Practical management of fall armyworm

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Fall armyworm, management, 2020, *Spodoptera frugiperda*

Take home message

Chemical control alone will not be enough to manage this pest in the long term

Introduction

This presentation is based on the practical experiences of the staff of the Black Earth Agronomy group in managing fall armyworm (*Spodoptera frugiperda*) in the Burdekin region of North Queensland and on the Darling Downs since March 2020.

The 2020 experiences

In January 2020, the Director General of DAF advised that fall armyworm (FAW) had arrived in Queensland across the Torres Strait.

In late April 2020, one of our clients planted a small block (10ha) of maize corn at Mona Park near Clare in the Burdekin Region. This field proved to be where my company started its education in dealing with fall armyworm.

At the time, no-one could tell us what strain of fall armyworm we were dealing with, or what insecticide resistance genes the FAW population was carrying.

In the beginning, we couldn't understand where all the fall armyworm larvae were coming from. We could find low numbers of egg rafts generating 2-3 larvae per plant distributed across a field. Then we discovered that the fall armyworm larvae were hatching in the egg rafts and then 'ballooning' or 'parachuting' in the breeze to colonize other plants. You only need one egg raft in 10 metres of row to produce a significant infestation of fall armyworm larvae per plant.

An application with deltamethrin to the Mona Park block at the 3-4 leaf stage killed the cluster caterpillars (*Spodoptera litura*) present in the crop but left the fall armyworm in the whorl behind. We realised that the plant stand of the crop was at risk and applied Altacor (PER89366). Acceptable levels of control were achieved to preserve the plant stand.

Critical early stage of development in maize

Based on regular and thorough scouting, we gained confidence in what was working and what was not in the Mona Park block and other early planted corn fields in the district.

In maize crops in the Burdekin in 2020, we settled on a strategy which included the following spray program to get the crop through to the 6 true leaf stage:-

1) Steward® (PER89530) The indoxacarb application was often mixed with a post-emergent herbicide for broadleaf weed control at the 2.5 to 3 true leaf stage. By trial and error, we found that indoxacarb was not effective in controlling FAW larvae if rain or irrigation fell 1-2 days after application. My current recommendation is to avoid using indoxacarb if rain is forecast in the 5 days following the spray.
2) Altacor (PER89366) (if deemed necessary by crop monitoring).

In some maize crops, we applied only one insecticide spray during the early stage of crop development because the FAW moths did not 'find' the corn field until it was already at the 4-5 true leaf stage. If crop monitoring indicated that two insecticide applications were required, they often occurred 7-10 days apart during the 2 to 5 true leaf growth stage.

On some farms, we were able to achieve acceptable levels of control with *Bacillus thuringiensis* (Bt) sprays until the third week of May 2020. By this time, the FAW population in the Burdekin and Bowen Regions was increasing exponentially. It reached the point where we were not confident that we would obtain acceptable levels of control using Bt. Consequently, we switched to conventional chemistry.

Cost savings can be made by applying the insecticide in a 50% band over the row, particularly when the crop is 2-4 true leaves.

Once the maize crop had reached 6-7 true leaves, we felt that the plant stand was not at risk. We decided to stop spraying and monitor the FAW larval population and the leaf damage that ensued. The leaf damage caused by large FAW grubs in the whorl from 6 true leaves up to tassel emergence can make the crop appear very 'mauled' but I don't believe that significant yield reductions resulted from this vegetative damage in 2020.

Critical late stage of corn development

By the time that *'most'* maize fields had tasselled, all the FAW larvae had gone to ground to pupate.

I was relieved that I did not have to recommend another spray to control FAW and Helicoverpa larvae moving down from the tassels to attack the developing cobs.

When the kernels had coloured and were midway through the soft dough stage, I thought that my job was done with FAW. Little did I know! There were large FAW and Helicoverpa in the tips of a high percentage of the cobs.

It is commonplace to find Helicoverpa going through their life cycle from eggs laid in the silks to large larvae in the tips before going to ground to pupate.

What wasn't expected was the behaviour of very small and small FAW larvae crawling beneath several layers of husk from the tips to midway down the cobs in most of the corn paddocks.

Several test strips were initiated using Altacor (PER89366) and Steward (PER89530) applied by air. The crops were too tall for most ground rigs. As you would expect, control of FAW larvae under the husk was not effective.

The FAW larvae proceeded to grow through to their final instar, feeding on the kernels midway down the cob length. At this late instar stage, they chewed exit holes through the husks to go to ground to pupate. This left many cobs with 2-3 large 'bullet holes' or damage that I describe as body grub damage. The risk of crop failure from aflatoxins and cob rots was very real and some growers prepared to harvest at high moisture rather than allow the crop to experience a rainfall event. Fortunately, it was a very dry finish and all crops were harvested successfully.

One interesting observation was that on three farms (6% of the total maize area under our supervision in 2020), the incidence of body grub damage was minimal. These farms were aerially sprayed with Altacor (PER89366) at tasselling/early silking because the crops were uneven and medium to large FAW larvae were still present when the tassel emerged.

