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| Project title | Parsnip: New variety evaluation |
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| Report: | Final report, 31 st March 2009 |
| Previous report | |
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| Location of project: | Skiff Farm, Land of Nod, Holme-on-Spalding Moor, E.R.Yorkshire |
| Project coordinator: | Mr John Kenyon (BCGA) |
| Date project commenced: | 1 st March 2008 |
| Date project completed | 31 st March 2009 |
| Key words: | Parsnip, varieties, yield, winter hardiness, disease tolerance, canker, cavity spot. |

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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

Parsnip evaluation trial highlights a number of key attributes for different varieties. Growers can use the results to guide their varietal choices based on the priority needs of their business and customers.

Background and expected deliverables

According to the BCGA there is an urgent need for independent variety assessments in parsnip. The project aimed to evaluate a range of parsnip varieties, from all the breeding companies, at one location in the Vale of York. Results would highlight varieties with better yield, quality and disease tolerance. Sources of parsnip varieties assessed are given at the end of the grower summary.

Oxidation is a major problem after trimming and varietal differences were recorded. Further work is required to see if this oxidation could be linked to the reasons for bruising in some varieties. Further investigation into the causes of lateral rooting and Pythium like cavities is also required. Both of these root disorders give rise to fiscal loss.

Summary of the project and main conclusions

The 14 varieties were sown on the 9th April 2008, conditions were good and the trial emerged well. Growth through the season was excellent, there were no foliar diseases recorded. By the time of the November lift, we had several frosts causing some foliar damage. The autumn and winter was the coldest for 15 years, subsequently there was no foliage re-growth in February 2009 when we did the second lift.

The main conclusions from the trial are summarised in the tables below:-

Table 1: Varietal differences at harvest 1:

Table 1 – Harvest 1 - Yield and Agronomic data

Harvested – 24th November 2008

| Variety | Source | Plants 6 to 8 weeks | | Foliage ** | | No | Yield | | | | | | Root Quality | | | | | | |
|----------------|--------|---------------------|-------|-------------------------|-----|-----|----------------------|--------|-------------------|-------|-------|-----------|--------------|-------|-------|-------|------|----------|-----------|
| | | Estab - lishment | Vigor | Appearance/ Strength | | | Roots M ² | Gross | Marketable – T/Ha | | | | | Waste | Crown | Shape | Skin | Bruising | Oxidation |
| | | | | M ² | * | Aug | | | Nov | Nov | total | <22 mm | 22 - 28mm | | | | | | |
| Arrow | Elsoms | 42 | 3.8 | 2.5 | 2.5 | 32 | 35.69 | 0.30 | 0.93 | 2.33 | 21.75 | 8.98 | 1.40 | 3.5 | 3.3 | 3.1 | 3.8 | 2.0 | 4.5 |
| New White Skin | Elsoms | 32 | 2.8 | 1.0 | 1.0 | 25 | 46.29 | 0.19 | 0.27 | 0.85 | 13.53 | 28.94 | 2.51 | 3.5 | 2.8 | 2.7 | 4.0 | 2.5 | 4.0 |
| Polar F1 | Elsoms | 40 | 3.5 | 2.0 | 2.0 | 28 | 42.85 | 0.29 | 0.73 | 1.11 | 22.78 | 14.85 | 3.11 | 4.0 | 4.0 | 2.8 | 3.5 | 3.0 | 4.5 |
| Panache F1 | Elsoms | 33 | 2.8 | 4.0 | 4.0 | 33 | 42.65 | 0.40 | 1.14 | 2.29 | 20.60 | 15.47 | 2.74 | 3.5 | 3.8 | 2.8 | 3.8 | 2.0 | 4.7 |
| Palace F1 | Elsoms | 39 | 3.8 | 3.0 | 3.0 | 37 | 38.25 | 0.32 | 0.94 | 2.65 | 25.21 | 6.79 | 2.35 | 4.3 | 4.3 | 4.0 | 3.7 | 3.0 | 4.3 |
| Picador F1 | Elsoms | 33 | 2.9 | 5.0 | 4.5 | 28 | 46.20 | 0.31 | 0.55 | 1.52 | 15.38 | 26.11 | 2.35 | 4.5 | 3.8 | 4.0 | 3.8 | 2.0 | 5.0 |
| Pinnacle F1 | Elsoms | 42 | 3.7 | 5.0 | 4.5 | 28 | 44.50 | 0.59 | 0.77 | 1.72 | 21.22 | 17.57 | 2.64 | 4.3 | 3.7 | 4.0 | 4.2 | 4.0 | 5.0 |
| Archer F1 | Tozers | 43 | 3.3 | 3.0 | 4.0 | 42 | 52.26 | 0.96 | 1.94 | 3.09 | 25.44 | 18.62 | 2.21 | 3.3 | 3.3 | 3.7 | 3.7 | 4.0 | 5.0 |
| Dagger F1 | Tozers | 39 | 3.5 | 2.8 | 2.8 | 35 | 42.22 | 0.65 | 1.68 | 2.83 | 24.17 | 10.99 | 1.78 | 3.7 | 3.7 | 3.7 | 3.8 | 3.0 | 4.7 |
| Javelin F1 | Tozers | 36 | 3.5 | 3.5 | 3.5 | 32 | 40.54 | 0.36 | 0.92 | 2.64 | 23.35 | 12.25 | 1.02 | 4.0 | 3.2 | 3.5 | 3.7 | 2.5 | 4.7 |
| Albion F1 | Tozers | 39 | 2.5 | 5.0 | 4.5 | 32 | 52.33 | 0.76 | 1.32 | 2.04 | 16.47 | 28.97 | 2.77 | 3.9 | 3.5 | 3.8 | 3.7 | 2.0 | 5.0 |
| Gladiator F1 | Tozers | 36 | 3.3 | 4.5 | 4.5 | 31 | 39.31 | 0.39 | 0.86 | 2.15 | 16.88 | 17.66 | 1.38 | 2.5 | 3.0 | 3.2 | 3.0 | 2.5 | 5.0 |
| Countess F1 | Niz | 37 | 3.7 | 1.5 | 1.0 | 36 | 38.31 | 0.68 | 1.05 | 3.09 | 21.94 | 10.82 | 0.72 | 2.8 | 3.5 | 4.0 | 3.2 | 4.5 | 5.0 |
| Duchess F1 | Niz | 41 | 3.8 | 3.0 | 2.5 | 34 | 47.49 | 0.25 | 1.16 | 1.79 | 19.12 | 24.29 | 0.89 | 3.5 | 3.0 | 3.8 | 3.4 | 4.0 | 5.0 |
| LSD @ P = 0.05 | | | | | | | 6.842 | 0.4329 | 0.8484 | 1.394 | 6.423 | 6.206 | 2.402 | | | | | | |
| Probability | | | | | | | < .001 | 0.031 | 0.046 | 0.052 | 0.010 | < .001 | 0.571 | | | | | | |
| CV% | | | | | | | 9.4 | 56.2 | 49.6 | 38.6 | 18.6 | 21.4 | 71.9 | | | | | | |

NOTE: *vigor: 5 = excellent 1 = v.poor; **foliage: 5 = v.strong & healthy. 1 = v.weak; ***crown: 5 = raised 1 = sunken; ****shape: 5 = well filled 1 = wedged & pointed;

*****skin: 5 = v.smooth. 1 = v.rough; *****bruising: 5 = no bruised 1 = very bruised; *****oxidation: 5 =none 1=v.brown; *****diseased: 5 = none 1 = v.severe.

