ORIGINAL RESEARCH ARTICLE

Effects of PEG6000 and NaCl stresses on germination of Benisuif-5 durum wheat genotype

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ABSTRACT

The present investigation has been performed to evaluate Benisuif-5 durum wheat genotype for tolerance to osmotic stress at two-factor experiment in a completely randomized design. The first factor (A) included four levels of PEG6000: 0 - distilled water; 5%; 10% and 20%. The second factor (B) included four levels of NaCl: 0 - distilled water; 50 mM; 100 mM and 200 mM. Seedling length, root numbers, seedling fresh weight, seedling fresh weight and dry weight, tissue water content, tolerance index, seedling length reduction, root number reduction, seedling fresh weight reduction and seedling dry weight reduction were measured in the study under each factor. After the analysis of the obtained results, it was concluded that, all the parameters values were reduced by both stresses under the different mechanisms

Keywords: *Benisuif-5 durum wheat, germination, PEG6000, NaCl.*

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INTRODUCTION

Crop improvement has come a long way, but modern agriculture is confronting some unheard-of hurdles to keep up with the expanding human demand . Physiological screening procedures are generally resisted by plant breeders because they are thought to be more expensive, time-consuming, and challenging to employ. Therefore, growing interest has been shown in the use of phenomic techniques to research plant phenotypes under laboratory conditions, especially in relation to improving "omic" approaches. Therefore, traditional manual plant phenotyping methods are still useful in plant breeding. These methods are very crucial in plenty of emerging nations.

Characteristics of the shoot morphology are frequently employed for phenotyping. Shoot parameters are typically simple to evaluate in many situations, where they are frequently identified by simple visual inspection. The placement of roots, especially those that may delve deeper into the soil, is critical in determining a plant's capacity to absorb vital resources like water and transportable nutrients. Hence, root design has a significant impact on crop plant growth and yield. Hence, utilizing polyethylene glycol (PEG_{6000}) in the medium to select for drought tolerance during the seedling phase is typically practical .

Because it is an inert, non-ionic water polymer and essentially impermeable chain, poly ethylene glycol (PEG) is frequently used to move water stress without seriously harming agricultural plants because it is not anticipated to permeate into plant tissue quickly .

PEG can also be employed to alter the osmotic potential of nutrient clarity cultures and transfer plant water shortages in a precise manner, according to unproven proprieties Hence, utilizing polyethylene glycol (PEG_{6000}) in the medium to select for drought tolerance during the seedling phase is typically practical . Na^+ and Cl^-, on the other hand, can enter plant cells and accumulate in the cytoplasm of sensitive cultivars or the vacuole of tolerant plants. A hereditary property, the ability to adapt osmotically in wheat is regulated by different alleles at a single locus on chromosome 7A. Previous research on the identification of wheat genotypes resistant to drought under various concentrations of PEG_{6000} and NaCl found substantial differences for many seedling characteristics. When combined, the seedling characteristics might distinguish between the examined genotypes' vulnerability to drought and NaCl.

The goal of the current study was to assess the Benisuif-5 durum wheat genotype's response to the effects of PEG_{6000} and NaCl stressors on germination in order to be employed in a breeding programme to create salt and drought tolerant plants. By doing this, the risks of production decline during difficult years can be decreased.

MATERIAL AND METHOD

On the germination and early growth of Benisuif-5 durum wheat seedlings, a two-factor experiment was carried out in the Genetics Laboratory of the Faculty of Agriculture of University of Sohag, Egypt, using a completely random design. Four categories were included in the first factor (A) of PEG_{6000}: 0 - distilled water; 5%; 10% and 20%. Four levels of NaCl were included in the second component (B).: 0 - distilled water; 50 mM; 100 mM and 200 mM to be osmotically equivalent in PEG_{6000} and NaCl solutions.

Twenty grains from each treatment were separated, sterilised for five minutes with 5% sodium hypochlorite (NaOCl), allowed to dry at room temperature, and then rinsed three times with sterile distilled water. Following that, grains were added to [(150 X 15 mm) covered at the bottom with a cotton layer] Petri plates that had been sterilized. Equal quantities of the intended osmotic solutions (10 ml each of the modified PEG_{6000} and NaCl concentrations) were used to moisten the dishes. Each dish received three milliliters of the right solution daily. In the dark growth germination chamber (at 25±0.5°C and 80±1% of relative humidity), these Petri plates were used.

