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Grower Summary – HNS 107a

Container HNS: Improving water management within growing media

Headline

Practical tests have been developed to test the efficacy of wetting agents and mulching materials for improving water management within container growing media. Results show that wetting agents are more beneficial in peat-based media than the more open textured peat-free medium, Sylvamix. Three wetting agents were identified that were economical to use and gave good wetting efficacy over a 6-month longevity. Coarse mulches such as pine bark or Cocoshell can significantly reduce evaporation from the surface of growing media.

Background and expected deliverables

There is an increasing need to improve the efficiency of water use on container nurseries. This is being driven by rising costs of water, and increasing legislation affecting its availability and potential pollution from nursery runoff. In addition, more efficient use of water for container crops through improved distribution, uptake and retention by containers is fundamental to achieving crop uniformity, maintaining quality, and ultimately to controlling and manipulating growth.

The water repellent nature of very dry peat media is well known, and dry pots, which are difficult to wet or re-wet, contribute to many of the problems of water management, and labour intensive spot watering found on nurseries. This project is one of several aimed at improving the efficiency of water use and irrigation in container nursery stock, and concentrates on the potential role of ***wetting agents*** and ***mulches*** (but not water retentive polymer gels) in water management.

The expected deliverables from this project were:

- Development of standard tests that could be used to evaluate and compare key properties of commercial wetting agents and mulching products for growing media.
- An assessment of the relative effectiveness of a range of commercial wetting agents on wetting ability of peat based and non-peat media, and their longevity and cost effectiveness under practical conditions.
- An evaluation of the effect of wetters and mulches on improving uniformity of irrigation and growth, and any savings in water and labour for spot watering that may be achieved in a container production system.

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Summary of the project and main conclusions

Laboratory based tests and experiments were carried out using media in 9 cm and 2 litre containers without plants to assess the key properties of several wetting agents and mulches.

Liquid and granular formulations of wetting agents were examined, including simple non-ionic formulations and more recent polymeric non-ionic surfactants, which are reputed to be longer lasting. Also two 'organic' formulations based on plant extracts were included. Tests were carried out with both nursery stock medium / coarse grade sphagnum peat (Scotts) and the peat-free medium, Sylvamix Nursery Stock grade, approx. 60% v/v composted pine bark + 40% v/v Sylvafibre from forestry trimmings (Melcourt Industries).

Table 1 Wetting agents used (Granular and Liquid) and media incorporation rates

Product	Type	Supplier	Rate in media*
Aquamix Granular	G	Fertil (France) via Fargro	0.5 g/litre
Aquamix Liquid	L		0.2 ml/litre
Saturaid Granular	G	Debco (Australia) via RH Professional Horticulture	1.5 g/litre
Ultrawet	L	Vitax Ltd	0.1 ml/litre
Celcote	G	Certis	2.0 g/litre
PsiMatrix	L	Aquatrols (USA) via Avoncrop Ltd	0.15 ml/litre
Biowet	L	Amega Sciences plc	0.2 ml/litre
Suffusion Granular	G		0.75 g/litre
Suffusion Liquid	L		0.2 ml/litre
Biowetter	L	Biotechnica Services Ltd via Vitagrow (Fertilisers) Ltd	0.6 ml/litre
Washing up liquid	L	Tesco Lemon Concentrated	1.0 ml/litre

* For liquids, these were diluted with water and added to media in the mixer. For 20 litre experimental mixes, the appropriate wetter was added to 1.0 litre water. Proportionately, much smaller volumes could be used in bulk loads down to about 5.0 litres/m^3 (per 1000 l) media depending on moisture level of the starting mix and providing mixing was thorough.

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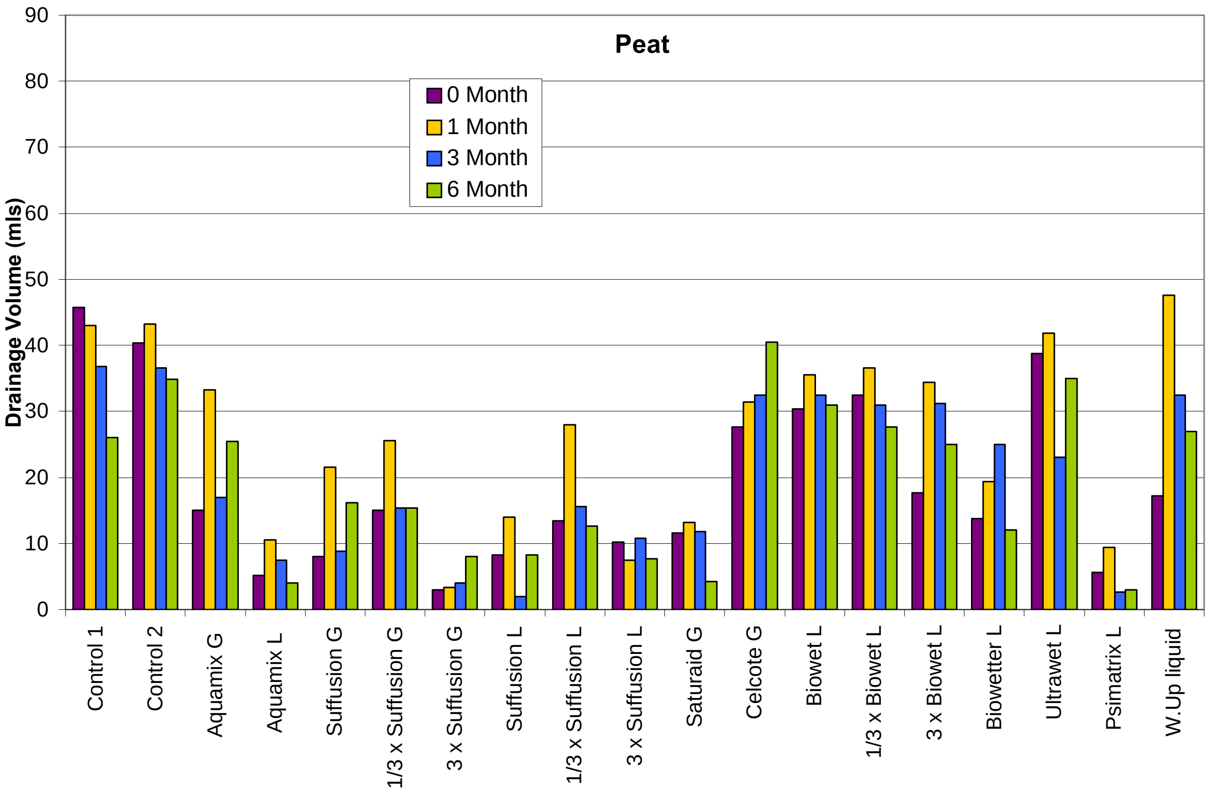
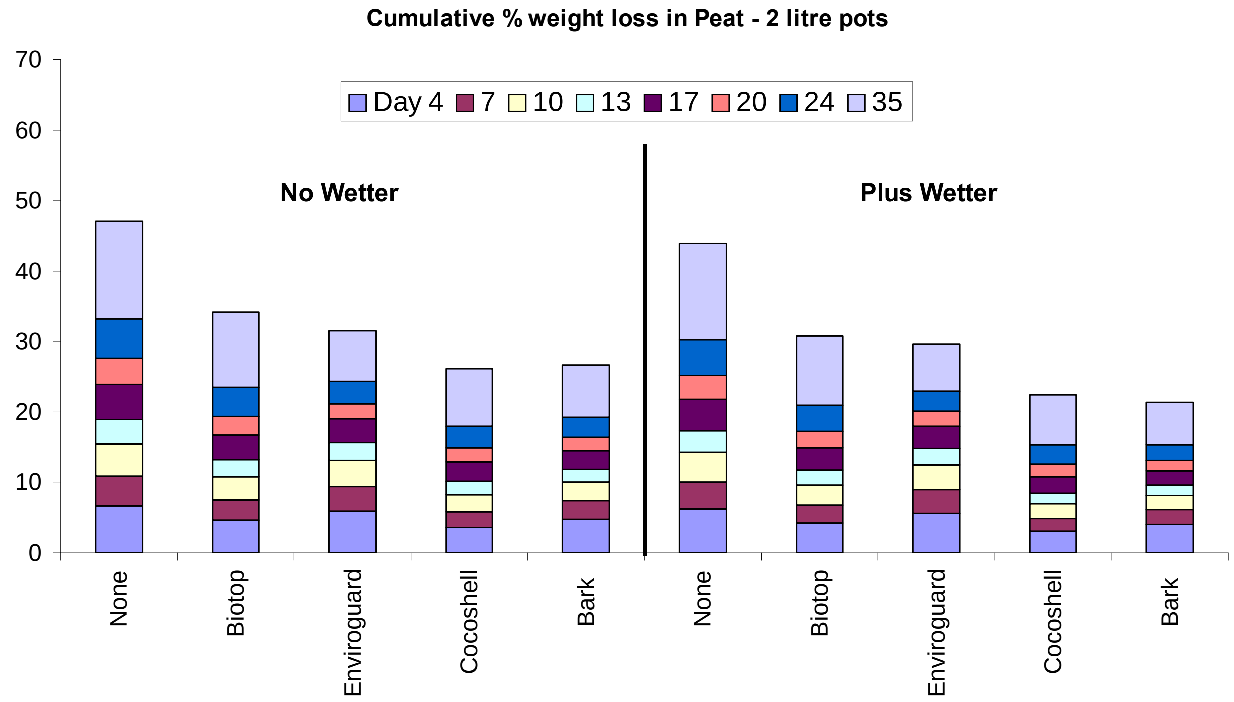
- Peat when very dry is more difficult to rewet than Sylvamix.
- Wetting agents are likely to be more effective in peat, which has a higher water holding capacity, than the more open textured media Sylvamix.
- A 'Pour-Through' test was developed for samples of media left undisturbed in containers, thus enabling wetters to be tested for their longevity.
- Moisture status of media has a major effect on wettability. Drying back samples to a standard moisture content of about 20% v/v before undertaking the pour through test gave consistent and reproducible results.
- Results from longevity testing demonstrated that washing up liquid rapidly biodegrades and by 1 month has lost efficacy as a wetting agent. Some other wetting agent products – Aquamix, Suffusion, Saturaid and Psimatrix, remained effective for at least 6 months following regular wetting and drying cycles to simulate a nursery environment. See Figure 1.
- Celcote, Ultrawet, and two organic formulations Biowet and Biowetter were less effective.
- Where liquid (L) and granular (G) formulations of the same product were compared, liquids were as effective or better than the granules, and much more economical. Taking material costs into account, treatment of media with Suffusion Liquid, Psimatrix (liquid) or Aquamix Liquid appeared the best value for money at about £1.00 - £2.00 per m^3. Other less effective treatments could cost up to £6.00 / m^3 at recommended rates of use.

Figure 1. Longevity of wetters in peat. Standard 'Pour-Through' test using 100 ml water into 9 cm pot. Some wetters tested at ⅓x and 3x standard rates.



- Wetters improve horizontal distribution of water within peat but not Sylvamix when applied from pot drippers.
- Evaporative losses from the media surface are not influenced by the presence of wetters (Figure 2). Peat loses moisture faster than Sylvamix and 9 cm pots dry out faster than 2 litre containers.
- In laboratory tests, a 1.5 - 2.0 cm depth of Cocoshell or Cambark 100 mulch significantly reduced evaporative losses by almost half compared to unmulched media. The finer textured and more absorbent materials Biotop and Enviroguard were less effective.

Figure 2. Effect of mulches on reducing evaporative losses from containers.



- No phytotoxicity was shown by any of the wetting agents when tested with mustard seedlings.

This project has demonstrated the potential for wetting agents and mulches under controlled conditions. Ideally a further evaluation with crops under nursery conditions is required and should concentrate on the following areas:

- The practicality of re-treatment of containers during the season, and the effectiveness of wetters after re-treatment.
- Further test of the benefits of wetters for capillary irrigation.
- Undertake experiments with plants in container production systems (primarily overhead) to evaluate the effect of wetters and mulches on improving uniformity of

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irrigation and growth, and estimates of savings in water and labour for spot watering that may be achieved.
- Evaluation of mulches under outdoor growing conditions.

Financial benefits

More data from the use of wetters and mulches in nursery growing systems is required to quantify the 'bottom line' benefits of water and labour savings, and associated advantages such as improved crop uniformity and quality that might be expected. However, it is clear that more efficient use of water will be required by nurseries in the future, and the project has shown that the use of wetters and mulches have potential to contribute to this as part of a package of water management improvements. For example, the benefits of a very uniform overhead or drip delivery system will be lost if water fails to be absorbed evenly by the growing medium, and a proportion is lost by 'run-through'. Wetters therefore have the potential to make the best use of the irrigation system. Likewise with mulches, in addition to potential water savings, a drier growing medium surface will reduce growth of moss, liverwort and weeds, and save labour on weeding by hand.

For a peat based growing medium at least, the £1.00 – 2.00 / m^3 cost of wetting agent treatment for a 6-month useful life would appear to be a worthwhile proportion of the £25 – 30 / m^3 total cost.

Action points for growers

- Check out the need for wetters with your media by turning out some containers. How thoroughly and uniformly are pots wetting up after irrigation on freshly potted and well established crops? Is there evidence of run-through and dry patches even after being 'well watered'?
- Where wetting or rewetting is inadequate (particularly in peat based media), look at incorporating a wetter such as Suffusion liquid, Psimatrix or Aquamix liquid at media mixing, or applying it to established crops as a drench.
- Consider using coarse textured mulches such as bark or Cocoshell on containers which are more exposed to drying out such as bed edges.

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Acknowledgments

Thanks are extended to all the suppliers of wetting agents and mulches for samples used in the project. Also thanks to Dr Arnie Rainbow (Rainbow-Wilson Associates) for initial guidance in the development of the 'Pour-Through' test for wetting agents.

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SCIENCE SECTION

INTRODUCTION

There is an increasing need to improve the efficiency of water use on container nurseries. This is being driven by rising costs of water, increasing legislation affecting water availability and potential pollution from nursery runoff. In addition, more efficient use of water for container crops through improved distribution, uptake and retention by containers is fundamental to achieving crop uniformity, maintaining quality, and ultimately controlling and manipulating growth. This project is one of several aimed at improving the efficiency of water use and irrigation in container nursery stock, and concentrates on the potential role of ***wetting agents*** and ***mulches*** in water management. Water retentive polymer gels are not being considered in this project.

Wetting agents

Typical commercial problems include:

- Initial wetting up of media after potting can require repeated and laborious hand watering. Poor or uneven initial wetting up can be responsible for uneven establishment of recently potted nursery stock.

- Overhead irrigation systems with wind drift, foliage canopy interference and 'edge effects' all compound problems with uneven water distribution both between, and within, containers. More expensive drip and sub-irrigation systems may also be prone to uneven water distribution to a lesser extent.

- Difficulties maintaining or re-establishing capillary contact in sub-irrigation systems (i.e. between containers and matting or sand bases).

- Patches of dried out pots, which are difficult to re-wet. High labour costs are incurred for spot watering by hand and picking up blown-over dry containers.

- Poor crop uniformity and growth resulting from over and under-watered pots within the bed and uneven leaching of nutrients. This will contribute to crop losses and poorer grade-outs.

- Difficulty of implementing effective irrigation scheduling, automation or potential for more subtle control of growth and flowering through restricted watering regimes (re: Water LINK project HNS 97).

- Wastage of water and risks of waterlogging / disease through excessive watering (for the driest pots).

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Anionic surfactants, including soaps and detergents, are unsuitable as wetting agents because they biodegrade too rapidly. Several basic non-ionic wetting agents have been available for many years, although they may have poor retention in growing media. More recently, newer products with different active ingredients and modes of action have become available including polymeric non-ionic surfactants. These are reputed to last longer because of strong retention by growing media particles, and slow degradation. There are also a few 'organic' products based on plant extracts. Wetting agents are available as liquids or granules, with some products available in both formulations. Dry granules are easier to incorporate evenly into media during mixing, although liquid formulations can be added satisfactorily when diluted with water. Top up or retrospective treatments of container plants during the season require liquid formulations to be applied as a drench. Top dressings of some granular formulations are also suggested.

Properties claimed for wetting agents include:

i) Easier and more rapid initial wetting and re-wetting of dry growing media.
ii) Improved redistribution of water within the container. For example minimising 'run-through' or 'channelling' of water through good lateral spread.
iii) Better retention of water by moist growing media.
iv) Improved capillary action.
v) Better drainage of surplus water (e.g. avoidance of 'perched water table' in the base of containers).
vi) Good longevity.

There was a need for independent testing of products commercially available in the UK for efficacy against these criteria. There are no UK or EC official standard test procedures for media wetting agents. However, some work has been done by Rainbow and Wilson (personal communication), and Australian researchers, which we have referred to in developing procedures in this project.

It is well known that the primary physical components of the substrate have a large influence on its wettability, and that peat based media can be much more difficult to wet than those with a significant mineral content such as loam or sand for example. Sphagnum moss peat becomes very hydrophobic when dry, probably because a significant amount of waxy cuticle can remain on the surfaces of partly decomposed leaves and stems. Peat based growing media still dominate the nursery stock industry, but to reflect the increasing importance peat-free alternatives, examination of the effects of wetting agents with a well established peat-free product, 'Sylvamix', were included in the project.

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Mulches

In addition to wetting agents, there are a range of mulches available for treating the surface of growing media. Their primary application has been as a non-chemical weed suppressant, but their potential to reduce water loss from the surface of growing media was also evaluated in this project.

Objectives

The overall aim of the project was to establish whether wetting agents or mulches are a useful aid to improving efficiency of irrigation management, through improving uniformity of water distribution within and between containers, capture of applied water and ultimately plant growth, quality, labour and water savings.

The first stage of the project was to develop and use some standardised tests to measure the important properties of different wetting agents and mulches in growing media to allow comparisons of different materials to be made under controlled conditions. This report describes several laboratory based tests and experiments using media in containers, without plants, to assess these properties.

