Insects associated with pecan trees, *Carya illinoinensis*: characterisation, impact and control

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Project overview (1 October 2021 – 30 September 2022)

During this fiscal year, three principal objectives were pursued: (1) continue with insect surveys in the Hartswater, Prieska and Modimolle regions (also initiate insect surveys in the Muden area, KwaZulu-Natal); (2) characterise naturally-occuring endophytic fungi associated with pecan trees in the Muden area; (3) continue pheromone-based surveillance and damage-correlation of African bollworm, *Helicoverpa armigera*, and false codling moth, *Thaumatotibia leucotreta*, in the Hartswater, Prieska and Jacobsdal regions (also initiate surveillance in the Muden area, KZN). Following, a brief overview of each of the three research areas.

1. **Insect surveys**

Background

Pecan nut trees, *Carya illinoinensis* (Juglandaceae), are native to North America and serve as host plant for at least 15 important insect pest species (listed in *Insects Associated with Pecan Cultivation in South Africa* by Hatting 2018. See also Chapter 23 (Pests) in *Production Guidelines for Pecan*, edited by Sippel and Du Toit, 2021), although only one of these 'true' pecan insect pests is associated with pecan cultivation in South Africa; *i.e*., yellow pecan aphid, *Monelliopsis pecanis*. However, as the local area under pecan cultivation expands, the dynamics of the host-pest relationship may also change, especially amidst a climate-changing environment. Ultimately, 'new' incursions are likely, with some exotic species posing a severe threat to the South African pecan industry. Another scenario entails 'host switching', where an indigenous insect moves from a particular vegetation type to now exploit a previously unaffected host plant, whether indigenous or exotic. A local example is the long-horned beetle, *Cacosceles newmannii* (Cerambycidae), moving onto sugarcane and causing economic losses for the unsuspecting growers. In addition to the abovementioned, development of resistance to chemical insecticides poses equal risks, but can be averted if sound pest control measures are practised; see "*Beginsels vir volhoubare insekbeheer by Pekanproduksie"* by Hatting 2020 (online publication on SAPPA website: https://www.sappa.za.org/wp-content/uploads/docs/2020/11/IPM-5-Nov-2020.pdf). The ongoing insect surveys thus serve as pre-emptive approach in alerting the local industry of new incursions and/or changes to the pest status of insects associated with pecan cultivation. Concurrently, grower awareness of beneficial insects is stimulated; an insect grouping which renders a valuable ecosystem service by suppressing pestiferous species.

During the 2021/22 reporting period, a total of 2 873 insects were collected at Hartswater, Prieska, Modimolle and Muden (last mentioned site initiated March 2022). The overall ratio (%) of potentially pestiferous : beneficial : neutral insects was 58 : 24 : 18. The site-specific insect numbers (n) and ratios are visually depicted in Figures 1-4. Note, above data exclude all ants, as well as a large number of flies recovered from the Muden site during April 2022. Fortunately, no (new) exotic incursions were noted in this reporting period.

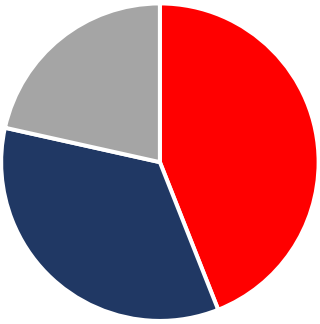

Fig. 1. Hartswater (n = 545)

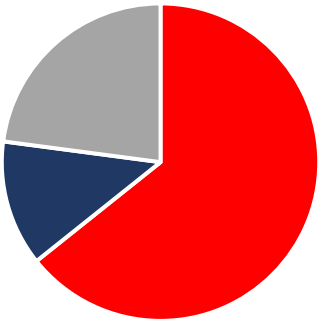

Fig. 2. Prieska (n = 909)

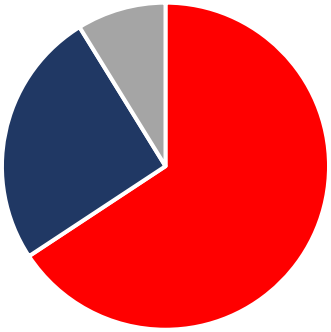

Fig. 3. Modimolle (n = 1 038)

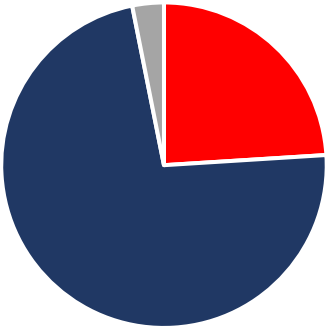

Fig. 4. Muden (n = 1 120)

Fig. 1-4. Comparative number of insect 'types' recorded in each of the four regions from 1 October 2021 to 30 September 2022. Red = potentially pestiferous, Blue = beneficial, Grey = neutral (characterised as those species of which the activity/role on pecan trees remain uncertain).

