THE OLD WORLD BOLLWORM IN THE NEOTROPICAL REGION: THE EXPERIENCE OF BRAZILIAN GROWERS WITH HELICOVERPA ARMIGERA

Adeney de Freitas Bueno and Daniel Ricardo Sosa-Gómez, Embrapa Soybean Researchers, Londrina, Paraná, Brazil, adeney.bueno@embrapa.br and daniel.sosa-gomez@embrapa.br describe how the old world bollworm was identified in Brazil and the strategy employed to control it.

Keywords: Integrated Pest Management, soybean, caterpillar, Brazil, Helicoverpa armigera

Pest identification and its occurrence
In Brazil, Helicoverpa armigera was identified for the first time in February 2013, almost simultaneously and independently by taxonomists Dr. Alexandre Specht and Dr. Vitor Becker. As a consequence, on 22 March, EMBRAPA officially reported its occurrence in Brazil to the Brazilian Ministry of Agriculture, Livestock and Food Supply (Notification Report n° 70570.000355/2013-2). The pest identification was based on male genitalia morphology and confirmed by sequences of mitochondrial genes. Even though just registered in 2013, it may be possible the pest was present in the country before 2013 as H. armigera is difficult to distinguish from Helicoverpa zea. Moreover, for a non-expert, other Helicoverpa spp. (Figure 1) can be easily confused with Heliothis virescens (Figure 2), another pest commonly found infesting soybean and cotton in Brazil. In addition, in its first year in Brazil, the pest was already widely spread, a distribution pattern usually expected to take many months to occur.

In 2013 and 2014, high prevalence of H. armigera was found in Western Bahia, an important agricultural state in Brazil, causing serious damage on soybean, corn and especially cotton. Damage reports reached $0.8 billion in the first crop season (2012/2013), even though this number could not be calculated precisely. Generally speaking, in Brazil, the most important crops infested by H. armigera were cotton, soybean, corn, green beans, tomatoes, citrus and pastures. However, in corn it is common to find mixed infestations of H. zea and H. armigera. In soybean and cotton, mixed infestations of Helicoverpa armigera and Heliothis virescens might also occur. Moreover, H. armigera also has been found feeding on weeds, such as Conyza bonariensis (Asteraceae: flax-leaf fleabane, wavy-leaf fleabane or Argentine fleabane) and Rumex spp. (Polygonaceae: docks or sorrels). H. armigera's polyphagous nature often maintains high populations throughout the whole year due to the great host availability and this can cause problems in the management of this pest.

It is important to point out that, in some Brazilian states such as Bahia, typically dry and warm with large areas of suitable crops as host plants, pest occurrence and consequently damage has been higher when compared to other regions of the country. In Southern Brazilian states, for example, H. armigera prevalence has been low; even though localized attacks on green beans, coffee, wheat, citrus and some other crops have been reported.

Helicoverpa armigera in Brazil: 2 years of experiences
Increased caterpillar feeding on soybean pods had been reported by growers earlier than 2013, but the pests had probably been confused with other Lepidoptera species. The misidentification might also have happened in other crops. As a consequence, inappropriate control strategies, especially chemical control, were used. In this context, it is crucial to emphasize that the success of integrated pest management...
HELCOVERPA ARMIGERA

2012/2013 crop season was difficult due to a lack of knowledge about the appropriate control measures and the identity of the pest. Inefficient and/or insufficient rates of insecticides were frequently applied and this merely killed beneficial arthropods, thereby reducing natural biological control and worsening pest outbreaks.

Helicoverpa spp. and Heliothis virescens are pests naturally more tolerant than other species to most of the common insecticides requiring higher rates to be controlled efficiently. However, because of the recent occurrence in the country, Brazilian growers faced their first season with H. armigera with no recommended insecticide registered for use against the pest. During the second crop season (2013/2014), the situation for H. armigera control was completely different. As a result of cooperative work between growers, research institutions, universities and government amongst other contributors, different insecticides were registered and recommended for use. Biological control agents such as baculovirus, for example, were imported from countries like Australia, for use in Brazil. Moreover, the Brazilian government, throughout its institutions (EMBRAPA, for example), established a large task force to have most of the growers and consultants all over the country trained to identify and control the pest correctly. Embrapa Research teams traveled all over the country, visiting different states and cities, giving lectures to growers and consultants emphasizing the correct management of the pest and the importance of sustainable use of pesticides. These intensive training programs were performed in 32 localities spread in 18 states (Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Minas Gerais, Mato Grosso do Sul, Mato Grosso, Goiás, Distrito Federal, Tocantins, Pará, Amapá, Roraima, Maranhão, Piauí, Alagoas, Sergipe and Bahia). More than six thousand technicians from cooperatives, extension services and growers received instructions from 30 researchers from Embrapa, in a four month period. This resulted in a 2013/2014 crop season with lower problems with H. armigera in Brazil, a pest that was kept under control in most of the Brazilian farms even though its occurrence still caused some yield loss in areas with favorable climate conditions (dry and warm) and where, integrated pest management (IPM) was not fully adopted.

