Moss Control in a Proteaceae Crop©

David Parlby
Proteaflora Nursery Pty Ltd., PO Box 252, Monbulk VIC 3793
Email: daveparlby@vic.chariot.net.au

INTRODUCTION

This paper will be divided into two parts. The first part will look at the various products that can be used to control moss in a production nursery and their effects on controlling moss. The second part will be a phytotoxicity trial on selected plants from the Proteaceae family. By the end of the trial it is hoped that one or more effective moss control chemicals will be found. An effective chemical will be assessed by a 90%+ control coverage. An effective chemical will also be judged on whether it has any phytotoxic effect on the plant.

Moss thrives on moist, fertile, and slightly acidic to acidic soils in shady areas. There are environmental ways of controlling moss such as changing factors to make them less favourable for moss development. Unfortunately most production nurseries have one or multiples of these factors which make very favourable growing conditions for moss, and which they are unable to remove. This makes it hard to control the moss through environmental methods.

Prevention is better than a cure; however trying to prevent moss growing can be a problem. Moss spores are spread through water, air, and soil. Water treatment at Proteaflora cannot kill the spores at the current rates, while water filters don't block the spores. Proteaflora uses chlorine dioxide as a water treatment. The spores can be killed by heat treating the media; however spores travelling by air can re-infect the media.

METHODS

Growing Moss. A total of 180 moss samples (10 samples per treatment rate, at three rates per chemical) were collected from pots found at Proteaflora Nursery and then potted into 75-mm pots. These were then placed in an area of the nursery, separate from regular nursery stock to minimize the spreading of moss to nursery plants. Even though the moss is removed from regular nursery stock, a controlled moss-friendly environment was maintained by placing plants close together as found in the nursery. Also shade cloth was placed on a frame over the moss to simulate the shade produced by the plant that would normally grow over the top of the moss in a nursery environment. The moss samples were irrigated on a cycle normal to nursery practices, including extra water application on hotter days. A seaweed solution was applied to the moss twice a week at a rate of 15 ml of solution to 9 L of water, to assist the moss to grow more quickly. The moss remained under the shade cloth during the whole trial, however the extra water and fertiliser was stopped 7 days prior to evaluating the trial.

Once the moss had produced an even coverage over the pots, a control sample was selected; this represented the average growth over all the moss samples.

Part One: Efficacy Trial. Six chemicals/products were used to control the moss:

1. Biogram (o-phenyl, phenol sodium salt).
2. Vinegar.
3. Surrender (benzalkonium chloride).
4. Iron sulphate.
5. Odorless food sanitizer (O.F.S) (benzalkonium chloride).
6. Kendocide (dichlorophen sodium salt).

The chemicals were chosen because they are widely used in the industry to control moss. Odorless food sanitizer is the exception, being chosen because it is a biocide used at Proteaflora with similar active ingredients to Surrender. Each chemical was applied at three different rates; high, medium, and low. These were determined by finding the recommended rate of use, which then became the medium rate. High and low rates were established 5–10 ml on either side of the medium rate.

The rates used for the chemicals were:

- Biogram (high 20 $ml \cdot L^{-1}$, medium 10 $ml \cdot L^{-1}$, low 5 $ml \cdot L^{-1}$)
- Vinegar (high 100%, medium 75%, low 25%)
- Surrender (high 20 $ml \cdot L^{-1}$, medium 10 $ml \cdot L^{-1}$, low 5 $ml \cdot L^{-1}$)
- Iron sulphate (high 10 $g \cdot L^{-1}$, medium 5 $g \cdot L^{-1}$, low 1 $g \cdot L^{-1}$)
- Odorless food sanitizer (O.F.S.) (high 20 $ml \cdot L^{-1}$, medium 10 $ml \cdot L^{-1}$, low 5 $ml \cdot L^{-1}$)
- Kendocide (high 10 $ml \cdot L^{-1}$, medium 5 $ml \cdot L^{-1}$, low 1 $ml \cdot L^{-1}$)

All chemicals were measured using a 20-ml syringe, except for the vinegar which was measured using a 1-L measuring jug and the iron sulphate which was measured using scales. Tap water was used to dilute each chemical concentrate to make 5-L solutions with the exception of the iron sulphate, which was dissolved in 1 L of water then filtered to remove all solids.

