



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(6): 1244-1246
Received: 24-03-2026
Accepted: 28-04-2026

Mahendra Kumar Yadav Kunvar
Bhagwant University Rajasthan
Sikar Road, Ajmer, Rajasthan,
India

Gyanendra Kumar
Bhagwant University Rajasthan
Sikar Road, Ajmer, Rajasthan,
India

VM Shukre
Bhagwant University Rajasthan
Sikar Road, Ajmer, Rajasthan,
India

Phool Chand
Technical Assistant Department of
Agricultural, Uttar Pradesh, India

RP Singh
Bhagwant University Rajasthan
Sikar Road, Ajmer, Rajasthan,
India

Corresponding Author:
Mahendra Kumar Yadav Kunvar
Bhagwant University Rajasthan
Sikar Road, Ajmer, Rajasthan,
India

Genetics of yield and yield contributing traits in quality protein maize (*Zea mays* L.)

Mahendra Kumar Yadav Kunvar, Gyanendra Kumar, VM Shukre, Phool Chand and RP Singh

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i6p.5857>

Abstract

Quality Protein Maize (QPM) is an important biofortified crop developed to improve protein quality and nutritional security. The present investigation was undertaken to study the genetic architecture, combining ability, and nature of gene action governing yield and yield contributing traits in QPM. Eight parental inbred lines were crossed in an 8×8 diallel mating design including reciprocals and evaluated over three growing seasons, namely rabi-2023, rabi-2024, and kharif-2024. Analysis of variance revealed significant differences among genotypes, seasons, and genotype $\times$ season interactions for all the studied traits, indicating the existence of substantial variability. Significant variation among parents, hybrids, and reciprocals suggested the importance of additive and non-additive gene actions. Graphical analysis indicated predominance of over-dominance for most of the traits including plant height, ear height, kernels per row, 100-kernel weight, and grain yield per plant. The estimates of dominance components were generally higher than additive components for most yield traits, revealing the importance of non-additive gene effects. The results suggested that heterosis breeding could be effectively utilized for the improvement of grain yield and associated traits in QPM. The identified superior hybrids and parental lines can be utilized in future breeding programmes aimed at developing high-yielding and nutritionally superior maize hybrids.

Keywords: Quality Protein Maize (QPM), Diallel analysis, combining ability, gene action

Introduction

Maize (*Zea mays* L.) is one of the world's most important cereal crops and serves as a staple food, feed, and industrial raw material. It ranks after rice and wheat in global importance and contributes significantly to calorie and protein intake in developing countries. However, conventional maize protein is deficient in essential amino acids such as lysine and tryptophan, which limits its nutritional value. Quality Protein Maize (QPM) was developed to overcome this limitation through incorporation of the opaque-2 gene and modifier genes that improve protein quality. Improvement of grain yield in QPM is a major breeding objective because yield is a complex quantitative trait influenced by several genetic and environmental factors. Knowledge of gene action, combining ability, and heterosis is essential for designing efficient breeding strategies. Diallel analysis provides valuable information regarding additive and non-additive gene effects through estimates of general combining ability (GCA) and specific combining ability (SCA). The present investigation was therefore undertaken with the objective to study the genetic control of yield and yield contributing traits in QPM under different environmental conditions.

Materials and Methods

The experimental material comprised eight QPM inbred lines: HUZQPM 10, HUZQPM 9, CML 163, CML 169, CML 451(P2), HKI 193-1, VQL 1, and VQL 16. These parents were crossed in all possible combinations including reciprocals following an 8×8 diallel mating design. The experimental material consisting of parents and hybrids was evaluated during rabi-2023, rabi-2024, and kharif-2024 seasons. Observations were recorded for days to 50% tasseling, days to 50% silking, plant height, ear height, ear length, ear diameter, kernel rows per ear, kernels per row, 100-kernel weight, and grain yield per plant. Analysis of variance (ANOVA) was performed to determine the significance of genotypic

differences. Graphical analysis following Hayman's approach was carried out using Vr-Wr regression to estimate the nature of gene action. Genetic components including additive variance (D), dominance variance (H1 and H2), net dominance effect (F), and environmental component (E) were estimated.

Results and Discussion

Analysis of variance over seasons revealed highly significant differences among genotypes, seasons, and genotype $\times$ season interactions for all traits studied, indicating considerable variability among experimental materials. Significant variation among parents and hybrids suggested the presence of diverse genetic constitution among parental lines.

