Biorenewables Development Centre

Plants • Processes • Products

Report developed for:

Viresco UK Ltd

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An investigation into the efficacy of peat-free compost containing humate in comparison to traditional peat based compost as a growth media.

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Contents

1. EXECUTIVE SUMMARY 3
2. VIRESCO UK LTD'S BRIEF TO THE BDC 4
3. INTRODUCTION 5
4. METHODOLOGY 5
5. FINDINGS 6
   5. 1. Plant growth 6
   5. 2. Plant health 7
   5. 3. Root growth 9
6. CONCLUSIONS 11
7. RECOMMENDATIONS 11
8. NEXT STEPS 12
9. REFERENCES 12
10. APPENDICES 13
   10. 1. Appendix A – Plant growth 13
   10. 2. Appendix B – Plant health 15
   10. 3. Appendix C – Root growth 17

1. Executive Summary

Sustainability concerns regarding harvesting peat from peat bogs for use in potting compost has prompted the search for an alternative product. Many peat-free alternatives, such as coir, are of poor nutritional quality, requiring the use of additional fertiliser to obtain robust plant growth.

Viresco UK Ltd is a family run company, which offers a range of natural products to promote plant growth and help reduce fertiliser and chemical usage. Humate which is formed from the decomposition of plant matter, is one such product and claims to be a natural growth stimulant, which can boost peat-free compost to give improved plant health, vigour and growth.

The Biorenewables Development Centre (BDC) was commissioned by Viresco to carry out a short trial to assess plant growth in peat-free coir compost with and without the addition of humate, compared to a traditional peat-based compost, using two plant types commonly used in plant growth trials: basil (*Ocimum basilicum*) and snapdragon (*Antirrhinum* sp).

Both were chosen for having differing nutrient and water requirements: snapdragon is sensitive to a high pH, which can cause stunted or uneven growth, while basil is susceptible to iron deficiency in soils with a high pH and needs a fertile soil for optimal growth.

Once seedlings were transferred onto the three different media tested, plant growth was observed over a period of four weeks, and performance compared and analysed statistically:

- The growth of basil plants was similar on all three composts and no significant differences were observed. Plant growth on both peat-based and coir compost containing humate were very similar; the addition of humate to the coir-based compost provided no significant benefit or detrimental effect on plant growth
- Snapdragon plants, however, showed significantly better growth on the peat-free coir compost containing humate, compared to growth on coir compost alone, although this improved growth was not as strong as the growth on the peat-based compost.

Root systems of both plant types were visibly stronger on the peat-free coir compost containing humate, compared with the two other composts; further work would be required to prove the significance and long-term effect of this observation.

2. Viresco UK Ltd's brief to the BDC

Peat has been used as a growing medium by gardeners for centuries, but due to sustainability and ethical issues around peat growing, alternatives are being sought. Coir is one of the main alternative products trialled by gardeners; however, it is more nutrient poor than peat, requiring the use of more fertiliser.

Viresco UK Ltd sells humate, which is formed from the decomposition of plant matter. It is a natural growth stimulant and its addition to growth media is said to result in healthier plants with larger and more efficient root systems, and improved vigour. Its use is believed to reduce watering requirements and the amount of fertilisers required for healthy plant growth. However, there are no proper scientific studies or trials about the benefits of using humate in the UK. With more and more environmental concerns about the increased usage of fertilisers, it is highly relevant to have trials to prove efficacy of humate, which is a natural product in enhancing growth and reducing fertiliser requirement.

The BDC has trialled a peat alternative coir-based compost with and without addition of humate, and compared plant growth in these media to growth in a traditional peat-based compost.

Two plant types were grown – basil (*Ocimum basilicum*) and snapdragon (*Antirrhinum* sp), both of which are commonly used in plant growth media trials.

Seeds were germinated in standard seedling compost; healthy seedlings were then potted into each of the three growing media in multipots.

Plants were to be scored weekly for size, health and vigour for two months. However the experiment was terminated after four weeks due to the rapid growth of the plants and sufficient data accumulation. At the end of the experiment root size and morphology were also compared.

3. Introduction

Peat formed when organic material decomposed in the waterlogged and acidic conditions of bogs and fens. It has been extracted from these bogs and used as a growth medium by gardeners for centuries, but due to the impact its extraction has on the environment, the UK government has now set up a Sustainable Growing Media Task Force and has plans in place for a voluntary phase-out of peat use by amateur gardeners by 2020 and professional gardeners by 2030 [1, 2].

Alternatives to peat have been sought for many years and coir remains one of the most suitable options, although it can be of poor nutrient value, with plants requiring additional feeding relative to peat [2]. Coir is a natural fibre produced from coconut husks which has a naturally higher pH than peat.

