Defining economical action levels for avocado bugs (Miridae) and the use of areawide IPM to warn growers of possible outbreaks

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SUMMARY
An attempt was made to develop a reporting system to pre-warn farmers for outbreaks of avocado bugs causing pimple-like protrusions on avocado fruit during the flowering and fruit set periods. Avocado bugs were monitored by visual scouting on three farms representing three different habitats in the Soutpansberg district. Data is presented on degree-day models as well as an areawide Integrated Pest Management (IPM) reporting system.

The aim of this research is to further develop methods to warn growers well in advance on possible avocado bug outbreaks so that control can be done more effectively. This method could also in the future prove to be useful to monitor and report on other insect pests.

This is the first report of a three-year project to further collect data with the aim to find correlations between the number of avocado bugs per tree and damage resulting in packhouse cull of fruit.

INTRODUCTION
It is difficult for farmers to know in advance when a certain pest (or disease) might pose a possible threat. Many attempts have been made in agriculture to assist farmers with various models that can predict when pests or diseases have to be controlled (Brett, 2008; Roberts, 2006; US Dept. Agric, 2004). The most common method is using climate data and degree-day models to make the predictions.

Many methods of pest surveillance are used to monitor the build up of pests and diseases (FAO, Department of Agriculture and Co-operation, 2007). Whenever such a build up of a certain monitored pest reach a designated level where economic losses will occur, the early warning system should warn growers to apply effective control measures.

The avocado bug complex (Miridae) in the Soutpansberg district was used in this study to develop an early warning system. Avocado bugs (*Lygus* spp.) feed on the epidermis of avocado fruit during the flowering and fruit set period (Alberts, 2009). Pimple-like protuberances are formed on the avocado skin where the avocado bugs feed. In a worse case scenario up to 30% of the fruit in an orchard can be affected. The pest complex therefore is of importance and should be controlled if insect numbers increase to levels that could cause economical losses.

The early warning system should have the following properties:

- Effective mapping of the number of bugs in each area.
- Quick feedback system to the farmers in the affected area.
- A database with relevant climate data to store all historical data.
- Ongoing correlation of trends to continuously refine the forecast model.
- An internet web forum where open discussions can take place.

The same early warning system can later be adapted to include other pests and diseases.

MATERIALS AND METHODS

Area
Three farms representing three different climate areas were chosen in the Soutpansberg avocado production area. Ten trees per orchard and three orchards per farm were scouted weekly from week 26/09 to week 38/09 (21 June to 19 September 2009).

- Amana, Levubu area – altitude: 670 m.
- Springfield, Slopes of Soutpansberg – altitude: 778 m.
- P Thomas, on the top of the Soutpansberg – altitude: 1 223 m.

Scouting method
Ten randomly selected trees per orchard and three orchards per farm representing that scouting area were chosen. Weekly counts of all the visible avocado bugs on the trees in a circular band around the outside perimeter of the trees were made. A band about 60 cm

wide (from hip to eye level) was chosen because of its easy access. Mature trees (about 8.5 m diameter) were chosen. The 60 cm scout band represents about 14% of the total surface area. The total number of avocado bugs counted in this band was multiplied by seven (14% x 7 = 98%) to calculate the theoretical number of avocado bugs on the tree. Dennil and Du Pont (1992) found a 98% correlation in the vertical distribution of avocado bugs on a tree.

Early warning system using freeware GIS computer programs

Google Earth: Google Earth is a well known freeware virtual globe, map and geographic information system (GIS) program that allows users easy access to any part of the globe. Google Earth was chosen as a GIS program because of its availability and ease of use.

Google Earth has many built in functions, but there are many more other freeware computer programs available that tie in with this program through Keyhole Markup Language (KML files) and thereby add more functions.

GE Graph v2.2.2a: GE Graph is a freeware program written by R Sgillo of the Cocoa Research Center (CEPLAC/CEPEC) Ilheus, Bahia, Brazil, that can link in with Google Earth through KML files.

GE Graph can draw various types of graphs on any specified co-ordinate on Google Earth. This allows users to see their familiar surroundings in 3D with their own block names or numbers and with bar graphs drawn on the blocks that correspond with a particular week's scouting data.

As we have stated previously, the early warning system should have effective mapping probabilities, combined with quick feedback to farmers in an area-wide program. The combination of Google Earth and GE Graph allows for this.

RESULTS

Avocado bug orchard survey

Insects are cold blooded animals and are therefore affected much more by temperature than warm blooded animals. The threshold temperatures for insect activity can be plotted very accurately by entomologists in a laboratory. For *Lygus* the lower threshold temperature was taken as 12.2ºC (Pickel, 1990).