After 15 days, the seedlings were collected. Growth factors were investigated in relation to seedling length (was measured in centimeter with ruler at the time of experiment termination), root numbers (was done by counting the roots in each seedling)), seedling fresh and dry weight (weighed in grammes (g) at the conclusion of the experiment for the fresh weight of the seedlings, and then dried for 72 hours in a hot air oven at 65 °C before being weighed once more for the dry weight), tissue water content, was calculated and represented as a percentage using the:

TWC (%) = (seedling fresh weight - seedling dry weight/ seedling fresh weight) x100), tolerance index, was calculated by dividing the dry weight of the stressed seedlings by the dry weight of the control seedlings , seedling length reduction percentage, root number reduction percentage, seedling fresh weight reduction percentage and seedling dry weight reduction percentage equal (value under stress level - value at 0 level)

RESULTS AND DISCUSSION

The reduction magnitude was observed for almost considered PEG_{6000} levels for all studied parameters. Whereas, the reduction scores were found for all considered NaCl levels for for all studied parameters as exhibited in Figs (1-20) because the grains could not absorb the induced solutions, due to the toxic effect on germination embryos.

Concerning seedling length that is obvious in Figs (1 and 2), the levels differ significantly from one another of PEG_{6000} and NaCl comparing with distilled water (0% & 0 mM), that could result in plants responding favorably to stressors, as demonstrated by its lower value.

In the context of root numbers, research reported here observed that, the root numbers were increased with the increase PEG_{6000} levels, as demonstrated by its high value. In spit of, the root numbers decrease with the increase NaCL levels,

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as demonstrated by its lower value as exhbited in Figs (3 and 4) stated that an important factor in determining a plant's capacity to extract essential resources from the soil, such as water and mobile nutrients, is the distribution of roots, particularly those that can reach deeper into the soil. Hence, root architecture significantly influences agricultural plant growth and yield..

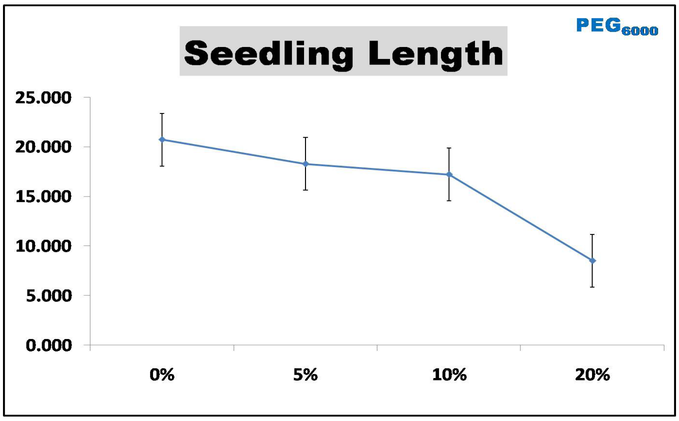

Fig. 1: Effect of the different levels of PEG_{6000} on Seedling Length of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

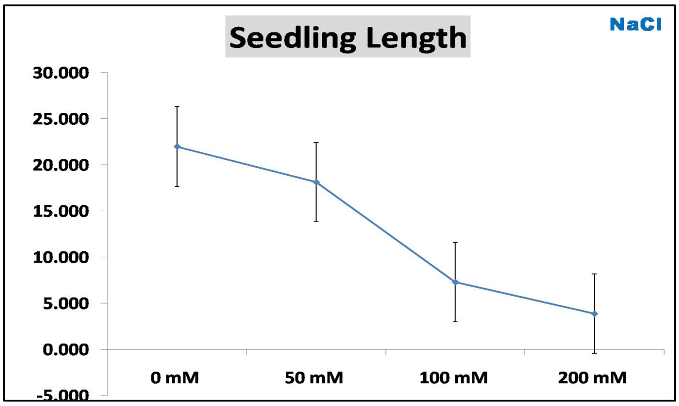

Fig. 2: Effect of the different levels of NaCl on Seedling Length of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

