agronomy

MDPI

Article

Assessing the Suitability of Multivariate Analysis for Stress Tolerance Indices, Biomass, and Grain Yield for Detecting Salt Tolerance in Advanced Spring Wheat Lines Irrigated with Saline Water under Field Conditions

Muhammad Mubushar [1], Salah El-Hendawy [1,2,*], Muhammad Usman Tahir [1], Majed Alotaibi [1], Nabil Mohammed [1], Yahya Refay [1] and ElKamil Tola [3]

[1] Department of Plant Production, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Saudi Arabia
[2] Department of Agronomy, Faculty of Agriculture, Suez Canal University, Ismailia 41522, Egypt
[3] Department of Agricultural Engineering, College of Food and Agriculture Sciences, King Saud University, Riyadh 11451, Saudi Arabia
* Correspondence: mosalah@ksu.edu.sa; Tel.: +966-5-3531-8364

Abstract: Successfully evaluating and improving the salt tolerance of genotypes requires an appropriate analysis tool to allow simultaneous analysis of multiple traits and to facilitate the ranking of genotypes across different growth stages and salinity levels. In this study, we evaluate the salt tolerance of 56 recombinant inbred lines (RILs) in the presence of salt-tolerant and salt-sensitive control genotypes using multivariate analysis of plant dry weight, measured at 75 (PDW-75) and 90 (PDW-90) days from sowing, biological yield (BY), grain yield (GY), and their salt tolerance indices (STIs). All RILs and genotypes were evaluated under the control and 15 dS m^{-1} for two consecutive years (2019/2020 and 2020/2021). Results showed significant main effects of salinity and genotype as well as their interactions on four plant traits. Significant genotypic differences were also found for all calculated STIs. STIs exhibited moderate to strong relationships with the four plant traits when measured under either the control or salinity conditions and between each other. The principal component analysis (PCA) showed that the most variation among all analyzed variables was explained by the first two PCs, with the PC1 and PC2 explained at 61.8–71.8% and at 28.0–38.2% of the total variation, respectively. The PC1 had positive and strong correlations with the four plant traits measured under salinity conditions and STI, YI, REI, SWPI, MRPI, MPI, GMPI, and HMPI. The PC2 had strong correlations with BY and GY measured under the control conditions and SSI, TOL, RSE, and YSI. The PC1 was able to identify the salt-tolerant genotypes, while the PC2 was able to isolate the salt-sensitive ones. Cluster analysis based on multiple traits organized 64 genotypes into four groups varied from salt-tolerant to salt-sensitive genotypes, with the salt-tolerant group attaining higher value for plant traits under salinity conditions and the STIs related to the PC1. In conclusion, the use of multivariate analysis together with the STIs that evaluated the performance of genotypes under contrasting environmental conditions will help breeders to distinguish salt-tolerant genotypes from salt-sensitive ones, even at the early growth stages of plant development.

Keywords: biomass; bread wheat; grain yield; growth stages; principal component analysis; ranking; Ward's cluster analysis

Citation: Mubushar, M.; El-Hendawy, S.; Tahir, M.U.; Alotaibi, M.; Mohammed, N.; Refay, Y.; Tola, E. Assessing the Suitability of Multivariate Analysis for Stress Tolerance Indices, Biomass, and Grain Yield for Detecting Salt Tolerance in Advanced Spring Wheat Lines Irrigated with Saline Water under Field Conditions. *Agronomy* **2022**, *12*, 3084. https://doi.org/10.3390/agronomy12123084

Academic Editor: Krisztina Bela

Received: 9 November 2022
Accepted: 1 December 2022
Published: 5 December 2022

1. Introduction

Today, the world is facing the worst food crisis, while drastic and unexpected changes in the climate are predicted to have a wide range of detrimental effects on global food security. This is because these changes are often accompanied by an increase in the intensity and frequency of several abiotic stresses. Such stresses would further threaten global food security because they are causing extensive yield losses in many food crops around