

Comparisons of established weed control methods in container nurseries against a novel weed control device

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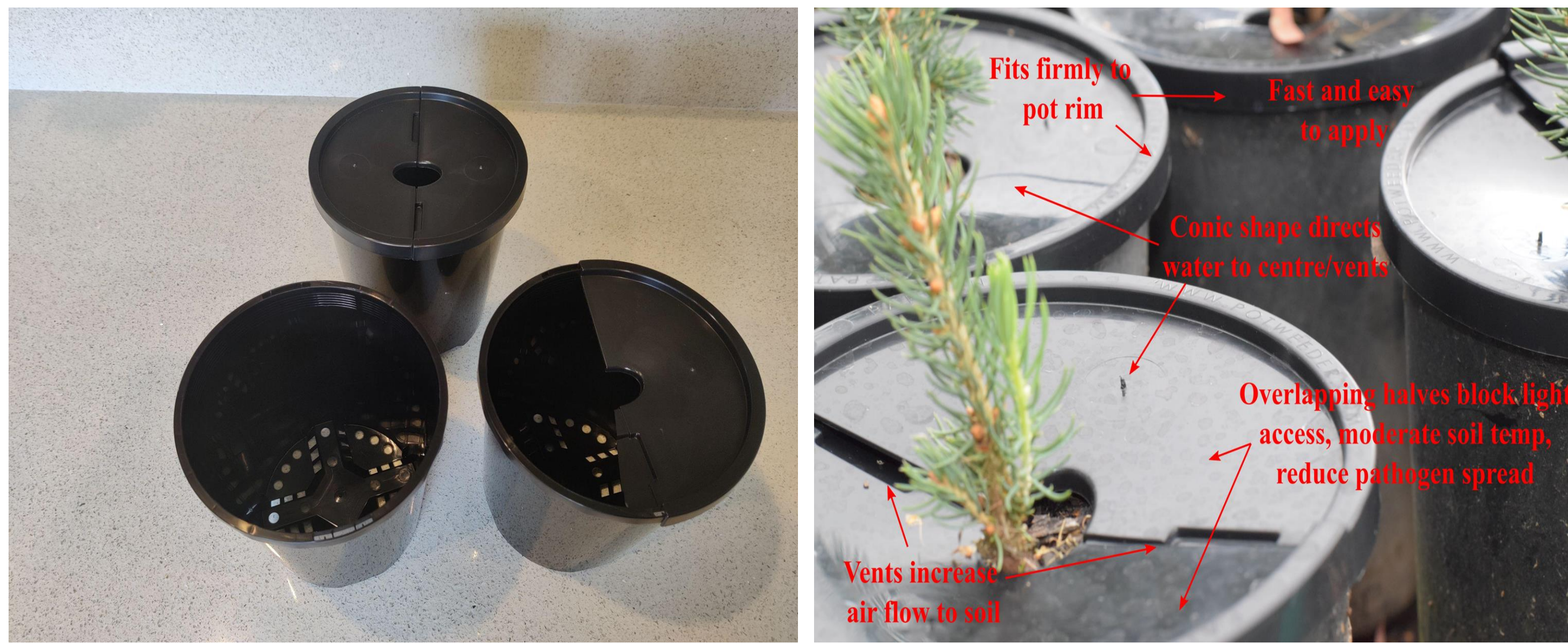
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Abstract

Weed control is a significant cost to nurseries worldwide, requiring the frequent and extensive use of manual labour, mulches or coir weed mats, and herbicide treatment to maintain healthy plant growth and good presentation of potted products. The PotHead™ device (PotHead), in development by Deeweedy Pty Ltd since June 2021, seeks to improve long-term weed control for container nurseries and reduce the dependency on herbicide use in container crops. A comparative study of the efficacy of the PotHead against current industry weed control practices was conducted at Spruced Nursery in the peak growing season. Oven dry weights of weeds taken from the treatment groups showed the PotHead significantly outperformed all established treatment methods in terms of relative weed reduction. Growth was considerably more consistent and uniform in potted plants with PotHeads applied, although increases in height were slightly lower overall than in the other groups. Follow up trials demonstrated an increased water retention and temperature moderation within the growing media with a PotHead applied.

