Vegetable Propagation: Grower-led peat reduction & replacement demonstration trials 2021

Interim summary report

25/11/21

Project title:	Vegetable Propagation: Grower-led peat reduction & replacement demonstration trials 2021
Project number:	FV 464a
Project leader:	Barry Mulholland, ADAS
Report:	Interim summary report, [Dec 2021]
Previous report:	[Annual report, Month Year]
Key staff:	Chloe Whiteside, ADAS Andrew Watson, ADAS Peter Seymore, ADAS
Location of project:	Grower Sites – Farringtons (Lancashire), Sheepgate Nursery (Lincolnshire), Crystal Heart Salads (Yorkshire), G's (Cambridgeshire), Barfoots (Sussex), Elsoms Seeds (Lincolnshire)
Industry Representative:	Grower-led project with representatives from businesses listed above
Date project commenced:	26 April 2021
Expected completion date	31 March 2022

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

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Headlines

- Though not major, some differences in plant growth were seen between the standard peat used at nurseries and the commercially available peat reduced medias supplied by Growing Media Manufacturers (GMMs).

- Raw materials which were supplied by GMMs fell largely into three categories that could be defined below
    - A high Air-Filled Porosity (AFP) group that would have greater mechanical utility.
    - A mid-range AFP group of four materials that will likely have a positive plant response.
    - Low AFP materials that behave similarly to peat but could offer blending opportunities.

Grower Action Point

- High chloride levels present in some of the peat free media is believed to be the cause for poor germination. Growers should do chemistry tests before using new media.

Background

The need to reduce or replace peat use in commercial propagation is driven by Defra and minister's targets to be peat-free by 2030. There is also uncertainty regarding peat availability with the new Republic of Ireland (ROI) rules on the extraction of peat from bogs greater than 30 Ha, which now require companies to go through a licensing and planning regime, and the fact that Bord na Mona no longer have plans to harvest peat. Most of the peat that is used in commercial horticulture in the UK comes from the ROI.

From January 2015 to December 2019 Defra, AHDB, and the peat manufacturing and users' industry funded a £1 million project, CP 138, entitled 'Transition to responsibly sourced growing media use within UK horticulture'. The broad aims were to:

- Construct a growing media performance prediction model, which could be used to produce desired blends at least cost, without the need for extensive trialling
- Evaluate the blends produced in commercial crop production systems and to

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- Hold demonstration days for growers, to facilitate the uptake and management of blends

The ADAS-led project delivered a model for predicting the performance of responsibly sourced growing media (RSGM) blends based on coir, bark, wood fibre and green compost. In doing this ADAS developed raw material testing procedures for quantifying physical and chemical properties of RSGM media - bulk density, air filled porosity, available water, pH, electrical conductivity and cation exchange capacity. The model uses three of these physical properties that were identified as crucial in describing the functionally of media: air filled porosity, available water and bulk density.

Peat-free blends and reduced peat blends were produced, and their performances evaluated for different horticultural crops in CP 138. Overall, crops with shorter cropping times such as pot herbs were more sensitive to reduced-peat and peat-free blends, than longer term crops e.g. shrubs in the hardy nursery stock sector.

Growing media manufacturers are keen to use the model generated in CP 138 to develop new commercial blends, and individual growers / businesses can also access the model through a service provided by ADAS. However, further work is required to look at the vegetable propagation sector. Whilst modules and blocks were tested in CP 138, it was difficult to find suitable replacements with the range of materials that were on offer at the time within the project.

This project builds on the outcomes of project CP 138. Three growing media manufacturers were involved (ICL, Klasmann-Deilmann and Sinclair), and propagation was carried out at Crystal Heart Salads, Farringtons Nursery and Sheepgate Nursery. Subsequent growing on of crops in the field was completed by G's Growers, Barfoots, Elsoms and Farringtons. The project approach will create the platform to incorporate new materials and create new high performing blends that allow the vegetable propagation industry to transition to "choice" in future peat free growing media market.

Methods

The project was divided into two main parts: using existing commercial products and creating new suitable growing media blends (prototype blends). Three different growing systems were

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examined; blocking, modules and Ellepots which is a new technology that uses paper wrapping to contain media.

Using GMMs proprietary materials in propagation

Blocking compost

Propagation trials using the blocking method were carried out at Crystal Heart Salads, East Yorkshire, from June to July 2021. Two peat-reduced blends (15% reduced and 30% reduced) were supplied by one growing media manufacturer, although only the 15% reduced blend was used. The grower did not want to use the 30% reduced product as some of the peat-free pieces were chunky and there were concerns that this could cause damage to the blade which cuts the blocks.

The 15% reduced product was run through the machine on 24 June 2021 (week 25) to fill the trays and create the blocks (**Figure 1**). The blocking machine automatically adds water to the media, to ensure the product is the right consistency to make a stable block. The blocks were used in two demonstrations, one on lettuce (cv. Challenge) and one on celery (cv. Victoria). Seeds were sown using the seeding machine and trays were placed on the floor under glass and grown alongside the nursery standard product for comparison. Irrigation was overhead by automatic boom. A data logger was placed in the demonstrations to collect temperature and humidity data during propagation.

Figure 1. Blocks created using 15% peat-reduced media

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Once plants reached planting size, a sub-sample of trays were sent to G's Growers, Cambridgeshire, for planting in the field. The lettuce was planted on 14 July 2021 (week 28) using an automatic planter. The nursery control was planted first, followed by the 15% reduced peat. The plants were planted into two large demonstration plots. At the same time, trays of nursery control and 15% reduced lettuce plants were returned to ADAS Boxworth for assessment. Young plants were assessed for height (mm), quality (0-3 scale), fresh weight and dry weight. In addition, 25 blocks per media were dried in the oven at 80°C for 48 hours and dry weight recorded, along with block volume, so that bulk density could be calculated.

The celery blocks were planted on 27 July 2021 (week 30) using a smaller automatic planter. As with the lettuce, plants were planted into two large demonstration plots and trays of young plants were returned to ADAS Boxworth for assessment, using the same assessment criteria.

Once the lettuce field crop had reached maturity (**Figure 2**), 30 heads from each demonstration plot were harvested by hand (03 September, week 35) and returned to ADAS Boxworth for assessment. Heads were assessed for head weight, head diameter and internal core length.

For the celery field crop, ADAS were notified by G's in the first week of November that the crop was not going to mature further and so was due for destruction. ADAS harvested 10 plants per plot and assessed the plants for stick length and stick weight and the number of sticks were counted.

Figure 2. Lettuce planted in the field in week 28 (left) and at harvest in week 35 (right)

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Ellepots

Propagation trials using the Ellepots method were carried out at Crystal Heart Salads, East Yorkshire, from June to August 2021. This is a new technology being trialled by the grower. The system utilises a paper case which is filled with free-flowing media to create a plug (**Figure 3**). Three growing media blends were supplied by two manufacturers for the trial (50% peat-reduced, 70% peat-reduced and 100% peat-free), which were compared against the nursery standard control product.

