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INDUCED SYNCHRONY IN POD MATURITY IN MUNGBEAN {*Vigna radiata* (L.) W*ilczek*}

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ABSTRACT

The aim of this study was to investigate the synchrony in the maturity of mungbean and to study the correlation in days to flowering and pod maturity in two diverse mungbean genotypes through induced mutagenesis. The mungbean genotype K851 was the best combiner for early flowering and early pod maturity where as accession Sona was the best general combiner for more synchrony in pod maturity. The best specific combination for early flowering and early pod maturity was in K851 and for highest synchrony in pod maturity was in Sona. Degree of indetermination (DDd) was controlled by both additive and dominance gene effects with predominant effect of additive component. Only additive and dominance gene effects controlled the days to first flower (DDd_1) and degree of indetermination from first pod maturity to 90% pod maturity (DDd_2), respectively. The high narrow and broad sense heritability for days to first flower, days to first pod maturity and 90% pod maturity revealed more proportion of their genetic variation due to additive gene effects. The selection for synchrony in pod maturity is suggested to be made in advanced generation due to the low narrow sense heritability for degree of indetermination from first flower to 90% pod maturity.

Keywords: mungbean, synchrony, mutagenesis, pod, maturity.

INTRODUCTION

Mutation breeding is a type of conventional breeding technique useful for creation of desirable variability in crop and could be a driving force for evolution besides selection in mungbean. Induction of mutation could be created through physical and chemical mutagens (Ahloowalia *et al.*, 2004; Chopra 2005; Jain 2005; Sangsiri 2005; Yaqoob and Rashid 2001). Several authors previous reported the positive effect of synchronous pod maturity in seed yield (Afzal *et al.* 2003; Brar *et al.*, 2002; Chen *et al.* 2008; Hamid *et al.* 2004; Pierre *et al.* 2003). Induction of flowering and synchronous transformation from vegetative phase to the floral initiation is important stages of synchronous pod maturity (Corbesier *et al.* 2003). The time of pod maturation also plays an important factor in the synchronous pod maturation and could be due to variation in the degree of indetermination of growth duration (Brar *et al.*, 2002; Rekha and Langer 2007; Sekhon *et al.*, 2004; Sharma-Natu and Ghildiyal 2005; Zheng 2004). The degree of indetermination (DDd) has been described as the period from first flower initiation to 90 % pod maturity in mungbean by Na Lampang *et al.*, (1988).

Despite the importance of synchronous maturity, in mungbean pod ripening is not synchronous (Yeates *et al.*, 2000). Uneven pod maturity and maturation leads to low yield potential and low harvesting index (HI) in Mungbean (Bushby and Lawn 1992; Egli and Bruening 2002). A high HI could be achieved with high proportion of total biomass production. Thus in order to increase the seed yield, selection of higher HI could be achieved through synchronous maturity. This has been previously identified by (Bisht *et al.*, 1998a; Bisht *et al.*, 1998b) who indicated the inverse effects of seed yield due to high leafiness and asynchronous flowering.

Opportunities further exist to investigate potential synchronously maturing mutants in mungbean through induced mutagenesis. Such induced mutagenesis could help mungbean to be accepted as the main pulse crop in Asian countries in high fertile lands and sufficient without completing directly with major crops like wheat, rice and cotton. The objective of this experiment was to investigate the synchrony in pod maturity in terms of DDd.

MATERIALS AND METHODS

This study was conducted with an aim to investigate novel mungbean mutants with synchronous maturity. To achieve this aim only two mungbean genotypes, K851 and Sona were selected and trials were set up during the year 2000-2001 and 2001-2002. Induced mutagenesis (10Gy, 20Gy, 30Gy and 40Gy) was performed with γ-radiation (Cobalt 60) using 100 uniform and healthy seeds of K851 and Sona for the M_1 generation. About 400 treated and control (untreated) seeds were sown in the field and seeds of M_1 plants and control were harvested separately and planted in plant progeny rows in M_2 generation.