Further practical evaluations of efficacy in a nursery situation with a crop are required to fully assess the value of these products. These could not be carried out within the timescale of this project, and further work at HRI Efford was unfortunately curtailed by the station's closure in October 2003.

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TEST REPORTS

Wetting Agent materials

Table 1 Granular (G) and Liquid (L) formulated wetting agents and media incorporation rates

Product	Formulation	Supplier	Rate in media*
Aquamix Granular	G	Fertil (France) via Fargro	0.5 g/litre
Aquamix Liquid	L		0.2 ml/litre
Biowet	L	Amega Sciences plc	0.2 ml/litre
Suffusion Granular	G		0.75 g/litre
Suffusion Liquid	L		0.2 ml/litre
Biowetter	L	Biotechnica Services Ltd via Vitagrow (Fertilisers) Ltd	0.6 ml/litre
Celcote	G	Certis	2.0 g/litre
PsiMatrix	L	Aquatrols (USA) via Avoncrop Ltd	0.15 ml/litre
Saturaid Granular	G	Debco (Australia) via RH Professional Horticulture	1.5 g/litre
Ultrawet	L	Vitax Ltd	0.1 ml/litre
Washing up liquid	L	Tesco Lemon Concentrated	1.0 ml/litre

* For liquids, these were diluted with water and added to media in the mixer. For 20 litre experimental mixes, the appropriate wetter was added to 1.0 litre water. Proportionately, much smaller volumes could be used in bulk loads down to about 5.0 litres/m^3 (per 1000 l) media depending on moisture level of the starting mix and providing mixing was thorough.

Product rates used were based on manufacturers' recommendations.

Some other experimental wetting agents (Quadrangle Q900, Cutinol Plus, Cutonic Foliar Booster, and Tallow amine) were also included in initial pilot study tests, but it was decided standard test procedures needed to be established first before they were examined further.

Growing media

In some pilot observations, coir was looked at, but even fully dry untreated coir remained easy to rewet so this medium was dropped from further study in favour of another peat alternative.

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The two media used were:

1 Nursery stock grade medium / coarse Shamrock peat - Scotts

2 Nursery stock grade Sylvamix (approx 60% composted pine bark + 40% Sylvafibre forestry trimmings) - Melcourt Industries

1 Water Repellence Tests

Objective

Gain some experience with a published test, designed to test how water repellent a growing medium is. See if it gives initial indications of relative efficacy of wetting agents.

Method

This test was based on the Australian Standard AS 3743 as described in Handreck and Black, *Growing Media for Ornamental Plants and Turf* (3rd edn. 2002) (Photo 1, Appendix).

1 Dry the test medium at 40 °C overnight.
2 Fill a pot saucer with dry medium to a minimum depth of 20 mm.
3 Make a small depression in the centre with a standard light bulb.
4 Pour on 10 ml of deionised or distilled water into the centre of the depression.
5 Record the time for the water to soak into the mix. The water is regarded as having soaked in when slight tilting of the dish gives no movement of water in the wet patch.

Peat and Sylvamix media incorporating a selection of wetters, plus untreated controls were mixed. Stocks of prepared media were kept sealed in polythene bags in a cold store to prevent excessive drying out or deterioration. Standard rates as listed in Table 1 were used, plus a half and quarter rate of the Suffusion Liquid formulation in peat only.

Samples of undried media were first tested with steps 2 - 5 above, using 3 replicates of each treatment. These saucers of media were then placed in a drying oven overnight at 40 °C, and the tests then re-run.

Subsequently, the test was repeated using new samples of media that had been dried in an oven at 60 °C for 24 hours.

Results

For the initial test with undried media, water absorption times, even for the untreated control medium, were all less than 5 sec (data not shown). After partial drying, treatment differences in water absorption times were apparent (Fig 1.1). The Sylvamix media were less water repellant than peat. For each medium, the untreated controls gave the longest absorption times. Although there appeared to be some large differences between wetting agents, they were not always

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consistent between media types. The amount of variability between replicates of some treatments also guarded against detailed comparisons at this stage.

Fig 1.1 Water repellence using partially dried media (mean of 3 reps)

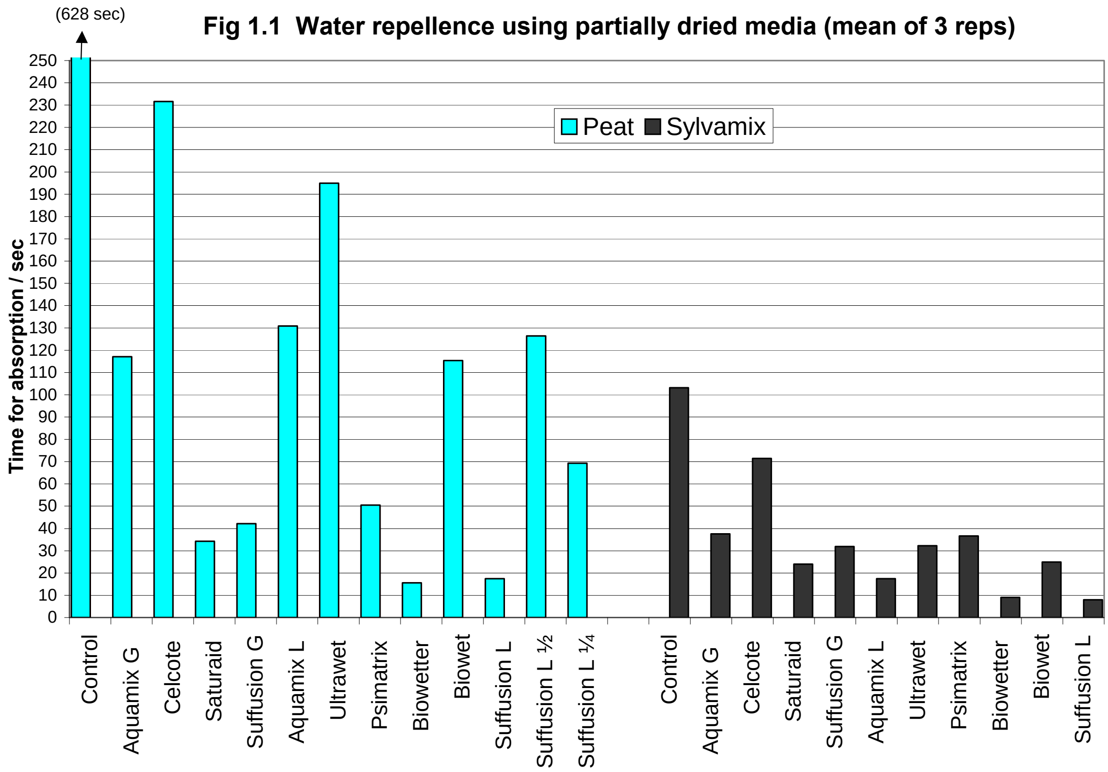
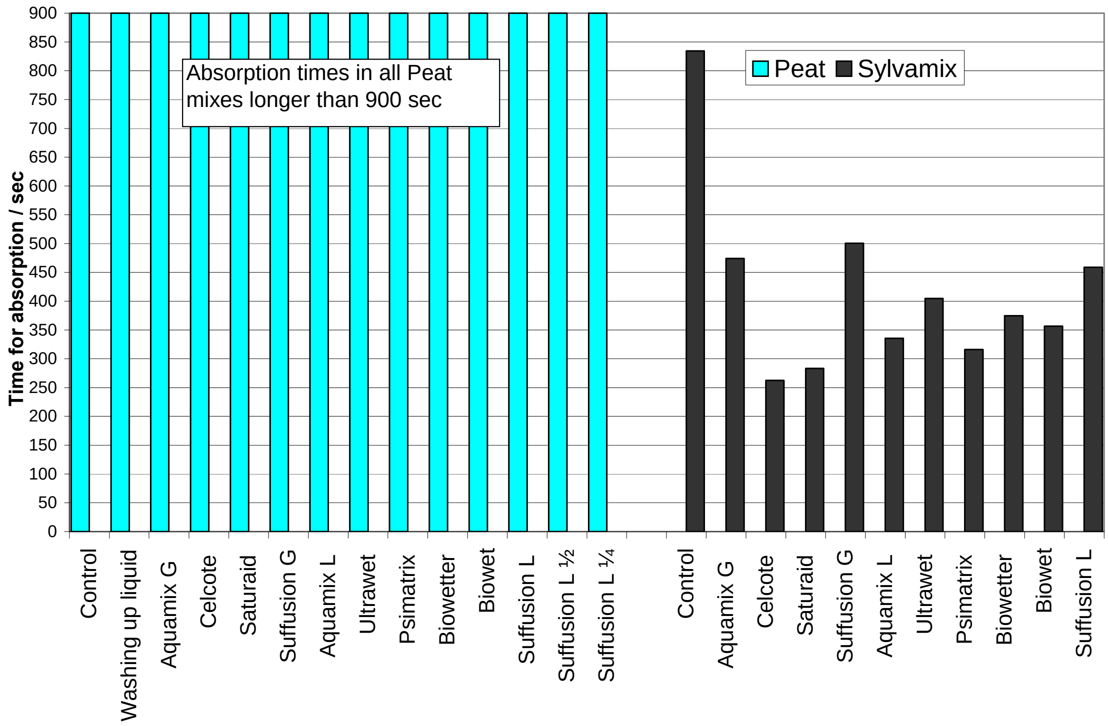


Fig 1.2 Water repellence using fully dried media (mean of 3 reps)



With the second batch of fully oven-dried media (60 °C for 24 hours), all the peat mixes proved very water repellent with little or no absorption after 15 minutes. The Sylvamix media did show

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a large difference in absorption time between the control and the mixes containing wetters, but even the fastest wetter took 250 sec compared to times under 40 sec in the previous test (Fig 1.2).

Conclusions

Peat media, once dry, is more difficult to wet than Sylvamix.

The moisture status of the growing media has a very large effect on test results. The first batch oven dried overnight at 40 °C still contained sufficient moisture to prevent the highly hydrophobic effect observed with the second samples dried for 24 hours at 60 °C. The test may be useful for making some relative comparisons between media tested at the same time, but further experience is needed before using the test to give reliable quantitative results.

2 'Pour-Through' test

Objective

Design a test that will reliably measure the wetting and re-wetting ability of growing media in containers.

Method (1)

The principle of this test was simple. A given quantity of water was poured onto a container of growing medium, and the quantity of drainage measured. The amount of water retained was a measure of wettability. However, standardising a procedure to give reliable results was difficult and time consuming.

Media mixes made up for the water repellence tests described above were also used for the initial experiments with this procedure. Three replicate full depth 9 cm pots (Plantpak 9F) were filled for each of the media, which were at a moisture content suitable for potting (approx. 50 - 70% w/w).

A consistent method of filling, tapping and levelling off pots was used to ensure a consistent volume per pot. Water was poured onto test pots using apparatus as shown in Photos 2 & 3 (Appendix). Some mixes absorbed all of a 50 ml dose of water without drainage, so this was increased to 100 ml. As with the water repellence test, the experiment was performed once on fresh moist media, then repeated following partial drying of the pots overnight in an oven. Finally the experiment was repeated using fully oven-dried media.

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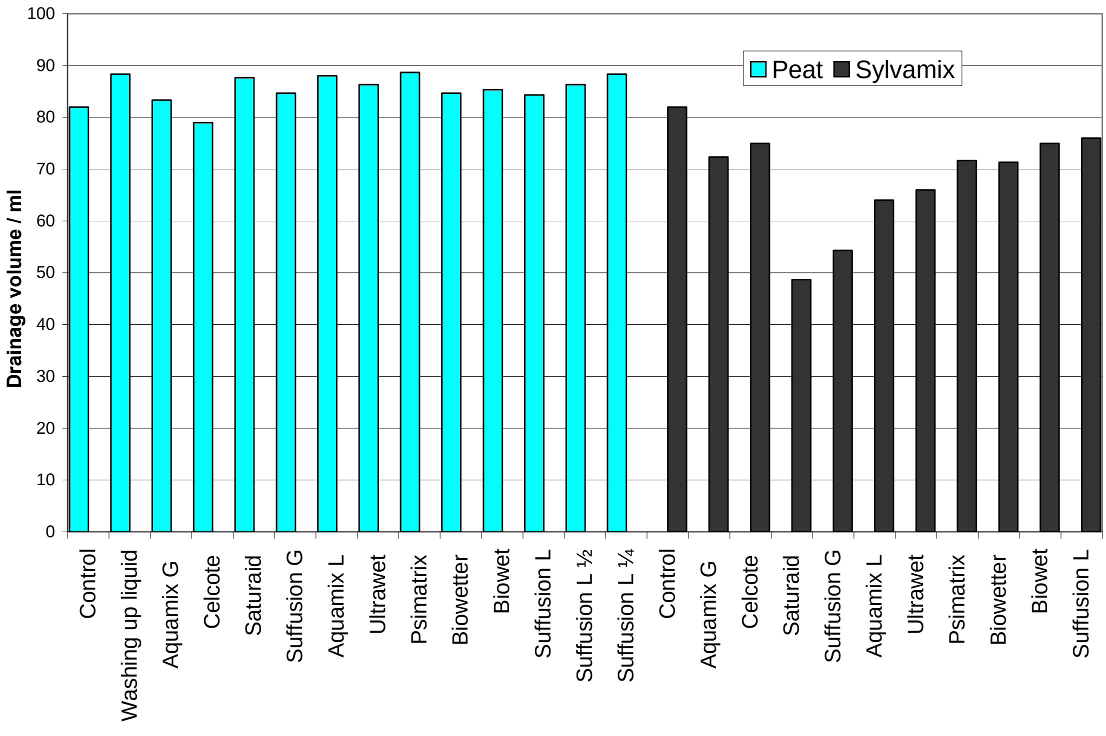
Results (1)

The results from the batches of fresh and partially moist media, were unexpected. Although there was reasonable consistency between the replicates, the untreated control peat and Sylvamix did not show poor wettability compared to most of the wetter treatments and did not follow a logical pattern (data not shown). It is likely that moisture levels in the media in both tests were still too high for the wetting agents to improve absorption.

With the next experiment using fully oven-dried media, results showed similarities to the water repellence test. All the treatments in peat showed little wettability with 80 - 90 mls of the 100 ml water applied draining straight through the pots, whereas wetters in Sylvamix showed some absorption (Fig 2.1). Differences from the control, however, were not large except for Saturaid and Suffusion Granules.

Fig 2.1 Drainage from Pour-through test on fully dried media (mean of 3 reps)



Method (2)

Rainbow and Wilson drafted a method (currently unpublished) whereby a sample of growing medium is dried back to a known moisture content before the pour through test is done. Their recommendation is that moisture content is expressed as % on a volumetric rather than a weight basis, as it helps enable meaningful comparisons between media that differ in dry matter bulk density. From their experience with peat, moisture content should be < 24% v/v, and for comparison of data over time, fixed at about 15 - 20% v/v. They point out that samples that are too moist will tend to obscure latent differences in wettability. Their method used loose media that was dried back on a tray to the desired moisture content before filling pots. The limitation

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with this method was that it could not be used to test a sample of settled medium in a container repeatedly over time to assess changes in wettability and wetting agent longevity in a nursery environment.

We therefore modified the procedure to allow media to be dried back to an estimated 20% v/v while still in the container. We filled containers using the standard procedure as previously described, but then watered them thoroughly through a fine rose to ensure media was well settled in the container. An estimate of the actual volume of settled media in the pot was made by measuring the height of the media surface from the pot rim, and calibrating volume with different levels of water in a sealed pot. Eight replicate samples of peat and Sylvamix in 9 cm pots were wetted and settled, and then fully oven dried and weighed. Knowing the volume of the test samples of media, it was then possible to estimate the weight each pot needed to dry back to for a 20% v/v moisture content using the following formula:

$$W = S + (20/100 \times V)$$

Where W = weight of media + pot at 20% moisture content (g)
S = weight of fully dried media + pot (g)
V = volume of settled media in container measured as above (ml)

The value of S was found to be about 48 g for our settled sample of dried peat and 82 g for Sylvamix (inclusive of 12 g pot weight). The value of S varied with V, but the error was negligible over the range of media volumes encountered (275 - 320 ml).

To improve precision with the test, 5 replicate pots / treatment were used to test the procedure using a limited range of 8 wetter treatments (including control) x 2 media. The methodology otherwise was followed as described above, using 100 ml pour through doses per pot.

Results (2)
As in previous tests there were clear differences in water retention in the Sylvamix compared to the peat (Fig 2.2). But unlike the pour through test with fully dried peat, which was almost totally hydrophobic, peat at 20% v/v moisture level, while still appearing ‘dry’, showed good absorption with wetters compared to the control, and overall more absorption capacity than Sylvamix. Good differences between the control and wetter treatments were still evident in the Sylvamix. Differences between wetter treatments were not very great, but Biowet in peat did not appear as good as Saturaid, Suffusion G and Suffusion L. Also, washing up liquid in this fresh mix gave as good wetting action as the proprietary products.

