

Project at a Glance

- 1. Title of the Project:** Evaluation and production of cytoplasmic genetic male sterility (CGMS) based hybrids for enhancement of productivity and stability of yield in pigeonpea.
- 2. Name of the Funding Agency:** DAC, Ministry of Agriculture & Cooperation, Govt. of India Under NFSM
- 3. Name of the Coordinator :** Dr. N Nadarajan
Director, IPR, Kanpur

4. Cooperating centers and name of the PIs & Co-PIs

S.No.	Cooperating Center	Principal Investigator	Co-Principal Investigator
1.	IIPR, Kanpur	Dr. I. P. Singh Principal Scientist	Dr. Abhishek Bora Scientist
2.	ICRISAT, Hyderabad	Dr. K.B. Saxena Principal Scientist	-
3.	SDAU, S.K. Nagar	Dr. Y Ravindra Babu Principal Scientist (Pulses)	-
4.	PDKV, Akola	Dr. A .N. Patil Senior Research Scientist	Shri M P Meshram Jr. Scientist
5.	TNAU, Coimbatore	Dr. A. R. Muthaiah Professor (Pulses)	-
6.	PAU, Ludhiana	Dr. Sarvjeet Singh Principal Scientist	Dr. Inderjeet Singh Senior Scientist
7.	IARI, New Delhi	Dr. R.S. Raje Sr. Scientist	-
8.	ARS, Gulberga	Dr. P.S. Dharmaraj Professor	--
9.	ARS, Badnapur	Dr. K R Kambale Principal Scientist	Dr Srikant Sarode Scientist
10.	JNKVV, Jabalpur	Dr. D N Khare Principal Scientist	-

5. Voluntary Centers

S.No.	Cooperating Center	Cooperator	Associate
1.	ARS Bharuch	Dr A R Nizama Sr. Scientist	-
2.	MPKV, Rahuri	Dr. P.N. Harer Principal Scientist	Dr. LB. Mhase Associate Scientist
3.	RR,S Rewa	Dr. D N Khare Principqal Scientist	-
4.	RARS, ANGRAU, Warangal	Dr. P. Jagamohan Rao Senior Scientist	Dr. T. Shobha Rani Scientist
5.	NPRC, Vamban	Dr. M Pandiyan Sr. Scientist	-
6.	UAS Bangalore	Dr. M Byregowda Principal Scientist	-

6. **Duration of the project** : 1 Year
7. **Date of start of the project** : 01.04.2011
8. **Date of Completion of project** : 30.03.2012
9. **Budget of the project** : Rs. 180.28 Lakh

Mission and Objectives

Mission: Development of CGMS based high yielding commercial hybrids.

Objectives:

- 1. To produce new high yielding CGMS-based hybrids in early and medium maturity groups and assessing their yield superiority and stability in different agro-ecological zones of India.**
- 2. To evaluate already developed CGMS-based hybrids of early and medium maturity groups in multilocal trials for assessing their yield superiority and stability in different agro-ecological zones of India.**
- 3. To develop molecular markers for testing the purity of hybrids for grow out test.**
- 4. To build human resource capacity for production of hybrids and hybrid seed through training.**

Summary of the Progress Report (2011-12)

In order to develop CMS based hybrids in short and medium duration pigeonpea, research activities envisaged under different programmes were carried out at ten locations and six voluntary centers. Programme-wise progress made during 2011-12 is summarized as under:

A. Development of Hybrids

In total, 819 experimental hybrids were made at different centers. Of them, 568 in short duration and 251 in medium duration pigeonpea were attempted at IIPR, PAU, IARI, TNAU, ICRISAT, PDKV, SDAU and JNKVV involving available CMS lines and restorers.

