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Phosphorus use and acquisition efficiency of *Solanum tuberosum* L.

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Background

To sustain crop production, phosphorus (P) often has to be applied as fertilizer. This is causing several problems as P is a limited resource and at the same time leads to eutrophication of water bodies. One way to deal with these problems is to increase the P use and acquisition efficiency of crops.

Agronomic P use efficiency (aPUE) = $(Y_{high}-Y_{low})/\Delta P_{fert}$ (Eqn 1), where Y_{high} and Y_{low} are the yield of the fertilized and unfertilized plants, respectively, and ΔP_{fert} is the difference of the applied P fertilizer between the two treatments (after Hammond et al., 2009).

P acquisition efficiency (PAE) = $[P]_{low}/[P]_{high}$ (Eqn 2), where $[P]_{low}$ is the P concentration in the shoots and tubers of unfertilized plants and $[P]_{high}$ is the P concentration in the shoots and tubers of fertilized plants (after López-Arredondo et al., 2014).

Figure 1: Experimental setup

Material and methods

32 potato genotypes (including 19 European, 5 South American, 4 Asian and 4 North American genotypes) were grown from seed tubers in Mitscherlich pots (n=3; Figure 1). The pots were fertilized with a nutrient solution containing 0.5 g N, 0.1 g Mg and 0.99 g K every second week. The experiment had two different P levels: 0.4 g P per pot (applied every second week) and 0.0 g P (n=3). Micronutrients were supplied once during the experiment. The shoots were harvested after ca. 12 weeks. The tubers were harvested 4 weeks after the shoots. The plant material was dried and ground before extraction of P. Total P was extracted by ashing the material at 550 °C and dissolving it afterwards in 25% HCl. The P concentration was determined colorimetrically.

Results

The results for the calculated agronomic P use efficiency and for the calculated P acquisition efficiency are shown in Figure 2 and 3, respectively.

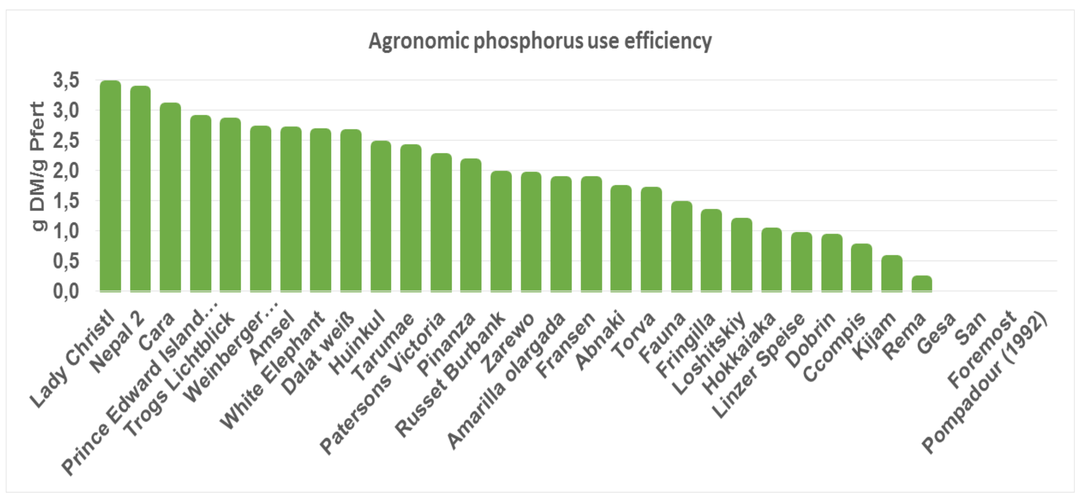

Figure 2: Agronomic P use efficiency of different potato genotypes calculated after Eqn (1).

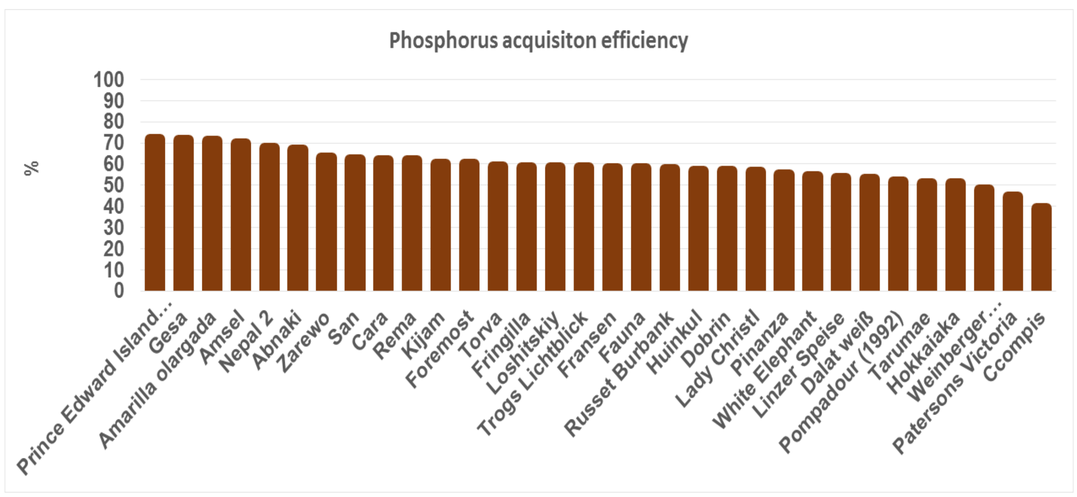

Figure 3: P acquisition efficiency of different potato genotypes calculated after Eqn (2).

Conclusions and outlook

The 32 investigated potato genotypes differed in their P acquisition efficiency and their agronomic P use efficiency. It indicates that by selection of an appropriate genotype, the amount of applied P fertilizer could be reduced. The genotype with the highest P acquisition efficiency (Prince Edward Island Blue) was not the one with the highest agronomic P use efficiency. However, it is possible that the high PAE masked the aPUE, due to a high P uptake. For future experiments it is therefore recommended that the P acquisition efficiency and the agronomic P use efficiency are investigated separately.

References

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López-Arredondo DL, Leyva-González MA, González-Morales SI, López-Bucio J and Herrera-Estrella L. 2014. Phosphate nutrition: Improving low-phosphate tolerance in crops. *Annual Review of Plant Biology* **65**: 95-123.

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