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Evaluation of Avogreen as Post-harvest Treatment for Controlling Anthracnose and Stem-end Rot on Avocado Fruit

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ABSTRACT

Biological control was commercially evaluated at several packhouses. Biocontrol effectiveness varied throughout the season. A possible reason for the poor performance of biocontrol could perhaps be ascribed to product formulation.

UITTREKSEL

Biologiese beheer was kommersieel geevalueer by verskillende pakhuise. Variérende resóltate was verkry regdeur die seisoen. Teleurstellende data reflekteer dalk op nie-effektiewe produkformulering.

INTRODUCTION

Avocado was introduced to South Africa by the Dutch settlers and is currently the second most important subtropical crop cultivated locally. The avocado industry has become an important earner of foreign exchange for the country, since the bulk of the fruit is exported by sea mainly to European countries. Fruit quality varied over the years and incidence of post-harvest diseases were as high as 38% in certain export consignments (Bezuidenhout & Kuschke, 1982).

Post-harvest diseases anthracnose and stem-end rot (SE) are generally regarded as the two most important post-harvest diseases in SA. Darvas & Kotzé (1987) described several pathogens associated with SE in SA, while anthracnose is caused by *Colletotrichum gloeosporioides* (Penz.) Sacc.

Control of post-harvest diseases has mainly been achieved through the use of pre- and post-harvest chemicals. However, global environmental concern and chemophobia has resulted in the withdrawal of certain chemicals and the reluctance to develop new products, particularly for small niche markets.

Between 1988 -1996, several biocontrol semi-commercial post-harvest experiments were performed at various avocado packhouses (Korsten *et al.,* 1988; 1989; 1991; 1993; 1995). Biocontrol seemed a viable option and it was decided to test the antagonist on a commercial scale. The antagonist had to be formulated to ensure a product with a long shelf life and consistent high viable counts. The aim of this study

was therefore to evaluate this formulation, originally developed for pre-harvest applications, on a commercial scale for control of avocado post-harvest diseases.

MATERIALS AND METHODS

Bacillus subtilis previously shown to be effective in controlling avocado pre- and post-harvest diseases (Korsten *et al,* 1995, 1997), have been commercialised. The product Avogreen is marketed as a wettable powder at a concentration of 10^9 cells/g product for pre-harvest applications. The product formulation was used for post-harvest applications at 100g product / 1l commercial wax, unless mentioned otherwise. Two geographically distinct avocado production areas were selected with three representative packhouses i.e., Tzaneen (Westfalia Estate, Letaba and Bassan packers) and Nelspruit (HL Hall & Sons, Burpak and Koeltehof). Packhouses were selected based on the difference in post-harvest handling of fruit. This was done to evaluate biocontrol effectiveness under different operational systems. Fruit used in all experiments were commercially picked early in the morning from one specific block. Although all fruit from that specific consignment were treated according to the various treatments, only random samples of 10 boxes per treatment were taken for evaluation. In all cases, treatments included an untreated and biological control treatment and in the case of Westfalia also a chemical treatment (Prochloraz, Omega 5 ppm). After treatment, fruit was cold stored at 5°C for 28 days to simulate export conditions. However, in certain cases fruit were stored slightly longer or shorter due to technical problems or, were not stored at all. Fruit was ripened at room temperature until ready-to-eat before being rated for anthracnose and SE both externally and internally on a 0-10 scale (Korsten, 1993). Data were subjected to analysis of variance and treatment comparisons were made using Duncan's multiple range test. The following experimental protocols were used:

Westfalia Estate

Six experiments were done throughout the season, three using the cultivar Fuerte (3 April; 22 May; 24 June), two Hass (8 May; 10 July) and one Ryan (13 August). Fruit were handled on the packingline as follows; a commercial chlorine spray-wash (HTH 1000 ppm) followed by water spraying, hot air drying, commercial waxing (Stayfresh, Dormas) 1l/ton fruit and hot air drying (52°C) before being sorted and packed. Two control treatments were included in the first experiment (3 April) ie. a chlorine washed and then waxed treatment and an unwashed treatment. In the case of the latter treatment, fruit was not handled on the packingline at all, but were immediately packed on arrival at the packhouse. The chemical was applied on line just prior to the commercial wax application and thus just after the chlorine washing and drying. The antagonist was applied incorporated in the wax after the chlorine wash. With the second experiment of the season (8 May), an additional chemical treatment was included that had no chlorine wash. An integrated treatment was also included that first had the chlorine wash, chemical spray followed by the antagonist application applied in the wax. The third experiment of the season (22 May) consisted of the following standard treatments: biological, chemical and chlorine washed control. The fourth (24 June) and

fifth (10 July) experiment had an additional integrated treatment as described. In the case of the fifth experiment, the antagonist was also applied at concentrations of 10 and 50 g/l wax. The final experiment (13 August) of the season at Westfalia had an additional treatment where the antagonist was applied in water with an ultra low volume spray applicator (Micronair), just prior to commercial waxing.

