Avocado orchard soil surface crusting and PAM

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ABSTRACT
Optimal water use for irrigation is becoming very important. Soil crusting in avocado orchards inhibit sufficient water infiltration, water uptake by roots and enhances water loss through erosion. The alleviation of these soil crusts can improve water infiltration, root water uptake and decrease water loss through surface run-off and erosion.

KEYWORDS
Soil crusting, avocado orchard, Polyacrylamide, water use, irrigation

OBJECTIVES
- The use of Polyacrylamide for the alleviation of soil crusting in avocado orchards.
- Increasing water infiltration and decreasing soil crust strength with the use of Polyacrylamide.

INTRODUCTION

Studies on the influence of Phosphogypsum (PG) and a combination of PG and Polyacrylamide (PAM) on the water run-off, amount of water stored in the soil and yield and water use efficiency were determined by Stern, Van der Merwe, Laker & Shainberg (1992). In this study, PG and PAM were applied together in order to flocculate the soil colloids and improve the soil structure. Flocculation of the soil colloids is necessary for PAM to form stable aggregates. This was done under sprinkler irrigation. This study proved that PAM was efficient and created beautiful soil aggregates, whereas the soil surface at the control was sealed.

More water was already stored in the soil after the second irrigation with PAM, compared to the control. This increased substantially after the third, fourth and fifth irrigation. Because of the greater amount of water which infiltrated after each irrigation, the wheat roots in the PG treatment absorbed 24% more water, compared to the control. With the PAM (plus PG) treatment, 51% more water was absorbed, compared to the control. With PG, the wheat yield was 6% higher and with PAM (plus PG), 42% higher compared to the control. It must be remembered that all treatments received the same amount of irrigation. With PG, the irrigation water-efficiency was 17% higher and with PAM, (plus PG) 45% higher than the control. PAM was applied to the soil in a spray solution at 20 kg/ha.

With crops like, for example, fruit, nuts and grapes, it may not necessary be about increased yield, but to get the same result (crop yield) with less water. An increased yield was realised with the alleviation of a soil crust with a soil conditioner in a citrus orchard under micro-irrigation, without the application of gypsum. This was because the soil contained enough salts. Gypsum alone had absolutely no effect.

In field studies on the effect of soil conditioners and mulch on run-off from kaolinitic and illitic soils (Stern, Laker & Van der Merwe, 1991), PAM (plus PG) again increased water infiltration and decreased run-off losses significantly, compared to the control. In these trials it was found that even an application of 5 kg PAM/ha was efficient, and that the standard application of 20 kg/ha was not necessarily needed. An article on this study ended with the following: "*The relatively low rates of the material required and the option of applying PAM solution through an irrigation system holds merit for use in practice. Further research on rates and methods of PAM application in the field is needed*".

Much research was done in the 1950/60s with soil conditioners in order to improve soil structure and/or to stabilise structure. The research was successful. Unfortunately, it was very expensive because large amounts needed to be applied in order to stabilise the whole plough layer. In the 1970s, the Water Research Commission also funded a study in regard to this, but with relatively poor results, although the Polyvinyl acetate (PVA) in the laboratory increased the water stable aggregates from 2% to 45%. It must be noted that it was PVA and not PAM, and the objective of the study was not to alleviate the soil crust. This study was done by Botha, Bennie & Burger (1979).

MATERIALS AND METHODS

Trial sites were selected in an avocado orchard in the Brondal area, outside Nelspruit in Mpumalanga. These trial sites all represented sites with serious soil crusting. Nine applications were done in triplicate (Table 1). The results were subjected to ANOVA and Fischer (LSD) t-test at a 95% confidence interval, using GenStat 64-bit release 17.1.

Table 1. Treatments applied during the experiment.

	Treatment	Concentration (g/m²)
T1	Control	0.0
T2	PAM	0.5
T3	PAM	1.0
T4	PAM	2.0
T5	PAM dry	2.0
T6	PAM	0.5
T7	PAM	0.5
T8	Commercial compost	2.0 litre/m²
T9	Humic acid (HA)	2.0 ml/m²

RESULTS AND DISCUSSION

Water infiltration rate

Results indicate significant differences between all treatments, with compost's water infiltration rates significantly higher than all PAM treatments (Fig. 1, Table 2). Water infiltration rate also increased significantly with higher PAM applications, in the order 20 kg/ha > 10 kg/ha > 5 g/ha.

