Cercospora spot of avocado – Validation of spray timing: Final results

MH Schoeman[1] and R Kallideen[1,2]

[1]Agricultural Research Council – Tropical and Subtropical Crops,
Private Bag X11208, Nelspruit 1200, SOUTH AFRICA
[2]University of KwaZulu-Natal,
Scottsville, Pietermaritzburg 3201, SOUTH AFRICA

E-mail: maritha@arc.agric.za

ABSTRACT

Cercospora spot of avocados, caused by *Pseudocercospora purpurea,* is one of the most important pre-harvest avocado fruit diseases in South Africa. For the forecasting of spore release and optimum time for the first spray, a forecasting model developed in the early 1980's is currently used. Due to climate change it became crucial to re-evaluate this model. The aim of this study was to determine if the current model is still valid for forecasting the first spray and, secondly, to refine the current model by considering the effect of humidity and/or leaf wetness as determining factors for spore release. In the 2018/19 season (2nd year of study) spore traps were only placed in a high disease pressure unsprayed 'Fuerte' orchard at the Agricultural Research Council-Tropical and Subtropical Crops (ARC-TSC) (Nelspruit area). Spore traps consisted of vaseline coated slides held horizontally. Slides were changed and examined daily and weekly. To determine the critical time for fruit infection, a bagging trial was also carried out at the ARC-TSC site in the 2018/19 season. Fruit were covered with paper bags at the beginning of the season before fruit became susceptible. Every fortnight or monthly, some bags were removed and replaced to allow infection. At harvest, fruit were evaluated for the presence of Cercospora spot. Spore trapping and disease index data were correlated with weather data to develop forecasting models. Several new models were developed to forecast timing of first spray. Humidity and leaf wetness were not found to be significant determining factors for spore release to be included in any model. The current prediction model was found to still be a useful tool to forecast the timing of the first spray, but should be used in combination with monitoring of fruit size.

INTRODUCTION

A model to forecast the number of conidia in a given area (Z value) as well as the optimum timing of the first spray was developed in the early 1980's by Dr JM Darvas (Darvas, 1982). The model is Z (number of conidia) = -58.99 (constant) + 3.22X (X is mean weekly temperature in °C) + 0.18Y (Y is weekly rainfall in mm). The model is currently locally used for deciding on when to commence spraying. Due to the effects of climate change, it became necessary to re-investigate the existing model to determine whether this model is still valid.

Over two seasons (2017/18 and 2018/19) extensive spore trapping data were collected from a high disease pressure unsprayed 'Fuerte' orchard at the ARC-TSC in Mbombela/Nelspruit. Spore trapping data as well as data from a bagging trial were used to better understand the epidemiology of the disease. Weather data were also collected over two seasons and correlated with spore trapping data as well as disease index data.

During the first season various new models were developed using the spore trapping data. The new models were found to follow a very similar pattern during the 2017/18 season as the Z value model, but with a few discrepancies. As was found with the Z value model, rain and temperature are the most important weather parameters determining when spores will be released and when infection periods are expected.

The 2018/19 season was a much drier season, in particular the period September to December. This report deals with a short summary of the 2018/19 season's spore trapping and bagging results. Some data regarding the models developed were omitted from this report as this data will be published, together with the data from this report, in a scientific publication and as part of an MSc thesis. All models developed over the two seasons as well as the Darvas (Z value) model were used to validate spray timing for Cercospora spot.

OBJECTIVE

The objective of the study was to determine if the equation developed by Darvas (1982) is still a valid model for forecasting spore release and the timing of the first spray for effective control of Cercospora

Potassium nitrate

the preferred K and N source

Litchi

Spray Ultrasol® K Plus when fruit development commences (ca. 2 g stage) to increase fruit size

Mango

Spray Ultrasol® K Plus during flowering to increase fruit retention

Avocado

Spray Ultrasol® K Plus with triazol growth retardant during flowering to increase number of fruits

Ultrasol® K Plus

Foliar fertilization is an important tool for the sustainable and productive management of crops:

- When soil conditions limit availability of soil applied nutrients;
- When the stage of plant growth, the internal demand and the environment conditions interact to limit a delivery of nutrients to critical plant organs
- In conditions when high loss rates of soil applied nutrients may occur
- When certain foliar applications are tested and proved to result in measurable and positive plant parameter responses.

