

CHARACTERS LIMITING PRODUCTIVITY IN *Vigna radiata* (L.) WILCZEK

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Twenty four characters at maturity phase of plant growth were studied in 286 green gram (*Vigna radiata* (L.) Wilczek) germplasm lines. Variability was large for most of the characters. Pod yield, biological yield and harvest index were three major determinants of seed yield. The harvest index had negative significant association with biological yield and its related characters in late maturing varieties. Vegetative dominance and low harvest index in late group and low biological yield in early and medium groups are the limiting factors resulting in low productivity in green gram.

Green gram (*Vigna radiata* (L.) Wilczek) is an important grain legume with high nutritional quality and forms an excellent nutritive component in cereal-legume combined diet system. The studies on variability and inter-relation of pod and seed characters were conducted earlier and results well documented (Joshi and Kabaria, 1973; Borthakur and Hazarika, 1977; Rathnaswamy *et al.* 1978). The present study was aimed to study and relate the characters such as number of leaves on main stem and branches, petiole length, dry matter production and harvest index in addition to the pod and seed characters with seed yield.

MATERIALS AND METHODS

Two hundred and eighty six green gram lines with diverse ecogeographical origin were studied. The augmented randomised block design (Federer, 1956) with 11 blocks was adopted. Each germplasm line was raised in a single row of 4 m length and 45 cm

apart with an intra row spacing of 15 cm. Fifteen characters were studied at the time of maturity namely plant height (PH), petiole length (PTL), peduncle length (PDL), branches per plant (BP), leaf number on the main stem (LMS), leaf number on the branches (LB), cluster number per plant (CP), pod number per plant (PP), pod length (PL), seed number per pod [SP], pod yield per plant (PY), 100 seed weight (SW), total biological yield per plant (BY), seed yield per plant (SY) and harvest index (HI). The total germplasm lines were further grouped into early, medium and late according to the total duration from seeding to harvest.

Duration group	Duration (days)	Number of germplasm lines
Early	60 days and below	68
Medium	61 — 70	125
Late	71 and above	90

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The estimates of mean, coefficient of variability, simple correlation and partial regression analyses were done (Panse and Sukhatme, 1957).

RESULTS AND DISCUSSION

Seed yield is the commercial end product in green gram and depends upon a number of component characters. In the present study, the germplasm lines studied were classified durationwise to realise meaningful inter relationship between different characters. Duration had direct positive influence on yield and many of its component traits. Early varieties exhibited low mean value while the late group had high mean value for all the characters except PL, SP and SW (Table-1). Comparitively the characters BP and LB had high amount of variability, while for CP, PP, PY, DMP, and SY, the variability was moderate. The existing germplasm still offers much scope for selection to identify efficient lines for direct evaluation or as parent material in recombination breeding.

The simple correlation coefficient among the 15 characters are presented in Table 2. The characters PH, PTL, PDL, BP, LMS, LB, CP, PP, PY, DMP, in early, medium and late groups were positively and significantly associated with SY with the exception of LMS in late group. Among them PY and BY had very strong positive association with SY. PL, SP and SW had no significant association with seed yield in early and medium lines, while PL and SP alone showed positive association with SY in late group. PL was found to have significant positive association with SP and SW,

while SP and SW had no association between themselves. These three characters showed mostly non significant associations with most other characters or even negative significant association with CP and PP. Thus PY, BY and HI were the three major yield components which significantly contributed to SY when others were kept constant. This was confirmed by partial regression coefficient and standardised partial regression coefficients (Table-3).

The association of HI with SY different among duration groups. The early and medium groups showed positive relation between these two characters. In late group, non significant association between HI and SY was observed. PH, PTL, PDL, BP, LMS, LB and BY had significant negative association with HI in the late group. In grain legume only seed is economically useful. Seed is the end product of biological yield and the harvest index. There are opportunities for raising yield by improving the HI. Negative association of BY and HI in late groups is largely a function of non-uniform distribution of photosynthetic activity over the growth period and inefficient partitioning of photosynthete to the sink. This is more evident in late varieties, where the excess negative growth, non-synchronous flowering and delayed senescence of leaves are the common phenomena (Table 4). Thus the limitation in late types is not due to PY and BY, but an unbalanced distribution between the reproductive pods and the negative parts of the plant resulting in low HI.

On the other hand, the principal factor limiting yield in early group is

Table 1 Mean, range and co-efficient of variability among early (N=68), Medium (N=125) and late (N=90) lines of green gram.

