The polyphagous shot hole borer and its potential impact on the South African macadamia industry

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Since its first detection in KwaZulu-Natal in February 2017, the polyphagous shot hole borer (PSHB) has spread rapidly throughout South Africa, now reported in every province except Limpopo (Paap, 2018). Centered mainly in urban areas, the most seriously affected species include English oak, boxelder, Chinese maple and London plane. In agriculturally important species, orchard infestation has only been reported for pecan in South Africa although reports of PSHB on avocado trees, peach, citrus, grapevine, plum and guava trees have been confirmed in private gardens (Van den Berg, 2019).

PSHB, Euwallacea fornicatus, and a typical gallery or network of tunnels lined with the Fusarium symboint. *Photo credit: Samantha Bush*

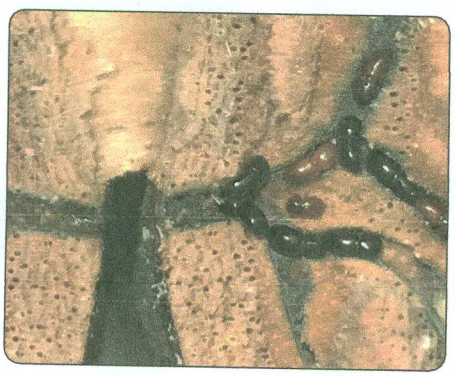
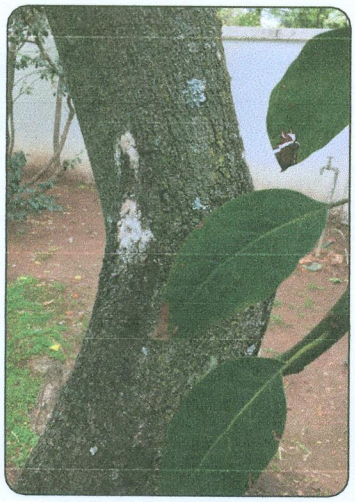


Figure 24. The polyphagous shot hole borer and the tunnels in which it "grows" its fungal symbiont as food source.

Behaviour of the PSHB

PSHB is an ambrosia beetle; these beetles are known to bore into wood tissue creating a network of tunnels known as a gallery. The beetles inoculate the walls of these galleries with specific fungi that serve as a food source (Freeman, 2012). *Fusarium euwallaceae* is one of three main fungal partners or symbionts associated with PSHB and the cause of Fusarium dieback. *F. euwallaceae* is mildly pathogenic and thus the majority of fatalities attributed to PSHB occur due to mass invasion in which numerous galleries increase the fungal load, blocking vascular tissue and leading to dieback.

In March 2019, the first case of PSHB on macadamia trees in KwaZulu-Natal was confirmed by members of the Macadamia Protection Programme based at FABI. Many other species of beetle are also known to infest trees in a similar manner to PSHB. Beetles other than PSHB have increasingly been reported on macadamia in South Africa, and include for example, *Xyleborus bispinatus, Xylosandrus crassiusculus, Xylosandrus germanus, Scolytoplatypus fasciatus,* and a species of *Euplatypus* (FABI, diagnostic clinic), all commonly regarded as secondary pests attacking stressed and dying trees (Wood, 2007). The external symptoms of PSHB on macadamia versus other beetles are not easily distinguishable via field observations and growers are encouraged to contact the FABI diagnostic clinic for identification (https://www.fabinet.up.ac.za/index.php/hosted-sites/diagnostic-clinic).



1. Sugar fountain on avocado tree in response to PSHB infection.

2. Frass from PSHB tunneling protruding from wild plum tree.

3. No clearly distinguished symptoms of PSHB infection on macadamia sample.

Figure 25. Various symptoms on polyphagous shot hole borer infestations on different tree species.

Symptoms as well as susceptibilities of host tree species to the beetle and fungus are highly variable. To better understand how macadamia will react to a PSHB infestation, pathogenicity assays were conducted on nice commercially planted cultivars that included hybrids as well as *M. integrifolia* species. Inoculations were conducted using the agar plug method for seedlings, and the toothpick method for detached branches.

