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Inheritance of pod setting under low temperature in pigeonpea

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Abstract

Six basic populations (P_1, P_2, F_1, F_2, B_1 and B_2) of 12 crosses involving four susceptible (MAL 17, NDA-1, BHUA 96-13-3 and BHUA 96-21-4) and three tolerant (MAL 19, NDA 99-1 and NDA 49-6) genotypes were analyzed to observe the inheritance of pod setting under low temperature in pigeonpea [*Cajanus cajan* (L.) millsp]. All the F_1 s bore pods even under low temperature as was evident in tolerant parents indicating the dominancy of pod setting over susceptibility. The F_2 segregation ratio of 3:1 (tolerant : susceptible) indicated that pod setting is governed by single dominant gene. The observations of segregation pattern of B_1 (F_1 x tolerant parents) further confirmed the F_2 ratio since all the plants bore pods under low temperature. Similarly B_2 (F_1 x susceptible parents) also exhibited 1:1 (tolerant: susceptible) segregation further confirmed the F_2 ratio.

Key words: Pigeonpea, *Cajanus cajan,* inheritance, pod setting, low temperature

Introduction

Pigeonpea [*Cajanus cajan* (L.) millsp.] is the second most important pulse crops of our country [1]. It is a short day plant [2] and has been classified into four maturity groups; extra-early, early, medium and late [3]. In Northern India, the available long duration (late) varieties (maturity >200 days) are highly thermo-sensitive which have to suffer extreme of low (<6°C) and high (>35°C) temperatures during flowering and pod setting, resulting in poor yield. The photoperiod and temperature were observed to be responsible for flowering and fruiting in several crop plants. However, in pigeonpea, temperature has been found to play a crucial role for pod setting [4, 5]. The inheritance of pod setting under low temperature in pigeonpea is not yet reported. Therefore, the present investigation was carried out to study the genetics of pod setting in pigeonpea.

Materials and methods

From a collection of 140 germplasm lines that were screened for pod setting under low temperature, four thermo-sensitive (susceptible), namely, NDA 1, MAL 17, BHUA 96-13-3 and BHUA 96-21-4 and three thermo-insensitive (tolerant) i.e., MAL 19, NDA 99-1 and NDA 49-6 genotypes/varieties were selected and grown on ridges at Agricultural Research Farm, Banaras Hindu University, Varanasi during *Kharif*, 2002-2003.The crosses were made in line x tester fashion to obtain 12 cross combinations. All the 12 F_1s along with their parents were grown one row each in randomized block design with three replications during *Kharif*, 2003-2004. Each plot consisted of single row of 4 meter length and row to row and plant to plant distances were 75 and 25 cm, respectively. Further all the 12 F_1s alongwith their parents were also grown separately in crossing block to obtain 12 each of B_1s and B_2s besides 12 fresh F_1 seeds. F_1s were also selfed to produce seed for F_2 generation.

The final experiment comprising of six basic populations (P_1, P_2, F_1, F_2, B_1 and B_2) of 12 crosses accommodating one row each of parents and F_1s; two rows each of B_1s and B_2s and five rows of each F_2s, were grown in compact family block design with three replications during *Kharif*, 2004-2005. Ten randomly selected plants from each row were scored for first flower opening and first pod setting in two consecutive years i.e. 2003-2004 and 2004-2005 as per procedure given below:

Procedure for screening the thermo-sensitive/insensitive genotypes in relation pod setting under low temperature

After bud initiation, 10 randomly selected plants per row in each replication of parents were inspected on alternate days to record the data on first flower opening and first pod setting besides recording the minimum and maximum temperature (°C). The genotypes in which first flower opening followed by pod setting were successful even at lower temperature of ~ 9.3°C, treated as tolerant whereas the others who failed to set pod at

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above temperature were treated as susceptible. Following this technique, parents and F_1s (2003-2004) and all the six basic populations (2004-2005) were screened (Table 1) for pod setting under low temperature.

The x^2 test [6] was used for the study of inheritance of resistance/tolerance to pod setting under low temperature and test of goodness of fit of assumed ratios in segregating F_2 and back cross generations.

Results and discussion

From the perusal of Table 1, it appeared that there was no significant differences towards first flower opening in all the genotypes (tolerant, susceptible and F_1s) in relation to lower temperature (~9.3^{o}C) indicating thereby that first flower opening was least concerned with lower temperature. However for pod setting, significant differences were evident in tolerant and susceptible genotypes in relation to lower temperature. In tolerant genotypes, pod setting even took place at ~9.3^{o}C of lower temperature with mean of 10.2^{o}C whereas, susceptible genotypes could set pod at comparatively higher value (~13.3^{o}C of lower temperature with mean of 15.4^{o}C). Mean of higher temperatures varying from 24.4 to 29.1^{o}C were observed to be optimum for pod setting in all the genotypes which was in conformity with earlier report [5].