Figure 1 shows the Degree Days (DDU) from May 2009 to January 2010. The minimum and maximum temperature from which the physiological time has been calculated is also shown. Avocado trees start flowering in May and can continue up to September. During the winter (June and July) when temperatures are low, the avocado bug activity is relatively low. As soon as temperatures rise during August and September, more flowers open and more avocado bugs are found feeding on these flowers. The avocado bug complex does not breed on avocados. The mature insects fly in to the orchards to feed when avocado flowers are available and day time temperatures are favourable.

In **Figure 2** the average weekly temperatures (MaxT, MinT and AveT) are plotted with polynomial trend lines. The total weekly rainfall is also shown. The optimum range for *Lygus* spp. is shown as a green background. Minimum temperatures drop lower than 12.2ºC bottom threshold value during the whole flowering and fruit set period. Daily maximum temperatures are well in the optimum range for this period. The avocado bugs become active every day from about 09:00 when daytime temperatures rise higher than 12ºC. During this period the daytime maximum temperatures never rise higher than the estimated 34ºC upper threshold temperature. After fruit set, when most fruits reach an average diameter of >3 mm, all the avocado bugs leave the orchards. *Lygus* spp. feed on many indigenous plants. The most popular plant families that they feed on are: Asteraceae, Malvaceae, Rosaceae, Verbenaceae (Guilermo, 2005) and also conifers (South, 1991). Many common weed species and other indigenous road side plants are found belonging to these plant families. Vernonia myriantha (Asteraceae), the Blue bitter-tea, is a very common shrub or small tree found in the Soutpansberg district along the roadsides. Many *Lygus* bugs are found on these Vernonia plants that flower in the same period as the avocado orchards.

Degree-day models cannot be used for avocado bugs to predict life cycles on the crop, because only the

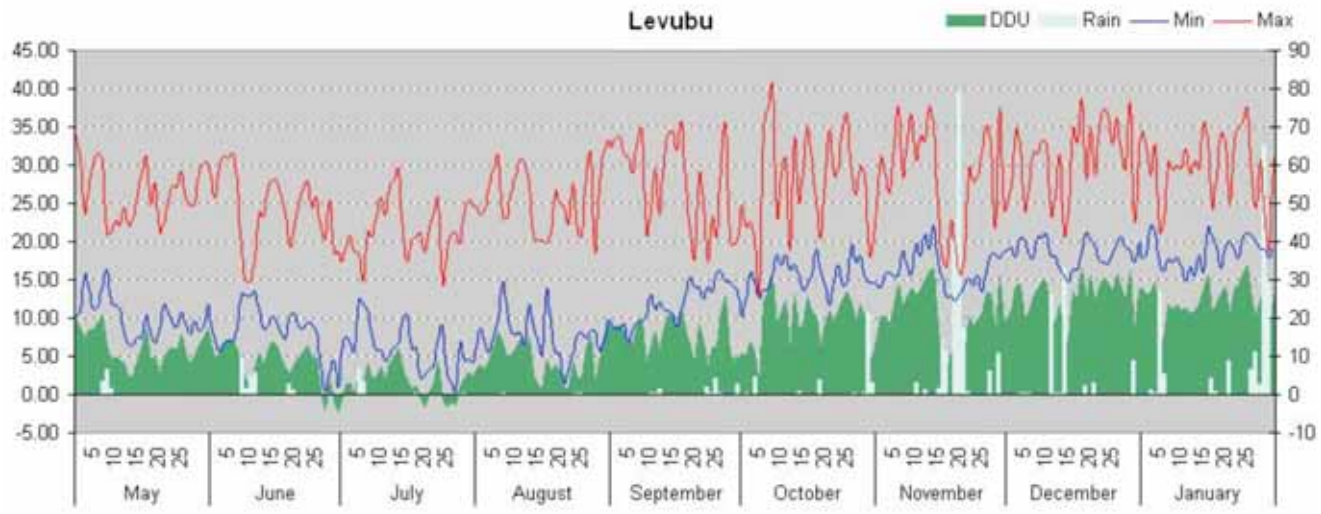

Figure 1. Maximum and minimum temperature and physiological time for *Lygus*. Base temperature 12.2ºC.

mature stages visit avocado orchards. It is, however, of importance to calculate their physiological time in an effort to try and predict how many avocado bugs might visit avocado orchards each season.

It is interesting to note that the very few avocado bugs per tree from week 26 to week 31 correspond not only with lower minimum temperatures, but also with the amount of open flowers per tree. The normal flowering pattern for avocado starts with a few first flowers opening in May or June. The peak flowering period (full bloom) is during July and August.

The data displayed in **Figure 3** shows the weekly total average amount of avocado bugs per tree on the three sites monitored. The Amana farms in the central Levubu area (altitude 670 m) had the lowest number of avocado bugs. These farms lie within an intensively farmed area with banana, avocado, macadamia and guava as main crops.

