Modelling possible avocado bug outbreaks using a practical GIS reporting system

AJ Alberts

Agricultural consultant
E-mail: driesa@mweb.co.za

SUMMARY

It has always been a problem to forecast the occurrence of pests on agricultural crops accurately. The use of climate data to determine the optimum favourable conditions for the occurrence of a pest organism has been widely and mostly successfully used world wide.

Avocado bugs were monitored by visual scouting on three farms representing three different habitats in the Soutpansberg district during the 2008 to 2011 period. Weekly monitoring during each flowering period of avocado bugs in the Soutpansberg district and correlating their occurrence to a full set of climate data, has been used to compile a forecast model that can be used to predict the possible outbreak of the avocado mirid complex.

An easy GIS reporting system was developed to share integrated pest management data within area wide integrated pest management actions.

Coloured sticky cards and visual scouting was used to monitor avocado bugs over this period. Correlating the numbers of monitored avocado bugs per season to the damage caused to packed avocado fruit, was difficult because of the high variation between bug numbers and damaged fruit.

This final report presents a summary of the data as well as a practical solution for monitoring avocado minute sucking bugs in area wide IPM programmes.

INTRODUCTION

Descriptions of unsightly pimple-like protrusions on the skin of avocado fruit have been regularly reported by pack houses in the Soutpansberg district. The first report on unsightly bumps on avocados in South Africa from the Hazyview area was attributed to a *Taylorilygus* spp. (Du Toit *et.al.*, 1993). The pimple-like protrusions which are found on avocado fruit from the Soutpansberg district and Tzaneen area did not match the bumps, also called "vosknoppe". An unidentified mirid (probably a *Lygus* spp.) was found to dominate the Hemipteran complex visiting avocado flowers during the 2008 to 2012 flowering seasons.

Du Pont and Dennil (1996) have also reported that similar pimple-like protrusions were found on the skin of 'Hass' (10%) and 'Fuerte' (2%) fruit after feeding by the citrus leafhopper *Penthimiola bella* (Stal) (Homoptera: Cicadellidae).

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 the past 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 do the predictions.

Many methods of pest surveillance are used to monitor the build up of pests and diseases (FAO Department of Agriculture and Cooperation, 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 on time.

The avocado bugs (*Lygus* spp.) feed on the epidermis of avocado fruit during the flowering and fruit set period (Alberts, 2009). The pimple like protuberances which are formed on the avocado skin where the avocado bugs feed, can in a worse case scenario affect up to 30% of the fruit in an orchard.

This pest complex therefore is very important and should be controlled if insect numbers increase to levels that could cause economical losses. An early warning system should therefore have the following properties:

- It should effectively map the number of monitored bugs in a specific area.
- It should have a quick feed back system to the farmers in the affected area.
- It should have a relevant climate database to

store all historical data.
- Ongoing correlations of trends to continuously refine the forecast model should be done.
- An internet web forum should exist where open discussions can take place between all participants.

Maximum losses of up to 30% have been reported by various pack houses and farmers in the past. In most years, however, the losses are less than 5%.

The pimple-like lesions does not have any scarred tissue below the skin, but does make fruit unsightly and bruising of the pimples might lead to early fruit decay during transit or ripening. The bump-like lesions do have scarred tissue below the epidermis, suggesting that the *Taylorilygus* spp. injects a more powerful enzyme into the fruit than the insects causing the pimple-like lesions.

MATERIALS AND METHODS

Weekly scouting for mirids visiting the avocado flowers was done for the past three seasons to determine their spread and abundance. During the first year coloured sticky cards were used to monitor all the insects that visit the avocado flowers. In that study it was found that a number of mirid species visit avocado flowers and that the pimples caused by their feeding cannot be attributed to one species alone.

RESULTS

Coloured sticky cards

During the 2008 flowering season coloured sticky cards were used to monitor all the insects that visit avocado flowers. White, green, light blue, yellow and red cards were used. Different colours attracted different kinds of insects. In Figure 1 it was found that the Miridae visiting avocado flowers were much more attracted by the red and green cards.

The total amount of heat units (using 12.2ºC as base temperature) over the flowering period correlated well with the number of mirids caught per week.

New method of determining physiological time

Avocado flowering in the South African avocado growing districts occur in the colder May to September period. Most of the larger insect sucking bugs (Pentatomidae and Coreidae) hibernate during the winter period. The minute avocado sucking bug complex (Miridae), however, is very active during this colder period. A new method of calculating physiological time for them was proposed to explain why they are still active whilst the larger insects hibernate. A body surface to volume ratio was used to explain how these small insects quickly gain enough heat early every morning during the winter period to allow them to feed and cause damage to the very small avocado fruitlets.

A new method was proposed using hourly temperature values to calculate the physiological time for those hours that exceed the base temperature. The following formula was used to calculate the physiological time of Miridae during the colder part of the season when temperatures frequently dropped below the base temperature:

$$GDD_{new} = S((H_1 - T_{base})/24, (H_2 - T_{base})/24, \ldots . \ldots . (H_{24} - T_{base})/24)$$

(where all negative values were taken as 0).

Figure 2 shows how this method explains the activity of the smaller insects during the colder periods of the season. The positive heat units from 09:00 to 18:00 allow the insects to be active for most of the day.

Table 1 shows that the new method did not really differ much from the standard method when the total amount of heat units over a time period was compared.

