LANDSCAPE LEVEL CONTRIBUTIONS IN CORN, COTTON, AND SOYBEAN IN MIXED PRODUCTION SYSTEMS FOR *HELICOVERPA ZEA* POPULATIONS

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Abstract

Helicoverpa zea (Boddie) is a major pest of corn, cotton, and soybean and is commonly controlled through the use of foliar applied insecticides or transgenic crops expressing the *Bt (Bacillus thuringiensis)* gene. To prevent the selection of resistant populations, refuge systems have been implemented into the agroecosystem. To test the efficacy of these traits and efficiency of various refuge systems on *H. zea*, an experiment was conducted at the Monsanto Learning Center in Scott, Mississippi. A field trial containing five refuge scenarios in field corn was established, each with different trait combinations, in the 2016 growing season. Treatments consisted of non-*Bt* plantings, solid plantings of Trecepta and VT Double Pro, and an 80:20 and 90:10 blended refuge (RIB). Each variety was planted in a 33.5m x 20.7m block. All blocks were allowed to be naturally infested with *Helicoverpa zea*. After the immature *zea* exited infested ears and entered the soil for pupation, whole corn plants were removed from the blocks. Four plots were established within each block to serve as replications. Twenty-five moth emergence traps were placed within each treatment and monitored weekly for adult emergence. All data was analyzed using SAS 9.4. This experiment displayed that the RIB refuge system production performed similarly to the bulk planted non-*Bt* field corn.

Introduction

Since the commercialization of genetically modified crops, producers have seen reduced dependence on foliar insecticide applications while improving yield. For example, in cotton, *Bt* crops have successfully controlled the tobacco budworm, the pink bollworm, armyworms, and loopers. *Bt* corn controls the borer complex and whorl stage corn earworms successfully. However, when it comes to the ear stage, controlling the earworm is not complete. During this experiment, three varieties were used to determine corn earworm adult production from both *Bt* and non-*Bt* field corn. To determine total contributions of corn earworm adults, emergence traps were implemented and checked weekly and totaled for adults. Refuge systems were also integrated to determine efficacy using the “refuge in a bag” (RIB) approach. In cotton growing areas, there is a corn refuge requirement of 20% non-*Bt*. RIB is a standard bag of seed, however, a percentage of the bag is filled with non-*Bt* seed, in this case, 20%. The refuge system is based on the idea that in the rare case that a resistant corn earworm adult emerges from *Bt* corn, it will mate with one of the many susceptible adults from the non-*Bt* refuge, producing susceptible offspring. RIB offers the convenience of not having to bulk plant a separate refuge while forcing compliance with the refuge requirement.

Materials and Methods

In 2016, a field study was conducted at the Monsanto Learning Center in Scott, Mississippi. Five separate traited genotypes of field corn were planted at a rate of 79,040 seeds per hectare. Corn was planted on 96.52 cm rows. The five genotypes tested and their incorporated traits are listed in Table 1.

Table 1. Genotypes of corn planted in the 2016 field trial in Scott, MS with incorporated trait names.

Trade Names	**Incorporated Traits**
RoundUp Ready II	RRII herbicide resistance trait
VT Double Pro	Cry1A.105, Cry2Ab2
Trecepta	Cry1A.105, Cry2Ab2, VIP3Aa20
Trecepta (80:20) RIB & RoundUp Ready II	Cry1A.105, Cry2Ab2, VIP3Aa20 20% RRII refuge
Trecepta (90:10) RIB & RoundUp Ready II	Cry1A.105, Cry2Ab2, VIP3Aa20 10% RRII refuge

The corn was allowed to mature to the silk stage where natural infestations of corn earworm began. Corn silks were checked for substantial oviposition. Once this had occurred, eggs were allowed to hatch and the larvae were allowed to feed until they began pupation in the soil. Once the larvae had left the ear entered the soil to pupate, corn was cut down and removed from the plot area to make room for emergence traps. Twenty-five emergence traps were placed throughout the entirety of each plot spanning a total of 38.1 sq. meters. Individual trap measurements were 1.5 meters by 1.2 meters. Plastic cups with removable lids were implemented onto the traps to catch corn earworm adults. Throughout the growing season, adult emergence was quantified by which genotype they had emerged.

