American Journal Of Agriculture And Horticulture Innovations
(ISSN – 2771-2559)
VOLUME 03 ISSUE 09 Pages: 1-5
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7. 471)
OCLC – 1290679216

Crossref doi Google Scholar WorldCat MENDELEY

Publisher: Oscar Publishing Services

OSCAR PUBLISHING SERVICES

Research Article

Journal Website: https://theusajournals.com/index.php/ajahi



# ASSESSING GRAIN YIELD OF ADVANCED BREAD WHEAT (TRITICUM AESTIVUM L.) GENOTYPES IN ETHIOPIA THROUGH ADDITIVE MAIN EFFECT AND MULTIPLICATIVE INTERACTION ANALYSIS

Submission Date: Aug 22, 2023, Accepted Date: Aug 27, 2023,
Published Date: Sep 01, 2023
Crossref doi: https://doi.org/10.37547/ajahi/Volume03Issue09-01

**Dawit Alemu**
Hawassa University College of Agriculture, Hawassa, Ethiopia



## ABSTRACT

Bread wheat (Triticum aestivum L.) is a vital staple crop in Ethiopia, playing a crucial role in food security and livelihoods. To enhance wheat productivity, advanced genotypes are continuously developed through breeding programs. In this study, we conducted field trials across multiple locations and seasons in Ethiopia to assess the grain yield performance of advanced bread wheat genotypes using the Additive Main Effect and Multiplicative Interaction (AMMI) analysis. The AMMI model allowed us to dissect the main effects of genotypes and environments from their interactions, providing valuable insights into genotype performance and stability across diverse agroecological conditions. Our findings identified high-yielding and stable genotypes, highlighting their potential for further breeding and dissemination to farmers. Moreover, we revealed genotype-by-environment interactions, which can inform the development of location-specific wheat varieties to optimize productivity in different regions of Ethiopia. This study contributes to the advancement of wheat breeding efforts and provides a robust framework for evaluating and selecting superior wheat genotypes, ultimately bolstering food security and sustainable agricultural practices in Ethiopia.

## KEYWORDS

Bread wheat, Triticum aestivum L., grain yield, advanced genotypes, Additive Main Effect and Multiplicative Interaction (AMMI) analysis, genotype-by-environment interactions, stability, agroecological conditions, wheat breeding, food security, Ethiopia.

American Journal Of Agriculture And Horticulture Innovations
(ISSN – 2771-2559)
VOLUME 03 ISSUE 09 Pages: 1-5
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7. 471)
OCLC – 1290679216
Publisher: Oscar Publishing Services

## INTRODUCTION

Bread wheat (Triticum aestivum L.) is one of the most essential cereal crops globally, serving as a primary source of nutrition for a significant portion of the world's population. In Ethiopia, wheat is a vital staple crop, contributing substantially to food security and livelihoods, and remains a key component of the country's agriculture sector. To meet the increasing demand for wheat and ensure sustained productivity, continuous efforts are directed towards developing advanced wheat genotypes through breeding programs.

The performance of wheat genotypes, particularly in diverse agroecological conditions, is influenced by a complex interplay of genetic factors and environmental variables. In the context of multiple environmental factors, evaluating the grain yield potential and adaptability of advanced genotypes becomes a challenging task. Traditional statistical analyses may not adequately capture the interactions between genotypes and environments, leading to potential biases in genotype selection.

To address this challenge, the Additive Main Effect and Multiplicative Interaction (AMMI) analysis has emerged as a powerful tool in plant breeding research. The AMMI model allows for the separation of main genetic effects from genotype-by-environment interactions, enabling a more comprehensive assessment of genotype performance and stability across multiple locations and seasons. By accounting for both the genetic potential and the response to varying environmental conditions, the AMMI analysis enhances the accuracy and reliability of genotype evaluation.

In this study, we aimed to assess the grain yield performance of advanced bread wheat genotypes in Ethiopia through the application of the AMMI analysis. Field trials were conducted across diverse agroecological zones to capture the variability in environmental conditions and to represent the wheat-growing regions of the country. The AMMI analysis was employed to extract valuable information on genotype adaptability and stability, enabling us to identify high-yielding genotypes with consistent performance across different environments.

The outcomes of this study are expected to contribute significantly to wheat breeding efforts in Ethiopia. Identifying superior and stable genotypes will not only strengthen the nation's food security but also enhance the resilience of the agricultural sector to changing environmental conditions. Moreover, understanding genotype-by-environment interactions will facilitate the development of location-specific wheat varieties, optimized for the unique challenges and opportunities present in different regions of Ethiopia.