This tassel spray is now standard practice for Black Earth Agronomy **whether or not** there are FAW larvae present at tasselling until research or experience proves otherwise.

Subterranean behaviour

In some corn and soybean plantings, we found that FAW can behave like cutworm.

Case 1

Once volunteers from a previous crop of soybeans had been sprayed out, we discovered that large FAW can quite happily survive under the soybean trash layer for some time before attacking corn plants at the 1-2 true leaf stage. In this case, chlorpyrifos was applied in the late afternoon to control ’cutworm’ and the crop damage subsided.

Case 2

This subterranean ’cutworm’ behaviour was replicated in an August planted crop of soybeans. The grower had a few scattered grass weeds (feathertop Rhodes, crowsfoot and summer grass) in the field where he intended to plant winter soybeans. The grower worked the ground with discs before hilling up and pre-watering.

After a week, small weeds which had germinated were sprayed with glyphosate prior to planting. Before the crop emerged, the field was sprayed with paraquat and metolachlor before flushing the field again to ensure an even crop emergence and survival of the inoculant for successful nodulation. The crop emerged very well.

At the one trifoliate leaf stage, we noted that the soybean seedlings were being attacked above and below ground level. We could find no larvae on the leaves and stems so we proceeded to dig underneath the crop row. There we found large FAW larvae down to 5cm deep in the soil profile.

These larvae were chewing through the base of the seedings below ground level. In the evening, the larvae were feeding on the leaves and stems above ground. We applied deltamethrin because chlorpyrifos is not registered for ’cutworm’ in soybeans. Either the deltamethrin was effective OR the large FAW pupated soon after application, but crop damage subsided quickly and an acceptable plant stand was achieved.

Case 3

In 2021, we have seen a repeat of this behaviour where FAW larvae have infested grass seedlings in the fallow prior to sowing corn. The grasses were sprayed out prior to planting but the larvae seem to be able to survive in the soil until the crop emerges.

Other potential host crops

For those sorghum crops planted in the Burdekin in January-March 2020, we found very few FAW larvae infesting the crops grown on our client’s properties.

Similarly for Panorama Millet planted in July or Shirohie Millet planted in August 2020.

We have anecdotal evidence that FAW have caused significant leaf damage in forage sorghum around Gumlu.

FAW larvae have also penetrated capsicum bells without leaving obvious points of entry. It is disconcerting when ‘unblemished’ fruit reach the markets containing FAW larvae!

Negligible numbers of FAW larvae have been found in green beans, mungbeans or soybeans in the Burdekin.

The 2021 experiences

Corn

Due to the price of corn falling to $280 per tonne in the Burdekin, most growers have decided not to grow corn this winter, especially when the cost of production has increased significantly due to fall armyworm. An increased level of crop monitoring by the grower or his consultant is also required to manage the pest.

In 2021, we have chosen not to recommend Altacor (PER89366) in the early growth stages of corn to reduce our reliance on this valuable insecticide group.

We now suggest that our clients use emamectin benzoate (PER89371) instead.

This season, we only have 3 blocks of popcorn (Var. R502 Butterfly) which were planted in early April. To date, we have sprayed the crop 3 times for FAW, twice with emamectin benzoate (PER89371) at the 2-5 true leaf stage and once with Altacor (PER89366) at tasselling. Emamectin benzoate (PER89371) was chosen at the early stages because the weather was rainy and unpredictable. The grower also used QM FAW/methomyl (PER89279) to attract and kill the FAW moths.

Sorghum

One of the neighbouring farms in the Burdekin planted large areas of grain sorghum during the wet season (January-March 2021). The neighbour said that he did not treat any of his sorghum for fall armyworm.

In some blocks, he estimates that crop losses of 50% have occurred in both dryland and irrigated sorghum blocks due to FAW damage. In these cases, high numbers of FAW larvae were present during the late vegetative phase which led to significant damage by large FAW larvae to the developing head in the boot.

In a telephone hook-up last year, I was advised that this type of damage had been observed in grain sorghum crops grown in Texas in the USA (Anthony Hawes *pers.com*). The USA experience suggested that the FAW larvae hidden by the leaves surrounding the developing head in the boot cannot be killed by insecticide sprays. Consequently, you would have to recognise that you had a developing problem with FAW numbers **before** the crop reached the boot stage.

What larval sizes and numbers constitute a spray threshold in vegetative sorghum?

We did not observe this type of head damage in the mid-January planted sorghum on our clients' properties on the Central Darling Downs this season. The FAW larval population remained low throughout the crop's growth and development.

A similar circumstance exists in corn. We have found that you cannot kill FAW larvae feeding on the developing tassel in the whorl until the tassel emerges from the surrounding sheath of leaves. The timing of a spray can be very difficult to determine if a crop is uneven in tassel emergence.

Area wide management

Without doing a statistical analysis of our scouting records, it was apparent to the staff of Black Earth Agronomy that if you fail to control a significant population of FAW larvae in a crop on your farm or on a neighbouring block in your local district, you can generate your own FAW plague or pandemic.

It becomes a numbers game.

In a highly susceptible crop such as corn, you are in big strife if you start to find 2 egg rafts per metre of row in a crop at the 2 true leaf stage. This equates to 200-400 eggs per metre.