Results and Discussion

Moths were counted across the span of four months throughout the summer. At emergence initiation, adult production was substantial but decreased after five weeks (Figure 1). From the middle of September until the beginning of November, very few adults were collected across any of the technologies (Figure 1). It was a very dry fall season until early November, in which Scott, MS received a rainfall event (Figure 1). Following the rainfall, there was a surge in emergence throughout the month until the trial was concluded at the end of November (Figure 1).

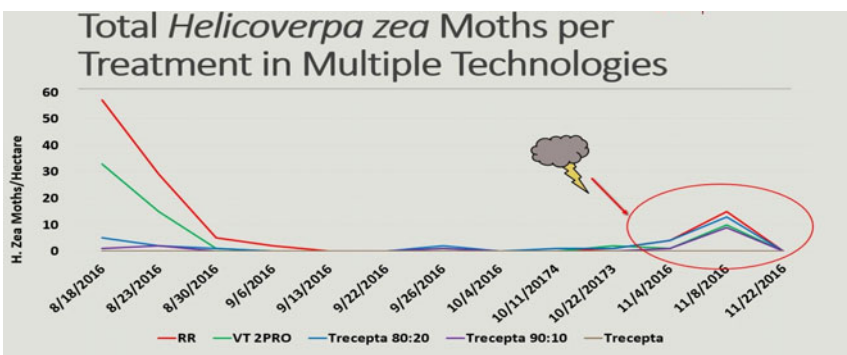

Figure 1. Total corn earworm adults per treatment across all technologies.

For total production numbers, the non-*Bt*, RoundUp Ready II corn produced approximately 8,500 adults per hectare (Figure 2). The VT Double Pro produced only 50% less than the non-*Bt* RoundUp Ready corn (Figure 2). Trecepta produced zero adults across all sampling dates (Figure 2). The Trecepta including the 20% RIB blend produced approximately 25% adults of the non-*Bt* RoundUp Ready II corn (Figure 2). While the Trecepta including the 10% RIB blend produced approximately 12% of the adults that the non-*Bt* RoundUp Ready II produced (Figure 2).

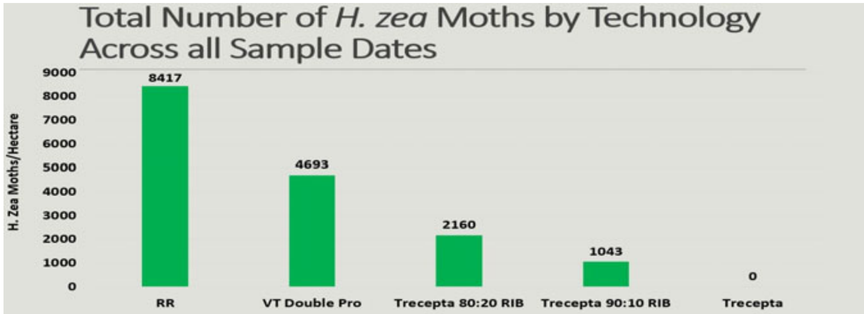

Figure 2. Total numbers of corn earworm adults by technology across all sampling dates.

Summary

In summary, this experiment provides improved understanding of corn earworm adult production from the aforementioned corn genotypes. With these data, the efficacy of the RIB refuge strategy approach can be better assessed. The RIB approach is important, not only because it reduces the rate of resistance development, but it forces compliance to the refuge requirements. However, one drawback to RIB is the possibility of cross-pollination of the *Bt* and the non-*Bt* plants. Corn silks that are cross pollinated produce kernels that can express insecticidal properties. In this particular experiment, when it comes to adult corn earworm production, the data shows that the RIB treatments performed similarly to the equivalent non-*Bt* variety as a percentage of the total non-*Bt* blend. This data can be used to better populate resistance models to evaluate corn earworm population contributions.