For the seedling trials as well as detached branch inoculation assay only small lesions were observed six weeks after inoculation (less than 1,8 cm). When compared to a known reproductive host (a species in which both the beetle and fungus are able to establish and beetle reproduction can occur) such as London plane, lesions of about 5 cm were recorded after two weeks post-inoculation and on avocado trees 5 cm lesions were recorded six weeks post-inoculation. Overall, the Fusarium fungus therefore appears to grow more slowly in macadamia and lack aggressiveness. This slow growth of *F. euwallaceae* may be a contributing factor in why beetle reproduction has not been observed in macadamias in either South Africa, California or Israel (Eskalen, 2013). The fungus is however still introduced into the tree, thus the long term effect of the fungus on the tree remains an essential question to be answered to accurately assess the risk that the PHSB-fungus combination poses to the South African macadamia industry.

Based on the results of this preliminary trial, the outcome of this study appears to be more optimistic than initially anticipated. The lack

of aggressiveness shown in the pathogenicity trials as well as the notably low number of confirmed cases of PSHB in macadamia (three infested trees to date) provide a hopeful picture for growers. However, future work should focus on the increase of beetle attacks recorded from macadamia orchards and the management of tree stress inducing factors that are the primary cause of secondary beetle attack.

Recommendations

In terms of practical management on farms, we advise farmers to remove Castor Bean (*Ricinus communis*) as the PSHB breed and multiply quickly in woody stems of older plants. Furthermore, farmers should also closely monitor other reproductive host trees that are grown in close proximity to the orchards. As mentioned above these include species like English oak, London plane, maples, boxelders, etc. By reducing the number of possible breeding host trees for the beetle, the risk to non-reproductive hosts like macadamia and pecan can be reduced to a minimum.

Acknowledgements

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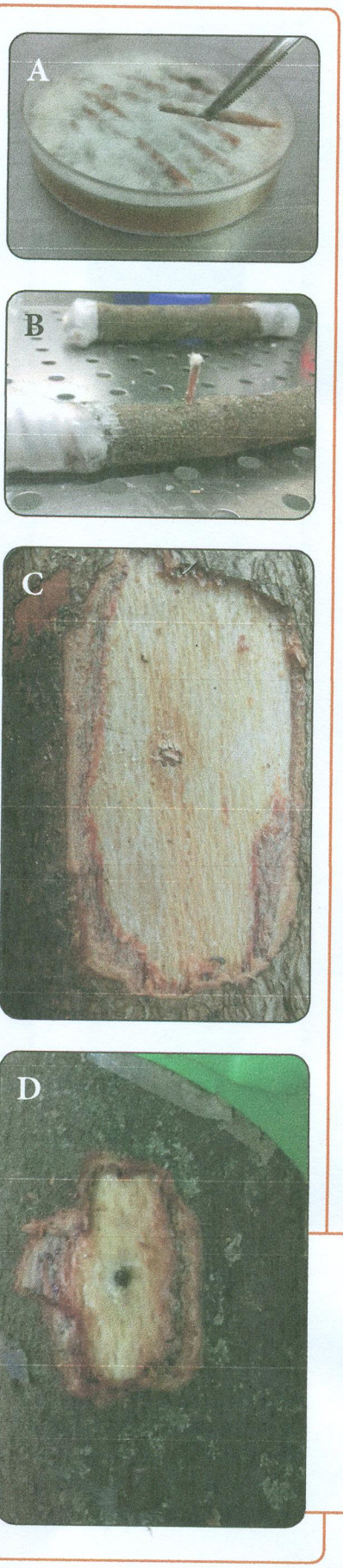

Pathogenicity assays. Inoculation with the symbiont, Fusarium euwallaceae, *was conducted by (A) incubating sterile toothpicks with the fungus for 2 weeks and (B) placing them in drilled holes in macadamia branches. (C) Some lesions developed after 6 weeks on detached macadamia branches. (D) No lesions developed after 23 weeks on live, relativly healthy macadamia tree.*

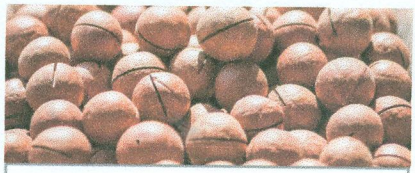

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Figure 26. Pathogenicity assays of the fungal symbiont of the polyphagous shot hole borer on macadamia branches.