Humate, or humic acid, is the main acidic component of peat and can be extracted from deep underground. It is sold as a plant growth stimulant to increase root growth and vigour, thereby enabling plants to uptake more nutrients from soil [3, 4]. Viresco supplies several powdered grades for different purposes – here we used their finest grade (less than 0.5mm), which was used at a dosing rate of 1 kg/m^3 compost (Figure 1).

Figure 1: Humate powder

If humate can be used as an additive in coir-based composts, it may stimulate the plant growth and enable gardeners to have a sustainable alternative to peat-based composts.

The plants selected for this trial, basil and snapdragon, are commonly used in plant growth media trials. They have differing nutrient and water requirements, so should give a good test of the treatments in the trial. Snapdragon, for example, is sensitive to a high pH, which can cause stunted or uneven growth [5]. Basil is susceptible to iron deficiency in soils with a high pH, and needs a fertile soil [6].

4. Methodology

Basil seeds (Suttons, 'Sweet Basil') and Snapdragon seeds (Suttons, 'Day and Night') were sown in seed trays filled with Levingtons P1 compost and grown in a Sanyo controlled environment cabinet at 22 oC day, 18 oC night, with a 16 hour day length.

After three weeks, individual seedlings were transplanted into one of three different composts in 15 well-inserts:

1. Levingtons F2+S peat-based compost
2. Sinclair Coir- based (Potting and bedding)
3. Sinclair Coir-based (Potting and bedding) + Humate added at 1 kg/m3, mixed well

Thirty seedlings were transplanted per compost for each plant type; they were grown in a controlled environment room under the same growth conditions used for germination. Seedlings chosen were as uniform as possible, and tray positions were randomised. All composts were from LBS Horticulture.

Plant growth was scored by measuring the height of the plants weekly for four weeks.

Plant health was scored visually each week, on a scale of 'weak', 'normal' or 'good', and any yellowing of leaves was scored as a sign of nutrient deficiency [6].

Roots were scored visually on a scale of 'weak', 'normal', 'good' or 'very strong' at the end of the experiment.

5. Findings

5. 1. Plant growth

Plant growth data are shown in Appendix A.

The total growth during the experiment between the three treatments was compared and analysed statistically using a one way ANOVAs test by Genstat v15. Analysis shows that the data produced for both plant species is statistically sound.

5.1.1. Basil

There were no significant differences in the growth of basil on the three different treatments. The graph (Appendix A) shows that the plants on the coir-based compost grew slightly better than on the other treatments, but this was not statistically significant. The plants on the peat-based compost and the coir plus humate compost were very similar in their growth, which may indicate that the addition of humate to the coir-based compost makes it more equivalent to the peat-based compost.

5.1.2. Snapdragon

There were differences observed in the growth of snapdragon. All three treatments are significantly different from each other. The best growth was seen on the peat-based compost, whereas the snapdragon plants grew least well on the coir-based compost. The addition of humate to the coir-based compost however, resulted in significantly better growth than in the coir alone ($p=0.042$) which shows that humate had a positive effect on growth.

After 4 weeks, many basil and snapdragon plants were so tall that they had outgrown the space on the shelves in the controlled environment facility, and were in danger of becoming damaged as they came into contact with the lights (Figure 2). The decision was made to terminate the experiment at this time.

Figure 2: Basil and snapdragon plants at 4 weeks

5. 2. Plant health

Plant health data are shown in Appendix B.

5.2.1 Basil

The basil plants grew vigorously on all treatments and were all healthy with no sign of stress. No differences in plant health were recorded between the three treatments, as can be seen from Figure 3.

Figure 3: Basil plants: from left to right – growth on peat, coir, coir + humate

5.2.2 Snapdragon

The snapdragon plants did not respond well to being transplanted and initially showed signs of stress such as wilting. One plant from each treatment died, possibly as a result of this handling. As the experiment progressed and the plants became established, some snapdragon plants showed severe signs of stress with yellowing and mottling of leaves, which were possibly due to nutrient deficiency. This occurred mostly in plants grown on the coir-based compost, but there were also some affected plants on the coir plus humate compost. Plants grown on the coir and coir plus humate media were not as healthy as the plants on the peat-based compost, which displayed dark green leaves (Figures 4 and 5).

Figure 4: Snapdragon plants: from left to right – growth on peat, coir, coir + humate

Figure 5: Snapdragon plants : growth on coir (on the left) and peat (on the right)

From the data, over 70% of the plants grown on coir compost alone showed some deficiency symptoms, compared to just over 40% of plants grown on coir plus humate compost, and none of the plants on peat-based compost. This indicates that the addition of humate has a positive effect on the growth of the plants compared to those on coir compost alone.

5. 3. Root growth

Root growth data are shown in Appendix C.