The Springfield area (altitude 778 m) had the highest amount of avocado bugs, followed by the Thomas area (altitude 1223 m). Both these areas are cooler and lie in areas where extensive forestry is done. Both these areas are near or adjacent to pine forests which are shown to be a host to *Lygus* spp.

The data in **Figure 4** shows the total number of avocado bugs per block on each of the three farms monitored (I = Amana; II = Springfield and III = Thomas). Total number of avocado bugs per tree did not vary much at Amana, which also had the least amount of avocado bugs. The number of avocado bugs per orchard on the other two farms varied much in some weeks. No satisfactory explanation could thus far be found for this phenomenon as all orchards followed the same flowering pattern.

Correlations

No correlations were possible this season, as the fruit have not yet been harvested. Visual scouting, however, showed more fruit damaged at the sites with higher proportions of avocado bugs monitored. Preliminary estimates are: Amana less than 1%, Springfield and Thomas both between 3% and 5% fruit with pimples on the epidermis that could result in a packhouse cull. The final data, when available, will be used to calculate the correlations between avocado bug numbers and fruit cull in the packhouses for this season.

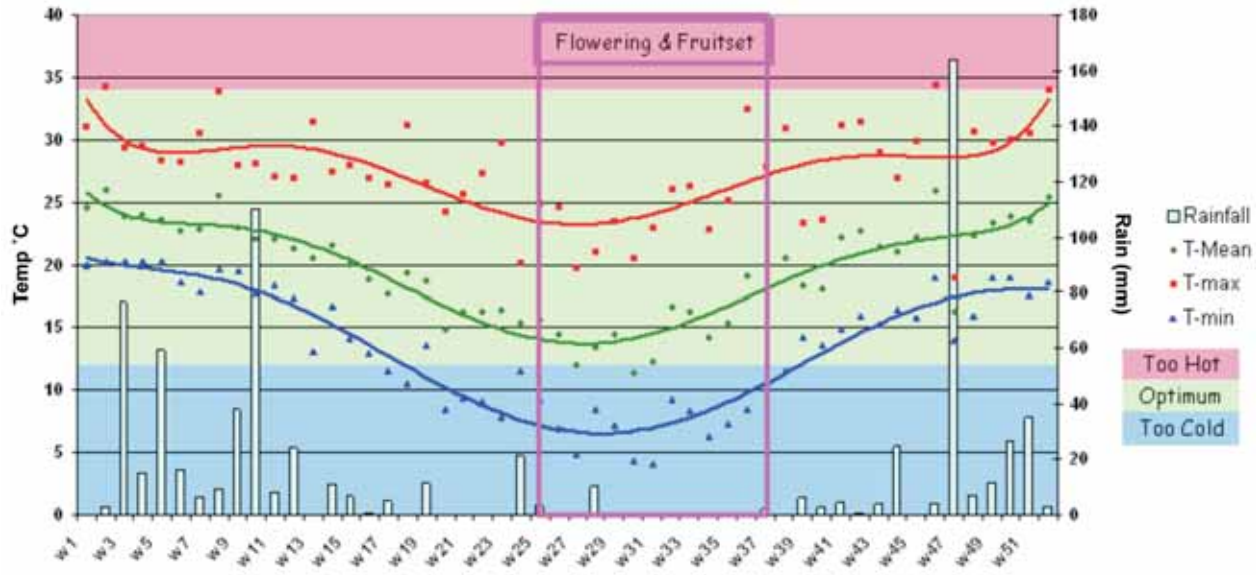

Figure 2. Average weekly temperatures and rainfall for 2009.

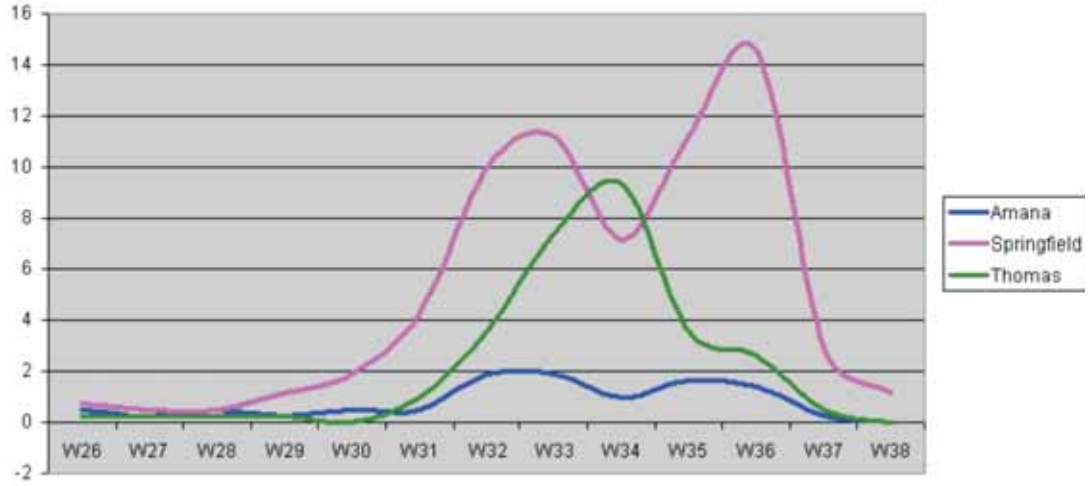

Figure 3. Total number of avocado bugs per tree from week 26/09 to week 38/09.