Letaba

Only one experiment was done at Letaba (21 May) which included an untreated control and a 10 and 50 g antagonist/l applied as a fine water spray mist. The antagonist was applied as a water spray since fruit is not commercially waxed in that particular packhouse. Fruit was stored at 7°C taken down to 5 °C for 28 days.

Bassan

Five experiments were done (8, 16, 22, 30 April and 14 May). In all cases only an untreated control (Tag wax) and a biocontrol treatment (100g/l Tag wax) were used. Fruit was stored and evaluated as described.

HL Hall & Sons

Although several experiments were done at Hall & Sons, only data from two trials will be given. This is mainly due to current technical problems encountered with retrieving data. The experiments were done on the 22 and 29 April. The control treatment included fruit being SU 319 (quaternary ammonium compound, 0.8 %) spray washed, water rinsed, air dried, waxed (Sempafresh) and air dried as described before. The antagonist was applied incorporated in the wax at 100g/l Sempafresh. With each experiment 10 boxes were kept for immediate ripening and evaluation and 10 boxes were placed at 7°C cold storage for 28 days.

Burpak

Of the various experiments done at Burpak only two sets of data are available at this stage (Experiments done on the 23 April and 14 May). An untreated control and a 100g antagonist formulation/l Sempafresh wax were used. All fruit received at the packhouse were dipped into a standard chlorine bath, prior to being washed and waxed.

Koeltehof

Seven experiments were done at Koeltehof using mainly Fuerte (23, 29 April, 3, 9 May, 12 June) and to a lesser extent Hass (20 June, 24 July). The first four experiments consisted of the two standard treatments (untreated control and the 100g antagonist formulation/1l Sempafresh wax). The last three experiments were aimed at evaluating different preparations of the antagonist formulation. On the 12th of June the antagonist was tested at the recommended concentration (100 g/l) and at 1/10 the original

concentration. However, prior to treatment, the antagonist/wax mixtures were given a heat shock treatment (80°C for 10 min). On the 20th of June a liquid antagonist formulation was compared to a heat shock treatment (80°C, 10 min), and a pre-prepared antagonist mixture (mixture was made up 24h prior to application).

Only data of external anthracnose will be given since similar tendency was noted for SE.

RESULTS

Westfalia Estate

Only data or external autusacnose will be given since similar tendencies were marked for SE.

Biocontrol proved ineffective in significantly reducing post-harvest diseases in four of the six experiments (3rd April, 8th May, 24th June, 10th July) (figures 1, 2, 4, 5). Biocontrol proved effective in two of the experiments and significantly reduced anthracnose (22nd May, 13th August) (figures 3, 6). What is perhaps important to notice is the similar poor performance of the commercial chemical treatment. The chemical treatment could not significantly reduce anthracnose in three of the five experiments where it was included (3rd April, 24th June, 13th August) (figures 1, 4, 6). Effective control was only achieved in one experiment (22nd May), while a significant increase in anthracnose severity was recorded with the chemical treatment on the 8th May (figures 2, 3).

Letaba

Disease incidence was low. None of the two biological control treatments had any significant effect on reducing post-harvest diseases when compared to the control.

Bassan

Disease incidence in general was moderate to low. Only one experiment (8th April) showed that the biocontrol treatment could significantly reduce anthracnose severity externally (figure 7). With the other treatments no significant difference was found between treatments.

