Development of a cytoplasmic-nuclear male-sterility system in pigeonpea

Progress Report 1996-97

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GMS based hybrids:

- high yield
- high adaptation
- greater wilt resistance
- greater drought tolerance
- very poor adoption

Impact of hybrid technology (Niranjan et al.)

- seed production cost within affordable limits
- reluctance in removing flowering plants
- insufficient compensation
- delayed payments
- demand for hybrids is high
- CMS hybrid would become popular

.... GMS based hybrid technology and its R&D have paid dividends in terms of creating AWARENESS AND INFRASTRUCTURE at the national level .....

Approaches

- use of alien cytoplasm
- mutagenesis

Table 1. Pollen sterility and frequency of male-sterile plants in different genome transfer stages (GTS)

Year/ Season	Genome transfer stage	No. of plants	Pollen sterility (%) range	Frequency of male-steriles (%)
1991	1	1	37	0
1992	2	5	23-97	20
1993	3	4	5-100	75
1993G	4*	8	93-100	100
1994	5	29	4-100	54
1994R	6 (9-8 sel.)	42	5-100	38
1994G	6 (12-3 sel.)	23	5-100	70
1995	7 (9-8 sel.)	403	5-100	51
1995	7 (12-3 sel.)	332	5-100	54

* [(*C. sericeus* x ICPX 880227-10-1 x ICPL 90035) x ICPL 85030] = Plant IV x ICPL 85030
G = Glasshouse; R = *Rabi* season

Action plan for 1996-97 season

- Use large population in each cross
- Increase intensity of selection within promising 'A' lines
- Exercise selection within promising 'B' lines through progeny testing
- For effective selection adopt pollen viability test
- Exercise selection for fertility restorers within the segregating populations
- Search new sources of 'B' and 'R' lines in diverse germplasm
- For rapid information grow 2-3 generations within a year using field/glasshouse facilities

Table 2. Number of pollinations made and plants examined for pollen viability in 1995-96 and 1996-97 seasons

Materials	1995-96		1996-97		
	Crosses	Pollinations	Plants examined	Crosses	Pollinations
Wide hybridization					
9-8 selections	389	16,478	3,026	294	14,700
12-3 selections	228	8,118	3,738	236	22,000
Fertility restoration	158	7,900	8,000	151	15,100
Total	775	32,496	14,764	681	51,800
Mutagenesis					
Selections	146	9,608	60	258	14,591
Fertility restoration	174	7,800	-	33	4,252
Total	320	17,408	60	291	18,843
Grand Total	1,095	49,904	14,824	972	70,643

Table 3. Summary of selections made among 9-8 progenies in GTS 8 during 1996 rainy season.

Prog No.	No. of progenies		Plants examined	Remarks
	Planted	Selected		
2	73	10	1065	Selections from RCW 19
5	21	1	421	
8	24	3	363	
9	34	4	322	
10	86	12	838	
1	22	0	-	Selections from BW-6
3	19	0	-	
7	16	0	-	
11	17	1	17	
12	15	0	-	
13	20	0	-	
15	1	0	-	
16	2	0	-	
18	8	0	-	
19	7	0	-	
25	5	0	-	
26	7	0	-	
28	12	0	-	
Total	389	31	3026	

Table 4. Segregation for male-sterility in 9-8 selections in GTS 8 grown in RCW 19 during 1996-97 rainy season.

Plot No.	Selection	Pollinator	Number of plants		% Steriles
			Total	Sterile	
157	A 2-1	B-48	45	30	67
158	A 2-2	B-2	10	8	80
159	A 2-2	B-49	22	15	68
163	A 2-8	B-97	6	5	83
164	A 2-10	B-4	27	18	67
185	A 2-22	B-58	17	13	77
193	A 2-33*	B-15	19	18	95*
194	A 2-33*	B-62	16	16	100*
195	A 2-33*	B-109	5	5	100*
2999	A 2-33*	B-(OP)	32	32	100*
209	A 2-46	B-21	11	8	73
420	A 5-27	B-33	19	13	68
425	A 8-3	B-45	4	4	100
431	A 8-6	B-14-2	6	5	83
437	A 8-14	B-77-2	10	8	80
447	A 9-1	B-55	9	8	89
449	A 9-3	B-58	18	12	67
460	A 9-22	B-171	37	26	70
463	A 9-26	B-63	11	8	73
258	A 10-1	B-69	28	18	64
261	A 10-3	B-70	12	9	75
271	A 10-11	B-121	7	5	71
272	A 10-13	B-28	18	12	67
277	A 10-14	B-170	10	7	70
286	A 10-20	B-126	4	4	100
287	A 10-21	B-80	32	20	67
289	A 10-24	B-81	26	18	69
290	A 10-26	B-35	11	8	73
294	A 10-27	B-83	7	7	100
307	A 10-34	B-134	4	4	100
322	A 10-39	B-92	17	15	88
908	A 11-30	B-16	17	17	100
	Total		517	396	81

* Most promising 'A' line

Table 5. Summary of selections made among 12-3 progenies during 1996 rainy season.

Prog. No.	Number of progenies		Plants examined	Remarks
	Planted	Selected		
2	22	5	424	Selections from RCE 24 field
7	54	14	770	
8	57	4	476	
9	18	1	159	
1	7	0	141	Selections from RM 1A field
3	2	0	140	
4	6	0	244	
5	9	0	332	
6	19	2	445	
10	7	0	95	
11	5	2	79	
12	7	3	195	
13	13	2	213	
14	2	1	25	
Total	228	34	3738	

Table 6. Segregation for male-sterility in 12-3 selections in GTS 8 grown in RCE 24 and RM 1A during 1996-97 rainy season.