DISCUSSION AND CONCLUSIONS

Insect scouting is the most important aspect of an integrated pest management system. Scouting for insects in orchards or fields are, however, also time consuming and labour intensive. The best method for scouting insects are those that are easy to do and which are accurate. In the past scouting for Miridae have been done with sticky traps (Alberts, 2004) and with sweep nets (Peña, 2003). Both these methods are labour intensive and time consuming and extensive training must be done regularly to keep the insect scouts sharp and accurate.

More work must be done in future to find ways where semio-chemicals can be used as it would allow for accuracy and ease of use.

Farmers participating in an areawide IPM program should be prepared to send their weekly scout data to a central co-ordination office for analysis and sending it out again to all farmers in the area. SUBTROP technical officers are placed strategic in each production area and could function as central co-ordinating points.

With the use of simple and easy obtainable freeware GIS programs, it is possible to analyse data en distribute it to farmers in an areawide IPM program.
The action threshold for avocado bugs are at the moment as follows (Donkin, 1999):

- On year: 20% flower infestation = 5% packhouse cull.
- Off year: 10% flower infestation = 3% packhouse cull.

New correlations will be made with this season's data when packhouse information becomes available.

As a further aim of this study, attention will also in future be given to the biological control of avocado bugs as part of the IPM program. Special attention will be given to possible trap crops and host plants.

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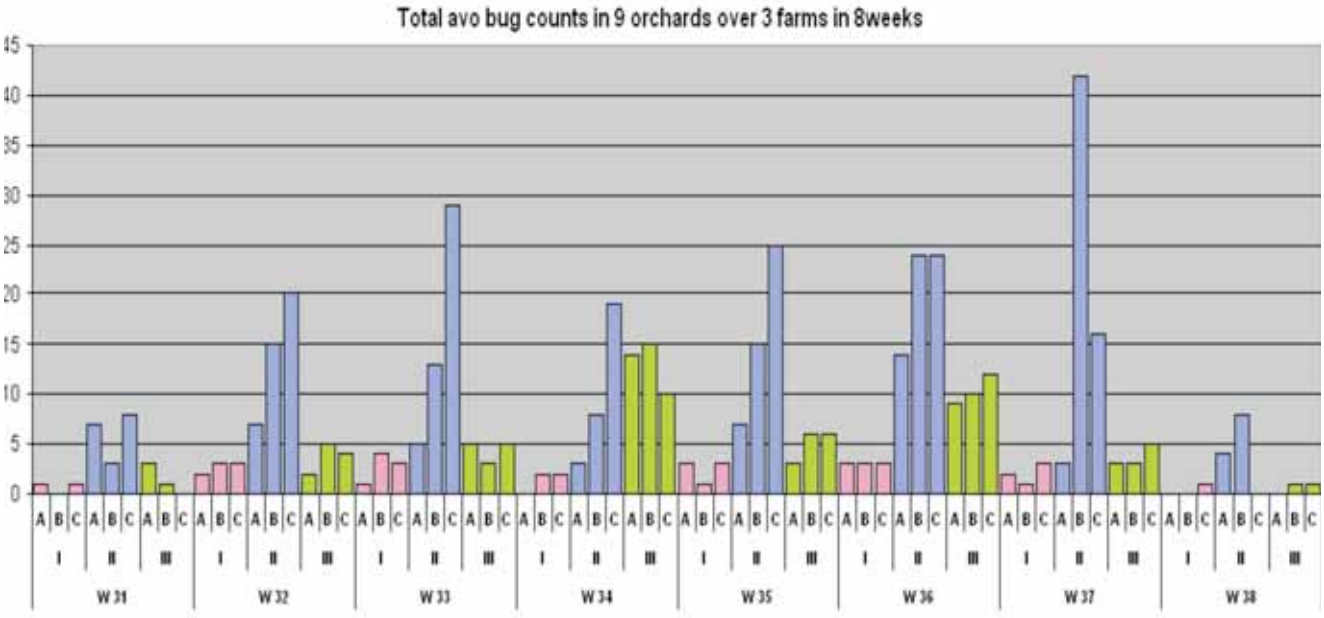

Figure 4. The weekly total number of avocado bugs per tree for three orchards and three sites over a eight-week period.