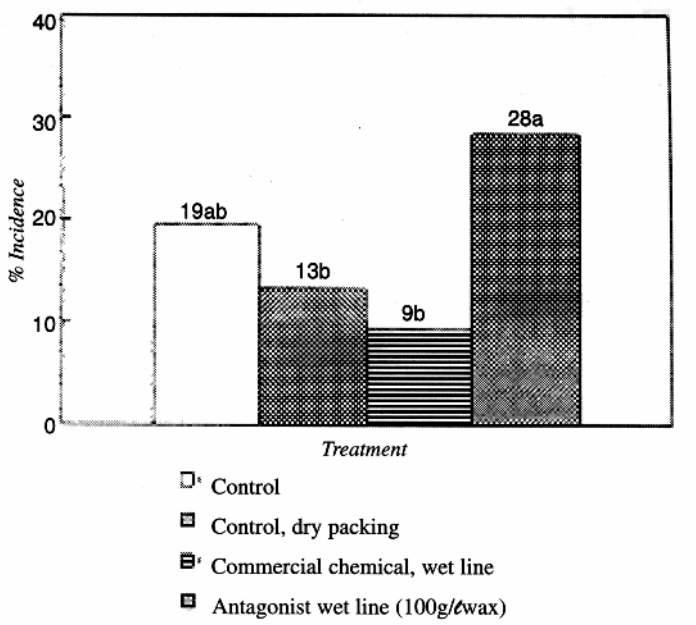

Figure 1: Post-harvest commercial packhouse experiments at Westfalia Estate, 3rd April using Fuerte cv fruit evaluating treatment effect on external anthracnose severity. Fruit was commercially HTH chlorine washed prior to treatment, except for the control, which was dry packed (Pr>F=0.0058)

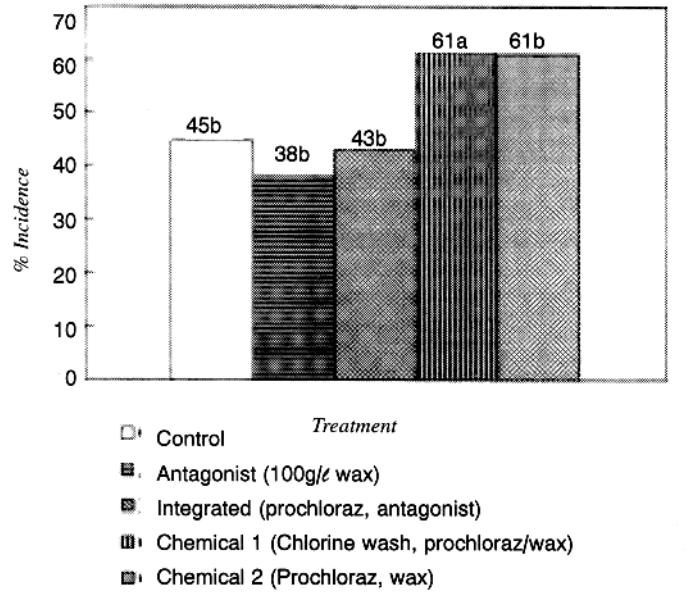

Figure 2. Post-harvest commercial packhouse experiments at Westfalia Estate, 8th May, using Hass cv fruit, evaluating treatment effect on external anthracnose severity (Pr>F=0.0001).
Fruit was commercially HTH chlorine washed prior to treatment except for the second chemical treatment

HL Hall & Sons

A significant reduction in anthracnose severity was found in one of the two experiments, but only with fruit ripened immediately after treatment (figure 8). No significant reduction in anthracnose severity was evident when fruit were first cold stored.

Burpak

Biocontrol proved ineffective in reducing anthracnose externally and even increased severity in the first experiment 23rd April (figure 9).

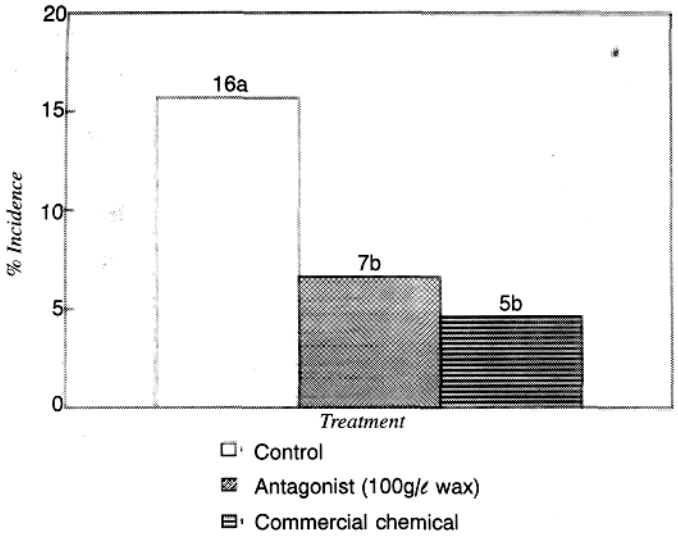

Figure 3. Commercial post-harvest packhouse experiments done at Westfalia Estate, 22nd May, on Fuerte cv fruit evaluating treatment effect on anthracnose severity (Pr.>F=0.0424).

