Soil health, fruit yield, quality and nutritional value of avocado as influenced by different mulch types: Preliminary results

B Nzanza and P Pieterse

Natuurboerdery Research Centre, ZZ2-Bertie van Zyl
Mooketsi 0825, South Africa
E-mail: zz204@telkomsa.net

ABSTRACT
Field experiments were initiated in 2010 at ZZ2-Bertie van Zyl Farms on two orchards located in Politsi and Mooketsi. The aim of the study was to investigate the influence of mulch types on soil health, yield, quality and nutritional value of avocado. The four treatments, *viz*. grass, eucalyptus chips, composted chips mulch and an untreated control, were arranged in a completely randomised design with three replications. Each treatment consist of three replications with 15 trees in each. Soil samples were analysed using the Cornell soil health assessment test (chemical, physical and biological attributes) prior to the start of the trial. Soil moisture fluctuations were recorded using DFM continuous logging probes. The paper presents baseline assessment of soil health in the two locations. Preliminary results on moisture regime are also presented.

INTRODUCTION
Mulching, which is described as the application of any layer of plant or other suitable organic material to the surface of the soil, has been used to manage root-rot diseases in avocado (Wolstenholme *et al*., 1996) and improve physical, chemical and biological characteristics of soil. Mulch application improves soil biological characteristics by supporting a large and more diverse population of micro organisms, which on its turn inhibits development of harmful soil pathogens, particularly *Phytophtora* species (Broadbent & Baker, 1974; Downer *et al*., 2001). The influence of mulch on soil physics include decreased water run-off, reduced compaction and therefore improved soil permeability and improved soil water holding capacity (Tuney & Menge, 1994). The decomposition of organic mulch further results in the release of plant nutrients in a readily available form (Wolstenholme, *et al*., 1996).

The Cornell Soil health concept involves integrating and optimising the biological, chemical and physical properties of the soil (Gugino *et al*., 2009). The aim of this study was to investigate the influence of different mulch types on soil health and yield, as well as the quality and nutritional value of the fruit. Baseline information with respect to soil health assessment of the two locations prior to the trial onset is reported.

MATERIALS AND METHODS

Study location
This trial was laid out on ZZ2-Bertie van Zyl (Pty) Ltd Farms in Politsi and Mooketsi using three-year old 'Hass' on clonal Duke7 and Dusa rootstocks. The trees were planted with a spacing of 10 x 5 resulting in a stand of 200 trees per ha. Politsi is characterised by high annual rainfall (> 1000 mm), whereas the total precipitation received at Mooketsi was less than 650 mm. Mean monthly maximum and minimum temperatures for the past year at Politsi were 29˚C and 18˚C, respectively, whereas at Mooketsi temperatures were and 27˚C and 15˚C, respectively. At Politsi the soil is classified as clay (clay 45%, sand 36% and slit 19%), whereas at Mooketsi the soil is classified as a sandy loam (71% sand, 24% clay and 4% silt).

Experimental design and treatments
Treatments were arranged in a completely randomised design with three replications consisting of 15 trees per replication. A total of four treatments was used: three mulch treatments, *viz.* grass, eucalyptus chips and composted chips and a control. The mulches were applied in strips of approximately 3 m wide to a thickness of 15 cm, covering the whole area between and under the trees up to 20 cm from the stem.

Data collection
Soil samples were collected at depth of 30 cm and sent to ZZ2-Laboratories, Polokwane, South Africa. The Cornell soil health test (**Table 1**) consisted of 32 potential indicators of which 12 were selected for

soil health baseline assessment. The choice of the 12 tests were based on cost, sensitivity to soil management and consistency (Gugino *et al*., 2009). Cornell soil health scoring functions were applied for individual indicators (Andrew *et al*., 2004) and expressed on a percentage scale (Gugino *et al*., 2009).

The amount of ready available water (RAW) was measured with DFM continuous logging probes (**Figure 1**-**2**). The probes measure water availability in three zones, *viz*. top root (10 and 20 cm), root (10, 20 and 30 cm) and buffer (40, 60 and 80 cm). On the graph, root zones are subdivided into three colour strips. The blue strip represents free water (too wet). The green strip represents the withdrawal of RAW between 0 and 50%, whereas the brown strip is the withdrawal of 50 to 100% of the RAW. The spikes in the top three graphs indicate wetting instances (irrigation and rainfall). The graphs at the bottom of the figure illustrate the rainfall (pink bars) and evapotranspiration (green line).