- Cronje, R.B. and Mostert, P.G. 2008. A management program to improve yield and fruit size in litchi - third season's report. S.A. Litchi Growers' Assoc. Yearbook 20:6-12.
- Cronje, R.B. and Mostert, P.G. 2009. A management program to improve yield and fruit size in litchi - final report. S.A. Litchi Growers' Assoc. Yearbook 1 21 :6-15.
- Oosthuyse, S.A. 1993. Effect of spray application of KNO_3, urea and growth regulators on the yield of Tommy Atkins mango. S.A. Mango Growers Assoc. Yearbook 13: 58-62.
- Oosthuyse, S.A. 1996. Effect of KNO_3 sprays to flowering mango trees on fruit retention, fruit size, tree yield, and fruit quality. S.A. Mango Growers Assoc. Yearbook 16:27-31.
- Oosthuyse, S.A. and Berrios, M. 2014. Effect of spray and/or soil application of paclobutrazol, and spray application of potassium nitrate during flowering on new shoot growth and cropping of "Mendez" avocado. In proceedings of the 29th Horticultural Congress, Brisbane, August 17-22, 2014 (in press).

SQM AFRICA

Contact details:
Mr. Duncan Napier: (082) 772 2207

E-mail: spn-emea@sqm.com

Registered by: SQM Africa (Pty) Ltd. / Act 36/1947: K5020 N= 130g/kg; P=0g/kg; K=380g/kg

sqmnutrition.com

spot. The second objective was to consider including humidity (RH) and/or leaf wetness (LWet) in the prediction models as a determining factor.

MATERIALS AND METHODS

Spore trapping 2018/19 season

During the 2018/19 season two spore traps were placed in the 'Fuerte' orchard at ARC-TSC from September 2018. Slides were changed weekly on both traps from early October 2018 onwards. In addition, slides were also changed daily from September 2018 to March 2019. For the daily spore trapping, four extra pegs were placed onto both traps also used for weekly spore trapping.

Infection periods
2018/19 Season

During the 2018/19 season, the bagging trial was carried out at the ARC-TSC site. Fruit were covered with brown paper bags from beginning of October 2018 when fruit were not yet susceptible. Every fortnight, 30 bags were removed to facilitate infection and then replaced at the end of the fortnight. Towards the end of the season 20 bags were removed and replaced, as many bags were lost due to November drop and adverse weather storms (hail) experienced during the season. In addition to the two-weekly exposure periods, 30 bags were also opened for a monthly time exposure period.

Fruit were harvested in April 2019 and evaluated for Cercospora spot on a scale of 0-5, where

0 = clean fruit
1 = 1-5 spots with diameter of combined lesion area 1-5 mm
2 = 1-5 spots with diameter of combined lesion area 6-10 mm
3 = 1-5 spots with diameter of combined lesion area >10 mm
4 = 6-10 spots
5 = >11 spots.

RESULTS

2018/19 Season
Weekly spore trapping

Weekly spores trapped at the ARC-TSC site and rainfall from October 2018 – March 2019 are presented in Figure 1.

Very low numbers of spores were detected in the first period starting from 10 October 2018. In the second period from 17-23 October, a high number of spores were trapped. During this period rainfall occurred and spores were trapped, as was found in the 2017 season in periods where rain occurred. On 24 October, average fruit size was 29.7 mm in diameter.

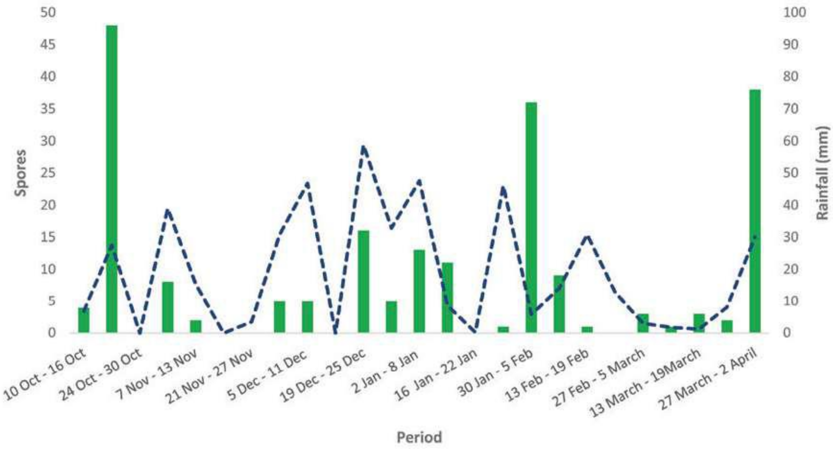

Figure 1: The mean weekly number of spores trapped at the ARC-TSC site and weekly rainfall in the period October 2018 to March 2019