Character		Mean \pm SE	CV (%)	Range
<i>Maturity Phase</i>				
PH (cm)	E	31.55 \pm 0.81	21.25	18.1-45.7
	M	40.07 \pm 0.71	19.96	25.9-72.2
	L	46.16 \pm 0.89	18.24	26.9-73-3
PTL (am)	E	10.35 \pm 0.25	19.77	6.6-15.9
	M	12.06 \pm 0.19	17.73	7.5-18.5
	L	13.85 \pm 0.40	27.53	7.8-39.9
PDL (cm)	E	12.66 \pm 0.41	26.64	6.7-20.2
	M	16.95 \pm 0.30	20.99	9.9-25.1
	L	17.29 \pm 0.29	15.89	9.7-24.1
BP	E	0.65 \pm 0.10	126.07	0-4.2
	M	0.91 \pm 0.07	85.16	0-4.8
	L	1.14 \pm 0.08	70.05	0-4.2
LMS	E	6.09 \pm 0.13	17.91	2.8-9.4
	M	6.81 \pm 0.13	21.23	4.4-15.6
	L	7.23 \pm 0.19	25.40	4.8-14.4
LB	E	1.60 \pm 0.29	150.80	0-30.0
	M	2.58 \pm 0.22	96.27	0-14.6
	L	3.93 \pm 0.34	82.67	0-18.0
CP	E	6.09 \pm 0.29	38.65	3.6-13.2
	M	7.71 \pm 0.24	35.01	3.4-21.2
	L	10.73 \pm 0.27	25.41	6.0-23.6
PP	E	18.39 \pm 0.19	40.94	8.0-45.0
	M	22.89 \pm 0.78	38.12	9.2-64.8
	L	32.17 \pm 0.81	26.07	21.0-70-0
PL (cm)	E	7.39 \pm 0.13	14.46	5.7-11.1
	M	6.99 \pm 0.05	8.84	5.9-8.8
	L	6.75 \pm 0.02	7.33	5.2-8.0
SP	E	10.53 \pm 0.12	9.27	8.7-12.0
	M	10.85 \pm 0.09	9.61	8.7-15.0
	L	10.88 \pm 0.09	7.53	8.2-13.5
PY (g)	E	9.11 \pm 0.37	33.30	4.5-18.0
	M	11.53 \pm 0.34	33.17	4.0-25.4
	L	15.64 \pm 0.37	22.56	3.6-28.3
SW (g)	E	4.10 \pm 0.10	20.39	2.4-6.6
	M	4.03 \pm 0.06	15.60	2.6-6.4
	L	3.91 \pm 0.03	8.30	3.3-4.7
EY (g)	E	14.15 \pm 0.34	31.76	7.0-27.0
	M	19.41 \pm 0.61	35.21	10.0-46.2
	L	26.40 \pm 0.87	31.72	12.1-64.4
HI (%)	E	43.65 \pm 0.46	8.69	34.2-53.5
	M	38.20 \pm 0.52	15.18	22.5-49.1
	L	35.58 \pm 0.72	16.84	18.7-54.8
SY (g)	E	6.18 \pm 0.28	35.16	3.1-13.0
	M	7.43 \pm 0.26	36.77	2.5-20.1
	L	10.52 \pm 0.30	26.70	5.0-20.1

E = Early

M = Medium

L = Late

N = Number of lines studied

Table 2: Correlation coefficients among characters in early (E), medium (M) and late (L) duration groups of green gram

	PTL	PDL	BP	LMS	LB	CP	PP	PL	SP	PY	SW	BY	SY	HI
PH	E	0.67**	0.73**	0.30*	0.55**	0.27*	0.44**	0.54**	-0.09	0.32**	0.18	0.66**	0.65**	0.10
	M	0.78**	0.71**	0.22*	0.36**	0.35**	0.41**	0.46**	0.13	0.21*	-0.03*	0.69**	0.64**	0.01
	L	0.64**	0.45**	0.42**	0.37**	0.52**	0.37**	0.32**	0.25	0.05	-0.02	0.60**	0.64**	0.53**
PTL	E	0.60**	0.19	0.41**	0.15	0.17	0.24	0.31*	0.38**	0.45**	0.23	0.52**	0.47**	0.03
	M	0.59**	0.24**	0.43**	0.31**	0.35**	0.36**	0.27**	0.26**	0.56**	0.09	0.66**	0.60**	-0.06
	L	0.41**	0.25*	0.25*	0.46**	0.28**	0.33**	0.07	0.04	0.41**	0.05	0.56**	0.34**	-0.40**
PDL	E	0.09	0.37**	0.07	0.15	0.31*	-0.08	0.19	0.39**	0.39**	0.01	0.43**	0.43**	0.16
	M	-0.01	0.31**	0.12	0.22*	0.28**	0.07	0.25**	0.50**	0.50**	-0.02	0.54**	0.53**	0.04
	L	0.17	0.32**	0.20	0.08	0.22*	-0.04	0.01	0.35**	0.35**	0.04	0.37**	0.28**	-0.22*
BP	E	0.16	0.98**	0.85**	0.63**	-0.19	0.03	0.73**	0.73**	-0.25*	0.73**	0.68**	0.68**	0.01
	M	0.07	0.93**	0.75**	0.69**	0.02	-0.03	0.51**	0.51**	-0.12	0.55**	0.53**	0.53**	0.04
	L	-0.02	0.92**	0.73**	0.42**	0.41	0.16	0.54**	0.54**	0.02	0.67**	0.57	0.57	-0.24*
LMS	E	0.14	0.25*	0.36**	0.04	0.28*	0.28*	0.38**	0.38**	-0.02	0.48**	0.41	0.41	-0.09
	M	0.14	0.09	0.11	0.15	0.20*	0.20*	0.29**	0.29**	0.03	0.39**	0.28**	0.28**	-0.24*
	L	0.08	-0.04	0.01	0.02	-0.13	-0.13	0.04	0.04	0.15	0.25*	0.02	0.02	-0.37*
LB	E	0.87**	0.56**	-0.23	0.01	0.72**	-0.31*	0.72**	0.72**	-0.31*	0.72**	0.68**	0.68**	0.05
	M	0.82**	0.76**	0.04	0.02	0.61**	-0.04	0.61**	0.61**	-0.04	0.67**	0.64**	0.64**	0.01
	L	0.79**	0.50**	0.39**	0.20	0.51**	-0.02	0.51**	0.51**	-0.02	0.78**	0.61**	0.61**	1.33
CP	E	0.74**	-0.37**	0.02	0.75**	-0.43**	0.74**	0.74**	0.74**	-0.43**	0.74**	0.72**	0.72**	0.07
	M	0.86**	-0.12	-0.04	0.64**	-0.24**	0.66**	0.66**	0.66**	-0.24**	0.66**	0.65**	0.65**	0.07
	L	0.63	0.41**	0.20	0.73**	-0.12**	0.72**	0.72**	0.72**	-0.12**	0.72**	0.68**	0.68**	0.15

