Grower Summary

FV 413a

Predicting high risk plantings to manage postharvest pinking in lettuce

Final 2016

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GROWER SUMMARY

Headlines

- Over both years Iceberg lettuces displayed moderate levels of rib pinking and Cos lettuces displayed low levels of rib pinking after cold storage for 2 weeks.
- Iceberg and Cos lettuces showed high levels of butt pinking after cold storage for 2 weeks.
- The main factors that influenced the risk of a crop developing pinking after harvest were SNS index > temperature > water inputs > fresh weight (maturity).
- Harvesting mature heads of both crops increased the probability of pinking.
- Soil type had greater effect on butt pinking than rib pinking in Iceberg lettuce but had similar effects in Cos lettuce
- Growing conditions during establishment had a significant effect on the risk of pinking developing after harvest, with both crops having a greater probability of rib and butt pinking if the first 20% of the crop cycle was warmer and wetter.
- The environmental conditions during the middle 20% of the crop growth cycle (3rd quintile) was important for both crops. This is the period when the leaves that will be found on the outside of the trimmed head are produced. The probability of rib pinking in Iceberg lettuce was greater with warmer and wetter conditions but the probability was reduced in Cos lettuce.
- The last 40% of the growth cycle (quintile 4 & 5) was important for rib pinking in Iceberg lettuce with cooler conditions associated with an increased probability of rib pinking. The conditions had no effect on Cos lettuce.

Background

Following harvest some lettuce can produce pink colouring in the butt and ribs of the outer leaves. This is termed Pinking and, in spite of the development of new varieties with claims of reduced pinking, continues to present substantial problems for producers in both UK and imported crops. Poor product on the shelf reduces sales and leads to more complaints and consumer dissatisfaction. A recent review of research into lettuce pinking (FV 413) identified that issues such as high rainfall/over irrigation have a direct influence on expression of pinking.

This project took Iceberg and Cos lettuce samples from a number of UK commercial lettuce growing locations over two growing seasons. The heads were assessed over storage for the development of pinking and other quality measures. This information was combined with data on the environmental conditions (agronomic and meteorological) that each crop had experienced. This data was separated into 5 equal periods (quintiles) of crop growth, Q1-5.

The availability of multiple lettuce crops from March - October meant that a wide range of weather conditions were incorporated into the model over two years.

The aim of this work was to:

a) identify the environmental and crop factors that increase the risk of a crop developing rib and butt pinking after harvest;
b) develop guidelines identifying high-risk crops based on local meteorological and crop input records; and
c) enable growers to manage crops through the supply chain to the benefit of the customer.

Summary

The crop growth duration ranged from 41 days from planting (Cos and Iceberg) to 78 days (Cos) and 87 days (Iceberg) over the season. The crop cycle was separated into five periods (quintiles). Hence, each quintile represents a period of between 1 and 2 weeks depending on the crop duration. It was assumed that the developmental stages (i.e. hearting) would occur at a consistent stage in crop growth.

Variation in Soil Nitrogen Supply (SNS) Index was very strongly associated with a changed risk of pinking developing. Fertilizer records were inconsistent between locations and nutrient input from fertilizer was not included in the model. The use of SNS represents the soil type and an indication of residual nitrogen (and wider soil nutrient and organic matter properties). The risk of rib pinking in iceberg lettuce was greatest in crops grown in soil of Index 1, but it was greatest in Index 3 soils for Cos lettuce. Cos lettuce also had the lowest risk of rib pinking when grown in Peat soils. The pattern with soil index and butt pinking was confusing, with the risk of butt pinking in Iceberg lettuce greatest in soils of Index 1 and 2 and peat soils. In contrast the risk of pinking in Cos lettuce was least in Index 1 and 2 soils.

Temperature was associated with a number of significant responses in discolouration (Table A). In Iceberg lettuce, higher temperatures in Q1 and Q3 were associated with a significant increase in the risk of rib pinking but a significant reduction in risk if the temperatures was higher in Q5. A similar response was observed in Q1 and Q5 for butt pinking in Iceberg lettuce.

Cos lettuce had a different pattern of response, higher temperatures in Q1 increased the probability of butt and rib pinking, this response changed in Q2 with a reduction in risk of rib pinking but an increase in risk for butt pinking. The reduction in risk of rib pinking was an even stronger response to higher temperatures in Q3, with no response in butt pinking. By the end of the growing cycle higher temperatures increased the risk of butt pinking only.

