Helicoverpa armigera, Old World Bollworm

Technical Working Group Meeting

18 November 2014- Portland Oregon

6:30 Dan Borchert began meeting

Introduced attendees (list of attendees and affiliation at end of report)

- **Introduction about the detection in Puerto Rico:**
  - As of 12/17/14, *Helicoverpa armigera* have been identified from five municipalities captured in pheromone traps placed near fields of bean, okra, pigeon pea, rice, squash and sorghum.
  - Currently more traps are being deployed in Puerto Rico over a larger area with 327 traps deployed thus far.

DAMAGE

- **How much damage (in terms of yield loss) does *H. armigera* typically cause?**
  - Damage in cotton from *Helicoverpa armigera* can be up to 100% in unmitigated fields; 10-20% yield loss with conventional pesticide management is typical, 5-7% loss with *Bacillus thuringiensis* (Bt) cotton (Bollgard II); cost is about $350 per hectare in Australia.
  - Damage on soybeans in Brazil reached 100% in non-Bt soybeans and 10%(?) in Bt soybeans, but the complete insecticide mitigations utilized were not known. *H. armigera* displaced *H. zea* in Brazil in many cropping situations with *H. armigera* prevalent on dicot plants and *H. zea* on monocots.

- **Does the magnitude of damage vary by host type and geographical region? Tropical vs. Temperate?**
  - Yes. In tropics more damage is observed, while this may be primarily attributed to greater number of generations and longer growing seasons, there are many possible factors that could affect population growth and impact. In the tropics there also are significant levels of egg parasitism occurring by *Trichogramma pretiosum,* which occurs naturally.

- **In terms of type and magnitude of damage (unmitigated), how different is *H. armigera* from zea?**
  - *Helicoverpa zea* damage
    - *Helicoverpa zea* is managed in cotton primarily with Bt technology (Bollgard II). Similar rates of crop damage are observed in the U.S. from *H. zea* as are observed from *H.armigera* in Australia, but in the southeastern cotton growing

region there are the additions of 1-2 oversprays for *H. z*ea control with diamide chemistries typically being used. Stink bug management and mitigations in cotton also occur each year with applications of organophosphates, which are not as effective on lepidopteran cotton pests. The frequency of IPM field scouting in cotton has been reduced with the adoption of Bt crops from twice per week to once, this has reduced the ability to time and direct insecticide sprays as effectively for lepidopteran pests due to the short interval from oviposition to larval emergence.
    - In soybean, *H. zea* can be an occasional problem, which can be managed with the use of pyrethroids, *H.armigera* is resistant to pyrethroids. *Helicoverpa zea* is most problematic in soybeans when 'ultra-late' planted beans (planted after corn) are grown and sprays are necessary for management of *H. zea* in those situations.
- *H. armigera* on soybean
    - In Brazil, the early plantings have been damaged extensively with soybean plants being completed chewed out to the ground. However, the international TWG members acknowledged that it is not typically a problem, and *H. armigera* damage in soybean is more frequently sporadic.

- **Is the damage observed before or after spray is applied?**
    - Insecticide resistance is not as evident in 1st and 2nd instar *H.armigera* larvae and many insecticides (even pyrethroids) may provide effective control and reduce damage after application. Insecticide resistance is more evident in 4th and 5th instar larvae.

HOST

- **What are the host differences and similarities for *H. armigera* and *H. zea*?**
    - *H. armigera* may have a wider host range than *H. zea*, but the extent and impact on the other hosts needs to be determined.
    - At the moment this is one of the critical pieces of information. It is necessary to obtain host information from experts on both *H. armigera* and *H. zea*. (in process)

- **When they feed on the same host are there similarities or differences in magnitude of damage, types of damage seen (plant parts affected), yield loss, control measures necessary, and resistance development?**
    - The group was of the opinion that damage for the two species would be similar in type and magnitude on coincidental hosts. For example, in cotton, most of the damage is on bolls, but can also feed on vegetation. For corn damage the two species have similar reported type of damage and magnitude, feeding on the end of the corn ear.

PATHWAY

- **Are we more likely to get it through human-assisted movement or adult flight?**
    - The group believed that *H. armigera* would most likely move to the continental United States through insect movement. However, there is some perception from concerned

citizens that inspections and preventative measures to prevent entry of *H.armigera* are not as effective as we think they are.
    - The adults are highly mobile and should be able to easily migrate to the U.S. through favorable air currents as the populations are established closer to the U.S. …i.e. if insect populations are high in Puerto Rico, other islands in the Caribbean or eventually Central America.

