# *Parental Environment Effects on Seed and Seedling Quality of Different Tomato Genotypes*

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## Background

Seed quality as the foundation of commercial production is a complex trait that is influenced by many factors such as genetics, environment and crop management. Seed and seedling vigour is determined by the parental environment and genetic background. An accurate understanding of parental environmental effects on seed and seedling performance will be important for improving seed quality through breeding programs.

## Objective

The effect of nutritional parental environment on seed and seedling performance in two tomato genotypes was investigated: *Solanum lycopersicum* cv. money maker (Money) and *Solanum pimpinellifolium* (Pimp). They were grown under different concentrations of phosphate (P) and nitrate (N) from flowering onwards (Table 1). After seed harvesting extensive phenotyping using the Germinator package was performed and the effect of different concentrations of nutrients on the seed and seedling quality of next generation was assessed.

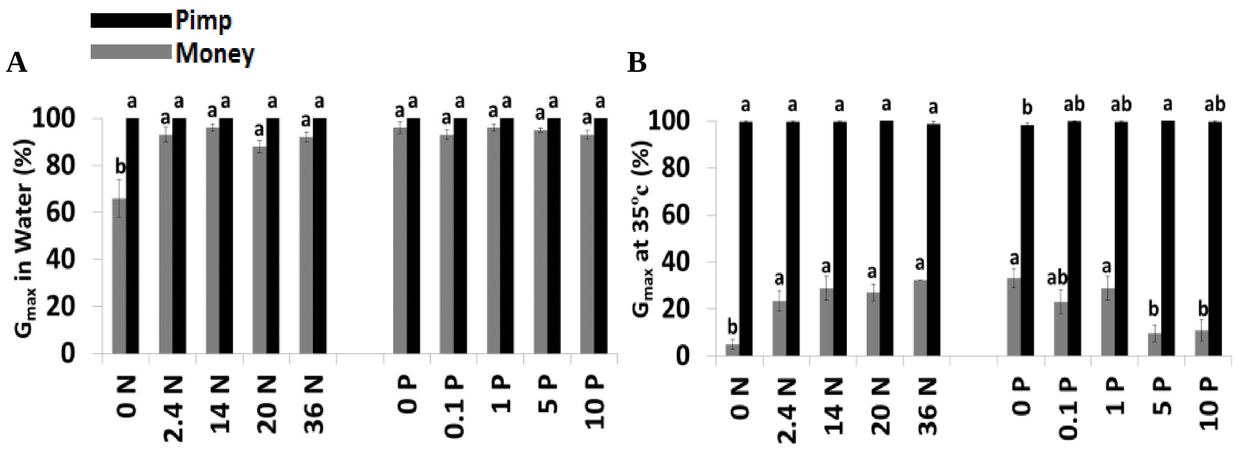
**Table 1.** Nutrient conditions of tomato plants from flowering onwards

| | Nitrate | Phosphate |
|---|---|---|
| **Control** | 14 mM | 1 mM |
| **Very low N** | 0 mM | 1 mM |
| **Low N** | 2.4 mM | 1 mM |
| **High N** | 20 mM | 1 mM |
| **Very high N** | 36 mM | 1 mM |
| **Very low P** | 14 mM | 0 mM |
| **Low P** | 14 mM | 0.1 mM |
| **High P** | 14 mM | 5 mM |
| **Very high P** | 14 mM | 10 mM |

## Result

### *The effects of different nutrient regimes of parental plants on seed and seedling quality traits*

Under normal germination conditions only very low nitrate (0 mM) decreased the germination percentage in Money. Under suboptimal conditions such as high temperature, Money seeds from plants grown in 0 mM nitrate, had very low germination percentages (4%) while higher concentrations of nitrate resulted in significant higher germination percentages. Phosphate showed an opposite effect with lower seed germination percentages for higher phosphate concentrations in the paternal environment (Figure 1). Pimp was in general much less sensitive for the paternal environment.