The PotHead™

The PotHead is a simple device to improve the control of weeds in potted plants. Each unit consists of two concave half circles which interlock to block light to the growing media. They are made of a lightweight, flexible, recycled UV-resistant polypropylene (the same material used to make standard pots) with an expected life of more than five years in the sun. Labour intensive integrated weed management is currently considered the only effective method in the industry, involving disciplined nursery hygiene - alternating between or combining coir mats or bark mulch, herbicide and laborious hand weeding.



Features

- Like pots used in production, the PotHead can be sterilised by autoclave or bleach dip, re-used and rotated through a nursery repeatedly.
- A recent study showed that a considerable percentage of evaporating water is recaptured and returned to the plant, reducing watering requirements (Moston and Ranson, 2022)
- Fast application to pots and a single application required, unlike coir mats which often need to be replaced every 6-12 months.

Field trial at Spruced Nursery

Spruced Nursery produces a significant proportion of the Australian Christmas tree industry's potted Christmas trees and planting stock, as both tubestock, 2:1 and 2:2 potted transplants. Aggressive weeds are a major problem for the nursery which primarily grows slow growing and delicate conifers. The wider nursery industry is also struggling as labour costs and availability have worsened post Covid-19. Coir mats, mulch and herbicide costs have risen as with the rest of the supply chain and currently available herbicides are losing efficacy and facing imminent restrictions due to environmental concerns. Spruced hosted this trial to test the prototype PotHead devices

The Problem

Weed control can cost thousands to hundreds of thousands of dollars each year in large nurseries, with this task being highly manual in nature – teams of manual weeders cycle, as often as once a month in summer, around the nursery in a never-ending battle with weeds. Weeding can also be a cause of staff attrition and workplace injuries – requiring gruelling hours often bent over on hands and knees removing weeds manually.

Increasing labour costs and other factors relating to the recent Covid-19 pandemic have exacerbated the problem. The horticulture industry also faces growing concerns over the environmental impacts of herbicide use and the development of weed resistance to them. These factors have renewed a need for a novel, non-chemical weed control solution.

Some mechanical devices have been deployed (often in combination with herbicides) to reduce the costs of controlling weeds, but each of these has design deficiencies which limit their cost effectiveness. Herbicides even at maximum label rates give only limited control with no effect on mosses.

A recent study by McLeod (2018) has revealed that the costs of labour, herbicides, and the application of weed prevention methods are a considerable financial investment for Australian growers, with the annual cost of weed control in Australia estimated to be approximately \$5 billion AUD (\$3.6 USD)

A study by Mathers (2003) revealed U.S nursery growers were spending an estimated \$500 to \$4000USD/acre (\$1235 to \$9880/ha) of containerised plants on manual removal of weeds with economic losses due to weed infestations estimated at \$7000/acre (\$17,290USD/ha). Substantial testing was undertaken by the American Society for Horticultural Science on alternative weed control methods, however the various innovations at this time were found wanting due to high cost or design flaws and have not become industry standard (Chong, 2003)



