CHASING DROUGHT STRESS IN LPA1-1 MAIZE MUTANT: EVALUATION OF THE ROOT SYSTEM ARCHITECTURE AND PHOTOSYNTHETIC PARAMETERS

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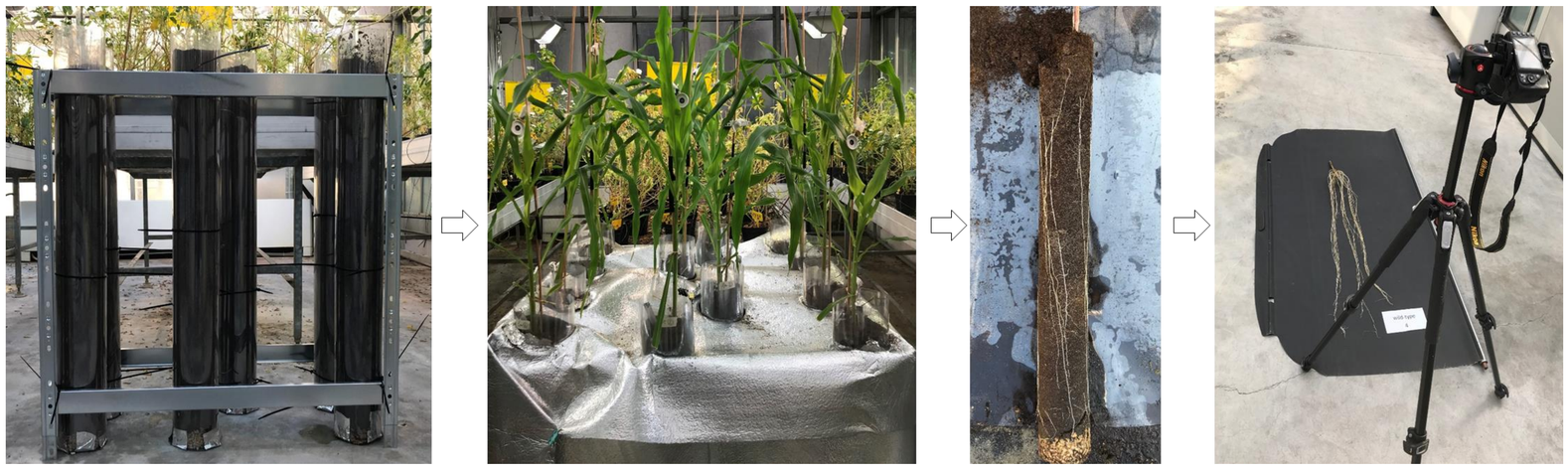
Introduction

Phytic acid (PA) is the major storage form of phosphate (P) in the seeds. It is accumulated as phytate mixed salts with different cations, reducing their bioavailability. Only ruminants can degrade PA due to the presence of phytases in the digestive tract, while monogastrics assimilate 10% of phytate in the feed and 90% is excreted, contributing to P pollution. Hence, many *low phytic acid* (*lpa*) mutants have been isolated in major crops. Among different *lpa1* mutants in maize, *lpa1-1* is characterized by a 66% reduction in PA, followed by a proportional increase in inorganic P. Unfortunately, PA decrease is followed by many negative pleiotropic effects on plant performance. Among these, a greater susceptibility to drought stress was observed on *lpa1-1*, which could be caused by an alteration in root system architecture (RSA) or in the aerial part of the plant.

The aim of this work was to identify the limiting factor in *lpa1-1* mutant under drought stress, analyzing and collecting parameters both on the hypogeal and epigeal part of the plant. Here we compared *lpa1-1* to a wild phenotype using different approaches, spanning from the greenhouse to the field.



Methodology

In order to monitor **root depth** over time, **mesocosms** (13.5 × 100 cm, top diameter × height) were built using transparent PVC sheets to better access the root system and were filled with sandy soil. Plants were grown till flowering in the greenhouse using the same amount of water and urea. Two experiments were carried out in the mesocosms at different times (**1°experiment** and **2°experiment**).

Root system architecture was also evaluated in the **field** (Figure 2). Ten roots per genotype were sampled through a shovel and the soil was removed by vigorous rinsing.