PRELIMINARY RESULTS

Preliminary results, before mulch application, showed that soils from Politsi and Mooketsi have an overall soil health score of 57% and 47%, respectively. The low soil health scores in both locations were due to low biological index (32%) in Politsi and very low biological (23%) and physical (23%) indices in Mooketsi (**Table 2**). The low soil biological score observed in both locations were due to very low active carbon content (7% and 4%, respectively). Active carbon is an indicator of soil organic matter that is readily available as an energy source for the soil microbes (Gugino *et al*., 2009).

Substantial differences in soil physical score between Politsi (71%) and Mooketsi (23%) were due

Table 1. Thirty-two potential indicators evaluated for use in the soil health assessment.

Biological	Chemical	Physical
1. Active carbon	12. pH	24. Bulk density
2. Carbon	13. Cation exchange capacity	25. Available water capacity
3. Potential mineralisable nitrogen	14. Potassium	26. Penetration resistance
4. Beneficial nematode population	15. Magnesium	27. Dry aggregate size (<0.25 mm)
5. Parasitic nematode population	16. Calcium	28. Dry aggregate size (0.25-2 mm)
6. Root health assessment	17. Phosphorus	29. Dry aggregate size (2-8 mm)
7. Total fungi	18. Sodium	30. Stone fraction
8. Total bacteria	19. Iron	31. Subsurface hardness
9. Flagellates	20. Zinc	32. Surface hardness
10. Amoeba	21. Copper	
11. Ciliates	22. Boron	
	23. Manganese	

Table 2. Soil health baseline assessment of the two sites.

PARAMETERS	SITE A		SITE B	
	Value	Scoring	Value	Scoring
BIOLOGY				
Active carbon (mg/kg)	59.1	7%	34.4	4%
Carbon (%)	0.96	32%	0.48	16%
PMN (μN/g/wk)	5.24	45%	6.52	56%
Root health – Bean (score 1-9)	4.24	42%	1.5	15%
		32%		23%
PHYSICS				
Aggregate stability (%)	68.6	69%	9.6	10%
Available water (mm/m)	141	71%	110	55%
		70%		23%
CHEMISTRY				
pH (KCl)	5.6	70%	7.3	100%
P (Bray II) (mg/kg)	6	30%	39	70%
K (mg/kg)	174	60%	278	70%
Ca (mg/kg)	542	60%	1600	50%
		73%		81%
SOIL HEALTH SCORE:		**57%**		**47%**

to differences in aggregate stability between the two locations. Politsi had 69% in aggregate stability as compared to 10% in Mooketsi. According to Kemper and Koch (1966), aggregate stability increases as the clay content increases. Politsi had 45% clay content as compared to 24% in Mooketsi. Soil aggregates and their stability have a strong influence on characteristics such as infiltration, aeration, erosion and the soil's ability to transmit liquids, solutes, gases and heat (Topp *et al*., 1996).

Preliminary observations on the effect of mulch on soil moisture fluctuations showed a marked difference

