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SUSCEPTIBILITY OF THE FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE), AT SANTA ISABEL, PUERTO RICO, TO DIFFERENT INSECTICIDES

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The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), is a polyphagous migratory pest, which is endemic to the Western Hemisphere attacking more than 80 plant species including maize, sorghum, cotton, rice, millet, peanut, alfalfa, and other cultivated and wild plant species (Knipling 1980; Pashley 1986; Vickery 1929). Presence of multiple generations and the ability to migrate and feed on a wide range of host plants makes FAW one of the most severe economic pests throughout the Western Hemisphere. In corn, yield losses due to FAW damage can reach up to 32% in the United States (Wiseman & Isenhour 1993) and 45-60% in Nicaragua (Hruska & Glandstone 1988). Insecticides are used as major components of IPM to control the pest, because its ability to migrate long distances and feed on a broad host range make other control options less efficient. Although chemical insecticides can provide effective control of crop pests including FAW (Young 1979), control of FAW has been fully dependent on insecticides, and, as a result, the pest has developed resistance to major classes of insecticides in several locations (Yu 1992; Berta et al. 2000; Pitre 1988).

In Puerto Rico where many seed companies produce seed corn throughout the year, FAW is the number one pest, which makes it very difficult to get any yield without insecticide application. Insecticides are sprayed 3 times a wk during the peak season and up to 25 sprays have been made in one crop cycle, which places heavy selection pressure on the pest for development of insecticide resistance. The objective of the present study was to assess the susceptibility of Puerto Rico a FAW population to insecticides.

A laboratory insecticide bioassay experiment was conducted at Dow AgroSciences (DAS) Research Station, Santa Isabel, Puerto Rico in Jun 2010. Third instar larvae derived from a field population of FAW collected from the central farm of the station on corn plants were used in a petri dish experiment. A total of 10 insecticides (Table 1) were evaluated each at the commercial (manufacturer's) recommended rate. The insecticides were applied using small (200 mL) plastic hand sprayers. Two "shots" of fine droplets of the spray mixture were applied to each petri dish, which provided adequate coverage of the filter paper to mimic the field spray coverage. The untreated control larvae were sprayed with an equal amount of water to avoid the effect of moisture differences in the petri dishes. Treatments were replicated 5 times in a completely randomized design. Four insecticides i.e. spinosad, Spinetoram, acephate, and thiodicarb, which showed highest 16 h mortality of FAW in the first bioassay experiment, were selected and used in an additional study to evaluate dose response. Each of these insecticide was tested at 2 ×, 1 ×, ¾ × and ½ × the recommended rate. The experimental set up and protocols were the same as in the first experiment.

At 16 h after application, spinetoram, acephate, and thiodicarb caused significantly higher (≥60%) FAW mortality compared to other

TABLE 1. LIST OF INSECTICIDES AND THEIR ACTIVE INGREDIENTS (A.I.) USED IN THE BIOASSAY EXPERIMENT AGAINST THE FALL ARMYWORM, *SPODOPTERA FRUGIPERDA*.

Trade name	active ingredient	Rate (oz/a)[1]	mL/L	PPM	Manufacturer
Coragen®	Chlorantraniprole (18.4%)	3.5	5.5	5500	DuPont
Belt® SC	Flubendiamide (39.0%)	3	4.8	4800	Bayer
Tracer®	Spinosad (44.2%)	2	3.2	3200	Dow Chemicals
Radiant® SC	Spinetoram (11.7%)	4	6.3	6300	Dow Chemicals
Avaunt®	Indoxacarb (30.0%)	3.5	5.5	5500	DuPont
Warrior®	Cyhalothrin (11.4%)	3.5	5.5	5500	Syngenta
Intrepid® 2F	Methoxyfenozide (22.6%)	8	12.7	12700	Dow Chemicals
Orthene® 97	Acephate (97.4%)	8	12.7	12700	AMVAC
Larvin® 3.2	Thiodicarb (34.0%)	30	47.6	47600	Bayer
Capture® 2 EC	Bifenthrin (25.1%)	6.4	1.0	1000	FMC Corporation

[1]1 ounce = 28.35 grams.

treatments, and the effects of spinosad, chlorantraniprole and cyhalothrin were intermediate ($F_{3,\ 161}$ = 15.2, P < 0001) (Fig. 1). A similar trend in FAW larval mortality was observed at 48 h after insecticide application (Fig. 1). Spinosad at 48 h caused a level of mortality that was similar to that of spinetoram, acephate, and thiodicarb. Cyhalothrin also showed an increased larval mortality at 48 h that was equivalent to spinetoram and acephate.