This situation requires repeated sprays to reach the 6 true leaf stage. Even then, you may finish up with one large FAW larva buried deep down in the whorl of every plant, which you cannot control with insecticide. Without disease or parasitism, this has the potential to produce 13,333 moths per ha which begin another cycle in the later stages of the crop or migrate to your neighbour's susceptible crop.

Trichogramma

We have tried releasing *Trichogramma pretiosum* which you can buy commercially. We can definitely 'see' a high number of parasitised Helicoverpa eggs in the field but we haven't seen FAW egg rafts which have been significantly parasitised. The staff of Black Earth Agronomy have also caged FAW egg rafts together with commercially reared *T. pretiosum* but have ended up with a cage full of FAW hatchlings! We have not counted the number of eggs in the FAW egg rafts or the number of larvae that actually hatched so we do not have an accurate measurement of the level of parasitism. Melina Miles, DAF Entomologist in Toowoomba, and Siva Subramaniam, the DAF Entomologist in Bowen, might have more accurate numbers from their research in controlled, laboratory environments.

Other pests and diseases of fall armyworm

High levels of parasitism by a parasitic wasp called *Cotesia ruficrus* were recorded in maize crops monitored by Steve and Anna Madden, agricultural consultants in Northern NSW, in the spring of 2020. It is uncertain whether this parasitic wasp species would be a suitable candidate for mass rearing in a commercial insectary. This could be a research project for an aspiring entomologist or entrepreneur?

Fawligen (Permit No. PER90820) is a virus preparation which infects and kills small FAW larvae. To date, Black Earth agronomists have not trialled Fawligen as a 'stand-alone' product against FAW in corn in the Burdekin. It has been used as a mixing partner with conventional insecticides to lower the potential for the development of insecticide resistance. We have felt that the FAW pressure in the corn has been too high and the prevailing minimum temperatures too low to risk a stand-alone application of Fawligen.

Metarhizium (formerly known as Nomuraea) is a fungi genus that has shown that it can kill FAW in NQ. Occasionally, we have come across FAW larvae which have been infected by a local species of Metarhizium in maize crops but the incidence is very low. In the Giru district in the Burdekin, Metarhizium was responsible for the death of a significant number of cluster caterpillars (*Spodoptera litura*) in soybean crops at the end of summer in 2021. I understand that commercial preparations of Metarhizium could become available in Australia in the next few years.

Attract and kill technologies

This technology offers a lot of potential to reduce the FAW moth population on a farm and would be the core of an area wide management plan where susceptible crops are grown.

Magnet® was developed 18-19 years ago as a feeding attractant for Helicoverpa moths which were killed by an insecticide added to the mix. The Magnet/insecticide mix is applied in a very coarse spray to the crop row at a pre-determined interval (36 or 72 metres).

In the winter of 2020, all the Magnet supplies in Australia were sent to the Ord river irrigation area to aid in protecting the seed corn and sorghum production areas.

AgBitech were able to import the active ingredients to make and distribute another batch of Magnet by the end of August 2020.

Magnet (PER89398) was applied commercially to sweetcorn crops in the Bowen and Burdekin regions in the spring and early summer of 2020. Dead Helicoverpa and FAW moths could be found at the base of the corn rows the day after application. The overall effect of applying Magnet to reduce the incidence and distribution of FAW across the farming enterprise was inconclusive in 2020.

In an experiment, Black Earth staff discovered that a large number of moths of various species including FAW could be caught in pheromone bucket traps where the pheromone lure was replaced with a Magnet lure. This experiment was conducted adjacent to a field where poor control of FAW larvae had been achieved. The aim of the experiment was to determine how attractive Magnet was to FAW moths rather than as a tool to reduce the moth population in a particular area of the field.

New attractant products are being developed to target fall armyworm moths. These include Smartgreen Biosciences QM FAW and Organic Crop Protectants ACTTRA FAW.

More trial work needs to be conducted to determine which attractant works best on FAW moths and to quantify the benefits of suppressing moth numbers across a farming district. Quantifying the effect of attract and kill technology is a difficult task.

Different attractant products applied to different fields in a district might be more beneficial than relying on one attractant?

More research needs to be conducted on insecticides to mix with the moth attractants.

The moth attractants do attract a whole range of insect species including beneficials such as lady beetles. Having broad spectrum insecticides such as methomyl as the mixing partner may be useful in the short term. In the future, we need more specific adulticides which target the pest species and conserve the majority of the beneficial insects.

The development of Bt cotton technology and nuclear polyhedrosis virus (NPV) for controlling Helicoverpa in grain sorghum was fundamental to the Area Wide Management of Helicoverpa in the mixed cropping systems on the Darling Downs.

It will take a mixture of different technologies to manage FAW in the future.

Ultimately, developing an Area Wide Management Plan for FAW and assessing its success or failure might be the best course of action. Over time, the diseases, predators and parasites in the local environment might adapt to the availability of the new food resource and assist us in managing the pest.

One thing I am sure of is that we can’t rely on chemical control to manage this pest in the long term.

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