Recommendations by Subtrop are that spraying should commence when the fruit are smaller or equal to 25 mm in diameter. As disease was recorded for the period (10-24 October), infection already took place in this period. In order to have prevented disease development, spraying should have commenced in the period 10-24 October as soon as the fruit are 25 mm in diameter. Spores trapped in the periods 31 October to 6 November and the following period also coincided with periods when rainfall was recorded, as well as in the periods from 28 November to 11 December. Several spore peaks were observed throughout the season following the trend of rainfall, however, as in the 2017/18 season this was not observed towards the end of the season. No spores were trapped in the periods when no rainfall was recorded.

Spores were trapped as late as the last week in March 2019, as was found in the 2017/18 season when spores were trapped in the third week of March. As the fungus has a 3-month latent period, these spores are insignificant for fruit harvested in April. For 'Fuerte' fruit in certain production areas which are only harvested in late June or July, protection of fruit during this period then becomes very important. Producers in these areas tend to stop spraying too early, resulting in severe Cercospora spot on these fruit. The peak at the end of January is important for fruit to be harvested at the end of April, as this falls within the 3-month latent period.

When the weekly conidia trapped were compared with rainfall alone for the period September to December, a much weaker correlation was found in comparison with the previous season. For the entire season, the correlation was even lower. Much less rain was recorded in the 2018/19 season in the period September-December (Sept-Dec) in comparison to the previous season. The highest correlation (negative) for the period Sept-Dec was found with average maximum temperature (Avg MaxT) and average temperature (AvgT). The negative correlation of the air temperature to the number of conidia can be explained by the actual cooling effect of rain, as was found by Darvas (1982).

Daily spore trapping

Daily spores trapped at the ARC-TSC site for a 7-month period from September 2018 to March 2019 are presented in Figure 2. The daily data are presented as weekly counts. As no spores were trapped in September, data from September were omitted from the graph. The general observation was as was found in the 2017/18 season, that spores were predominantly trapped in periods when rainfall occurred.

When daily data presented as weekly counts for Sept-Dec were correlated with weekly weather data, the highest correlation was found between spores and rainfall.

Infection periods

Fruit from the 2018/19 season at the ARC-TSC site were harvested in April 2019 and evaluated for Cercospora spot. The results were expressed in terms of a disease index according to Wheeler (1969), where infection index = (Sum of all numerical ratings/total number of fruit) x (100/Maximum disease category (5)).

The infection indices for the 10 periods, as well as the index for fruit, covered the entire period and fruit exposed the entire period are presented in Figure 3. The highest disease index for Cercospora spot were recorded for fruit opened during the entire period. Of the two weekly exposure periods, highest disease indices were recorded for the period 21 November to 5 December. Weather conditions were, however, favourable throughout the season for infection to occur from the time fruit became susceptible in October. Spores were also available throughout the season, creating high-risk infection periods from the time fruit became susceptible.

The disease index values for the 2018/19 season for each two-week period were correlated with weather data and a disease index model was developed. The highest correlation, although poor, was

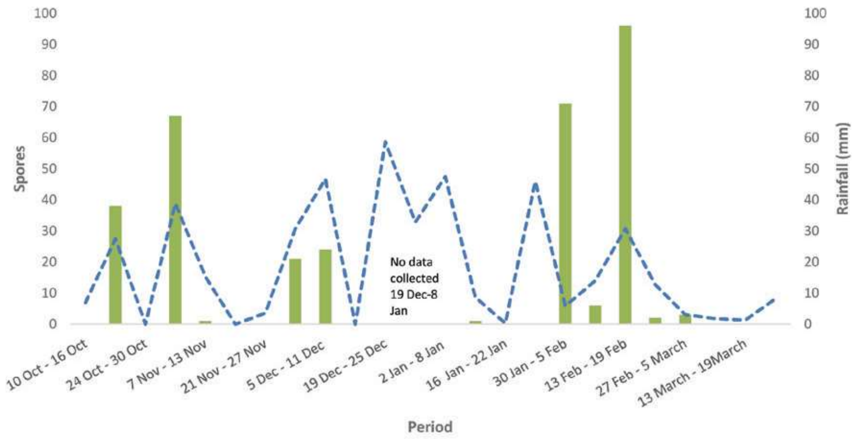

Figure 2: The daily spores trapped at the ARC-TSC site presented as weekly counts and the weekly rainfall in the period October 2018 to March 2019