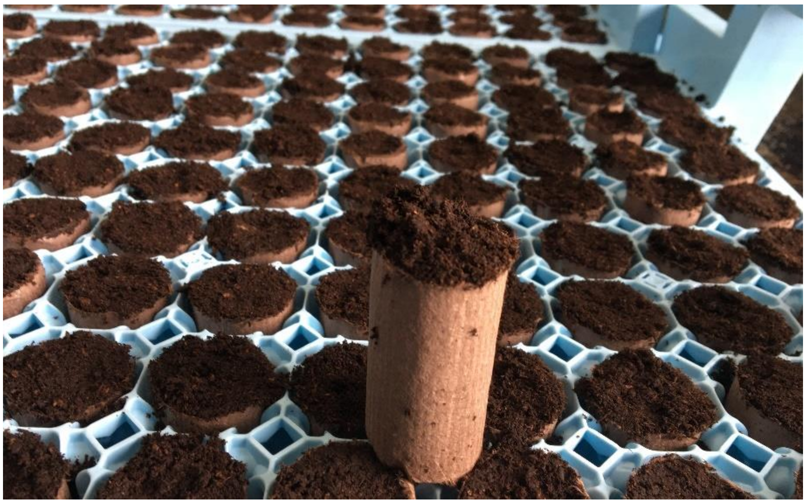

Figure 3. Ellepot plug design using nursery standard growing media as a filler

The trays were filled with media from 25 – 27 June (week 25) and the celery was sown on 26 June. The lettuce was sown on 16 July (week 28) so that both species would be ready for planting at the same time. The trays were placed on the floor under glass and grown alongside the nursery standard product for comparison. Irrigation was overhead by automatic boom. Once the plants were ready for planting, a sub-sample were sent to G's for planting. As the Ellepot planting machine was not available, plants were planted by hand into demonstration plots. Both the lettuce and celery were planted in the same field on 07 August (week 31). Trays were also returned to ADAS Boxworth for assessment and plants were assessed for height (mm), fresh weight and dry weight.

As with the blocking, ADAS were notified by G's in early November that the celery crop was not going to mature further and so was due for destruction. ADAS harvested 10 plants per plot and assessed for stick length and stick weight and the number of sticks were counted. Unfortunatelty the lettuce plots were damaged by a heavy frost and could not be harvested.

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Modules

Propagation trials using modules were carried out at Sheepgate Nursery, Lincolnshire, and Farringtons Nursery, Lancashire, from June to August 2021. The set-up process was similar and the growing media blends used were the same. At each site, a 15% reduced product and 30% reduced product were compared against the nursery standard control product. In addition, at Sheepgate, a 100% peat-free conventional product and 100% peat-free organic product were used.

Module trays were filled at Sheepgate using the peat-reduced products on 24 June 2021 (week 25) and seeds of tenderstem (Inspiration), kale (Reflex) and winter cauliflower (Cartagena and Isadora) were sown. The trays were placed in the germination area for two days and then set out on upturned pots on the floor, under glass. Trays were grouped by growing media product and all were watered and fed in the same way using an overhead boom. The peat-free trays were filled and sown on 30 June 2021 (week 26). All media was run through the machinery to fill the module trays.

The trial at Farringtons was set-up on 25 June 2021 (week 25) using the same growing media products, which were run through the nursery machinery to fill the trays and sow the seed. Plant species at Farringtons were spring greens (Winter Supreme and Verve) and kale (Reflex). As with Sheepgate, trays were placed in the germination room for 2 days before moving into the glasshouse where the trays were sat on upturned pots (**Figure 4**). Data loggers were placed at each nursery to record temperature and humidity throughout the propagation period.

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Figure 4. Trays set out under glass on upturned pots at Farringtons

The Sheepgate trial was visited by ADAS on 20 July (week 29) and Farringtons was visited on 23 July (week 29). Plants were assessed at both sites for % germination within a sub-sample of trays and photographs were taken. Once the plants were ready for planting, a sub-sample of trays were collected from each site and returned to ADAS Boxworth where they were assessed for height, fresh weight and dry weight. The plants from Farringtons were planted in fields owned by Farringtons Nursery from 04-10 August (week 31-32). A sub-sample of Cartagena and Inspiration from Sheepgate were planted at Barfoots in Hampshire on 13 August 2021 (week 32) and a sub-sample of all four plant species from Sheepgate were planted at the Elsoms demonstrations trial ground in Spalding. All field trials were planted using an automatic planter.

On 14 October (week 41), the tenderstem broccoli at Elsoms was assessed for its first pick, assessing the % of plants flowering per plot and the weight of stems harvested from 10 plants per plot. At the time of writing, end of November 2021, nothing else was ready for harvest at any sites.

Prototype blends

A selection of raw materials were submitted by the growing media manufacturers (GMMs) to ADAS Gleadthorpe. In total, 20 raw materials were submitted. All materials were also sent to Natural Resource Management labs (NRM) for chemical analysis. Growing media properties for each material were tested in duplicate, due to resource constraints. As for CP 138 Available Water values were measure at 5kPa.

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Raw materials were characterised in terms of three physical parameters:

- Air Filled Porosity (AFP)
- Dry Bulk Density (DBD or D_b)
- Available Water (AW)

Briefly:

- AFP is the amount of water the substrate can hold
- DBD is the density of the substrate
- AW is the amount of water that can be extracted from the substrate by the plant

Previously, in project CP 138, the AFP, DBD and AW values were measured for a large number of raw substrate materials (peat, coir, bark, wood fibre and green compost) provided by several GMMs. Those results form a backdrop against which other materials can be compared. In addition, CP 138 determined that there is a link between plant performance and the value of these parameters. In particular, low AFP high AW values are to be preferred.

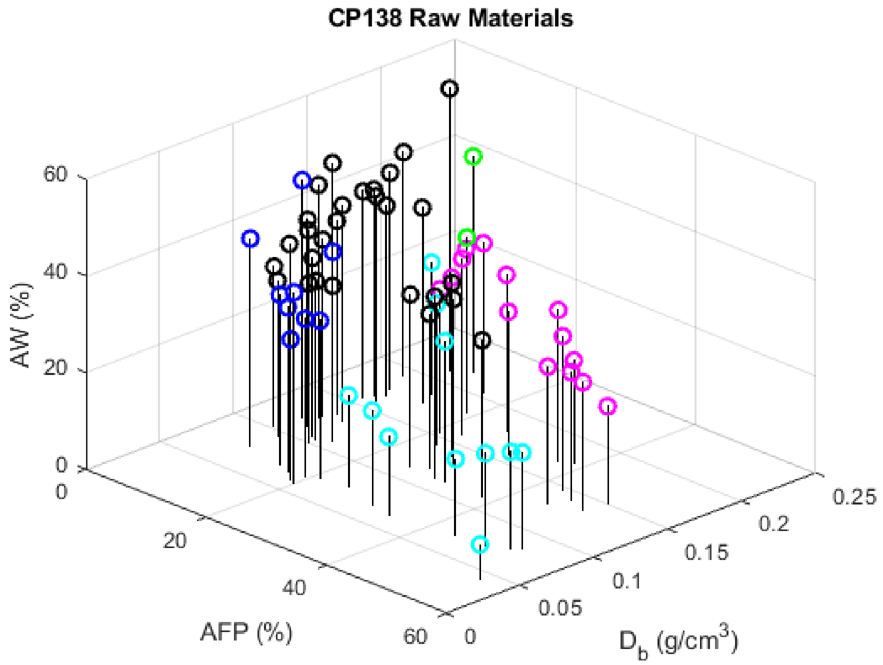

Figure 5: Physical parameter values for a collection of raw substrate materials. Black rings denote peat. There are two classes of peat. The larger cluster (smaller AFP) is fine peat, the smaller cluster (higher AFP) is coarse peat. Other materials are coir, green compost, wood fibre and bark.

