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Epistatic and Other Genetic Variances in Green Gram Varieties[1]

P. R. Godhani, B. G. Jaisani and G. J. Patel

Tobacco Project, Gujarat Agricultural University, Anand Campus — 388 110

ABSTRACT

Study of the parents, F_1, F_2 and backcross generations involving either parents of five green gram crosses revealed that the additive gene effect was involved in the expression of days to flower and number of branches per plant; whereas, besides additive gene effect, dominance and nonadditive epistatic gene effects were also involved in the expression of plant height. The dominance gene effect was principally responsible for grain yield whereas dominance and nonadditive epistatic gene effects were involved in the expression of pod yield. The expression of pods per plant was controlled by nonadditive epistatic gene effect, while pod length was controlled by additive and additive × additive or dominance gene effects. Besides additive × additive gene effect, additive and dominance were also found responsible for the expression of seeds per pod. Isolation of superior genotypes from the segregating population followed by *inter se* crossing, keeping adequate sample size for each cycle would be more desirable for effective utilization of the gene effects observed for grain yield and its attributes.

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INTRODUCTION

GREEN gram *Vigna radiata* (L) Wilczek is an important pulse crop but little is known about the nature of genes involved in the expression of yield and its attributes. Murty (1970) reported dominance × dominance gene action for plant height, number of branches, number of pods, seeds per pod, pod yield and grain yield; additive and epistatic (additive × dominance) actions for days to flower, and dominance as well as additive × additive gene actions for pod length. Singh and Jain (1971) found the presence of general combining ability variance for pod length. The present study was taken up to have better understanding of the nature of genes governing grain yield and its attributes as a prerequisite to the crop improvement programme.

MATERIALS AND METHODS

Data were obtained from the parents, F_1, F_2 and backcrosses involving either parents of the following green gram crosses:

Cross number

1. S.293 — 3 × A.101 — 4
2. S.293 — 3 × T.44
3. S.293 — 3 × S.291 — 1
4. S.293 — 3 × S.62
5. S.293 — 1 × S.62

T.44 is an improved cultivar of the Indian Agricultural Research Institute

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TABLE 1

Gene effects and per cent of variability (R^2 in parentheses) for various characters studied among five crosses.

Characters/crosses	*d*		*h*		*Epistasis*			
					d × d		*Remaining nonadditive*	
Days to flower								
Cross 1	22·38**	(36)	2·36	(4)	31·00**	(49)	3·31	(11)
Cross 2	327·18**	(64)	16·10*	(3)	154·16**	(31)	5·73	(2)
Cross 3	103·99**	(82)	7·25*	(5)	11·74*	(10)	2·11	(3)
Cross 4	37·03**	(53)	14·09*	(20)	7·25	(10)	5·86	(17)
Cross 5	273·94**	(86)	17·25	(6)	11·50	(3)	7·60	(5)
Plant height								
Cross 2	467·03**	(45)	309·35**	(30)	86·36**	(8)	86·13**	(17)
Cross 3	5·34	(1)	169·69	(16)	160·14	(15)	355·40*	(68)
Cross 5	592·40**	(59)	256·33*	(25)	17·16	(2)	73·16	(14)
Number of branches								
Cross 2	0·97*	(22)	2·22**	(50)	0·61	(14)	0·32	(14)
Cross 4	3·09**	(75)	0·45	(11)	0·16	(4)	0·20	(10)
Cross 5	17·01**	(82)	0·41	(2)	0·10	(1)	2·56**	(15)
Pods per plant								
Cross 2	54·64	(3)	200·86	(9)	90·57	(4)	873·74**	(84)
Pod length								
Cross 1	0·34**	(26)	0·15*	(12)	0·73**	(55)	0·04	(7)
Cross 3	0·02	(5)	0·00	(0)	0·32**	(57)	0·10*	(38)
Cross 4	0·28**	(43)	0·30**	(46)	0·01	(3)	0·02	(8)
Cross 5	1·15**	(79)	0·00	(0)	0·13*	(10)	0·08	(11)
Seeds per pod								
Cross 1	0·35**	(28)	0·00	(0)	0·89**	(72)	0·00	(0)
Cross 3	0·02	(2)	0·46**	(64)	0·14*	(19)	0·05	(15)
Pod yield								
Cross 2	3·72	(1)	64·91	(10)	8·91	(1)	287·19**	(88)
Cross 4	164·38	(20)	645·28**	(78)	4·80	(1)	5·48	(1)
Cross 5	79·43	(8)	690·45**	(70)	8·98	(1)	102·22	(22)
Grain yield								
Cross 2	0·09	(0)	151·01**	(53)	38·65	(14)	46·87*	(33)
Cross 4	139·66**	(20)	524·73**	(77)	15·43	(2)	3·38	(1)
Cross 5	19·34	(3)	393·47**	(70)	8·90	(2)	70·26	(25)