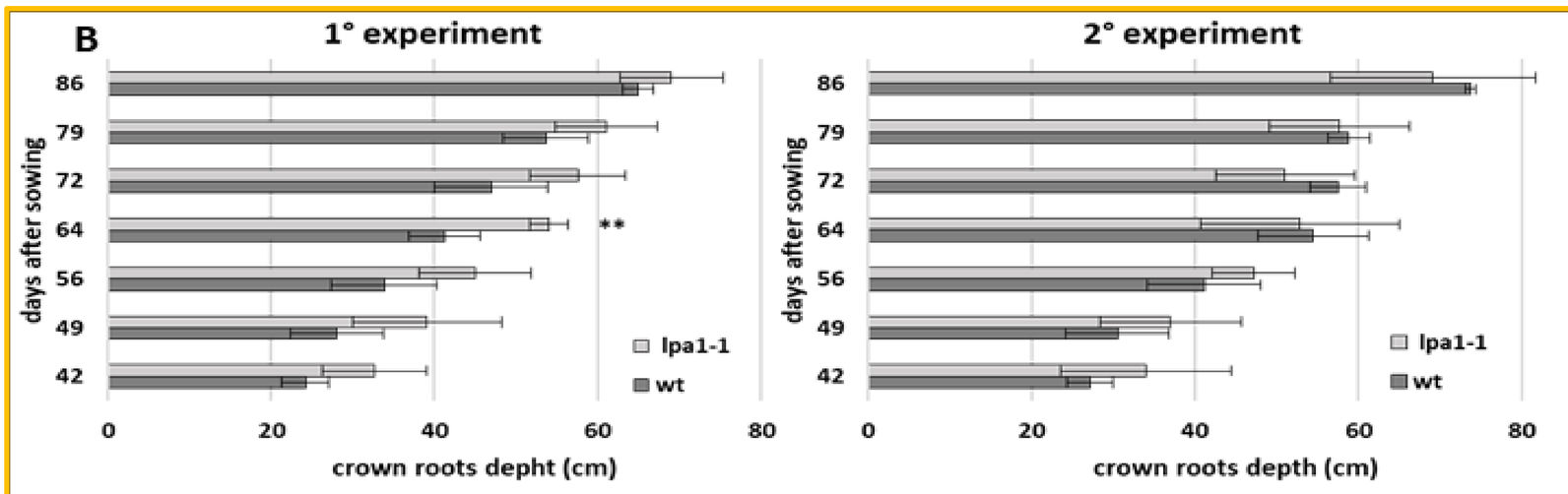


Figure 1_ Depth of the post-embryonic **crown roots** measured weekly. The data represent the means of three biological replicates. Student's t test (*P<0.1, **P<0.05 and ***P<0.01).

Figure 2_ Different parameters on crown and brace roots were collected in the field but no significant differences were found (data not shown).

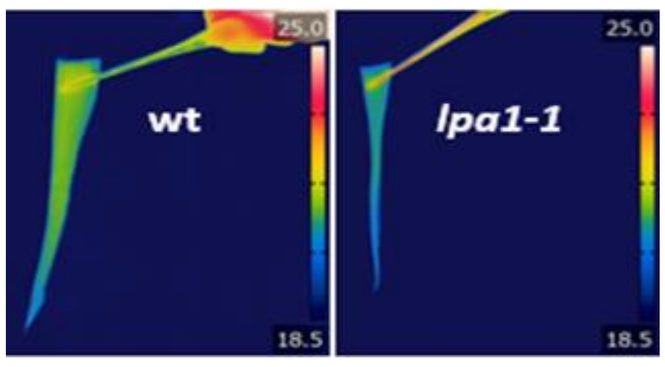


Figure 3_ Representative images acquired with the **thermographic camera** in the **mesocosms**. *lpa1-1* exhibited reduced leaf temperature, possibly due to increased water loss from leaves.

