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GENETIC ANALYSIS IN GREEN GRAM (*VIGNA RADIATA* (L.) WILCZEK) SUBJECTED TO NORTH CAROLINA MATING DESIGN-I

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ABSTRACT
Genetic studies were conducted on progenies developed in F_2 generation of an intervarietal cross made between powdery mildew resistant parent BPMR 156 and powdery mildew susceptible parent SML-668 of green gram using NCD-1. Significant differences among females in males in sets for all the traits in the study were observed. Dominant variance were more pronounced except for the traits like plant height, pod cluster per plants, pods per plant, 100 seed weight and yield per plant indicating the importance of dominant gene effects for those traits. Partial dominance was observed for plant height, number of pods per plant and yield per plant.

INTRODUCTION

Green gram (*Vigna radiata* (L.) Wilczek) is one of the most important grain legume in India. It is an excellent source of easily digestible good quality protein. Considerable efforts have been made in past to improve the productivity and quality of green gram. But fails to develop a cultivar having bold seeds and powdery mildew resistance might be due to tight linkage between genes responsible for bold seeds and powdery mildew susceptibility. Thus, mating of randomly selected plants in segregating generation of a cross in between parents having contrasting characters will not only helpful in creating greater variability by breaking tight and unfavorable linkages for effective selection over the longer period but also creates new populations with high frequencies of rare recombinants. Before such populations can be used for the genetic improvement, an efficient breeding methodology has to be formulated. For this purpose, information would be required on the relative proportion of additive and non-additive variances.

Hence, the present study was conducted with the aim to get information of additive and dominant genetic variances for different traits in mungbean and to find out suitable powdery mildew resistant recombinant among the biparental progenies produced by using North Carolina Design-I (Comstock and Robinson 1948, 1952).

MATERIALS AND METHODS

The present investigations were carried out at the Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, during the crop season 2010-2012. The biparental progenies were developed in F_2 population of varietal cross made between powdery mildew resistant and small seeded parent BPMR-156 and powdery mildew susceptible and bold seeded parent SML-668, using the NCD-1 mating design suggested by Comstock and Robinson (1948, 1952) during Kharif 2010. Four F_2 plant were designated as male parents and crossing each of these to four different females. The plants used as males and females were chosen at random and no seed parent was used in more than one mating. Thus, the sixteen biparental progenies obtained constituents one set. Similarly, second set was produced.

The seeds of biparental progenies were sown in a Randomized Block Design (RBD) with two replications in each cross. All the biparental progeny were grown in two rows of 3 meter length with spacing of 30 cm between row and 15 cm between plants in each replication. The experimental plot was surrounded by non-experimental border rows of highly powdery mildew susceptible variety Kopargaon to screen the powdery mildew resistant progeny. Recommended package of practice was carried out to raise good crop. The observations were recorded on five randomly selected plants from each progeny in each replication in respect of ten characters *viz*., Days to 50% flowering, Days to maturity, Plant height (cm), number of primary branches per plant, number of pod clusters per plant, number of pods per plant, number of seeds per pod, 100 seed weight (g), Seeds yield per plant (g) and Powdery mildew disease incidence (%). The genetic analysis was done as per the method out-lined by Comstock and Robinson (1948; 1952). Heritability in broad sense was calculated by Hanson *et al*. (1956) and expected genetic gain selection were calculated as per formula suggested by Robinson *et al.* (1949).

RESULTS AND DISCUSSION

Analysis of variance (Table 1) revealed that males in sets were significantly different for all the traits under study except days to 50% flowering, primary branches per plant and seeds per pod, while females in males in sets were found significant for all the traits indicating that females had substantial contribution for creating variation among progenies as compared to males and there exist significant genetic differences among plants randomly chosen as seed parent *i.e.* females. Joseph and Santhoshkumar (1999), Jayaprada *et al.* (2005) and Kujur and Lavanya (2011) also found significant differences between males and females used for intermating.