Fifteen randomly selected plants of uniform size were selected to record data for the following characters:

1. Days to first flower (D_1)
2. Days to first pod maturity (D_2)
3. Days to 90 % pod maturity (D_3)
4. Degree of indetermination (DD) for pod maturity (DDd) was calculated as below:

i) DDd from first flower to 90% pod maturity (DDd_1) = $(D_3-D_1)*100/D_3$
ii) DDd from first pod maturity to 90% pod maturity (DDd_2) = $(D_3-D_2)*100/D_3$

Statistical analysis

Only two varieties with 5 treatments were used for statistical analysis. Statistical analysis (2/5 treatments) were performed through factorial random block design in M_1 generation. In M_2 generation the statistical analysis was performed simply through randomised block design. Statistical software SPSS (version15) was used for Pearson multivariate tests for correlation studies.

RESULTS

The results indicated 11 synchronously matured plants were observed in the K851 and 7 mutants were observed in the Sona. The synchronously maturing plants were isolated mostly in 30Gy and also in 10, 20 and 40 Gy dose. The analysis of variance indicated a significant variance ($P<0.008$) in K851 and ($P<0.001$) for flowering, maturity and DDd for growth duration (DDd) is presented in Table-1. The mean sum of squares revealed that the days to first pod maturity, days to 90% pod maturity and DDd from first flower (DDd_1) to 90% pod maturity (DDd_1) were controlled by higher residual/environmental effect in K851 than Sona. A high heritability of 89% or more in the first flowering, first maturity, 90% of pod maturity and the degree of indetermination was observed (Table-2). The genotypic variance (Vg) ranged between 8-22%. A similar Vg for first flowering, first maturity and degree of indetermination from first pod maturity and 90% pod maturity indicated that all the three traits were additive, whilst, a higher Vg for 90% pod maturity and degree of indermination from first flowering to 90% pod maturity indicated these traits had the presence of dominance.

The mean days to flowering was lowest in 20 Gy (41.1) and ranged 41.3-43.6 days in K851. In Sona, the mean days of flowering was lowest in 20 Gy (42.6) and ranged 43.1-44.9 days in Sona (Table 3.). The mean days to maturity was lowest in 20 Gy (59.8) and ranged between 60.2-65.1 days in K851. In Sona, the mean days of flowering was lowest in control (65.3) and ranged 65.5-69.1 days. A lower DDd_1 ranged between 44.9-45.8 days in 20, 30 and 40 Gy than control (50.0) in K851 was observed. Whilst in Sona, a lower DDd_1 in 10 Gy (44.9) than contro (45.7) and DDd_2 in 10 Gy (14.4) than control (17.1) was also observed (Table-3.).

Correlation between days to flowering and the days to maturity in mungbean

The correlation were significant (r = 0.7) between mean days to flowering of K851 with the first maturity of the plant (Table-4.). Significant (r = 0.7) correlation between the mean days to flowering and first flowering in Sona (Table-4). The correlation between the first flowering and the first maturity was also significant (r = 0.7). Highly significant (r = 0.9) correlation between the mean days to flowering in Sona to the days to first maturity and full maturity (r = 0.9) was observed. The correlation between mean days to first maturity and the full maturity was also highly significant (r = 0.8). The full maturity was also significantly (r = 0.6) correlation with the degree of in determination between first pod maturity to the 90 % pod maturity.

Inverse correlation in days to full flowering to the mean days to flowering was observed in K851 and could be a reason in the inverse correlation between DDd in the first flowering to the 90% flowering with the mean flowering in K851. A similar inverse correlation was also observed between mean days to flowering to the DDd in maturity days in K851.

Table-1. Analysis of variation (ANOVA) through linear regression analysis of K851 and Sona mutagen treated seeds.

ANOVA (a)

Model	Parameter	Sum of Squares	df	Mean Square	F	Sig.
K851	Regression	1938.730	4	484.682	32.460	.008(a)
	Residual	44.795	3	14.932		
	Total	**1983.524**	**7**			

ANOVA (b)

Model	Parameter	Sum of Squares	df	Mean Square	F	Sig.
Sona	Regression	1949.167	4	487.292	431.188	.000(a)
	Residual	3.390	3	1.130		
	Total	**1952.557**	**7**			

Legends: df: degrees of freedom; F: F distribution; Sig: Level of Significance at $P<0.05$ and $P<0.0001$

Table-2. Descriptive statistics of mean, coefficient of variation, genotypic and phenotypic variance and heritability of days to flowering and the maturity days of mungbean of K851 and Sona.