All chemicals were applied using a 5-L pressure pack sprayer and applied to saturation point.

One week after the moss had been treated it was evaluated by estimating the percentage of moss browning within each pot. A follow up examination was undertaken 6 weeks following the original application to determine whether the moss was killed or just its growth postponed by the chemical.

Part Two: Phytotoxicity.

Phytotoxicity Test. Once the effective rates had been established in the efficacy trial, the chemicals were applied directly to plants at the lowest rate that they were effective against the moss. The chemicals were applied to selected Proteaceae taxa representing the different genus types grown at Proteaflora, based on the availability of stock, popularity, and maturity. These were: *Protea* 'Sylvia', *Protea* 'King Pink', *Leucospermum* 'Succession II', *Telopea* 'Shady Lady Red', *Serruria* 'Blushing Bride', *Leucadendron* 'Safari Sunset', and *Banksia* 'Birthday Candles'.

For each chemical a tray was set up containing three 75-mm-pot samples of each taxon. Each taxon was grouped together to simulate nursery conditions, with spaces between each taxon (filled with empty 75-mm pots).

Three control plants of each taxon were separated from the experimental plants and used as a comparison to the treated plants.

The result of the phytotoxicity test determined whether a follow-up test was required which would then be at a greater or lesser rate, following the method above.

RESULTS

Part 1: Efficacy Trial. Chemicals were deemed effective based on results 1 week after application. The moss was observed in the weeks to follow (Table 1).

Biogram. At the low and medium rates of Biogram 95% of the moss was browned (see Fig. 3 for example) and 100% of the moss was browned at the high rate. Small patches of green moss and green fruiting bodies remained at the low and medium rates.

Vinegar. The vinegar produced 100% browned moss in the medium and high rates and 99% at the low rate with some green fruiting bodies found. The vinegar treatment samples had a slightly crisp look to the moss.

Surrender. All Surrender treatments showed positive results at all rates. At the low rate 85% of the moss browned and at the medium rate 99% browned. Both rates showed small areas of green moss. Surrender was also effective at the higher rate, with 100% of the moss browning.

Iron Sulphate. The iron sulphate showed no effect across all rates, other than blackening fruiting bodies at the medium and high rates (Fig. 1).

O.F.S. At the low rate 70% of the samples were browned, with the remaining 30% being lighter in colour than the control. At the medium rate 30% of the samples treated were browned with the remaining 70% yellowing in colour. Between 80%–85% of the samples sprayed with the high rate were browned while the surviving samples were a lighter green than the control.

Kendocide. Kendocide showed little change when treated at the low rate (5%–10% browning) (Fig. 2). A high percentage (95%) of the moss in the medium Kendocide rate was browned (Fig. 3). When treated with the high rate the moss was completely browned and no fruiting bodies were visibly green.

Control. The control thrived in the conditions and 0% of the moss was browned (Fig. 4).

Table1. Estimated percentage browning of moss at each rate of chemical applied 1 week after application.

	Rates (%)		
Chemical used	Low	Medium	High
Biogram	95	95	100
Kendocide	10	95	100
Surrender	85	99	100
Vinegar	99	100	100
Iron Sulphate	0	0	0
O.F.S.	70	30	85
Control	0	0	0

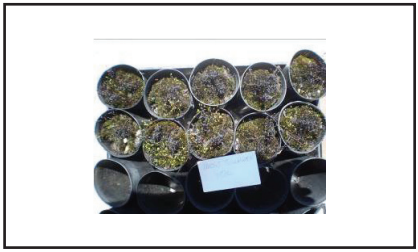

Figure 1. Blackened fruiting bodies on the iron-sulphate-treated moss.