The effect of **water inputs** was generally less than that of temperature (Table A). This can be explained by the fact that low rainfall can be mitigated by irrigation meaning that commercial crops should not be short of water during growth, although heavy rain would lead to excess water availability. Rib pinking in Iceberg lettuce was sensitive to water inputs in Q3 and Q5 with greater volume of water input associated with a small increase in probability in Q3 and a small decrease in probability in Q5. Butt pinking responded to early availability of water with a small increase in risk in Q1 and a small decrease in risk in Q2. In Cos lettuce the risk of both rib and butt pinking increased with higher volumes of water in Q1 and decreased with higher volumes in Q2. The risk of butt pinking was also more strongly reduced when Q5 was wetter.

Table A. Effect of water availability and temperature over 5 periods during the crop cycle on the probability of rib pinking increasing from score 1 – score 2 in Iceberg and Cos lettuce.

Iceberg Lettuce

	Q1	Q2	Q3	Q4	Q5
↑Water			↑		↓
↑Temp	↑↑		↑↑	↓↓	↓↓

Cos Lettuce

	Q1	Q2	Q3	Q4	Q5
↑Water	↑↑	↓			
↑Temp	↑↑↑↑	↓↓	↓↓↓↓		

Harvesting more **mature crops** has been suggested as a factor that increases the risk of pinking (HDC FV 413) in whole heads. More mature crops are generally heavier and larger, which would lead to higher fresh weight and greater head circumference being associated with maturity. In contrast more dense (less mature) heads would have higher weight but smaller circumference. In this study greater fresh weight was associated with increased risk of rib and butt pinking in both Iceberg and Cos lettuce suggesting that maturity of the head at harvest is a key factor in subsequent pinking. Increased density could also explain the increased risk of pinking in Cos ribs.

Early growth

This study suggests that both Iceberg and Cos lettuce are influenced by the growing conditions in the first 1-2 weeks following transplanting with higher temperatures and water availability being associated with a significant increase in the probability of pinking in the butt and ribs following harvest (Table A). This was a surprising finding. The leaves produced during this time are not part of the harvested head, so any response to temperature and water status at this time must be due to changes in long term factors within the plant, maybe linked to the

biochemistry of the ribs and butts and/or a consequence of growth form i.e. cell differentiation in the meristem leading to larger or smaller cell size in subsequent ribs and leaves.

Mid growth

Cos and Iceberg responded differently to conditions during mid-growth (Table A). In Iceberg lettuce, the probability of rib pinking increased when Q3 was warmer and wetter, in contrast, with Cos lettuce, the probability decreased strongly when Q3 was warmer. Butt pinking was not influenced by Q3 conditions in either crop. The explanation of this response is not obvious. In Iceberg lettuce, it suggests that leaves that develop and expand under warmer conditions have more fragile ribs, as seen by the increased rib cracking, whereas the same conditions in Cos lettuce produce more resilient ribs. The morphology of leaf ribs differs between the two crops with Cos lettuce having more pronounced ribs, often with a hollow core. Understanding this response may be of use to breeders in developing crops that are more resilient to post harvest handling.

Late growth

The stage of growth before harvesting was important for iceberg lettuce but less so for Cos. Wetter and warmer conditions reduced the risk of rib and butt pinking in Iceberg lettuce i.e. cooler and dryer conditions would increase the risk. In Cos there was no effect on rib pinking and dryer, warmer conditions increased the risk of butt pinking. The leaves produced in Q5 would be within the head so any response would be due to general head water status and the turgidity of ribs and leaves at harvest. It may be that cooler conditions prior to harvest slow down growth and lead to higher turgidity at harvest in Iceberg lettuce. This could lead to greater rib cracking when the plants were handled. However, rib cracking and pinking were a lower risk when Q5 had greater water availability. In Cos lettuce the robust ribs may be less sensitive to plant water status. More work is needed to understand this response, which was counter to grower expectations that wetter environments close to harvest are associated with pinking.

Financial Benefits

Pinking losses are hard to quantify, but can account for substantial customer complaints at certain times of the year and batch rejections. The importance of the work to the industry can be gauged from the willingness of seven businesses to provide crop samples for the study.

Action Points

In order to reduce the probability of pinking of wholehead lettuces, growers should:

1. Avoid harvesting over mature heads
2. Monitor temperature during crop growth and trend values against long-term averages.
3. Identify crops planted at higher than average temperatures as higher risk crops
4. Monitor growing environment during the middle of the crop cycle when the outer leaves of the trimmed head are being formed. Iceberg lettuce produce more delicate ribs and Cos lettuces more resilient ribs when this middle 20% of the crop cycle is warmer.
5. Identify Iceberg crops that experience a cooler end to the season as being at a greater risk of pinking.