Note: Shaded boxes denote best 'performers'

Table 2: Varietal differences at harvest 2:

| Table 2 – Harvest 2 - Yield and Agronomic data | | Harvested – 10 th February 2009 | | | | | | | | | | | | | | | | | |
|--|--------|--|-------|-------------------------|-----|-------------------------|-------|-------------------|--------|--------|-----------|-----------|--------------|-----------|-------|------|----------|-----------|---------|
| Variety | Source | Plants 6 to 8 weeks | | Foliage ** | | No | Yield | | | | | | Root Quality | | | | | | |
| | | Estab - lishment | Vigor | Appearance/ Strength | | Roots M ² | Gross | Marketable – T/Ha | | | | | Waste | Crown | Shape | Skin | Bruising | Oxidation | Disease |
| | | | | M ² | * | Aug | Nov | Feb | total | <22 mm | 22 - 28mm | 28 - 34mm | 34 - 50mm | 50 - 75mm | Total | *** | *** | ***** | ***** |
| Arrow | Elsoms | 42 | 3.8 | 2.5 | 2.5 | 37 | 44.71 | 0.48 | 1.11 | 2.51 | 25.31 | 14.40 | 0.85 | 3.5 | 2.5 | 2.0 | 3.3 | 2.0 | 4.0 |
| New White Skin | Elsoms | 32 | 2.8 | 1.0 | 1.0 | 26 | 47.53 | 0.18 | 0.65 | 0.77 | 11.52 | 33.00 | 1.36 | 3.0 | 2.0 | 2.0 | 3.3 | 2.5 | 2.5 |
| Polar F1 | Elsoms | 40 | 3.5 | 2.0 | 2.0 | 33 | 47.65 | 0.49 | 1.12 | 2.41 | 21.93 | 20.30 | 1.43 | 3.5 | 3.5 | 3.0 | 3.5 | 3.0 | 4.5 |
| Panache F1 | Elsoms | 33 | 2.8 | 4.0 | 4.0 | 33 | 49.22 | 0.60 | 0.66 | 1.34 | 21.53 | 23.00 | 2.06 | 3.5 | 3.5 | 2.0 | 3.3 | 2.0 | 4.0 |
| Palace F1 | Elsoms | 39 | 3.8 | 3.0 | 3.0 | 38 | 43.20 | 0.64 | 2.30 | 1.72 | 24.29 | 13.00 | 1.24 | 4.3 | 4.5 | 3.5 | 4.0 | 3.0 | 5.0 |
| Picador F1 | Elsoms | 33 | 2.9 | 5.0 | 4.5 | 29 | 50.77 | 0.41 | 0.66 | 1.12 | 15.99 | 29.70 | 2.92 | 4.0 | 4.0 | 4.0 | 3.5 | 2.0 | 4.0 |
| Pinnacle F1 | Elsoms | 42 | 3.7 | 5.0 | 4.5 | 32 | 52.06 | 0.58 | 0.50 | 2.83 | 20.16 | 26.80 | 1.16 | 4.3 | 4.5 | 4.0 | 3.5 | 4.0 | 2.0 |
| Archer F1 | Tozers | 43 | 3.3 | 3.0 | 4.0 | 42 | 54.63 | 0.89 | 3.08 | 2.53 | 24.32 | 21.40 | 2.45 | 3.5 | 3.5 | 4.0 | 3.5 | 4.0 | 4.0 |
| Dagger F1 | Tozers | 39 | 3.5 | 2.8 | 2.8 | 36 | 45.45 | 0.78 | 1.95 | 2.50 | 23.86 | 15.00 | 1.19 | 3.0 | 3.0 | 3.5 | 3.2 | 3.0 | 4.0 |
| Javelin F1 | Tozers | 36 | 3.5 | 3.5 | 3.5 | 35 | 41.76 | 0.60 | 1.62 | 2.00 | 20.23 | 15.20 | 2.14 | 3.0 | 3.0 | 3.0 | 3.0 | 2.5 | 4.0 |
| Albion F1 | Tozers | 39 | 2.5 | 5.0 | 4.5 | 35 | 55.45 | 0.87 | 2.10 | 2.09 | 14.99 | 32.70 | 2.74 | 3.0 | 3.5 | 2.3 | 4.0 | 2.0 | 4.5 |
| Gladiator F1 | Tozers | 36 | 3.3 | 4.5 | 4.5 | 33 | 48.54 | 0.59 | 0.59 | 2.37 | 17.01 | 26.90 | 1.07 | 2.5 | 2.5 | 2.0 | 3.8 | 2.5 | 3.5 |
| Countess F1 | Niz | 37 | 3.7 | 1.5 | 1.0 | 36 | 50.65 | 0.69 | 1.50 | 2.32 | 23.63 | 21.30 | 1.20 | 4.5 | 3.5 | | 4.0 | 4.5 | 5.0 |
| Duchess F1 | Niz | 41 | 3.8 | 3.0 | 2.5 | 35 | 50.80 | 0.73 | 1.33 | 1.28 | 20.89 | 24.40 | 2.22 | 3.0 | 4.0 | 4.5 | 4.0 | 4.0 | 5.0 |
| LSD @ P = 0.05 | | | | | | | 8.290 | 0.3818 | 0.8795 | 1.378 | 5.701 | 10.95 | 1.782 | | | | | | |
| Probability | | | | | | | 0.063 | 0.063 | < .001 | 0.101 | < .001 | 0.006 | 0.310 | | | | | | |
| CV% | | | | | | | 10.1 | 37.3 | 38.3 | 41.4 | 16.6 | 28.8 | 61.9 | | | | | | |

NOTE: * vigor: 5 = excellent 1 = v.poor; **foliage: 5 = v.strong & healthy. 1 = v.weak; ***crown: 5 = raised 1 = sunken; ****shape: 5 = well filled 1 = wedged & pointed;
 *****skin: 5 = v.smooth. 1 = v.rough; *****bruising: 5 = no bruising 1 = v. bruised; *****oxidation: 5 =none 1=v.brown; *****diseased: 5 = none 1 = v.severe.

Note: Shaded boxed denote best 'performers'

It should be noted also that Polar and Pinnacle had unexplained plant losses of over 25% between emergence and harvest.