5.3.1. Basil

In general, all of the basil plants had good root systems. Over 60% of the plants grown in coir plus humate compost had very strong roots, compared to around 40% in plants grown in either peat or coir alone. Moreover, the roots of plants grown in coir plus humate compost were visibly thicker and more branched than those grown in peat (Figure 6).

Figure 6: Root growth: from left to right – growth on peat, coir, coir + humate

5.3.2. Snapdragon

The snapdragon plants grown in peat-based compost had the most uniform roots with over 60% having normal healthy root systems, whereas over 60% of the plants grown in coir alone had visibly weak or poor roots. The best root systems, however, were seen in the plants grown in coir plus humate compost, where over 40% had good roots compared to only 20% of the plants grown in either peat-based or coir alone composts. The snapdragon plants grown in coir alone and coir plus humate composts had visibly thicker, whiter roots, as can be seen in Figure 7.

Figure 7: Snapdragon root growth: from left to right – growth on peat, coir, coir + humate

Statistical analysis was not carried out on the data for root growth as these were only visually scored. Also, no dry weight assessments were made due to the time constraints in this short study; this may have shown other differences and could be considered for further research.

6. Conclusions

For basil, the addition of humate to the coir compost resulted in no significant difference in the height of the plants compared to plants grown in the other composts. Plants grown on all three treatments, i.e. coir; coir plus humate; and peat-based composts, were similarly healthy and showed no signs of stress. However, there was a difference in the root growth, with plants grown in coir containing humate compost having visibly stronger root systems; it is worth noting this feature was not quantified in this short study, and therefore further work would be needed to demonstrate any significant difference. This observation would seem to agree with previous research that humic substances have more of an effect on the below ground parts of the plants than the aerial parts[7].

Snapdragon plants, however, differed significantly between the three treatments tested. The addition of humate to the coir growth medium resulted in taller and healthier plants compared to those grown on coir alone, but they were not as strong as the plants grown on peat. The root systems of the plants grown on coir plus humate compost were stronger and appeared thicker than the ones on peat, but further work would again be required to quantify and prove the significance of this. The coir compost would naturally have had a higher pH than the peat therefore this would have contributed to the lack of growth of the plants on coir alone. The addition of humate would have reduced the pH of the coir, which would have made this compost more favourable for growth of the snapdragon plants.

7. Recommendations

This experiment was conducted on a small scale with adequate numbers of plants to enable statistical analysis to assess the growth of plants over a short term experiment. As it was not possible to fully assess the change in root morphology observed in this short study, this may be an area that Viresco would wish to focus on using longer-term growth studies.

The BDC, therefore, recommends that further work may be of value to Viresco and will help determine whether the addition of humate to coir compost has a significant effect on root growth, by doing a larger scale trial for a longer period. This would enable the study of several aspects of root growth, including weight, branching, morphology of root hairs and uptake of nutrients, which were outside the scope of this project, and consequently the impact it may have on water and fertiliser need to obtain comparatively vigorous plants.

8. Next steps

We will contact you in the next two weeks to arrange a follow-up discussion, answer any queries that you may have on the report and advise on potential future work as suggested in our recommendations above. If you have any questions in the meantime, please don't hesitate to get in touch with Sue Heywood (susan.heywood@york.ac.uk) or Aurélie Bovi (aurelie.bovi@york.ac.uk)