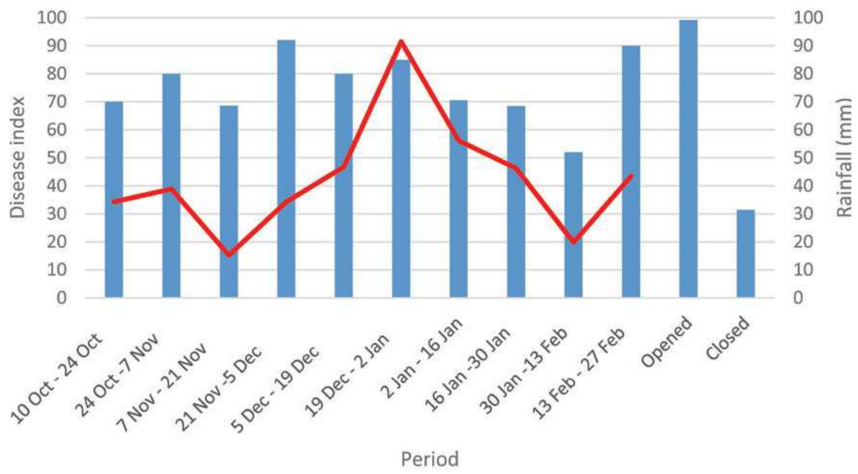

Figure 3: Cercospora disease severity in the unsprayed 'Fuerte' orchard at ARC-TSC (Two-weekly periods)

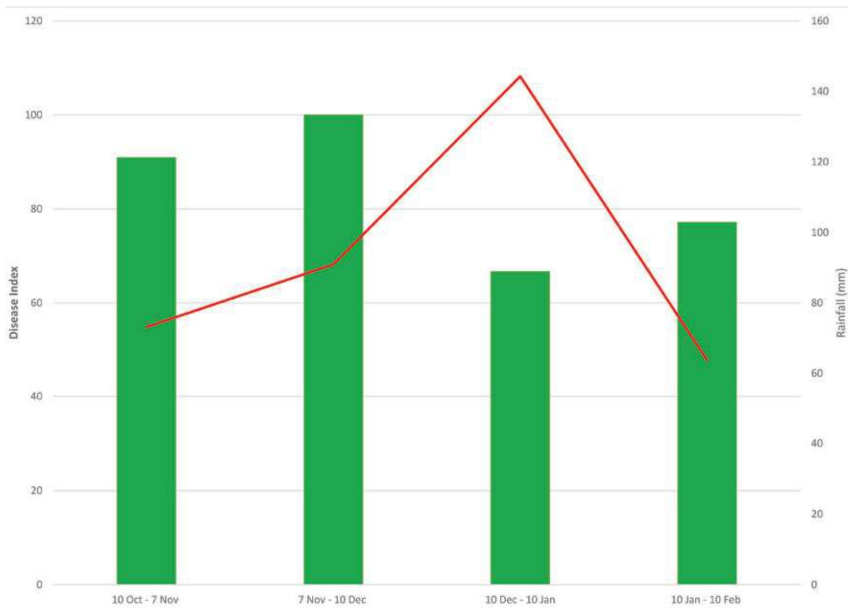

Figure 4: Cercospora disease severity and the monthly rainfall in the unsprayed 'Fuerte' orchard at ARC-TSC (Monthly periods)

between disease incidence and rain. Darvas (1982) also found poor correlation between monthly exposure periods and rainfall, but found good correlations between monthly cumulative exposure periods and rainfall.

The infection indices for the monthly exposure periods for the 2018/19 season at the ARC-TSC site are presented in Figure 4. Exposures on a monthly basis from October to February showed that more infection occurred on fruit exposed in October and November than in January and February. Due to many bags damaged during the season, data could not be obtained for February and March.

Validation of spray timing

From two seasons' data it is clear that the Z value model cannot be used in isolation to determine the timing of the first spray for Cercospora spot control. Fruit size is as important as the Z value and should be used in combination with the Z value to determine commencement of the first spray. Very high temperatures experienced in the last few seasons in September resulted in Z values >15 with no spore release occurring and fruit still very small and not yet susceptible. All models, including the Z value model, showed that temperature and rainfall are the most important weather parameters.