It may be emphasized here that at lower temperature of < 6^{o}C, all the genotypes (tolerant and susceptible) appeared to stop their flower opening/pod setting, clearly indicating that there is no marked differences among the genotypes for the trait under study at low very (<6^{o}C) temperature. At our station we could be able to record only minimum and maximum temperatures, though duration of higher and lower temperatures might be also attributed to initiate the pod setting in different genotypes. Based on pod setting at lower temperature (~ 9.3^{o}C), all the six populations were evaluated for their fruiting behaviour. It was observed that all the F_1s could set pod at similar temperature (9.2^{o}C with mean of 10.4^{o}C) as were the tolerant parents, (9.3^{o}C with mean of 10.2^{o}C) whereas the susceptible genotypes could set pod at comparatively higher temperature of 13.3^{o}C with mean of 15.4^{o}C. It clearly indicated that tolerant is dominant over susceptibility. The F_2 segregation ratio of 3:1 (tolerant: susceptible) indicated that pod setting under low temperature is governed by single dominant gene designated as 'TR'. The observations of segregation pattern of B_1 (F_1 x tolerant parents) further confirm the F_2 ratio since all the plants were observed to set pods under low temperature. Similarly, B_2 (F_1 x susceptible parents) also exhibited 1:1 (tolerant: susceptible) segregation further confirmed the F_2 ratios.

From these observations, it may be concluded that pod setting in pigeonpea is governed by single dominant

Table 1. Weighted values (range and mean) of lower and higher temperature (^{o}C) in relation to first flower opening and first pod setting in the tolerant, susceptible and F_1s over two years (2003-04 and 2004-05) in long duration pigeonpea

Genotype / F_1	First flower opening				First pod setting			
	Lower temperature(^{o}C)		Higher temperature(^{o}C)		Lower temperature(^{o}C)		Higher temperature(^{o}C)	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Tolerant								
2003-2004	8.6-13.7	10.2	22.3-28.2	26.0	7.3-12.3	9.0	18.4-27.4	23.9
2004-2005	10.9-13.8	11.7	25.6-30.7	28.5	10.4-13.6	11.1	26.4-28.8	27.0
Mean	10.0-13.6	11.2	24.3-29.1	27.3	9.3-12.8	10.2	24.8-27.6	25.5
Susceptible								
2003-2004	8.3-14.7	12.7	18.4-30.6	24.0	12.3-15.1	14.2	27.2-30.2	29.5
2004-2005	10.6-14.5	12.3	20.5-28.8	25.2	13.9-18.5	16.6	20.8-29.9	28.6
Mean	10.4-14.6	12.5	20.3-28.9	24.6	13.3-16.2	15.4	26.4-29.8	29.1
F_1 generation								
2003-2004	8.0-13.7	10.2	22.3-28.2	25.0	7.3-10.9	9.1	18.4-28.2	22.1
2004-2005	10.8-14.5	12.8	25.4-31.2	26.7	9.6-12.0	11.6	23.5-28.8	26.6
Mean	10.0-13.9	11.5	24.5-29.4	25.8	9.2-11.8	10.4	22.5-28.3	24.4

