Lenin MEDINA-OROZCO[1]

Biochar application in saline soils to increase wheat germination success in central Mexico

[1]Tecnológico Nacional de México / I. T del Valle de Morelia, Morelia, Michoacán.

Introduction

Wheat is one of the most important crops globally. The decrease in wheat production is associated with factors that include; reduction of land areas, climate change and abiotic factors that generate stress in the plant. The salinity and drought of the soil are reflected in the reduction in the germination rate and therefore in the production. The technologies used to increase the germination rate are based on biotechnology, soil organisms and seed priming; however, techniques such as the use of biochar have been scarcely studied (Miransari and Smith, 2019; Semida et al., 2019). Mexico reported during the year 2021, a planted area with wheat about 553,825 ha, 73,911 ha are rainfed and the rest irrigated, with yield of 1.92 t/ha. Much of the wheat cultivation is carried out in soils with salinity problems. The results are limited to the central region of Mexico and applicable to Vertisols (Figure 1, 2). The main objective of the study was to evaluate the effect of biochar on the germination rate and soil water retention in the early stage of wheat cultivation.

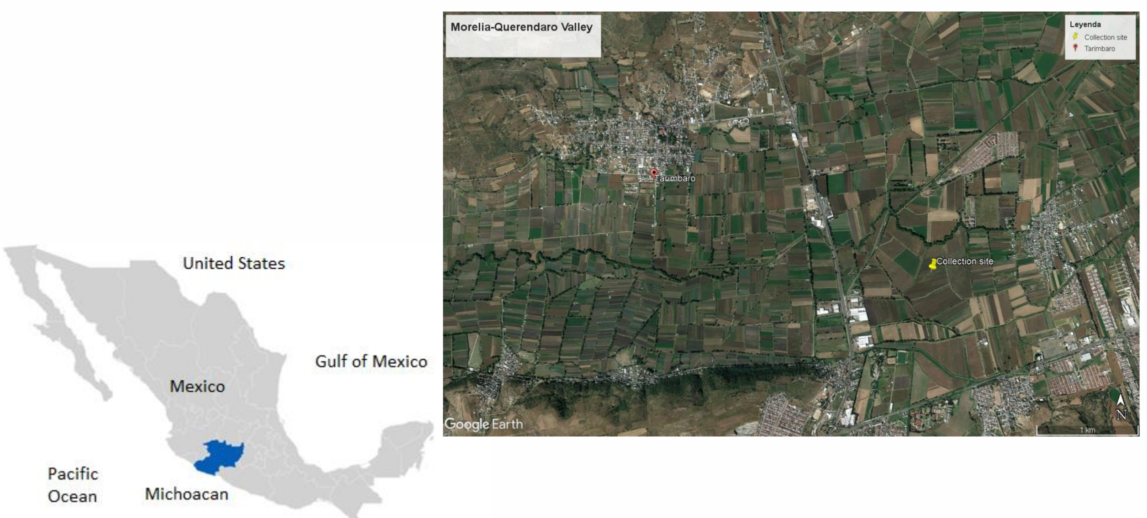

Figure 1: Localization and soil collection site.

Methodology

Wheats of the Urbina S2007 variety were planted in 19 L pots with 600g of soil with a pH of 8.0, the climate is of the sub-humid temperate type with summer rains, an average temperature of 19°C and annual rainfall of 796 mm. The trial consisted of 60 pots with two seeds each, and an experimental design of three complete blocks with a control (T0) and a treatment (T1). T1, consisted of the addition of 1% (w/w) of crushed biochar. The biochar was obtained from the pyrolysis of corn cob biomass at temperatures of 600 °C. The seed was obtained with the certifying institute in Mexico. Germination in the trial was evaluated according to the Zadoks scale (Z0, 09/99). Soil water retention (SWR) in the soil was performed using the lysimeter technique. Soil pH was measured before and at the end of the experiment (2:1 ratio).

Figure 2: Wheat fields in central Mexico with conventional practices for burning wheat residues.

Results and Discussion

The seed germination rate was 62.5 % in T1 and 25 % in T0, values adjusted to the maximum possible value of 96 %, with statistical difference (p = 0.01200).

The SWR presented values for T1 of 525.5 ± 27.2mL in contrast to (T0), where the average value was 420 ± 41.9mL. in other words, SWR increased by 21%. The values are statistically significant (p = 0.00001).