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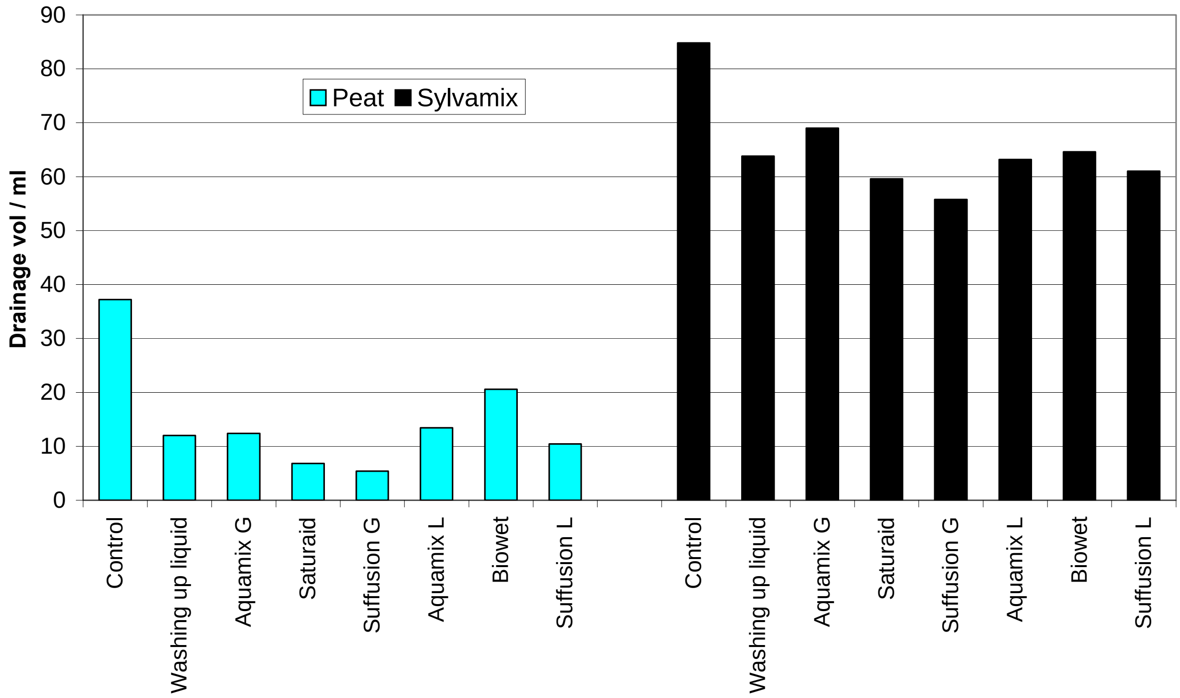
Fig 2.2 Drainage from pour through test on media at 20% v/v



Method (3)

Some 9 cm and 2 litre containers of media as used for the Retention of Moisture experiments (see on), were used to see whether comparable results to the laboratory pour through test could be obtained from using an overhead sprinkler system to apply water more slowly to the containers when pots had reached 20% v/v moisture. An overhead sprinkler system applying water at about 6 - 8 mm / hour was used with treatments laid out in a randomised block. The test pots were wedged into slightly smaller pots lined with polythene bags to catch the run through with sufficient space above the drain water to prevent re-absorption. Total quantities captured by each container and the amount of run through could thus be measured. For the 9 cm and 2 litre pots respectively, irrigation doses averaged 102 (s.d. 31.4) ml/pot and 480 (s.d. 156.0) ml/pot respectively. Three replicates of the 9 cm pots were compared with the pour through and sprinkler systems, and 5 replicates of 2 litre pots were used with the sprinkler system only. A double set of control treatments were used for comparisons.

Results (3)

Fig. 2.3 illustrates the run through expressed as a % of that applied. For the 9 cm pots tested with the pour through method, large differences in wettability of the peat mixes were apparent. Both formulations of Aquamix and Suffusion, and Saturaid gave good absorption, whereas Biowet and the washing up liquid were little different from the controls. These tests were done about 1 month after the mixes had been made for the previous experiment which had been carried out indoors, and it is likely that biodegradation of the washing up liquid treatment had occurred at this stage. Apart from Suffusion G, the Sylvamix treatments differed little.

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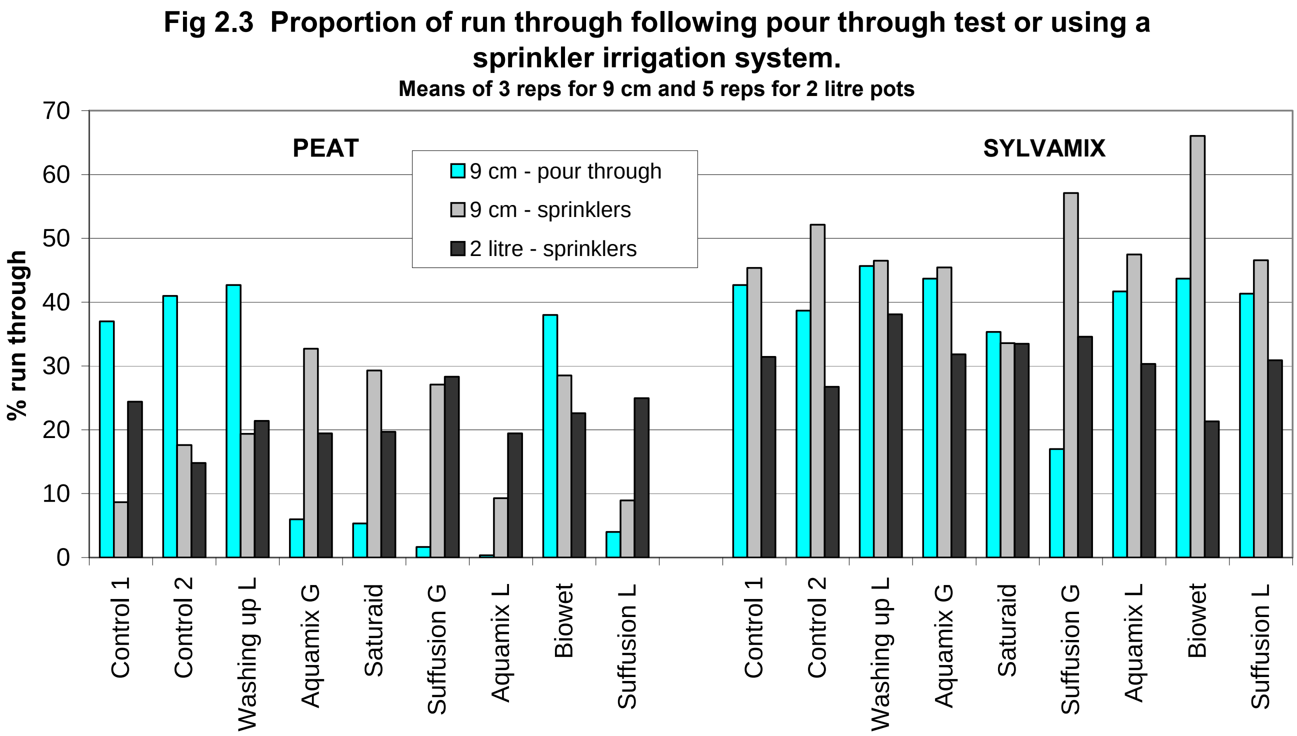

The treatments which had been wetted under the sprinklers gave somewhat variable and unexpected results, with the control treatments for the peat absorbing water as least as well as the treatments containing wetter. Whether this was a result of the water having been applied more slowly under the sprinklers, and the wetters thus being of less benefit is not clear and needs further investigation. However, there was some considerable variation from pot to pot in the total quantities of water captured under the sprinklers. The proportion of run through was also correlated with the amount of water received; it is likely that this proportion increased markedly as pots approached their water holding capacity.

Conclusions

Wettability of media has again shown to be sensitive to moisture content, with 'oven dry' peat being apparently more hydrophobic than Sylvamix, whereas moderately dry peat being more absorbent. Standardising the moisture level before testing is thus important for obtaining reproducable results. The laboratory pour through test applied to pots dried back to about 20% v/v appears to give a reasonably reliable measure of wettability of growing media in containers. This should form a good basis for testing longevity of wetting agents.

Further investigation is needed before this method can be extrapolated to pots wetted using sprinklers.

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3 Longevity testing for wetting agents

Objective

To test the efficacy of a range of wetting agents over time using the standard pour-through method.

Trial 1, May – November 2002

Method

Peat and Sylvamix media were each combined with six wetter treatments plus an untreated control. 9 cm pots were used with five replicates of each and sufficient pots to enable sampling to take place after 0, 1, 3, and 6 months. The trial started in mid April 2002. To simulate nursery conditions, the containers were laid out in Empot carrier trays in randomised blocks under overhead sprinklers on an outside gravel bed. The sprinklers applied water at a rate of about 8 mm / hr, and irrigation was applied for 30 minutes twice a day. Pots were removed at the sampling times and left to dry back to 20% v/v before having the standard pour-through tests done.

Results

Start of trial sample

See Fig 3.1 below. In peat, the control mix allowed almost 40% of the applied water through. All the other wetters performed well in peat although the Biowet was the poorest, allowing 20% of the applied water through. The Suffusion granule and Saturaid mixes with peat performed the best allowing only about 5% - 7% of applied water through.

As in previous experiments, Sylvamix retained less water when 100 ml was applied at 20% v/v moisture content. In the control, 85% of the applied water drained through. The addition of all wetters to the Sylvamix improved its water holding capacity. Again, Suffusion granules and Saturaid performed slightly better than the other wetting agents.

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Fig 3.1 Longevity trial 1. Run through at start of trial

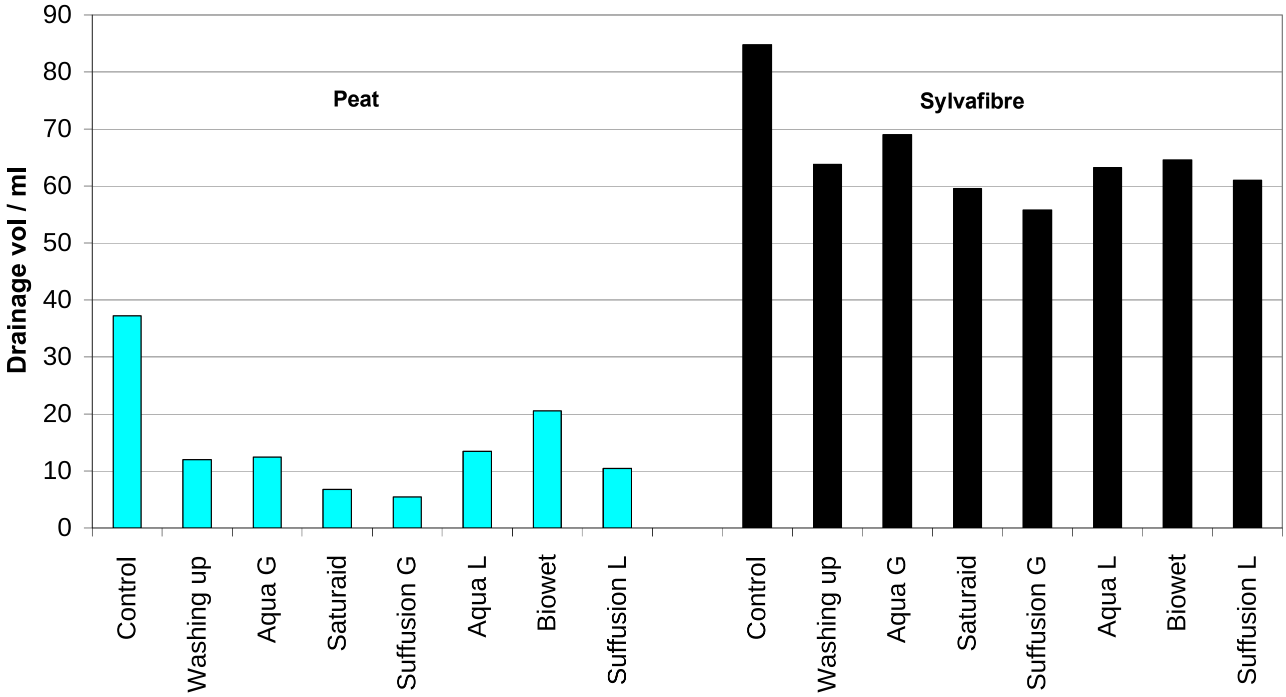
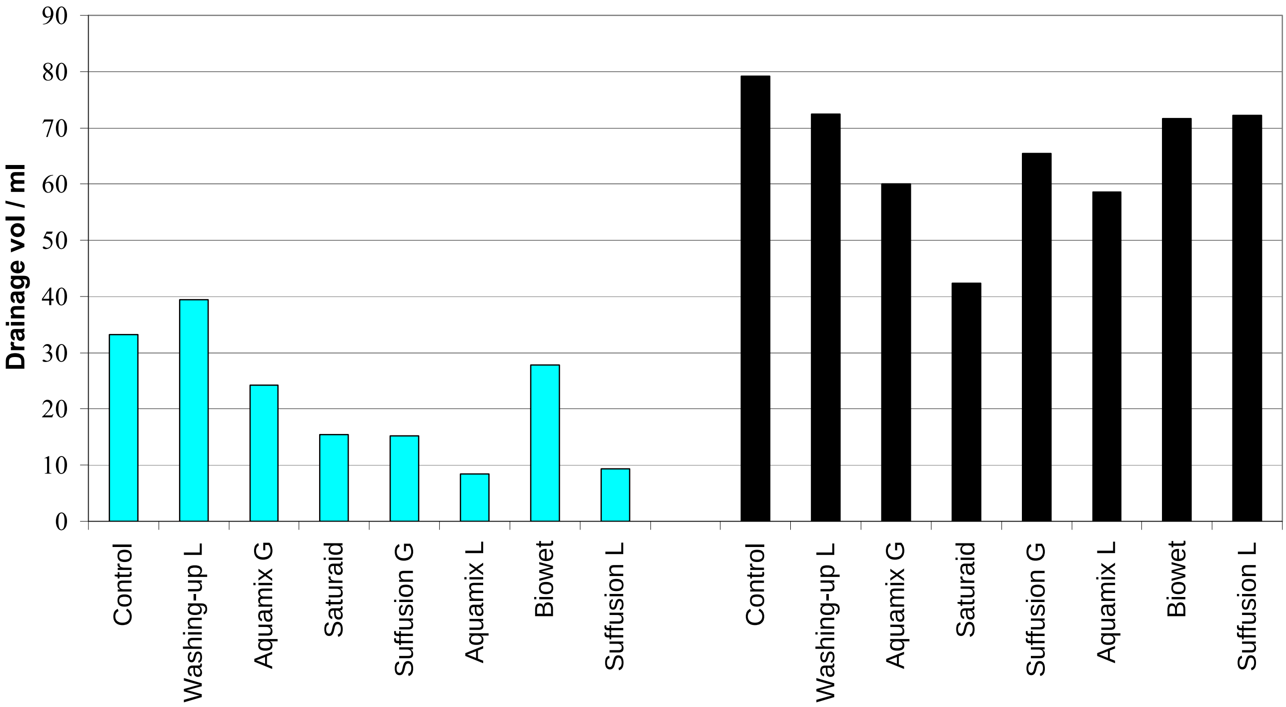


Fig 3.2 Longevity trial 1. Run through after 1 month



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Sample at 1 month

As at the start, the largest difference was between the peat and the Sylvamix, regardless of wetter, with the peat retaining more water when the pour through tests were done (Fig 3.2).

All the wetters in the peat, with the exception Aquamix liquid, were slightly less effective after one month, but all apart from the washing up liquid were wetting better than the control. The washing up performed as well as most other wetters at the start of the experiment, but was worse than the control after one month, showing clear evidence of degradation. As in previous experiments, Biowet did not appear to be as good as some other wetters.

In Sylvamix, after one month, the control still performed poorer than the wetters, but differences were often small. Saturaid, however, looked promising at this stage.

Water holding capacity

At this point, an additional test for water holding capacity of the two media was undertaken to help explain the large difference in overall results between peat and Sylvamix. It was suspected that the water holding capacity of Sylvamix was less than that of peat, and adding 100 ml of water in the pour through test was taking it nearer to its capacity and thus causing relatively more drainage.

Five replicate 9 cm pots of each mix were heavily watered to saturation and drained for 30 minutes. The medium was weighed when wet, and again following oven drying to obtain a total water content. The volume of settled media in the pots was estimated as previously described.

At pot capacity, peat contained 75% v/v water, and Sylvamix 56% v/v. For an average volume of 300 ml per 9 cm pot, this was equivalent to about 225 and 168 mls respectively. After drying back to 20% v/v, pots would have contained about 60 ml, so adding a further 100 ml during the pour through test would have raised levels to
160/225 = 71% of the pot capacity for peat
160/168 = 95% of the pot capacity for Sylvamix.

While both these amounts are within the total WHC for each mix, significant drainage could be expected from the Sylvamix in particular, because the application rate would have exceeded the rate at which water could be absorbed throughout the pot volume.

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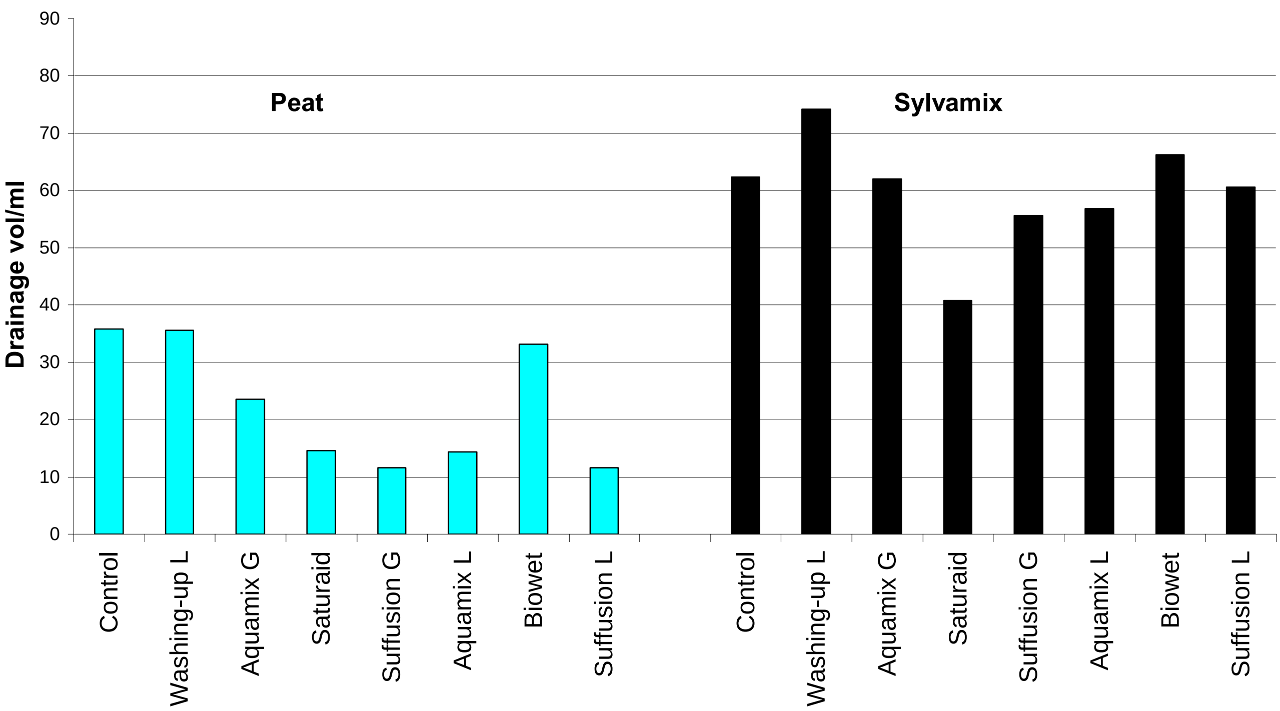
Sample at 3 months (Fig. 3.3)

After the pots had been outside under the sprinkler system for three months a further sample was taken. Again, the trends were very similar to those at the start and at the one-month sample with the largest difference being between the peat and the Sylvamix.