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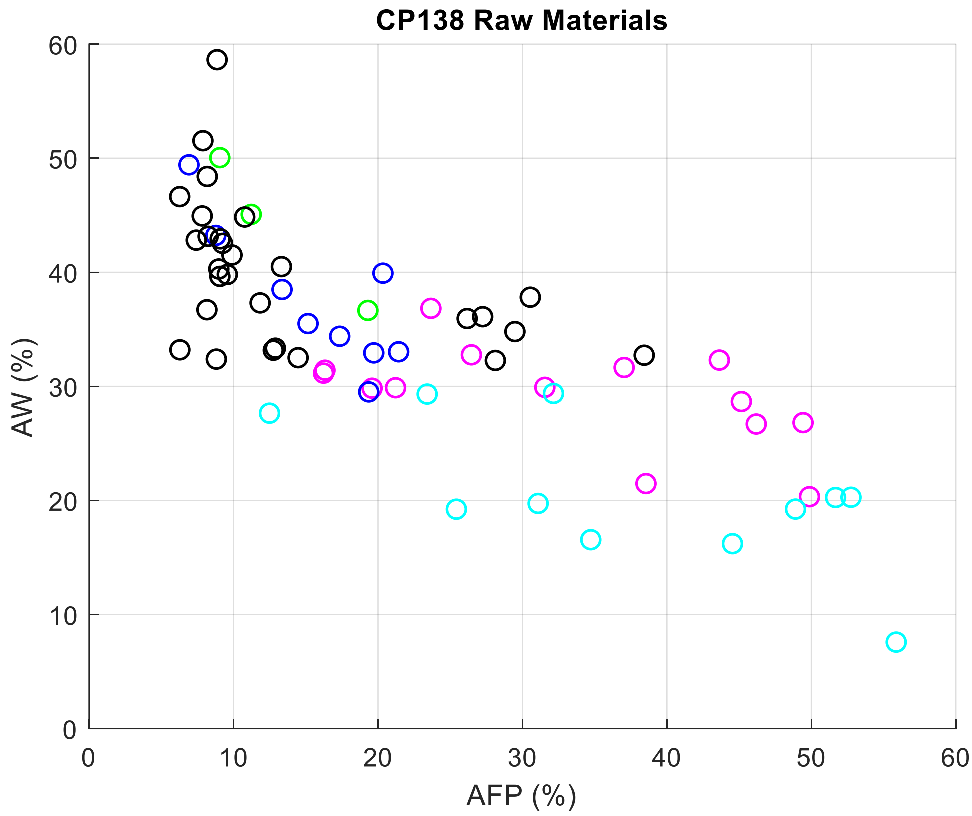

Figure 6: Physical parameters in 2D. This plot shows the same data as the previous figure but projected along the DBD axis such that DBD values vanish. Black rings denote peat. Other materials are coir, green compost, wood fibre and bark.

Figure 6 shows the same data as **Figure 5** but viewed along the DBD axis. This serves to highlight the relationship between AW and AFP. There are more green compost markers in this view since some have high DBD values and do not appear on the axes of the previous figure.

An important point to note from these figures is that the two types of peat have reasonably clustered values of AFP and AW. The same is broadly true for coir. However, bark and wood fibre span a very large range of AFP, including some high values associated with poor plant response. This attribute undermines the description of a growing media blend in terms of percentage of ingredients, since barks and wood fibres are highly variable.

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Green composts are shown to be promising materials in terms of physical parameters. However, they come with additional challenges such as the presence of unwanted contaminants.

Results

Existing commercial products

Blocking compost

Pre Planting

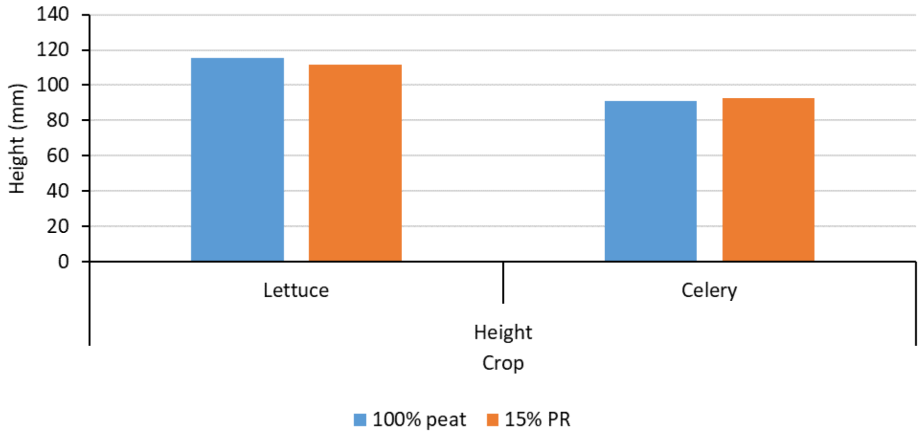

Figure 7: Height of young plants assessed prior to planting at G's.

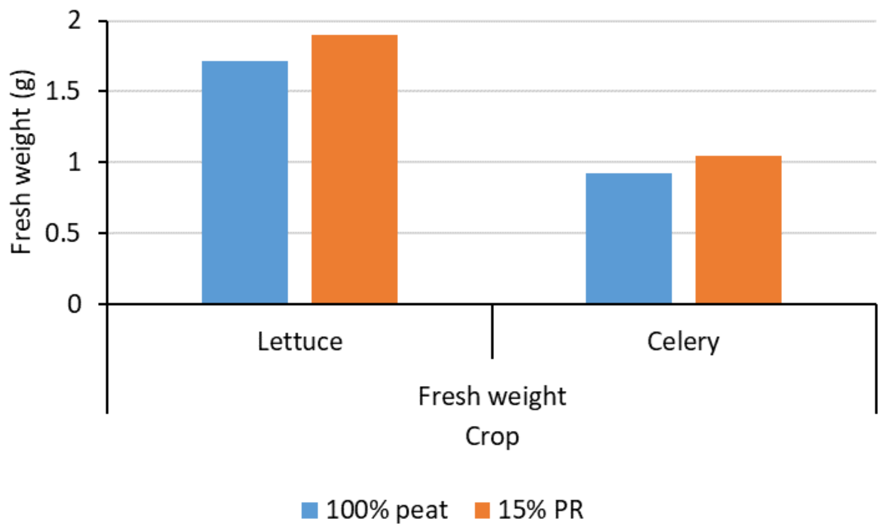

Figure 8: Fresh weight of young plants assessed prior to planting at G's.

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Figure 7 shows the crops heights of the lettuce and celery with the 100% peat and 15% PR mixes. There was little difference between the two mixes in either crop prior to planting. **Figure 8** shows that there were some small increases in fresh weight with the 15% PR growing media compared to the 100% peat in propagation. Due to the demonstration nature of this project statistical analysis could not be done to determine if this was due to the tested medias or other variables.

Harvest- Lettuce

Table 1: Average weight, diameter, and core length of the harvested lettuce from blocking compost

	Average lettuce weight (g)	Average lettuce diameter (cm)	Average lettuce core length (cm)
100% peat	689.31	15.78	4.71
15% PR	665.43	15.43	4.10

Table *1* shows that the 100% peat had slighter higher averages across the three categories compared to the 15% PR. Lettuce weights were largely similar **(Figure 9)** between the two media types apart from at the lower weights (<600g) where the 100% peat stayed higher than the 15% PR on average. Presenting the data as in **Figure 9** helps show the variability in the weights instead of just comparing the average alone as given in

Table ***1***.