At 96 h after application, all insecticides except methoxyfenozide and bifenthrin, resulted in more than 80% FAW larval mortality (Fig. 1). Spinosad, spinetoram, acephate and thiodicarb resulted in relatively quick (16 h) mortality of FAW larvae. Indoxacarb, flubendiamide, indoxacarb, and cyhalothrin required longer (≥ 96 h) to achieve higher levels of mortality of FAW.

Among the insecticides used in the dose rate study against FAW larvae, thiodicarb and acephate caused significantly higher mortality ($F_{3,161}$ = 15.2, P < 0001) than did spinosad (Fig. 2). As was true in the first experiment, for all insecticides, percent larval mortality significantly increased with increasing time after insecticide application (Fig. 2). Overall, increasing insecticide dose rate resulted in increased FAW mortality (Fig. 2). However, there were no significant differences in FAW mortality between the 2 × and 1 × commercial rate of any of the insecticides.

Summary

Although there are differences in the speed of lethal activity, most of the insecticides we tested were effective in controlling FAW. This might be attributed to regular pest scouting and applying insecticides in rotation or combination, which may have helped to delay development of resistance and, thus, to keep the FAW population susceptible to those insecticides. Moreover the dose rate study showed that applying thiodicarb, acephate, spinetoram or spinosad at the current 1 × rate is sufficient to control FAW; and higher rates should not be used. Further studies, taking into consideration the biology of the pest and the phenology of the crop to determine the right time and frequency of application of those insecticides under field conditions, could help to achieve high levels of control and prolog the effectiveness of the products. Moreover, the evaluation of insecticide susceptibility of FAW populations from different regions is important as the variability of insecticide resistance/susceptibility characteristics in FAW populations may assist in determining the origin of FAW infestations and in developing an appropriate management strategy (Pitre 1986).

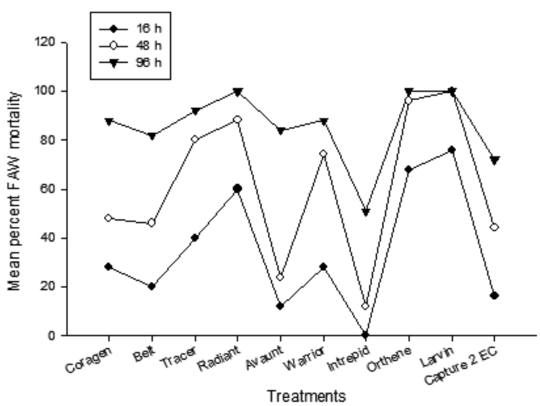

Fig. 1. Percent corrected mortality of fall armyworm (FAW) third instar larvae at 16, 48, and 96 h after insecticide application.

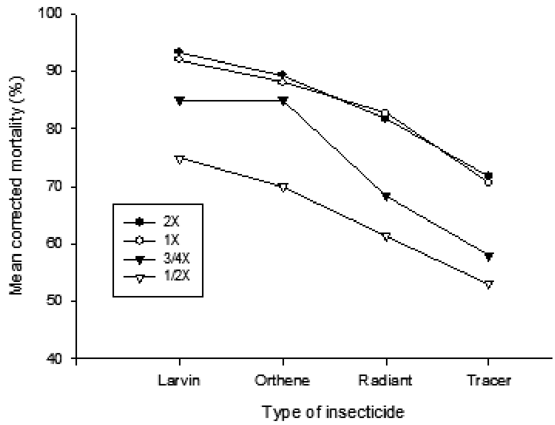

Fig. 2. Percent mortality of fall armyworm (FAW) third instar larvae caused by different rates of various insecticides.

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