Beneficials at the four sites comprised mainly ladybird beetles (Coccinellidae), spiders (Araneae), praying mantises (Mantidae), lacewings (Chrysopidae) and assassin bugs (Reduviidae). A very prominent ladybird species observed at the Hartswater site during 2021/22 was *Harmonia axyridis*, *i.e.*, the harlequin or Asian ladybird. This is an exotic species, first noted in South Africa around 2004 in the Western Cape (see http://www.scielo.org.za/pdf/sajs/v103n3-4/10.pdf). The high number of adults recovered during April'22, is most likely linked to the yellow pecan aphid, serving as prey and typically associated with pecan trees during February/March each year. The larval stage of these adults could have been sustained by these aphid populations prior to pupal-formation and adult emergence, although adults are highly motile (Fig. 5) and some may have also entered the orchard in search of 'late' aphid populations.

Thus far, the newly added Muden site has revealed a very strong beneficial insect component, comprising 73% of all insects collected (n = 1 120 insects over 3 surveys). Moreover, although grouped as 'potentially pestiferous', many specimens of the grass stinkbug, *Carbula* sp., were collected during February'22; this stinkbug, however, is not known to cause damage to pecan nuts. This further reduces the injury risk posed by the 24% of insects in this group (Fig. 3; red).

Fig. 5. Adults (±7mm in length) of the Asian ladybird, *Harmonia axyridis* (Coleoptera: Coccinellidae). Note delicate hind wings extended under protective elytra (Photo: JL Hatting)

The most prevalent pest insects recorded at Hartswater were snout beetles or weevils (Curculionidae; biting-chewing mouthparts), mottled stinkbug (*Pseudatellus raptorius*; Fig. 6) and the seed-bug *Paromius gracilis* (Hemiptera: Rhyparochromidae). Last mentioned was also noted in relatively high numbers during June'22 at Prieska. Two other prevalent insects at Prieska were the green citrus leafhopper, *Empoasca distinguenda,* and (unidentified) tree crickets (Orthoptera: Gryllidae). Similar to the previous seasons, the Modimolle surveys revealed notable numbers of snout beetles, particularly *Dereodus schoenherri* (Coleoptera: Curculionidae). This species and other snout beetles recorded on pecan trees are mainly foliage-feeders and not necessarily serious pests. However, as previously cautioned, pecan producers should be on the lookout for the exotic pecan weevil, *Curculio caryae* (see photos on page 39-40 of the *Pecan Insect Guide*), and hickory nut weevil, *Conotrachelus hicoriae*. These insects affect the nuts and are considered primary pecan pests in the United States, but still absent from South Africa. Ongoing surveillance for these species is needed across the South African pecan industry.

Fig. 6. Mottled stinkbug, *Pseudatellus raptorius* (Photo: JL Hatting)

2. Endophytes

Research progress on endophytes in pecan (in particular the entomopathogenic fungus, *Beauveria bassiana*) has been reported on in previous SA Pecan articles. With the addition of the Muden site in 2022, it was decided to explore the natural occurrence of endophytic fungi associated with two cultivars at this site (Choctaw [young trees] and Ukulinga [older trees]). Leaves were collected from healthy trees during April'22, surface sterilised and cut into small sections and then plated on a nutrient agar. Fungal colonies were isolated into pure culture and sent to Inqaba Biotech for molecular (ITS) identification. A total of 7 cultures were distinguished; 3 from Choctaw and 4 from Ukulinga. The fungi were identified as follows:

Choctaw host plant

Epicoccum nigrum

Xylaria venosula

Alternaria sp.

Ukulinga host plant

Epicoccum nigrum

Nigrospora oryzae

Cladosporium sp.

Didymella coffeae-arabicae

Knowledge of resident 'background' fungi in pecan trees is needed when attempting artificial introduction/establishment of *B. bassiana* as endophyte. To further explore this notion, several young trees were topically sprayed (3 sequential applications to the point of run-off) with the commercial product '*Eco-Bb*' during February, April and June 2022. Leaves were again collected during October 2022 and will be subjected to molecular techniques for verification of *B. bassiana* presence/absence. Results to be reported during the 2022/23 cycle.