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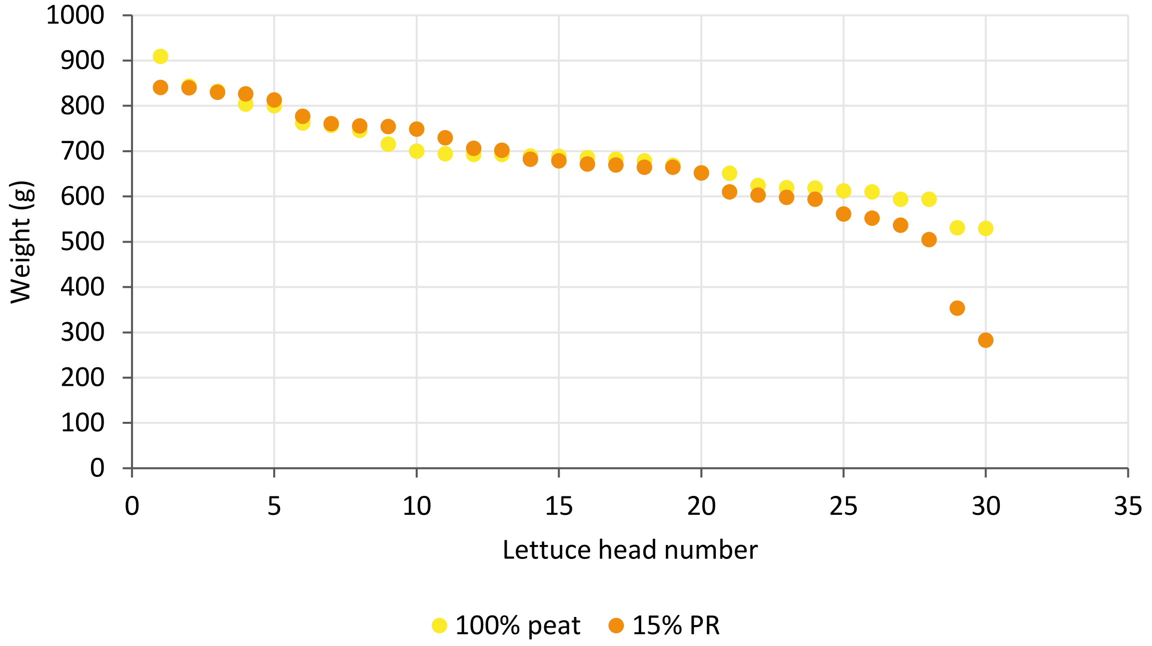

Figure 9: Weight by lettuce head number, data was ranked by weight for each of the two growing media types.

Harvest – Celery

Table 2: Average number of celery sticks per plant, average stick length and weight from blocking compost.

	Average no. of sticks	Average celery stick length (mm)	Average celery stick weight (g)
100% Peat	15.7	540.02	28.13
15% PR	16.5	575.45	31.69

Table 2 shows that there was little variation in the average number of sticks between the two treatments, average stick length was higher in the 15% PR and the celery stick weight was also higher than the 100% peat control.

Ellepots

Despite being used in the Ellepots propagation system the 100% peat-free were not sent for planting or assessment because after germination plants failed to grow. Preliminary investigation from the NRM analysis implied a nutrition issue with high chloride levels present rather than it being an issue with the physical properties of the media.

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Pre planting

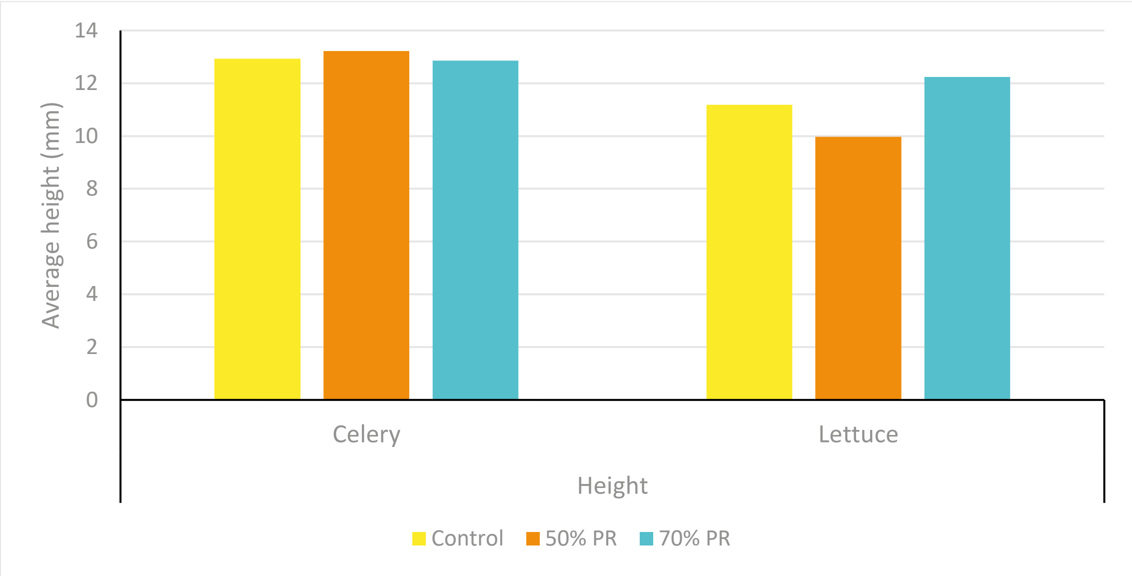

Figure 10: Height of young plants assessed prior to planting at G's.

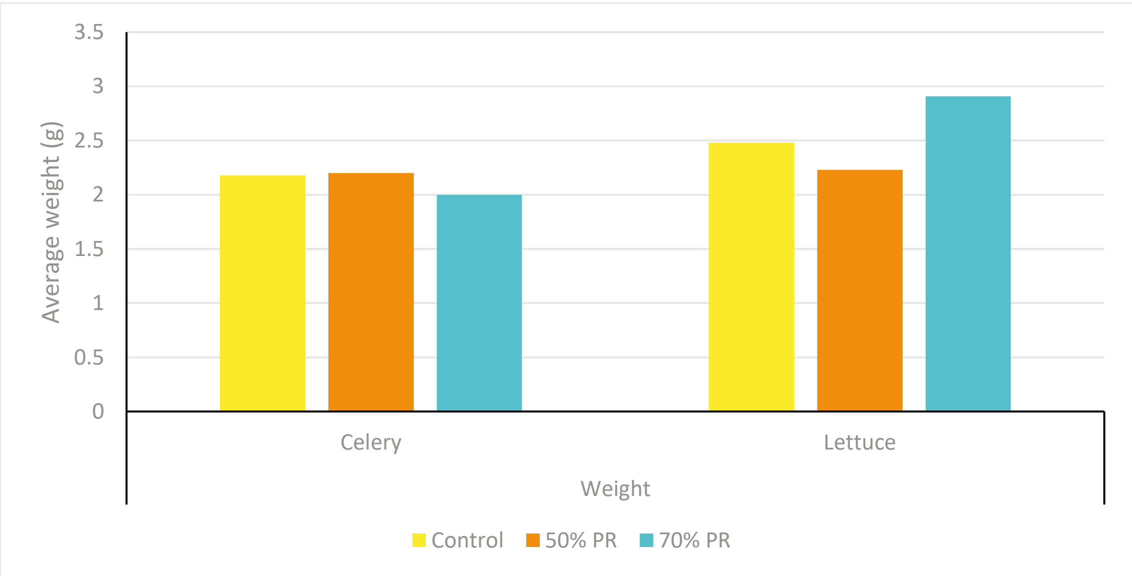

Figure 11: Fresh weight of young plants assessed prior to planting at G's.