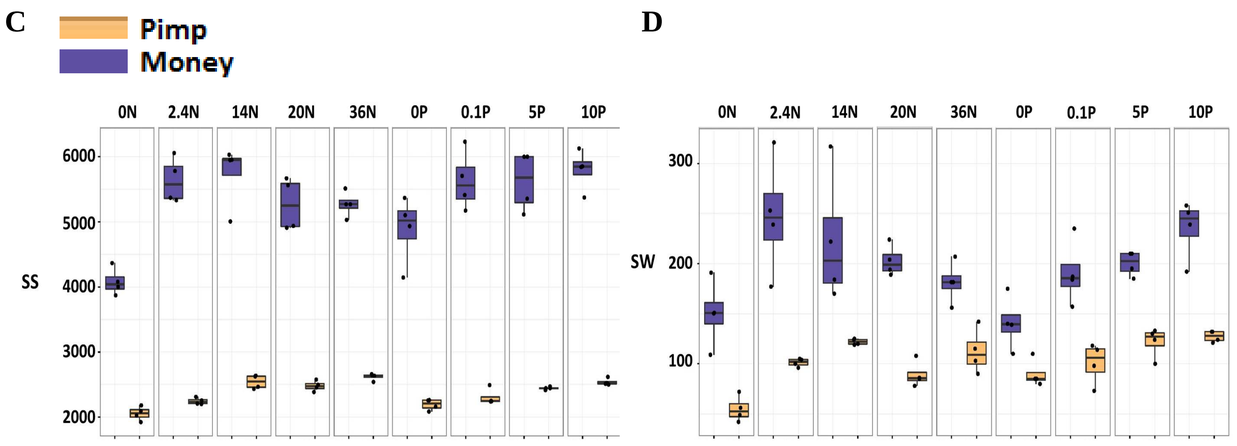




Figure 1. Effects of the paternal nutritional environments on seed germination traits of both Money and Pimp. (A) germination in water, (B) germination at high temperature (35 °C), (C) Seed size and (D) seed weight.

## Metabolic analysis

GC-TOS-MS analysis of dry seeds of Money and Pimp developed under the different parental environments, identified 89 (50 known + 39 unknown) metabolites. Principle component analysis for primary metabolite profiles showed a clear separation of the two species (Figure 2, 3).

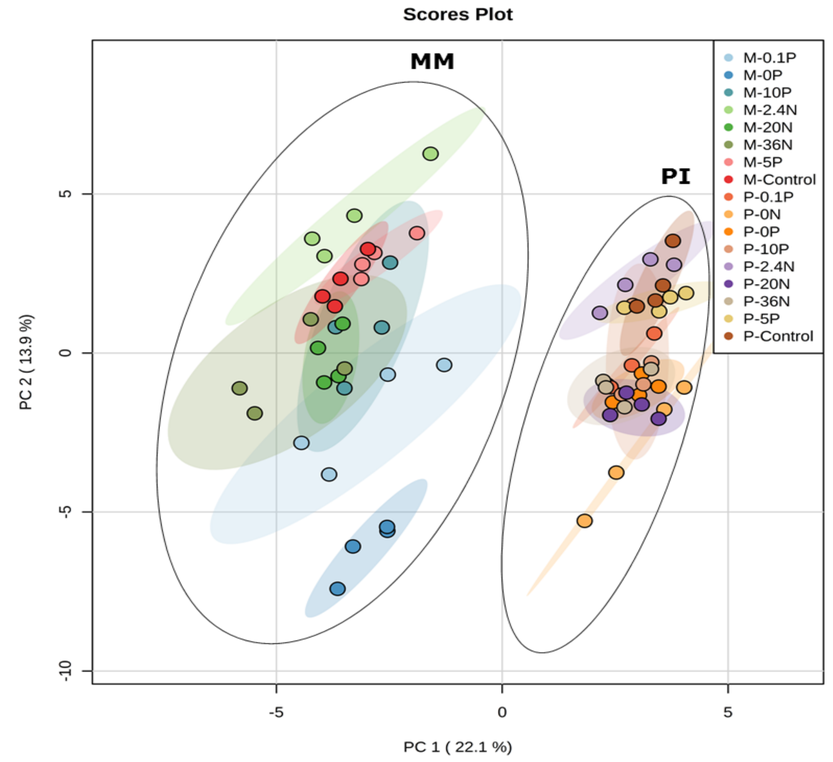



**Fig. 2.** Principle component analysis (PCA) of all the 89 identified metabolites of the different parental environments (MM: *Solanum lycopersicum cv. Moneymaker*; PI: *Solanum pimpinellifolium*).