The components of variance and average degree of dominance have been given in Table 2. Data indicated that variances due to females was significant for all the traits studied except days to 50% flowering and number of primary branches per plant. While dominance variance is significant for the traits, days to maturity and powdery mildew incidence in per cent. Variance due to males in sets as well as additive genetic variances were non-significant for all the characters. Variances due to males and additive variance were more pronounced for the traits like plant height, pod clusters per plant, pods per plant, 100 seed weight and yield per plant indicating the importance of additive gene effects for those traits. Similar result has been reported by Mehandi *et al.* (2013), Jayaprada *et al.* (2005) and Joseph and Santoshkumar (2000)

Variances due to females and dominance variance were more pronounced for the traits like days to 50% flowering, days to maturity, primary branches per plant, number of seed per pod and powdery mildew incidence, indicating the importance of dominant gene effects for those traits. Similar results were also reported by Jayaprada *et al.* (2005) and Kujur and Lavanya (2011).

Environmental component of variance *i.e.* ó ^{2}e was greater than ó ^{2}m and ó ^{2}f for all the traits except days to maturity, yield per plant and powdery mildew incidence in per cent (where ó ^{2}f > ó ^{2}e) and 100 seed weight and yield per plant (where ó ^{2}m > ó ^{2}e). Hence environment also contributed significantly to the variation in biparental progenies for all these traits. The role of environment in variation was also reported by Kanwar and Korla (2004) in caualiflower and Dhameliya and Dobariya (2009) in brinjal.

Some variances found negative which ultimately resulted in negative estimates of average degree of dominance in some characters while plant height, pods per plant and yield per plant shows partial dominance. In all other traits negative estimates of average degree of dominance were recorded either

Table 1: Analysis of variance of biparental progenies for different characters in green gram

Source of variation Characters	*df*	Mean Sum of Squares (M. S. S.) Days to 50% flowering	Days to maturity	Plant height (Cm)	No. of Primary branches /plant	No. of Pod Clusters /plant	No. of Pods / plant	No. of Seeds / pod	100 seed weight	Yield/ plant (g)	PM incidence in per cent
Sets	1	0.02	0.14	1377.80**	0.70*	56.95**	2091.01**	10.51	0.03**	256.69**	221.46**
Replication in sets (R/S)	2	0.20	1.58	11.05	0.08	0.12	14.56	0.01	0.00	16.08	3.00
Males in sets (M/S)	6	1.12	3.74**	223.60**	0.35	62.59**	842.32**	5.04	2.31**	108.74**	1657.46**
Females in males in sets (F/M/S)	24	1.64*	6.43**	45.19**	0.36*	2.41**	169.92**	10.45*	0.08**	22.59**	1858.24**
Replication × Females	30	0.74	0.64	6.85	0.16	0.52	11.79	4.71**	0.00	8.02**	9.22
Error	256			10.71	0.61	3.85	32.48	1.91	0.02	1.41	22.34
Total	319										

* Significant at 5% level; ** Significant at 1% level

Table 2: Components of variances and average degree of dominance for different character in mungbean

Sr.n.	Characters Variances	σ^2m ± S. E.	σ^2f ± S. E.	σ^2e ± S. E.	σ^2A ± S. E.	σ^2D ± S. E.	Average degree of dominance (α)
1.	Days to 50% flowering	-0.065 ± 0.093	0.452 ± 0.245	0.736** ± 0.184	-0.260 ± 0.372	2.069 ± 2.327	α
2.	Days to maturity	-0.336 ± 0.324	2.894** ± 0.896	0.920** ± 0.230	-1.344 ± 1.296	12.919** ± 4.471	α
3.	Plant height (Cm)	4.460 ± 2.813	3.834** ± 1.257	10.708** ± 0.766	17.841 ± 11.250	-2.505 ± 8.069	0.848
4.	No. of Primary branches/plant	0.000 ± 0.005	0.020 ± 0.011	0.614** ± 0.018	- 0.000 ± 0.021	0.080 ± 0.514	α
5.	No. of pod Clusters/plant	1.505 ± 0.783	0.188* ± 0.075	3.848** ± 0.058	6.019 ± 3.131	-5.266 ± 3.704	αα
6.	No. of Pods/plant	16.810 ± 10.595	15.813** ± 4.721	32.481** ± 1.318	67.240 ± 42.380	-3.988 ± 15.654	0.938
7.	No. of Seeds/pod	-0.135 ± 0.096	0.574* ± 0.290	1.906** ± 0.526	-0.541 ± 0.384	2.839 ± 2.487	α
8.	100 seed weight	0.056 ± 0.029	0.008** ± 0.002	0.018** ± 0.000	0.223 ± 0.116	-0.191 ± 0.706	αα
9.	Yield/ plant (g)	2.154 ± 1.368	1.457* ± 0.627	1.409 ± 0.897	8.616 ± 5.473	-2.789 ± 5.650	0.593
10.	Powdery mildew incidence in per cent	-5.020 ± 24.398	184.901** ± 51.539	22.344** ± 1.031	-20.078 ± 97.592	759.684** ± 34.857	α