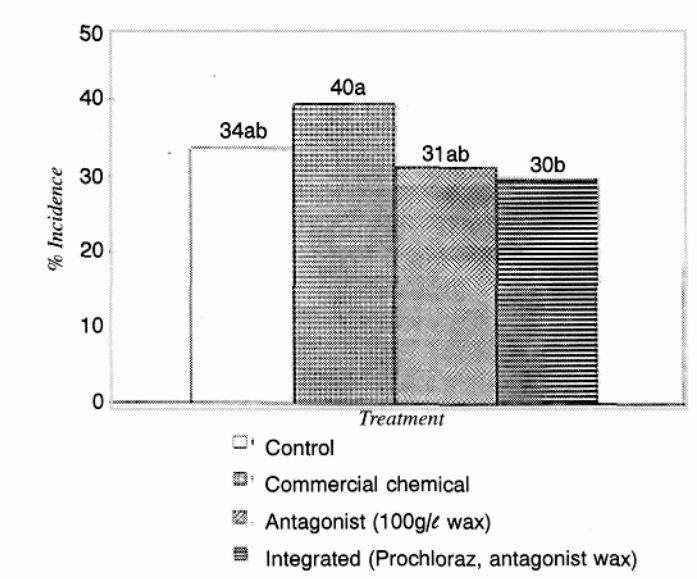

Figure 4. Commercial post-harvest packhouse experiments done at Westfalia Estate, 24th June, on Fuerte cv fruit evaluating treatment effect on anthracnose severity (Pr.>F= 0.085). Fruit from all treatments were commercially HTH washed prior to treatment and were not cold stored after treatments.

Koeltehof

Biocontrol resulted in no significant reduction in post-harvest diseases when experiments were done on 23rd April, 3rd May and 9th May (figure 10). The experiment done on the 29th of April showed a significant increase in anthracnose severity (figure 10). An experiment done on June 12 where different antagonist formulations or concentrations were used, proved effective and showed a significant reduction in external anthracnose (figure 11) and a similar tendency was observed on the 20th of July (figure 12).

DISCUSSION

Considerable variation in biocontrol effectiveness was recorded during the 1997 season when tested on a commercial scale. Commercial performance of antagonists has always been questioned and is regarded as one of the biggest obstacles for biocontrol acceptance. The erratic results that were obtained could probably be attributed to product formulation used at the start of the season. The formulation was designed to ensure a long shelf-life thus having spores instead of vegetative cells. All previous packhouse experiments have been done with vegetative cells and proved effective (Korsten, 1993). By changing product formulation or giving it a heat shock treatment, enhanced antagonist performance. It is perhaps also important to note that fruit were placed at 7 to 5”C immediately after treatment, giving the antagonist no time to sporulate. Once removed from cold storage, the antagonist can only then start germinating at which stage the quiescent infections have already progressed into a full blown infection of host cells. Other changes such as using a lower concentration and pre-preparing the antagonist before usage did not significantly enhance product

performance. Of interest perhaps is the similar variation in effectiveness of the chemicals used in this study. Effective control was only achieved in one of the five experiments where fungicides were tested. Similar reports on inconsistency of product performance has been reported by Boshoff (1997) and Korsten (1993).

Of particular concern was the significant increase in external anthracnose severity that was observed with the biological, chemical and integrated control experiments. With regard to the biocontrol experiments, it is perhaps noteworthy to mention that the increase in severity was only evident with external anthracnose lesions and not internally. With the specific product formulation, selective nutrients are added to ensure high antagonist yields. It is possible that excess nutrients available in the formulation might act as a nutrient base for the pathogen. These more readily available nutrients can be utilised by the pathogen which causes a superficial spreading of mycelium and superficial enlargement of the lesion. Unexpected increase in disease with the use of fungicides has also previously been reported (Subhash, 1988) and was attributed to changes of deposition in fungicides which might affect the balance between epiphytes and pathogens.