Nursery worker weeding potted Douglas fir trees

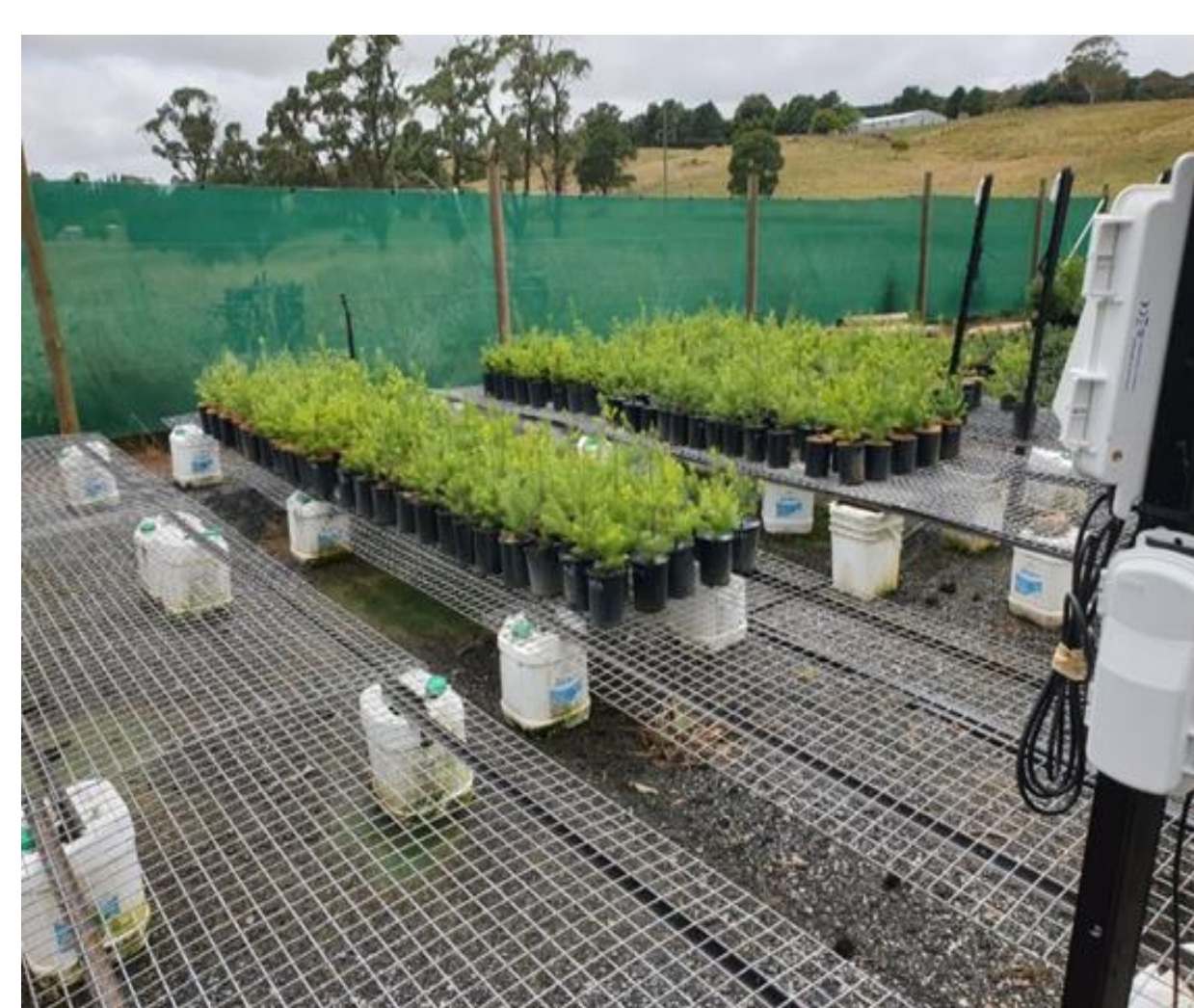
The Experiment

Introduction

The Deeweedy PotHead device is claimed to be a major improvement over best practice, such as use of herbicides or coir mats. In coir mats, weeds are often seen to grow around the perimeter of, along the radial slit and sometimes straight through the fibrous mat. Interviews with nurserymen around Australia conducted by the authors suggest that common nursery weeds are developing resistance to currently available herbicides and that they are not enough to suppress weeds alone. Using them at the maximum label rates may also impact the growth of the potted plants. This trial aims to quantify differences between the PotHead and current best practices on the control of weeds in pots and on growth of the potted plants.

Hypotheses

The expectation is that the opaque and non-porous plastic PotHeads will largely remove light access to weeds compared to other methods, significantly reducing their growth without harming the growth of the potted plants.