3. Pheromone-based surveillance and damage-correlation of false codling moth, *Thaumatotibia leucotreta* and African bollworm, *Helicoverpa armigera*

Background

The South African Pecan Nut Producers Association has expressed the desire to gather more 'pecan-specific' data on the flight patterns and damage potential of the false codling moth (FCM) (see pages 46-48, *Pecan Insect Guide*) and African bollworm (see pages 49-50, *Pecan Insect Guide*). Both pests have an adult moth stage, enabling monitoring of male moths by pheromone trapping. Monitoring of moth flights (using bucket funnel traps and yellow sticky traps, loaded with a sex pheromone) was initiated during September 2020 at the farm level. During 2021/22 a total of 33 traps were serviced in the Vaalharts (22 traps), Prieska (3), Jacobsdal (4) and Muden (4) regions. Traps are being serviced every two weeks for sorting and counting. Moth flights will be monitored over three seasons to account for seasonal variation. Partial second-year datasets (October 2021 to September 2022) for FCM and bollworm flights (all regions combined) are presented in Fig. 8 and Fig 9, respectively.

Detailed, region-specific graphs will be compiled at the end of the 3-year project. Thus far, moth activity (both species) is noted from August to October, across all sites.

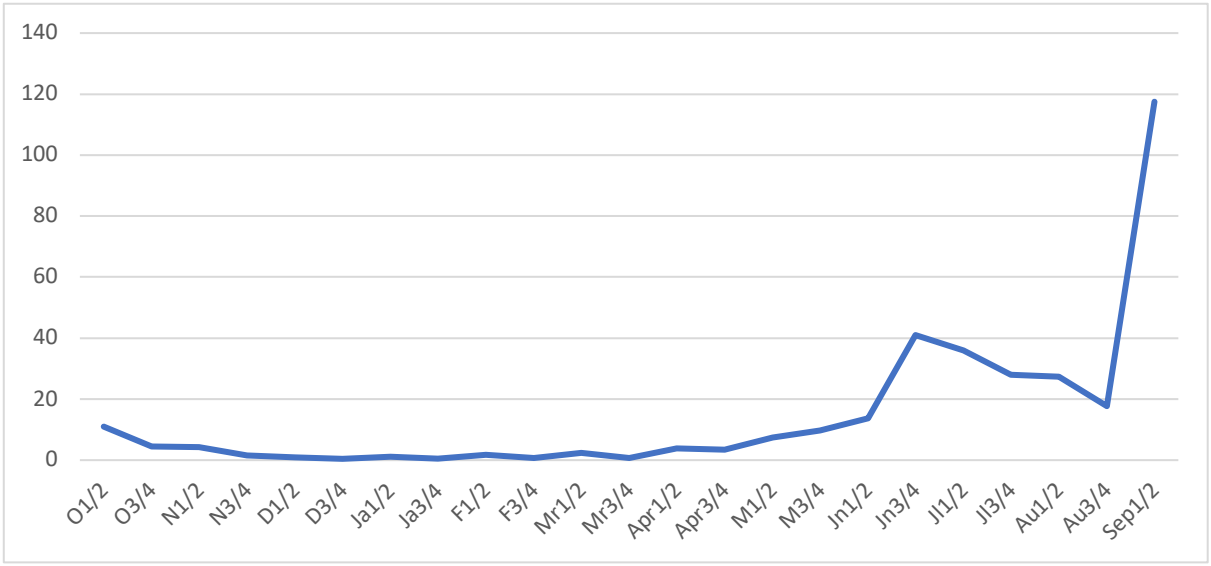

Fig. 8. FCM flights from 1 October 2021 to 15 September 2022. O1/2 denotes October week 1 and 2; O3/4 = October weeks 3 and 4, etc.