9. References

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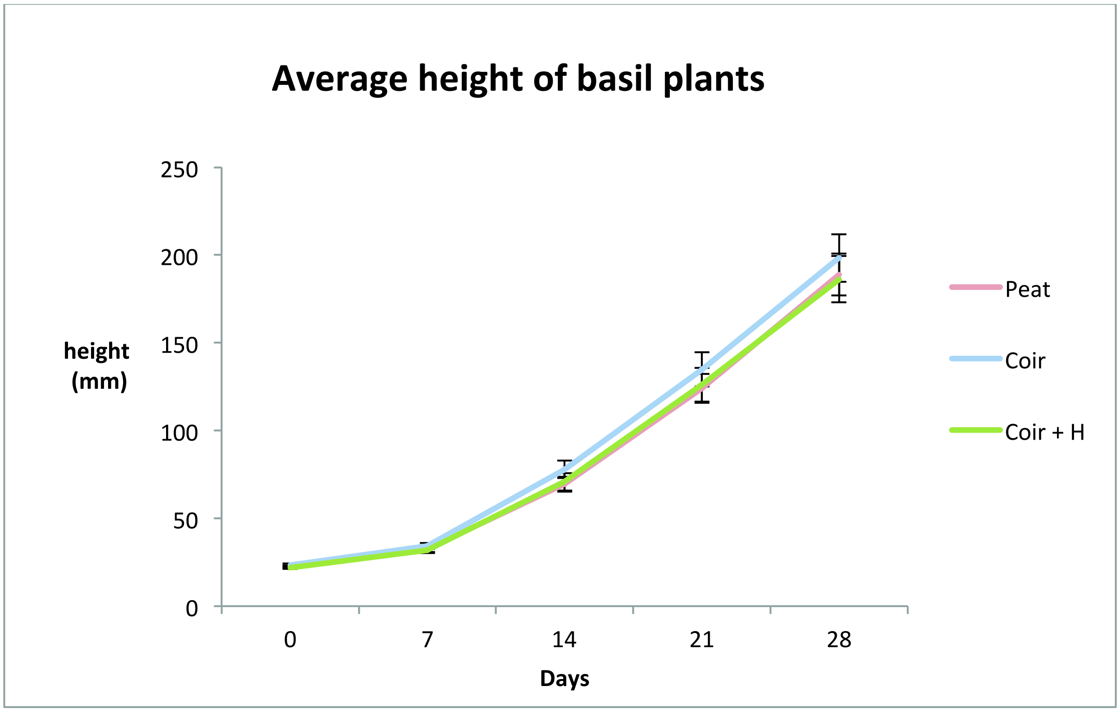
