

ASSESSING THE PHOTOSYNTHETIC CAPACITY AND STAY-GREEN TRAIT OF BREAD WHEAT (*Triticum aestivum* L.) CULTIVARS AND LINES UNDER FIELD CONDITIONS

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Abstract. This study evaluated the chlorophyll dynamics and photosynthetic potential of 20 bread wheat cultivars and lines during the stem elongation and grain filling periods. Results showed a significant increase in chlorophyll content from an average of 42.5 SPAD in the stem elongation stage to 51.6 SPAD during grain filling. Among the evaluated genotypes (ranging from 39.8 to 54.4 SPAD), cultivars such as *Qorasuv*, *Zarbuloq*, *Gurt*, and lines GA №55/2024, KP-183/2017, AE №7/2020, and D-83/2024 demonstrated significantly higher photosynthetic activity compared to the standard cultivar *Zamin-1* (48.0 SPAD). By maintaining stable chlorophyll synthesis under heat and moisture deficit, these superior genotypes guarantee stable grain yield and high quality, serving as valuable donors for future breeding programs.

Keywords: bread wheat (*Triticum aestivum* L.), cultivar, breeding line, genotype, chlorophyll dynamics, photosynthetic potential, stem elongation period, grain filling period, abiotic stress.

Introduction

Globally, bread wheat is one of the most important cereal crops, and it is considered an economic crop utilized for food, seed, and industrial purposes. According to data from the FAO, global wheat grain production amounts to 766 million tons. Of this, 19% comes from China, 14% from India, a certain percentage from Russia and the USA, and 6% from France [1]. The continuous growth of the global population and the reduction of irrigated arable lands mean that the current rate of food production cannot keep pace with rapidly increasing demand. Increasing wheat yield in the coming decades is one of the most critical objectives of modern agriculture. Therefore, enhancing wheat yield through the development of improved wheat cultivars is one of the most urgent tasks today [2].

The primary objective of traditional wheat breeding is to develop cultivars capable of growing and developing across diverse agro-ecological conditions. In the context of global climate change, it is essential to conduct research focused on selecting genotypes that possess the necessary genes controlling key traits [3].

To significantly increase yield and profitability in agriculture, the main focus in wheat breeding must be on selecting new genetic sources that can adapt to the environmental conditions of each region, are resilient to the adverse effects of climate change, and produce high-quality, stable yields, and subsequently developing new cultivars based on them.

Materials and methods

The study was conducted in 2026 in the irrigated experimental fields of the central experimental farm at the Scientific Research Institute of Rainfed Agriculture.

As the research object, 20 bread wheat cultivars and lines were sown in the competitive testing nursery in the third decade of October in autumn. Sowing was performed using a specialized SKS-7-10 breeding seeder in 25 square meter plots with 4 replications using a randomized design, at a seeding rate of 4 million seeds per hectare. The cultivar Zamin-1, which is well-adapted to the climatic conditions of the region, was selected as the standard check cultivar. GenStat 3 software was utilized for the randomized arrangement of the samples in the experimental design.

Chlorophyll content measurements were carried out during the stem elongation and grain filling periods of the bread wheat using a specialized handheld device, the "Plant Nutrition Analyzer (PNA-4)". During the measurement process, careful attention was paid to ensuring that the leaves were not wet from dew or rain, remaining completely dry and clean. Measurements were primarily taken on the flag leaves of the plants, and care was taken to avoid placing the midrib (thick central vein) of the leaf into the measuring chamber of the device. For each experimental plot, measurements were taken 3 times from 5 different leaves, and their average values were recorded. All field measurements were conducted on clear, sunny, and windless days with low air humidity. [4].

For the mathematical analysis of the experimental results, ANOVA statistical analyses in OriginPro (2024) software were utilized.

Experimental Results and Discussion

Chlorophyll is the primary pigment of the photosynthesis process. Its content serves as an indicator of the plant's photosynthetic potential and stress condition. As a result of drought, salinity, heat, or nutrient deficiency, chlorophyll degradation occurs in the leaves, and yellowing (chlorosis) is observed [5].

During the breeding process, high chlorophyll content indicates the active functioning of the plant's photosynthetic apparatus, a high potential for tolerance to abiotic stresses (drought, heat), and the intensive synthesis of assimilates [6].

A sharp increase in chlorophyll content was observed in the 20 bread wheat cultivars and lines studied in the competitive testing nursery during the transition from the stem elongation period to the grain filling period. This change is directly explained by the bread wheat maximizing its photosynthesis process to form the spike and supply the necessary nutrients to the grain. During the stem elongation period, the chlorophyll content in the leaves of the bread wheat was found to range from 35.0 SPAD to 49.5 SPAD. In this period, high photosynthetic indicators were demonstrated by the cultivars Zarbuloq (49.5 SPAD), Qorasuv (48.6 SPAD), Muzbuloq (46.8 SPAD), and the standard check Zamin-1 (46.4 SPAD). During the grain filling period, which determines the yield and grain quality of wheat, the chlorophyll content was observed to range from 44.6 SPAD to 62.7 SPAD. During this period, a high level of photosynthetic apparatus activity was observed in the cultivars and lines GA №55/2024 (62.7 SPAD), Qorasuv (60.2 SPAD), Zarbuloq (59.0 SPAD), KP-183/2017 (58.4 SPAD), and AE №7/2020 (55.5 SPAD) (Figure 1).