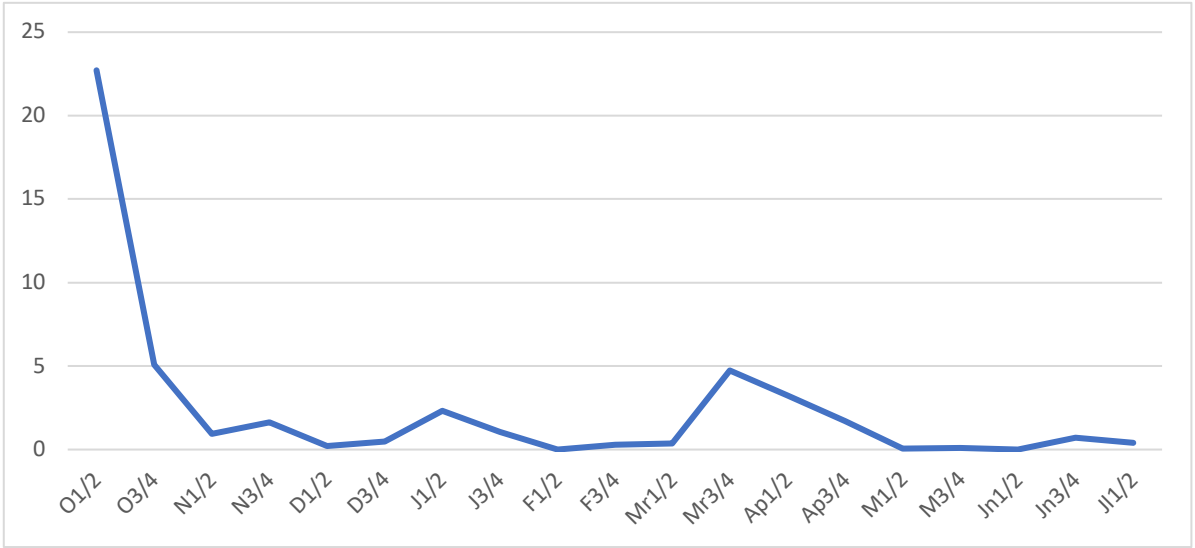

Fig. 9. Bollworm moth flights from 1 October 2021 to 15 July 2022. O1/2 denotes October week 1 and 2; O3/4 = October weeks 3 and 4, etc.

Early-season moth flights may result in bollworm damage to flower buds and/or developing nutlets. Flower buds are high in nutritional value and hence attractive to bollworm. Likewise, developing nutlets are also targeted (see Fig. 48c in the *Pecan Insect Guide*), which may lead to nutlet abortion. To further investigate this notion, all aborted nutlets were collected from the soil surface within a 2m radius around selected trees during December 2021. A total of 29 trees (*i.e.*, 12 Wichita, 7 Choctaw, 6 Western, 2 Pawnee, 1 Mohawk and 1 Ukulinga) were inspected at Bull Hill (3 trees), Jan Kempdorp (6), Tadcaster (3), Hartswater (3), Magogong (3), Prieska (7) and Modderrivier/Jacobsdal (5). Nutlets were sorted according to size (3 categories: small [<10mm], medium [>10 – 15mm], large [>15mm]) and inspected for bollworm feeding damage (Fig. 10). These data will later be used to investigate possible correlations/interactions among the parameters: flight patterns, nut abortion, nut size, cultivar, % damage and/or area. Year 2 observations show nutlet abortion ranging from 6 to 258 nutlets per tree. However, from a total of 1 609 nutlets collected, only 2.5% showed feeding damage associated with bollworm. The data also suggest higher abortion by the cultivar Choctaw in the Vaalharts region. Amalgamated data over 3 years will enable a representative average for interpretation and, hence, a better understanding of the bollworm and its impact on pecan production.

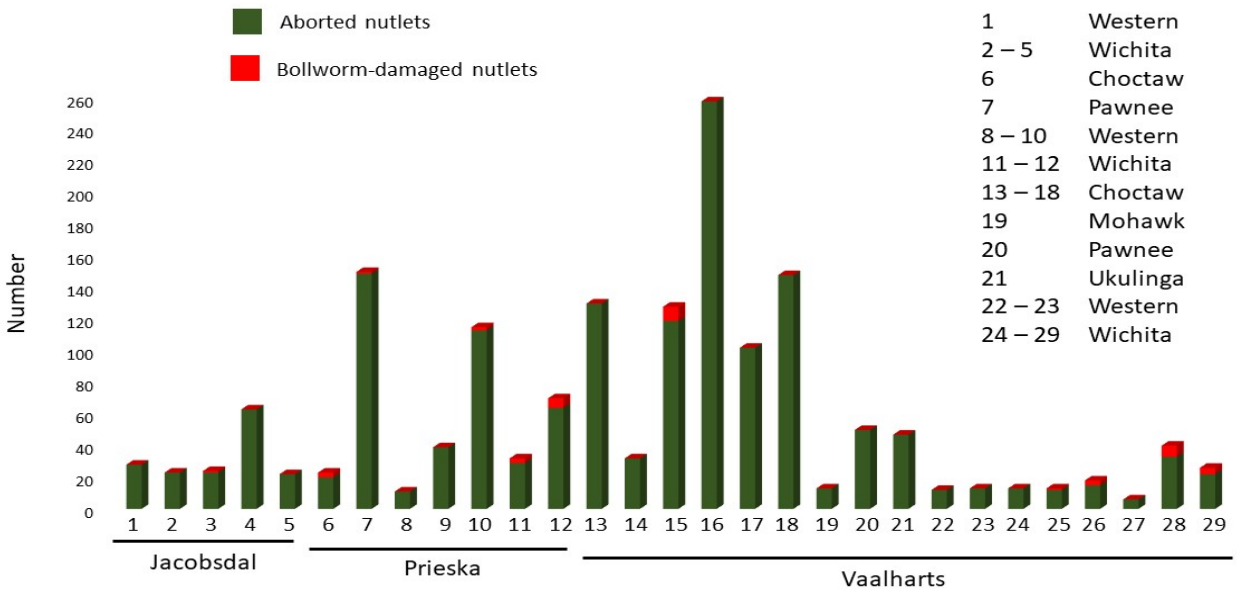

Fig. 10. Number of aborted and bollworm-damaged nutlets across regions and cultivars