Figure 10 showed the average heights of both the celery and lettuce plants. There was little variation between the three products for celery. There was more variation in the lettuce heights with the 70% PR having the highest heights on average. There was slightly more variation in the weights than the heights for the celery (**Figure 11**) though not much overall. The lettuce plants also had variation in the weights but only within a grams (1g) range.

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Harvest - Celery

Table 3: Average number of celery sticks per plant, average stick length and weight from Ellepots.

	Average no. of sticks	Average celery stick length (mm)	Average celery stick weight (g)
Control	13.8	514.02	33.75
50% PR	14.2	502.22	32.36
70% PR	14	500.48	35.50

At harvest the 50% PR had the highest average number of sticks per plant, however, the control still had the highest mean stick length. The 70% PR had the highest mean weight **(Table 3)**.

Harvest - Lettuce

Unfortunately, the lettuce crop was heavily damaged by frosts and considered un-harvestable by G's.

Modules

At the time of writing there is still outstanding data to be collected from the treatments involving modules.

Pre planting – Tenderstem broccoli

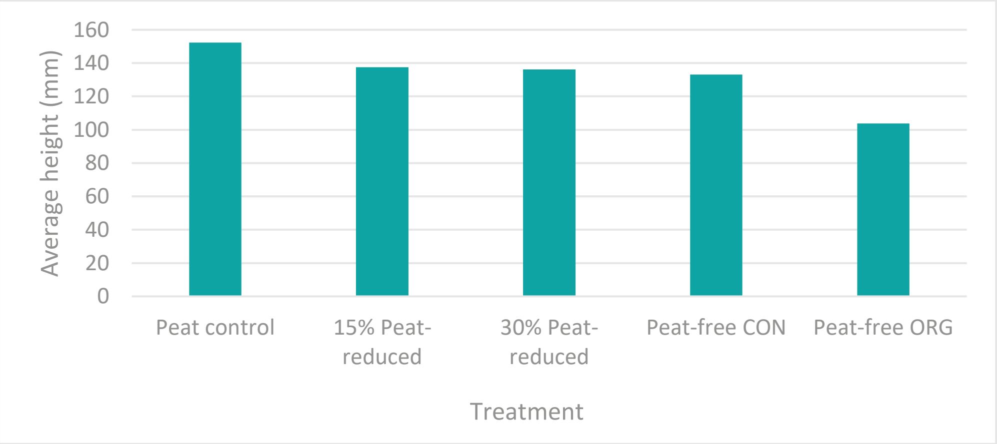

Figure 12: Average height of the different treatments prior to planting. Peat-free CON = Peat free conventional. Peat-free ORG = Peat free organic

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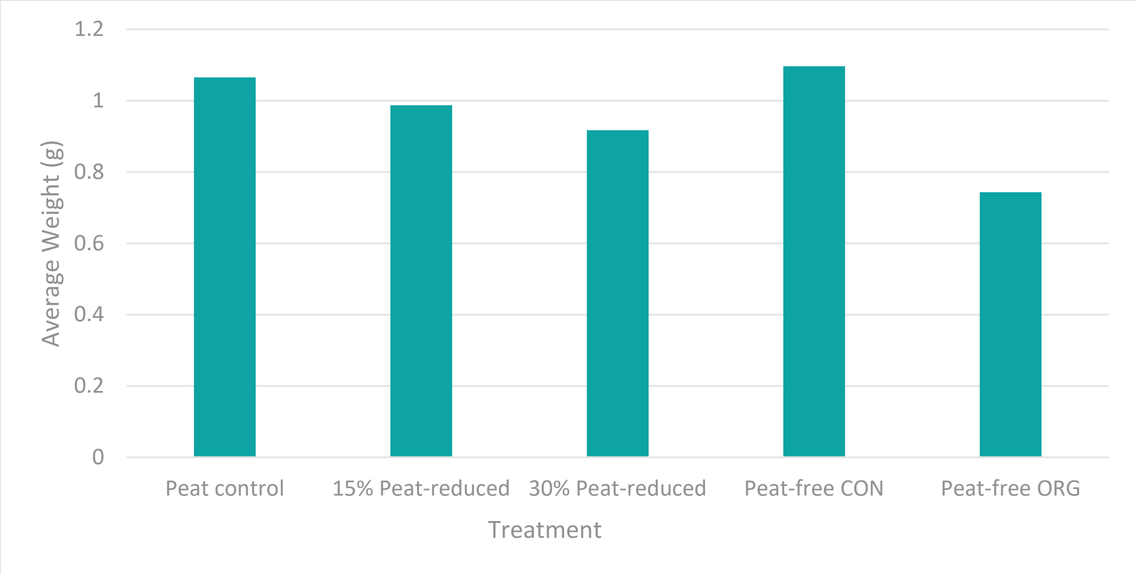

Figure 13: Average weight of the different treatments prior to planting. Peat-free CON = Peat free conventional. Peat-free ORG = Peat free organic

Figure 12 & **Figure 13** show the averages of the tenderstem broccoli prior to planting. There were some general trends with the peat free organic having the lowest height and weight overall. With height the peat control appeared to perform the best but weight saw the highest average with the peat free control.

Harvest – Tenderstem broccoli

Table 4: Mean weight per broccoli plant and total plant counts per plot.

	Mean weight per plant	Total plants per plot
Control	163.9	87
15% peat reduced	127.5	88
30% peat reduced	115.9	87
Conventional peat free	173.8	85
Organic peat free	143.9	82

Table 4 shows the mean weight and total plants per plot. There does appear to be some variation with mean weight with the peat control and the conventional peat free medias having the highest weight per plant. Total plants per plot were relatively consistent across treatments.

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GMMs Raw Materials versus CP 138 Reference Data

The average values for the project materials are shown in **Figure 14**. Note the changes to the axe's limits for AFP and DBD.