Experiment running at Spruced nursery in January 2022 with weather monitoring station in foreground

Methodology

- 90 day trial period run from 27 January - 27 April (mid Summer to mid Autumn)
- Two hundred commercially graded Douglas Fir trees in 140mm diameter pots were selected from Spruced nursery. Four randomised groups of fifty were created with each group assigned a different weed control method.
- The four weed control methods consisted of; A. Untreated control, B. Deeweedy PotHead™ devices, C. Coir fibre weed disc and D. Common nursery pre and post-emergent herbicide (Macspreed Dismiss Oryzalin 10g/kg and Oxyfluorfen 20g/kg), was applied at the label rate of approximately 0.15g per pot.
- The experiment was set up under typical nursery conditions and watering schedules with Hobolink remote weather stations set up monitoring weather at 15 minute intervals. Moisture probes monitoring soil moisture were set up in 4 sample pots.
- Weeds were removed thoroughly by hand in all pots prior to experiment start. Weed control treatments were then applied. All plants root collar diameter and total height were measured at the start and end of the 90 days.
- Weed growth and experimental progress was monitored by a time-lapse camera taking one photo per day over the trial period.
- At the end of the 90 day period all pots were carefully weeded and Douglas firs measured, and the weeds for each group separated into buckets. The weeds were then processed by double rinsing and removing as much of the remaining substrate as possible.
- The weeds were dehydrated and weighed in accordance with established academic practice (Clemson, 2022).

Results

Figure 1 is representative of the total oven dry weight of the weed matter in each treatment group. As the moss clusters found in group C and group D were difficult to extract from the substrate they were embedded in, these were measured separately to the other weeds.

The PotHead reduced the average weed density per container by approximately four times compared to the next best performing competitor, an effect that increased when also including collected moss. As a percentage of the control, the PotHead was shown to reduce weeds by 81.7% compared to the control, markedly greater than each of the other treatment groups, which performed similarly in terms of weed reduction at 25.9% for group C and 25% for group D when moss was excluded from these groups.



Figure 1

Figure 2 displays the normalised change in plant height during each trial for each separate population of 50 pots using the weed control methods outlined in Figure 1. Figure 3 displays the normalised increase in stem thickness of the same populations as Figure 2.

One individual Douglas Fir died in the herbicide group, the only loss recorded in the experiment. The only significant difference (P value below 0.05) between any two populations in these measurements according to two-tailed T-tests occurred between the height increase of the Herbicide group and PotHead group, with the herbicide group showing greater mean height gain. The difference was not significant between herbicide and coir or control treatments however.