Plot No.	Selection	Pollinator	Number of plants		% Steriles
			Total	Steriles	
7	A 2-9	B-321	17	12	71
8	A 2-9	B-6	5	5	100
16	A 2-31	B-332	11	8	73
17	A 2-31	B-9	7	6	86
6	A 2-6	B-319	8	6	75
38	A 7-17*	B-386	31	29	94*
44	A 7-22*	B-389	26	21	81*
45	A 7-22	B-15	11	7	64
51	A 7-26	B-392	30	22	73
54	A 7-27	B-4	21	13	62
55	A 7-27	B-509	16	14	88
56	A 7-28	B-394	47	32	68
59	A 7-30	B-7	11	8	73
60	A 7-33*	B-397	11	10	91*
61	A 7-33*	B-510	25	18	72*
62	A 7-33*	B-14	12	10	83*
67	A 7-9	B-68-2	20	13	65
73	A 7-27	B-79-2	5	3	60
74	A 7-28	B-84-4	8	6	75
80	A 8-3	B-399	32	20	63
81	A 8-3	B-2	16	10	63
94	A 8-12	B-407	26	17	65
103	A 8-18	B-14	42	27	64
138	A 9-2	B-423	24	17	71
789	A 6-11	B-360	7	7	100
798	A 6-24	B-369	3	3	100
813	A 11-8	B-449	8	7	88
814	A 11-12	B-450	5	4	80
818	A 12-4	B-456	17	13	76
821	A 12-11	B-460	8	7	88
823	A 12-12	B-461	9	7	78
826	A 13-5	B-464	8	7	88
829	A 13-8	B-468	2	2	100
838	A 14-11	B-479	9	9	100
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	Total/Mean		538	400	85

* Promising progenies

Table 7. Pollen fertility of hybrids involving some male-sterile selections derived from wide hybridization and unrelated genotypes during 1996 season

Cross	Pollen fertility of hybrids		
	>95%	95-90	89-85
A 7-22 x R-40	*		
A 2-16 x R-55			*
A 2-18 x R-104			*
A 5-14 x R-352		*	
A 8-29 x R-421	*		
A 10-6 x R-438			*
A 8-29 x R-518	*		
A 4-17 x R 88034	*		
A 1101-7 x R-87-5	*		

Table 8. Summary of materials planted and selections made in mutant progenies, 1996-97 season

Identification	Crosses		Sibs	
	Planted	Selected	Planted	Selected
575	16	2	11	3
577	9	2	3	2
579	13	3	3	1
831	12	0	18	4
836	8	3	16	5
839	17	3	0	0
880	20	4	6	2
882	21	4	5	1
960	7	0	1	1
979	12	0	2	0
Total	135	21	65	19

Fertility restorers of mutant CMS selections

ICPL 87091
8095
89011
89018
MPG 537

Table 9. Response to selection in some promising progenies derived from mutagenesis and wide hybridization.

Progeny	1995		1996		1996 selections		
	Pop.	% Sterility	Pop.	% Sterility	Prog.	Pop.	% Sterility
Wide hybridization (9-8 selections):							
2	44	55	1339	48	10	178	76
8	26	54	544	45	3	20	85
10	42	74	717	52	12	176	72
Wide hybridization (12-3 selections):							
2	34	62	408	58	4	48	77
7	32	72	634	59	14	274	75
8	29	83	344	62	4	116	64
Mutants (sibs):							
575	26	85	359	52	2	100	68
880	110	66	507	42	4	150	67
882	84	77	646	48	4	263	66
Mutants (crosses):							
575	26	85	452	61	3	109	80
831	45	80	591	65	5	194	75
836	44	82	524	64	7	235	73

Table 10. Segregation for male-sterility in crosses, sibs, and maintainers in the progenies of mutant selection number 575.

Season	Identification	No. of plants		% Steriles
		Total	Steriles	
1995	A 575	26	22	85
1996	A 575 sibs	365	219	60
	A 575 crosses	359	185	52
	B 575 sibs	110	40	36
	B 575 crosses	121	15	12
	B 575 selection - 1	7	0	0
	- 2	5	0	0
	- 3	23	3	13

Stability

Months Sept, Nov, Dec

Temp. range 10°C - 31°C

Microsporogenesis

- Fertile and sterile similar upto pre-meiotic stage
- degeneration at late stage

Seedling deformities

- Normal seedlings 7%
- Defective primary leaves 62%
- Flat stem/twin seedlings 16%
- No germination 15%

Table 11. The most promising CMS materials identified in 1996 season

Plot No./ Materials	Cross	Number of plants		% Sterility
		Total	Steriles	
Wide hybridization				
193	A 2-33 x B-15	19	18	95
194	A 2-33 x B-62	16	16	100
195	A 2-33 x B-109	6	6	100
2999	A 2-33 x B (OP)	32	32	100
908	A 11-30 x B-16	13	13	100
38	A 7-17 x B-386	31	29	94
44	A 7-22 x B-389	26	21	81
60	A 7-33 x B-397	11	10	91
61	A 7-33 x B-510	25	18	72
62	A 7-33 x B-14	12	10	83
Mutagenesis				
1529	SAM A-1529 x B-1544	22	19	86
1532	SAM A-1532 x B-1545	67	54	81
1543	SAM A-1543 x B-1552	11	9	82
1619	SAM A-1619 x B-1650	22	18	82
1639	SAM A-1639 x B-1660	10	8	80
1676	SAM A-1676 x B-1708	17	15	88
1764	SAM A-1764 x B-1804	10	8	80