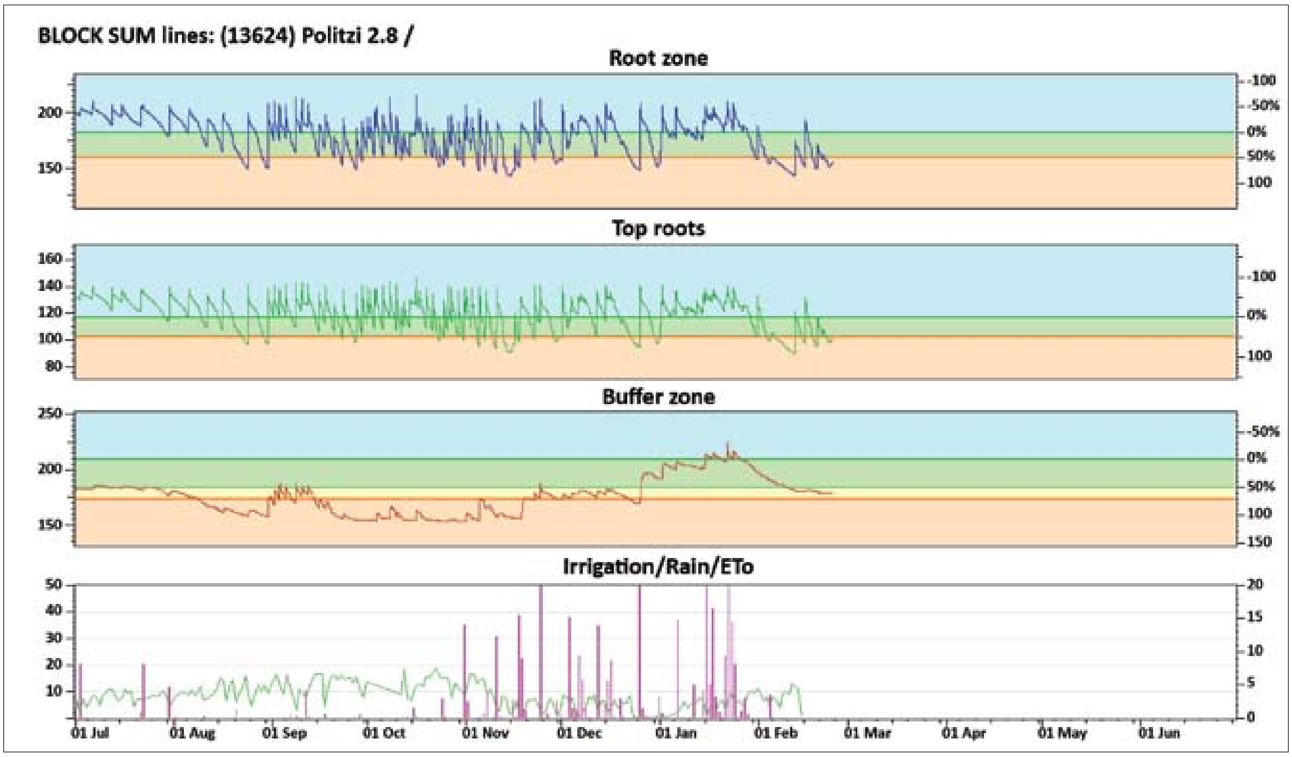

Figure 1. The amount of ready available water (RAW) over time in the soils of the control plot in a three-year old 'Hass' orchard at Politsi.

