Grower Summary

Precision Agriculture: AI- and Expert-based approach to forecast fruit production in high intra-field variation settings

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Annual report 2021

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Project leader:	Jack Stevenson, University of Lincoln
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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.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

Merits of quantifying environmental variation to improve forecasted yield estimates and reduce operating costs by forecasting polytunnel phyto-climate using deep learning techniques

Background

Depending on the farm, a polytunnel for strawberries can be configured in a variety of ways, such as the number of tables in the tunnel, the type of ground in the tunnels, the length of the tunnels, the ability to “air” the tunnel via vents and doors, etc. This variation can affect the growing environment and best practices that should be applied to the crop growing in the tunnel, as well as the strawberry cultivars that can be grown in the tunnel. By quantifying this variation, we hope to be able to help growers understand how their tunnel is affecting the optimal growing environment of the strawberry crop.

From this, a strawberry plant’s yield can be considered a function of its genetics, environment, and external management. One useful tool for approximating a non-linear function such as yield is neural networks (NNs). These computer programs learn a dataset to solve a given problem, such as image classification or next word prediction. In terms of the yield prediction problem, we would need to consider a variety of factors that can stress a plant, such as disease, irrigation amount, temperature, air flow, pest management, etc. Furthermore, for NNs to provide a meaningful output they need a large amount of data, and when considering a tunnel phyto-climate, there is usually one or two observations for the entire tunnel, which is also used across an irrigation block. Whilst this can provide an idea of the tunnel, it cannot fully describe the environment of the tunnel. This indicates a need to create a more detailed image of the tunnel environment, which can then be fed into a NN for it to learn how the tunnel changes during the growing season. We talk more about an indicative dataset for polytunnel temperature and humidity, and what this can begin to show us in the results section below.

Summary

This project focuses on quantifying how the variation of polytunnel configurations used to grow strawberries affect the temperature and humidity of the polytunnel Phyto-climate, two factors that are important in both strawberry yield and disease management. This should lead to further understanding on how different parts of the tunnel interact, as it can be inferred that

different regions grow differently. As can be seen in Table 1.A, the total yield from Riseholme in the 2021 growing season is lower towards the centre of the tunnels, with the west tunnel providing less total yield over the east tunnel.

Table 1.A: Average row yields from the 2021 growing season, along with the row placement within the tunnel.

Row Number	Row placement	Total usable yield
1	Field East Edge, East Tunnel East Edge	4662.557
2	East Tunnel East Centre	4125.160
3	East Tunnel Centre	4280.029
4	East Tunnel West Centre	4678.116
5	East Tunnel West Edge	4084.242
6	West Tunnel East Edge	3415.271
7	West Tunnel East Centre	3504.293
8	West Tunnel Centre	3323.787
9	West Tunnel West Centre	3517.371
10	Field West Edge, West Tunnel West Edge	4121.618

Initial results using the west Riseholme tunnel indicates that there is a greater variation in humidity over temperature, and as a tunnel in the northern hemi-sphere, the south side of the tunnel was warmer than the rest of the tunnel on average. These results were obtained from multiple temperature and humidity sensors placed in the tunnel, providing a higher spatial resolution of data than what is typically gathered for polytunnels.

At the current state in the project, we are purely looking at quantifying the temperature and humidity of a single tunnel. This is due to temperature and humidity affecting both how the plant grows, as well as how disease can grow and spread across the tunnel, if left unmanaged. Often a single observation point is used to represent the entire environmental state of the tunnel. This means that decisions regarding irrigation and humidity control are only representative of the observed area. By using small wireless sensors in a regular grid to create a more accurate representation of the tunnel, we hope to be able to build a better understanding of a polytunnel environment at a given timestamp and how it can affect plant management and fruit production.

Financial Benefits

At the project's current state, we claim that this project can lead to cost savings through a reduced number of crop disease spraying or application of irrigation to the crop such that the crop is not under a water/nutrition related stress. These will lead to concrete numbers as to the financial benefits from the project's work.

Action Points

By the submission of the next annual report, we aim to have some recommendations on how a polytunnel configuration can affect fruit yield.