CONTROL

- **Will *H. armigera* be controlled by the same practices already in place for *H. zea*, and if not, what additional controls will be required? Mitigated vs Unmitigated?**
    - *Bt* options are available for the different major agronomic hosts (corn, cotton, and soybeans)
    - It will be necessary to develop a plan and prepare insecticide resistance management tactics for *H. armigera* as pyrethroids may not be effective due to the presence of resistance genes. Diamides are effective insecticides for management of *H. armigera* now, but it is necessary to have management options and resistance plans in place to reduce the development of resistance to these and other chemical controls.
    - A recommendation was made for efforts to screen *H. armigera* for types of insecticide resistance currently present in the populations to make it possible to develop better resistance management plans.

- **Comments about U.S. pesticide use to control *H. zea***
  Corn: For control of *H. zea* in the U.S., two sprays (oversprays) are applied to corn with that contains a single toxin gene *Bt*, primarily in the southern U.S. where there is greater pressure of *H. zea*. The planting of corn hybrids utilizing multiple *Bt* toxins has increased in many areas of the U.S. (Reay-Jones and Reisig, 2014). This reduces the amount of non-*Bt* refuges and provides increased control of *H. zea.*

  Diamide chemistry is considered to be providing good control against lepidopteran pests. The Southeastern U.S. is sprayed (oversprayed) with diamides to control lepidopteran pests in cotton. For control of stink bugs organophosphates are more effective and in some cases OP+ pyrethroids are used against stink bugs. Sprays directed at sucking pests are seasonal and in relation to the biology of the pests, so these sprays might not well be timed appropriately to result in control of *H. armigera*.

- **Comments on pesticide use outside the U.S. against H. armigera**
  <u>Insecticide sprays on non-Bt crops</u>: On average 10 sprays were reported to be applied for *H. armigera* control on traditional cotton, but sometimes even up to 15 sprays were necessary.

  <u>Insecticides on Bt crops</u>: In the temperate areas of Australia, additional insecticides were rarely sprayed on Bt plants.

- **For the crops affected, what are the typical number of controls applied for *H. armigera* and *H. zea*?**

Helicoverpa armigera- Non-Bt cotton, 10-15 sprays per year, Bt cotton no sprays in south, but 1 or 2 sprays max in tropical northern area. There has been no observation of the development of resistance. *H. zea* requires a few applications for management in Bt cotton, with multiple applications necessary in non-bt cotton.

Helicoverpa zea-Weeds are big drivers in crop production systems as they provide suitable hosts for populations to build on in fields where Bt crops may otherwise be providing control. Pigweed is a good host for *Helicoverpa* spp. and is often found in and around cropping fields**.**

In soybeans, the impact of *H. zea* on soybeans has been examined and when R1-R2 soybeans were infested with *H. zea*, a reduction of 0.04 bu/ac was reported by Donald Cook (2012) in Mississippi.

Diamides, spinosads and pyrethroids are the main insecticide tools for management of *Helicovera* spp. *Helicoverpa armigera* has developed high levels of resistance to pyrethroid insecticides and this will impact the use of chemicals from that insecticide class for resistance management. There is the report of some diamide resistance developing in Brazil and it would be good to find more information on this in preparation in the event of the arrival of *H.armigera* to the continental U.S.

- **Natural enemies**
  Egg parasitism of *H. armigera* by species such as *Trichogramma pretiosum* occurs mainly in tropical areas, with 70-90% parasitism reported. The level of parasitism was reported to be lower in colder more temperate regions. *Trichogramma pretiosum* is established in the U.S. as well as other *Trichogramma* egg parasitoids. However, effective management of the Heliothine complex, even with augmented releases of *Trichogramma exiguum,* was not observed in North Carolina cotton fields (Suh *et al*. 2000).

