How to determine plot dimensions for variety testing in hybrid potato?
WP4

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Introduction

- Field trials are essential to evaluate the performance of new varieties
- Variance observed = sum of genetic differences + environmental factors.
- Your interest = genetic differences.
- How can you determine that?
- To adjust the plot size and its shape in a trial.
- These slides provide a step-by-step plan to determine the optimal plot size and shape of a hybrid potato trial.

Step 1: Determine the traits of interest and the required precision

Different tuber traits show variation within a plot to a different extend. Therefore, different plot sizes are needed to reach the same degree of precision for different traits.

Figure 1 shows the decrease of LSD% for different tuber traits with increasing plot size. LSD% is the percentage difference that the trait means of two hybrids need to have to be significantly different.

For example, the LSD% of tuber shape is approximately 6% at a plot size of 25 plants, for tuber weight it is around 20% at the same plot size. So for different traits a different plot size is needed to reach the same level of precision.

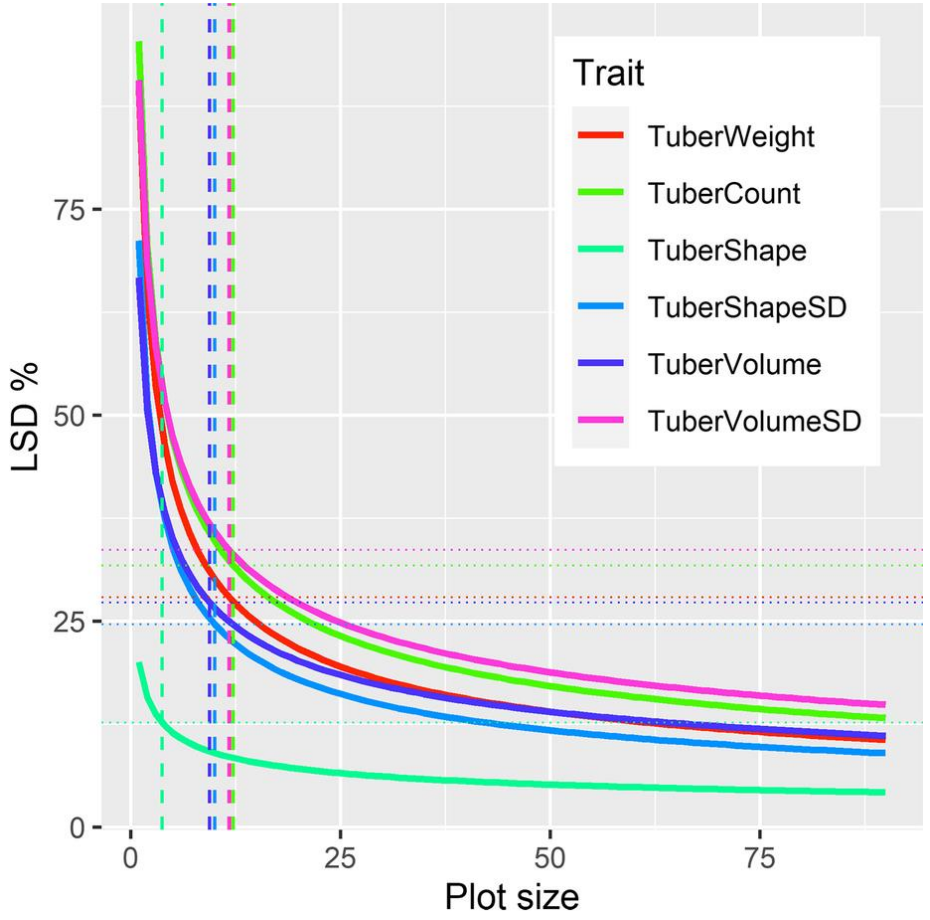

Figure 1: Least significant difference between cultivar means as a percentage of the trait mean (LSD%) in its dependence on plot size in number of plants per plot. Traits include tuber weight, tuber count, tuber volume, SD of tuber volume, tuber shape and SD of tuber shape. The dashed line indicates the plot size corresponding to the point of maximum curvature and the dotted line the LSD% achieved at that plot size

Step 2: Choose homogeneous spot in the field

Soil variability can be determined in the field, a higher soil variability leads to more variation within and between plots. Figure 2 shows LSD% for different plot dimensions.

Figure 2 was made based on data of a homogeneous field. It shows that on a homogeneous field, plot size is more important than plot shape. For example, when using a plot size of 10 plants for tuber shape, plot dimensions could be five plants on two ridges or two plants on five ridged. In both cases, LSD% is 9%.