Centre	Number of hybrids developed			Remarks
	Short	Medium	Total	
IIPR	15	-	15	>1000-5000 seeds were harvested from different each and every cross combination
PAU	261	-	261	Range of the number of seeds harvested from cross combination was 2-64.
IARI	74	-	74	Sixteen CMS lines of A2 cytoplasm and ten of A4 cytoplasm were crossed with 6 restorers.
TNAU	70	48	118	CMS lines of A2 cytoplasm and A4 cytoplasm were used to develop cross combinations...
ICRISAT	82	-	82	57 promising hybrids were reconstituted and 25 new combinations were developed
Gulbarga	-	-	-	Information not available.
PDKV	36	58	94	Number of seed varied from 20-2537 in different cross combinations.
SDAU	30	57	87	Fertility restoration will be evaluated
JNKVV	-	88	88	Seven CMS lines of A2 cytoplasm and one line of A4 cytoplasm were used to develop cross combinations...
Badnapur	-	-	-	Information not available.

B. Evaluation of Hybrids

As per the technical programme, nine trials namely, IHT (early) North Zone, IHT (early) Central Zone, IHT (early) South Zone, AHT 1 (Early) North Zone, AHT 1 (Early) Central Zone AHT 1 (Early) South Zone, AHT 2 (Early) North Zone, IHT (medium) Central and South Zones and AHT-1 (medium) Central Zone were conducted at different locations with details as given below:

Trial	# of locations	Location	Hybrids	DOS
IHT(E) NZ	5	IIPR, Kanpur (Main Farm)	4+3	26-Jun-11
		IIPR, Kanpur (NRF)	4+3	18-June-11
		PAU, Ludhiana	4+3	31-May-11
		Faridkot, Punjab	4+3	7-Jun-11
		IARI, New Delhi	4+3	1-Jun-11
IHT(E) CZ	7	SDAU, SK Nagar	7+3	19-Jul-11
		PDKV, Akola	7+3	9-Jul-11
		JNKVV, Jabalpur	7+3	8-Jul-11
		ARS, Badnapur	7+3	18-Jul-11
		MPKV, Rahuri	7+3	13-Jul-11
		RARS, Rewa	7+3	12-Jul-11
		ARS, Bharuch	7+3	15-Jul-11
IHT(E) SZ	6	TNAU, Coimbatore	5+3	13-Sep-11
		ICRISAT, Patancheru	5+3	-
		ARS, Gulberga	5+3	16-Jul-11
		RARS, Warangal	5+3	18-Jul-11
		UAS, Bangalore	5+3	-
		NPRC Vamban	5+3	15-Jul-11
AHT 1(E) NZ	5	IIPR, Kanpur (Main Farm)	2+3	26-Jun-11
		IIPR, Kanpur (NRF)	2+3	18-June-11
		PAU, Ludhiana	2+3	31-May-11
		Faridkot, Punjab	2+3	7-Jun-11
		IARI, New Delhi	2+3	1-Jun-11
AHT 1(E) CZ	4	SDAU, SK Nagar	3+3	19-Jul-11
		PDKV, Akola	3+3	9-Jul-11
		JNKVV, Jabalpur	3+3	8-Jul-11
		ARS, Badnapur	3+3	18-Jul-11
AHT 1(E) SZ	5	TNAU, Coimbatore	4+3	13-Sep-11
		ICRISAT, Patancheru	4+3	-
		ARS, Gulberga	4+3	19-Jul-11
		RARS, Warangal	4+3	18-Jul-11
		UAS, Bangalore	4+3	10-Aug-11
AHT 2(E) NZ	5	IIPR, Kanpur (Main Farm)	1+3	26-Jun-11
		IIPR, Kanpur (NRF)	1+3	18-June-11
		PAU, Ludhiana	1+3	31-May-11
		Faridkot, Punjab	1+3	7-Jun-11
		IARI, New Delhi	1+3	1-Jun-11
IHT(M) CZ & SZ	13	SDAU, SK Nagar	11+4	17-Jul-11
		PDKV, Akola	11+4	9-Jul-11
		JNKVV, Jabalpur	11+4	8-Jul-11
		ARS, Badnapur	11+4	18-Jul-11
		MPKV, Rahuri	11+4	14-Jul-11
		RARS, Rewa	11+4	12-Jul-11
		ARS, Bharuch	11+4	15-Jul-11
		TNAU, Coimbatore	11+4	17-Aug-11
		ICRISAT, Patancheru	11+4	-
		ARS, Gulberga	11+4	15-Jul-11
		RARS, Warangal	11+4	18-Jul-11
		UAS, Bangalore	11+4	22-Jul-11
		NPRC Vamban	11+4	15-Jul-11
AHT-1(M) CZ	5	SDAU, SK Nagar	5+4	17-Jul-11
		PDKV, Akola	5+4	9-Jul-11
		JNKVV, Jabalpur	5+4	8-Jul-11
		ARS, Badnapur	5+4	18-Jul-11
		MPKV, Rahuri	5+4	14-Jul-11