POTENTIAL ACTIONS

- **We are a regulatory agency, dealing with invasive pests. Is this something that can be regulated?**
  - Aside from the current regulations of mitigation and inspection of imported commodities from areas where establishment is known, there are not many other regulatory options to prevent the introduction of *H. armigera*. With the probable establishment of the pest in the Caribbean and possibly other areas of the western hemisphere, it is probably just a matter of time before the infestation gets here.
  - Other distribution reports:
    - The Netherlands reported *H. armigera* on a shipment from the Dominican Republic. There were also discussions about potential for area-wide survey programs in the Caribbean Basin and there are efforts currently underway to help survey for potential detections in the area.
    - Mexico surveyed for *H.armigera* in four states from January 1- December, 6 2014: Guanajuato, Durango, Jalisco and Sinaloa. http://www.senasica.gob.mx/?id=6205

        - There was also discussion about the lack of knowledge about presence of *H. armigera* (as well as other invasive species) in Cuba and the problems related to the inability to communicate with them. It was recommended that information on the presence of *H.armigera* in Cuba may be obtained through other countries that have communications with Cuba such as Canada, Australia or Mexico.

- **What are we going to do? Options?**
    - Eradication
        - There will likely be a recurring influx of *H. armigera* into the U.S. once it becomes established closer to the border. Eradication is not a likely scenario or a productive solution as it was deemed to have a low chance of success.
        - The early stages of detection in Puerto Rico are underway and the full extent of establishment is not known, although it is expanding in size with expansion in survey activities. Presently, there does not seem to be a benefit from extensive treatments in Puerto Rico for eradication. Existing management strategies for *H. zea* may maintain populations of *H. armigera* at a lower level and slow the future potential spread to the continental U.S., but this depends on what additional trapping results yield and if *H. armigera* is moving into the area frequently from other areas of South America or the Caribbean. If there are frequent reintroductions, then eradication of even a small population may be a costly and short lived project with low chance of success.

    - **Are the detection and delimitation surveys going to be helpful?**
        - The group talked about the benefit and extent of the survey in Puerto Rico and in other areas of the U.S. Discussion was mixed on the overall value of large scale, long term survey on the island. Presence on Puerto Rico is known, but not the extent of the infestation. Additional information about the source(s) of the infestation, insecticide resistance in the population and damage that is being observed was believed to have greater value than overall area of establishment. It was believed that knowledge about new foreign distribution, resistance genes and spread had more potential impact and that it may be beneficial to utilize some of the resources currently designated for Puerto Rico in other areas of the country or the hemisphere. Increased surveillance in southern states has been planned for the upcoming year. It is also necessary to know when the pest eventually arrives and when the continental spread, monitoring and management activities commence.

- **Additional information**
    - Communicate with Mexico about potential infestation closer to their southern border and determine if any ongoing surveillance activities are in place.
    - Need to develop a communication plan. Develop similar to Soybean Rust (SBR) response plan that involved and coordinated the activities of Universities, Industry and Government agencies.

- Cytochrome P450 is a mechanism responsible for the pyrethroid resistance in insects and it is widely expressed in *H. armigera*, but not as widely expressed in *H. zea*. This may represent a rapid DNA based identification marker.
- The two species are closely related and have been found to interbreed developing hybrids—some hybrids in Brazil's group have *H. zea* mitochondrial DNA, but the *H. armigera* genitalia characteristics (B3).

The group recommended that APHIS begin the development of strategies for long-term control in the U.S. as the pest is going to be next to impossible to eradicate once in the U.S. Early involvement of other USDA agencies such as the Agricultural Research Service (ARS) and National Institute of Food and Agriculture (NIFA) is recommended as well as Regional IPM centers and industry partners. Additionally, APHIS should develop a clear communication strategy about why eradication will not work for this pest.

Attendees:
Dan Borchert- USDA APHIS, Darren Kriticos-CSIRO, Godshen Pallipparambil- NCSU, Jaap vanKretschmar- NCSU, Julieta Bramblia- USDA APHIS, Meron Zalucki-University of Queensland, Tom Walsh-CSIRO, Michael Toews- University of Georgia, Dave Lance-USDA APHIS, Russ Bulluck-USDA APHIS, David Heckel-Max Planck Institute, Greg Sword- Texas A&M, Ryan Kurtz- Cotton Incorporated.

References cited:

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Reay-Jones, F.P.F and D.D. Reisig. 2012. Impact of corn earworm injury on yield of transgenic corn producing Bt toxins in the Carolinas. Journal of Economic Entomology. 107(3): 1101-1109.

Suh, C.P.C., D.B.Orr, J.W. Van Duyn and D.M. Borchert. 2000. *Trichogramma exiguum* (Hymenoptera: Trichogrammatidae) releases in North Carolina cotton: evaluation of heliothine pest suppression. Journal of Economic Entomology. 93(4): 1127-1136.