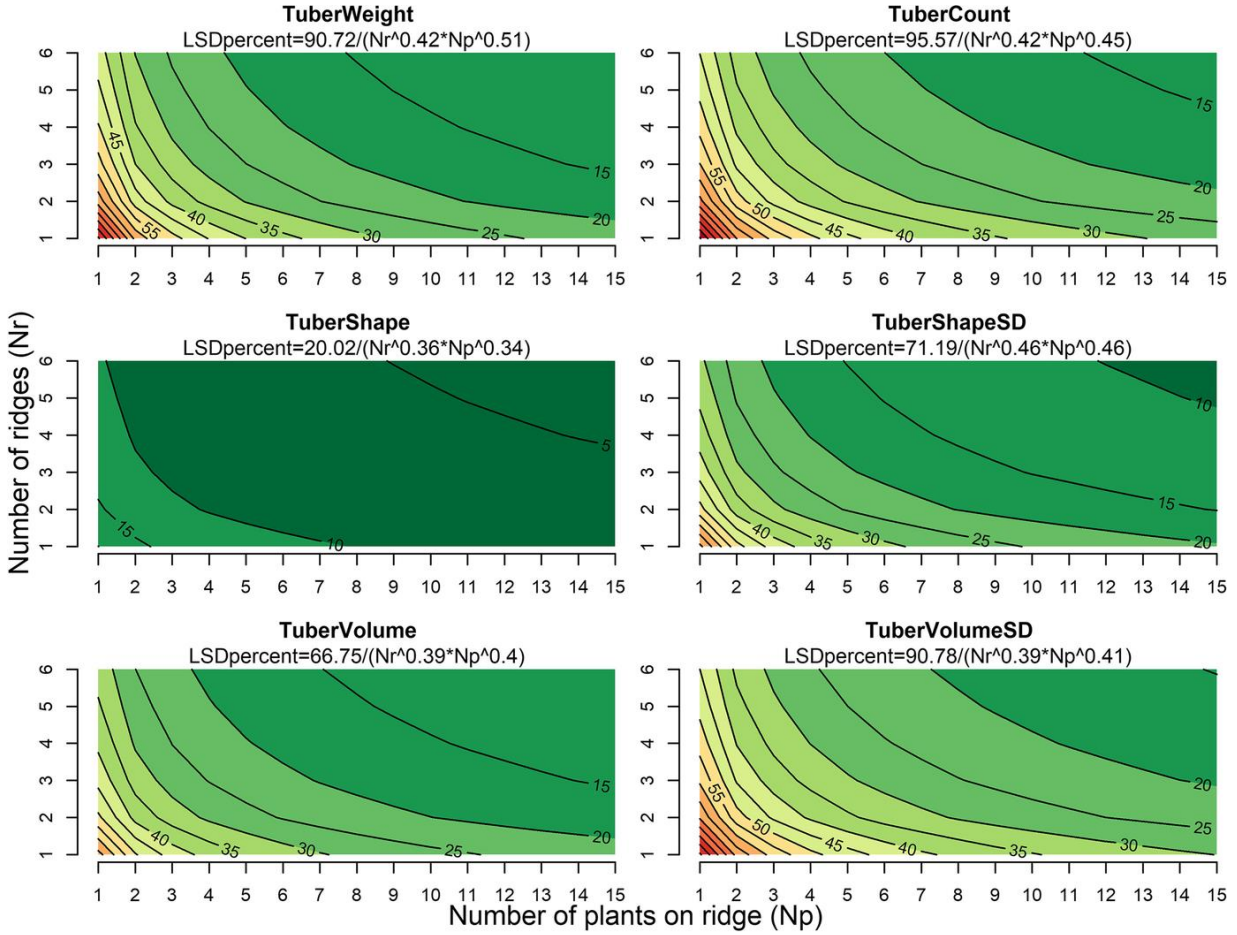

Figure 2: Least significant difference between cultivar means as a percentage of the trait mean (LSD%) for different plot sizes when using different plot shapes

Step 3: Calculate LSD% for different plot dimensions

The equations of Table 1 can be used to calculate LSD% for different plot dimensions and choose the best one for your trial. Equations are based on three replicates, LSD% for different replicate numbers can by calculated by multiplying the LDS% by sqrt(3/n_r), with n_r = number of replicates.

Table 1: Equations to calculate least significant difference between cultivars as a percentage of the trait mean (LSD%) for different traits when using a certain plot size (number of plants) or shape. N_r = number of ridges, N_p = number of plants per ridge.

Trait	Plot size	Plot shape
Tuber weight	LSD% = 90.27/(plot size)^0.48	LSD% = 90.72/(N_r^0.42·N_p^0.51)
Tuber count	LSD% = 95.41/(plot size)^0.44	LSD% = 95.57/(N_r^0.42·N_p^0.45)
Tuber volume	LSD% = 66.70/(plot size)^0.40	LSD% = 66.75/(N_r^0.39·N_p^0.40)
Tuber volume SD	LSD% = 90.68/(plot size)^0.40	LSD% = 90.78/(N_r^0.39·N_p^0.41)
Tuber shape	LSD% = 20.05/(plot size)^0.35	LSD% = 20.02/(N_r^0.36·N_p^0.34)
Tuber shape SD	LSD% = 71.19/(plot size)^0.46	LSD% = 71.19/(N_r^0.46·N_p^0.46)

Step 3: Example

- The LSD% can be calculated with the equations in Table 1 (previous slide), for example, for tuber weight and a plot size of 4 plants: LSD% = 90.27/(4^0.48) = 46%.

- This means that a difference in yield can be determined between two varieties when they differ at least 46%.

- When increasing the plot size to 10 plants, the LSD% decreases to 30%, so smaller differences amongst varieties can be assessed.

Step 3: Example

- A breeder is planning a variety trial to compare yield amongst varieties with a plot size of 4 plants.
- The LSD% can be calculated with the equation for tuber weight in Table 1 (previous slide): LSD% = 90.27/(4^0.48) = 46%.
- This means that the breeder can determine the difference in yield between two varieties when they differ at least 46%. When increasing the plot size to 10 plants, the LSD% decreases to 30%, so smaller differences amongst varieties can be assessed.

Elaborate example

- Step 1: A breeder is planning a variety trial. The goal is to compare yield amongst the varieties.
- Step 2: A soil scan was made, and a homogenous spot in the field was chosen
- Step 3: The formula in Table 1 was used to calculate LSD% for different plot sizes. The minimal yield difference between two varieties that needs to be determined is 20%. This is reached at a plot size of 24: LSD% = (90,27/(24^0,48)) = 20%

- → Now plot size will be 24 plants

Further reading

More about the methods and results can be found in the following paper:

Stockem, J.E., Korontzis, G., Wilson, S.E., de Vries, M.E., van Eeuwijk, F.A., Struik, P.C. 2021 Optimal Plot Dimensions for Performance Testing of Hybrid Potato in the Field. *Potato Res.*

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