Variation in rooting habit of potatoes: potential for improving resource capture

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Potatoes are a major crop both in Scotland and globally, where they rank 4th in production. They are considered to be inefficient in their utilization of resources such as nutrients and water. Plants which have large root-soil interfaces (e.g. longer roots) are likely to be more efficient in capturing certain resources. As little is known about the genetics of the rooting habit of the potato, this study was undertaken to measure the variation in rooting traits of a range of genotypes grown in the field.

Plate 1 Field site at Gourdie, Dundee

Methods

Replicates of 10 potato genotypes, including seven cultivars of the European tetraploid potato (*Solanum tuberosum* Group Tuberosum), a diploid potato species (*S. tuberosum* Group Phureja; Mayan Gold) and two neotuberosum clones (derived from *S. tuberosum* Group Andigena) were selected.

Plants were grown from tubers in ridges under field conditions (plate1) for 11 weeks (Apr-Jun 2007) and harvested just prior to tuberisation.

Plate 2 Harvesting of roots in the field

Roots were excavated from an area of approximately 1 m^2 surrounding each plant, with care being taken to keep roots systems intact (plate 2).

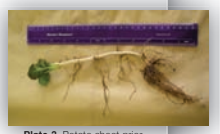

Plate 3 Potato shoot prior to root separation

Root systems were separated into basal roots (where shoots and tuber join), primary roots (where stem and stolons join) and stolon roots (plate 3). The number, length and dry weight of each root type was recorded along with plant characteristics, e.g. number of shoots and number of leaves per shoot.

The various root types were then scanned (plate 4) and the images were analysed using Winrhizo software which provided total length, surface area and average diameter. In addition, a sub-sample of roots was taken for analysis of mycorrhizal infection. Data are calculated relative to the weight of the seed tuber and presented as the mean of 4 replicates with standard error (s.e.) as bars or in parenthesis.

Plate 4 Scanned root system

Results

1. There were significant differences in root characteristics between cultivars, as shown in figure 1 where relative total root length varied from 428 cm g^{-1} seed tuber for Estima to 5341 cm g^{-1} seed tuber for Neotuberosum 145.

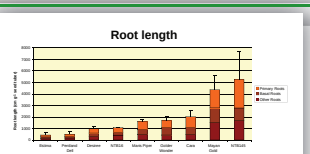

Figure 1 Total root length of potato cultivars partitioned into various root categories.

2. Variations were also found between the different root categories, shown in figure 2, with Neotuberosum 145 having the greatest number of stolon roots and Mayan Gold the greatest number of basal roots.

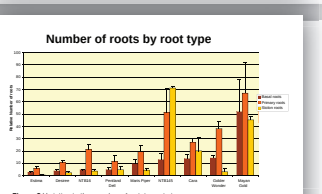

Figure 2 Variation in the number of potato roots in each category.

3. Table 1 demonstrates the large variation in other plant traits such as number of stolons, number of leaves and number of shoots

Cultivar	Number of stolons	Number of shoots	Number of leaves
Estima	18.5 (4.3)	5.3 (1.3)	29.0 (8.2)
Desiree	17.0 (2.0)	2.3 (0.3)	33.5 (5.8)
NTB16	36.3 (5.3)	4.3 (0.8)	45.3 (6.0)
Pentland Dell	24.0 (4.5)	3.8 (0.3)	30.3 (6.1)
Maris Piper	28.0 (3.4)	3.0 (0.9)	45.3 (12.5)
NTB145	26.3 (7.4)	4.5 (1.2)	48.8 (15.2)
Cara	49.5 (7.3)	5.3 (0.8)	58.8 (6.7)
Golden Wonder	40.5 (6.5)	6.5 (1.4)	60.5 (14.1)
Mayan Gold	23.8 (0.9)	6.5 (1.3)	90.5 (15.4)

Table 1 Number of stolons, shoots and leaves associated with each potato cultivar.

4. Strong correlations between above and below ground traits were observed with the number of shoots indicating a good diagnostic relationship with the number of roots (figure 3 a-c).

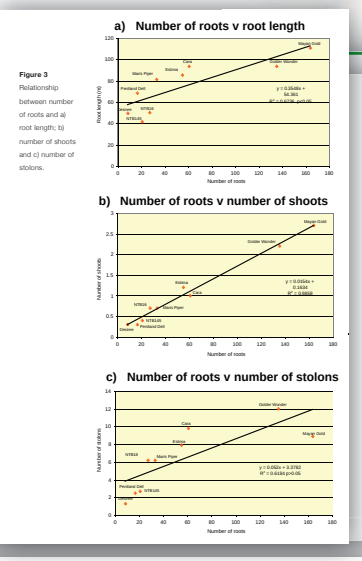

Figure 3 Relationship between number of roots and a) root length; b) number of shoots and c) number of stolons.

5. Mycorrhizal infection varied from 48% in the Mayan Gold variety to 86% in Golden Wonder.

Conclusions

- Significant variability in root character-istics exists between potato cultivars.
- The number of roots per plant depends strongly on the number of shoots arising from the seed tuber, and less strongly on the number of stolons these shoots bear. There is a correlation between total root length and root number, but this is relatively weak, therefore variability in individual root length between cultivars might be important.
- Potential exists for screening root character-istics due to the strong diagnostic relationship between above and below ground traits.
- The genotypic variation in the rooting traits of field grown potatoes suggests that resource capture might be improved through selection of appropriate root traits in potato cultivars.