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Mulching of Avocado Orchards to Increase Hass Yield and Fruit Size and Boost Financial Rewards a Three Season Summary of Research Findings

C Moore-Gordon • A K Cowan • B N Wolstenholme
Department of Horticultural Science, University of Natal, Private Bag X01, Pietermaritzburg 3209

ABSTRACT

Avocado yields are low when compared to other fruit tree crops, and the Hass cultivar, specifically, possesses an inherent tendency to produce a high percentage of small fruit. The application of thick composted pine bark mulch was investigated as a strategy to increase yield and to alleviate the small fruit problem in this cultivar. Mulched trees showed more prolonged and extensive root growth throughout the duration of the trial. Over three seasons, mulching elevated average fruit yields by 22,6%, and increased mean fruit mass by 6,6%.The number of fruit that were considered highly suitable, and acceptable for export, were increased by 45% and 20% respectively. Initial costs of the pine bark were off-set within two seasons, thus providing growers with a practical means of boosting financial returns, especially since pine bark is considered to have a half life of approximately five years.

INTRODUCTION

Avocado yields are low when compared to other fruit crops (Wolstenholme, 1986). In the Hass cultivar, problems of low fruit productivity are intensified by its inherent tendency to produce large numbers of small fruit (Kremer-Köhne & Köhne, 1995). There is poor consumer acceptance for small fruit on the overseas market, and since the South African avocado industry is predominantly export orientated, yearly financial losses by the industry are considerable. There is thus a need to find solutions to these problems, as potential financial rewards to producers could be substantial.

The long-term approach is to breed or select a new high yielding, large-fruited and black-skinned cultivar. Unfortunately, breeding programmes are time consuming and thus there is a need for an interim solution. Mulching with composted pine bark was investigated as a strategy to at least partly alleviate the extent of the problem. This strategy is based on the avocado's rainforest origin and adaptation to soils with a litter layer and a high humic content. Reinforced mulching (in addition to natural litter fall) simulates rainforest floor conditions, thus providing roots with improved and more natural edaphic growing conditions. It also alleviates several aspects of environmental stress.

The benefits derived from mulching include increased water and nutrient availability

(Gregoriou & Rajkumar, 1984), improved soil structure and porosity (Gallardo-Laro & Nogales, 1987) and a narrowing in the diurnal soil temperature range (Gregoriou & Rajkumar, 1984). In addition, mulching creates a suppressive environment for *Phytophthora cinnamomi* thus reducing the impact of this phytopathogen (Turney & Menge, 1994). All of these benefits of mulching, together with an adequate assimilate/nutrient supply, sustain fruit growth and development and reduce the incidence of small fruit by reducing the confounding effects of either stress-induced abscisic acid (ABA) accumulation and/or feedback regulation of photosynthesis. Mulching would be expected to increase the proportion of growth promoting hormones (especially cytokinins) relative to inhibitors (ABA), and seed coat viability would therefore be maintained and prolonged. This is known to be critical in permitting the fruit to continue rapid growth, through maintaining anatomical and physiological connections between fruit flesh and the seed (Blumenfeld & Gazit, 1974). Likewise, the incidence of pedicel 'ring neck' which may occur due to elevated xylem ABA levels (Adato & Gazit, 1976), would be reduced in healthy, non-water stressed trees (Whiley *et al,* 1986).

The objective of this research was to investigate whether mulching could be a practical cultural method of increasing mean Hass fruit size and overall yield through improved root activity, and to assess whether this practice was a commercially viable option available to growers. The authors have reported on the first two seasons results (Moore-Gordon *et al,* 1996). This paper summarizes results for a full three seasons.

MATERIALSAND METHODS

The study was conducted using six-year-old (in 1993) Hass trees on clonal Duke 7 rootstocks at a spacing of 7m x 7m. A total of 1,5m^3 per tree of coarse composted pine bark (Gromed® coarse potting mix) was applied in February 1993 under the canopy of six trees to a depth of approximately 15cm, and these trees were compared to six adjacent unmulched trees (figure 1). No additions were made to this mulch during the three year duration of the trial.

At harvest, fruit size distributions were determined for each tree and classified according to the number of fruit per standard 4 kg export carton. Total tree yields were calculated by adding the product of the number of fruit per count size and the class centre of all the count sizes.