The washing-up liquid continued to demonstrate its ineffectiveness with results broadly similar to the control. And again Biowet was the poorest of the wetters in both peat and Sylvamix. Saturaid, which looked promising after one month also performed well in the peat and was the best wetter in Sylvamix.

Fig 3.3 Longevity Trial 1 : Run through after 3 months



Sample at 6 months (Figs. 3.4 and 3.5)

In order to test the wetters' effectiveness over a longer period the last sample was left for six months in total. This exposed the pots to a greater range of weather conditions in addition to the overhead sprinklers.

Overall, the results indicate a reduction in the effectiveness of all the wetters with the exception of Saturaid, which again was the best performing wetter in both peat and Sylvamix.

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Fig 3.4 Longevity trial 1. Run through after 6 months

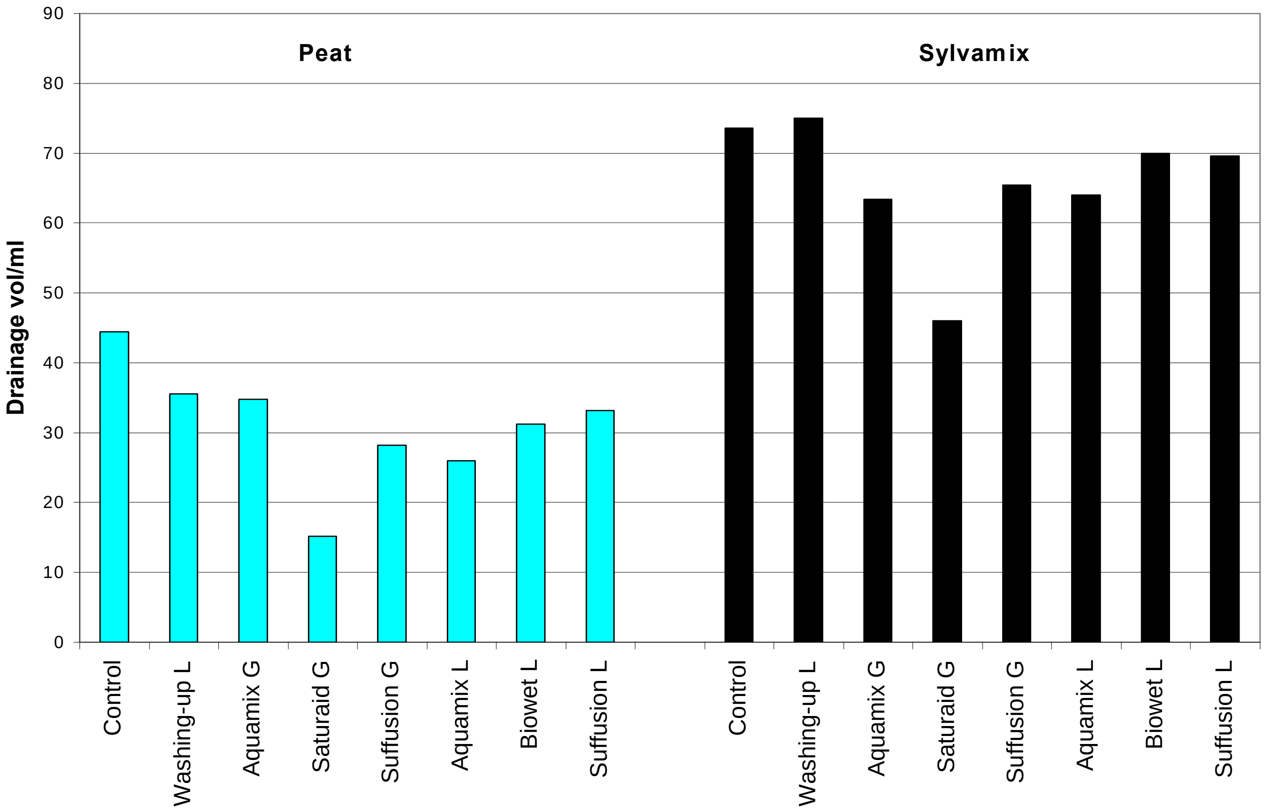
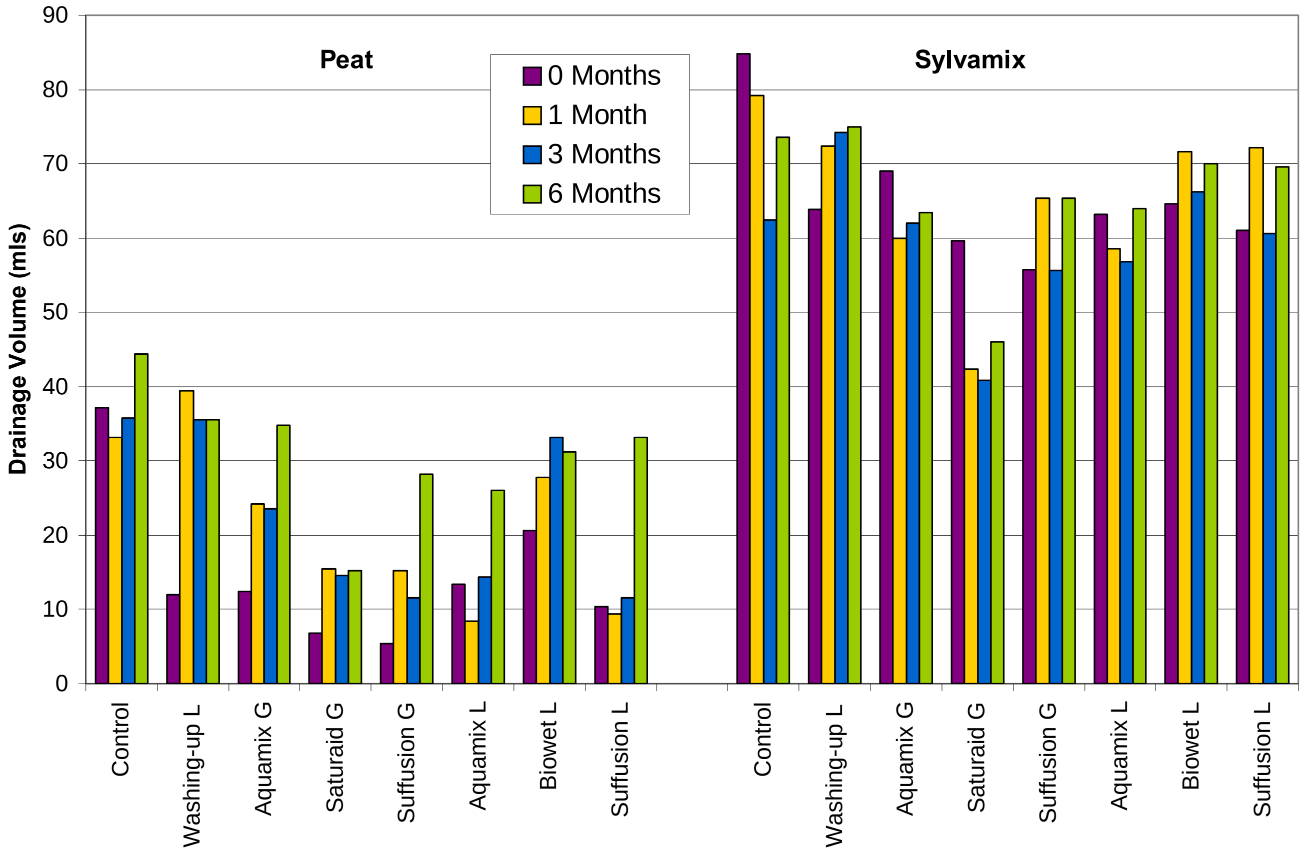


Fig 3.5 Longevity Trial 1 Summary. Run-though from 0 - 6 Month Samples.



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Trial 2, August 2002 – February 2003

Method

It was decided to repeat the longevity trial using a wider range of both organic and non-organic wetters, with some used at ⅓x and 3x rates. All the pots were placed under protection in order to control the water applied by overhead sprinklers more uniformly.

All wetters were added to 1 litre of water prior to incorporation into 20 litres of media. The two control treatments also had 1 litre of water added to ensure evenness of moisture content between the mixes. Five 9 cm pots were filled according to the standard method for each of 17 wetters plus 2 controls (no wetter) in combination with the two media as before. This gave 38 treatments x 4 sampling occasions x 5 replicates to give a total of 760 pots. The pots were laid out in Empot carriers in randomised blocks on sand beds in a polythene tunnel. Overhead sprinklers applied water at a rate of approximately 8.5 – 10 mm/hr. Sample pots were removed after 1, 3 and 6 months, and left to dry back to 20% v/v before being subjected to the standard pour through tests. Table 2 lists the wetters and rates used.

Table 2 Wetters used in Trial 2 and rate of use (g or ml per litre of growing medium)

Wetter	Rate	Wetter	Rate
Control 1		Saturaid (granules)	1.5 g/l
Control 2		Celcote (granules)	2.0 g/l
Aquamix granules	0.5 g/l	Biowet (liquid)	0.2 ml/l
Aquamix liquid	0.2 ml/l	Biowet (liquid) x ⅓	0.067 ml/l
Suffusion granules	0.75 g/l	Biowet (liquid) x 3	0.6 ml/l
Suffusion granules x ⅓	0.25 g/l	Biowetter (liquid)	0.6 ml/l
Suffusion granules x 3	2.25 g/l	Ultrawet (liquid)	0.1 ml/l
Suffusion liquid	0.2 ml/l	Psimatrix (liquid)	0.15 ml/l
Suffusion liquid x ⅓	0.067 ml/l	Washing up liquid	1.0 ml/l
Suffusion liquid x 3	0.6 ml/l		

Results

Figure 3.6 summarises the results at 0, 1, 3 and 6 months in both peat and Sylvamix media.

Samples at start of trial

In peat, the greatest initial improvement in water holding ability was achieved with the Aquamix, Suffusion, Psimatrix, Biowetter, Saturaid and washing up liquid treatments compared to the untreated controls. The effect from Ultrawet, Celcote and Biowet (except Biowet at the 3x rate) were small or negligible. In Sylvamix, as in Trial 1, wetters were relatively less effective because of the overall lower WHC of this medium. Nevertheless, some of the most effective

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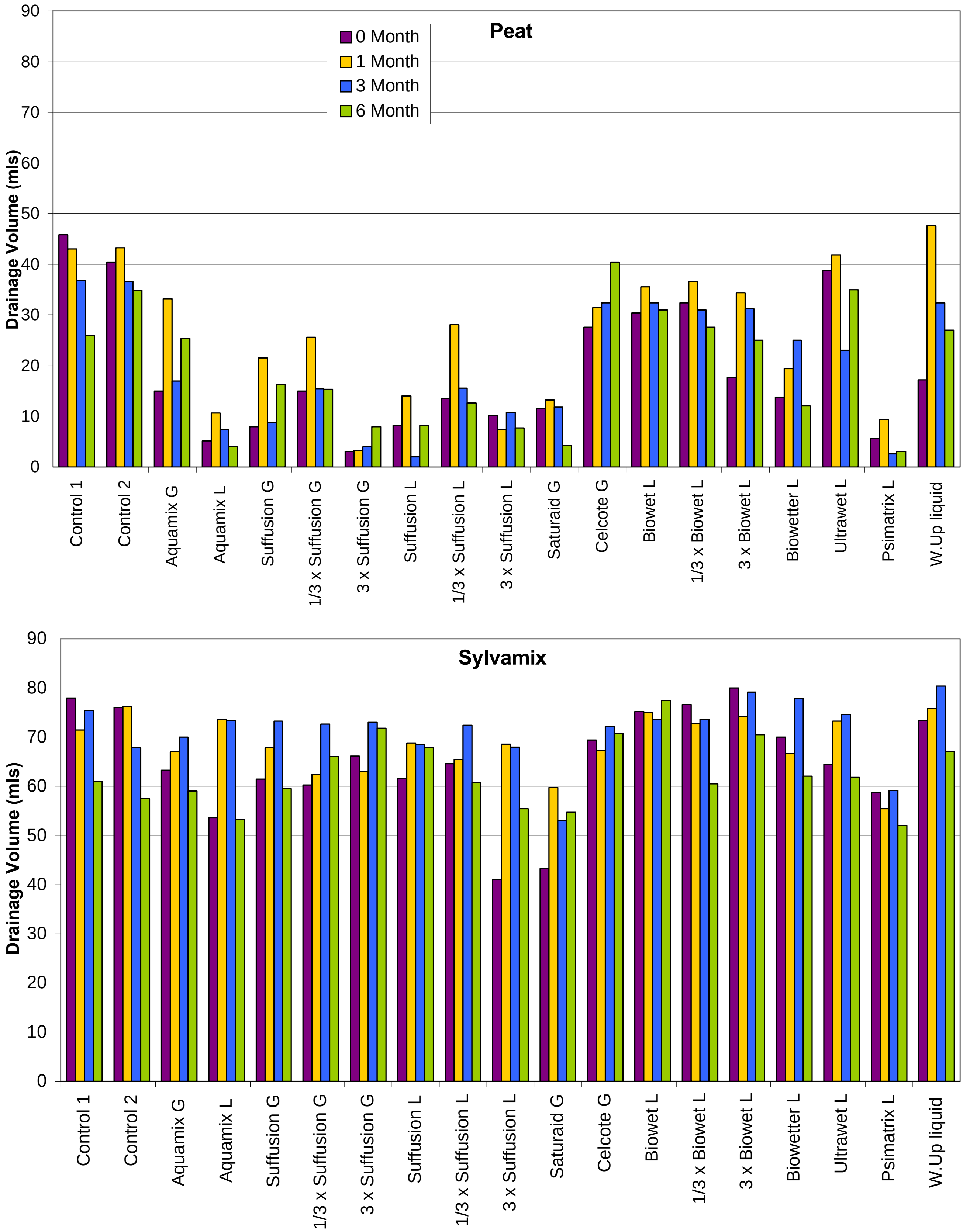
wetters in peat were also giving a measurable increase in water holding capacity in Sylvamix, in particular Aquamix L, the 3x rate of Suffusion L, Saturaid, and Psimatrix.

Figure 3.6 Longevity Trial 2 summary. Run-through from 0 – 6 month samples



Samples after 1, 3 and 6 months

After one month, the amount of run-through from the standard test had doubled for several of the peat treatments including Aquamix G, washing up liquid, some of the Suffusion liquid and granular treatments, and the 3x Biowet treatment. However, after 3 and 6 months, wettability was apparently restored, with run-through quantities from the test that were similar or even less than those at the start. Both the untreated control treatments in peat and Sylvamix also showed some improvement in wettability over time.

It is possible that the moisture status of the samples at one month was not uniform, or not at the standard level for the test which may have allowed a greater than expected run through. Also, the improvement in wettability over the trial shown by the control treatments, suggests that some 'maturation' of the media had occurred following the successive wetting and drying cycles they were subjected to. This may have encouraged a partial breakdown of the water repellent compounds in the substrate. Despite this, some of the wetter treatments, particularly in peat, showed they achieved significantly better wetting of the substrate throughout the trial than in the controls.

At the final sample at 6 months, Psimatrix, Aquamix L, Suffusion L and Saturaid G at the standard rates showed the best performance in peat, followed by Suffusion G and Biowetter. Results in Sylvamix were less clear-cut as the untreated controls showed apparently better wetting than some of the other treatments. Nevertheless several of the wetters that gave the best results in peat, such as the standard rates of Psimatrix, Saturaid G, and Aquamix L, also gave the best results in Sylvamix.

Adjusting rates of wetter did have some effect where they were compared. E.g. in peat, the 3x rate of Suffusion G (but not Suffusion L) performed better than the standard rate, and the ⅓ rate of both Suffusion formulations were poorer than the standard rate for most sampling dates. With Biowet, there was some slight indication that higher rates improved performance for some of the sampling dates, but even the 3x rate performed more poorly than most of the other wetters. However, there was insufficient evidence from this Trial to recommend using higher rates than our 'standard rate'.

Cost of wetting agent products

See Table 3 below. Treatment costs varied considerably, even amongst different formulations from the same manufacturer. For Aquamix and Suffusion, where liquid and granular formulations of the same product could be compared, the cost of using the liquid formulation was significantly lower. Granular formulations may be slightly more convenient to incorporate in a medium at the mixing stage, but with care, addition of a liquid in the right volume is not difficult, and is more economical. Although not examined in this project, re-treatment of media in the growing crop would, of course, also require the liquid formulation to be used. The most

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effective products in the longevity standard tests were Suffusion Liquid, Aquamix Liquid, Psimatrix and Saturaid Granular. Suffusion Liquid and Psimatrix were also amongst the least expensive of the product range, and so would appear to offer the best value based on these evaluations.