- In total, 26 short duration and 16 medium duration hybrids were evaluated at 18 locations.
- In **IHT (early) North zone**, four hybrids along with 3 checks were evaluated at five locations in North India. Range for days to 50% flowering among hybrids varied from 100 (PHP 34) to 119 (IPH 11-2) days while days to maturity had a variation from 144 (PHP 34) to 157 (IPH 11-1 and 11-2) days. The highest yielding hybrid was **IPH 11-1** (2063 kg/ha), recording **21.41% yield superiority** over the best check Pusa 992 (1699 kg/ha). This hybrid showed pollen fertility of 91.8 % with average seed size of 9.7 g per 100-grains (**Tables 1, 1A, 1B**).
- In **IHT (early) Central zone**, 7 hybrids along with 3 checks were evaluated at five locations in central India. Range for days to flowering among hybrids varied from 91 (IPH 11-4) to 104 (SKNPCH 0923) days. The total crop duration in hybrids ranged from 140 (IPH 09-08) to 152 (SKNPCH 0752) days. The highest yielding hybrid was **SKNPCH 0923** (1585 kg/ha), recording **24.80% yield superiority** over the best check GT H1 (1270 kg/ha). This hybrid showed good plant fertility (95 %) with good grain size of 9.7 g per 100-grains (**Tables 2, 2A, 2B and 2C**).
- In **IHT (early) South zone**, 5 hybrids along with 2 checks were evaluated at three locations in south India. Days to 50% flowering among hybrids ranged from 73 (CPH 09-15) to 78 (AKPHE-05002) days. Range for days to maturity among hybrids varied from 118 (CPH 09-15) to 124 (AKPHE-05002) days. The highest yielding hybrid was **AKPHE-05002** (1653 kg/ha), recording **12.67% yield superiority** over the best check CORG 9701 (1467 kg/ha). The plant fertility was good with 92 % fertility. The average grain size of 8.9 g per 100-grains (**Tables 3, 3A, 3B, 3C**).
- In **AHT 1 (early) North zone**, two hybrids along with 3 checks were evaluated at five locations in North India. Range for days to 50% flowering among hybrids varied from 115 (IPH 10-3) to 116 (IPH 10-2) days while days to maturity was 160 (IPH 10-2 and IPH 10-3) days. The highest yielding hybrid was **IPH 10-2** (2052 kg/ha), recording **31.28% yield superiority** over the best check Pusa 992 (1563 kg/ha). This hybrid showed pollen fertility of 97 % with average seed size of 8.3 g per 100-grains. Other hybrid with more than 10% yield advantage over the best check was **IPH 10-3** (**Tables 4, 4A, 4B, 4C**).
- In **AHT 1 (early) Central zone**, three hybrids along with 3 checks were evaluated at three locations in Central India. Range for days to 50% flowering among hybrids varied from 98 (AKPHE-04012) to 103 (SKNPCH-0835) days while range for days to maturity was 141 (AKPHE-04012) to 145 (SKNPCH-0835) days. The highest yielding hybrid was **SKNPCH-0835** (1440 kg/ha), recording **4.50% yield superiority** over the best

check GTH 1 (1378 kg/ha). This hybrid showed pollen fertility of 100 % with average seed size of 10.7 g per 100-grains (**Tables 5, 5A, 5B**).