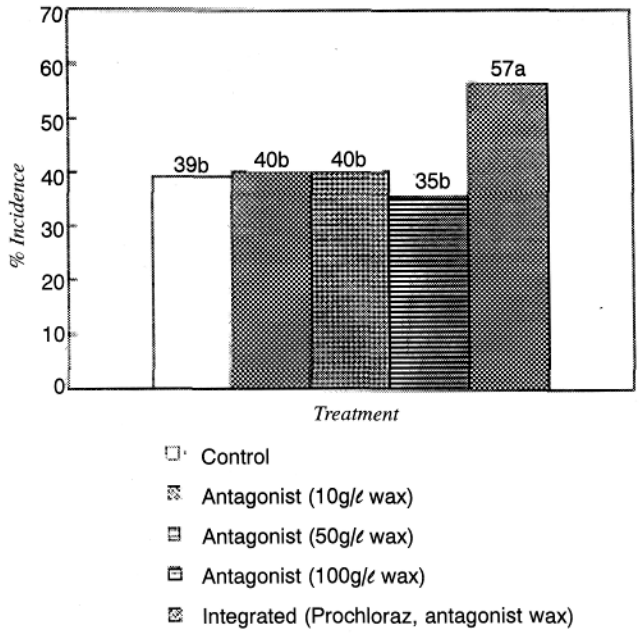

Figure 5. Post-harvest commercial packhouse experiments at Westfalia Estate, 10th July, using Hass cv fruit for evaluationg treatment effect on external anthracnose severity (Pr>F=0.0052)

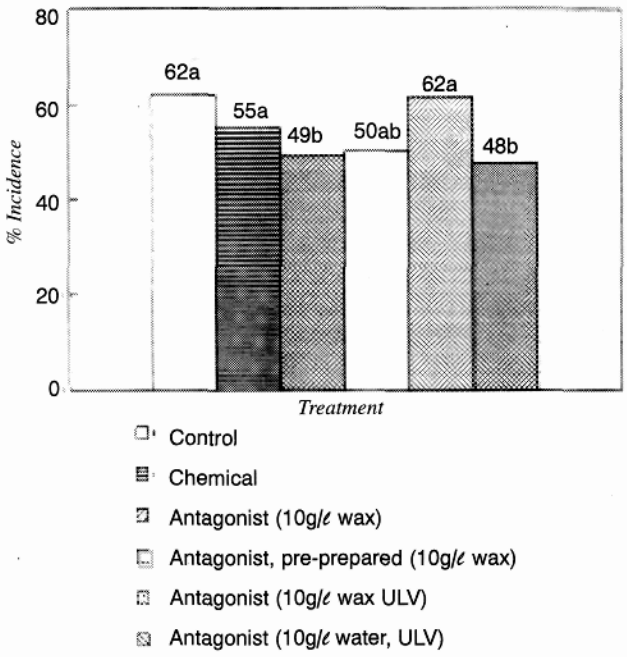

Figure 6. Post-harvest commercial packhouse experiments at Westfalia Estate, 13th August, using Ryan cv fruit evaluating treatment effect on external anthracnose severity.

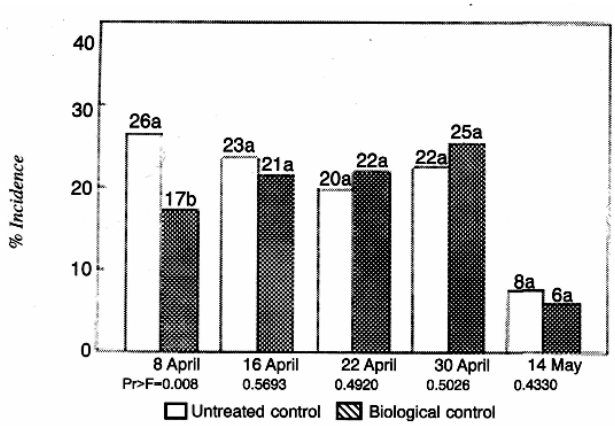

Figure 7. Post-harvest packhouse experiments at Bassan for control of anthracnose.

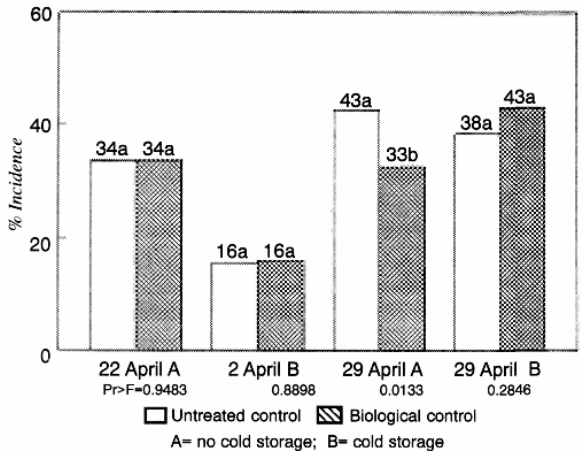

Figure 8. Post-harvest packhouse experiments at HL Hall & Sons for control of anthracnose where one half of the experiment was cold stored at 7°C for 28 days and the other half was immediately ripened for evaluation.

