INFLUENCE OF PLANTING LOCATION AND GROWING SEASON ON THE NUTRITIONAL QUALITY OF LUPIN

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INTRODUCTION

Lupin is a highly nutritious legume crop, particularly in terms of protein, and certain accessions can accumulate up to 40% of this macronutrient. They are also rich sources of zinc (Zn), magnesium (Mg), iron (Fe), potassium (K) and calcium (Ca) along with vitamin A, B and E (Bryant et al., 2022). Nutritional quality has often been studied in germplam accessions, but environmental effects has often been neglected. This research seeks to quantify the nutrient accumulation variations that could result in lupins when altering the crop location and over two different growing seasons.

METHODS

Seeds were harvested in two growing seasons (season 1, 2017-2018, and 2, 2018-2019) and from two locations (Córdoba, Loc 1 and Huelva, Loc 2, both in Spain). Protein concentration was determined using the Bradford method (Bradford, 1976) and the Pierce Coomassie Plus Assay Kit (Thermo Fisher Scientific, Massachusetts, USA). Mineral concentration was determined following microwave-assisted digestion through inductively coupled plasma - optical emission spectrometry (ICP-OES, Optima 7000 DV, PerkinElmer, USA).

RESULTS AND DISCUSSION

Results show that in season 1 grains had higher protein accumulation in Loc 1 (Figure 1.A), which was also the location where the crop yield was reduced. This aligns with previous research that shows a direct relation between lower yields and higher protein content in lupin seeds (Reckling et al., 2018). The low protein levels found in season 2 at both locations could also be related to the specific climateric conditions that were experienced during this season, resulting in a warmer year (+2C^{o}) with less overall rainfall than season 1 (-1,266 mm) (*data not shown*). Insuficcient mineral availability in the soil can also impact protein uptake. E.g., lower levels of sulphur and P specifically, can have a direct impact on the N content of legume shoots (Claro-Cortes et al., 2002). In season 1, P was higher in Loc 2 (Figure 1.B), while Mn, K and Zn had similar levels in both locations (Figure 1, C and D). The significant decrease in P accumulation in season 2 is attributted to drought stress. Several studies have shown that climate alterations may disturb the nutrient accumulation in major crops. In particular, drought stress has shown to limit P accumulation and reduced P translocation to the seed in soybean (Jin et al., 2015). Lastly, K accumulation was statistically similar on season 1 on both locations, displaying only a statistically difference during the second season in location 2 (Figure 1E), which could be a result of K fixation to some particles of clay that could be present in the soil at that specific season, conditioning the plant's ability to absorb the mineral (Solangi et al., 2019).

Finally, the levels of Fe, Mg and Ca did not show significant variation on their nutrient accumulation amongst seasons and locations (*data not shown*), a result that aligns with the expected resilience in mineral uptake of lupins that have been harvested in different environments (Ruiz-López et al., 2019).

CONCLUSIONS

In this study, nutrient accumulation of protein and minerals was more variable between seasons that between locations, this is mostly associated with the distinct climateric conditions of the two seasons. This was expected since temperature and water availability can influence greately the outcome of any given crop, even when locations for both trials were far from eachother, and soil quality was likely different between locations. When comparing the growing seasons, conditions of growing season 1 (2017-2018) seemed to provide a more

advantageous context for nutrient accumulation. Connecting the water availability, changes in temperature, amongst others, with the final outcome.

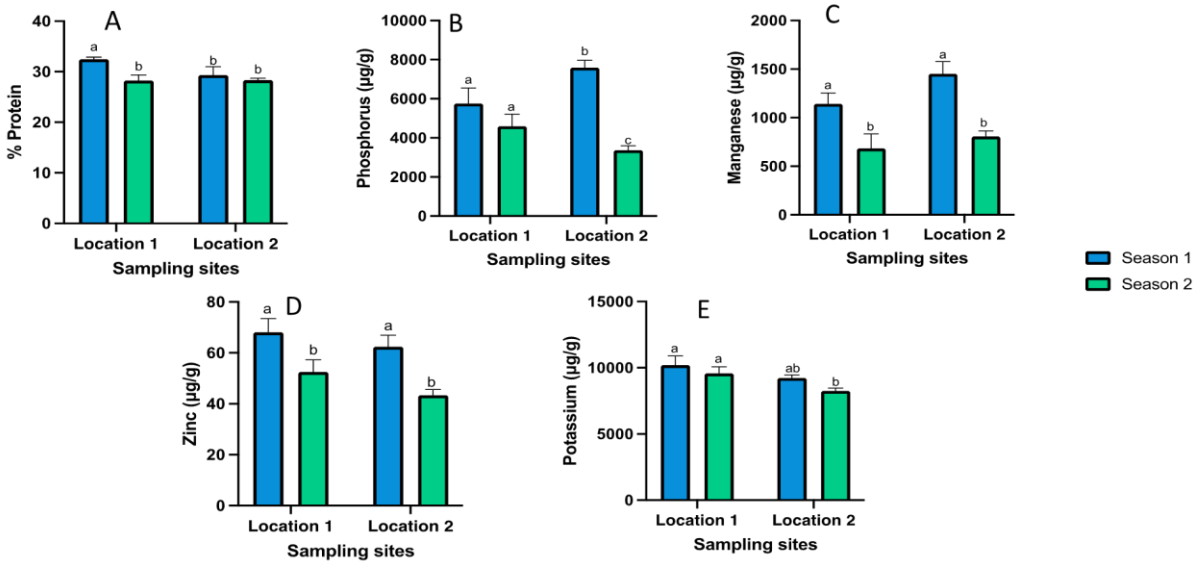

Fig. 1. Results of the effect of growing season and location on nutritional composition of lupin grains for protein (A), phosphorus (B), manganese (C), zinc (D) and potassium (E).

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