AHDB
HORTICULTURE

Grower Summary

CP 121

Towards precision inputs through improved understanding of the underlying causes of in-field variation in Lettuce crop maturity and yield

Annual 2016

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The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

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Before using all pesticides check the approval status and conditions of use.
Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the AHDB Horticulture office (hort.info.@ahdb.org.uk), quoting your AHDB Horticulture number, alternatively contact AHDB Horticulture at the address below.

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Project title:	Towards precision inputs through improved understanding of the underlying causes of in-field variation in Lettuce crop maturity and yield
Project number:	CP 121
Project leader:	Dr Jim Monaghan, Harper Adams University
Report:	Second annual report, March 2016
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Key staff:	Dr Ivan Grove - Supervisor Prof Simon Blackmore - Advisor
Location of project:	Harper Adams University, Newport, Shropshire TF10 8NB and G's Farm Cambridgeshire
Industry Representative:	Ed Moorhouse
Date project commenced:	7th April 2014
Date project completed	7th April 2017

GROWER SUMMARY

Headline

- Lettuce yield patterns were consistent over 2 seasons, in terms of high or low yielding zones, with no in-season variation.
- EC scans could not be used directly to predict lettuce yields or its zonal variations. However, they are useful for predicting variations in soil properties.

Background

Crop yields are influenced by soil properties, climatic conditions and agricultural practices and their interactions. Understanding the spatial variation of these factors is fundamental when assessing the spatial distribution of yields and making precision farming decisions.

Variability in the growth of lettuce transplants leads to variation in head weight and maturity at harvest and sometimes post-harvest quality. This causes a significant issue in field-grown lettuce where growers wish to harvest heads of a uniform size and weight. The efficiency of a single-pass lettuce harvest is determined by uniformity of the mature heads; most oversized/under-developed heads result in crop wastage.

It is known that the availability of soil nutrients and moisture can affect plant growth and that the spatial variability of soil texture, and thus soil properties contributes significantly to crop variability (Taylor *et al*., 2003). The relationship been between soil properties and soil electrical conductivity (EC) has been established and the potential for using EC soil scans to predict yield variation in long season crops has been reported (Taylor *et al*., 2003). As yet, no work has been reported in short season crops such as lettuce. This project aims to improve harvest efficiency in field-lettuce through enhancing yield uniformity or providing targeted solutions. The project focuses on understanding soil heterogeneity and its influence on yield variation in spatial and temporal aspects at a field scale.

The overall aims are to identify:

- how much of the variability in lettuce maturity, yield and postharvest quality is accounted for by soil properties.
- soil factors (edaphic factors) that cause the greatest variability in lettuce growth.
- the critical relative ranges for these factors which allow for the delineation of specific treatment zones.
- whether lettuce variability can be reduced by precision application of inputs or adjusted management for specific zones.

In the second year (2015) aims were to identify factors which correlated most with yield variation.

Hypotheses were that***:***

1. the variability pattern of lettuce yield is consistent over the studied area.

2. underlying soil properties in the area under investigation influence yield distribution.

3. variable field zones could be identified using soil and yield maps.

4. The sand proportion in soil texture affects yield.

5. variation in lettuce transplant size and placement affects subsequent growth.

Summary

In 2015 two field experiments were carried out to map lettuce yield and soil factors for part of the field P57, on G's grower's Ltd farm in Cambridgeshire. In addition a glasshouse experiment investigated the influence of texture (particularly sand proportion) on lettuce biomass production.

Objective 1: To investigate the consistency of the spatial pattern of lettuce yield.

There were no significant differences between two successive yields of Iceberg lettuce (*Lactuca sativa, cv. Kuala cru*) that were harvested from the field P57. Yield maps showed similar patterns for the two yields.

Objective 2: To investigate the influence of the underlying properties of the field soil on lettuce yield.

The yield patterns corresponded with the patterns of a few soil properties. The relationship between factors appeared to differ between the northern and southern zone of the studied area. Overall, the variation in yield was accounted for by differences in soil bulk density, sand proportion, potassium and nitrogen at 30-60cm depth, and phosphorus at 0-30cm depth and soil moisture. None of the measured soil parameters individually correlated with the EC values. A model including soil bulk density, sand proportion, total K, N and P, and soil moisture content at harvest described 42.8% of the variation in lettuce yield averaged over both crops. There were no significant differences in EC between the two depths investigated.

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Objective 3: To identify field zones using the produced maps.

Distinctive field zones were identified of high and low yield. These zones could not be predicted from EC or previous wheat yield maps. The relationship between soil factors changed between the northern and southern portions of the experimental area. Variation in EC correlated with the general level of variations in soil across the field but did not describe amplitude or positional effects at a meaningful crop level. The Formed Variograms showed that data have become largely variable when the sampling points become more than ~100m apart.

Objective 4: To investigate the effect of sand proportion in soil texture on early stage of growth and biomass production.

A glasshouse experiment (GH01) showed significant (negative) correlation between sand proportion and the fresh weight suggesting that the fresh weight of the transplants decreased with greater proportion of sand in the soil.

The sand proportion in a Silty Clay soil obtained from a similar field had a negative impact on lettuce growth.

Objective 5: To investigate the effect of pre-plant transplant variation, and variation of transplants placement on the uniformity of the final yield.

A glasshouse experiment (GH02) looked at the effect of four different placement positions on transplant fresh weight 14 days after planting. The results showed no significant difference between transplants positioned differently in the pots, in terms of biomass production 14 days after planting, which possibly suggested that the visible growth differences might require a bigger number of replicates to be confirmed.

Glasshouse experiment GH03 looked at the degree of variation in fresh weight amongst the transplants inside one commercially propagated tray. The results showed a considerable level of variation amongst propagated transplants of the same tray. This variation could explain partially in-field growth and yield variation.

Financial Benefits

The efficiency of a single-pass lettuce harvest is determined by the percentage of heads which meets the requirement of the buyers, which is in turn determined by the uniformity of the mature heads; oversized/under-developed heads result in crop wastage. Any reduction in variation will increase the proportion of heads harvested and hence return from a crop.

Action Points

- It is not recommended to use EC scans to predict yield variation in lettuce as EC levels did not correlate directly with lettuce yield, or any of the other parameters measured in this experiment.
- Large variation in EC values can be used to predict the general level of soil variations in soil across the field but cannot necessarily explain amplitude and positional effects of individual soil traits.
- EC scans can be used to target soil sampling within zones of variable EC values, as long as the distance between the samples (cores) is less than 100m apart depending on the size of the zone that needs to be sampled.