Table 3 Materials cost of treating growing media with wetting agents (Feb 2004 prices)

		Price (excl. VAT)			Rate of use*		
Supplier	**Wetter product**	**£ / pack**	**Pack size**	**Unit**	**Qty**	**Unit / m^3 of media**	**Treatment cost £ / m^3 media**
Amega Sciences plc	Biowet	39.00	10	litres	0.20	litre	0.78
	Suffusion Granular	120.00	20	kg	0.75	kg	4.50
	Suffusion Liquid	90.00	20	litres	0.20	litre	0.90
Fargro	Aquamix Granular	70.00	10	kg	0.50	kg	3.50
	Aquamix Liquid	48.60	5	litres	0.20	litre	1.94
Vitax	Ultrawet	112.00	10	litres	0.10	litre	1.12
Certis	Celcote	90.00	25	kg	2.00	kg	7.20
Vitagrow (Fertilisers) Ltd	Biowetter	50.00	5	litres	0.60	litre	6.00
Avoncrop Ltd	Psimatrix	45.00	5	litres	0.15	litre	1.35
RH Professional Horticulture	Saturaid Granular	53.00	20	kg	1.50	kg	3.98

*Rates in litre or kg / m^3 equivalent to ml or kg / litre. These incorporation rates were our 'standard' rates as used in the trials. Where a range of rates was given on product labels, a rate was chosen following guidance from product representatives. This was not necessarily the mid-point of the label range.

Conclusions from Longevity Trials 1 and 2

- Peat is more responsive to the use of wetters than Sylvamix both because peat has a higher water holding capacity, and also because components in peat appear more water repellent when dry.
- The degradation of washing up liquid after one month, previously shown in section 2, was demonstrated again here in the longevity trials.
- There were clear differences in wetter performance in peat. Suffusion, Saturaid, Aquamix and Psimatrix all performed well, whereas Celcote, Ultrawet, and the two organic formulations Biowet and Biowetter, were less good.
- In Trial 1, the effective wetters remained active until at least 3 months, but performance had apparently dropped off by the 6-month assessment. In Trial 2, the best wetters were still showing good performance at the 6-month assessment. This suggests that some manufacturers' claims of a 6 month longevity are reasonable, but future work could usefully extend assessments further to see if any wetters are capable of giving useful activity over a full growing season.
- Where liquid and granular formulations of the same product were compared, liquid formulations were as effective or better than the granular formulation.
- In the absence of further information, the standard rates as used in Trial 2 are recommended.
- Taking material costs into account, treatment with Suffusion Liquid, Psimatrix or Aquamix Liquid appeared the best value for money at between about £1.00 – 2.00 per m^3.

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4 Horizontal distribution of water from a drip irrigation system

Objective

To investigate whether the addition of a wetter to a media can improve lateral water distribution within the pot.

Method

In order to obtain an indication of lateral water distribution, 2 litre Rootrite pots were used; these were internally divided into four segments or legs 1/3 of the way up the pot. Each of these segments was placed in a container to collect the run-through with a pot dripper inserted above one of the segments (Photos 4 - 6, Appx. 1). Drainage from segments other than that below the dripper should be an indication of better water distribution.

Two media and three wetters (Saturaid, Aquamix granules & Aquamix liquid), plus an untreated control were used to give eight treatments. There were five pots of each treatment giving a total of forty pots.

An irrigation system consisting of forty drippers was set up in an unheated and shaded glasshouse. All the drippers were tested prior to insertion in the pots to ensure an even flow rate. This was found to be very uniform giving a dripper rate of 1000 – 1100 mls/hour. All pots were watered overhead to capacity and allowed to drain overnight before beginning testing. Drippers were inserted 5cm. from the pot edge. During testing, all drippers were run for 60 minutes.

Results

See also Tables 4.1 - 4.2 and Figs. 4.1 - 4.3

1st. test: 12.4.2002

The drippers were inserted in the 'south' segment and a mean dripper rate of 1074 ml/hour was recorded.

The addition of wetters had a positive effect when combined with peat. All three wetters spread water better than the control with both the Aquamix granules and the Aquamix liquid doubling the percentage of water in the pot sections not directly under the dripper, and the Saturaid almost double the control. (Table 4.1). Additionally, the Saturaid substantially increased the percentage of applied water retained in the pot whereas both Aquamix formulations were approximately equal tot he control (Table 4.2).

The results were quite different with Sylvamix. This medium had a much more open structure than peat, was more free draining, and retained less water (9-14% compared to 19-33% for peat). There was little evidence of lateral spread of water, with <1% of drainage from the non-dripper segments in the control, and <5% in mixes with wetter.

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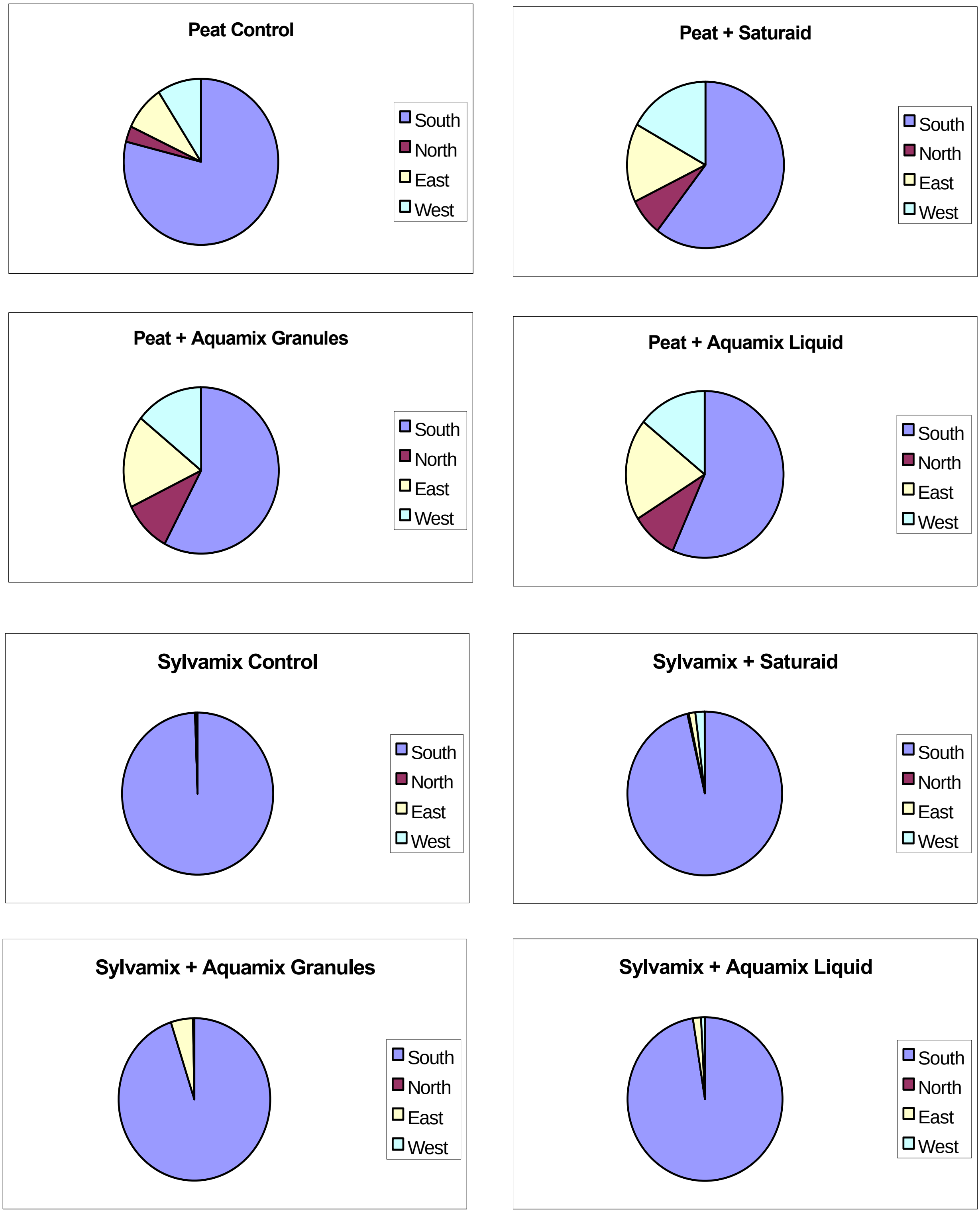
Fig 4.1 First test 12.4.2002. Percentage distribution of run-through in each segment of the pot, Dripper located in south segment.



2nd test 18.4.2002

All ‘holes’ left by the drippers were filled and gently firmed before the pots were left in the glasshouse to dry out before this second test. They were visibly dry on the surface and had started to shrink, slightly, away from the pot edges. The drippers were inserted in the ‘north’ segment this time and again left to drip for 60 minutes; a mean dripper rate of 1087 mls/hour was recorded.

In peat, the results were broadly similar to the first test with all three wetters improving the distribution of water within the pot. The percentage of applied water retained in the pot was very similar across all treatment including the control.

The results in Sylvamix were similar to the first test, with only negligible improvement in distribution with the addition of a wetter.

3rd test 3.5.2002

Pots were left in the glasshouse to dry out to a greater extent than at the second test. By this time the media had shrunk substantially and had developed a crust on the surface. All the pots were turned through 90° so that the west side became the south. Drippers were inserted as before and water applied for 60 minutes; a mean dripper rate of 1032 mls/hour was recorded

As previously in peat, wetters improved water distribution within the pot although, when compared to the previous two tests, a smaller percentage of the total run-through was recorded in the three segments other than the one with the dripper. However, in this test, the wetters had substantially improved the percentage of applied water retained in the pot when compared to the control. Between 46-52% was retained in the ‘plus wetter’ treatments compared to less than 30% in the control. The extent of surface wetness was also increased by the wetters with 95-98% of the surface moistened and the control just over 50%.

Again, wetters had relatively little benefit on improving water distribution in the Sylvamix media.

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Fig 4.2 Second test 18.4.2002. Percentage distribution of run-through in each segment of the pot. Dripper in north segment.

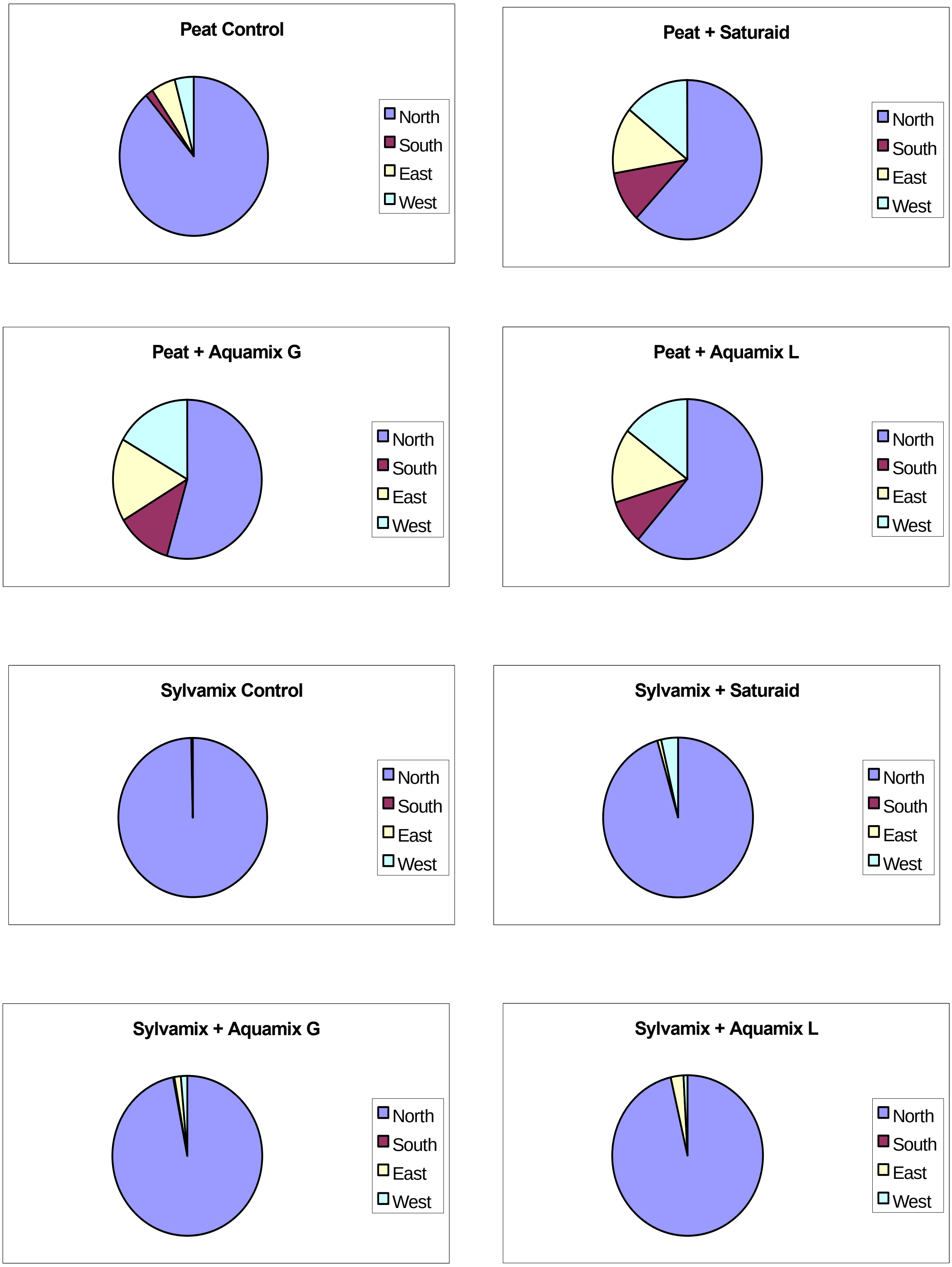

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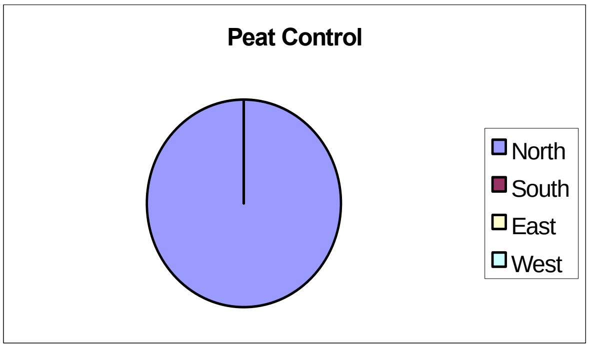
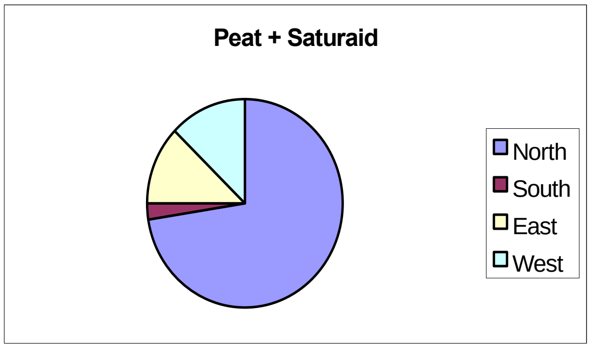
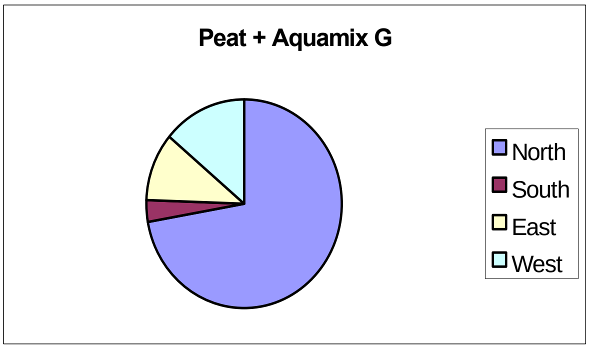
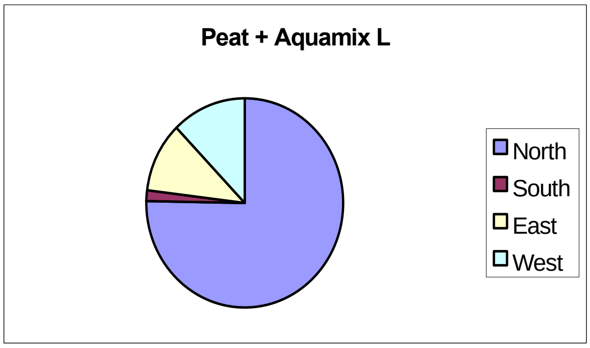
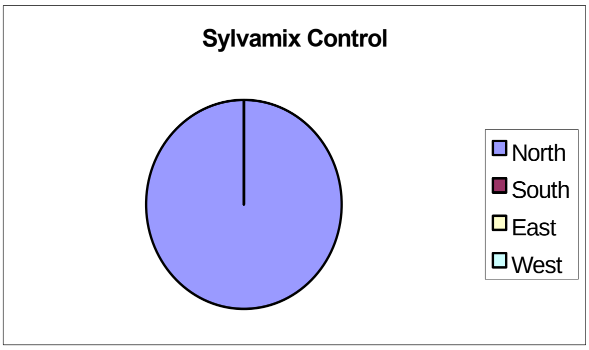
Fig 4.3 Third test 3.5.2002. Percentage distribution of run-through in each segment of the pot. Dripper in north segment.