As you would expect, all varieties increased overall yield between harvest 1 and 2. At harvest 1 there were large significant differences between varieties, whilst at harvest 2 yield differences were less.

Root crowns were looked at as to the ease of trimming due to crown shape.

With reference to root diseases, the trial was visually judged at both harvests for Black Canker – *Itersonilia pastinacae*, Phoma Canker – *Phoma complanata*, Cavity spot like symptoms, *Pythium spp* etc. The trial had relatively low levels of infection in all diseases however there was an increase between the two harvests. Black Canker was the predominant infection.

Lateral rooting severely affected several varieties at both harvests.

Financial benefits

- Direct financial benefits difficult to quantify.
- Data contained in this report will be invaluable in varietal selection in the future.
- Financial benefits will come from several main areas:
 - Varieties with higher yields as shown in comparison tables.
 - Selection of varieties with increased disease tolerance as shown in the comparison tables.
 - Crops of parsnips with disease symptoms (*Itersonilia* or Phoma) can become uneconomic to process for packing and a total crop loss situation can occur.

Action points for growers

- Examine your customer requirements.
- Evaluate your existing varieties and look at their performance in relation to customer requirements.
- The trials data have provided additional information to enable the grower to make correct variety choices to fulfil the above criteria.

Sources of Parsnip Varieties.

| <u>Name</u> | <u>Address</u> | <u>Country</u> |
|----------------------|---|----------------|
| Elsoms Seeds Ltd. | Pinchbeck Road, Spalding, Lincolnshire, PE11 1QJ. | UK |
| Tozer Seeds Ltd. | Pyports, Downside Bridge Road, Cobham, Surrey, KT11 3EH. | UK |
| Nickerson-Zwaan Ltd. | Joseph Nickerson Research Centre, Rothwell, Market Rasen, Lincolnshire, LN7 6DT | UK |

Science Section

Introduction

Parsnips are becoming an important crop in the UK and no independent trials have been carried out for many years.

The BCGA identified an urgent need to conduct an independent variety trial in 2008.

The purpose of the trial was to find varieties that meet the changing needs of producers and packers and to identify areas where variety choice can improve marketable yield.

Varieties were evaluated for various agronomic data including

- Initial seedling establishment and vigor.
- Foliage health.
- Maturity
- Yield.
- Disease tolerance to canker (*Botrytis pastinacea*) and cavity spot caused by *Pythium* spp.
- Root differences in produce quality.

Materials and methods

- To evaluate a range Parsnip varieties from all the breeding companies at one location in the vale of York.
- The purpose of this work is to locate new varieties with better quality and also disease tolerance
- All Parsnip breeding companies were invited to nominate varieties.
- Location was a commercial field location Skiff Farm, Holme on Spalding Moor in the Vale of York.
- The soil type was silty sand.
- Trial was sown with the growers Bassi parsnip drill..
- Varieties were grown in 4 replicated plots. 15metre long x 1 bed width wide within a commercial field crop of Parsnip.
- All subsequent husbandries were carried out by the grower as with the field crop.
- Observations were recorded on establishment, vigor and plant health through out the growing season.

- Harvesting was at two stages, one in November before the winter and one in February after the winter
- Plots were harvested by hand, taken back to PGRO and mechanically washed and size graded.
- Agronomic data were recorded on gross yield, marketable yield, foliage, and on aspects of root quality and health including bruising.
- Yield data were analysed by Analysis of Variance (Genstat 5)

Results see tables 1 & 2 and Appendix 1 to 12

The 14 varieties were sown on the 9th April 2008, conditions were good and the trial emerged well. Growth through the season was excellent, there was no foliar diseases recorded. By the time of the November lift, we had several frosts causing some foliar damage. The autumn and winter was of the coldest for 15 years, subsequently there was no foliage re-growth in February 2009 when we did the second lift.

The trial was assessed for:-

- Establishment and vigour
Arrow, Palace, Duchess, Pinnacle and Countess were judged the best.
- Foliage health and appearance
In August, Picador, Pinnacle, Albion, Gladiator and Panache were judged to be the best. In November, Picador, Pinnacle, Albion, Gladiator, Archer and Panache were judged to be the best
- Number of roots at harvest
Two varieties, Polar and Pinnacle had unexplained plant losses of over 25% between emergence and harvest. These losses may be from herbicide damage or soil born pathogens.
- Washed and graded marketable yield
As you would expect all varieties increased overall yield between harvest 1 and harvest 2. At harvest 1 there were quite significant differences between varieties, whilst at harvest 2 there were less.
In November Archer, Palace, Dagger and Javelin gave the highest yields in the total grade 22mm to 50mm, whilst in February it was the varieties Archer, Arrow, Palace, Dagger and Countess.

In the total grade 22mm to 75mm at harvest 1 the highest yielding varieties were Archer, Albion and Duchess, whilst at the second harvest Archer, Albion and Pinnacle had the highest yield.

- Root crown

The crowns were looked at as to the ease of trimming due to crown shape. At harvest 1, Picador was judged the best closely followed by Polar, Javelin, Pinnacle and Palace. Whilst at harvest 2 the much improved Countess was judge the best, closely followed by Palace, Pinnacle and Picador.

- Root shape

Roots were judged for shape at harvest 1 Palace, Polar, Picador and Panache were the best.

Whilst at harvest 2, Palace, Picador, Pinnacle and the much improved Duchess were the better ones.

- Skin finish

At harvest 1, Palace, Picador, Pinnacle and Countess were all judged to have the smoothest skins. At harvest 2 Countess and Duchess were the best closely followed by Archer, Picador and Pinnacle.

- Bruising after washing

At both the harvest we recorded very little bruising, Pinnacle and New White Skin were the best at H1 and Palace, Albion, Countess and Duchess where judged to be best

- Oxidation after trimming

24hrs after trimming varieties were judged for oxidation (browning). Both trial harvest created the same result with Countess, Duchess, Pinnacle and Archer were judged to have the least staining. Unfortunately Duchess and to a lesser extent Countess suffered from root splitting after trimming.

- Root diseases and disorders

The trial was visually judged at both harvests for Black Canker – *Itersonilia pastinacae*, Phoma Canker – *Phoma complanata*, Cavity spot like symptoms, possibly *Pythium spp*
The trial had relatively low levels of infection in all diseases however there was an increase between the two harvests. Black Canker was the predominant infection. With Palace, Pinnacle, Countess and Duchess showing no signs of any disease even by the February harvest. However at the second harvest Pinnacle suffered severe cavity like symptoms in all replicates.

Lateral rooting severely affected several varieties at both harvests. We think that a combination of growing season and the possible presence of *Pratylenchus* (root lesion nematodes) could be the possible causes. Several varieties appeared sensitive.