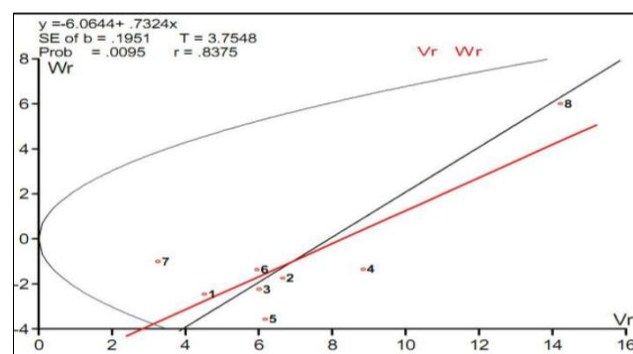


Fig 1: Vr-Wr graph for 100-kernel weight in Rabi – 2024

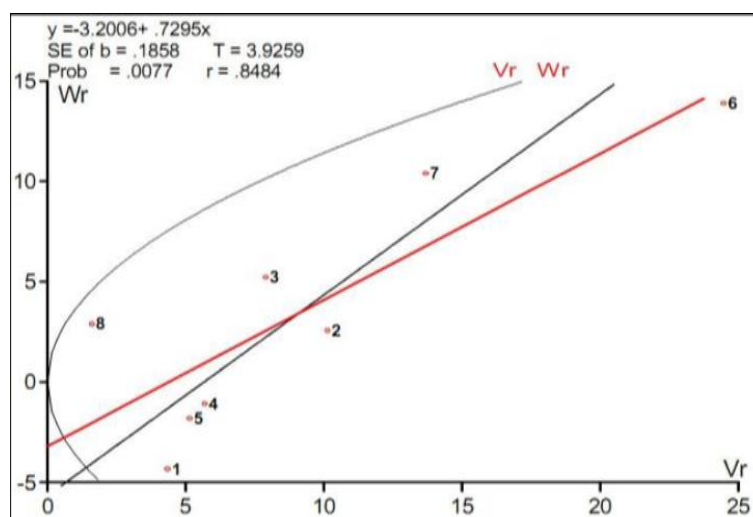


Fig. 2: Vr-Wr graph for 100-kernel weight in Kharif – 2024

The ANOVA for the diallel set indicated significant mean squares for treatments, parents, hybrids, and parent versus hybrids for all yield traits. The significant parent versus hybrid contrast indicated the importance of heterosis in QPM improvement.

Graphical analysis revealed different degrees of dominance for various traits. Days to 50% tasseling and silking exhibited partial dominance during rabi seasons and over-dominance during kharif season. Plant height and ear height consistently showed over-

dominance across seasons. Ear length, kernel rows per ear, kernels per row, 100-kernel weight, and grain yield per plant also exhibited over-dominance in most environments.

The regression analysis indicated limited genotype $\times$ environment interaction for several traits, whereas some traits exhibited epistatic interactions due to significant deviation of regression coefficient from unity.

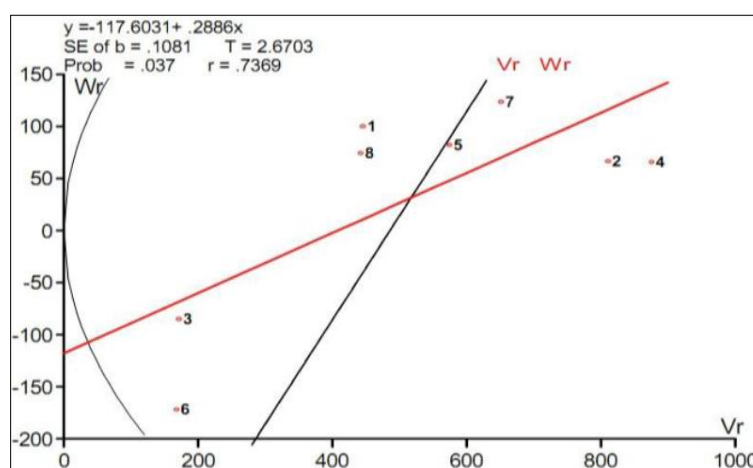


Fig. 3: Vr-Wr graph for grain yield per plant in Rabi – 2024

Estimates of genetic components showed that dominance variance components (H1 and H2) were generally greater than additive variance (D) for most yield traits. This confirmed the predominance of non-additive gene action. Significant positive

dominance effects for grain yield per plant and related traits indicated the potential utility of hybrid breeding.

The results are in agreement with earlier findings reported in maize by Haq *et al.* (2010)^[6], Wattoo *et al.* (2009)^[26], Zare *et al.*

(2011)^[27], and Kumar *et al.* (2012)^[12], who also reported over-dominance for grain yield and yield attributes.

Conclusion

The present study demonstrated substantial genetic variability among QPM inbred lines and hybrids. Over-dominance and non-additive gene action predominated for most yield traits, especially grain yield per plant. Therefore, heterosis breeding and hybrid development appear to be the most effective approaches for improving yield in QPM. The identified superior parental lines and hybrids can be further exploited in breeding programmes for development of high-yielding QPM hybrids.