When the dynamics of chlorophyll content in the leaves of bread wheat cultivars and lines at different ontogenetic stages were analyzed using a T-test, the average chlorophyll content of the genotypes during the stem elongation period was 42.5 SPAD. By the grain filling period, an increase in this physiological indicator was recorded, with the average value reaching 51.6 SPAD. This difference between the two periods scientifically confirms the intensive activation of the photosynthetic apparatus in bread wheat during the grain filling phase. From a physiological point

of view, the high chlorophyll content specifically during the grain filling period ensures a stable flow of nutrients and plastic substances from the leaves to the spike. This indicates that the studied genotypes possess the potential to produce high yields even under extreme climatic conditions (Figure 2).

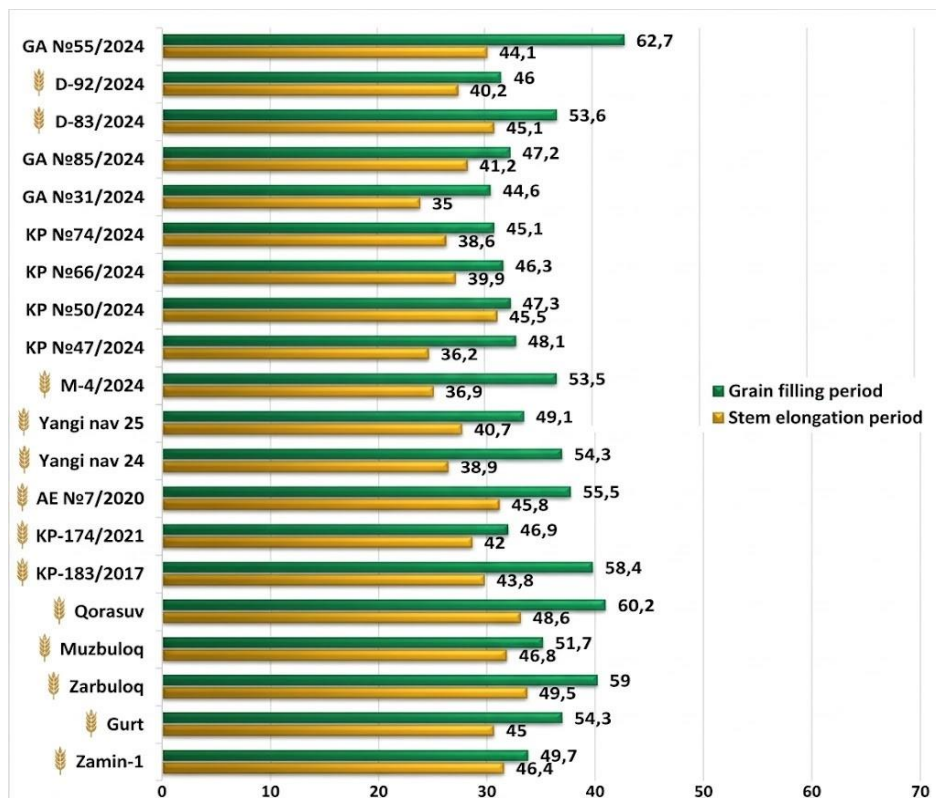


Figure 1. Chlorophyll content of bread wheat cultivars and lines during stem elongation and grain filling periods, SPAD.