Table 1 – Harvest 1 - Yield and Agronomic data

Harvested – 24th November 2008

| Variety | Source | Plants 6 to 8 weeks | | Foliage ** | | No | Yield | | | | | | Root Quality | | | | | | |
|----------------|--------|---------------------|-------|-------------------------|-----|----------------------|--------|--------|-------------------|-----------|-----------|-----------|--------------|-----------|-------|------|----------|-----------|---------|
| | | Estab - lishment | Vigor | Appearance/ Strength | | Roots M ² | Gross | | Marketable – T/Ha | | | | Waste | Crown | Shape | Skin | Bruising | Oxidation | Disease |
| | | | | M ² | * | Aug | Nov | Nov | total | <22 mm | 22 - 28mm | 28 - 34mm | 34 - 50mm | 50 - 75mm | Total | *** | **** | ***** | ***** |
| Arrow | Elsoms | 42 | 3.8 | 2.5 | 2.5 | 32 | 35.69 | 0.30 | 0.93 | 2.33 | 21.75 | 8.98 | 1.40 | 3.5 | 3.3 | 3.1 | 3.8 | 2.0 | 4.5 |
| New White Skin | Elsoms | 32 | 2.8 | 1.0 | 1.0 | 25 | 46.29 | 0.19 | 0.27 | 0.85 | 13.53 | 28.94 | 2.51 | 3.5 | 2.8 | 2.7 | 4.0 | 2.5 | 4.0 |
| Polar F1 | Elsoms | 40 | 3.5 | 2.0 | 2.0 | 28 | 42.85 | 0.29 | 0.73 | 1.11 | 22.78 | 14.85 | 3.11 | 4.0 | 4.0 | 2.8 | 3.5 | 3.0 | 4.5 |
| Panache F1 | Elsoms | 33 | 2.8 | 4.0 | 4.0 | 33 | 42.65 | 0.40 | 1.14 | 2.29 | 20.60 | 15.47 | 2.74 | 3.5 | 3.8 | 2.8 | 3.8 | 2.0 | 4.7 |
| Palace F1 | Elsoms | 39 | 3.8 | 3.0 | 3.0 | 37 | 38.25 | 0.32 | 0.94 | 2.65 | 25.21 | 6.79 | 2.35 | 4.3 | 4.3 | 4.0 | 3.7 | 3.0 | 4.3 |
| Picador F1 | Elsoms | 33 | 2.9 | 5.0 | 4.5 | 28 | 46.20 | 0.31 | 0.55 | 1.52 | 15.38 | 26.11 | 2.35 | 4.5 | 3.8 | 4.0 | 3.8 | 2.0 | 5.0 |
| Pinnacle F1 | Elsoms | 42 | 3.7 | 5.0 | 4.5 | 28 | 44.50 | 0.59 | 0.77 | 1.72 | 21.22 | 17.57 | 2.64 | 4.3 | 3.7 | 4.0 | 4.2 | 4.0 | 5.0 |
| Archer F1 | Tozers | 43 | 3.3 | 3.0 | 4.0 | 42 | 52.26 | 0.96 | 1.94 | 3.09 | 25.44 | 18.62 | 2.21 | 3.3 | 3.3 | 3.7 | 3.7 | 4.0 | 5.0 |
| Dagger F1 | Tozers | 39 | 3.5 | 2.8 | 2.8 | 35 | 42.22 | 0.65 | 1.68 | 2.83 | 24.17 | 10.99 | 1.78 | 3.7 | 3.7 | 3.7 | 3.8 | 3.0 | 4.7 |
| Javelin F1 | Tozers | 36 | 3.5 | 3.5 | 3.5 | 32 | 40.54 | 0.36 | 0.92 | 2.64 | 23.35 | 12.25 | 1.02 | 4.0 | 3.2 | 3.5 | 3.7 | 2.5 | 4.7 |
| Albion F1 | Tozers | 39 | 2.5 | 5.0 | 4.5 | 32 | 52.33 | 0.76 | 1.32 | 2.04 | 16.47 | 28.97 | 2.77 | 3.9 | 3.5 | 3.8 | 3.7 | 2.0 | 5.0 |
| Gladiator F1 | Tozers | 36 | 3.3 | 4.5 | 4.5 | 31 | 39.31 | 0.39 | 0.86 | 2.15 | 16.88 | 17.66 | 1.38 | 2.5 | 3.0 | 3.2 | 3.0 | 2.5 | 5.0 |
| Countess F1 | Niz | 37 | 3.7 | 1.5 | 1.0 | 36 | 38.31 | 0.68 | 1.05 | 3.09 | 21.94 | 10.82 | 0.72 | 2.8 | 3.5 | 4.0 | 3.2 | 4.5 | 5.0 |
| Duchess F1 | Niz | 41 | 3.8 | 3.0 | 2.5 | 34 | 47.49 | 0.25 | 1.16 | 1.79 | 19.12 | 24.29 | 0.89 | 3.5 | 3.0 | 3.8 | 3.4 | 4.0 | 5.0 |
| LSD @ P = 0.05 | | | | | | | 6.842 | 0.4329 | 0.8484 | 1.394 | 6.423 | 6.206 | 2.402 | | | | | | |
| Probability | | | | | | | < .001 | 0.031 | 0.046 | 0.052 | 0.010 | < .001 | 0.571 | | | | | | |
| CV% | | | | | | | 9.4 | 56.2 | 49.6 | 38.6 | 18.6 | 21.4 | 71.9 | | | | | | |

NOTE: * vigor: 5 = excellent 1 = v.poor; **foliage: 5 = v.strong & healthy. 1 = v.weak; ***crown: 5 = raised 1 = sunken; ****shape: 5 = well filled 1 = wedged & pointed;

*****skin: 5 = v.smooth. 1 = v.rough; *****bruising: 5 = no bruised 1 = very bruised; *****oxidation: 5 = none 1=v.brown; *****diseased: 5 = none 1 = v.severe.

Note: Shaded boxes denote best 'performers'