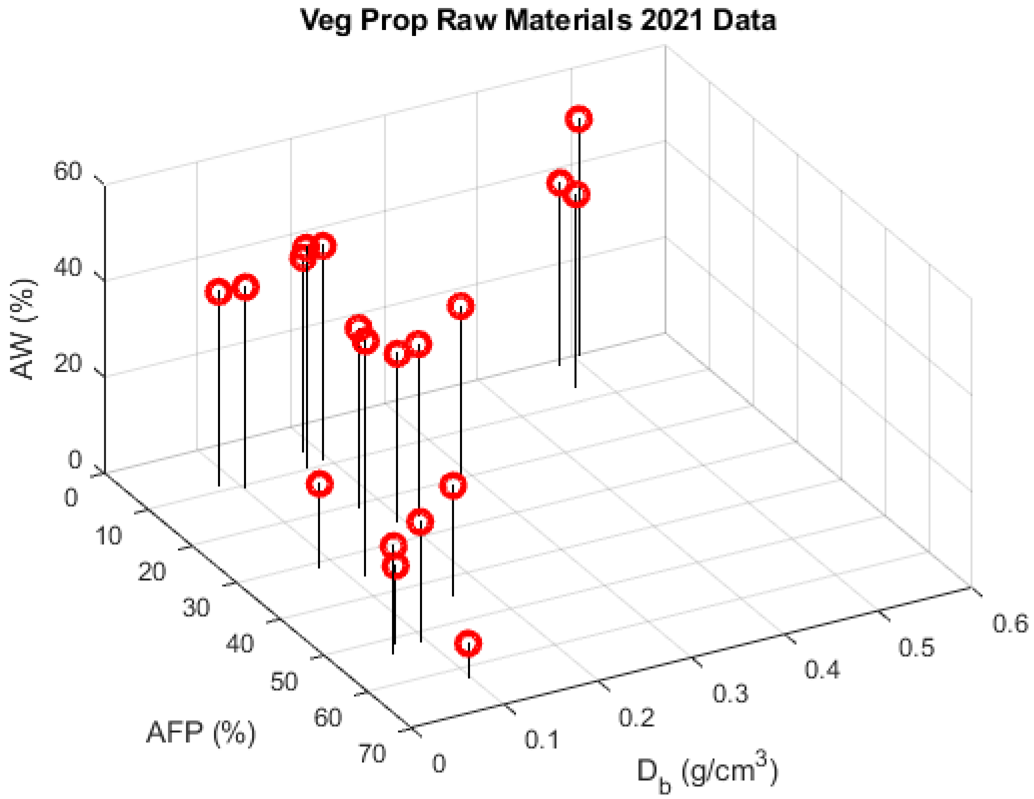

Figure 14: Project raw materials, physical properties in 3D. Note that compared to Figure 1 the AFP and DBD axes are extended.

Figure 14 shows only 19 points. The missing point has a very high DBD and is off the scale. In **Figure 15** the axis is extended in order to capture the missing point, but the penalty is packing together the rest of the data.

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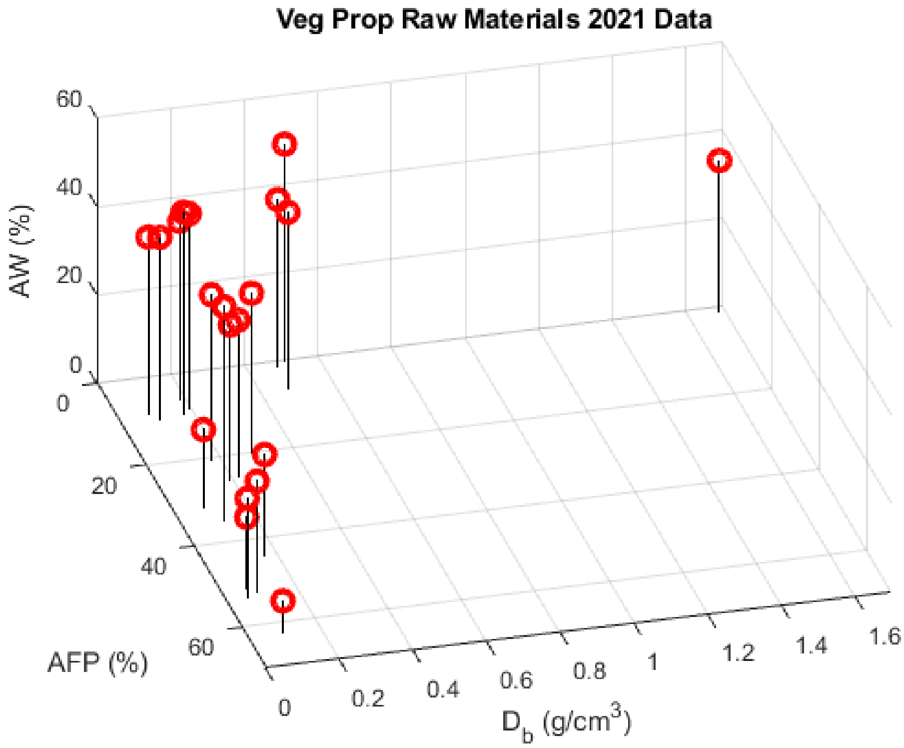

Figure 15: Project raw materials, physical properties in 3D with an extended DBD axis that captures an extreme point. The parameter values of the high DBD point are (AFP, DBD, AW) = (1.655, 1.679, 34.74)

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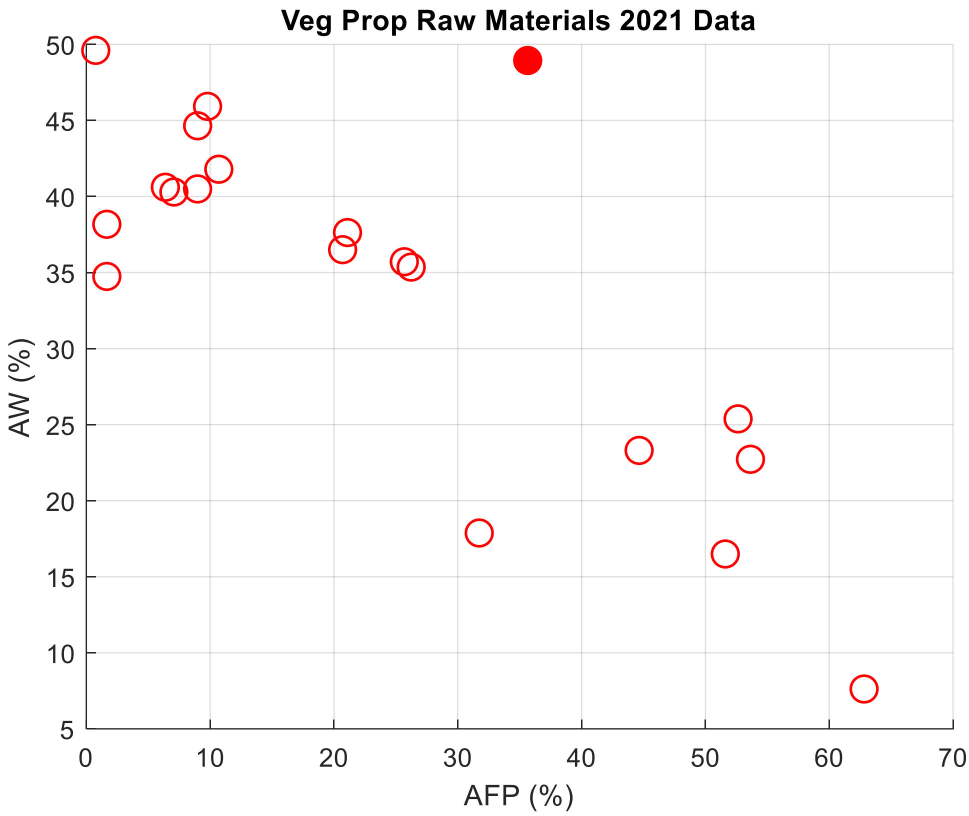

Figure 16: Project raw materials, physical properties in 2D. One point (indicated in solid red) lies outside the approximate AW-AFP envelope. The parameter values of this point are (35.65, 0.1124, 48.94).

