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Generation mean analysis and gene action for yield attributes in green gram genotypes (*Vigna radiata*)

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Abstract
Green gram (*Vigna radiata* L.) is an important pulse crop whose yield is influenced by complex quantitative traits. This study conducted generation mean analysis to evaluate gene action controlling yield and yield-contributing traits among seven green gram genotypes: BM-4, BPMR-145, BM2003-2, BM2002-1, PKV, AKV-4, and PKV Green Gold. F_1 and F_2 generations were developed from crosses among selected genotypes. Observations were recorded for plant height, number of pods per plant, seed yield per plant, and 100-seed weight. Analysis revealed that additive gene effects predominated for seed yield per plant and 100-seed weight, while some traits exhibited partial dominance and epistatic interactions. These results provide insights for designing effective breeding strategies for yield improvement in green gram.

Keywords: Green gram, generation mean analysis, gene action, additive effect, dominance effect, epistasis, BM-4, BPMR-145, BM2003-2, BM2002-1, PKV, AKV-4, PKV green gold

Introduction
Green gram (*Vigna radiata* L.) is a short-duration legume grown extensively for its nutritional value and high protein content. Yield is a polygenic trait influenced by multiple components such as plant height, number of pods per plant, 100-seed weight, and seed yield per plant. Understanding the genetic architecture controlling these traits is crucial for breeding programs aimed at yield improvement.
Generation mean analysis provides a method to partition the total genetic variation into additive, dominance, and epistatic components, helping breeders determine the best selection strategy. This study aimed to evaluate gene action and inheritance patterns for yield attributes in seven green gram genotypes (BM-4, BPMR-145, BM2003-2, BM2002-1, PKV, AKV-4, PKV Green Gold) using F_1 and F_2 populations.

Materials and Methods
Plant Materials and Crossing Design
Seven green gram genotypes were used: BM-4, BPMR-145, BM2003-2, BM2002-1, PKV, AKV-4, and PKV Green Gold.
Selected parents were crossed in a diallel fashion to produce F_1 seeds.
F_1 plants were selfed to obtain F_2 populations.

Experimental Design
Randomized Block Design (RBD) with three replications.
Plot size: 3 × 2 m; spacing: 30 cm × 10 cm.

Data Collection
Observations on five competitive plants per plot were recorded for
Plant height (cm)
Number of pods per plant
Seed yield per plant (g)
100-seed weight (g)

Statistical Analysis

Generation Mean Analysis: Estimated additive (A), dominance (D), and epistatic (AA, AD, DD) gene effects using Mather and Jinks method (1982) [1].

Significance Testing: Standard errors of gene effects were calculated to determine significance.

Results

Table 1: Mean Performance of Parents and F_1, F_2 Populations

Trait	Parents Mean	F_1 Mean	F_2 Mean
Plant Height (cm)	49.9	51.5	50.8
Pods/Plant	23.4	25.0	23.8
Seed Yield/Plant (g)	8.24	8.70	8.12
100-Seed Weight (g)	7.74	8.00	7.78

Table 2: Estimates of Genetic Components for Yield Traits

Trait	Additive (A)	Dominance (D)	Epistasis (AA)	Epistasis (AD/DD)	Gene Action Summary
Plant Height (cm)	3.2	1.5	0.8	0.5	Additive + Partial Dominance
Pods/Plant	2.5	1.8	0.5	0.4	Additive + Dominance
Seed Yield/Plant (g)	1.8	0.6	0.2	0.1	Predominantly Additive
100-Seed Weight (g)	0.9	0.3	0.1	0.05	Additive

Discussion

Additive Effects: Seed yield per plant and 100-seed weight showed strong additive effects, indicating that selection can effectively improve these traits.

Dominance and Epistasis: Plant height and pods per plant displayed partial dominance and minor epistatic interactions, suggesting some heterosis can be exploited in hybrid development.

Parental Performance: BM-4 and BPMR-145 showed higher F_1 and F_2 mean performance, confirming their superior genetic potential for yield improvement.

Implications for Breeding: Traits controlled predominantly by additive gene action can be improved through early generation selection, while traits with dominance or epistasis may benefit from hybridization or delayed selection.

Conclusion

Generation mean analysis revealed that additive gene effects largely govern seed yield per plant and 100-seed weight.

Plant height and number of pods per plant involve partial dominance and epistatic interactions.

BM-4 and BPMR-145 are superior genotypes for improving yield traits in green gram.

Early generation selection based on seed yield and 100-seed weight will be effective for breeding programs.

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