In the 2017/18 season (see 2018 SAAGA Yearbook article) and Table 1, Z>15 on 12 to 17 September and again on 5 October, but at this time fruit were not susceptible, as fruit were still smaller than 25 mm in diameter. The next time the Z value was >15 was in the period 25 October to 1 November, when the fruit were already greater than 25 mm in diameter and spraying should have already commenced. Fruit reached approximately 25 mm diameter size from 10 October and disease was detected on fruit exposed in the period 10-25 October. In the 2017/18 season, the Z value prediction resulted in an accurate prediction if 5 October was used and spraying should have commenced shortly after the 5th of October, as soon as fruit reach 25 mm in diameter, which was around 10 October in the orchard monitored.

In the 2018/19 season the Z value was >15 from 18 to 24 September and again from 27 September to 2 October, but fruit were still smaller than 25 mm and not yet susceptible. No spores were detected in these periods. Fruit were, as was found in the 2017/18 season, approximately 25 mm in this orchard only from 10 October. Spraying on 27 September would have been too early this season in the particular orchard. If the next Z value >15 was used, it would have been too late, as this was on 17 October and at this stage a peak in spore release occurred. Disease was recorded for the period 10-24 October, indicating that infection already took place in that period and protection of fruit was necessary before 10 October.

Several of the other new models developed over the two seasons are as valid as the Z value models in forecasting the timing of the first spray, when used in combination with fruit size. The 2017/18 Sept-Dec model forecast spraying from 4-8 Oct for the 2018/19 season and this corresponds to the Z value model and the fruit size reaching 25 mm in diameter in this orchard around 10 October. The 2018/19 weekly Sept-Dec model predicted spraying after 5 October as soon as fruit reached 25 mm in diameter. The 2018/19 two-weekly model predicted spraying on 14 October. This model also only has temperature as parameter, but did not predict spore release already in September. This prediction was still 4 days before the peak in spore release for the 2018/19 season, which occurred on 17 October. The weekly or daily Sept-Dec model predicted 4-9 October spraying, which also resulted in protection of fruit

Table 1: Comparison of the Darvas model and prediction models developed in the 2017/18 and 2018/19 seasons

Model	Z value above 15	Spores	Fruit size	Disease index
2017/18 season data				
Z value model	12-17 Sept	No spores	<25 mm	No disease
	5 Oct - 1 day	First spores 20- 26 September (4) 27 Sept - 3 Oct (33)	<25 mm	No disease
	25 Oct - 1 Nov	Spores trapped	>25 mm	Disease detected in period 10-24 Oct
2018/19 season data				
Z value model	18-24 Sept	No spores	<25 mm	No disease
	27 Sept - 2 Oct	No spores	<25 mm	No disease
	17 Oct - 1 day	Peak in spores (48) – too late to spray	29.7 mm	Disease detected in period 10-24 Oct
2017/18 Weekly Sept - Dec model	4-8 Oct	No spores	<25 mm	No disease
2018/19 Weekly Sept - Dec model	5 Oct	No spores	<25 mm	No disease
2018/19 Weekly Sept - March	5 Oct	No spores	<25 mm	No disease
2018/19 Two-Weekly Sep - Dec	14 Oct	4 spores already from 10 Oct 4 days before peak in spores of 48 on 17 Oct	>25 mm	Disease detected in period 10-24 Oct
2018/19 Weekly of daily Sept - Dec	4-9 Oct	No spores	<25 mm	No disease

before infection occurring from 10 October. This model uses rain as a parameter and not temperature.

CONCLUSION

Several new models were developed over two seasons and the Z value model was validated. The Z value predicted spore release in September in both seasons, but no spores were trapped at this stage. The reason for this was the high temperatures experienced in September during both seasons and, as temperature is the major parameter in the Z value model, this resulted in Z values above 15. If fruit size are, however, used in combination with the Z value, the model can still be a useful model to forecast timing of first sprays. New models developed follow the same trend as the Z value model and some also predicted spore release in September without any spore release, as this is also due to very high temperatures and temperature also being one of the parameters used in the models. The currently used Z value model was found to be as accurate as the new models developed if used in combination with fruit size and spraying should commence when the model value are ≤15 and the fruit size ≤25 mm.

REFERENCES

DARVAS, J.M. 1982. Etiology and control of some fruit diseases of avocado (*Persea americana*) at Westfalia Estate. D.Sc. (Agric) thesis, University of Pretoria, South Africa.

WHEELER, B.E.J. 1969. An introduction to plant diseases p 301. John Wiley & Sons Ltd, New York.