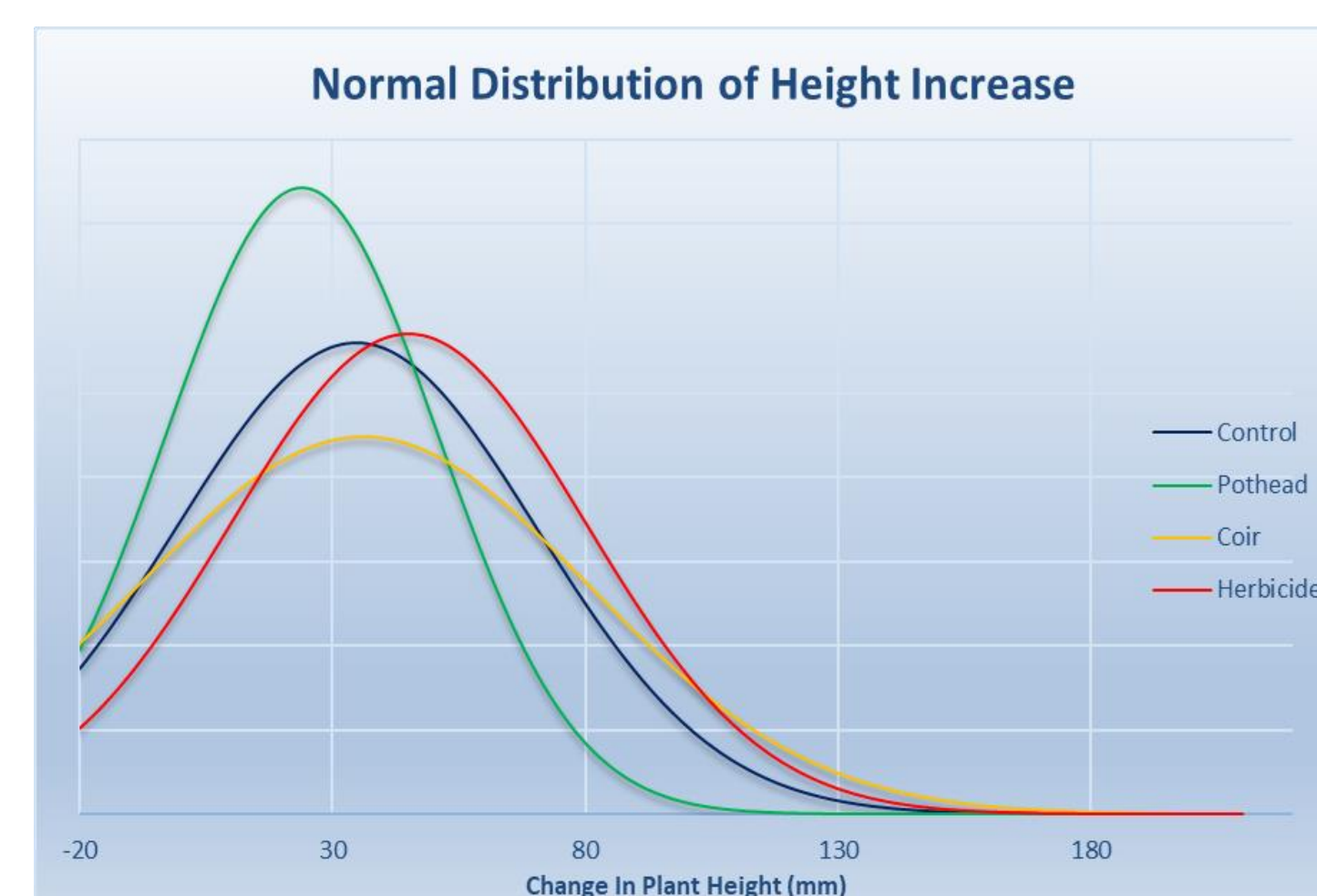


Figure 2.

