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# GENETIC ANALYSIS OF THREE MUNGBEAN CROSSES INVOLVING PARENTS WITH DIFFERENT PHOTOTHERMAL RESPONSE FOR GRAIN YIELD AND COMPONENT TRAITS

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## ABSTRACT

**The performance of hybrid generations of the cross Amp 45 x T 44 having both the photothermal nonresponsive parents was better than the cross Amp 20 x L 24-2 involving responsive parents for pods/plant, branches/plant, 100-grain weight and grain yield/plant. However, the performance of the cross Amp 45 x L 24-2 involving nonresponsive and responsive parents was the best. The analysis revealed that pods/plant, days to flower, grain yield/plant and plant height was governed predominantly by additive genes and duplicate digenic interaction in crosses involving parents of identical photothermal responsiveness while in the cross Amp 45 x L 24-2 all types of gene effect governed these traits. Transgressive segregates appeared in this cross. Intermating of transgressive segregates may lead to accumulation of favourable genes in the homozygous progenies.**

**Key words:** Epistasis, mungbean, dominance, additive, photothermal response.

Mungbean (*Vigna radiata* (L.) Wilczek) is grown in kharif as well as in spring/summer seasons in India. The growth, development and duration of this crop under different agroclimatic conditions and cropping systems depends upon response of genotypes to the abiotic factors especially photoperiod and temperature. Therefore, understanding about the inheritance of photothermo-responsiveness and its impact on different quantitative traits is essential. Keeping the above fact in view, the present investigation was conducted to study the inheritance pattern of grain yield and its component traits in three mungbean crosses involving photothermal responsive and nonresponsive parents.

## MATERIALS AND METHODS

The study was based on the analysis of parents, $F_1$, $F_2$ and backcross generations of three mungbean crosses, viz. Amp 45 x T 44, Amp 45 x L 24-2 and Amp 20 x L 24-2. The parental

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genotypes involved in crosses were either photothermo-insensitive (Amp 45 and T 44) or photothermosensitive (Amp 20 and L 24-2) type [1]. The materials were sown in 3 m long plots with spacing of 30 cm between rows and 15 cm between plants in three replications, keeping one row of each parent and $F_1$, two rows of $BC_1$, three rows of $BC_2$ and 15 rows of each $F_2$ population. Observations were recorded for seven quantitative traits on five plants of each parent and $F_1$ and 15, 20 and 30 plants of $BC_1$, $BC_2$ and $F_2$, respectively, per replication. The gene effects were estimated by weighted analysis of generation mean as described by Mather and Jinks [2].

## RESULTS AND DISCUSSION

The parents of insensitive x sensitive crosses (Amp 45 x L 24-2) differed by 21 days in their days to flowering. The $F_1$ of this cross took 42 days to flower and showed partial dominance of insensitive alleles. The $F_1$ of the cross Amp 45 x T 44 which involved both insensitive parents also flowered in 42 days falling almost at the midpoint value. The deviation might be due the contribution of recessive alleles from T 44 which was 5 days late to Amp 45. However, the $F_1$ of sensitive x sensitive cross (Amp 20 x L 24-2) flowered in 52 days indicating partial dominance of alleles contributed by Amp 20. The inheritance of photothermal responsiveness was found to be governed by three gene loci [1]. The alleles conferring insensitiveness to photothermal factors are dominant and cause early flowering white recessive sensitivity alleles delay it. The extent of delay depends on the number of alleles present in a parent [3].

The $F_2$ and backcross generations of all the crosses produced late progenies which might be due to the interactions of photothermal genes and background genotypes of the parents. Moreover, materials were generated in nontargeted environment and some erosion of alleles of insensitivity might be there.

The sensitive parents possess significantly larger number of pods/plant compared to insensitive parents. The sensitive parents also had better performance for branches/plant, grain/pod, grain yield/plant but were poor in grain weight. The performance of $F_2$ and backcrosses of sensitive x sensitive cross was poor but for other two crosses the performance of these generation improved indicating production of transgressive segregants.

The analysis revealed nonsignificant values of $\chi^2$ (Table 2) for grains/pod in all the three crosses; 100-grain weight in crosses, Amp 45 x T 44 and Amp 45 x L 24-2 and for branches/plant in Amp 45 x L 24-2, and Amp 20 x L 24-2, indicating adequacy of the additive dominance model to explain inheritance of these traits. For the remaining characters in all the three crosses $\chi^2$ values were significant, indicating digenic or multigenic interaction in the inheritance of these traits.