Table 2 – Harvest 2 - Yield and Agronomic data

Harvested – 10th February 2009

| Variety | Source | Plants 6 to 8 weeks | | Foliage ** | | No | Yield | | | | | | Root Quality | | | | | | |
|----------------|--------|---------------------|-------|-------------------------|-----|-------------------------|-------|--------|-------------------|--------|-----------|-----------|--------------|-----------|-------|------|----------|-----------|---------|
| | | Estab - lishment | Vigor | Appearance/ Strength | | Roots M ² | Gross | | Marketable – T/Ha | | | | Waste | Crown | Shape | Skin | Bruising | Oxidation | Disease |
| | | | | M ² | * | Aug | Nov | Feb | total | <22 mm | 22 - 28mm | 28 - 34mm | 34 - 50mm | 50 - 75mm | Total | *** | **** | ***** | ***** |
| Arrow | Elsoms | 42 | 3.8 | 2.5 | 2.5 | 37 | 44.71 | 0.48 | 1.11 | 2.51 | 25.31 | 14.40 | 0.85 | 3.5 | 2.5 | 2.0 | 3.3 | 2.0 | 4.0 |
| New White Skin | Elsoms | 32 | 2.8 | 1.0 | 1.0 | 26 | 47.53 | 0.18 | 0.65 | 0.77 | 11.52 | 33.00 | 1.36 | 3.0 | 2.0 | 2.0 | 3.3 | 2.5 | 2.5 |
| Polar F1 | Elsoms | 40 | 3.5 | 2.0 | 2.0 | 33 | 47.65 | 0.49 | 1.12 | 2.41 | 21.93 | 20.30 | 1.43 | 3.5 | 3.5 | 3.0 | 3.5 | 3.0 | 4.5 |
| Panache F1 | Elsoms | 33 | 2.8 | 4.0 | 4.0 | 33 | 49.22 | 0.60 | 0.66 | 1.34 | 21.53 | 23.00 | 2.06 | 3.5 | 3.5 | 2.0 | 3.3 | 2.0 | 4.0 |
| Palace F1 | Elsoms | 39 | 3.8 | 3.0 | 3.0 | 38 | 43.20 | 0.64 | 2.30 | 1.72 | 24.29 | 13.00 | 1.24 | 4.3 | 4.5 | 3.5 | 4.0 | 3.0 | 5.0 |
| Picador F1 | Elsoms | 33 | 2.9 | 5.0 | 4.5 | 29 | 50.77 | 0.41 | 0.66 | 1.12 | 15.99 | 29.70 | 2.92 | 4.0 | 4.0 | 4.0 | 3.5 | 2.0 | 4.0 |
| Pinnacle F1 | Elsoms | 42 | 3.7 | 5.0 | 4.5 | 32 | 52.06 | 0.58 | 0.50 | 2.83 | 20.16 | 26.80 | 1.16 | 4.3 | 4.5 | 4.0 | 3.5 | 4.0 | 2.0 |
| Archer F1 | Tozers | 43 | 3.3 | 3.0 | 4.0 | 42 | 54.63 | 0.89 | 3.08 | 2.53 | 24.32 | 21.40 | 2.45 | 3.5 | 3.5 | 4.0 | 3.5 | 4.0 | 4.0 |
| Dagger F1 | Tozers | 39 | 3.5 | 2.8 | 2.8 | 36 | 45.45 | 0.78 | 1.95 | 2.50 | 23.86 | 15.00 | 1.19 | 3.0 | 3.0 | 3.5 | 3.2 | 3.0 | 4.0 |
| Javelin F1 | Tozers | 36 | 3.5 | 3.5 | 3.5 | 35 | 41.76 | 0.60 | 1.62 | 2.00 | 20.23 | 15.20 | 2.14 | 3.0 | 3.0 | 3.0 | 3.0 | 2.5 | 4.0 |
| Albion F1 | Tozers | 39 | 2.5 | 5.0 | 4.5 | 35 | 55.45 | 0.87 | 2.10 | 2.09 | 14.99 | 32.70 | 2.74 | 3.0 | 3.5 | 2.3 | 4.0 | 2.0 | 4.5 |
| Gladiator F1 | Tozers | 36 | 3.3 | 4.5 | 4.5 | 33 | 48.54 | 0.59 | 0.59 | 2.37 | 17.01 | 26.90 | 1.07 | 2.5 | 2.5 | 2.0 | 3.8 | 2.5 | 3.5 |
| Countess F1 | Niz | 37 | 3.7 | 1.5 | 1.0 | 36 | 50.65 | 0.69 | 1.50 | 2.32 | 23.63 | 21.30 | 1.20 | 4.5 | 3.5 | 4.0 | 4.0 | 4.5 | 5.0 |
| Duchess F1 | Niz | 41 | 3.8 | 3.0 | 2.5 | 35 | 50.80 | 0.73 | 1.33 | 1.28 | 20.89 | 24.40 | 2.22 | 3.0 | 4.0 | 4.5 | 4.0 | 4.0 | 5.0 |
| LSD @ P = 0.05 | | | | | | | 8.290 | 0.3818 | 0.8795 | 1.378 | 5.701 | 10.95 | 1.782 | | | | | | |
| Probability | | | | | | | 0.063 | 0.063 | < .001 | 0.101 | < .001 | 0.006 | 0.310 | | | | | | |
| CV% | | | | | | | 10.1 | 37.3 | 38.3 | 41.4 | 16.6 | 28.8 | 61.9 | | | | | | |

NOTE: * vigor: 5 = excellent 1 = v.poor; **foliage: 5 = v.strong & healthy. 1 = v.weak; ***crown: 5 = raised 1 = sunken; ****shape: 5 = well filled 1 = wedged & pointed;

*****skin: 5 = v.smooth. 1 = v.rough; *****bruising: 5 = no bruising 1 = v. bruised; *****oxidation: 5 =none 1=v.brown; *****diseased: 5 = none 1 = v.severe.

Note: Shaded boxes denote best 'performers'

Discussion

- Oxidation was a major problem after trimming and Varietal differences were seen. Further work is required to see if this could be linked to the reasons for bruising in some varieties.
- Further investigation into the causes of lateral rooting and Pythium like cavities is required, as both of these root disorders give rise to fiscal losses and sensitivity could be genetic
- Unexplained losses in root numbers from emergence to harvest need investigation. A herbicide screen should be set up for variety sensitivity.

Conclusions

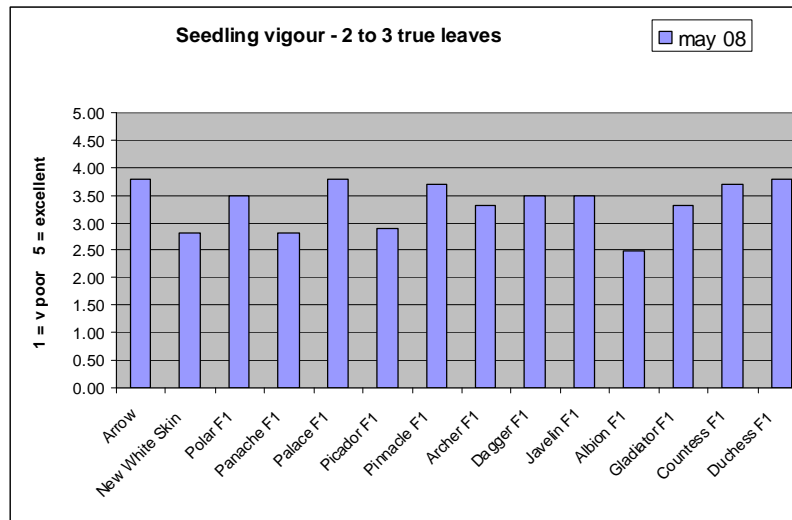
- Data contained in this report will be invaluable in varietal selection in the future.
- The trials have show that there are agronomic differences between varieties in yield, disease tolerance and many other root characters.
- Growers can benefit from increase pack out by the correct variety choices, by using varieties with better yield and root qualities.
- Crops of Parsnips with disease symptoms (*Itersonilia* or *Phoma*) can become uneconomic to process for packing and a total crop loss situation can occur.
- Direct financial benefits difficult to quantify due to lack of information from producers.