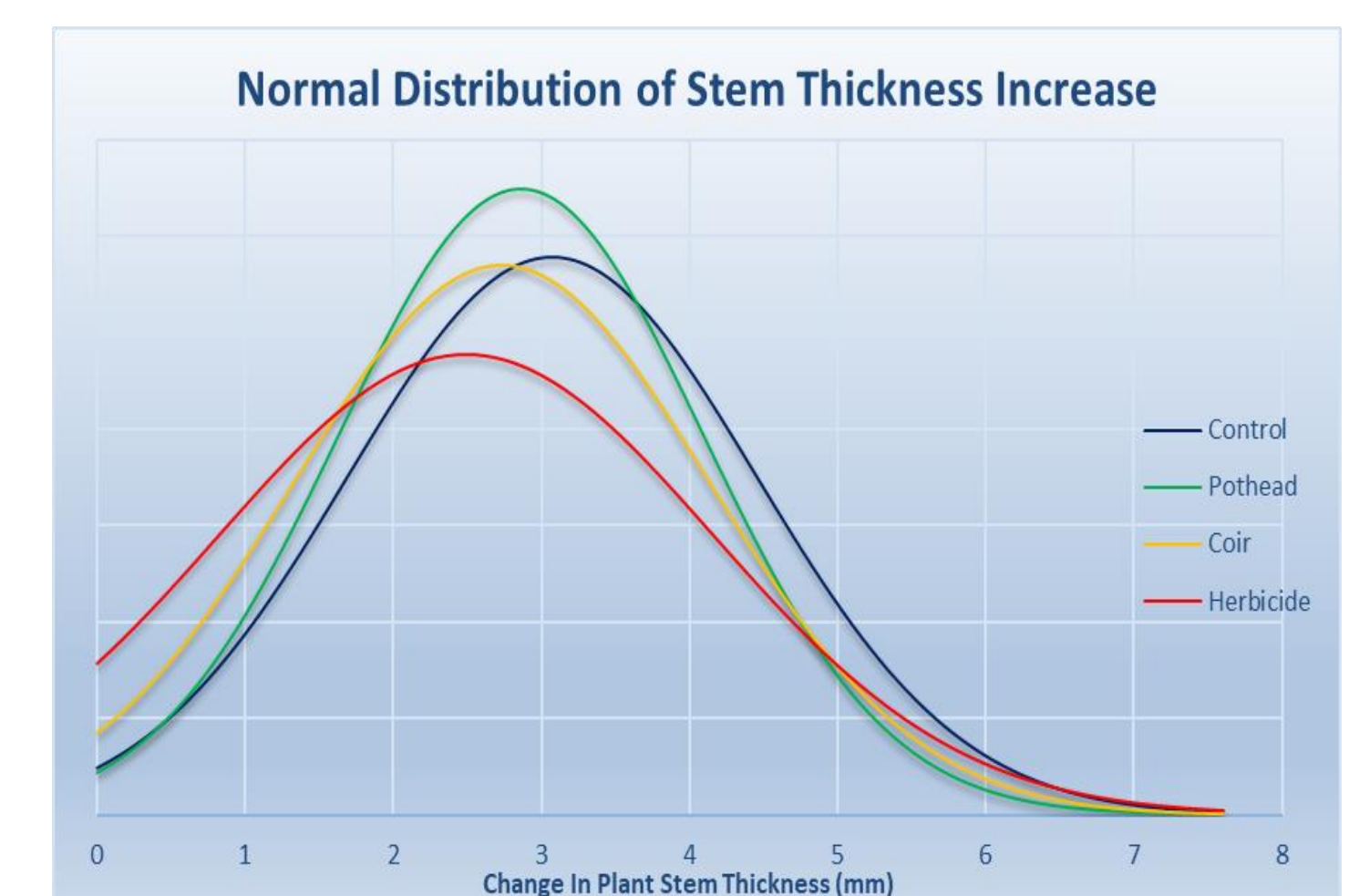


Figure 3.