Table 2. Segregation for pod setting under low temperature in pigeonpea

S.N.	Cross/generation	Observed segregation			Expected Ratio	χ^2-value	Probability
		Total plants	Tolerant	Susceptible	(Tolerant:Sensitive)		
1	P_1 NDA-1	32	0	32			
	P_2 MAL-19	32	32	0			
	F_1 NDA-1 x MAL-19	32	32	0			
	F_2 NDA-1 x MAL-19	156	127	29	3:1	3.42	0.06
	B_1 (MAL-19 x F_1)	60	60	0			
	B_2 (NDA-1 x F_1)	60	25	35	1:1	1.67	0.20
2	P_1 NDA-1	32	0	32			
	P_2 NDA 99-1	32	32	0			
	F_1 NDA-1 x NDA 99-1	32	32	0			
	F_2 NDA-1 x NDA 99-1	154	122	32	3:1	1.46	0.23
	B_1 (NDA 99-1 x F_1)	60	60	0			
	B_2 (NDA-1 x F_1)	60	28	32	1:1	0.27	0.61
3	P_1 NDA-1	32	0	32			
	P_2 NDA 49-6	32	32	0			
	F_1 NDA-1 x NDA 49-6	32	32	0			
	F_2 NDA-1 x NDA 49-6	156	124	32	3:1	1.68	0.20
	B_1 (NDA 49-6 x F_1)	60	60	0			
	B_2 (NDA-1 x F_1)	60	32	28	1:1	0.27	0.61
4	P_1 MAL-17	32	0	32			
	P_2 MAL-19	32	32	0			
	F_1 MAL-17 x MAL-19	30	30	0			
	F_2 MAL-17 x MAL-19	155	126	29	3:1	3.27	0.07
	B_1 (MAL-19 x F_1)	60	60	0			
	B_2 (MAL-17 x F_1)	60	27	33	1:1	0.60	0.44
5	P_1 MAL-17	32	0	32			
	P_2 NDA 99-1	32	32	0			
	F_1 MAL-17 x NDA 99-1	31	31	0			
	F_2 MAL-17 x NDA 99-1	156	125	31	3:1	2.19	0.14
	B_1 (NDA 99-1 x F_1)	60	60	0			
	B_2 (MAL-17 x F_1)	60	28	32	1:1	0.27	0.61
6	P_1 MAL-17	32	0	32			
	P_2 NDA 49-6	32	32	0			
	F_1 MAL-17 x NDA 49-6	30	30	0			
	F_2 MAL-17 x NDA 49-6	154	123	31	3:1	1.95	0.16
	B_1 (NDA 49-6 x F_1)	60	60	0			
	B_2 (MAL-17 x F_1)	60	24	36	1:1	2.40	0.12
7	P1 BHUA 96-13-3	32	0	32			
	P2 MAL 19	32	32	0			
	F1 BHUA 96-13-3 x MAL-19	32	32	0			
	F2 BHUA 96-13-3 x MAL-19	156	126	30	3:1	2.77	0.10
	B1 (MAL-19 x F_1)	60	60	0			
	B2 (BHUA 96-13-3 x F_1)	60	32	28	1:1	0.27	0.61
8	P_1 BHUA 96-13-3	32	0	32			
	P_2 NDA 99-1	32	32	0			
	F_1 BHUA 96-13-3 x NDA 99-1	32	32	0			

	F_2 BHUA 96-13-3 x NDA 99-1	154	121	33	3:1	1.05	0.31
	B_1 (NDA 99-1 x F_1)	58	58	0			
	B_2 (BHUA 96-13-3 x F_1)	60	28	32	1:1	0.27	0.61
9	P_1 BHUA 96-13-3	32	0	32			
	P_2 NDA 49-6	32	32	0			
	F_1 BHUA 96-13-3 x NDA 49-6	32	32	0			
	F_2 BHUA 96-13-3 x NDA 49-6	156	123	33	3:1	1.23	0.27
	B_1 (NDA 49-6 x F_1)	60	60	0			
	B_2 (BHUA 96-13-3 x F_1)	60	32	28	1:1	0.27	0.61
10	P_1 BHUA 96-21-4	30	0	30			
	P_2 MAL 19	32	32	0			
	F_1 BHUA 96-21-4 x MAL-19	30	30	0			
	F_2 BHUA 96-21-4 x MAL-19	154	120	34	3:1	0.70	0.40
	B_1 (MAL-19 x F_1)	58	58	0			
	B_2 (BHUA 96-21-4 x F_1)	60	32	28	1:1	0.27	0.61
11	P_1 BHUA 96-21-4	30	0	30			
	P_2 NDA 99-1	30	30	0			
	F_1 BHUA 96-21-4 x NDA 99-1	30	30	0			
	F_2 BHUA 96-21-4 x NDA 99-1	156	125	31	3:1	2.19	0.14
	B_1 (NDA 99-1 x F_1)	60	60	0			
	B_2 (BHUA 96-21-4 x F_1)	58	27	31	1:1	0.28	0.60
12	P_1 BHUA 96-21-4	32	0	32			
	P_2 NDA 49-6	32	32	0			
	F_1 BHUA 96-21-4 x NDA 49-6	32	32	0			
	F_2 BHUA 96-21-4 x NDA 49-6	160	130	30	3:1	3.33	0.07
	B_1 (NDA 49-6 x F_1)	60	60	0			
	B_2 (BHUA 96-21-4 x F_1)	58	30	28	1:1	0.07	0.79

gene which can be easily transferred by back crossing. However, it could be desirable, if the aforesaid experiment would have been conducted in a controlled temperature and photoperiod to have a clear picture about the inheritance of pod setting at low temperature. To have a realistic information on such type of studies, it is suggested that a large number of genotypes should be screened in controlled environment and resulted tolerant and susceptible genotypes, their F_1s and segregating generations need to be evaluated to confirm the finding of present investigation.

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