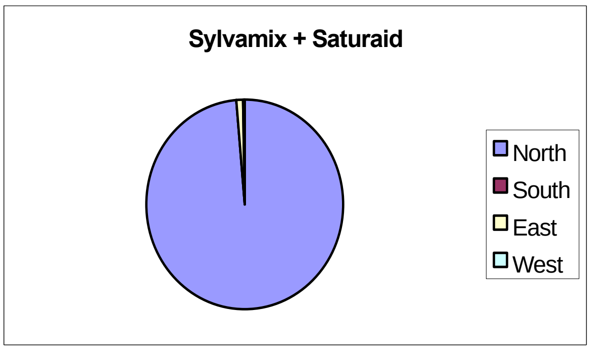


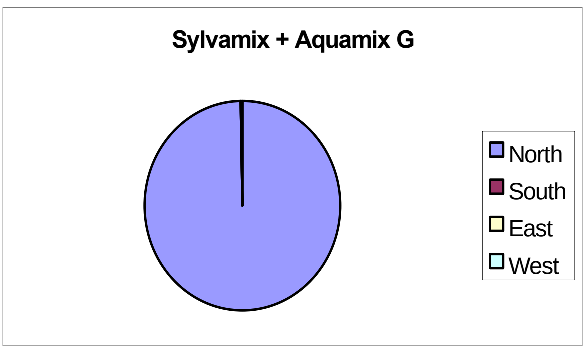












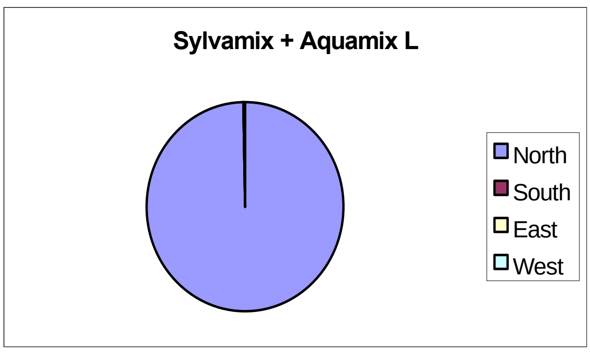


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Table 4.1 Percentage run through in sector with dripper vs other sectors

Media	Wetter	12.4.2002 % run through in section with dripper	12.4.2002 Total % run through in other three sections	18.4.2002 % run through in section with dripper	18.4.2002 Total % run through in other three sections	3.5.2002 % run through in section with dripper	3.5.2002 Total % run through in other three sections
Peat	None	78.97	21.03	89.01	10.99	100.00	0.00
	Saturaid	60.55	39.45	62.08	37.92	72.37	27.63
	Aquamix G	57.90	42.1	54.55	45.45	72.25	27.75
	Aquamix L	56.76	43.24	61.42	38.58	75.26	24.74
Sylva.	None	99.31	0.69	99.59	0.41	100.00	0.00
	Saturaid	96.50	3.50	95.61	4.39	98.63	1.37
	Aquamix G	95.01	4.99	96.81	3.19	99.65	0.35
	Aquamix L	97.55	2.45	96.42	3.58	99.62	0.38

Table 4.2 Percentage of the applied water retained by the pot and % surface wetness on 3.5.2002

Media	Wetter	12.4.2002	18.4.2002	3.5.2002	% surface wetness
Peat	None	19.2	24.7	26.3	52
	Saturaid	32.8	24.1	45.6	98
	Aquamix G	18.4	26.1	49.4	98
	Aquamix L	19.8	23.0	43.6	95
Sylva.	None	14.2	10.0	6.9	7
	Saturaid	9.6	10.8	10.6	12
	Aquamix G	8.6	11.1	7.1	5
	Aquamix L	8.8	12.2	14.3	26

Conclusion

Wetters can improve horizontal distribution of water in peat from localised surface applications such as from a dripper. Wetters also demonstrated significantly improved retention of water by dry peat in this test.

Lateral distribution of water in the more open structured Sylvamix is unlikely to be significantly improved from the addition of a wetter.

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5 Effect of wetter on capillary uplift

Objective

To test whether wetters improve the uptake of water from capillary matting.

Method

Rather than a large comparison of many wetting agents at this stage, it was important to establish whether the principle of improved capillary uptake with mixes containing wetters could be demonstrated with this test.

Just two wetters, Saturaid and Aquamix granules were used in the two media, together with untreated controls. This gave eight treatments with five replicates of each to give a total of 40 pots. During mixing, an equal quantity of water was added to the control and wetter mixes to ensure uniformity of moisture content between treatments within each medium. 9cm. pots were used and these were filled according to the standard method.

In the first part of the experiment, all the pots were placed into Empot carriers and then into large trays containing fully wetted capillary matting. The Empot carriers enabled the pots to be easily removed from the trays at the same time so that water uptake could be stopped for all pots together while weights were recorded. Water was added to the trays on a regular basis to ensure that the matting stayed fully wetted at all times. All pots were weighed at the start and at regular intervals during the rest of the day and the following day until they were perceived to have reached capacity. They were kept in a laboratory under ambient temperatures.

The same set of pots was used for the second part of the experiment. The fully wetted up pots were removed from the trays and allowed to dry back for 16 days. All pots were weighed daily to monitor any weight changes. After this they were placed back into the trays with fully wetted capillary matting and then had their weights monitored for the next 24 hours. Over this re-wetting period the trays had water added on three occasions to ensure that the matting stayed at capacity

Results

The addition of a both wetters in peat, improved rate of water uptake; after the first 30 minutes. The mean weight had increased by almost 15% where Saturaid had been added and by 13.7% with the addition of Aquamix granules. A total weight gain of 29.7% was recorded over the 24 hour period for peat with Saturaid and 27.8% for peat with Aquamix granules. The peat without wetter increased by 15.8% over the same period (Fig 5.1).

No water was taken up by any of the Sylvamix treatments from the matting for the first part of the experiment. The Sylvamix may have had a higher % water content than peat at the start of

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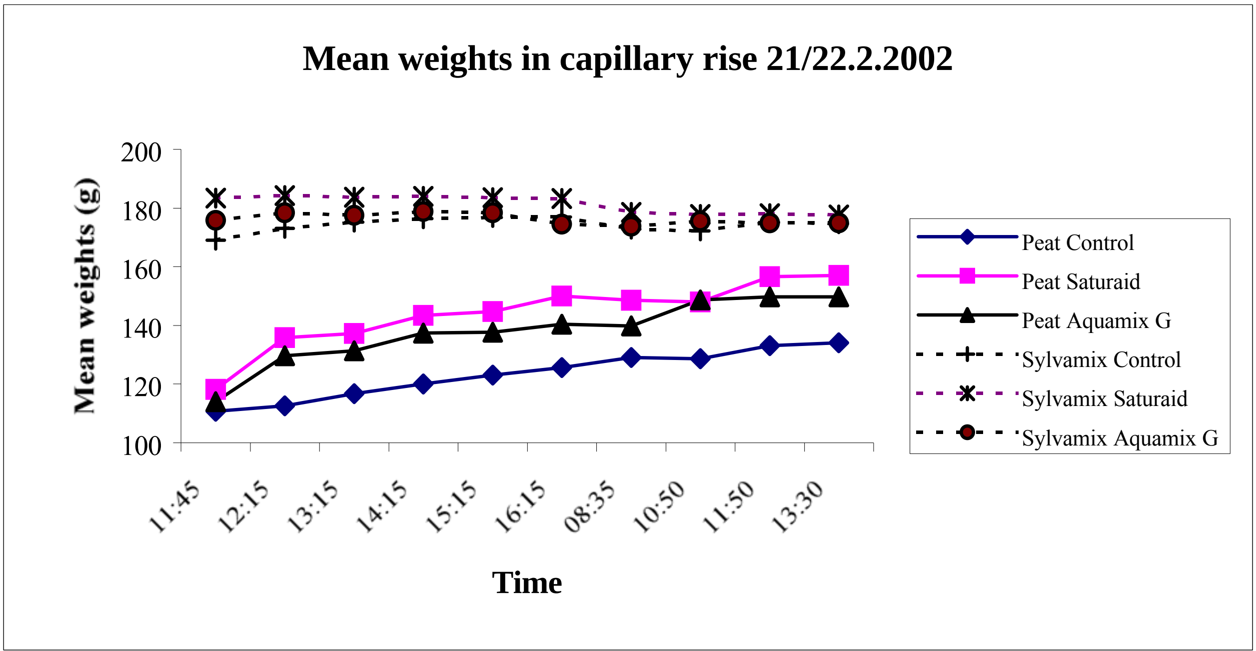
the experiment, but this was not assessed. The more open texture of Sylvamix may also have contributed to less water uptake ability.

Figure 5.1 – Weights of each mix at the start and over the following 24 hours after being placed onto fully wetted capillary matting.



Over the 16 day dry down period, all peat mixes lost proportionately more water than the Sylvamix media (Fig. 5.2). After placing all the pots back onto the wetted capillary matting the peat mixes regained weight very quickly over the first 5 hours, after which they continued to gain weight but at a slower rate. There was some evidence that the wetters increased rate of water uptake over the control, although by the end of 24 hours, differences were relatively small.

The Sylvamix treatments were slower to take up water, staying at a fairly constant weight for the first two hours after being placed back onto the matting. They then gained but more slowly than the peat, and had not reached their starting weights by the end of 24 hours. The wetting agents had little effect on capillary uptake ability in the Sylvamix.

Conclusions

This first test indicated that wetters might improve capillary uplift of water from capillary matting into containers for peat media. Slower water uptake was demonstrated in Sylvamix, and wetters had little effect in this medium.

Further investigation is needed before the magnitude and practical benefit of the apparent effects seen with peat media can be gauged. Of particular importance is the ability for media to either retain capillarity with mattings (or sand substrates) as they dry down, or facilitate re-establishment of capillary contact once broken.

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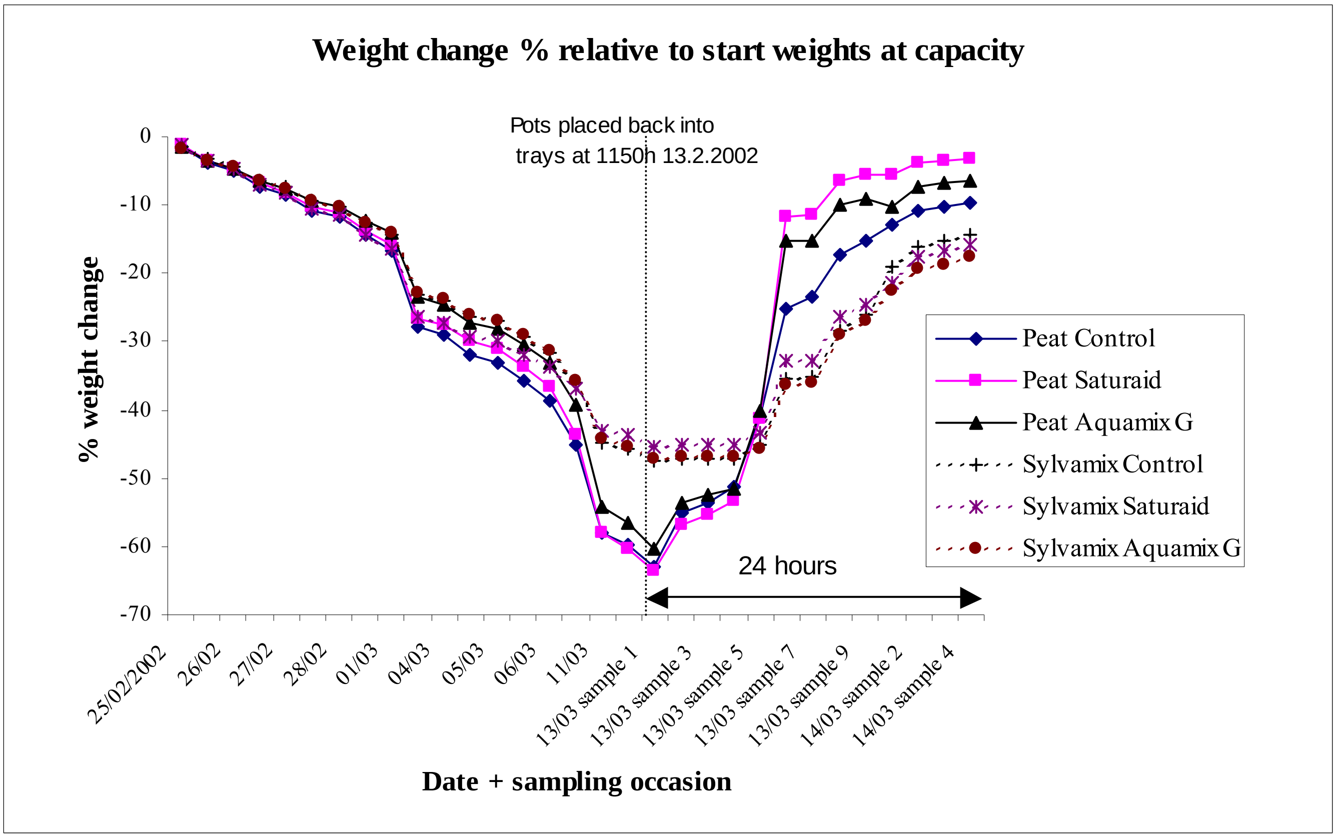
Figure 5.2 Percentage weight changes over both the drying out period of sixteen days and a re-wetting period of 24 hours. Means of 5 replicates per treatment.



6 Effect of wetters in reducing evaporation from media

Objective

To investigate whether the addition of a wetter reduces evaporation from growing media.

Method

Seven wetter treatments plus a double set of controls and two media were used to give a total of eighteen treatments with six replicates of each. The experiment was carried out on 2 litre and 9 cm pot sizes. All pots were filled using the method outlined in the standard test section, they were then wetted up to capacity, left to drain overnight and then weighed. Subsequent weighings were done twice a week.

The trial was placed in an unheated shelf-life room on weld-mesh benches to allow any moisture run-off to drain fully. Ambient temperature and relative humidity was monitored and ranged from 16 - 20 °C and 58 - 68% RH.

Results

See Figs 6.1 and 6.2 below.

Overall, wetters had little effect on water loss from the pots. The main factors were the pot size and media type.

9 cm pots lost proportionately more water over the 23 day test period than 2 litre containers. Peat also dried out faster than Sylvamix. This could be because peat had stronger capillary action and drew water faster from the body of the pot to the surface for evaporation.

Conclusion

The range of wetters tested did not show any significant ability to reduce evaporative water losses from growing media. It is likely, therefore, that apparent effects of slower drying out of media containing wetting agents are probably due to such media having absorbed water more efficiently to start with.

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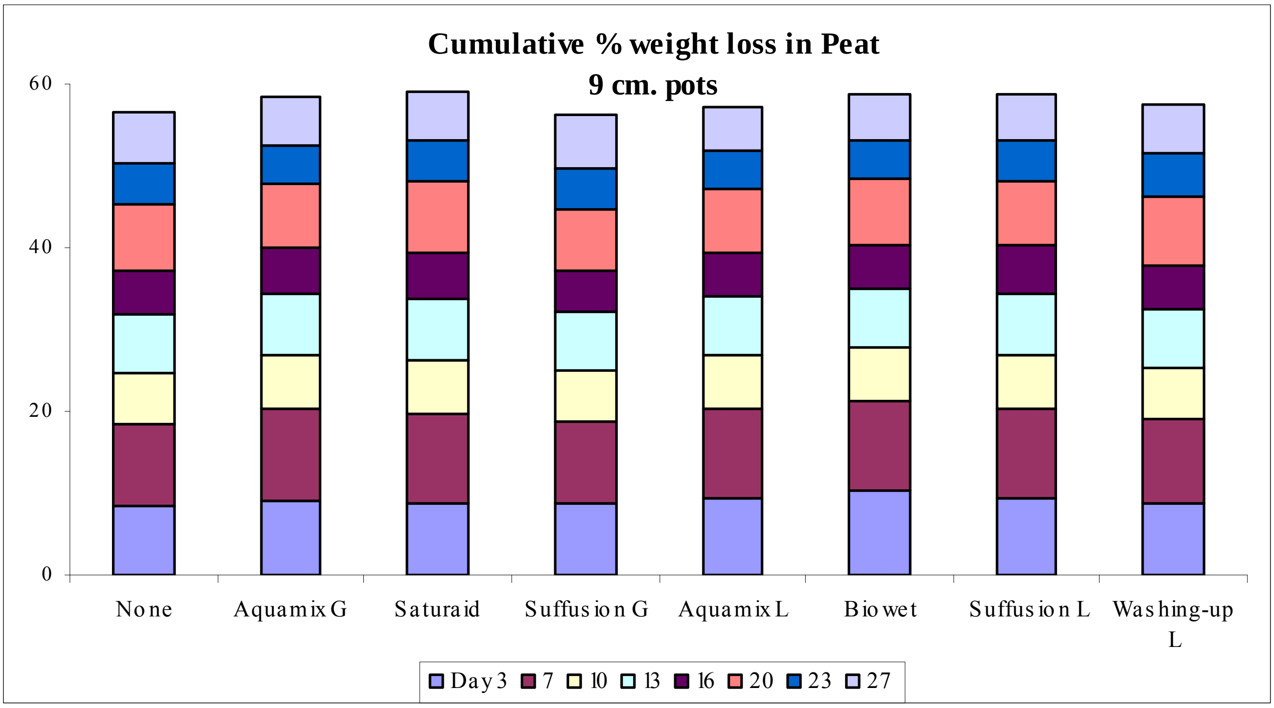
Fig 6.1 Cumulative weight loss in Peat and Sylvamix in 9 cm pots