To determine the effect of pine bark mulching on export potential, fruit was classified into three broad categories:

Highly suitable for export:	Counts 14 – 18
Acceptable for export:	Counts 10 – 12; 20 – 22
Not suitable for export:	Counts ≥ 24

For the breakdown of costs and financial rewards of the pine bark mulch, the following assumptions were made:

- 65% of fruit in the count size range of 10 22 were exported.
- Yearly mean on farm returns per hectare were used for the calculations.
- Labour costs of application were not taken into account.
- Potential savings on water and fertilizer bills were not taken into account.

It is important to remember that the cost of transport will obviously vary with distance from source.

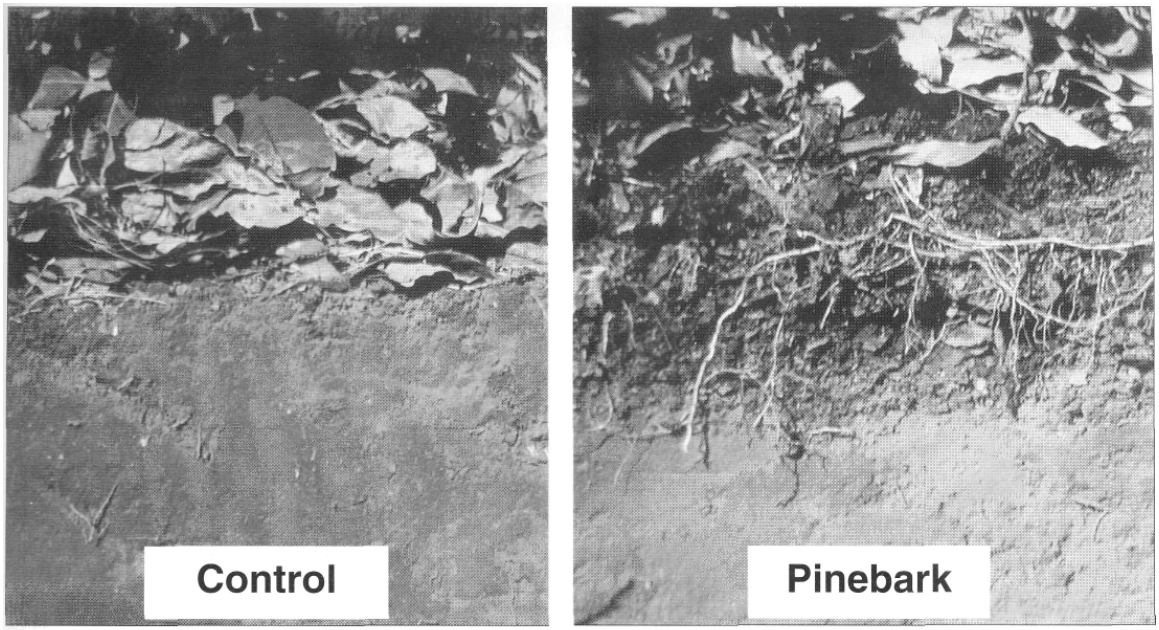

Figure 1
The composted pinebark mulch and control treatment

RESULTS AND DISCUSSION

Control (unmulched) trees show a typical fruit size distribution of the Hass cultivar with many fruit in the count size range of 22 to 26, and a high proportion of factory grade avocados (figure 2). Mulching with pine bark had the effect of shifting the overall count size distribution in favour of large fruit (figure 2). Overall fruit productivity was significantly ($P < 0,01$) increased by mulching with composted pine bark, and this positive response was achieved in three successive seasons (table 1). Over the three year duration of the trial, mulched trees produced an average of 22,0 ± 1,2 kg more than control trees, representing a 22,6 % increase in yield. Harvest results also confirmed the biennial bearing nature of cropping in avocado trees. A heavy crop in 1993/1994 was followed by a relatively light crop in 1994/1995, with high yields for the following season (table 1). Assuming that assimilate supply to growing fruit in a season of low yield is limiting, any improvement in resource accumulation and distribution to developing fruit as a result of mulching should considerably enhance fruit productivity.