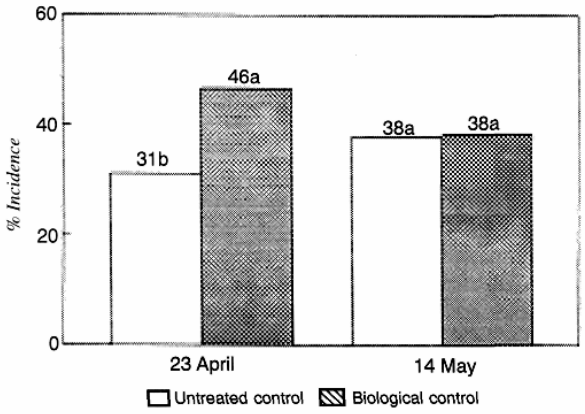

Figure 9. Post-harvest packhouse experiments at Burpak for control of anthracnose.

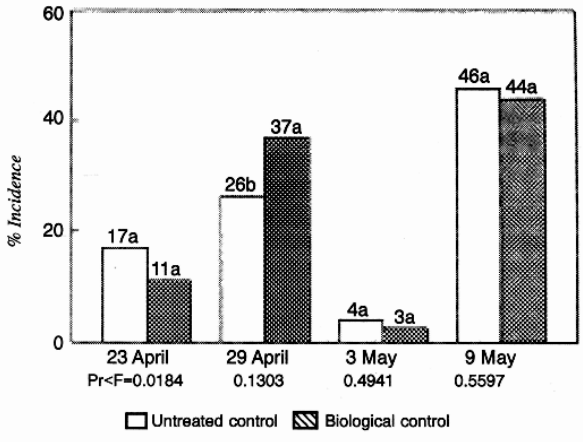

Figure 10. Post-harvest packhouse experiments at Koeltehof to evaluate anthracnose control using Fuerte cv fruit.

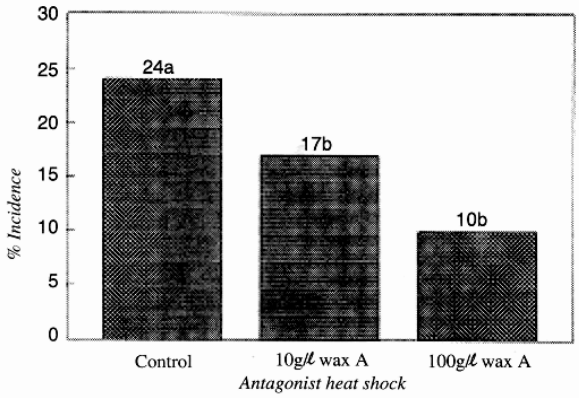

Figure 11. Post-harvest packhouse experiments at Koeltehof, 12th June to evaluate different biocontrol product preparations for control of anthracnose using Fuerte cv fruit.

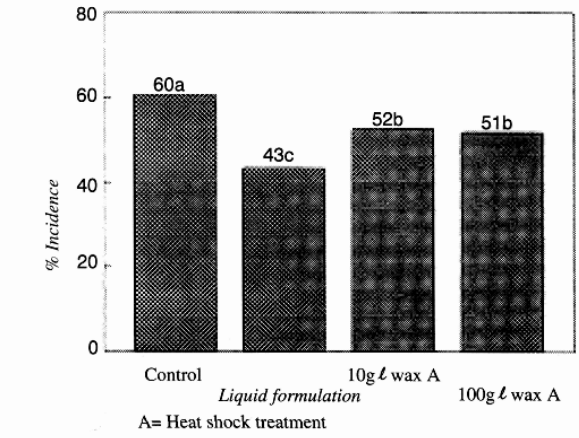

Figure 12. Post-harvest packhouse experiments at Koeltehof, 20th June to evaluate different packhouse formulations for control of anthracnose.

The particular formulation used in this investigation, is obviously not suited for post-harvest applications and should rather be used pre-harvestly. A separate formulation should thus be developed for packhouse applications as was indicated by the more effective performance of the liquid formulation.

ACKNOWLEDGEMENTS

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