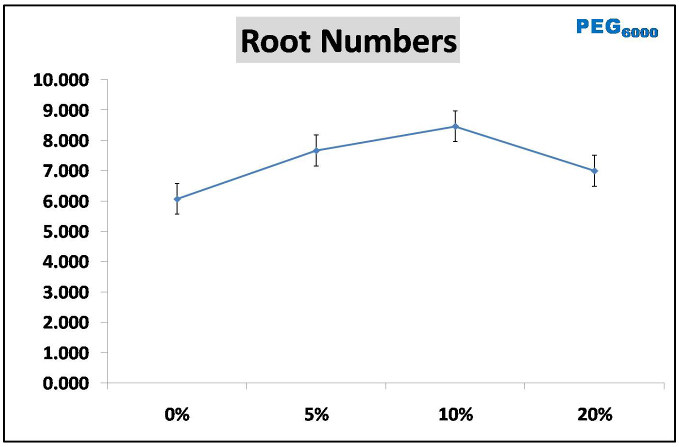

Fig. 3: Effect of the different levels of PEG_{6000} on Root Numbers of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

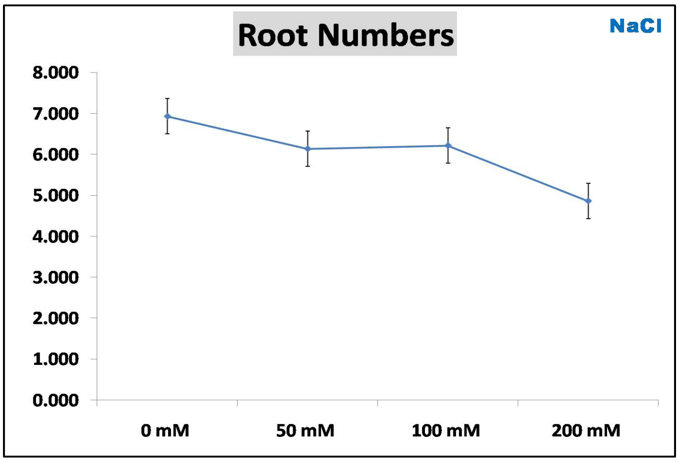

Fig. 4: Effect of the different levels of NaCl on Root Numbers of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

Seedling fresh weight was significantly decrease with the rising amounts of PEG_{6000} and NaCl. Meanwhile, seedling dry weight significantly increased with high levels of PEG_{6000} and decrease with high levels of NaCl as presented in Figs (5 – 8) as demonstrated by its lower value. reported that when osmotic potential rose, the fresh weight of seedlings of both drought-tolerant and sensitive durum wheat genotypes decreased. In additions, numerous other scientists have noted the declining trend in seedling fresh and dry weight who demonstrated that the fresh and dried weight of seedlings was significantly impacted by water stress.

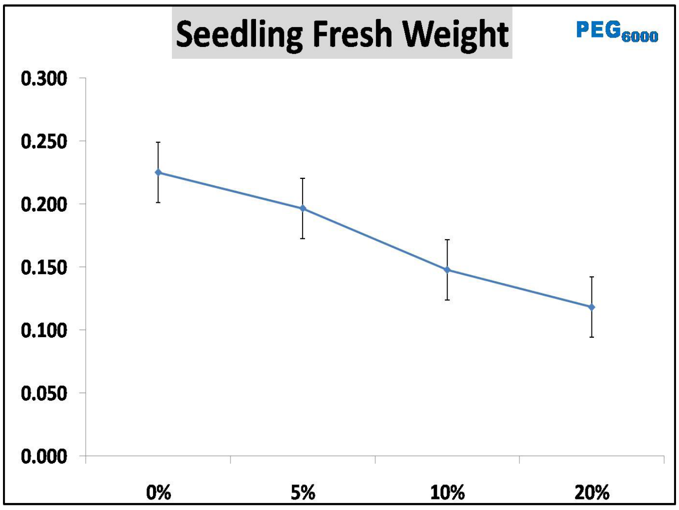

Fig. 5: Effect of the different levels of PEG_{6000} on Seedling Fresh Weight of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