Technology transfer

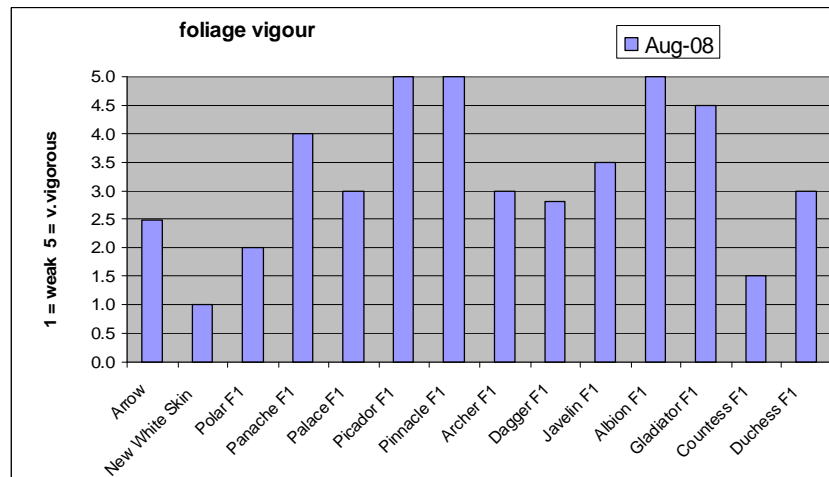
- 24th November 2008 demonstration of produce in trial field.
- 12th February 2009 demonstration of washed and graded produce at the PGRO.
- 19th March 2009 presentation of results at the BCGA/HDC technical seminar at Stockbridge House.