Discussion & Conclusions

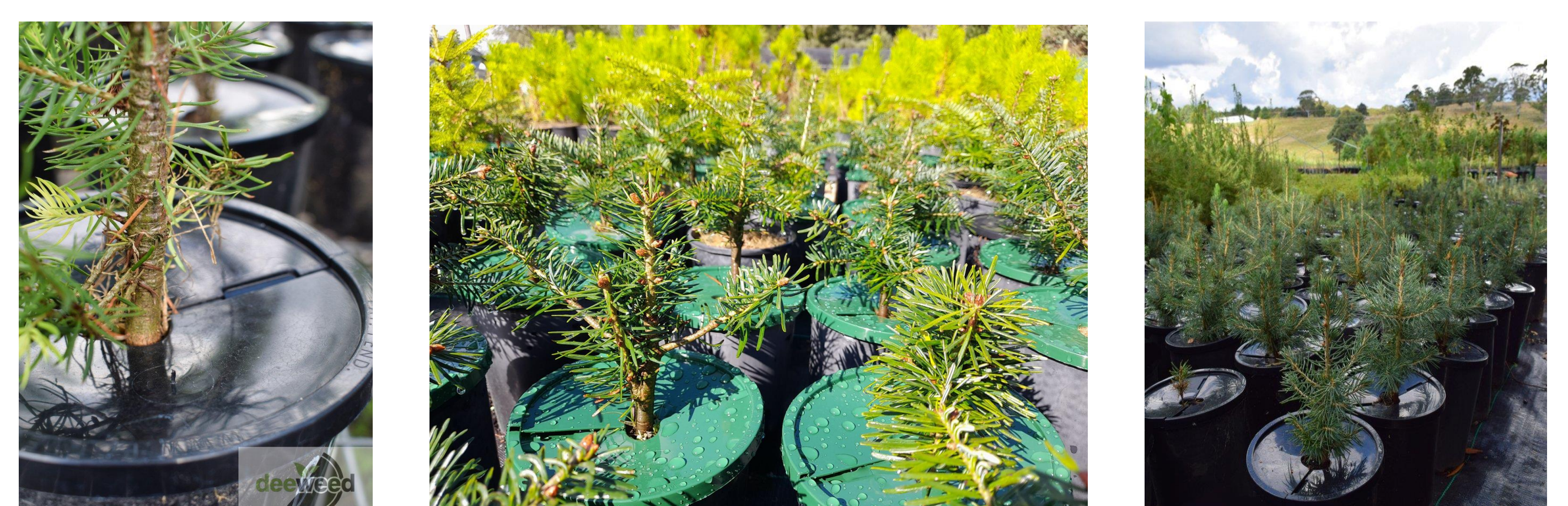
Weeds are constantly evolving and developments to the horticultural arsenal to combat these have been slowing in recent years. Indeed, nursery best practice weed management principles are similar to two decades ago while weed resistance to herbicides such as oryzalin and oxyfluorfen has increased steadily. As the overall weed loading was very low in this trial it is likely the plant growth was not significantly affected by weed growth, even in the control group. A longer running trial may show plant growth losses due to weed competition.

The herbicide 'Dismiss' used in the trial is permitted for use at maximum every 8 weeks. As the trial ran for just over 13 weeks, it is possible the herbicide weed control results would have been more competitive at the 8 week stage than they were by the end of the trial. A future study ending earlier may favour the herbicide more strongly. In the time lapse images and from monitoring, weeds could be seen to be growing considerably more from the herbicide group than the Potheads even at 8 weeks. It is also noteworthy that the PotHead and control did not develop moss. There may be a fertilisation effect of the herbicide or suppression of other weeds by the herbicide may favour moss growth compared to the control and PotHead. Coir mats may also provide a moist medium for moss to grow compared to the media in the control. Despite the media remaining moist beneath the Pothead, the prevention of light to the surface may have prevented the germination and growth of any moss in this group.

A subsequent experiment on water availability revealed that water loss from the pot is significantly lower under the PotHeads (see moisture retention trial: www.deeweedy.com.au/research/moisture-retention-trials). This led to the hypothesis that the plants under PotHeads were being overwatered compared to the other treatment groups. Another sub-experiment on temperature revealed the temperatures were more stable under the PotHeads which was predicted to affect growth however differences observed were insignificant. There were no significant differences between the treatment groups in terms of root collar diameter increase ($p > 0.05$) and no significant difference in height growth between coir and PotHead or control and PotHead. This indicates the weed control methods did not affect plant growth. The only outlier to this was the significant difference between the PotHead and Herbicide groups in height growth. This may indicate the herbicide caused a weak promotion of height growth compared to the PotHead. Conversely the mean stem thickness change was higher though not significantly in the Pothead group. Root collar diameter and height are two factors often taken together in assessing quality and health of plants in nursery grading systems. In summary, the relative weed suppression by the PotHead group and minor effects on plant growth indicate the PotHead could be a viable alternative to current weed control practices. Reducing the need for regular and laborious hand weeding and regular herbicide applications would provide immediate benefits to the horticulture industry with relevance worldwide.

Future Studies

Deeweedy are seeking other nurseries or researchers to further trial the PotHeads and provide feedback to guide the design process. Get in touch through the website here: <https://www.deeweedy.com.au/contact> and they'll send a box of Potheads and pots to suit. They intend to create PotHeads to suit common nursery production pots in the US, EU, UK, India, Japan, South Korea and China.



References

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