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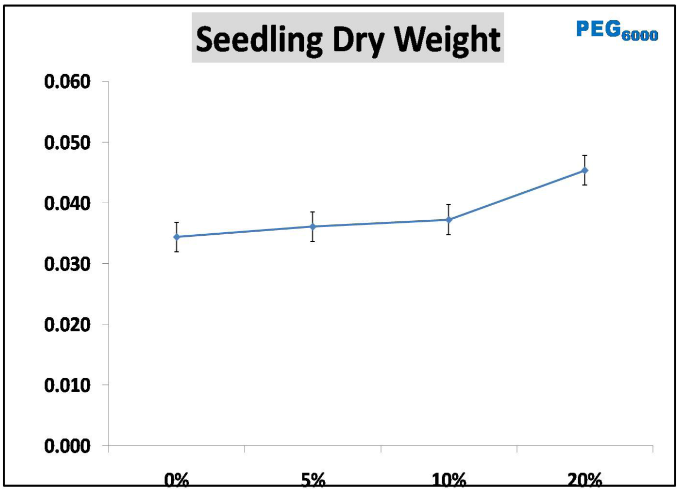

Fig. 6: Effect of the different levels of PEG_{6000} on Seedling Dry Weight of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

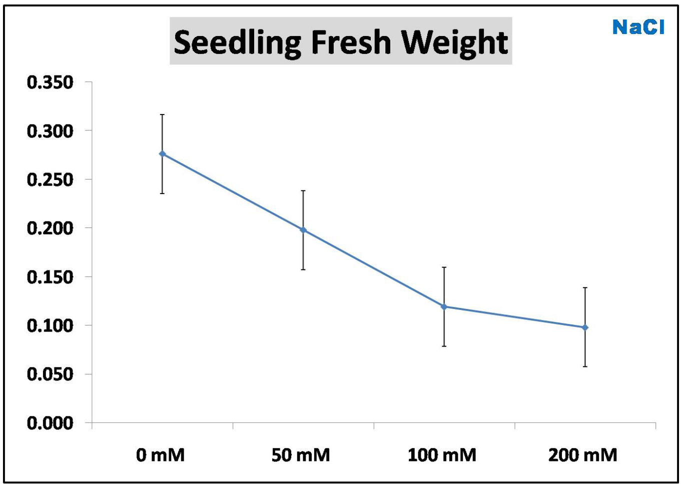

Fig. 7: Effect of the different levels of NaCl on Seedling Fresh Weight of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

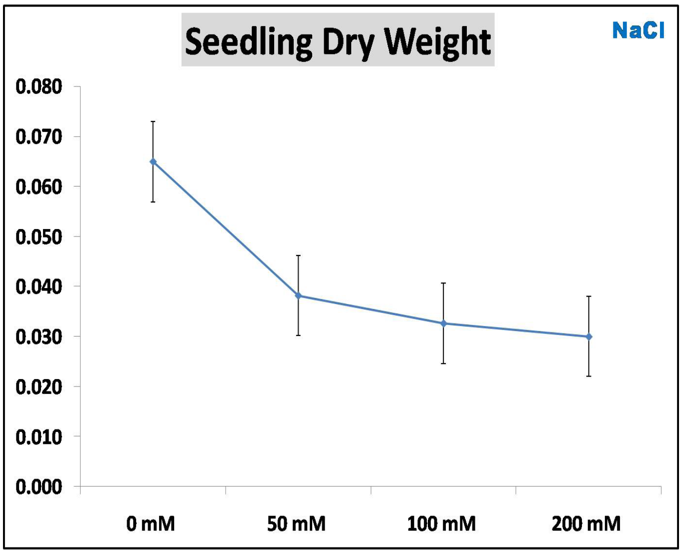

Fig. 8: Effect of the different levels of NaCl on Seedling Dry Weight of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

The values regarding tissue water content responded differently to the observations (Figs. 9 and 10). the results noted that, the tissue water content values was significantly derease under PEG_{6000} levels and only dereased under NaCl levels. Similar results were noted after treating wheat seeds with KCl, as reported by **.**