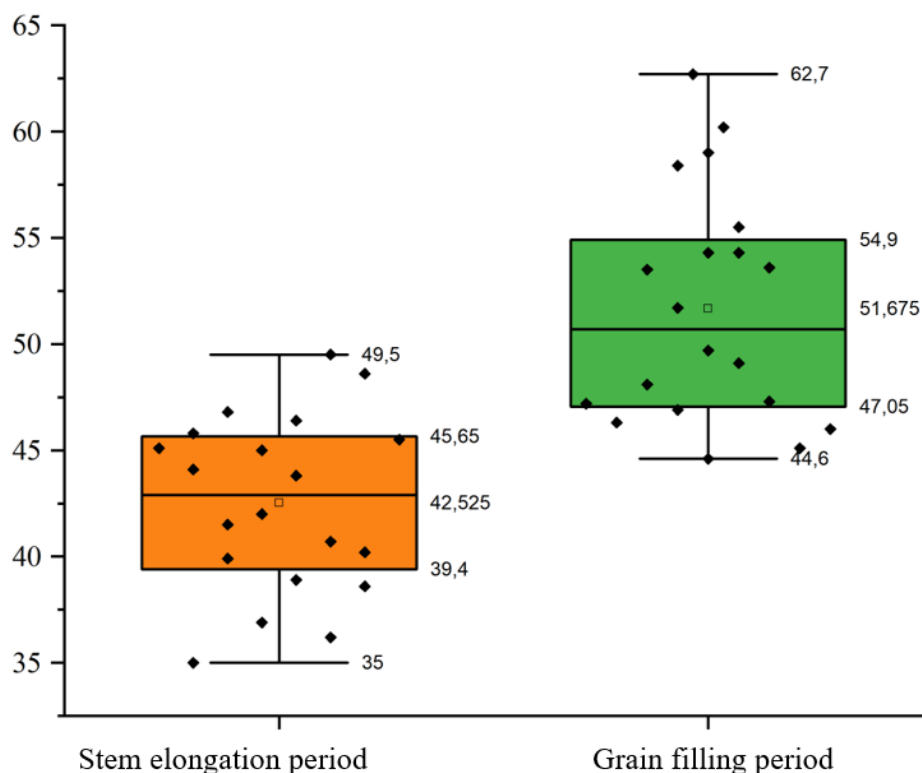


Figure 2. Chlorophyll dynamics of bread wheat cultivars and lines.

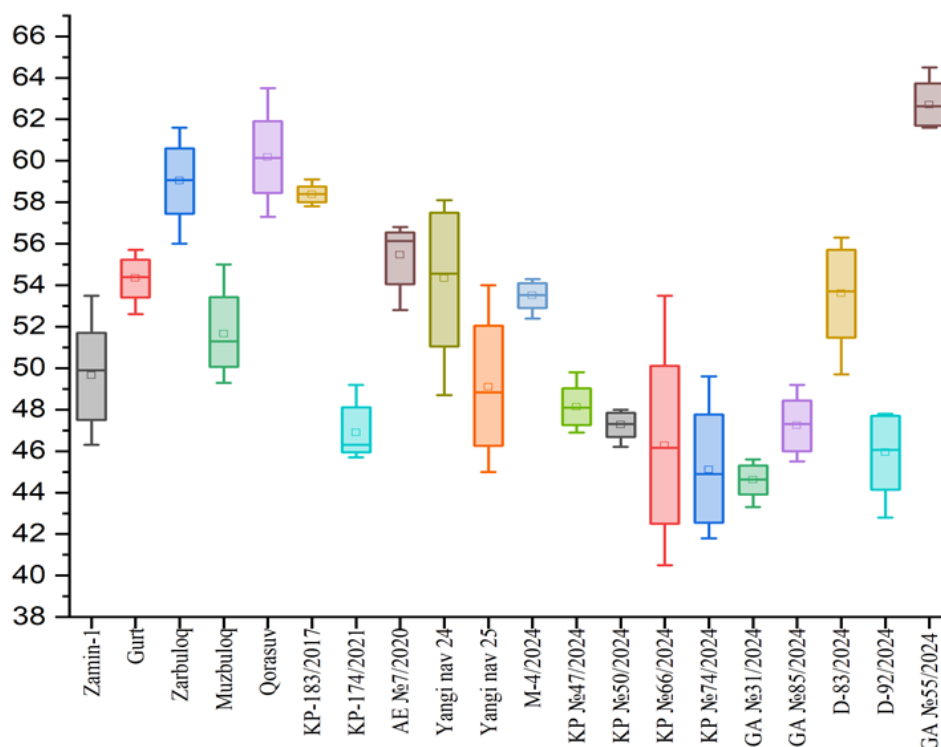


Figure 3. Average chlorophyll content of bread wheat cultivars and lines, SPAD.

When the average chlorophyll content in the leaves of 20 bread wheat cultivars and lines studied in the competitive testing nursery was analyzed, it clearly demonstrated the genetic diversity in the photosynthetic potential of the plants. According to the analyses, the average chlorophyll content of the cultivars and lines was found to range from 39.8 SPAD to 54.4 SPAD. In the Zamin-1 cultivar, which was taken as the standard check, the average chlorophyll content was observed to be 48.0 SPAD. It was determined that the indicators of the cultivars and lines Qorasuv (54.4 SPAD), Zarbuloq (54.3 SPAD), Gurt (49.7 SPAD), GA №55/2024 (53.4 SPAD), KP-183/2017 (51.1 SPAD), AE №7/2020 (50.6 SPAD), and D-83/2024 (49.4 SPAD) were higher compared to the check cultivar. In these genotypes, the activity of chlorophyll synthesis remains stable even under the influence of abiotic stress factors, including heat and moisture deficiency, which as a result guarantees the formation of grain with high technological quality and stability of yield.

Conclusions

An increase in chlorophyll content from an average of 42.5 SPAD to 51.6 SPAD was observed in the 20 bread wheat cultivars and lines studied in the competitive testing nursery during the transition from the stem elongation period to the grain filling phase. The average indicator across all genotypes ranged from 39.8 to 54.4 SPAD, demonstrating genetic diversity in the photosynthetic potential of the plants. Compared to the standard check cultivar Zamin-1 (48.0 SPAD), cultivars such as Qorasuv, Zarbuloq, and Gurt, as well as lines GA №55/2024, KP-183/2017, AE №7/2020, and D-83/2024, recorded higher results. As a result of maintaining an active photosynthesis process under conditions of heat and water deficit, these cultivars and lines guarantee the formation of grain with high technological quality and stable yield.

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