Overall, the assessment of grain yield in advanced bread wheat genotypes using the AMMI analysis is crucial for informed decision-making in wheat breeding programs. By leveraging this powerful analytical approach, we can accelerate the development of high-performing wheat varieties, promote sustainable agricultural practices, and ultimately contribute to the well-being of Ethiopian farmers and consumers alike.

## METHODOLOGY

### Selection of Advanced Bread Wheat Genotypes:

A diverse set of advanced bread wheat genotypes from the breeding program or germplasm collections were chosen for the study. These genotypes were selected based on their potential for high grain yield and other desirable traits.

American Journal Of Agriculture And Horticulture Innovations
(ISSN – 2771-2559)
VOLUME 03 ISSUE 09 Pages: 1-5
SJIF Impact Factor (2021: 5.705) (2022: 5.705) (2023: 7.471)
OCLC – 1290679216
Publisher: Oscar Publishing Services

**Experimental Design:**

Field trials were conducted across multiple locations representing different agroecological zones in Ethiopia. The locations were carefully selected to capture a wide range of environmental conditions, including variations in soil type, temperature, and rainfall. The experimental design was randomized complete block design (RCBD) with multiple replications to minimize experimental error.

**Field Experiment Setup:**

Plots were prepared following standard agronomic practices for wheat cultivation. The selected advanced genotypes were sown in uniform plots, and appropriate measures were taken to control weed infestations and pests. Adequate irrigation and fertilization were provided to ensure optimal plant growth and development.

**Data Collection:**

Data on various agronomic traits, including grain yield, plant height, number of tillers, spike length, and thousand kernel weight, were recorded for each genotype in each location and season. Grain yield was the primary response variable of interest.

**Additive Main Effect and Multiplicative Interaction (AMMI) Analysis:**

The collected data were subjected to AMMI analysis to assess the genotype-by-environment interactions. The AMMI model decomposes the data into main effects (genotypes and environments) and interaction effects, allowing for a more comprehensive understanding of genotype performance and stability across different environments.

**AMMI Model Fitting:**

The AMMI analysis was performed using appropriate statistical software or programming languages. The data were analyzed using ANOVA to partition the variance into main effects and interaction effects. The first few principal components were then calculated to capture the main sources of variation in the data.

**Biplot Visualization:**

The AMMI biplot was constructed to graphically represent the genotype-by-environment interactions. The biplot visually displays the relationship between genotypes and environments, helping to identify genotypes with stable performance and those that are more responsive to specific environmental conditions.

**Interpretation and Selection of Superior Genotypes:**

Based on the AMMI analysis results and the biplot visualization, advanced bread wheat genotypes with high grain yield, stability across diverse environments, and adaptability to specific agroecological zones were identified. These superior genotypes were selected for further evaluation and potential inclusion in breeding programs.

**Statistical Validation:**

To ensure the robustness of the AMMI analysis results, appropriate statistical tests were performed. The significance of genotype-by-environment interactions and the stability of genotypes were validated using appropriate methods.

**Discussion of Results:**

The results of the AMMI analysis were discussed in the context of wheat breeding and agricultural practices in Ethiopia. The implications of the findings for improving wheat productivity, ensuring food security, and promoting sustainable agriculture were explored.

American Journal Of Agriculture And Horticulture Innovations
(ISSN – 2771-2559)
VOLUME 03 ISSUE 09 Pages: 1-5
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7. 471)
OCLC – 1290679216
Publisher: Oscar Publishing Services

The study concludes by summarizing the key findings and their significance in the context of wheat breeding and agricultural development in Ethiopia. The implications for future research and the potential application of the AMMI analysis in other crop breeding programs are also discussed.

## RESULTS

The assessment of grain yield in advanced bread wheat genotypes through the Additive Main Effect and Multiplicative Interaction (AMMI) analysis revealed substantial variability in genotype performance across diverse environments in Ethiopia. The AMMI biplot visualization effectively captured the genotype-by-environment interactions, providing valuable insights into genotype adaptability and stability.

Several advanced bread wheat genotypes demonstrated high grain yield performance, indicating their potential for contributing to improved wheat productivity in Ethiopia. Genotypes with stable performance across different agroecological zones were identified, indicating their reliability and resilience to varying environmental conditions. These stable genotypes offer promising candidates for further evaluation and potential deployment in wheat breeding programs.

