



Relationship Between Agronomic Traits and Grain Nutrients in Barley Cultivars (*Hordeum vulgare* L.) Under Drought Stress Conditions

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Abstract: The grain-filling period of barley grown in Mediterranean regions is affected by drought stress. Understanding the correlations between micronutrients, agronomic and phenological attributes under water deficit would facilitate the selection of mineral-rich progenies through breeding. In this study, 10 cultivated barley genotypes, originating from different countries, were screened for 28 grain qualitative and quantitative traits under drought stress at the end of the season (DSES) and irrigation conditions (IC) using RCBD design with three replications in 2022 growing season. Cluster analysis showed in both conditions, the placement of the traits in groups was almost similar, and grain yield was placed in the same group with thousand grain weight, leaf chlorophyll index, grain fat content, number of days to physiological maturity, grain width, number of days to flowering, number of days to anthesis, grain protein content, grain zinc content and number of spikes per square meter.

Keywords: Barley, BLUP, Cluster analysis, Drought stress, Grain nutrients.

Introduction: Barley has been recognized as the most drought tolerant species among the cereals (Forster *et al.*, 2004) and due to its high genetic diversity, it is well adapted to different environmental conditions. Today, extreme weather events have increased leading to the volatility of crop production in many regions, thus increasing the possibility of jeopardizing global food security. Cultivating crops with improved tolerance to a combination of abiotic stresses is an effective solution to deal with the adverse effects of climate change (Panizo-Casado *et al.*, 2022). Due to the decreased availability and increased demand for water, drought stress is becoming more significant. The demand for clean water globally is currently 70% based on agriculture, and this percentage is expected to rise rapidly in the coming years (Kopecká *et al.* 2023). In the drought stress conditions, the interference of the absorption and depletion mechanisms along with the decrease in transpiration causes a decrease in the absorption of grain nutrients (Baligar *et al.*, 2001). Therefore, the reduction of available water in rainfed conditions reduces the amount of iron and other nutrients available to the plant. Reducing the amount of iron that can be absorbed by the plant not only causes a decrease in yield, especially under drought stress, but also causes a decrease in the nutritional value of barley and ultimately malnutrition in livestock and humans (Cakmak, 2008).

Materials and methods: In this research, ten barley cultivars (including three Iranian cultivars, six European cultivars and one Iraqi cultivar) were studied based on a randomized complete block design with three replications in a research farm located in the city of Babil, Al-Kifil District (32° 31 N, 44° 21 E; 35 m a.s.l), located in the southeast of Iraq during 2022-2023 growing season. Barley cultivars were screened for 28 grain nutrients and agronomic traits under drought stress at the end of the season and irrigation conditions. Ten plants were randomly selected in each replication and their average considered as the value of the measured trait. To analyse the data, the combined analysis of variance was performed using META R software considering the effect of environment and cultivar as fixed effect). The best linear unbiased prediction (BLUP) of the data in each environment was used as the average of the data for cluster analysis of traits by Ward's method and dendrogram drawing.

Results and Discussion: The effect of the environment on all traits was significant. The cultivar effect was significant for all traits except grain width and peduncle diameter. The interaction effect of variety and environment also for all traits except grain filling speed, plant height, peduncle length, spike weight, spike length, seed width, number of grains per spike, flag leaf width, peduncle diameter, thousand grain weight, leaf chlorophyll index and spike density were significant. Drought decreased the plant's height, spike length, awn length, peduncle length, number of grains per spike, flag leaf width, peduncle diameter, thousand grain weight. Previous studies have shown that drought caused reduction in the number of spikes, plant height and grains per spikes of barley, resulting in a significant decrease in thousand grain weight and grain yield (Samarah *et al.* 2009). Cluster analysis showed in both conditions, the placement of the traits in groups was almost similar, and grain yield was placed in the same group with thousand grain weight, leaf chlorophyll index, grain fat content, number of days to physiological maturity, grain width, number of days to flowering, number of days to anthesis, grain protein content, grain zinc content and number of spikes per square meter (Fig 1).

Conclusion: These results can be utilized to identify preferred key characteristics for focused breeding efforts, thereby accelerating the development of high-yielding barley varieties across diverse environments.

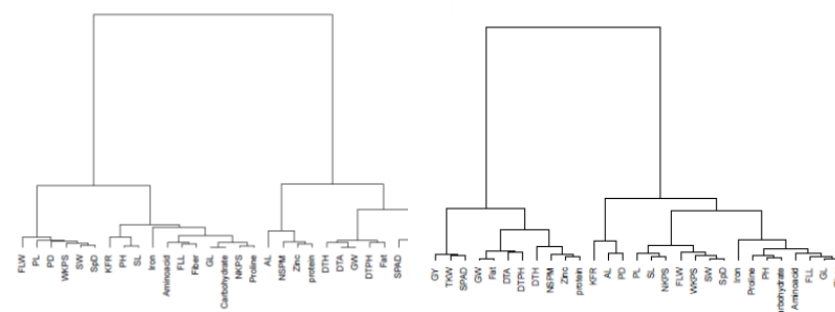


Figure 1. Ward clustering of measured traits based on Euclidean distance in drought stress (Left) and irrigation (Right) conditions

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