Appendices

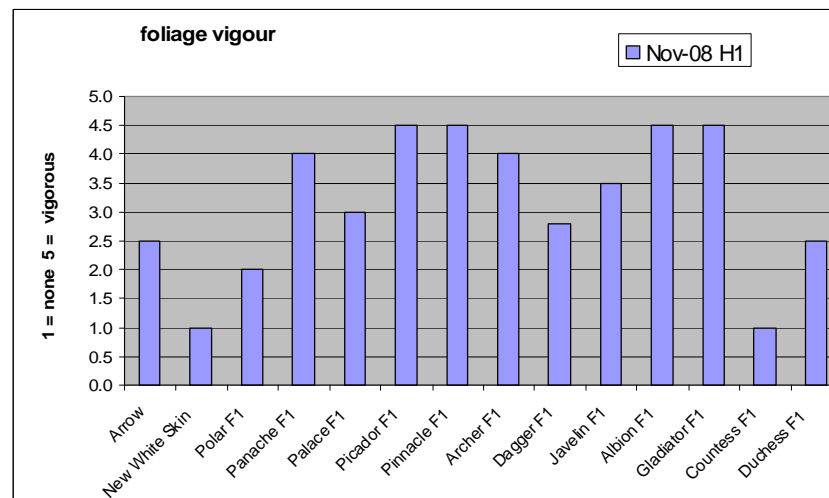
Appendix 1



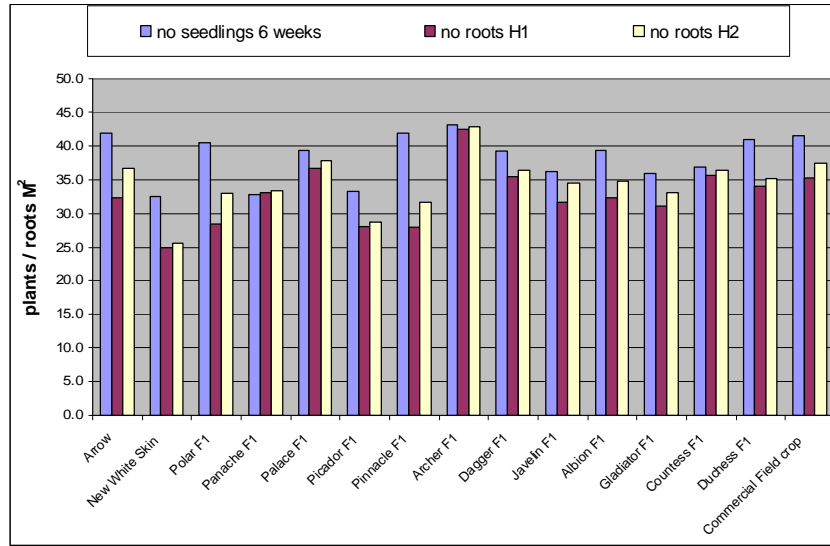
Appendix 2



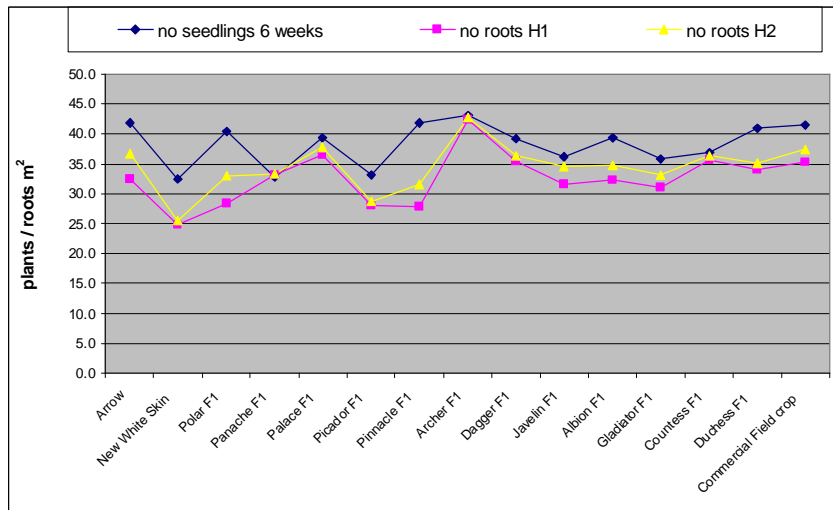
Appendix 3



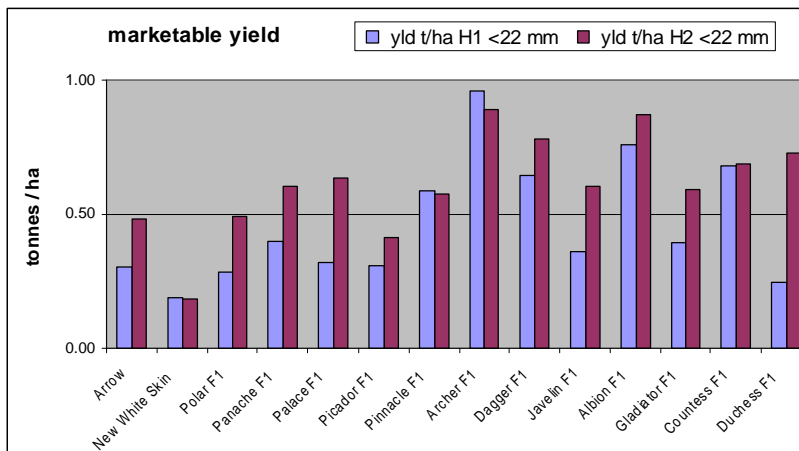
Appendix 4



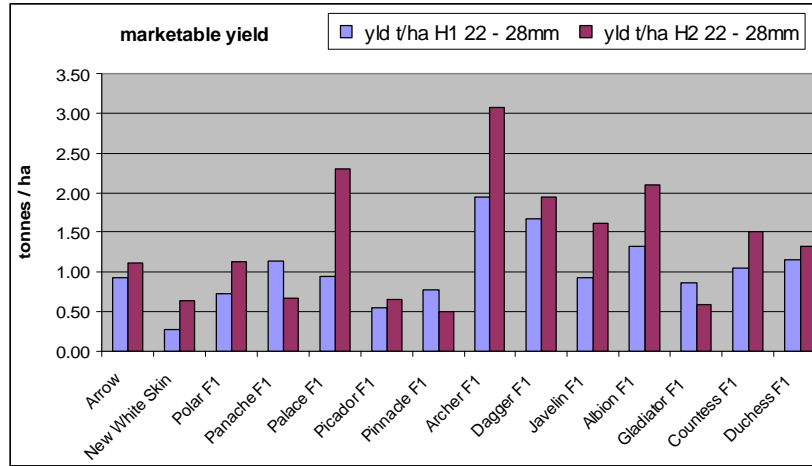
Appendix 5



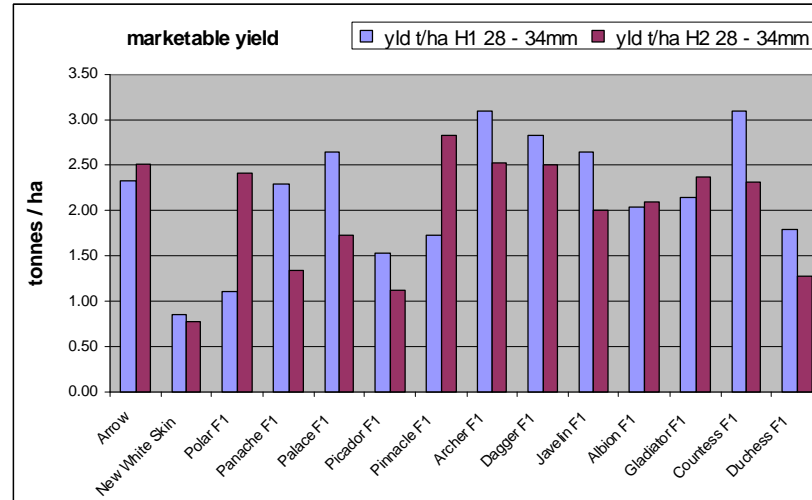
Appendix 6



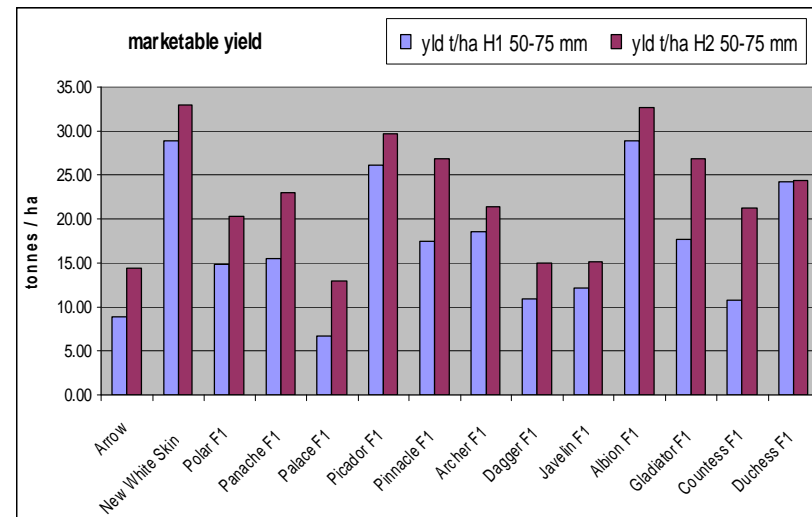
Appendix 7



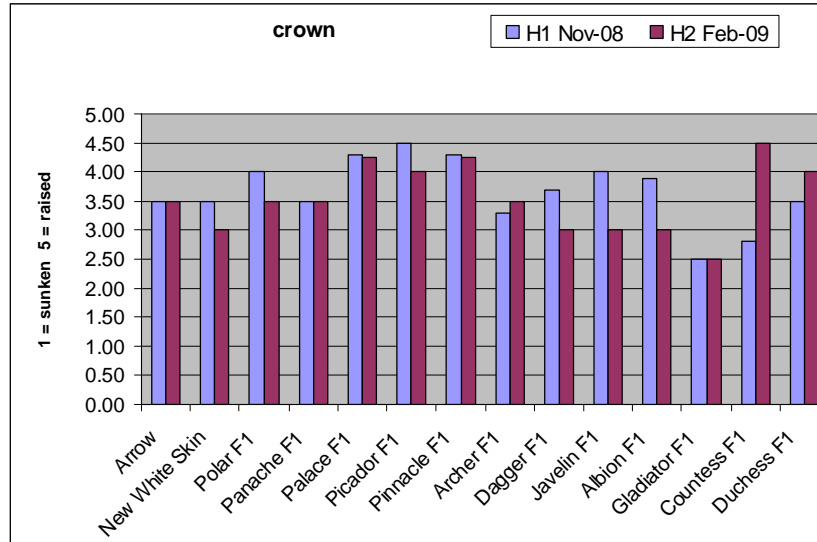
Appendix 8



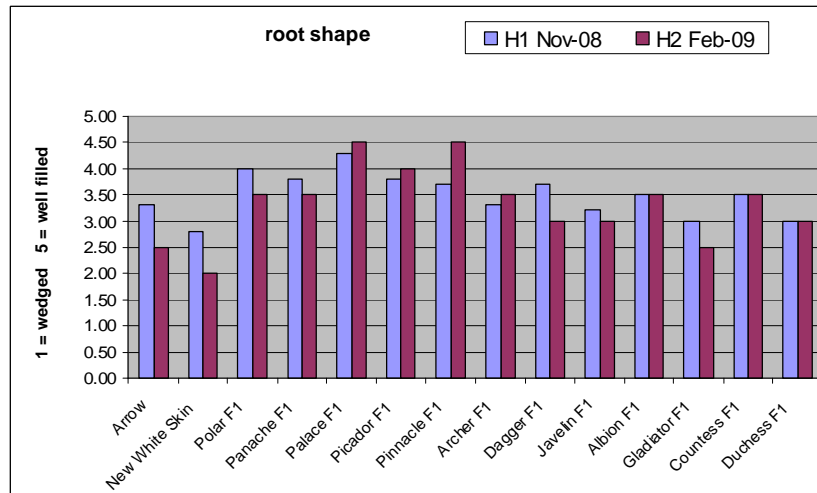
Appendix 9



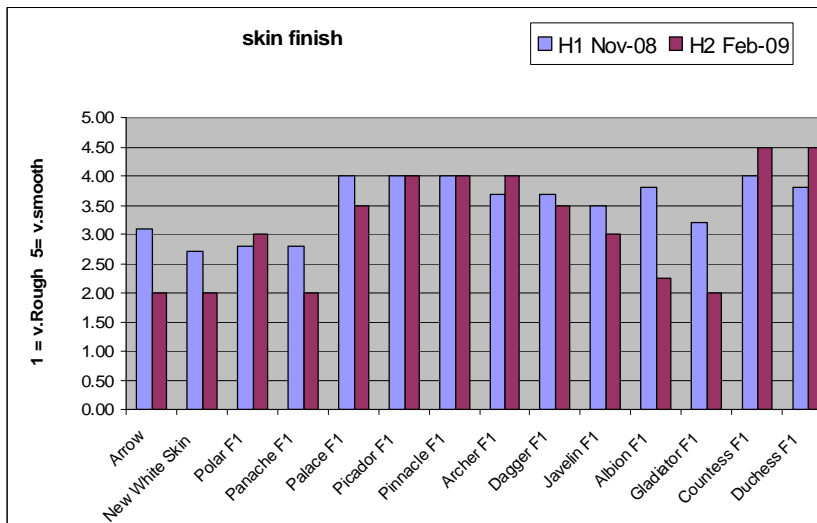
Appendix 10



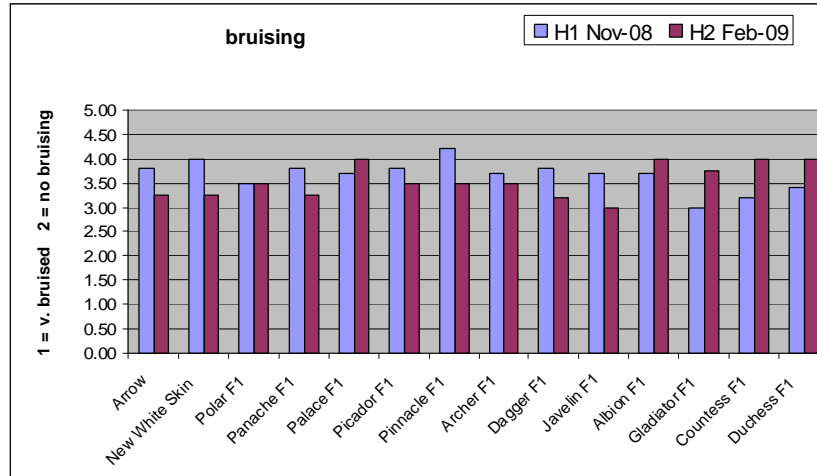
Appendix 11



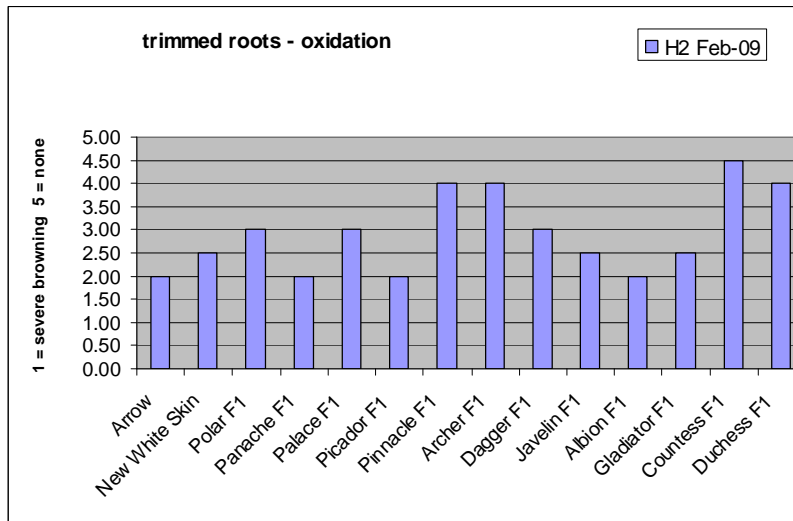