**Table 1. Mean performance of parents, $F_1$, $F_2$ and backcross generations for different quantitative traits in mungbean crosses**

| Character | Cross | $P_1$ | $P_2$ | $F_1$ | $F_2$ | $BC_1$ | $BC_2$ |
|---|---|---|---|---|---|---|---|
| Days to flower | Amp45 x T44 | 37.2 ± 0.4 | 42.2 ± 0.4 | 41.5 ± 0.5 | 49.4 ± 0.4 | 48.6 ± 0.4 | 50.8 ± 0.5 |
| | Amp45 x L24-2 | 36.8 ± 0.5 | 57.6 ± 0.6 | 41.8 ± 0.5 | 50.0 ± 0.4 | 49.5 ± 0.4 | 62.0 ± 0.6 |
| | Amp20 x L24-2 | 48.0 ± 0.3 | 59.0 ± 0.5 | 50.7 ± 0.4 | 55.0 ± 1.0 | 54.9 ± 0.3 | 56.0 ± 0.4 |
| Pods/plant | Amp45 x T44 | 49.6 ± 2.5 | 36.5 ± 1.7 | 46.5 ± 1.5 | 59.4 ± 1.1 | 62.2 ± 1.1 | 53.9 ± 1.4 |
| | Amp45 x L24-2 | 47.3 ± 2.1 | 48.7 ± 2.7 | 56.9 ± 2.4 | 52.4 ± 0.9 | 68.9 ± 1.3 | 69.9 ± 1.2 |
| | Amp20 x L24-2 | 66.8 ± 2.4 | 50.4 ± 2.4 | 41.1 ± 2.2 | 47.5 ± 0.9 | 69.8 ± 1.2 | 57.8 ± 1.5 |
| Plant height | Amp45 x T44 | 74.8 ± 1.0 | 75.1 ± 1.1 | 75.5 ± 1.0 | 63.4 ± 0.6 | 72.4 ± 0.7 | 74.2 ± 0.9 |
| | Amp45 x L24-2 | 70.4 ± 1.0 | 99.2 ± 1.0 | 79.5 ± 1.1 | 68.0 ± 0.6 | 68.1 ± 0.7 | 92.0 ± 0.4 |
| | Amp20 x L24-2 | 88.9 ± 1.1 | 100.9 ± 1.2 | 89.5 ± 1.1 | 90.6 ± 0.7 | 89.8 ± 0.6 | 99.8 ± 0.6 |
| Branches/plant | Amp45 x T44 | 5.5 ± 0.7 | 5.4 ± 0.5 | 8.4 ± 0.8 | 6.1 ± 0.2 | 5.0 ± 0.3 | 4.7 ± 0.3 |
| | Amp45 x L24-2 | 5.6 ± 0.5 | 5.7 ± 0.6 | 6.1 ± 0.6 | 6.2 ± 0.2 | 5.7 ± 0.2 | 5.4 ± 0.4 |
| | Amp20 x L24-2 | 6.9 ± 0.6 | 6.5 ± 0.7 | 5.0 ± 0.6 | 6.3 ± 0.3 | 6.6 ± 0.3 | 5.8 ± 0.4 |
| Grains/pod | Amp45 x T44 | 10.1 ± 0.4 | 10.1 ± 0.4 | 9.8 ± 0.4 | 10.5 ± 0.2 | 10.1 ± 0.2 | 10.3 ± 0.3 |
| | Amp45 x L24-2 | 9.2 ± 0.4 | 10.7 ± 0.4 | 9.9 ± 0.3 | 9.8 ± 0.2 | 9.8 ± 0.2 | 9.6 ± 0.3 |
| | Amp20 x L24-2 | 10.4 ± 0.4 | 11.6 ± 0.5 | 11.3 ± 0.5 | 10.7 ± 0.2 | 11.0 ± 0.2 | 11.1 ± 0.3 |
| 100-grain weight | Amp45 x T44 | 38.1 ± 0.7 | 3.0 ± 0.2 | 3.0 ± 0.2 | 3.1 ± 0.1 | 3.1 ± 0.2 | 3.0 ± 0.2 |
| | Amp45 x L24-2 | 3.2 ± 0.7 | 3.0 ± 0.2 | 2.7 ± 0.2 | 3.0 ± 0.1 | 3.1 ± 0.2 | 3.1 ± 0.2 |
| | Amp20 x L24-2 | 2.7 ± 0.1 | 2.9 ± 0.2 | 3.0 ± 0.2 | 2.4 ± 0.1 | 2.3 ± 0.1 | 2.3 ± 0.1 |
| Grain/yield plant | Amp45 x T44 | 13.6 ± 1.2 | 9.0 ± 0.8 | 18.5 ± 1.4 | 14.9 ± 0.5 | 15.2 ± 0.6 | 16.2 ± 0.8 |
| | Amp45 x L24-2 | 11.9 ± 0.8 | 12.4 ± 1.3 | 13.7 ± 1.1 | 13.3 ± 0.5 | 17.1 ± 0.6 | 9.9 ± 0.7 |
| | Amp20 x L24-2 | 15.2 ± 1.2 | 12.8 ± 1.2 | 10.4 ± 1.0 | 11.0 ± 0.4 | 15.4 ± 0.5 | 12.3 ± 0.7 |