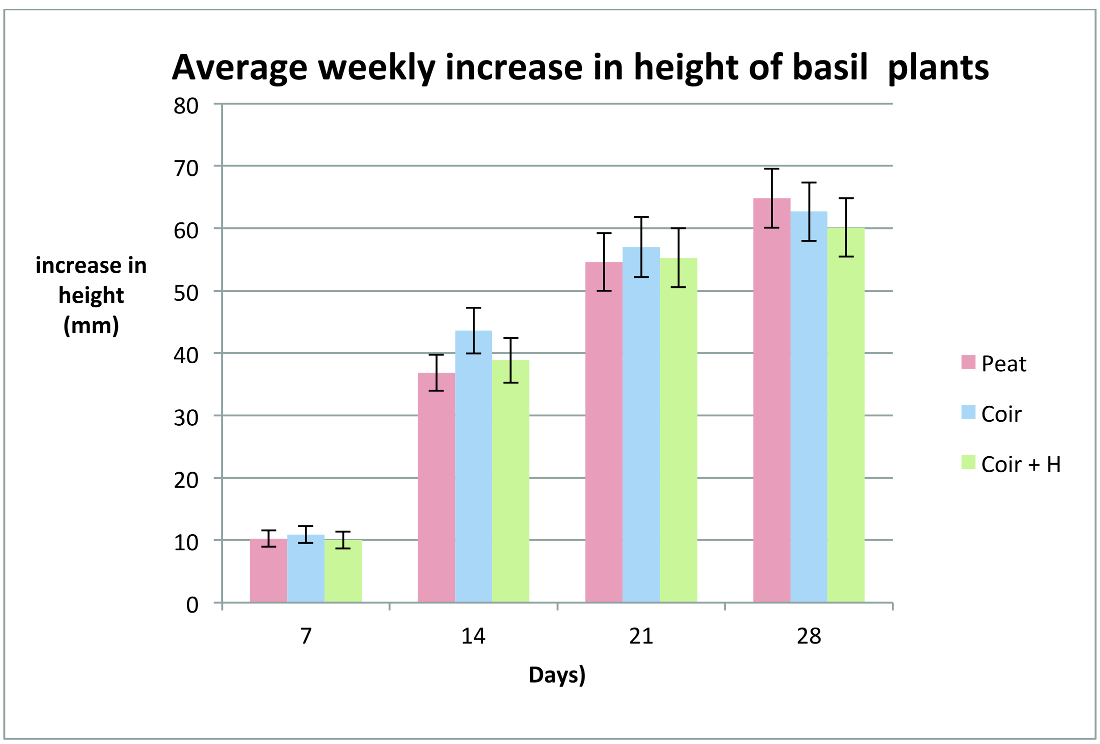
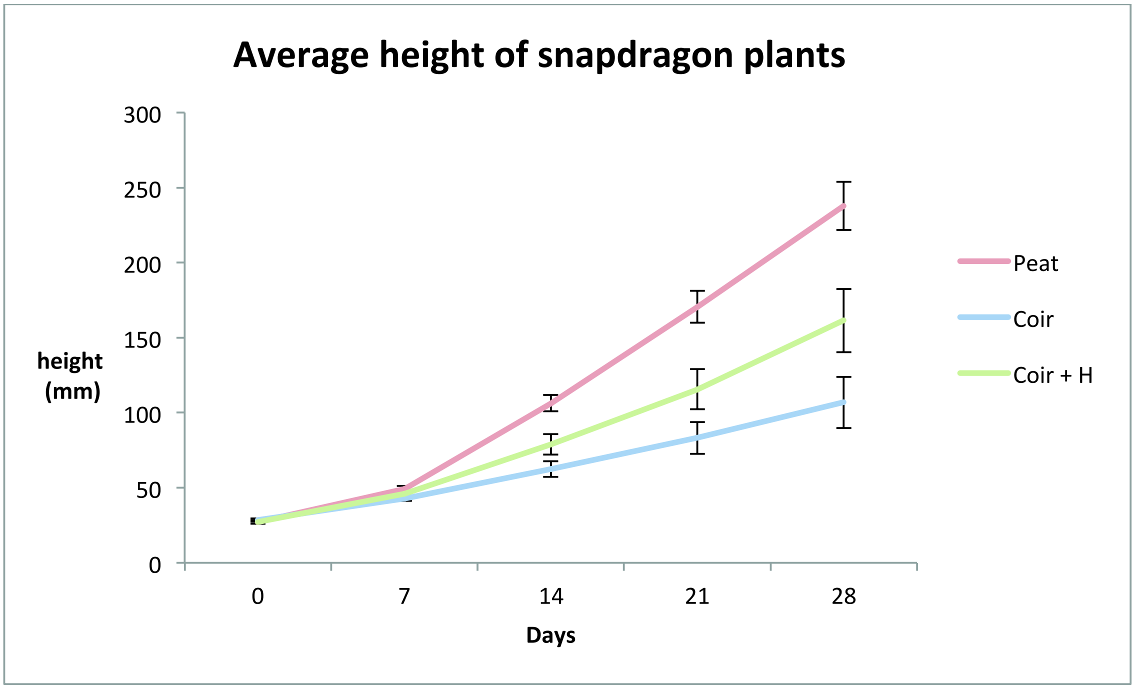
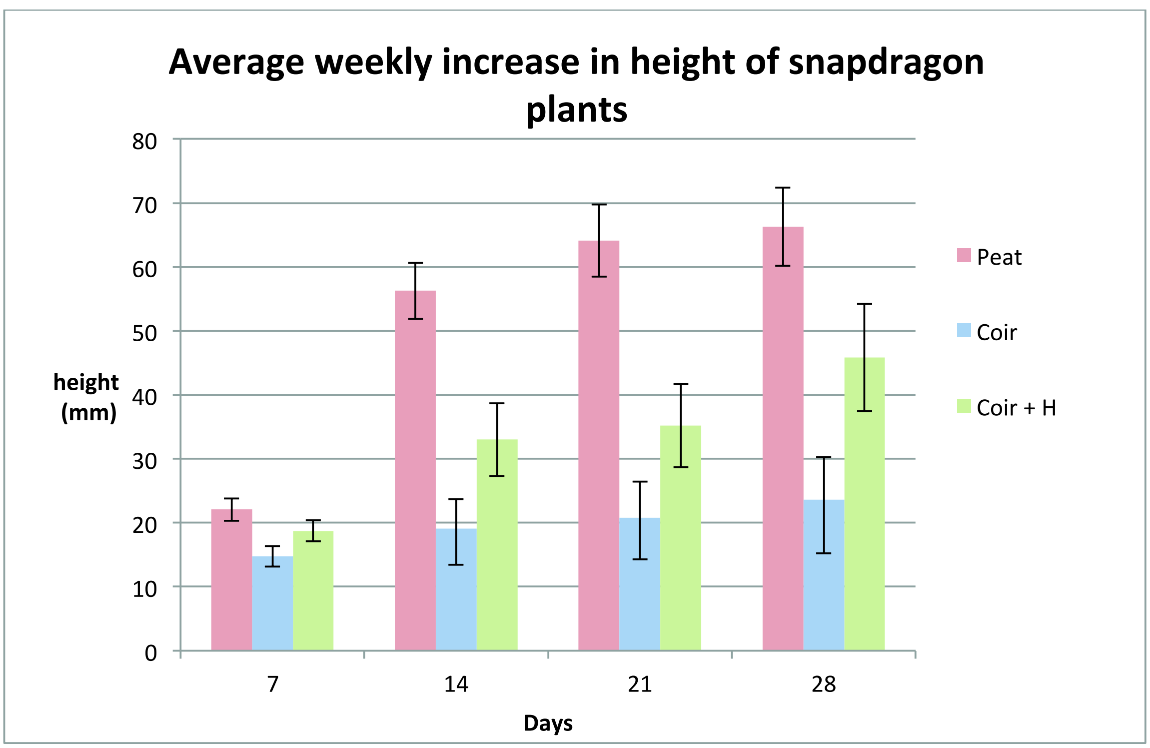
10. Appendices