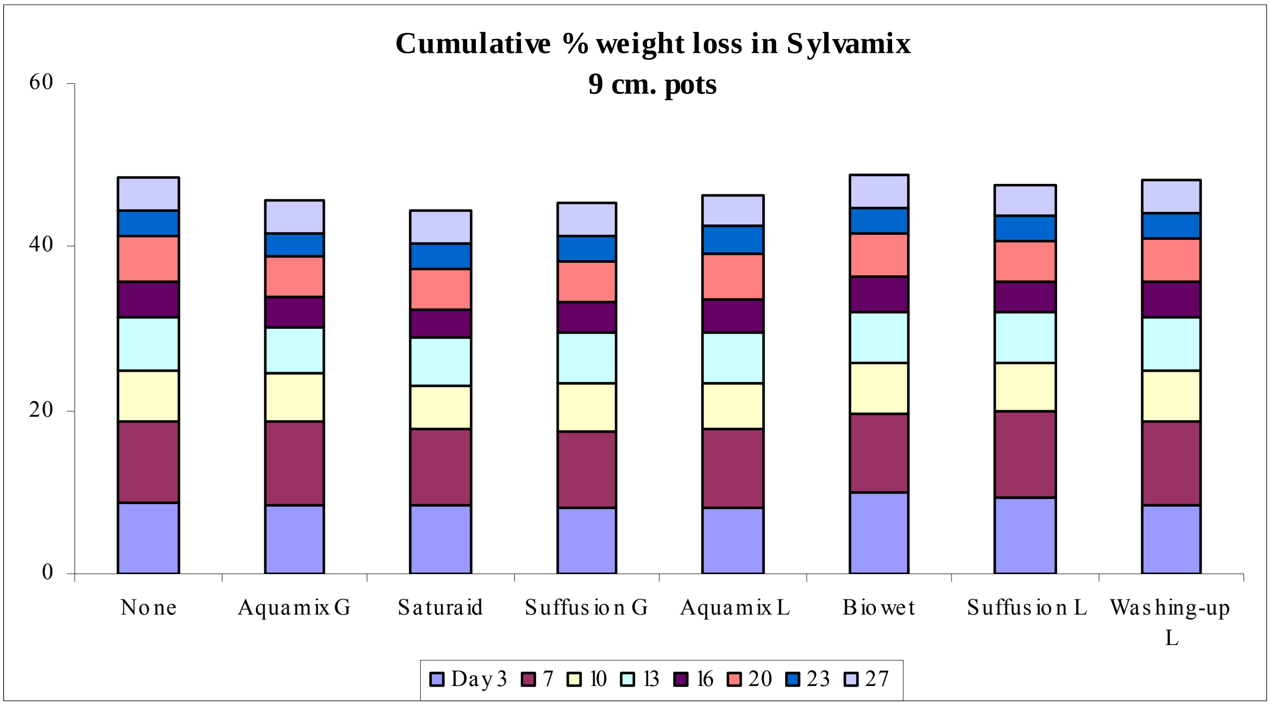


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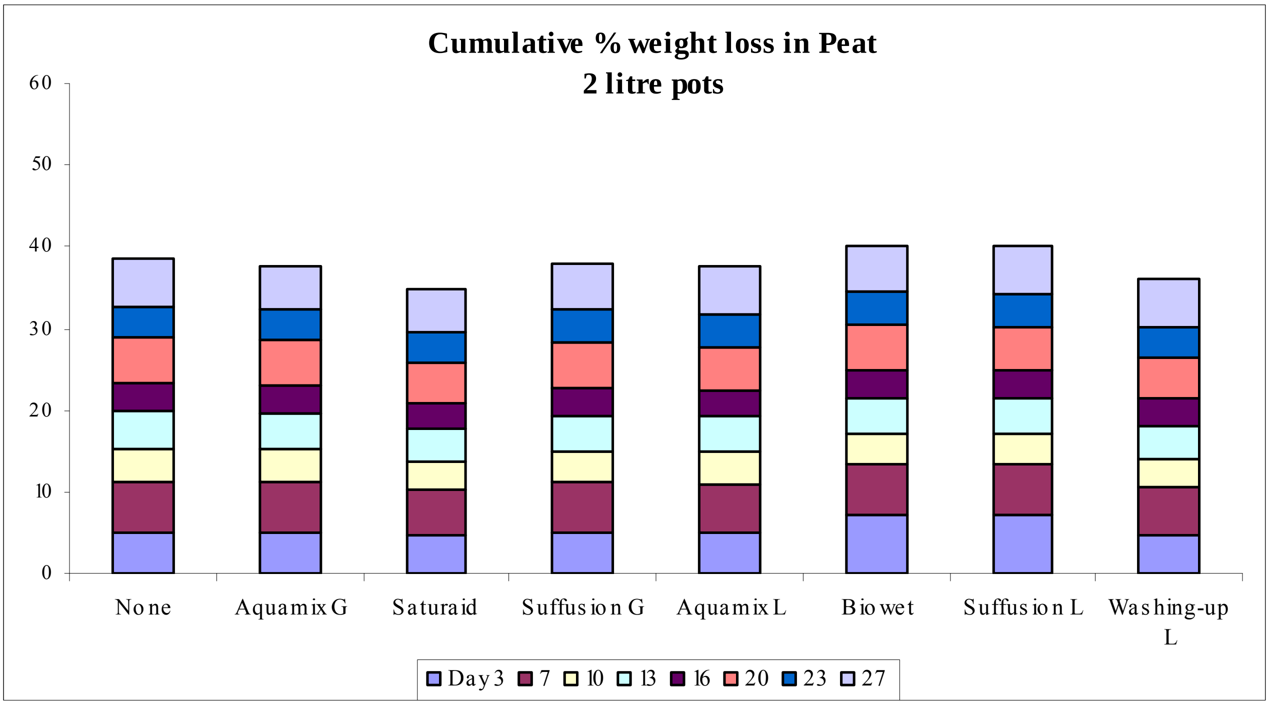
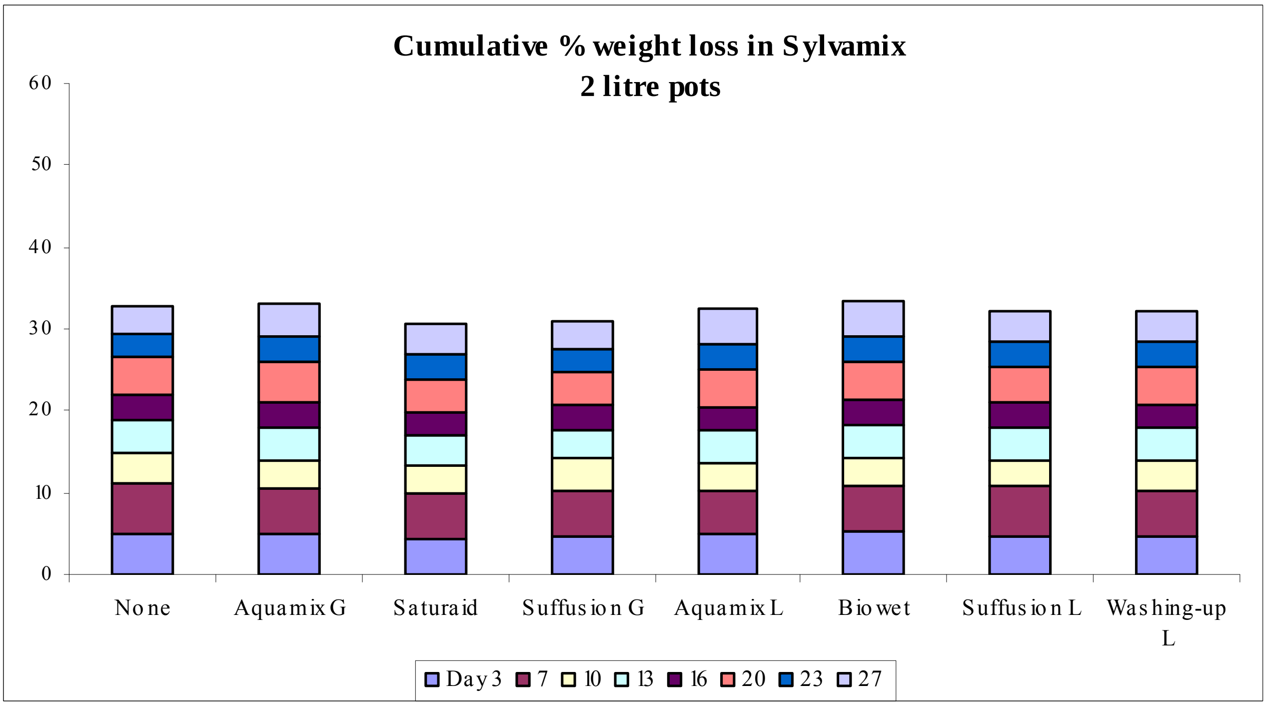
Fig 6.2 Cumulative weight loss in Peat and Sylvamix in 2 litre pots





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7 Effect of mulches in reducing evaporation from media

Objective

To investigate the potential of several mulch materials to reduce evaporative losses from container growing media.

Method

Two growing media treatments, two pot sizes with and without Aquamix Granule wetter were combined with four mulch treatments plus an unmulched control. Total 40 treatments each with 6 replicate pots. Pots were filled to within 2 cm of the pot rim, wetted up and then the following mulches were applied at the specified depth (Photo 7, Appx.).

Control	0 cm
Biotop	1.5 - 2.0 cm
Enviroguard	1.5 - 2.0 cm
Cocoshell	1.5 - 2.0 cm
Cambark 100	1.5 - 2.0 cm

Biotop is fine chopped *Miscanthus* mulch material with added starch, which helps bond it together after wetting to form a stable 'felt'. Enviroguard is a pelleted waste paper mulch, and Cocoshell is dry broken shells of cocoa beans. Pots were wetted again following mulch application to ensure pots were all at pot capacity, and also to wet and settle the mulches. They were left to drain overnight, then weighed, and subsequently weighed twice a week. The experiment was run in an unheated shelf-life room as per experiment 6 above.

Results

See Figs 7.1 and 7.2 below.

In this experiment, the same trends with pot size and media type as seen in experiment 6 were also observed. Namely, that water loss was greatest from 9 cm pots and peat mixes. However, here, the mulch treatments also had a large effect. For both pot sizes and media, the mulch treatments lost less water than the controls, and the Bark and Cocoshell mulches conserved more moisture than the Enviroguard and Biotop mulches. In some cases the Bark and Cocoshell mulches had lost less about 60% of the water than the control pots. Wetting agents again appeared to have little effect.

A good mulch needs to provide a barrier between dry ambient air and the media, and break capillary movement of water from the mix, but nevertheless be permeable. Because Bark and Cocoshell were coarse and remained dry, they were more effective as mulches than Enviroguard and Biotop, both of which retained overhead applied moisture, and maintained some capillary link with the growing media.

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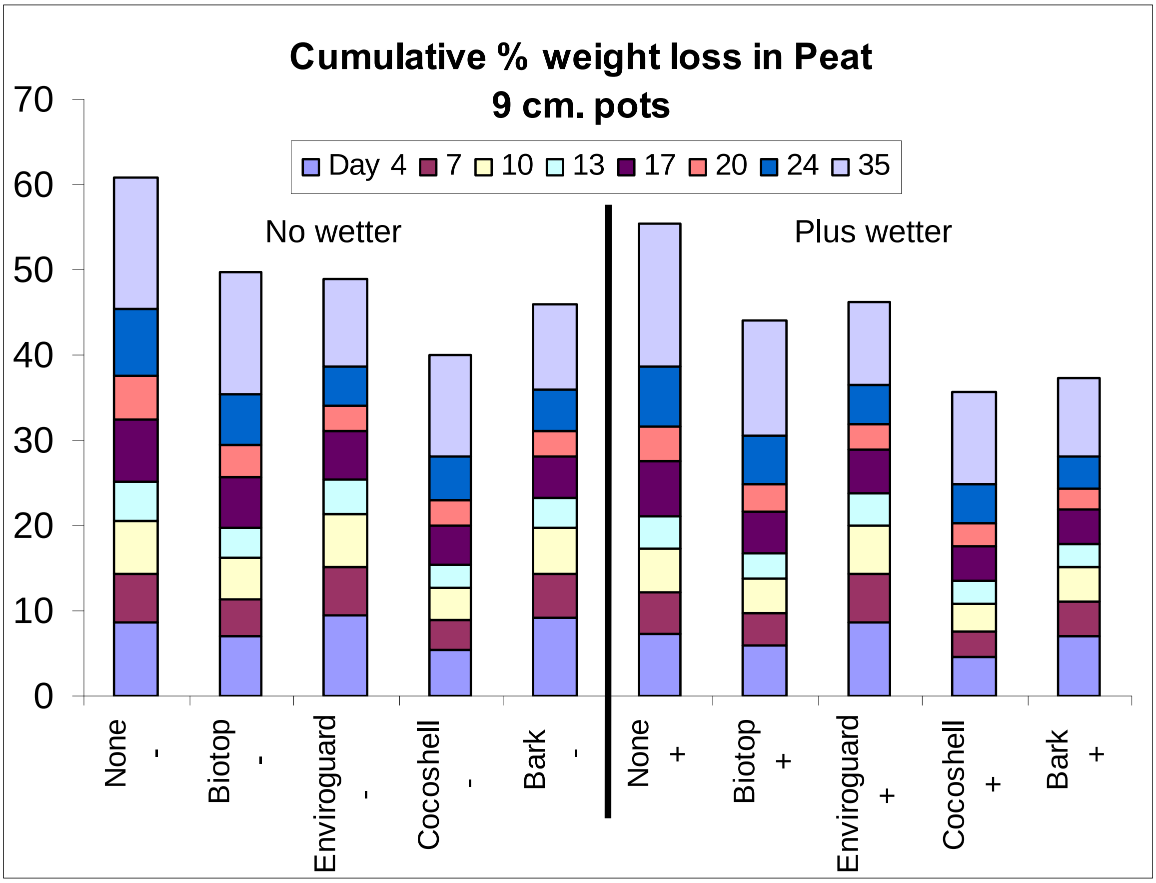
Fig 7.1 Cumulative weight loss in Peat and Sylvamix in 9 cm pots