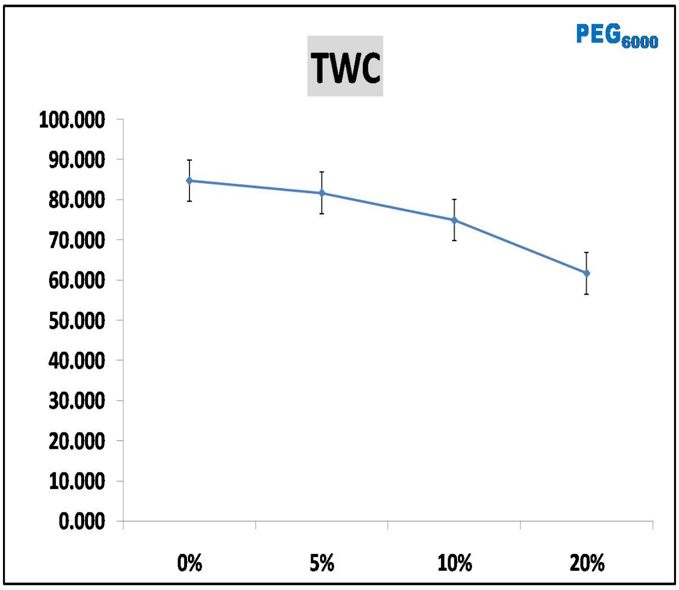

Fig. 9: Effect of the different levels of PEG_{6000} on Tissue Water Content (TWC) of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

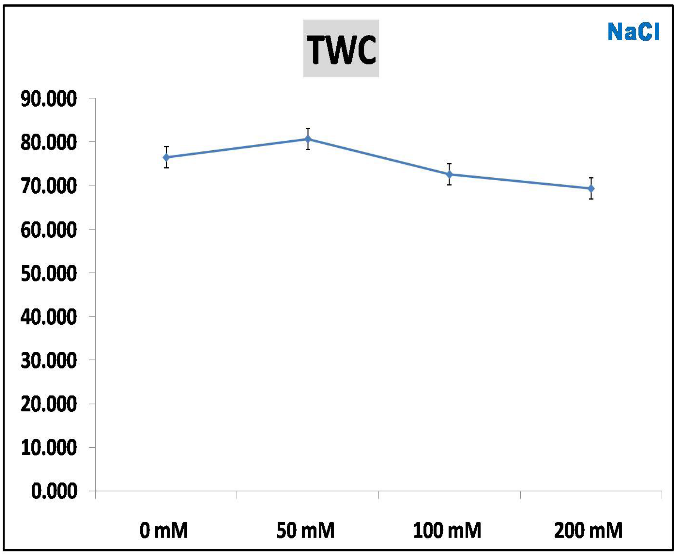

Fig. 10: Effect of the different levels of NaCl on Tissue Water Content (TWC) of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

Regarding tolerance index, the results showed that the genotype Bensiuif-5 durum wheat scored tolerant to PEG_{6000} than NaCl stress as noticed in Figs (11 and 12).

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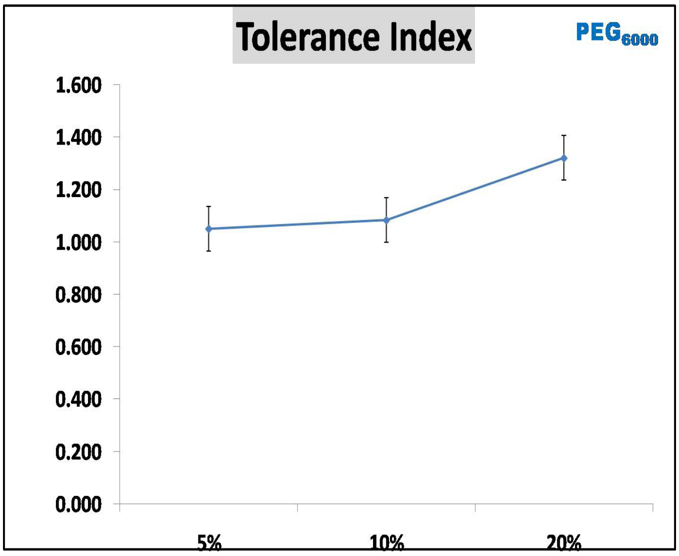