Figure 16 shows the full project raw material dataset in 2D. It is worth noting that some of these materials are peats. For some samples, the type of material is unknown to the project. Therefore, it is not appropriate to flag 'peat versus non-peat' materials.

Figures 17 & 18, combine the existing project CP 138 reference data with this new projects' materials, first in 3D then in 2D:

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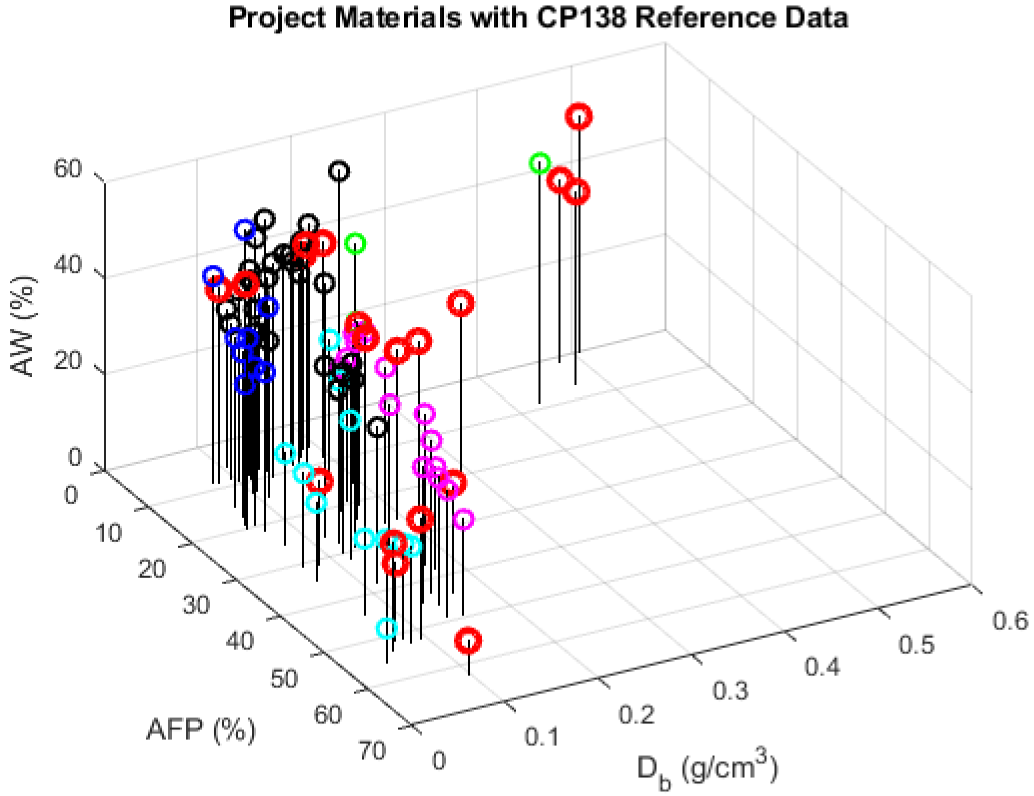

Figure

Figure 17: Reference data and project materials combined, 3D. The thick red circles denote project materials. The high-DBD value material is absent.

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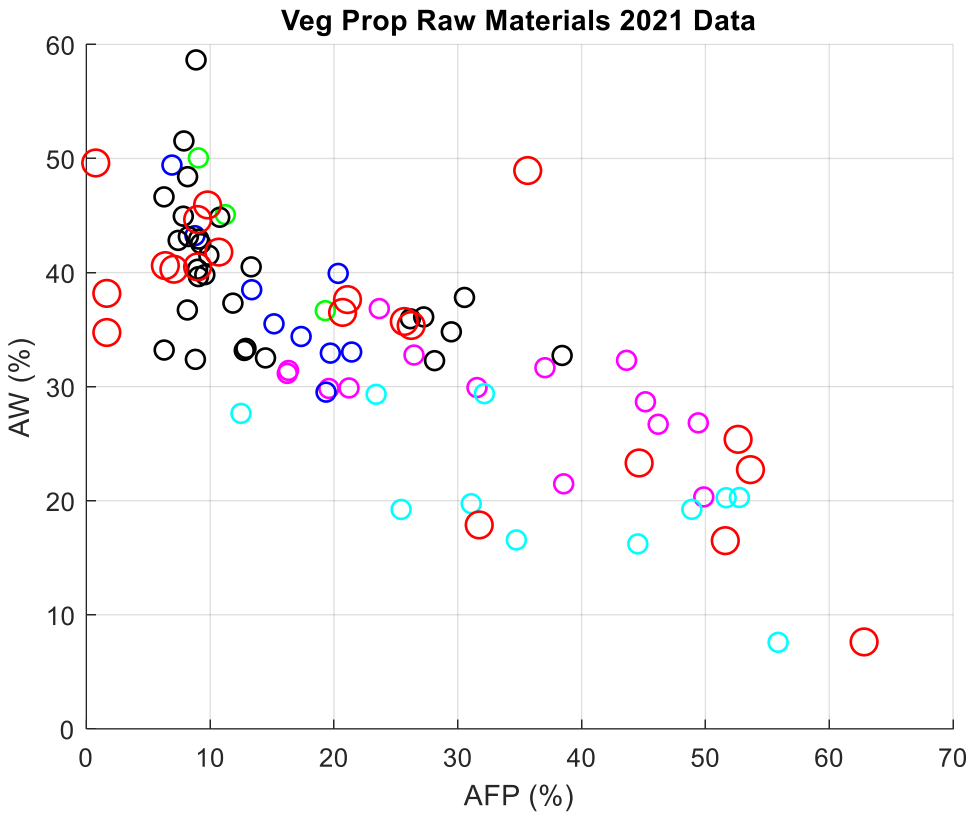

Figure 18: Reference data and project materials combined, 3D. Red circles denote project materials

Data Quality

As noted above, each of the physical parameter values were measured twice. The values plotted above are the average values of each pair. However, this strategy runs the risk of obscuring the spread in the data. To test the data quality, Figures 19 & 20 display *all data points* with the pairs linked by blue lines.