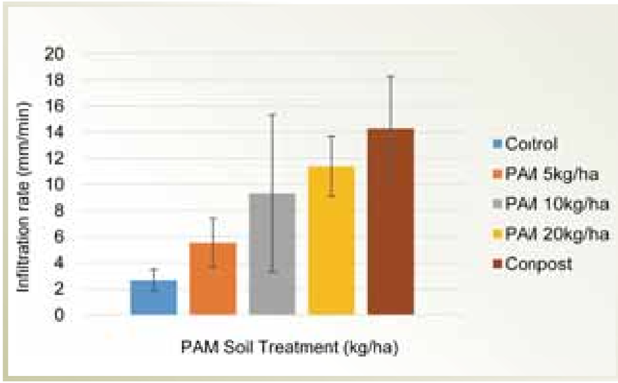

Figure 1. Water infiltration rate vs. Soil treatment.

Table 2. Water infiltration rate vs. Soil treatment.

Treatment	Mean Least Significant Difference (LSD)*
Compost	15.360a
PAM (20 kg/ha)	11.387ab
PAM (10 kg/ha)	9.323bc
PAM (5 kg/ha)	5.547cd
Control	1.613d

* Mean LSD values with the same letter do not differ significantly, while those with different letters differ significantly at the 5% level of significance

Crust strength

Results of soil crust strength indicated statistically significant differences between the control and all PAM treatments (Fig. 2, Table 3). Statistically significant differences also occurred between the control and the compost, compost/PAM and PAM/HA treatments. However, compost, PAM/compost performed the best, with PAM (20 kg/ha) the best PAM treatment.

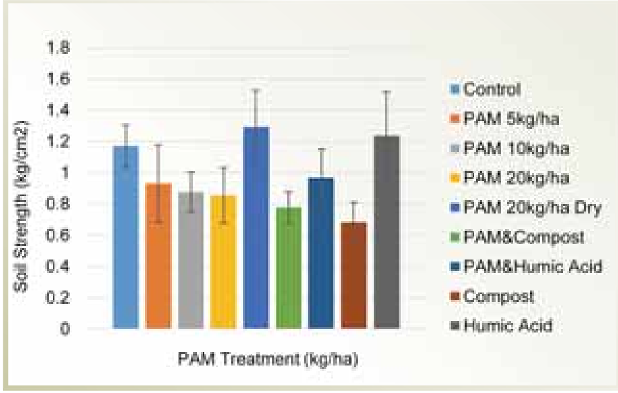

Figure 2. Crust strength vs. Soil treatment.

Table 3. Soil crust strength vs. Soil treatment.

Treatment	Mean Least Significant Difference (LSD)*
PAM (20 kg/ha coarse)	1.2986a
Humic acid (HA)	1.2433ab
Control	1.1700ab
PAM & HA	0.9680abc
PAM (5 kg/ha)	0.9118abc
PAM (10 kg/ha)	0.8767bc
PAM (20 kg/ha)	0.8546bc
PAM & compost	0.7590c
Compost	0.6825c

* Mean LSD values with the same letter do not differ significantly, while those with different letters differ significantly at the 5% level of significance

Treatment costs

When comparing the treatment costs of the different soil treatments, HA costs the least per unit but had also the least effect on alleviating soil crusts (Table 4). Compost costs the most per unit although performing the best with alleviating soil crusts, with PAM treatments costing the least per unit but performing very good with alleviating soil crusts.

Table 4. Treatment costs per unit.

Treatment	Concentration	Unit price (c)	Cost (R/ha)
PAM (g/m²)	1.0	3.9	156
	2.0	7.8	312
HA (ml/m²)	2.0	2.3	92
Compost (l/m²)	2.0	90.0	3600

CONCLUSION

Results of these trials indicated the positive reaction of PAM with alleviating soil crusts comparing to other more general soil conditioning products and methods. The 2 g/m^2 PAM treatment performed the best, while the 2 L/m^2 compost out performed PAM treatments, although, non-significantly. PAM treatment costs are very low while compost treatments are the highest. Further trials are neccessary.

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