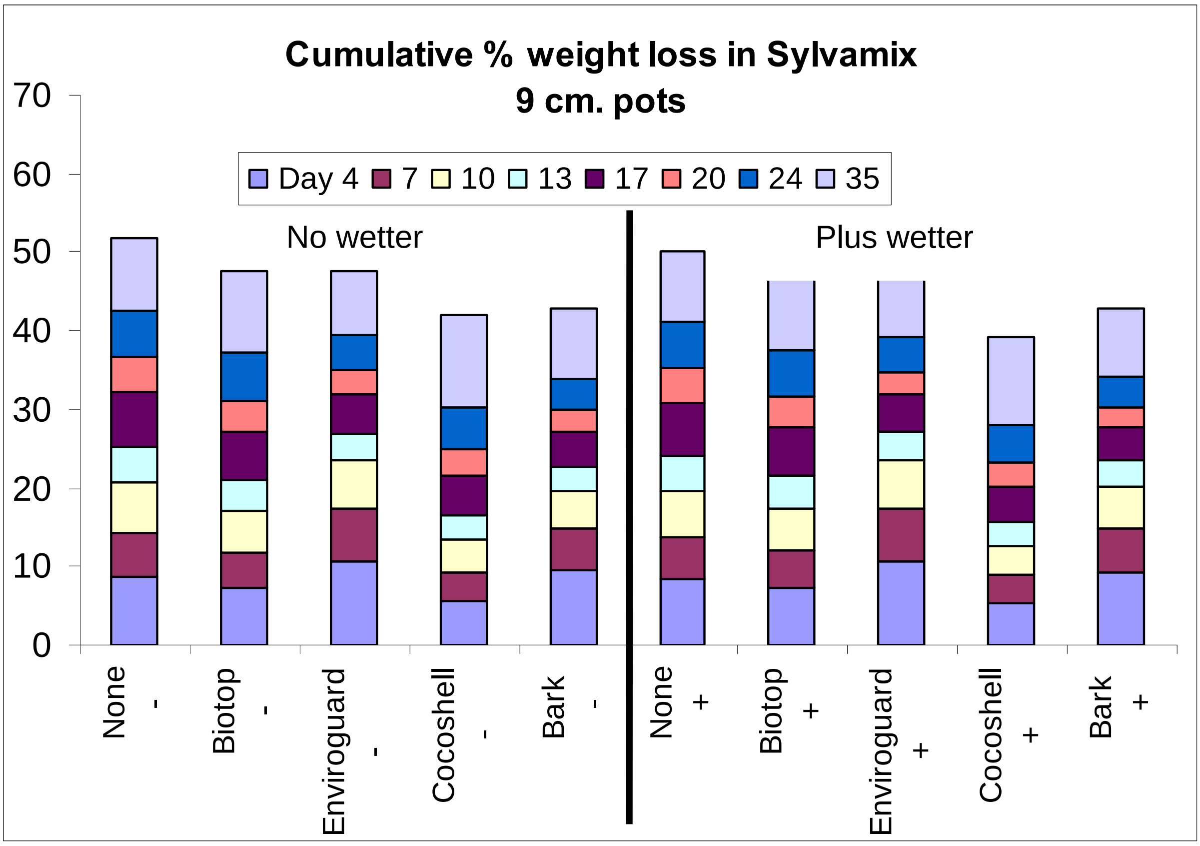


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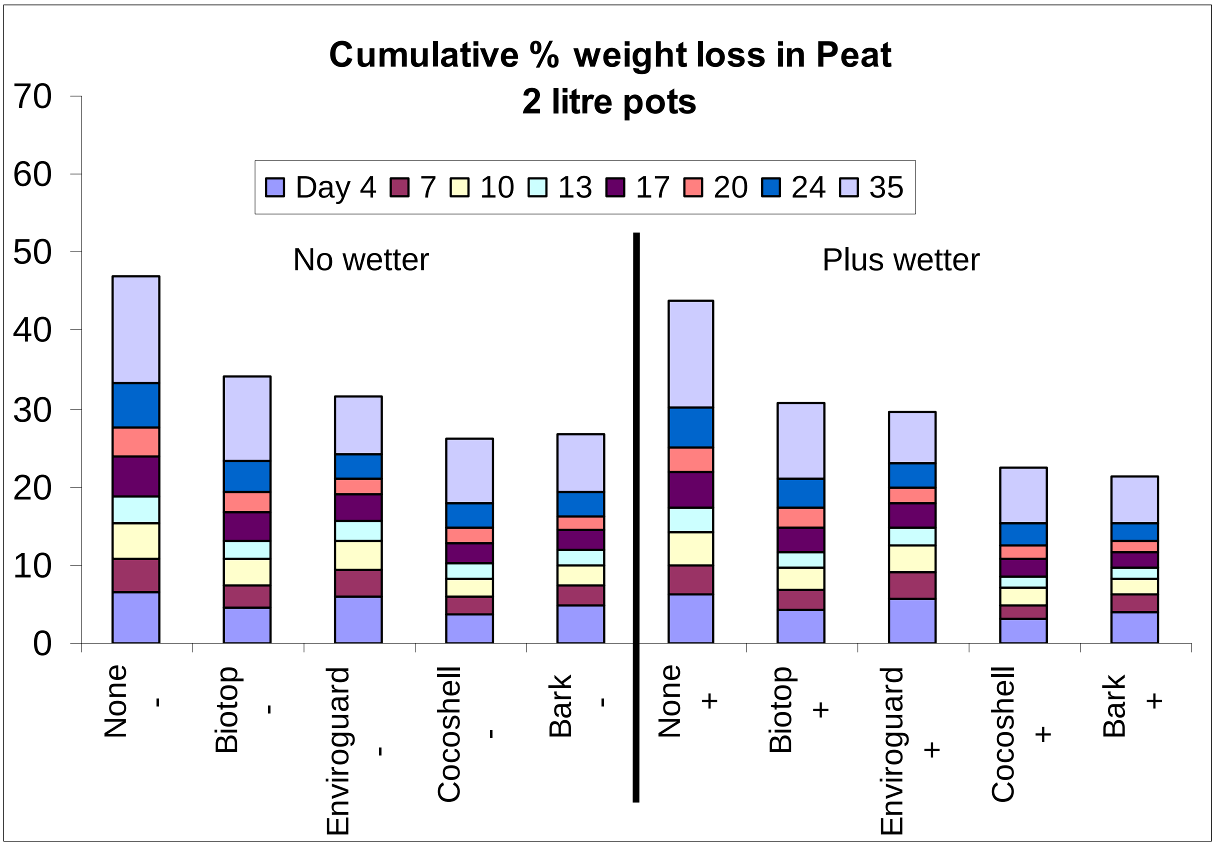
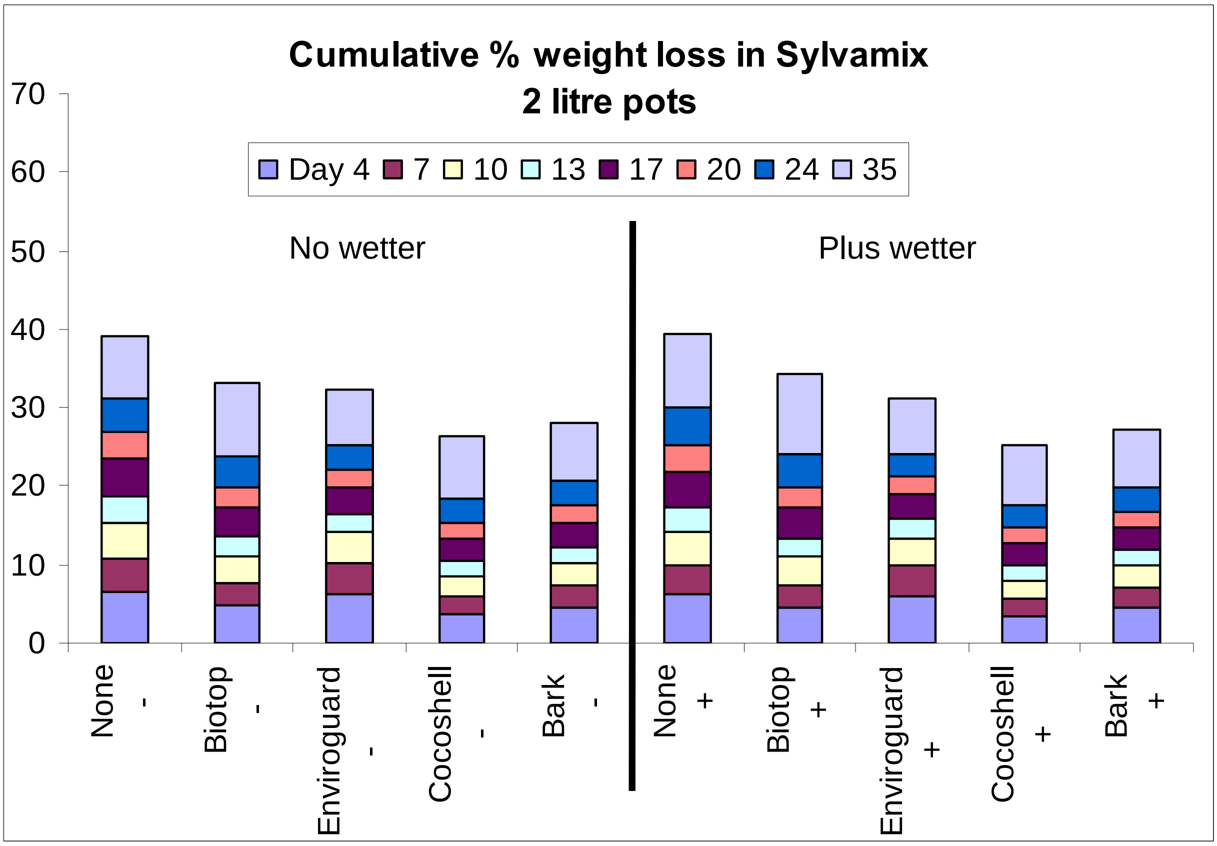
Fig 7.2 Cumulative weight loss in Peat and Sylvamix in 2 litre pots





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Conclusion

The addition of a Bark or Cocoshell mulch to a depth of 1.5 - 2.0 cm could make a significant contribution in reducing water loss from the surface of growing media.

Further experimentation is needed under outdoor conditions where containers are exposed to wind and sun. Experiments with containerised plants are also needed to determine the relative benefit of reducing evaporation from media surfaces compared to transpiration losses, and the potential for conserving irrigation.

8 Phytotoxicity testing of wetting agents

Objective

To check wetting agents for any possible harmful effects on plant growth.

Method

The 19 wetting agent x 2 growing media treatments used in Trial 2 of the longevity of wetters tests above were also used to test phytotoxicity. 20 mustard seeds (*Sinapsis alba*) per 9 cm pot were sown in peat and Sylvamix media. Five replicates of each treatment were used giving 190 pots in total.

Seeds were sown on 12 September 2002 and the number of seeds germinated were assessed on 20 September. On 26 September, leaves and stem growth was scored on a 0 – 3 scale for any phytotoxic effects such as distortion, and amount of root visible on the outside of the pot balls also given a 0 – 3 score.

Results

See Appendix, Photos 8 – 10. Germination in all treatments was virtually 100%, and there was no sign of phytotoxicity on shoot or root growth with any of the treatments in either growing medium. Growth, however, was slightly advanced in Sylvamix, with stronger root growth (mean root scores 2.7 and 1.0 for Sylvamix and peat respectively).

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SUGGESTIONS FOR FURTHER WORK

The laboratory-based tests have provided a basis for measuring the important properties of wetting agents and mulches under controlled conditions so that products can be compared. There is a need for further experimentation using container grown plants under nursery production systems to verify the practical benefits for the grower and to quantify water and labour savings and quality improvements that may be gained.

Further work should concentrate on:

- The practicality of re-treatment of containers during the season, and the effectiveness of wetters after re-treatment.

- Further test of the benefits of wetters for capillary irrigation.

- Undertake experiments with plants in container production systems (primarily overhead) to evaluate the effect of wetters and mulches on improving uniformity of irrigation and growth, and estimate savings in water and labour for spot watering that may be achieved.

- Evaluation of mulches under outdoor growing conditions.

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APPENDIX

PHOTOGRAPHS

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Photo 1 Australian Standard test for water repellence of growing media

Photo 2 Pour-through test apparatus

Photo 3 Pour-through test

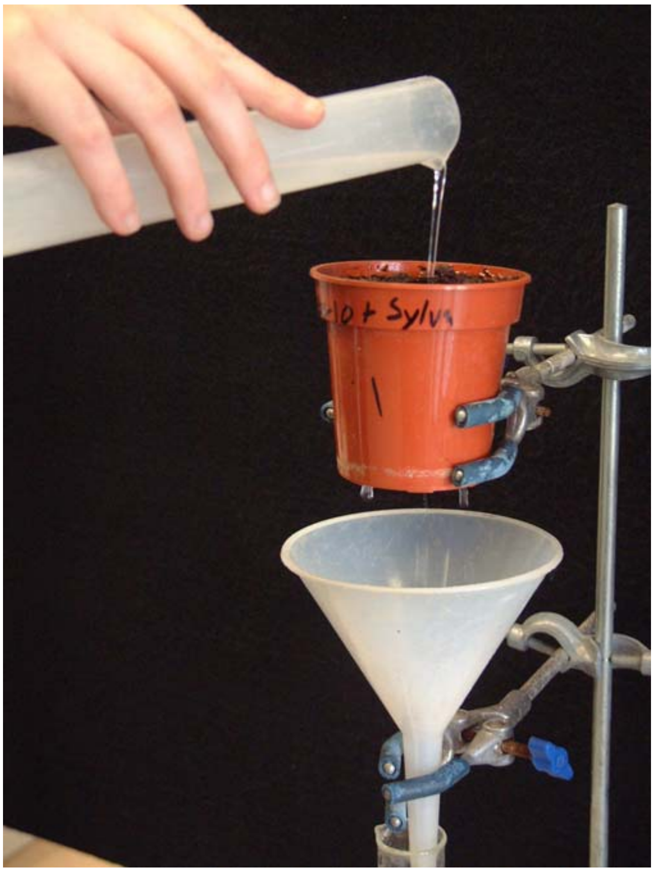
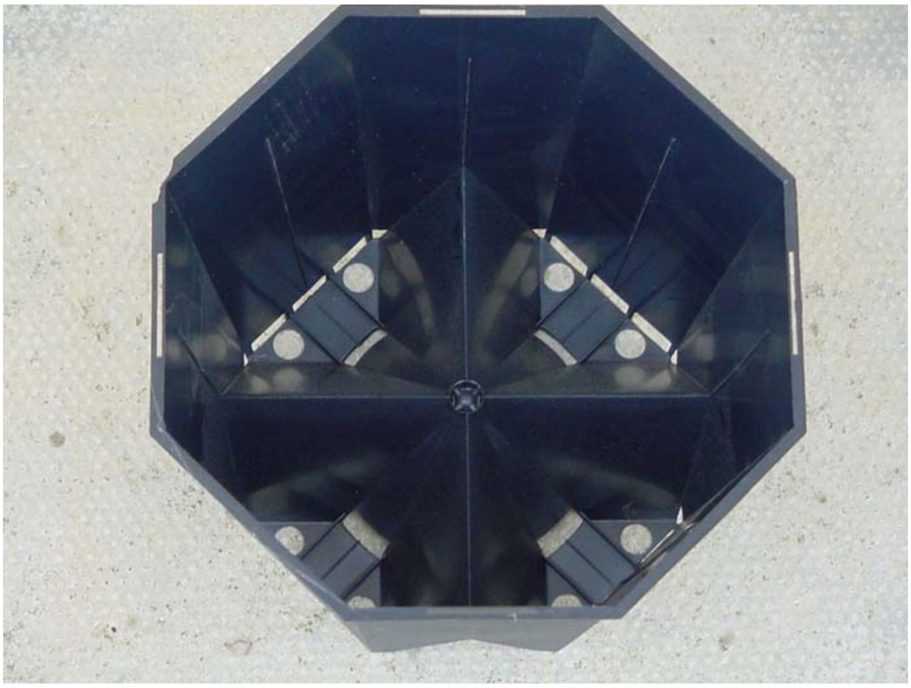


Photo 4 Rootaimer™ pot used for horizontal distribution testing



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Photos 5 and 6 Testing horizontal distribution of water from a dripper

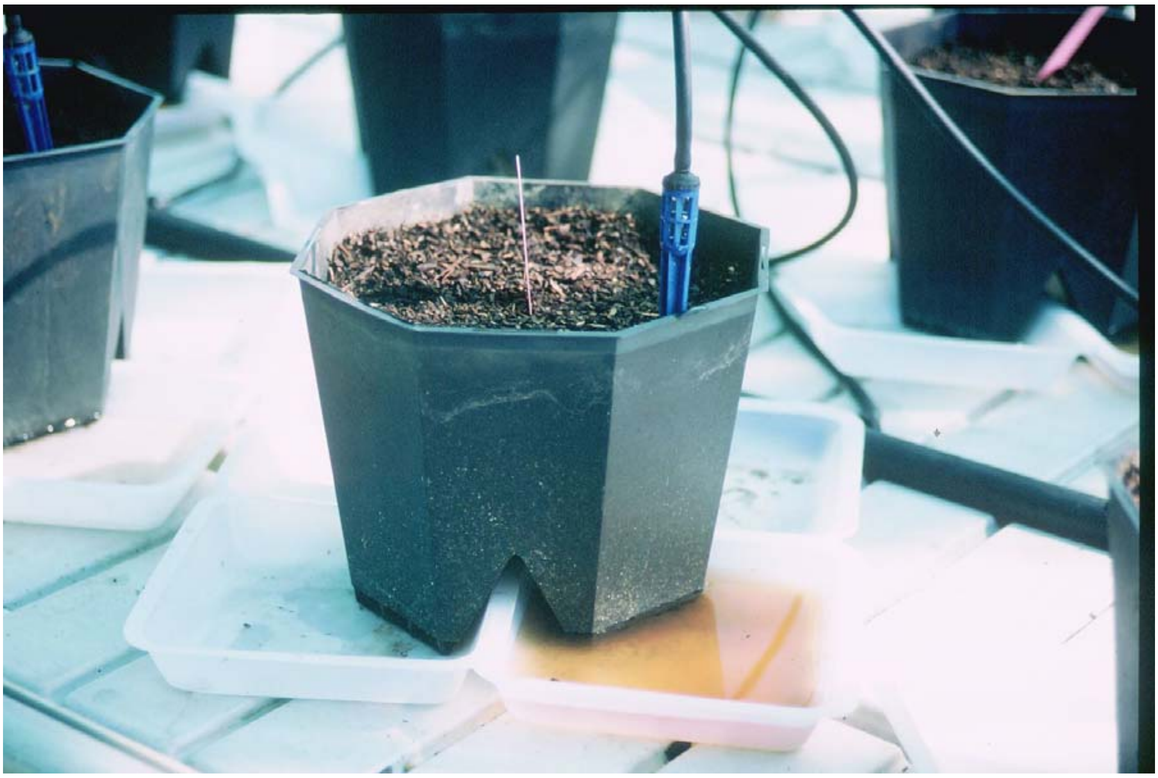

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Photo 7 Testing mulches on 9 cm pots

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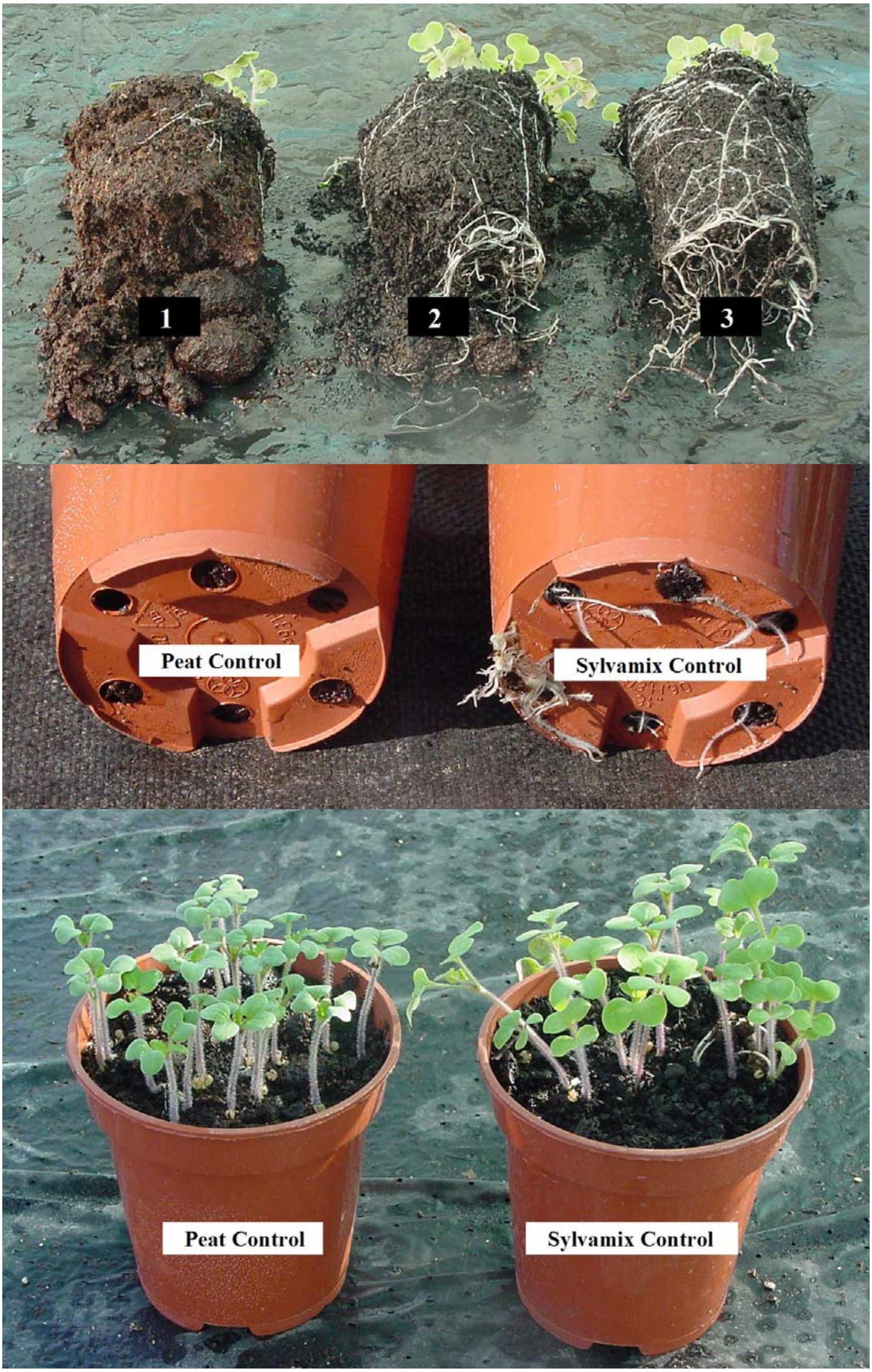
Photos 8 – 10 Phytotoxicity testing for wetters. Mustard seedlings showing no phytotoxicity symptoms two weeks after sowing, but better root growth in Sylvamix.



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