Fig. 11: Effect of the different levels of PEG_{6000} on Tolerance Index of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

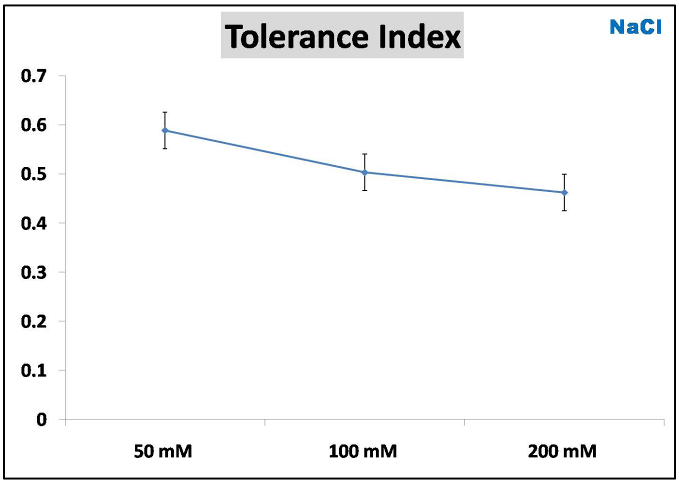

Fig. 12: Effect of the different levels of NaCl on Tolerance Index of Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

The reduction magnitude of the studied parameters were observed under different levels of PEG_{6000} and NaCl concentration.

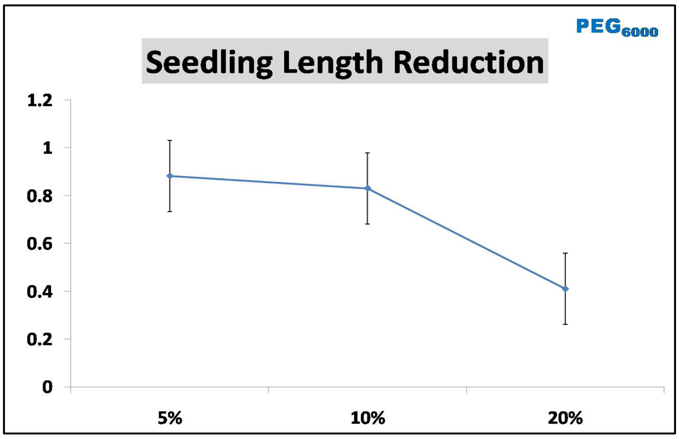

Fig. 7: Effect of the different levels of NaCl on reduction percentage of Seedling Length for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

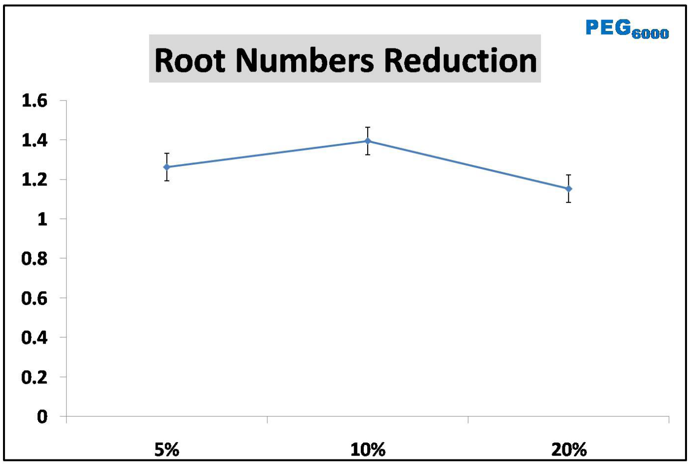

Fig. 8: Effect of the different levels of NaCl on reduction percentage of Root Numbers for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