10. 1. Appendix A – Plant growth

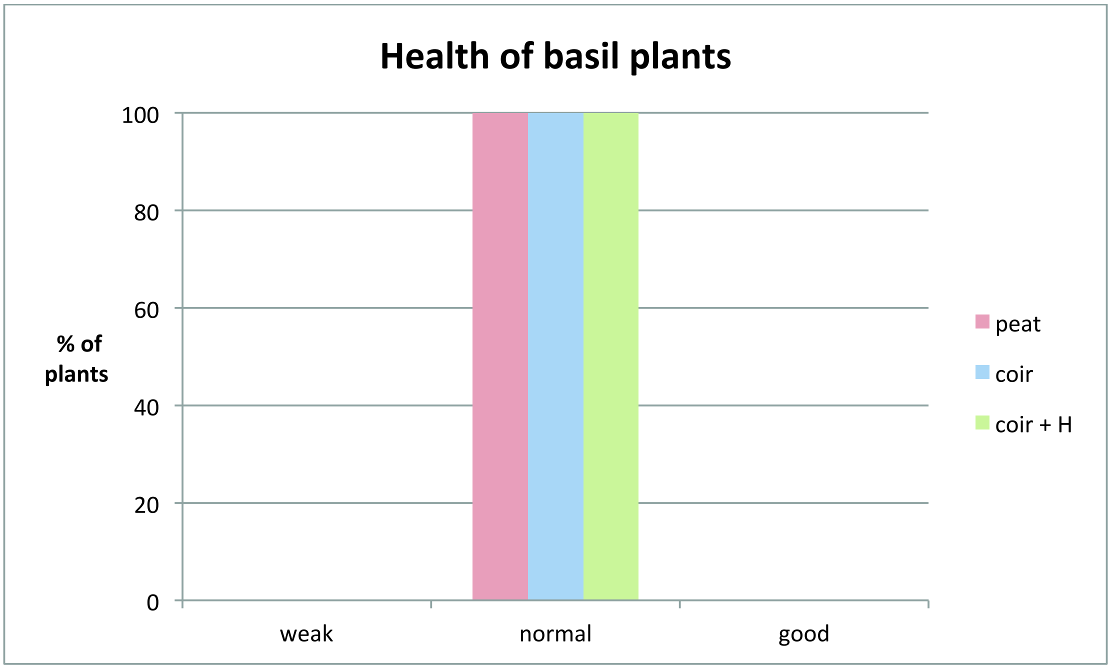


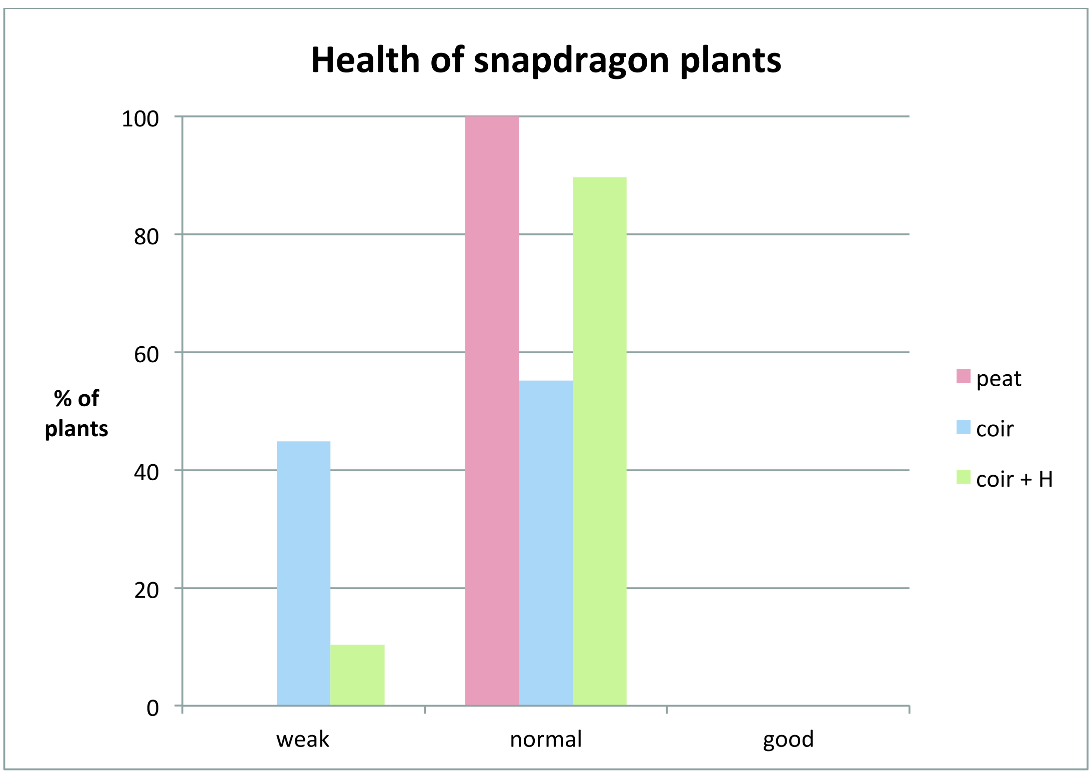


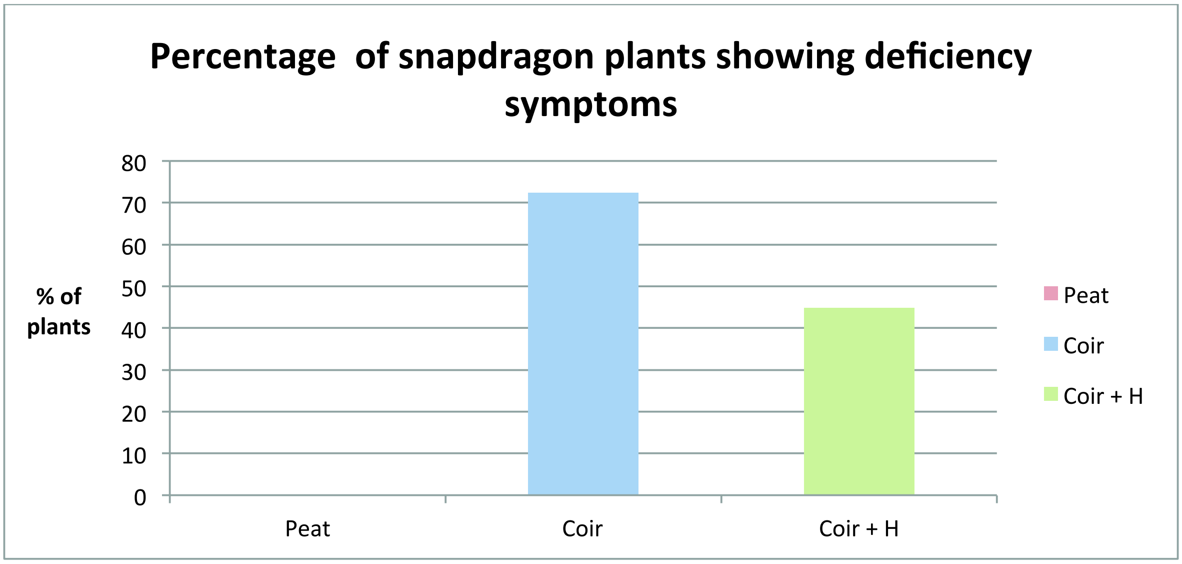

Average height of snapdragon plants
300
250
200
150
100
50
0
height
(mm)
0
7
14
21
28
Days
Peat
Coir
Coir + H


Average weekly increase in height of snapdragon plants
80
70
60
50
40
30
20
10
0
height
(mm)
7
14
21
28
Days
Peat
Coir
Coir + H