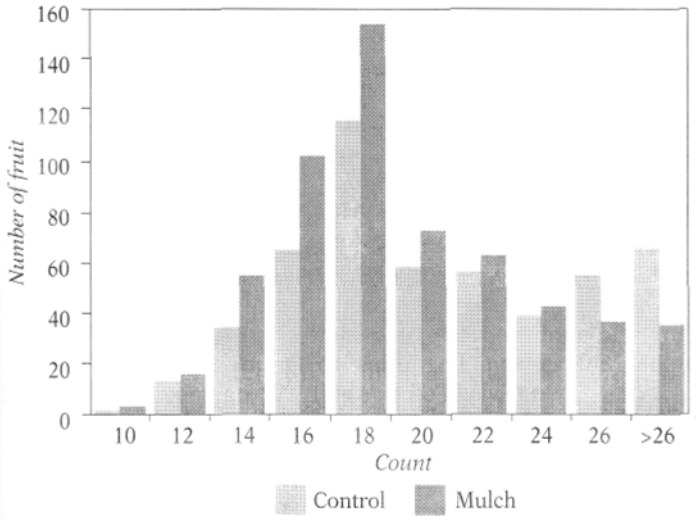

Figure 2
Mean Hass fruit size distribution at harvest. Values are expressed as a mean for each tree averaged over three seasons

Table I
Summary of the effects of pinebark mulching on Hass avocado fruit quality and quantity

	Control	*Mulch*	*Percentage increase*
1993/1994			
Mean fruit mass (g)	198,0	221,3	11,8**
Yield (t ha^{-1})	21,2	23,8	18,5**
1994/1995			
Mean fruit mass (g)	178,2	199,2	11,8**
Yield (t ha^{-1})	9,4	13,4	42,2**
1995/1996			
Mean fruit mass (g)	216,1	220,4	2.0
Yield (t ha-1)	31,7	35,8	18,9**
Overall			
Mean fruit mass (g)	203,1	216,5	6,6**
Yield (t ha^{-1})	20,0	24,4	22,6**

Data are means of six trees.
**denotes a significant ($p \leq 0,01$) increase in response to mulching

Mulching also resulted in fruit size being significantly ($P < 0,01$) increased by an average 13,4 ± l,2g, and this was achieved in spite of the increase in the number of fruit per tree. This response is particularly significant since problems of fruit size principally arise in trees with heavy crops (Lahav & Kalmer, 1977), as resources available for fruit growth have to be allocated to more sinks. A 12% increase in fruit mass in the first

season was achieved despite a yield of over 20 t ha-^{1} in control trees and nearly 24 t ha-^{1} in mulched trees. A similar 12% increase in fruit size was obtained in the second season of low yield (9,4 t ha-^{1} and 13,4 t ha ' in control and mulched trees respectively). Only in the third season of a very high yield (30,2 t ha-' and 35,8 t ha-^{1} respectively), was fruit size not significantly increased. To have maintained an excellent mean fruit size in this season, despite the high yield, was nevertheless remarkable.

Since the South African avocado industry is predominantly export orientated, it would be extremely beneficial to increase the proportion of export quality fruit. The increase in mean fruit mass coupled with elevated yields in response to mulching resulted in an increase in the number of fruit that meet export requirements for fruit size (table 2). Over the three season duration of the trial, mulching increased the number of fruit that are considered highly suitable for export (counts 14 18) by 45%, and in addition the number of fruit that are acceptable for export (counts 10-12; 2022) by 20%. During the same period the number of fruit that are deemed unsuitable for export was reduced by 29% in the mulch treatment (table 2).

Table2

Summary of the effects of pinebark mulching on export potential related to fruit size

	Control	*Mulch*	*Percentage increase*
1993/1994			
Suitable	200	344	+ 72,0
Acceptable	152	145	- 4,6
Not suitable	157	51	- 67,5
1994/1995			
Suitable	53	117	+ 120,8
Acceptable	71	114	+ 60,6
Not suitable	138	102	- 26,1
1995/1996			
Suitable	374	447	+ 19,5
Acceptable	152	190	+ 25,0
Not suitable	172	177	+ 2,9
Overall			
Suitable	209	303	+ 45.0
Acceptable	125	150	+ 20.0
Not suitable	155	110	- 29.0

Counts 14-18 were considered to be highly suitable for export; counts 10-12 and 20 22 were considered to be acceptable for export; and counts > 24 were considered not to be suitable for export. Figures are mean numbers of fruit per category per tree. Figures preceded by a positive sign indicate an increase by mulching, and figures preceded by a negative sign indicate a decrease by mulching.