Appendix 12



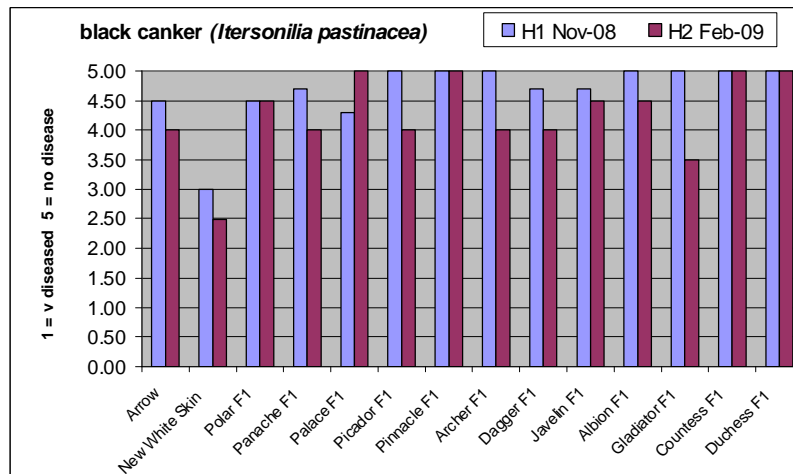
Appendix 13



Appendix 14



Appendix 15



Appendix 16 – Parsnip Variety Trial August 2008.



Appendix 17 – Parsnip Variety Trial February 2009.



Appendix 18 – Parsnip Demonstration 12th February 2009.



Appendix 19 - Source of varieties.

| Name | Address | Country |
|----------------------|---|---------|
| Elsoms Seeds Ltd. | Pinchbeck Road, Spalding, Lincolnshire, PE11 1QJ. | UK |
| Tozer Seeds Ltd. | Pyports, Downside Bridge Road, Cobham, Surrey, KT11 3EH. | UK |
| Nickerson-Zwaan Ltd. | Joseph Nickerson Research Centre, Rothwell, Market Rasen, Lincolnshire, LN7 6DT | UK |