á Negative estimates due to negative additive variance, *áá* Negative estimates due to negative dominant variance; * Significant at 5% level, ** Significant at 1% level.

Table 3: Estimates of heritability and expected genetic advance in biparental progenies

Sr. No.	Characters	Heritability $_{(b.s.)}$ in (%)	Heritability $_{(n.s.)}$ in (%)	Expected genetic advance	G.A. as per cent of mean
1.	Days to 50% flowering	71.06	*	*	*
2.	Days to maturity	94.72	*	*	*
3.	Plant height (Cm)	58.88	68.50	4.21	7.99
4.	No. of primary branches per plant	11.48	*	*	*
5.	No. of pod clusters / plant	16.36	+ +	2.63	25.60
6.	No. of pods/plant	66.07	70.23	8.58	23.15
7.	No .of seeds/pod	54.65	*	*	*
8.	100 seed wt.	63.98	+ +	0.80	28.26
9.	Yield/ plant(g)	80.52	+ +	3.96	36.43
10.	PM incidence %	97.06	*	*	*

* Small negative estimates; + + False estimate due to negative dominance variance.

due to negative dominance or additive variance hence assumed as zero *i.e.* no dominance or no additive genetic effect. In the present study, the negative variance observed could be attributed to sampling error as well as genetic-environment interaction might have resulted in biased estimates of total genetic variance as the experiment was conducted at one location during one season. Such negative estimates are not unusual and have been reported in wheat (Yunus and Paroda, 1983) and maize (Goodman, 1965; Williams *et al.*, 1965). According to Robinson *et al.* (1955), the variances, being quadratic quantities and by definition are never negative and it is reasonable to conclude that true values of these negative variances are infact small positive quantities and the negative estimates resulted from sampling error. Similar opinion was also put forth by Williams *et al.* (1965).

In the present study, the estimates of heritability in broad sense were high for all the characters except for plant height, number of primary branches per plant, number of cluster per plant and number of seeds per pod (Table 3). Similarly high values of heritability (in broad sense) for the character number of pods per plant and seed yield per plant (g) reported by Garje *et al.* (2013). Narrow sense heritability was calculated in only two characters *i.e.* plant height (68.50%) and number of pods per plant (70.23%). In remaining characters narrow sense heritability had either small negative or false estimates due to negative additive and dominance variances.

It was observed that the estimates for genotypic coefficient of variation (GCV) were lower than the phenotypic coefficient of variation (PCV) for all the characters indicating the important role of environmental variance in expression of different traits in green gram. The results obtained by Suresh *et al.* (2010), Singh *et al.* (2009) and Joseph and Santhoshkumar (2001) were in accordance to present findings. GCV estimated for number of pods per plant (21.46%) and seed yield per plant (21.44%) were found high. Similar findings were also reported by Suresh *et al.* (2010) and Singh *et al.* (2009). GCV for number of seeds per pod was found moderate, while other characters had lower GCV.

Among all the biparental progenies, progeny number 2 was found as most suitable recombinant showing significance in all the characters under study except days to maturity and 100 seed weight. It had higher average seed yield per plant (13.13 g), low incidence of powdery mildew (6.8%) and required 65 days for maturity. Progeny number 29 had significant performance in all the characters except days to maturity, 100 seed weight and powdery mildew incidence. Hence these biparental progenies can be utilized as base population for breeding programs. There might be chances of developing a highly productive cultivar of mungbean, having bold seed with powdery mildew resistance. While characters like days to 50% flowering, days to maturity, primary branches per plant, number of seed per pod and powdery mildew incidence having high dominant genetic variance can be improved by delay in character selection.

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