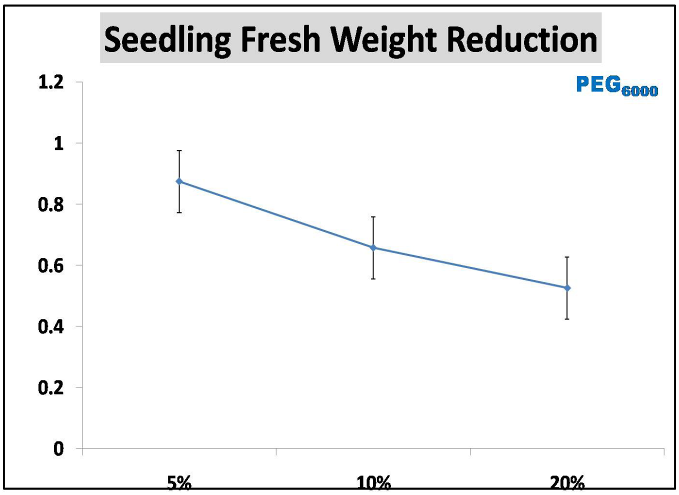

Fig. 9: Effect of the different levels of NaCl on reduction percentage of Seedling Fresh Weight for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

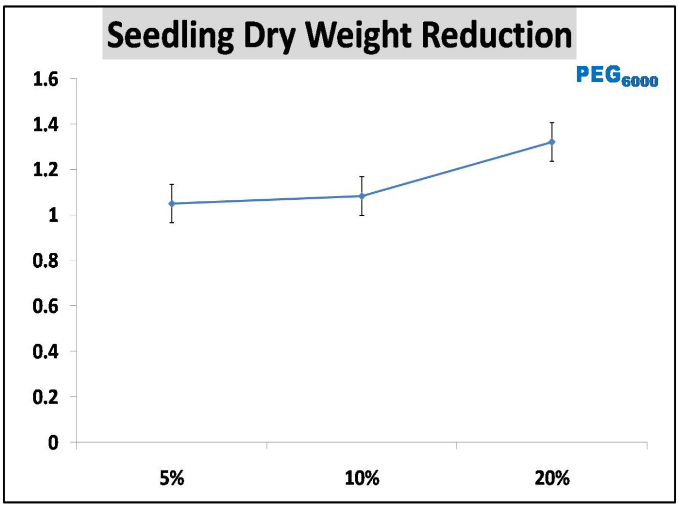

Fig. 10: Effect of the different levels of NaCl on

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reduction percentage of Seedling Dry Weight for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

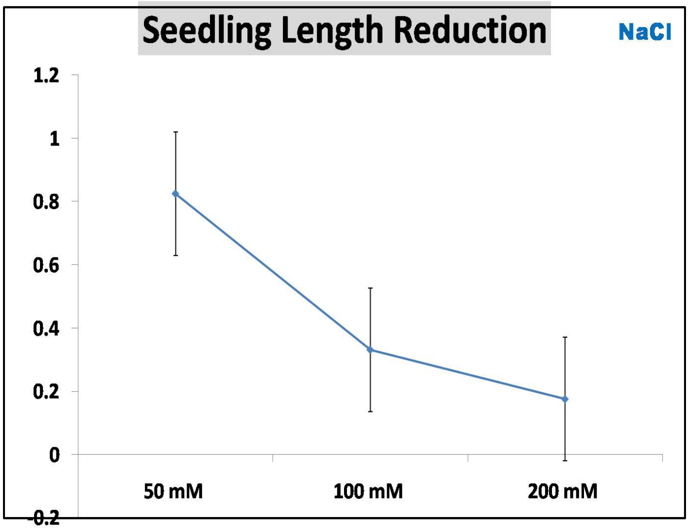

Fig. 17: Effect of the different levels of NaCl on reduction percentage of Seedling Length for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

