6 Peat-Free Substrate performance of Potted Coriander in Commercial life-cycle

6.1 Introduction

Significant social and political upheavals in recent years within the U.K. has created a pessimistic climate for business. Geopolitical factors such as Brexit, increased pressure for environmentally sound products and an increasingly unstable global economy due to Covid-19. The challenges of increasing global food security without exemplifying pressure on biodiversity, ecosystem services and climate change (Tscharntke et al. 2012) in the face of human activity causing global reductions in ecosystem quality is considerably more than any other point in time (Plant et al. 2001). This is felt particularly within the food production sector. This sector is vulnerable to changes in costs, labor availability, market access and resource availability (Despommier 2010). Within horticulture, one of these challenges has the potential to completely change how the sector operates: Ambitious targets for the elimination of peat used as a growing media, the most conventional and widely used substrate throughout the sector, are generating interesting and unique challenges (Bohne 2001; Raviv 2005). Development and execution of new products or systems requires vigorous testing, application and assessment to gather the requisite data for successful implementation [Hartz et al., 1996], and this is entirely true for microbially amended peat-free media. The commercial environment for leafy edibles is routinely similar across the U.K. (aside from field grown): Large glass houses with huge capacities are used grow a variety of crops for supermarkets. These rely on consistent profit margins per pot, with material expenses kept to a minimum all while producing consistently high quality croppings. This trial was designed to test the efficacy of hand-mixed peat-free media, amended with microbes and a unique fertilizer, in the relevant setting of a commercial glass house. The trial itself was a demonstration of how peat-free media may evolve to be a feasible alternative to peat based growing media, and the treatments undertaken to reach that point (I.E. the addition of mycorrhizal fungal).

6.2 Materials and Methods

6.2.1 Growing Environment

The large scale commercial pot grown herb production centers are highly automated, fine tuned systems that allow for significant and reliable production of mass market goods for the retail environment . The glasshouse facility used for this trial was located at the Vitacress Herbs Ltd. glasshouse facility in the S. coast of England, Lagness Rd, Chichester, PO20 1LJ (50 ∘ 48'50.0"N 0 ∘ 44'01.6"W). The temperature is maintained between a minimum 19-21 ∘ degrees with a RH of between 50-70% . Supplementary lighting is also used, more significantly in the winter months to compensate for shorter daylight conditions. This is a combination of high pressure sodium (HPS) and light emitting diodes (LEDs). This work occurred during the spring.

6.2.2 Materials

As per previous trial work, the substrate for this trial was hand mixed prior to potting. The materials were supplied by Bulrush Ltd several weeks before the trial was due to commence. This allowed for fresh material (see Table 18 for complete list of materials used) that would not have its physical and chemical properties altered due to the establishment of other, less desirable microbial components such as white rot fungi. The starter fertilizer used was also provided by Bulrush Ltd and was Yara PG MIX 15-10-20: 15.0% N, 4.4% P (10.1% P2O5), 16.6% K (20.0% K2O). Mycorrhiza was supplied through Plantworks LTD. This was a granular inoculum, saturated with 44spores from up to x6 species of unique and carefully selected species. The purpose of generating an inoculum with an array of species is to maximize the viability of inoculum across an array of growing conditions. This was applied at a recommended rate of 5ml per pot.

Table 18: Treatments for Commercial Trial *(n = 5)*.

Treatment	**Contents**	**Substrate**	n
Control	No additions	Peat-Free	180
Fertilizer	Starter Fertilizer (NPK)	Peat-Free	180
AMF	Mycorrhizal innoclumn	Peat-Free	180
AMF + Fertilizer	Mycorrhizal innoclumn + Starter Fertilizer (NPK)	Peat-Free	180
Commercial Control	Peat based substrate with NPK starter fertilizer	Peat-Free	30

6.2.3 Potting

Potting occurred off-site at a glasshouse research facility in Egham, Royal Holloway University. Pots were labelled and set into trays, trays were then pallet wrapped and labelled again and stacked into a car for transportation (see Figure 42). Substrate preparation (component mixing and amendment incorporation) occurred within 48hrs of transportation to the glasshouse with seeds and a final top coat of substrate occurring within 12 hours of transportation. This aimed to prevent any unintentional germination of the seeds. Concerns regarding the ability for the pots to survive transportation or suffer from significant shaking/altering of physical characteristics of the media appeared to unfounded. If any change in physical properties occurred, the entirety of the trial shared the same treatment, thereby negating any changes in homogeneity across the trial. The pots used for peat-free substrates were .48L capacity pots, with a 10.5 cm diameter, narrowing to 7.5cm at the base and 8cm deep. These were supplied by ScotPlantsdirect Ltd. and were chosen to match the specifications of the commercial pots used in the glasshouse facility for Coriander.However, the density of the pots was lesser and so some were crushed slightly when spaced, $<$10 were crushed and so did not significantly impact overall sampling population (n=720). Spacing is a process that occurs after *ca.* 12-14days of crop emergence. This processes occurs in order to allow for crop growth.