The estimate of 'd', 'h' and 'l' in the cross Amp 45 x T 44 for days to flower were significant with 'h' and 'l' having opposite signs, indicating involvement of additive, dominance and duplicate gene interactions in the inheritance. In the cross Amp 45 x L 24-2 'd', 'h', 'i', 'j', 'l' were significant indicating involvement of additive, dominance ad other digenic interactions in the control of flowering time. The cross Amp 20 x L 24-2 showed additive x dominance and dominance x dominance type nonallelic interactions. For plant height, dominance, additive x additive and dominance x dominance gene effects were important in the cross Amp 45 x T 44, while in the crosses Amp 45 x L 24-2 and Amp 20 x L 24-2, the additive, dominance and nonallelic interaction were important.

The significant values of 'i' and non-significant values of 'd' for branches per plant in the cross Amp 45 x T 44 indicated dispersal of alleles in the parents. The significant values of 'h' and 'l' with opposite signs, indicate duplicate type nonallelic interaction. The negative sign of 'i' also make it obvious that selection should be deferred to later generations when desirable segregates became available.

**Table 2. Estimates of gene effects for seven quantitative traits in mungbean crosses**

| Character | Cross | 'm' | 'd' | 'h' | 'i' | 'j' | 'l' | $\chi^2$ |
|---|---|---|---|---|---|---|---|---|
| Days to flower | Amp45 x T44 | 38.5 ± 2.0 | $2.55^{**}$ ± 0.3 | $40.5^{**}$ ± 5.1 | 11.2 ± 2.0 | - 0.8 ± 1.4 | $-37.6^{**}$ ± 3.2 | $559.6^{**}$ |
| | Amp45 x L24-2 | 33.9 ± 2.0 | $10.4^{**}$ ± 0.4 | $86.2^{**}$ ± 5.3 | $23.3^{**}$ ± 2.0 | $4.1^{**}$ ± 1.6 | $-68.3^{**}$ ± 3.4 | $570.7^{**}$ |
| | Amp20 x L24-2 | 51.8 ± 4.1 | $5.5^{**}$ ± 0.3 | 14.1 ± 8.5 | 1.7 ± 4.1 | $-8.9^{**}$ ± 1.2 | $-15.2^{**}$ ± 4.5 | $165.4^{**}$ |
| Pods/plant | Amp45 x T44 | 48.0 ± 5.8 | $-6.1^{**}$ ± 1.5 | 13.1 ± 14.9 | - 5.5 ± 5.6 | $28.7^{**}$ ± 4.7 | 19.3 ± 10.8 | $42.1^{**}$ |
| | Amp45 x L24-2 | 40.1 ± 5.3 | 0.7 ± 1.6 | $32.3^{**}$ ± 14.1 | 7.8 ± 5.1 | $59.1^{**}$ ± 4.8 | - 15.5 ± 9.6 | $154.3^{**}$ |
| | Amp20 x L24-2 | 6.3 ± 5.4 | $-8.2^{**}$ ± 1.7 | $168.0^{**}$ ± 14.3 | $64.9^{**}$ ± 5.2 | - 7.5 ± 5.0 | $-120.6^{**}$ ± 9.9 | $183.5^{**}$ |
| Plant height | Amp45 x T44 | 35.3 ± 3.3 | 0.2 ± 0.7 | $72.2^{**}$ ± 8.4 | 39.7 ± 3.2 | 3.2 ± 2.6 | $-32.0^{**}$ ± 5.5 | $225.7^{**}$ |
| | Amp45 x L24-2 | 36.4 ± 3.8 | $14.4^{**}$ ± 0.9 | $83.2^{**}$ ± 9.5 | $48.4^{**}$ ± 3.6 | $19.1^{**}$ ± 3.0 | - 4.1 ± 6.2 | $306.1^{**}$ |
| | Amp20 x L 24-2 | 97.8 ± 3.3 | $5.5^{**}$ ± 0.8 | $-20.3^{**}$ ± 8.0 | - 3.3 ± 3.2 | $-11.0^{**}$ ± 2.4 | $12.0^{*}$ ± 5.3 | $126.7^{**}$ |
| Branches/plant | Amp45 x T44 | 10.5 ± 1.3 | - 0.1 ± 0.4 | $-15.4^{**}$ ± 3.4 | $-5.0^{**}$ ± 1.3 | - 0.6 ± 1.2 | $13.3^{**}$ ± 2.6 | $27.8^{**}$ |
| | Amp45 x L24-2 | 5.6 ± 0.4 | 0.0 ± 0.3 | 0.5 ± 0.7 | — | — | — | 4.4 |
| | Amp20 x L24-2 | 6.9 ± 0.4 | - 0.5 ± 0.3 | $-1.5^{*}$ ± 0.7 | — | — | — | 2.0 |
| Grains/pod | Amp45 x T44 | 10.3 ± 0.2 | 0.1 ± 0.2 | - 0.1 ± 0.5 | — | — | — | 3.2 |
| | Amp45 x L24-2 | 9.9 ± 0.2 | $0.5^{*}$ ± 0.2 | - 0.1 ± 0.4 | — | — | — | 3.5 |
| | Amp20 x L24-2 | 10.8 ± 0.3 | 0.4 ± 0.2 | 0.1 ± 0.5 | — | — | — | 3.9 |
| 100-grain weight | Amp45 x T44 | 3.1 ± 0.2 | - 0.1 ± 0.2 | - 0.1 ± 0.3 | — | — | — | 0.2 |
| | Amp45 x L24-2 | 3.2 ± 0.2 | - 0.1 ± 0.2 | - 0.3 ± 0.3 | — | — | — | 1.0 |
| | Amp20 x L24-2 | 3.0 ± 0.5 | 0.1 ± 0.1 | - 2.4 ± 1.3 | - 0.2 ± 0.5 | - 0.3 ± 0.4 | $-2.0^{*}$ ± 0.9 | $14.9^{**}$ |
| Grain/yield plant | Amp45 x T44 | 8.1 ± 2.9 | $-2.3^{**}$ ± 0.7 | $17.0^{*}$ ± 7.6 | 3.2 ± 2.8 | $6.6^{**}$ ± 2.4 | - 6.5 ± 5.4 | $8.4^{*}$ |
| | Amp45 x L24-2 | 11.4 ± 2.7 | 0.2 ± 0.8 | 5.3 ± 7.1 | 0.7 ± 2.6 | $-14.8^{**}$ ± 2.4 | - 3.1 ± 4.1 | $41.2^{**}$ |
| | Amp20 x L24-2 | 2.6 ± 2.6 | - 2.2 ± 0.9 | $25.8^{**}$ ± 6.8 | $11.4^{**}$ ± 2.4 | - 3.8 ± 2.8 | $-18.0^{**}$ ± 4.7 | 26.7 |