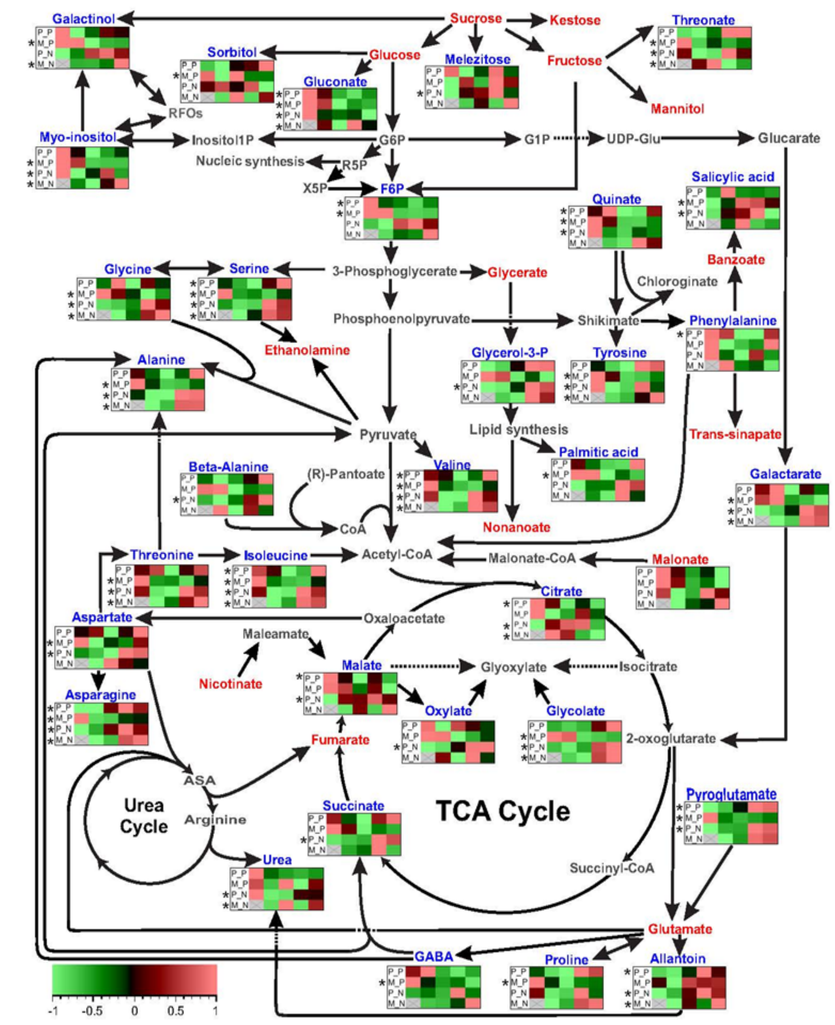



Figure 3. Overview of metabolic changes between the dry seeds of the two genotypes influenced by parental nutritional environments. Heatmaps contain four rows; top two rows represent P-P (Pimp Phosphate) and M-P (Money Phosphate) in different concentrations of phosphate (0, 0.1, 1, 5 and 10 mM from left to right). The bottom two rows represent P-N (Pimp Nitrate) and M-N (Money Nitrate) in different concentrations of nitrate (0, 2.4, 14, 20 and 36 mM).

## Conclusions

- Different amounts of phosphate and nitrate for tomato plants can influence seed and seedling traits specially under stressful germination conditions.
- Although different nutritional environments of tomato plants resulted in clear changes in seed quality traits in Money, hardly any effect was seen for Pimp seeds, showing that Pimp is tolerant to the different germination environments that were tested.
- Nitrogen-metabolism related metabolites like amino acids and γ-aminobutyric acid (GABA) and urea were significantly decreased in seeds from plants grown under lower amounts of nitrate for both genotypes (Figure 3).

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