Figure 42: Pots on trays, wrapped in plastic for transportation. Concerns regarding changes in substrate structure through movement proved unfounded due to the homogenous treatment of all pots due to a single trip to the growing facility.

6.2.4 Design

Due to the space available, a larger amount of pots were used for this commercial-scale trial (n = 720). Pots were placed on drainage benches (2x4m) with AMF amendments on a separate bench to limit cross contamination. x4 treatments were used with an additional commercial control. Treatments were layed out in blocks of *ca.* 40 pots. Each treatment was anonamized with both coloured sticks and pot labels. Assessments were made on *ca.* x25 pots per block for each treatment. Pots assessed were from the center of each block to minimize risk of treatment cross-contamination/edge effects.

6.2.5 Sensors

A Lux sensor (see Figure 43), built out of an Arduino Nano, LCD board and TSL9521 Lux sensor was used to determine light condition variations in both growing and market (i.e. supermarket conditions). This was to determine the effect of light quality (see Table 19) on commercially grown Coriander in Peat and Peat-Free growing media post-glasshouse. Additionally, A Wet sensor (Delta-T) was calibrated to 'Peat' and used to record % moisture during shelf-life assessment.

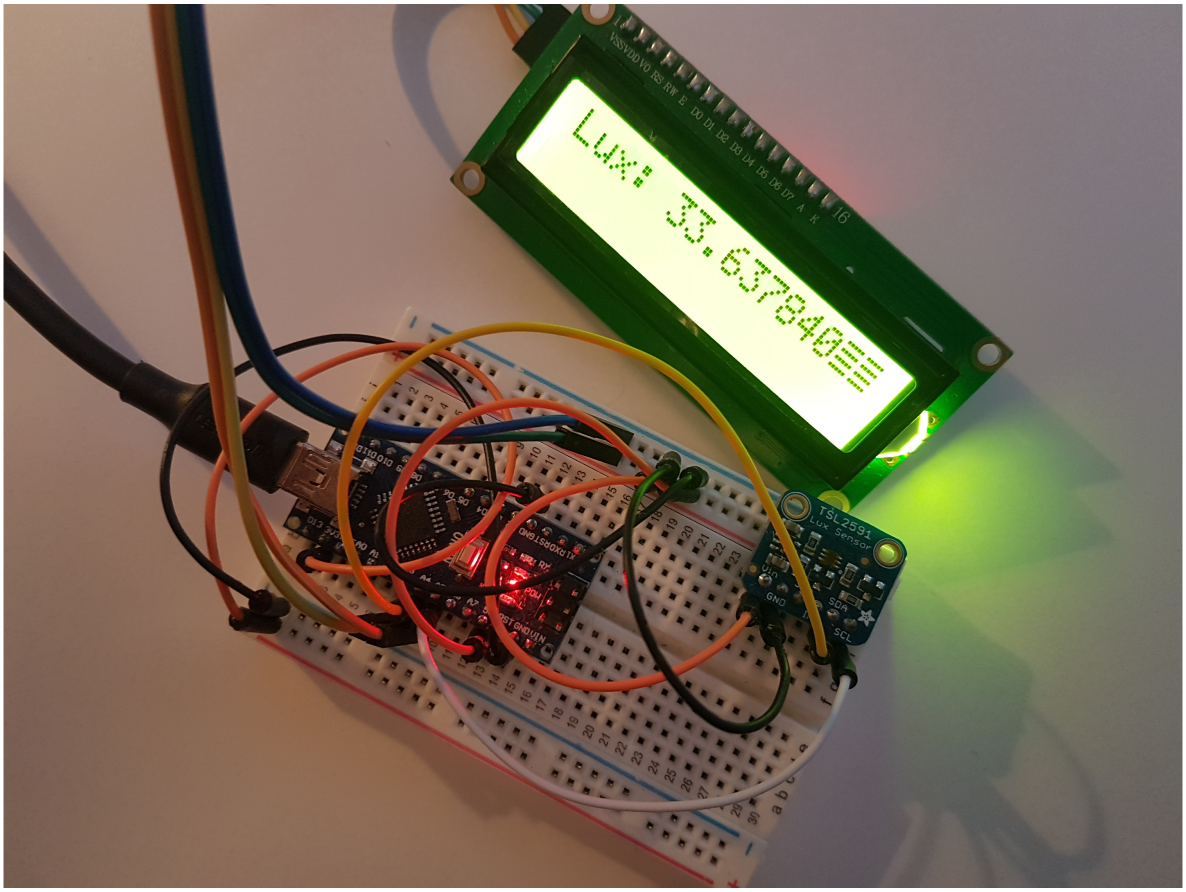

Figure 43: Lux sensor deployed during assessment of Commercial and market light conditions. This sensor is in prototyping phase as demonstrated by the use of a breadboard, rather than soldered components on a pcb board.

Table 19: Lux readings taken at crop height for potted herbs in various supermarkets.