Table 2 Cont.

	PTL	PDL	BP	LMS	LB	CP	PP	PL	SP	PY	SW	BY	SY	HI
PP	E						-0.37**	0.05	0.70**	-0.51**	0.68**	0.68**	0.13	
	M						0.12	-0.04	0.76**	-0.28**	0.73**	0.75**	0.16	
	L						-0.12	0.09	0.75**	-0.08	0.60**	0.66**	-0.04	
PL	E						0.57**	-0.05	0.64**	-0.01	0.07	0.07	-0.10	
	M						0.93**	0.15	0.45**	0.21	0.15	0.15	-0.12	
	L						0.54**	0.25	0.19	0.32**	0.27*	0.27*	-0.13	
SP	E						0.26*	0.07	0.27*	0.27*	0.24	0.24	0.02	
	M						0.14	-0.07	0.21*	0.18	0.18	0.18	-0.02	
	L						0.29**	-0.03	0.24*	0.24*	0.27*	0.27*	-0.21	
PY	E						-0.12	0.97**	0.98**	0.98**	0.26*	0.26*	0.26*	
	M						0.01	0.94**	0.92**	0.92**	0.07	0.07	0.07	
	L						-0.29	0.80**	0.93**	0.93**	0.03	0.03	0.03	
SW	E						-0.04	-0.12	-0.12	-0.12	-0.22	-0.22	-0.22	
	M						0.01	0.01	0.01	0.01	-0.08	-0.08	-0.08	
	L						0.03	0.08	0.08	0.08	0.09	0.09	0.09	
BY	E										0.96**	0.96**	0.11	
	M										0.93**	0.93**	-0.03	
	L										0.79**	0.79**	-0.41**	
SY	E										0.35**	0.35**	0.35**	
	M										0.33**	0.33**	0.33**	
	L										0.20	0.20	0.20	

*Significant at 5% level

**Significant at 1% level

Table 3: Partial regression coefficient and standardised partial regression coefficient (in parenthesis) of characters with significant values on seed yield

Character	Duration group		
	Early	Medium	Late
PY	0.290±0.058** (0.016)	0.290±0.029** (0.009)	0.293±0.044** (0.006)
BY	0.284±0.044** (0.016)	0.347±0.019** (0.012)	0.241±0.018** (0.009)
HI	0.106±0.009** (0.009)	0.164±0.006** (0.005)	0.196±0.011** (0.007)
R ² (Coefficient of determination)	0.995	0.989	0.982

Table 4: Flowering pattern and rate of biological yield in different duration groups

Group	Flowering period from sowing (days)	No. of flowering (days)	Plant height (cm)		BY	
			F	M	F	M
Early	31-38	9	0.78	0.18	0.18	0.32
Medium	32-42	11	0.80	0.28	0.17	0.42
Late	34-56	23	0.76	0.32	0.17	0.63

F Growth rate upto flowering.

M Growth rate from flowering to maturity

insufficient DMP before anthesis as well as during development. The above limitation was also pointed out by Kuo *et al.* (1978) and Pawar and Bhatia (1980). However, HI is usually high in early group. Rapid senescence of leaves is the characteristics of early lines and could be possibly caused by remobilisation of nitrogen from leaves to developing grains as reported by Sinclair and de Wit (1976) in early soybean lines.

The present material does not offer much scope for direct selection in early maturing lines with high yield potential: HI is the limiting factor in late group. So, breeding for high biological yield coupled with reasonably good level of harvest index seems to be an ideal approach for enhancing yield level in green gram.

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