$^{*,**}$Significant at p = 0.05 and 0.01, respectively.

The component 'i' was positive and significant for pods/plant in the crosses, Amp 45 x T 44 and Amp 45 x L 24-2, which indicated that alleles with positive effect were more often dominant. In the cross, Amp 20 x L 24-2, all the gene effects except 'j' were significant. The signs of 'h' and 'l' were opposite indicating duplicate epistasis in the inheritance of the trait in this cross.

The inheritance of 100-grain weight in the cross Amp 20 x L 24-2 mainly involved digenic interaction of dominance x dominance type.

The estimates of 'd', 'h' and 'j' were significant for grain yield/plant in the cross, Amp 45 x T 44. Positive and significant estimates of 'j' indicated that genes with positive effect were more often dominant. In the cross, Amp 20 x L 24-2, the estimates of 'h', 'i' and 'l' were significant with 'h' and 'l' having opposite signs. This indicated that mainly dominance and duplicate epistasis was involved in the inheritance of this trait. Significant 'i' and nonsignificant 'd' indicated dispersal of alleles in the parents. In the cross, Amp 45 x L 24-2, only 'j' component was significant indicating involvement of alleles with negative effects.

Thus, it is evident that days to flower, plant height, pods/plant and grain yield/plant were under the control of additive, dominance, digenic interaction in all the three crosses. Earlier workers [4–7] also reported involvement of similar gene effects. Under such situations simple procedure are not likely to be helpful in exploiting the genetic variability, intermating in segregating generations to exploit both additive and nonadditive components of genetic variability will be desirable.

The characters 100-grain weight, branches/plant and grains/pod were, by and large, under the control of additive genes and/or dominance type of interaction. Control of these characters mainly by additive gene effects was reported by earlier workers [7, 8]. Simple selection procedure like bulk or progeny selection may be applied for improvement of these traits.

It is interesting to note that the genetic architecture and inheritance pattern of grain yield/plant and component traits differed in crosses according to the involvement of identical or divergent parents for photothermal responsiveness. The crosses, Amp 45 x T 44 and Amp 20 x L 24-2 involving parents of identical photothermal response exhibited predominantly additive or additive x additive gene effects, while the cross Amp 45 x L 24-2 involving parents with different photothermal responses indicated involvement of dominance or dominance x dominance interaction in the inheritance of grain yield and pods per plant. The nonallelic interactions were of complementary or duplicate type, hence occurance of transgressive segregation was expected which lead to improved performance of $F_2$ and back-crosses. Therefore, method of handling of segregating generations will differ for two sets of crosses. There is scope to accumulate favourable genes by intermating of transgressive segregant and to select still better performing homozygous progenies.

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