Parameter	Min	Max	Mean		St. dev	CV	Vg	Vp	h^2
	Stat	Stat	Stat	SE	Stat	(%)	Stat	Stat	(%)
D_1	31	39	36.3	0.9	2.8	7.7	8.0	8.9	89.9
D_2	52	62	57.5	0.9	2.9	5.1	8.5	9.4	90.2
D_3	64	79	70.3	1.5	4.7	6.7	22.4	23.9	93.7
DDd_1	44.9	54.4	48.3	1.1	3.3	6.9	11.3	12.4	91.4
DDd_2	12.5	21.5	18.1	0.9	2.8	15.9	8.2	9.2	90.1

Legends: SE = Standard error, CV = Coefficient of variation, Vg = Genotypic variance, Vp = Phenotypic variance, h^2 = Broad sense heritability

Table-3: Mean scores of days to 50% flowering and days to maturity of K851 and Sona. [DDd from first flower to 90% pod maturity (DDd_1)]

Variety (dose)	**Days to flowering**			**Days to maturity**			**DDd_1**	**DDd_2**
K851	Mean	Min	Max	Mean	Min	Max		
Control	43.6	32	50	60.2	56	64	50.0	12.5
10	41.3	31	52	61.0	54	68	54.4	20.5
20	41.1	35	54	59.8	52	64	45.3	18.7
30	42.8	38	50	64.9	57	69	44.9	17.3
40	43.6	39	51	65.1	59	72	45.8	18.0
Sona								
Control	44.9	38	50	65.3	58	70	45.7	17.1
10	43.2	38	48	65.5	59	69	44.9	14.4
20	42.6	36	50	66.3	58	72	50.0	19.4
30	43.1	37	49	68.9	60	76	51.3	21.0
40	43.8	39	51	69.1	62	79	50.6	21.5

Table-4. Correlations among seed yield and its contributing traits of 15 selected mutant lines in M_2 generation of K851 and Sona.

		D_1	**D_2**	**D_3**	**DDd_1**	**DDd_2**
D_1	Pearson Correlation					
	Sig. (2-tailed)					
D_2	Pearson Correlation	0.70*				
	Sig. (2-tailed)	0.02				
D_3	Pearson Correlation	0.61	0.86**			
	Sig. (2-tailed)	0.05	0			
DDd_1	Pearson Correlation	-0.5	0.03	0.27		
	Sig. (2-tailed)	0.07	0.92	0.43		
DDd_2	Pearson Correlation	0.16	0.18	0.65*	0.45	
	Sig. (2-tailed)	0.65	0.60	0.04	0.18	

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

DISCUSSIONS

The major objective of the current study was to evaluate the induced synchrony in pod maturity in mungbean in terms of DDd. The significant correlation between D_3 and the DDd_2 could be important as the uniform pod maturity could help the mungbean to compete with major crops like wheat, rice and cotton as catch crop.

With the objective of early pod maturity, both K851 and Sona was the best general combiner for days to first flower, days to first maturity and days to 90% pod maturity. However, in both the genotypes the DDd from first flowering to pod maturity was found inversely correlated with the first flowering. Further higher residual effect in K851 could indicate the possibility of higher dominance in K851 than Sona and could indicate the preponderance of dominant genetic control for DDd_1 and DDd_2 in K851.

High broad sense and narrow sense heritability estimates were found for D_1, D_2 and D_3 and could indicate a higher proportion of additive genetic variance. The DDd_1 and DDd_2 showed high broad sense heritability but very low genotypic and phenotypic variance. The higher broad sense heritability estimates of D_1, D_2 and D_3, DDd_1 and DDd_2 indicate the higher success in selection for uniform pods maturing mungbean genotypes.

CONCLUSIONS

The present study suggests high broad sense heritability in the synchrony in pod maturity and could be selected in advanced generations.

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