Legend — * and ** indicate significances at 0·05 and 0·01 levels respectively.

The nonadditive gene effects were principally involved in the expression of this trait in both populations. About 72 per cent of genetic variability in cross 1 and 64 per cent of genetic variability in cross 3 were accounted by epistatic (additive × additive) and dominance gene effects respectively. Additive gene effect contributed 28 per cent genetic variability in cross 1, while additive × additive gene effect accounted for 19 per cent genetic variability in cross 3.

For pod yield, three populations (crosses 2, 4 and 5) had significant differences and nonadditive effects were principally involved. The dominance effect accounted for 78 and 70 per cent of genetic variability in crosses 4 and 5 respectively, while 88 per cent of genetic variability in cross 2 was due to non-additive interaction.

For grain yield character, three (crosses 2, 4 and 5) of the five populations had significant differences and non-additive effects were the principal contributors. About 53, 77 and 70 per cent of genetic variability in crosses 2, 4 and 5 respectively was due to dominance effect. The nonadditive interaction and additive effects were also involved for grain yield in crosses 2 and 4 and accounted for about 33 and 20 per cent of genetic variability respectively.

Though crosses 2, 4 and 5 were most desirable for yield improvement, each was lacking genetic variability for some yield attributes. Cross 2 did not have significant gene effect for pod length and seeds per pod, while crosses 4 and 5 were lacking significant genetic variability for number of pods and seeds per pod. Hence to pool all desirable yield attributes, a four-way cross involving A. 101-4, T.44, S.293-3 and S.62 would be most desirable. The gene effects observed for various traits in the present study and those reported by Murty (1970) revealed that dominance and epistacy were predominant.

When additive as well as nonadditive gene effects are involved, Comstock *et al.* (1949) have suggested the use of reciprocal recurrent selection for effective use of both additive and nonadditive gene effects; Patel (1959) has also suggested the use of cyclic method of breeding by selecting superior genotypes and interbreeding them, when similar gene actions are involved in FCV tobacco. In certain self-fertilizing crops like groundnut (Wynne *et al.*, 1970), soybean (Weber *et al.*, 1970), cotton (Howkins *et al.*, 1965; El-Adl and Miller, 1971; Meredith and Bridge, 1972), grain sorghum (Kirby and Atkins, 1968; Collins and Pickett, 1972), barley (Upadhyay and Rasmusson, 1967), and wheat (Widner and Lebsock, 1973), where pronounced nonadditive effects alongwith some additive effects were observed, use of hybrids (if commercial seed production is feasible) has been suggested; whereas for the development of lines, biparental approach, *inter se* crossing and/or reciprocal recurrent selection have been suggested to make use of both the types of gene actions. Green gram being a self pollinated crop, and in the absence of cytoplasmic genetic male sterility it would not be feasible to utilize these effects by releasing the F_1 hybrids for commercial cultivation but selection of desired plants from the segregating generations of the four-way cross mentioned earlier followed by selfing and *inter se* crossing would help in effectively synthesising the desirable genotype from grain yield view point, keeping adequate sample size for each cycle.

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