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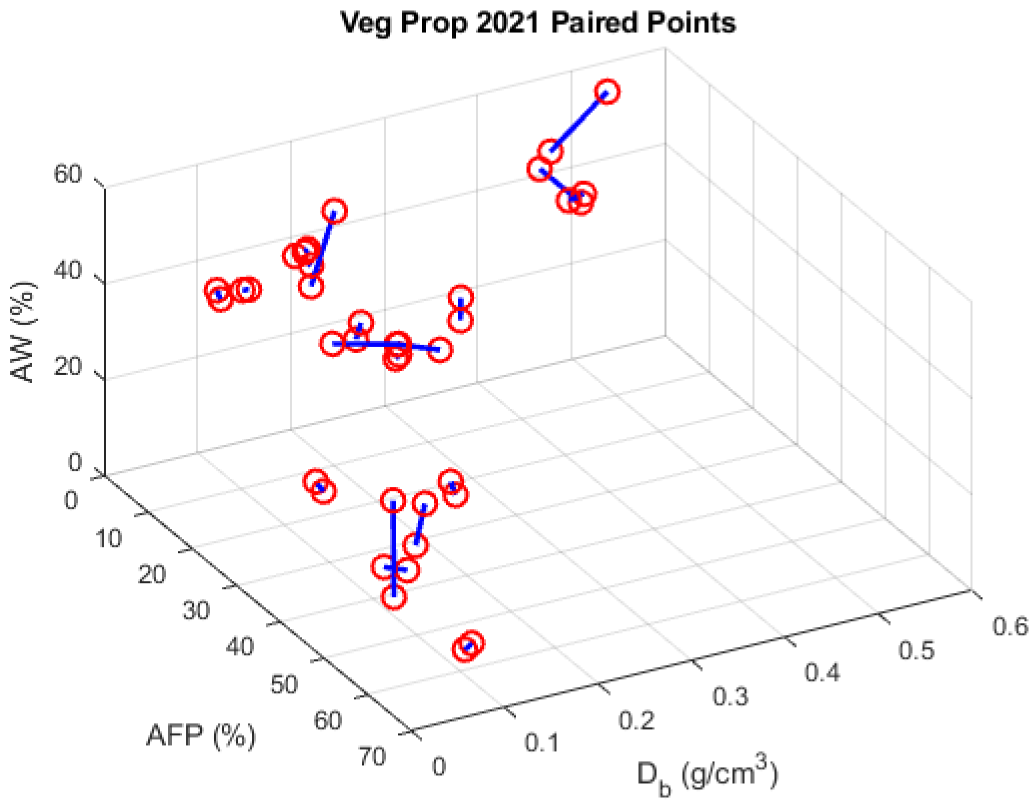

Figure 19: New materials data, all points in 3D, with points in a pair joined by blue lines.

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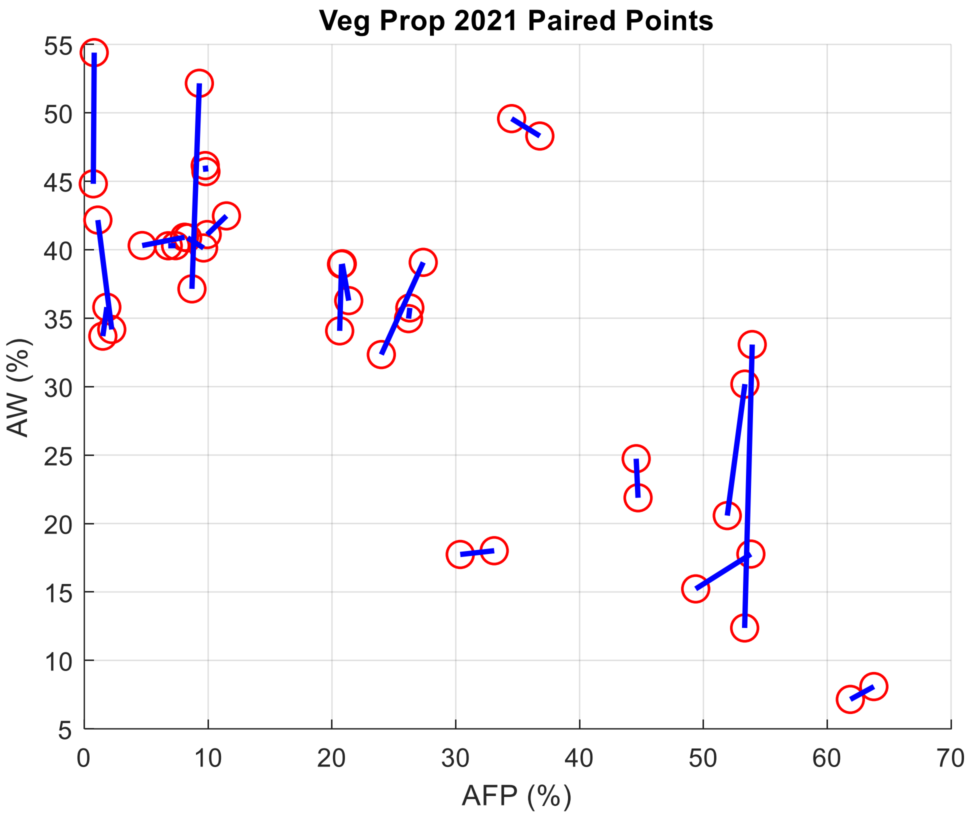

Figure 20: New materials data, all points in 3D, with points in a pair joined by blue lines

Prototype blend creation

At the time of writing prototype blends were still being designed by ADAS and had not been created or assessed.

Preliminary discussion

Existing commercial products

Despite minor differences for the celery and lettuce plants prior to planting in the blocking and Ellepots, there was some variation in the harvest results. However, there was not enough to distinguish whether these were localised variations from the demo plots as they were not replicated and no statistics could be performed. This was similar to the tenderstem broccoli. Due to this delving too heavily into the variations is risky to do, especially considering the measurements are not necessarily indicative of plant quality for sale. Conclusions made need to be considered carefully.

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Despite this, the general low levels of variation between treatments can be seen as a positive sign as it implies that reducing peat might not hamper crop production when viewed like this (without looking at other factors such as mechanisation or pot/ block structure). However, it is early days and there is more work to be done.

Physical parameters

Figure 17 & **Figure *18*** show that project materials fall broadly into three groups, ignoring the single point outside the AW-AFP envelope:

- There is a high AFP group that sit alongside the wood fibres. These materials are unlikely to correspond to good plant performance. If they have utility, it will lie in a contribution to the mechanical properties of the materials.
- Next, there is a mid-range group of four materials that broadly inhabit the space of coir and coarse peat. These materials are likely to be of use in terms of plant response.
- Finally, there is a large group of materials at low AFP values. Some of these values are typical of fine peats. Some are 'extreme' in the sense of being less than AFP = 7, which is roughly the cut-off for conventional fine peats. Those project materials at around AFP = 8 are likely to give good plant response. The three ultra-low AFP materials are an unknown quantity. However, in principle they offer the opportunity of blending with intermediate-value materials to produce something peat-like in terms of AFP.

There are some provisos, however. Some of the project materials are themselves peats, so in terms of the search for *peat free* they cannot contribute.

Chemical analysis

With one of the treatments failing to germinate and the chemical analysis from NRM showing high chloride levels it has been demonstrated that chemical analysis is critical for new growing medias to help sieve out those that would be detrimental to plant growth.

Physical parameters – Data quality

Figure 19 & **Figure 20** are quite revealing. For several materials the difference between the two measurements is substantial. For example, there is a material at AFP of approximately 53 for which the two AW values are 12.37 and 33.07. The average value used previously was 22.72 (see Figure 16 above). The spread in values is uncomfortably large and the use of an

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average of two values in such circumstances is highly questionable. It is probably fair to conclude that, given the nature of the materials and the difficulty extracting reproducible measurements, two values are not enough and going forward three should be considered a minimum to avoid potentially erroneous conclusions.

Preliminary conclusions

- Though not major, some differences in plant growth were seen between the standard peat used at nurseries and the commercially available peat reduced medias supplied by the growing media manufacturers.
- High Chloride levels present in some of the peat free media is believed to be the cause for a poor germination. Showing a need for chemistry tests before using media.
- New project materials tested fell largely into three categories that could be defined below
    - A high AFP group that would have greater mechanical utility.
    - A mid-range AFP group of four materials that will likely have a positive plant response.
    - Low AFP materials that behave similarly to peat but could offer blending opportunities.
- Two data points are not enough to extract reproducible materials, three data points should be strongly considered going forward.

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