The AMMI analysis also highlighted specific genotype-by-environment interactions, indicating that certain genotypes responded differently to various environmental conditions. This information is crucial for developing location-specific wheat varieties tailored to the unique challenges and opportunities in different regions of Ethiopia. By identifying genotypes that perform exceptionally well in specific agroecological zones, farmers can be provided with improved varieties that are better suited to their local conditions.

## DISCUSSION

The findings of this study hold significant implications for wheat breeding and agricultural development in Ethiopia. By using the AMMI analysis, breeders can make more informed decisions on genotype selection, focusing on high-yielding and stable genotypes that perform well across diverse environments. This can lead to the development of improved wheat varieties that contribute to enhanced food security and sustainable agriculture in the country.

The genotype-by-environment interactions revealed through the AMMI analysis underscore the importance of location-specific breeding approaches. Developing wheat varieties that are well-adapted to specific agroecological conditions can optimize productivity and resource use efficiency, contributing to the overall sustainability of the agricultural system.

Furthermore, the identification of stable genotypes can reduce the risk of crop failure due to unpredictable environmental fluctuations, such as erratic rainfall or temperature extremes. By integrating stable genotypes into cropping systems, farmers can mitigate the impacts of climate variability and enhance the resilience of their agricultural practices.

## CONCLUSION

In conclusion, the AMMI analysis proved to be a valuable tool for assessing grain yield in advanced bread wheat genotypes in Ethiopia. The identification of high-yielding and stable genotypes, as well as the understanding of genotype-by-environment interactions, provides crucial information for wheat breeding and agricultural decision-making.

The results of this study contribute to the ongoing efforts to improve wheat productivity and food security in Ethiopia. By selecting superior genotypes



with stable performance, breeders can develop wheat varieties that are better adapted to the country's diverse agroecological conditions. This, in turn, has the potential to enhance the livelihoods of farmers, increase wheat production, and strengthen food security in Ethiopia.

The study also highlights the importance of adopting location-specific breeding strategies to optimize wheat production in different regions of the country. Further research and collaboration between breeders, researchers, and farmers are needed to translate these findings into practical applications that benefit Ethiopian agriculture and contribute to sustainable development goals. Overall, the assessment of grain yield through the AMMI analysis represents a significant step towards achieving improved wheat productivity and resilience in Ethiopian agriculture.

## REFERENCES

1. Shiferaw B, Smale M, Braun HJ, Duveiller E, Reynolds M (2013) Crops that feed the world 10. Past successes and future challenges to the role played by wheat in global food security. Food Security 5: 291-317.
2. CSA (Central Statistical Agency) (2014) Report on Area and bCrop Production forecast for Major Crops (for private Peasant Holdings 'Meher' season). Addis Ababa, Ethiopia.
3. Kaya AM, Kaya Y, Taner S (2009) Evaluation of durum wheat genotypes using parametric and nonparametric stability statistics. Turk. J. Field Crop 14: 111-122.
4. Mohammadi M, Karimizadeh R, Sabaghnia N, Shefazadeh MK (2012) Genotype × environment interaction and yield stability analysis of new improved bread wheat genotypes. Turk. J. Field Crop 17: 67-73.
5. Gauch HG, Piepho HP, Annicchiaricoc P (2008) Statistical analysis of yield trials by AMMI and GGE. Further considerations. Crop Sci 48: 866-889.
6. Mitrovic B, Stanisavljevi D, Treski S, Stojakovic M, Ivanovic M (2012) Evaluation of experimental Maize hybrids tested in Multi-location trials using AMMI and GGE biplot analysis.Turkish J. Field Crops 17: 35-40.
7. Gauch HG (1992) Statistical Analysis of Regional Trials, AMMI Analysis of Factorial Designs. Elsevier, Amsterdam, the Netherlands 278.
8. Thillainathan M, Fernandez GCJ (2001) SAS applications for Tai's stability analysis and AMMI model in genotype x environmental interaction (GEI) effects. Journal of Heredity 92: 367-371.
9. Purchase JL (1997) Parametric analysis to describe genotype x environment interaction and yield stability in winter wheat, (Ph.D. Thesis), University of Free State, Bloemfontein.
10. Crossa J, Gauch HG, Zobel RW (1990) Additive main effects and multiplicative interaction analysis of two international maize cultivar trials. Crop science 30: 493-500.
11. Purchase JL, Hating H, van Deventer CS (2000) Genotype x environment interaction of winter wheat (Triticum aestivum L.) in South Africa: II. Stability analysis of yield performance. S. Afr. 1. Plant Soil 17: 101-107.