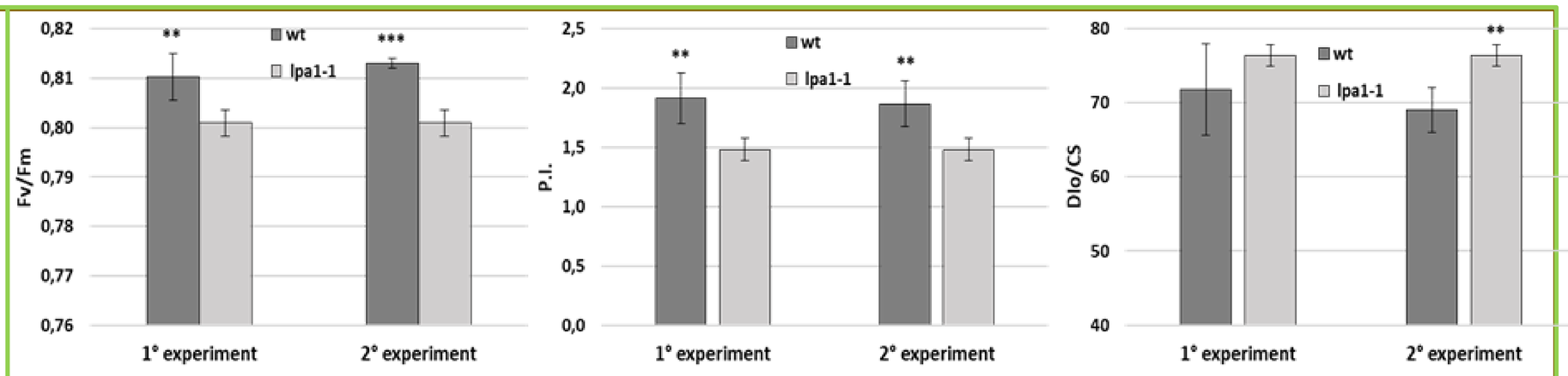


Figure 4_ In the mesocosms, the **fluorimeter Handy PEA+** was used to measure the maximum quantum efficiency of PSII (**Fv/Fm**), the Performance Index (**PI**) and the energy dissipated from PSII (**DIo/CS**). Pn and PI were reduced in mutant plants, probably due to a greater dissipation of energy. Values represent the mean of three biological replicates. Student's t test (P<0.1, **P<0.05 and ***P<0.01).

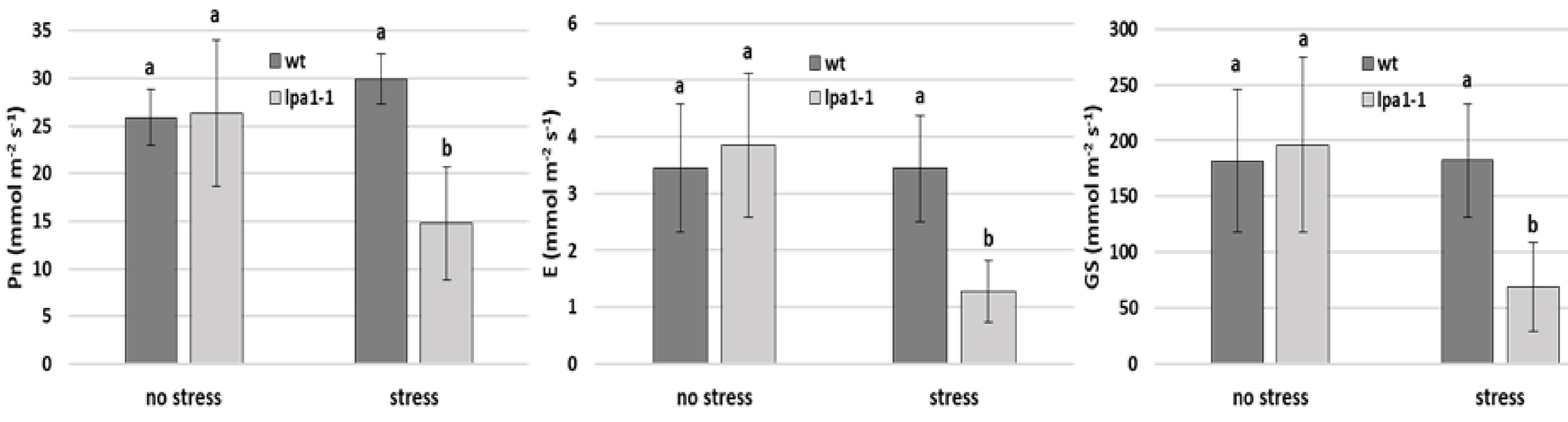


Figure 5_ The **CIRAS-2 System** was used in the **field** to measure the Net Photosynthetic CO2 rate (**Pn**), the Transpiration Rate (**E**) and the Stomatal Conductance (**GS**). Measurements were carried out under **optimal water conditions** and **moderate drought stress**. *lpa1-1* showed reduced Pn, E and GS, supporting the hypothesis that the drought stress observed in *lpa1-1* is caused by a reduced photosynthetic efficiency and not by a shallower root system. Values represent the mean of eight biological replicates. One-way ANOVA and post-hoc Tukey test.

Conclusion

low phytic acid mutants represent a great opportunity in underdeveloped countries, where the lack of important cations in the diet represents a serious problem for human health. Several breeding programs are in progress in order to develop new *lpa* varieties by conventional breeding and transgenic/genome editing methods. In this way it will be possible to exploit the nutritional properties of this mutant improving the P management in agriculture.