- In **AHT 1 (early) South zone**, four hybrids along with 2 checks were evaluated at four locations in South India. Range for days to 50% flowering among hybrids varied from 79 (SKNPCH-0626 and AKPHE-04012) to 95 (SKNPCH-0835) days while range for days to maturity was 126 (AKPHE-04012) to 130 (SKNPCH-0626) days. The highest yielding hybrid was **SKNPCH-0840** (1324 kg/ha), recording **40.40% yield superiority** over the best check CORG 9701 (943 kg/ha). This hybrid showed pollen fertility of 91 % with average seed size of 9.9 g per 100-grains. Other two hybrids viz. **SKNPCH-0626** and **AKPHE-04012** recorded **26.62** and **13.89 % yield superiority**, respectively over the best check CORG 9701 (943 kg/ha). Hybrids **SKNPCH-0626** and **AKPHE-04012** showed pollen fertility of 92 and 93 % with average seed size of 9.1 and 9.2 g per 100-grains, respectively. (**Tables 6, 6A, 6B, 6C**).
- In **AHT 2 (early) North zone**, one hybrid (**IPH 09-5**) along with 3 checks was evaluated at five locations in North India. Fifty per cent flowering and maturity took 112 and 157 days, respectively for this hybrid. Hybrid **IPH 09-5** (2038 kg/ha), recorded **33.90% yield superiority** over the best check AL 201 (1522 kg/ha). This hybrid showed pollen fertility of **94 %** with average seed size of 10.3 g per 100-grains (**Tables 7, 7A, 7B, 7C**).
- In **IHT (Medium) Central zone**, 11 hybrids along with 4 checks were evaluated at five locations in central India. The earliest flowering hybrid was AKPHM-13344 taking 103 days to 50% flowering while the ICPH 3359 took 120 days to 50% flowering. Range for days to maturity among hybrids varied from 158 (AKPHM-13344) to 172 (ICPH 3359 and ICPH 3477) days. The highest yielding hybrid was **SKNPCH-0932** (2077 kg/ha), recording **19.29%** yield superiority over the best check BSMR 736 (1741 kg/ha). This hybrid showed pollen fertility of **100 %** with average seed size of 10.8 g per 100-grains (**Tables 8A, 8D, 8E, 8F, 8G, 8H**).
- In **IHT (Medium) South zone**, 11 hybrids along with 4 checks were evaluated at five locations in South India. The earliest flowering hybrid was AKPHM-13344 taking 99 days to 50% flowering while the ICPH 3359 took 114 days to 50% flowering. Range for days to maturity among hybrids varied from 151 (AKPHM-13344 and SKNPCH-0860) to 165 (ICPH 3359) days. The highest yielding hybrid was **AKPHM-10259** (1520 Kg/ha), recording **2.91%** yield superiority over the best check CO 6 (1477 Kg/ha). This hybrid showed pollen fertility of **90 %** with average seed size of 10.6 g per 100-grains (**Tables 8B, 8D, 8E, 8F, 8G, 8H**).
- In **AHT-1 (Medium) Central zone**, five hybrids along with 4 checks were evaluated at four locations in central India. The earliest flowering hybrid was AKPHM-10178 taking 104 days to 50% flowering while the SKNPCH-0935 took 116 days to 50% flowering.

Range for days to maturity among hybrids varied from 165 (AKPHM-10178) to 169 (SKNPCH-0935) days. The highest yielding hybrid was **AKPHM-11303** (1618 Kg/ha), recording **35.39%** yield superiority over the best check BSMR 736 (1195 Kg/ha). This hybrid showed pollen fertility of **100 %** with average seed size of **12.3 g** per 100-grains. Other hybrids superior to best check were SKNPCH-0935 (16.23%), SKNPCH-0732 (11.12%) and AKPHM-10303 (5.69%). (**Tables 9, 9A, 9B, 9C, 9D, 9E**).