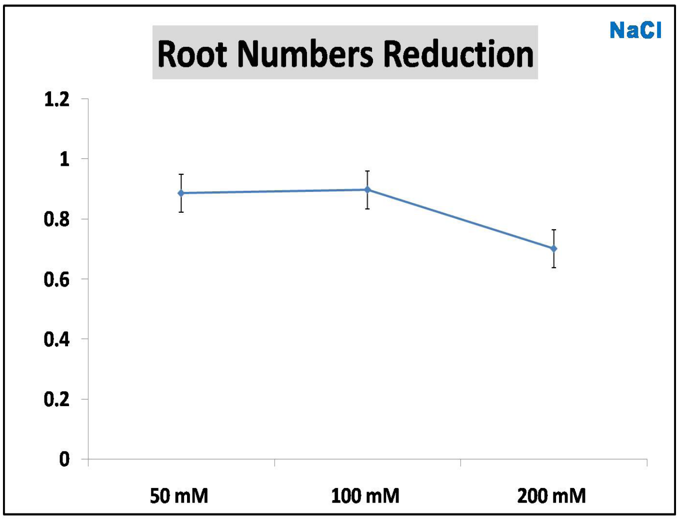

Fig. 18: Effect of the different levels of NaCl on reduction percentage of Root Numbers for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

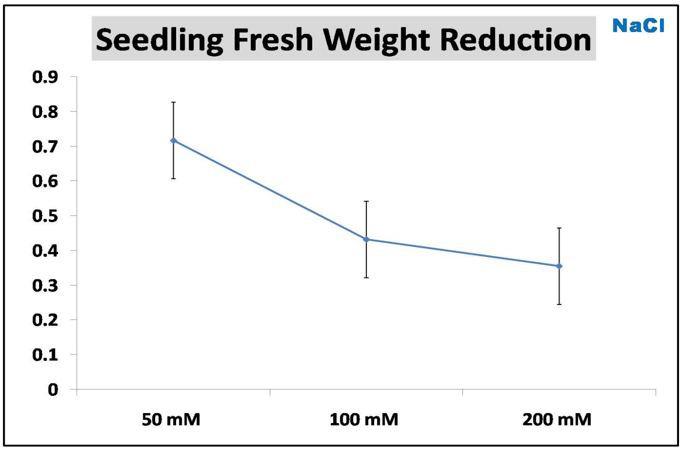

Fig. 19: Effect of the different levels of NaCl on reduction percentage of Seedling Fresh Weight for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

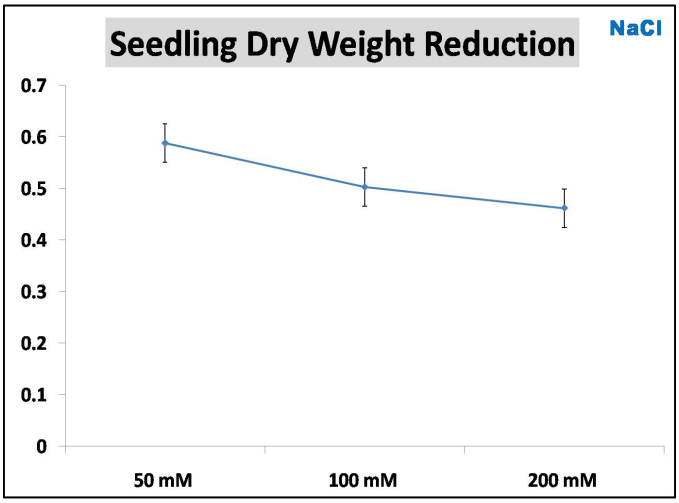

Fig. 20: Effect of the different levels of NaCl on reduction percentage of Seedling Dry Weight for Benisuif-5 durum wheat genotype (all means [± S.E.] are significantly different at P<0.05).

Overall, by contrasting the averages from control variations with those from the various treatments levels it can be observed that Treatments performed with PEG_{6000} and NaCl significantly reduced the average of the obtained values. These laboratory results can be regarded as a test that can be used to make a preliminary genotype selection and characterization for breeding drought resistance.

CONCLUSION

Considering the achived findings from the present study it is concluded that, treatments performed with PEG_{6000} and NaCl significantly reduced the average of the obtained values.

Consent and Ethical Approval

As per university standard guideline, participant consent and ethical approval have been collected and preserved by the authors.

Competing interests

Authors have declared that no competing interests exist.

Authors' Contributions

This work was carried out in collaboration among

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all authors. All authors read and approved the final manuscript.

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