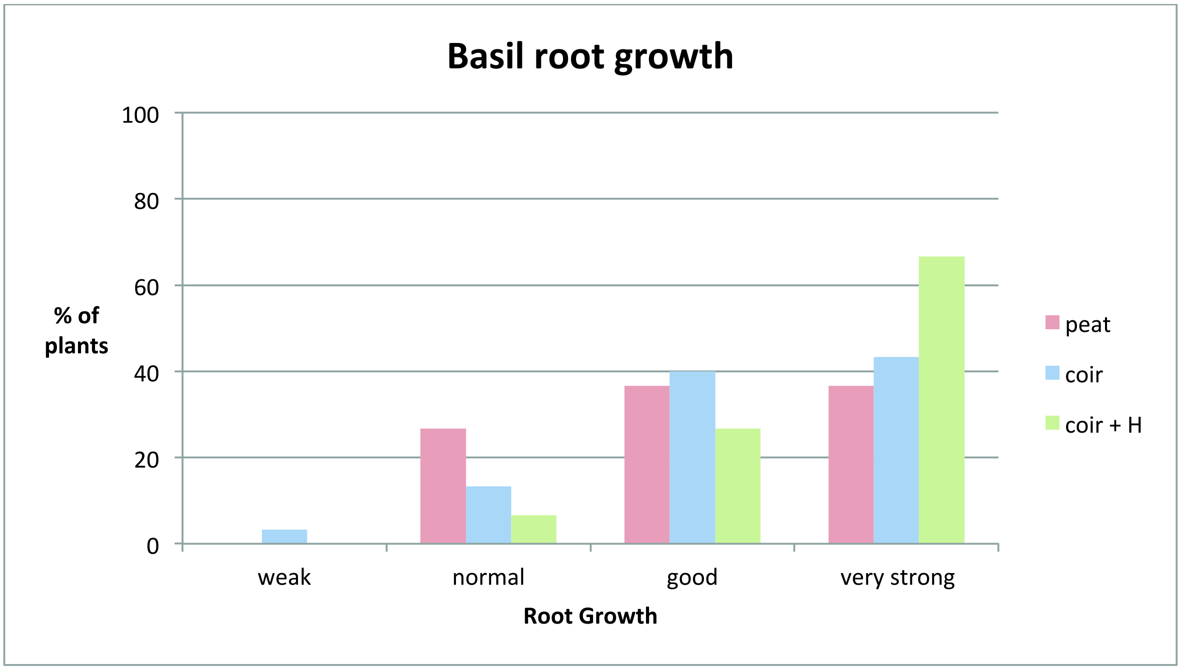
10. 2. Appendix B – Plant health

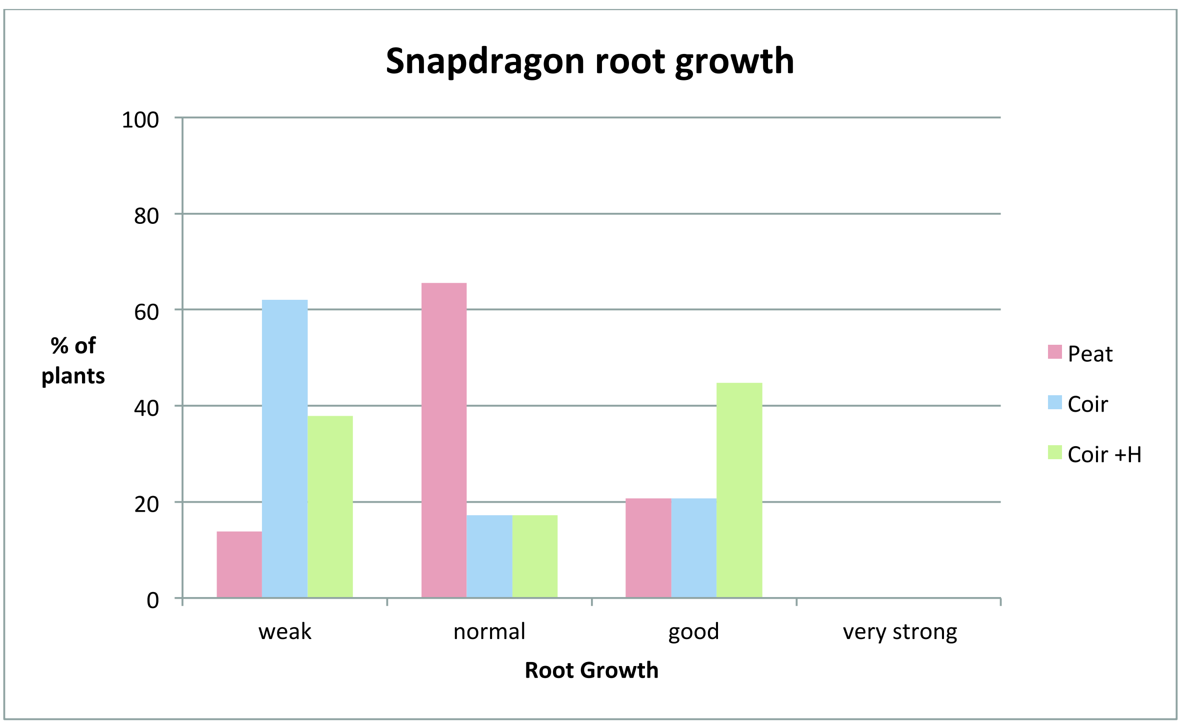





Percentage of snapdragon plants showing deficiency symptoms
% of plants
80
70
60
50
40
30
20
10
0
Peat
Coir
Coir + H
Peat
Coir
Coir + H

10. 3. Appendix C – Root growth





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The Biorenewables Development Centre (BDC) is a not-for-profit company, based at the University of York that helps businesses develop ways to convert plants, microbes and biowastes into profitable biorenewable products. Using cutting-edge science and technology, we bridge the gap between academia and industry to assist companies both in development and scale-up of new greener processes and products. Established through a collaboration between the world-renowned Green Chemistry Centre of Excellence and the Centre for Novel Agricultural Products, our expertise, services, open-access facilities and access to over 100 scientists across the fields of chemistry and biology puts the BDC in a strong position to help develop bio-based projects.

Many SMEs in Yorkshire and Humberside are eligible for two day's funded consultancy through the BDC ERDF Project - get in touch to learn more.

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