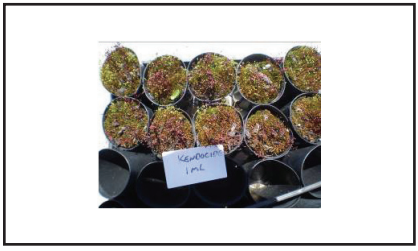

Figure 2. Example of unsuccessful results.

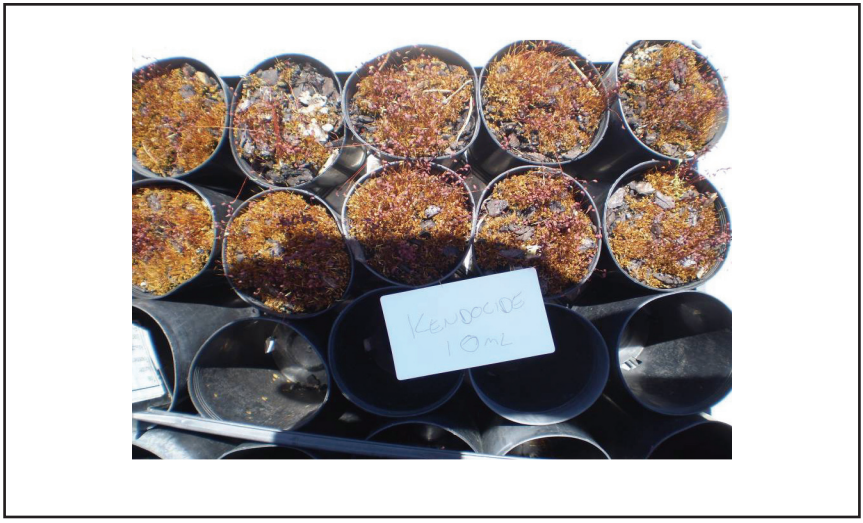

Figure 3. Example of browned moss (Kendocide 10 ml·L^{-1}).

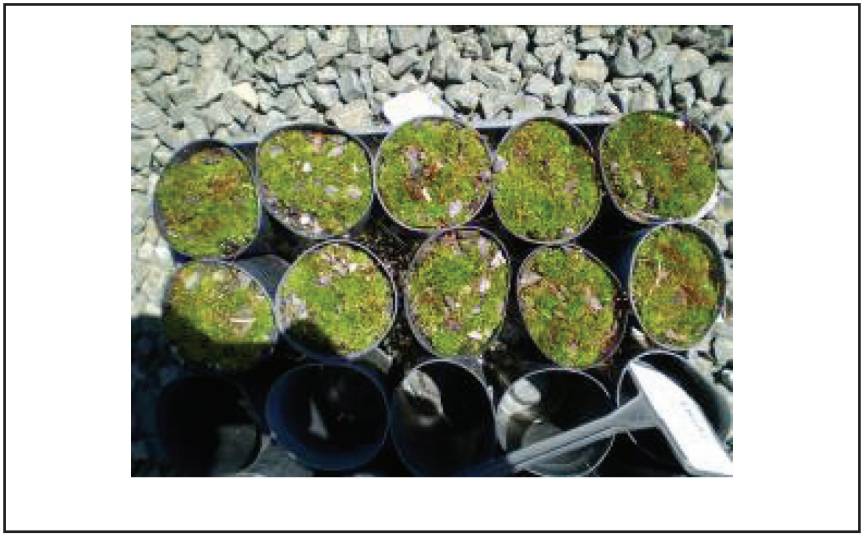

Figure 4. Control moss.

Part 2: Phytotoxicity. All results were compared to the control of each species, with no effect on the plant considered as a positive result.

Three treatments produced negative results; the *Leucospermum* was damaged on the low vinegar treatment with slight burning on the tips seen. Surrender (high rates) damaged three plant species (Figs. 5, 6, and 7); the *Leucospermum* and *Serruria* both showed tip burning while the *Banksia* showed some burning on the tips of the leaves with slightly deranged leaves (Fig. 5). Kendocide (high) treatment produced tip burning on the *Serruria* and the *Leucospermum*.