The increased yield and mean fruit size coupled with improved export potential as a

result of mulching, means that financial rewards to avocado producers could be considerably boosted, although costs of the mulch would have to be off-set. Considering that the half-life of composted pine bark is regarded as five years (Wolstenholme *et al,* 1996), and that the initial costs of the pinebark were off-set within two seasons (table 3), the application of pine bark or similar mulches provides avocado growers with another option of increasing profitability.

CONCLUSIONS

Although yield and fruit size are under the control of many interacting factors, and crop failures can be caused by climatic extremes and poor flowering, *inter alia,* this study has shown that mulching, through creating a more mesic root environment and reduced environmental stress, has the potential to substantially increase avocado yield and Mass fruit size. The practice of mulching thus presents avocado producers with an option to increase financial rewards, although cost of the mulch would have to be off-set. Choice of mulch must take into account factors such as cost, availability, C:N ratios and speed of breakdown. The initial expense of the coarse composted mulch used in this trial was off-set by a long life (the half-life is approximately five years), and greatly improved tree performance. It should be noted that these results were obtained in a relatively low stress (more mesic) environment and in a well managed orchard. Benefits of mulching might be greater under more stressful growing conditions.

Table 3
Breakdown of costs of and extra revenue generated by the application of a pinebark mulch

1993/94 Cost of pinebark + transport = R26 300 / ha (-R26 300)

Return / ha (On farm)

	Control	Mulch	Extra revenue	
1993/94	R34 700	R47 800	R13 100	(-R13 200)
1994/95	R16 300	R30 100	R13 800	(+R600)
1995/96	R70 500	R85 400	R14 900	(+R15 500)

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REFERENCES

ADATO, I. & GAZIT, S. 1976. Response of harvested avocado fruits to supply of indole-3-acetic acid, gibberellic acid and abscisic acid. *Agric. Food Chem.* 24: 1165 - 1167.

BLUMENFELD, A. & GAZIT, S. 1974. Development of seeded and seedless avocado fruits. *J. Amer. Soc. Hort. Sci.* 199: 442 - 448.

GALLARDO-LARO, F. & NOGALES, R. 1987. Effects of application of town refuse compost on the soil-plant system: a review. *Biol. Wastes* 19: 35 - 62.

GREGORIOU, C. & RAJKUMAR, D. 1984. Effect of irrigation and mulching on shoot and root growth of avocado (*Persea Americana* Mill.) and mango *(Mangifera indica* L.). *J. Hort. Sci.* 59: 109 - 117.

KREMER-KÖHNE, S. & KÖHNE, J.S. 1995. Approaches to solving the small Hass fruit problem: progress report. *South African Avocado Growers' Association Yearbook* 18: 59 - 60.

LAHAV, E. & KALMER, D. 1977. Water requirements of avocado in Israel. II. Influence on yield, fruit growth and oil content. *Amt. J. Agric. Res.* 28: 869 - 877.

MOORE-GORDON, C., WOLSTENHOLME, B.N. & LEVIN, J. 1996. Effect of composted pine bark mulching on *Persea Americana* Mill. Cv. Hass fruit growth and yield in a cool subtropical environment. *J. S. Afr. Soc. Hort. Sci.* 6: 23 - 26.

TURNEY, J. & MENGE, J. 1994. *Root health: mulching to control root diseases in avocado and citrus.* University of California, Riverside circular CAS 94/2.

WHILEY, A.W., PEGG, K.G., SARANAH, J.B. & FORSBERG, L.I. 1986. The control of *Phytophthora* root rot of avocado with fungicides and the effect of this disease on water relations, yield and ring neck. *Austr. J. Exp. Agric.* 26: 249 - 253.

WOLSTENHOLME, B.N. 1986. Energy costs of fruiting as a yield limiting factor with special reference to avocado. *Acta Hort.* 175: 121 - 126.

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