Helicoverpa armigera management

The IPM concept for H. armigera control as for any other pest species is based on the premise that cultivated plants tolerate certain levels of injury without economically significant yield reduction. Therefore, not all H. armigera populations will be taken as reaching pest levels and require control. The appropriate time to start the control measure in order to prevent economic loss is when the pest reaches the population level termed as the economic threshold (ET) which is, therefore, the time when control should be applied. Insecticide application before ET is reached is not economic and might cause more harm than good by killing natural biological control agents such as parasitoids, predators or entomopathogenic fungi, resulting in a pest increase, instead of control.

Brazilian researchers are studying control strategies for H. armigera intensively at the moment but some recommendations are adapted from what already existed in Australia.

(IPM) is dependent on the correct adoption of control strategies at the best timing possible, based on Economic Thresholds and appropriately pest identification (Figure 3). Therefore, effective Helicoverpa armigera management in the

Figure 2. Heliothis virescens attacking soybean plants.

Figure 3. Illustration of an Integrated Pest Management program in analogy to the construction of a house. (Adapted from Gallo et al. 2002).
In soybean, for example, one of the largest crops cultivated in Brazil, the management strategy is made for the complex Heliothine sub-family grouping both *Helicoverpa* and *Heliothis* genera together. Because of the difficulties of separating the two genera under field conditions and the similarities of injury caused by the two species, ET and control were established for the sub-family. Firstly, an appropriate sampling procedure (Figure 4) must be performed on at least 1 meter per 10 hectares and Heliothine pest control is not used until ET is reached accordingly to each crop development stage (Figure 5).

When control is needed, it is crucial to emphasize the importance of always favoring the use of ‘soft’ pesticides, which preserve natural biological control agents. These ‘soft’ insecticides include IGRs such as methoxyfenozide, diamides such as *chlorantraniliprole* and spinosyns such as spinosad. Smaller insects can also be controlled using baculoviruses and sprayable Bt. This is important because the practice of sustainable agriculture has been shown to be an effective pest management strategy. Even though, in theory, *H. armigera* has only recently arrived in Brazil, researchers have reported a large number of biological control agents that help to keep the pest below ET. Hoffmann-Campo *et al.* (Embrapa Soybean – data not published) collected insects to start a laboratory colony early in the 2013/2014 crop season, but most of the caterpillars died because of natural biological control (Table 1). Later, insects collected in the field at the end of the crop season, after the use of non-selective pesticides, did not have the same mortality rate. Another important report made by Brazilian researchers is that caterpillars can be efficiently controlled with the recommended insecticide even if the majority of the caterpillars are considered big, i.e. bigger than 1.5 cm (Figure 6). Terrified by the fear triggered by the presence of this new pest and the overwhelming number of news reports, many Brazilian growers had the false perception that caterpillars bigger than 0.8 mm would not be controlled.
by any pesticides and that insecticides should be applied based on the presence or absence of the pest. Fortunately, based on the preliminary results reported by Brazilian researchers (Figure 6) this seemed to be wrong. Insecticides used rationally, based on the ET, are efficient to manage the pest; and the use of ‘soft’ pesticides was always the best strategy.

Another lesson, learned by Brazilian growers during the first years occurrence of *H. armigera* is the importance of sampling the area before sowing the main crop. Because *H. armigera* can feed on different plant species, it is not difficult to find caterpillars even before crop season starts. During the 2013/2014 crop season at Parana State, soybean growers burned down weeds and sowed the crop without sampling. *Helicoverpa armigera* caterpillars which were already present on the weeds migrated to the newly emerged soybean plants causing death of some plants. After that, old IPM concepts were recalled. Whenever caterpillars are present burn down must be anticipated. Having a minimum period of two weeks between burn down (chemical drying) and sowing, any pest already colonizing the plot will be killed by starvation due to lack of host without the necessity of early insecticide application.

**Final remarks**

If on one hand, *H. armigera* brought some yield loss to some Brazilian growers in its first years in the country, on the other hand, this pest presence brought back some old IPM concepts which had been almost forgotten by most growers. During the years, increasing global food demands have led to a constant battle for higher crop yields, mainly on major crops such as soybean cultivated on more than 30 million of hectares in Brazil at the last crop season. It, combined with the relative low costs of some insecticides, has triggered an excessive use of pesticides in agriculture. Among the side effects of pesticide overuse, especially the non-selective ones are: a reduction in efficacy of the natural biological controls; fast pest resurgence; and resistance selection to the insecticides used, besides the potential danger to the environment and human health. With the presence of *H. armigera* in Brazil, growers are learning that to address these insect problems and still maximize agricultural production, pest control programs must be guided by a proper Integrated Pest Management (IPM) approach. IPM is based on the premise that plants can tolerate certain levels of injury with no economically significant reduction of yield; and insecticides should be used only as a complementary method, since natural biological control is able to keep pests under control when the crop environment is closer to a natural balance. To respect the economic threshold and choose more selective pesticides to beneficial arthropods when needed is the clue to the possibility in reducing the use of chemicals in agriculture, thus improving its sustainability with excellent pest control, including *H. armigera* management.

**Acknowledgments**

This paper was approved for publication by the Editorial Board of Embrapa Soja as manuscript number 10/2014.