References

1. Amiruzzaman M, Islam MA, Hassan L, Rohman MM, Miah MRU. Combining ability and heterosis for yield and component characters in maize. *Academic Journal of Plant Sciences*. 2011;4(2):84-90.
2. Balc A, Turgut I. Diallel analysis of maize inbred lines for grain yield and some agronomic traits. *Asian Journal of Plant Sciences*. 2006;5(1):1-4.
3. Bonaparte EENA. Diallel cross analysis of ear characters in maize. *Crop Science*. 1977;17:573-576.
4. Dawod KM, El-Badawy MEM, El-Hosary AA. Genetic analysis and heterosis in yellow maize. *Journal of Agricultural Science*. 2012;4(9):93-102.
5. Fan XM, Zhang YM, Yao WH, *et al.* Combining ability and heterotic grouping of tropical maize inbred lines. *Crop Science*. 2014;54:123-134.
6. Haq MA, Ajmal SU, Munir M, Gulfaraz M. Gene action studies of yield and yield-related traits in maize. *Pakistan Journal of Botany*. 2010;42(1):219-228.
7. Hossain F, Prasanna BM, Pixley K, *et al.* Genetic analysis of kernel modification in quality protein maize. *Plant Breeding*. 2008;127:17-22.
8. Hussain N, Ahmad N, Ghafoor A, Mahmood T. Genetic variability and combining ability studies in maize. *Pakistan Journal of Agricultural Sciences*. 2009;46(3):183-188.
9. Hussain S, Mubeen K, Ahmad A, Sohail M. Estimation of genetic parameters and gene action in maize. *International Journal of Agriculture and Biology*. 2014;16:1089-1094.
10. Jones DF. Gene action and heterosis in maize. *Genetics*. 1952;37:455-469.
11. Khodarahmpour Z. Diallel analysis for genetic evaluation of yield and yield components in maize. *African Journal of Biotechnology*. 2011;10(52):10661-10667.
12. Kumar GP, Reddy VN, Kumar SS. Combining ability studies in maize using diallel analysis. *Madras Agricultural Journal*. 2012;99(10-12):720-723.
13. Lopes MA, Pollak LM, Scott GE. Combining ability for grain yield and resistance traits in tropical maize. *Maydica*. 1995;40:113-120.
14. Lou XY, Lu YL, Shah T, *et al.* Genetic diversity and variation for protein content and kernel density in maize. *Crop Science*. 2005;45:930-935.
15. Mohamed AH. Inheritance of flowering and maturity traits in maize. *Agronomy Journal*. 1959;51:191-194.
16. Perez-Velasquez JC, Ceballos H, Pandey S. Combining ability and heterosis in tropical maize hybrids. *Maydica*. 1995;40:131-137.
17. Rajendran A, Muthiah AR, Joel AJ, Shanmugasundaram P. Combining ability studies for grain yield and quality traits in quality protein maize. *Electronic Journal of Plant Breeding*. 2014;5(2):264-272.
18. Ravikant, Sharma RK, Kumar A. Generation mean analysis for grain yield in maize. *Indian Journal of Genetics and Plant Breeding*. 2006;66(4):307-309.
19. Rood SB, Major DJ. Diallel analysis for flowering traits in maize. *Crop Science*. 1981;21:173-178.
20. Saeed MT, Saleem M. Genetic analysis of yield traits in maize. *Pakistan Journal of Biological Sciences*. 2000;3(4):684-685.
21. Sarac V, Nedelea G. Genetic inheritance of ear traits in maize. *Romanian Agricultural Research*. 2013;30:111-117.
22. Sofi PA. Gene action studies in maize using diallel analysis. *Crop Research*. 2007;33(1-3):118-122.
23. Sprague GF, Tatum LA. General versus specific combining ability in single crosses of corn. *Journal of the American Society of Agronomy*. 1942;34:923-932.
24. Srdic J, Pajic Z, Drinic G. Genetic analysis of yield components in maize. *Genetika*. 2007;39(1):119-128.
25. Turgut I, Balc A, Duman A. Gene action for grain yield and agronomic traits in maize hybrids. *Turkish Journal of Agriculture and Forestry*. 1995;19:151-156.
26. Wattoo FM, Saleem M, Ahsan M, Sajjad M. Gene action studies for yield-related traits in maize. *Pakistan Journal of Botany*. 2009;41(6):2957-2964.
27. Zare M, Choukan R, Heravan EM, *et al.* Gene action for some agronomic traits in maize under diallel crossing system. *African Journal of Agricultural Research*. 2011;6(17):4054-4060.
28. Machida L, Derera J, Tongoona P, MacRobert J. Combining ability and environmental interaction in quality protein maize hybrids. *Euphytica*. 2010;174:331-340.
29. Ngaboyisonga C, Njoroge K, Kirubi D, Githiri S. Genetic variation in kernel quality traits of quality protein maize. *African Journal of Biotechnology*. 2012;11(19):4408-4415.
30. Tuberosa R, Salvi S, Sanguineti MC. Genomics and breeding of quality protein maize. *Plant Breeding Reviews*. 2014;38:1-44.