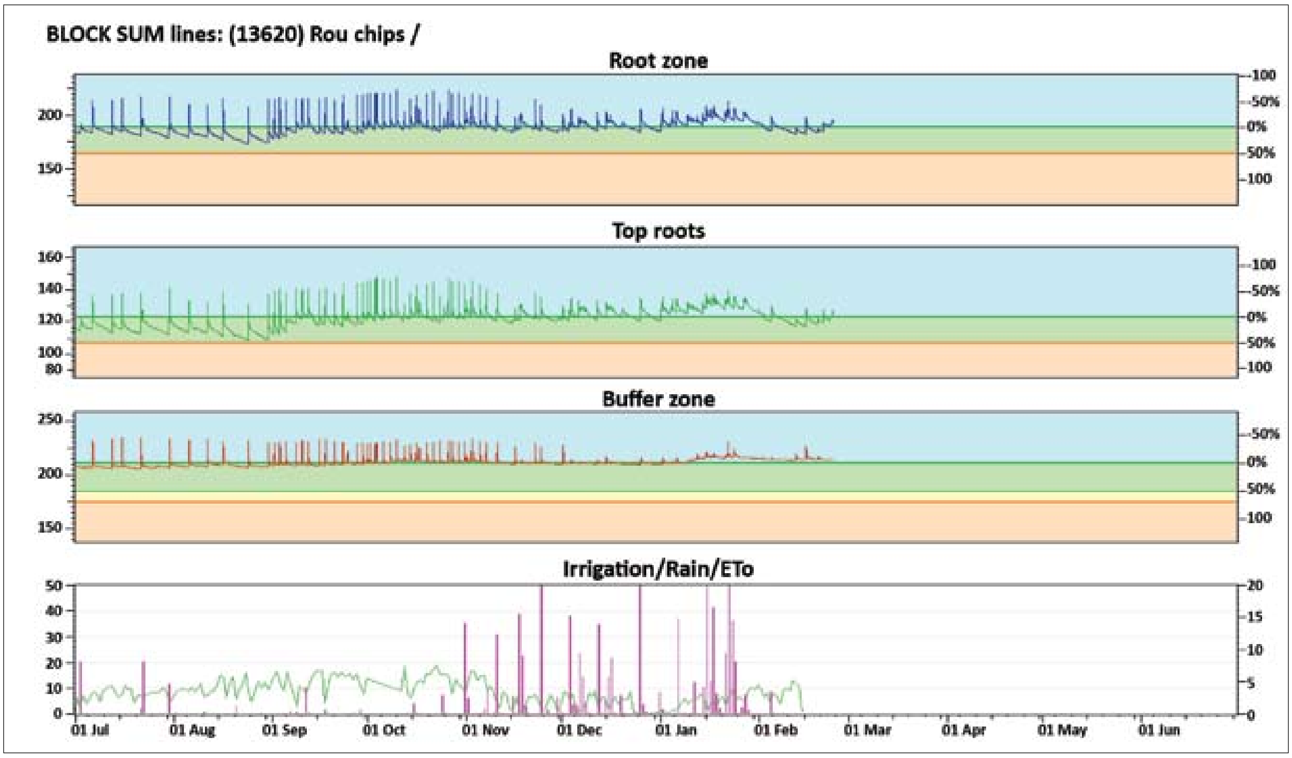

Figure 2. The influence of eucalyptus chips on the ready available water (RAW) in the soils of a three-year old 'Hass' orchard at Politsi.

between mulch-treated and control. Here, we only showed the differences between eucalyptus mulch and control in Politsi. Generally, mulch treatment (**Figure 2**) showed little soil moisture fluctuations, in comparison with the control treatment (**Figure 1**). These preliminary findings suggest that mulch created a more mesic environment underneath the tree. Similar results were observed in both locations with different mulch treatments (Data not shown).

CONCLUSION

Preliminary results, before mulching, indicated that soil from the two locations had a 10% difference in soil health score. Substantial soil health data will become available in near future. This will be used to establish the trend and compare changes in soil health due to mulching.

ACKNOWLEDGEMENTS

The authors thank the South African Avocado Growers' Association and ZZ2-Bertie van Zyl (Pty) Ltd for financial support of this project.

LITERATURE CITED

ANDREWS, S.S., KARLEN, D.L. & CAMBARDELLA, C.A. 2004. The soil management assessment framework: A quantitative soil quality evaluation method. *Soil science of America Journal,* 68: 1945-1962.

BROADBENT, P. & BAKER, K.F. 1974. Behaviour *of Phytophtora cinnamomi* in soils suppressive and conducive to root rot. *Australian Journal of Agricultural Research,* 25: 121-137.

DOWNER, J., MENGE, J.A., OHR, H.D., FABER, B.A., MCKEE, B.S., POND, E.C., CROWLEY, M.G. & CAMPBELL, S.D. 2001. The effect of yard trimmings as mulch on growth of avocado and avocado root rot caused by *Phytophtora cinnamomi*. Yearbook California Avocado Society, 83: 87-104.

GUGINO, B.K., IDOWU, O.J., SCHINDELBECK, R.R., VAN ES, H.M., WOLFE, D.W., MOEBIUS-CLUNE, B.N., THIES, J.E. & ABAWI, G.S. 2009. Cornell Soil Health Assessment Training Manual. Cornell University, New York, USA.

TOPP, G.C., REYNOLDS, W.D., COOK, F.J., KIRBY, J.M. & CARTER, M.R. 1996. Physical attributes of soil quality. In: Gregorich, E.G., Carter, M.R.Ž. Eds., Soil Quality for Crop Production and Ecosystem Health. Elsevier, Amsterdam, pp. 21-58.

TURNEY, J. & MENGE, J. 1994. Root health: mulching to control root disease in avocado and citrus. California Avocado Society Circular No. CAS-94/2.

WOLSTENHOLME, B.N., MOORE-GORDON, C.S. & ANSERMINO, S.D. 1996. Some pros and cons of mulching avocado orchards. *South African Avocado Growers' Association Yearbook*, 19: 87-91.