Recording of data in a geographical information system (GIS)

The value of a forecasting system of possible pest outbreaks lies in the timely distribution of weekly scouting data to all the avocado growers in a specific area. If the scout data from various growers in a specific area can be collected on a weekly basis, a very useful distribution map of the pest species can be drawn and sent to those growers.

By using Google Earth™ as a very convenient freeware GIS program, and applying the monitored data with freeware GE-Graph™ software to the Google

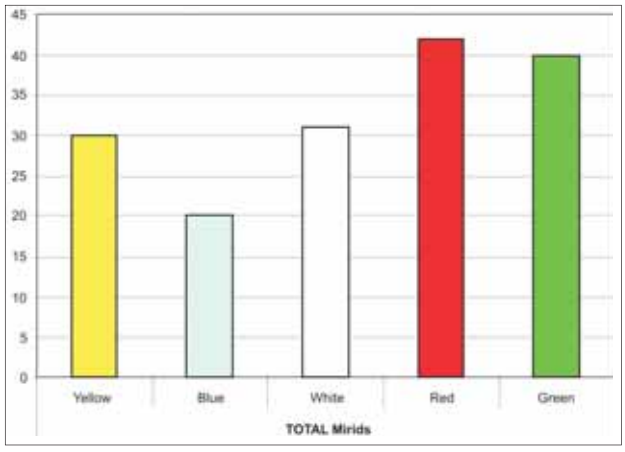

Figure 1. Total number mirids caught on sticky cards during the 2008 avocado flowering period.

Table 1. A comparison of heat units between the standard method of calculation of physiological time and the proposed alternative method.

Number of heat units	Conventional method	New method	Difference
Total for period	110.75	113.93	3.17
Average per day	3.57	3.68	0.10

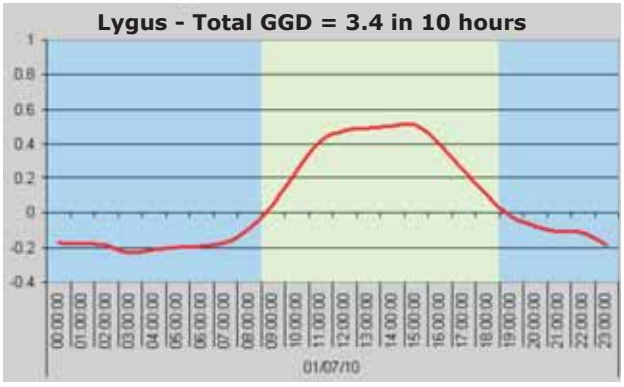

Figure 2. The physiological time for a mirid using an alternative proposed method.

Earth software, it makes it possible to distribute the necessary distribution information regularly to growers via e-mail.

DISCUSSION AND CONCLUSION

The complex minute sucking bugs belonging to the Miridae are causing different types of damage to avocado fruits during the flowering season and just thereafter.

The typical bumps on the avocado skin called "vosknoppe" are caused by a *Taylorilygus* species. The pimple-like lesions that are also found on the skin of avocado fruit, and especially the 'Fuerte' cultivar, are caused by a complex of unidentified mirids.

The damage done by the *Taylorilygus* species is more severe, because it also affects the flesh under the skin of the avocado. The lesions caused by the mirid complex are only pimple-like protuberances on the skin of the fruit.

Monitoring these mirids is important during the whole flowering season. Monitoring with green and red coloured sticky cards has proved to be successful, but a trained scout can also monitor the situation very successful with visual scouting in the mornings from 07:30 to 10:00.

The new way of calculating physiological time showed that small insects have the ability to quickly gain enough heat every morning to be active during the day. Scout data can be applied to forecast the spread of insect pests in an area and also to pre-warn growers to make the necessary precautions in time.

REFERENCES

ALBERTS, A.J. 2004. First report on the identification of possible causes of pimple-like skin protuberances on avocado fruit in the Soutpansberg area. *South African Avocado Growers' Association Yearbook*, 27: 21-31.

ALBERTS, A.J. 2009. Minute sucking bug complex causing pimples on the skin of avocado fruit in the Soutpansberg District. *South African Avocado Grower's Association Yearbook*, 32: 69-72.

BRETT, K. 2008. Early warning system for a devastating pest. *ACIDF Newsletter*, Spring 2008, Issue #19.

DUPONT, F.M.A. & DENNILL, G.B. 1996. An ecological study of the damage done to avocado fruits by citrus leafhopper Penthimiola bella (Cicadellidae) and coconut bug Pseudotheraptus wayi (Coreidae) in South Africa. *International journal of pest management*, 42 No2: 107-112.

DU TOIT, W.J., STEYN, W.P. & DE BEER, M.S. 1993. Occurrence of protrusions on avocado fruit and the causative agent. *South African Avocado Growers' Association Yearbook*, 16: 100-102.

FAO Department of Agriculture and Cooperation, GOI – FAO, 2007. Outline systems requirement to support Pest Surveillance in Agriculture.

ROBERTS, M.J. *et.al.* 2006. The Value of Plant Disease Early-Warning Systems. USDA Economic research report No 18, Apr 2006.

UNITED STATES DEPARTMENT OF AGRICULTURE. 2004. The early warning system for forest health threats in the United States.

Freeware software

GE-Graph: http://www.sgrillo.net/googleearth/gegraph.htm

Google Earth: http://www.google.com/earth/index.html

EarthPlot: http://www.earthplotsoftware.com/