A follow-up trial was conducted using Surrender and Kendocide (both at a medium rate) but not vinegar as a negative result was achieved at the lowest possible rate. Both chemicals produced the same result as that found at the high rate of application as above.

Figure 5. Example of phytotoxicity on *Banksia* ('Birthday Candles').

Figure 6. Example of phytotoxicity on *Leucospermum* 'Succession II'.

Figure 7. Example of phytotoxicity on *Serruria* 'Blushing Bride'.

DISCUSSION

After reviewing the results of the moss treatment and the phytotoxicity test, it can be seen that Biogram and O.F.S. come out with the best results on paper in this trial. Both browned the moss at the higher rates and followed up with no phytotoxic results. Biogram knocked the moss down for a longer time (1 week) and browned 100% of the moss whereas O.F.S. browned 85% of the moss but this recovered quicker.

Even though these two chemicals came out of the trial as the best moss control chemicals, due to their effective control and lack of phytotoxicity, both vinegar and Kendocide controlled moss for a longer period of time.

The vinegar browned the moss which did not recover for 4–5 weeks for the lower rate and 5+ weeks for the medium and high rates. Kendocide (which is commonly used in the nursery industry to control moss) browned the moss at the high and medium levels with a recovery time of 5–6 weeks.

Both of these treatments showed phytotoxic results on selected taxa (Table 2).

However these treatments were done as a worst case scenario, in normal cases the foliage would not be covered with the chemical, as the treatment would be isolated to a targeted area (e.g., the moss). Therefore, if the person was aware of what could happen if the plant was sprayed then they could try to avoid spraying the plant. At Proteaflora Nursery it would be likely that *Protea*, *Telopea*, and *Banksia* taxa would be targeted for moss control since they have a more moss-friendly environment.

Surrender, which is also a chemical designed to control moss, had good results controlling the moss. The phytotoxicity test was attempted at the high and medium levels for Surrender. However during the phytotoxicity test, Surrender caused burning on the *Serruria*, *Leucospermum,* and *Banksia*. The *Banksia* leaves became

distorted when treated at the high and medium levels of Surrender treatment. Because 3 of the 7 species produced negative results Surrender would work well as a moss control on paths and gravel areas (where there are no plants).

My recommendation would be Kendocide (10 ml·L^{-1}) or vinegar (25%). As discussed earlier both these treatments had good results at controlling moss; however there are follow up trials which will need to be undertaken. These include: increased rates on Biogram (e.g., 25 ml·L^{-1}+), O.F.S. (e.g., 50 ml·L^{-1}+) and Kendocide (e.g., 20 ml·L^{-1}+), and a different rate for vinegar (e.g., 35%–50%).

Also when a rate that will successfully control moss is established, a larger trial within a nursery situation will need to be undertaken. The regrowth will need to be evaluated to see if there is any effect on the plant at its second flush of growth.

Disclaimer: Of course, these chemicals may have different effects on different plant species, and others should conduct their own phytotoxicity trials before applying chemicals over their stock.

Acknowledgement. I would like to thank the following people for their assistance in this trial and developing this paper: Andrew Mathews, Paul Armitage, Sue Mathews, and Miranda Thomson. Thanks to management at Proteaflora Nursery for allowing me to use their plants and equipment.

Table 2. Phytotoxicity results.

	Plant						
Treatment	*Protea* 'Sylvia'	*Protea* 'King Pink'	*Leucodendron* 'Safari Sunset'	*Serruria* 'Blushing Bride'	*Telopea* 'Shady Lady Red'	*Leucospermum* 'Succession II'	Banksia 'Birthday Candles'
Biogram							
Kendocide				X		X	
Surrender				X		X	X
Vinegar						X	
O.F.S.							

X = the plants that were damaged at a high level (vinegar was treated at the low level).