The standard chlorpyrifos was applied at 1.4 l per hectare, while the control consisted of applying water to the sorghum plants.

Treatment plots were sampled 24 hours after application of insecticide to determine the number of live and dead fall armyworm larvae. Whole plant destructive samples consisted of 100 plants at random from the middle rows of each treatment plot. Additional insect samples were taken as above at day 4 after treatment application to determine fall armyworm larval mortality. Yield at harvest (13% seed moisture) within treatments was determined from sampling 5 m of row from the middle 2 rows of each plot. Plants were harvested by hand (clipped panicles) and seed were thrashed in plastic bags and weighted on an electric scale in the laboratory. The data were analyzed by Analysis of Variance and F test, and means were compared using Tukey's test at P=0.01 significance level.

RESULTS AND DISCUSSION

The greatest level of fall armyworm mortality (63.3%) among treatments was recorded in chlorpyrifos treatment plots at 24 hours after application, followed by lufenuron (28.3%), teflubenzuron (21.0%), and Neem oil (12.0%) (Table 1). The other treatments had no effect on the pest at this time. The insect growth regulators, lufenuron and teflubenzuron, had greater effect on first and second instar larvae, than on later stages of larval development. The larger larvae remained active in these treatments at this time. This same level of insecticide efficacy on larval stages after 24 hours was observed for the chlorpyrifos treatment, suggesting that the insecticide was less effective on mid-to late stages of larval development than on early instars.

The lack of control of fall armyworm larvae with *B. bassiana* and NPV at 24 hours after application can be attributed to the fact that these insecticides are slow acting after being ingested by the larvae, as is the case with NPV, or after being absorbed through the cuticle or natural openings, as is the case with *B. bassiana*. Whereas, Neem, a natural plant produce, also being a slow acting insecticide, caused some larval mortality (12%) after being injested. The larvae stop feeding and eventually die after Neem treatment. The sugar water treatment did not influence fall armyworm infestation, as expected.

Any effects that might be expected would be considered as secondary by attracting natural enemies that would serve as predators and parasites of eggs and larvae. Teflubenzuron and lufenuron were the most effective insecticides (92.0 and 91.8%, respectively) at 4 days after spray application, followed by chlorpyrifos (63.3%) and Neem (16.5%); the other treatments provided little mortality (0.8 to 4.8%) at this time (Table 1).

The larvae that survived these treatments were in the last instars. Although Neem has been reported to be a good botanical insecticide inhibiting larval feeding and allowing natural enemies to prey on the immatures (Parada, 1995) or resulting in dehydration of the larvae (Lagunes, 1995), this botanical provided only 16.5% mortality at 4 days after the spray application in this study.

The low levels of insect mortality in the botanical and microbial insecticide treatments at 4 days after application in this study would suggest that these materials were not effective on fall armyworm larvae and may not be alternative insecticide products for control of this pest on sorghum. Factors that may have influenced the effectiveness of these insecticides might include contamination and viability of the fungus (Ferron, 1978).

A fungus applied in the field should have high viability during the first 24 hours after application with suitable environmental conditions, including wind, relative humidity and sunlight (radiation). Unfavorable conditions could result in mortality of fungal conidia before they germinate and penetrate the insect body.

The same general effects of the sugar water treatment were observed after 4 days, as at the 24 hour observation, except that some natural enemies (ie., *Polibia* sp., a wasp) were recorded feeding on fall armyworm larvae. Although this treatment proved to have little influence on fall armyworm infestation where natural enemy populations were low, it might have a greater effect on pest mortality when natural enemy infestations are present at greater population levels. Sugar water could be added to chemical, biological or botanical insecticide sprays to increase natural enemy activity and improve efficacy of the treatments. However, sugar water additions to insecticide treatments could have an effect on moth oviposition by increasing egg deposition and eventual larval population.

Although there were numerical differences in sorghum yields from treatment plots, only a significant difference was observed between the treatment with greatest yield (Neem) and the treatment with the lowest yield (botanical insecticide). The improved yield from the Neem treatment is difficult to explain, particularly when considering the ineffectiveness of this product for control of fall armyworm larvae in this study. The generally greater yields and greater fall armyworm mortality from the insect growth regulators lufenuron and teflubenzuron and the chemical insecticide chlorpyrifos would suggest that these materials could be considered in selecting an insecticide for use in an insect pest management program directed against the fall armyworm on sorghum in this area of Central America.

Table 1. Mortality of fall armyworm 24 hours, and 4 and 7 days after treatment applications in sorghum (35 days after planting). San Andres, El Salvador. 2001.

Treatments	Percent mortality at times after spray application	
	24 hours	4 days
Chlorpyrifos	63.3 a [1/]	63.3 b
Lufenuron	28.3 b	91.8 a
Teflubenzuron	21.0 b	92.0 a
Neem (oil)	12.0 c	16.5 c
Botanical	0.8 d	0.8 d
Untreated	0.8 d	2.8 d
Beauveria bassiana	0.0 d	4.8 d
Nuclear polyhedrosis virus	0.0 d	3.3 d
Sugar water	0.0 d	2.5 d

[1/] Means with the same letter are not significantly different (Tukey's test, P = 0.01).

Table 2. Sogrhum yield from insecticide treatment plots infested with fall armyworm. San Andres, El Salvador. 2001.

Treatment	Yield (kg/ha)
Neem (oil	3040 a [1/]
Lufenuron	2826 b
Sugar water	2696 c
Teflubenzuron	2554 d
Chlorpyrifos	2446 e
Beauveria bassiana	2250 f
Nuclear polyhedrosis virus	2237 f
Untreated	2201 f
Botanical	2044 f

[1/] Means with the same letter are not significantly different (Tukey's test, P=0.01).

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