The pH values for the soil, after the experiment, were 8.5 and 8.0 for T1 and T0 respectively.

Biochar presented a significant effect on germination, Semida et al., 2019, report studies with 100 % increase rates in germination of sunflowers, with applications of 1 % (w/w) of biochar, possibly due to changes in the characteristics of the soil after the application of biochar; while for wheats in trials without soil, the germination rate is low.

Probably one of the variables that explains the increase in the germination rate is the SWR, by increasing the amount of water available to the plant in the early stages of development.

Opposite to what was expected in saline soils, the pH presented an increase in its value, however, the potential effect of biochar on the absorption of sodium from the soil solution and the increase in the absorption of nutrients (Ali et al., 2017), explain the increase in the germination rate.

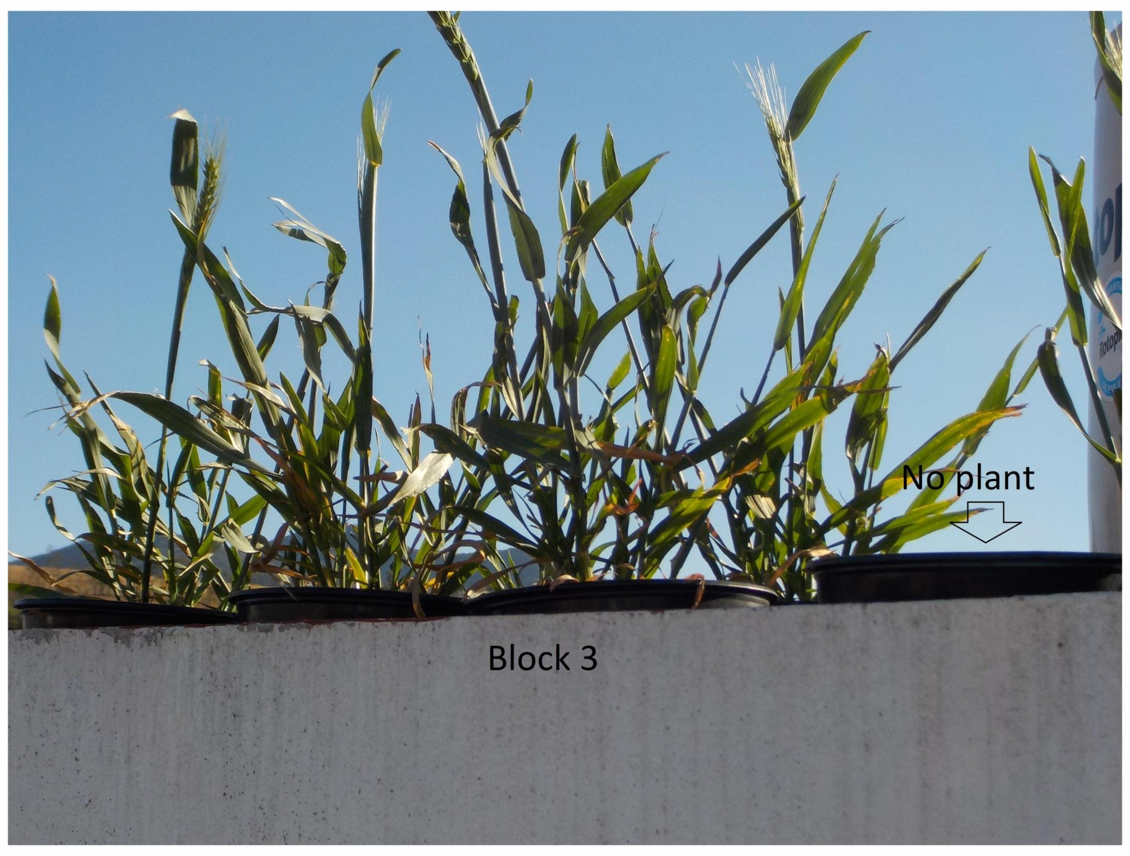

Figure 3: The image shows a block of plants where successful and unsuccessful germination can be seen.

Conclusions

Biochar has potential to increase wheat germination in saline soils and is an alternative strategy to other complex options such as biotechnology and seed priming.

References

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