Day	**Supermarket 1**	**Supermarket 2**	**Supermarket 3**	**Supermarket 4**
Lux Readings	330	456	334	532

6.3 Results

6.3.1 Emergence

Crop counts were observed at first day of emergence (E+0) and E+2, E+3 and E+5 days (see Figure 44). The Peat-Free treatments were assessed for growth, however a Peat (commercial control) assessment was unavailable due to initial assessments occuring on a different variety of Coriander. The highest emergence rates at 5 days were the AMF treated pots at 26 counts per pot (26.89 and 26.33 for AMF and Fertilizer + AMF treatments). This was a significant

($p<0.05$) increase in the emergence count of the Peat-Free control for 5 days growth (20.54 per pot). The lowest performing treatment at 5 days was Fertilizer, with 15.21 counts per pot.

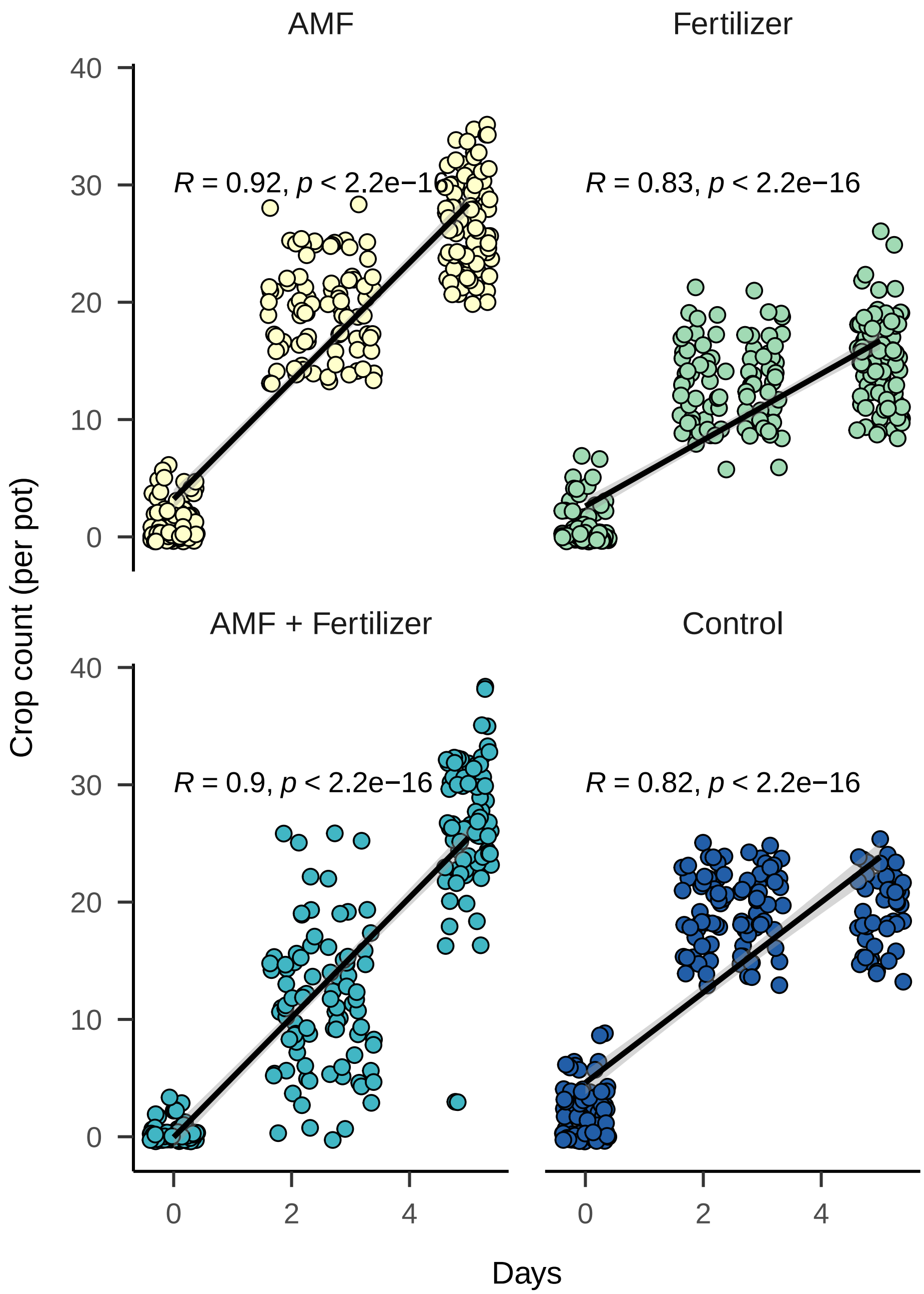

Figure 44: Scatter plot of Emergence crop count over time with linear regession line (R). The addition of mychorrizal elements increases the relationship between emergence and time. A plateau for further crop emergence is demonstrated in the Control (R=0.83) and Fertilizer (R=0.82) treatments. This is contrasting to AMF and AMF+Fertilizer treatments wherin crop counts countinue to rise as indicated by increased crop counts per pot. A commercial Peat based control was not available due to initial assessment of incorrect variety for Coriander.