- Four hybrids viz. IPH 09-5, AKPHE-10303, AKPHE-11303 and IPH 10-2 showed resistance and three hybrids viz. AKPHE-04012, AKPHE-10178 and IPH 10-3 showed susceptibility to *Fusarium* wilt at IIPR. Hybrids, IPH 09-5, AKPHE-04012, AKPHE-10178 and AKPHE-10303 showed susceptibility to *Fusarium* wilt at Gulbarga. Four hybrids viz. AKPHE-04012, AKPHE-10178, AKPHE-10303 and AKPHE-11303 showed susceptible reaction to sterility mosaic disease at Bangalore. (**Table 10**).

C. Studies on identification of molecular markers

- AT I I P R, Kanpur in order to assess the genetic diversity in existing A, B and R- lines in pigeonpea, genomic-DNA was extracted from 12 A (sterile lines), 12 B (maintainer lines) and 38 R (restorer lines). The 12 A-lines were derived from three different cytoplasm *i.e.* *C. cajanifolius*, *C. scarabaeoides* and *C. sericeus*. To start with, PCR optimization was carried out for a total of 196 BAC-end sequences derived SSRs (BESSRs) (also known as CcM series). Scorable amplicons were obtained for all the SSRs. However no DNA polymorphism was detected using these SSRs. This may be due narrow genetic base of *Cajanus* and less informative SSR markers used for analysis. In order to address the problem of low marker polymorphism, an extensive survey was performed on availability of SSR marker in public domain in pigeonpea. This search resulted in identification of more than 4000 for pigeonpea. Of these, a total of 150 SSRs were chosen for synthesis and the selection was based on following marker features:

- i) hyper variable nature or Class II SSRs (having SSR tract length ≥ 20 bp)
- ii) higher polymorphism information content (PIC)
- iii) greater resolving power.

PCR profiles were standardized for all newly synthesized 150 SSRs and six SSR markers viz. CCB9, CCB10, HASSR4, HASSR5, HASSR6 and Ccttc001 exhibited DNA polymorphism among the A-and R-lines used in the present investigation.

- At TNAU, Coimbatore polymorphic SSRs were identified for the parents ICPA 2155 (CMS line) and PA 128R (Restorer line) of hybrid CPH 09-12 and parents ICPA 2043 (CMS line) and CO 25R (Restorer line) of hybrid CPH 09-3.
- At SDAU S K Nagar, 40 microsatellite primers that were analyzed; three primers viz; CcM0021, CcM0030 and CCB9 were selected which produced three unique bands in parents and their hybrid. One band of size 190bp produced by CcM0030 was conspicuous. It was not present in female parent GT 288A but was present in male parent GTR 11 and hybrid GTH 1. It could facilitate in identifying the veracity of the hybrid seed produced on GT 288A with GTR 11.

D. Capacity Building for Hybrid Pigeonpea Programme

- At SDAU S K Nagar, Training for Maintenance breeding of field crops was organized on 16-17 Dec 2011. That includes Seed production and Maintenance of A, B and R lines of CGMS based pigeonpea hybrids. Total 40 participants (from SAU's, KVK's and Department of Agril. Govt. of Gujarat) were trained.
- AT ICRISAT, Hyderabad a total of 336 persons including Seed officers, Agriculture Officers, and farmers of Ranchi, Maharashtra and Odisha States were trained in hybrid seed production technology. In this program 42 officers from NSC were also trained in pigeonpea hybrid seed production activities during 2011 season.

Table 1: Mean performance of short duration hybrids in IHT (E) over the locations in North Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant Fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% Gain over best check
1	IPH 11-1	112	157	91.8	9.7	2063	I	21.41
2	IPH 11-2	119	157	94	9.7	1958	II	15.25
3	IPH 11-3	112	156	95.5	9.0	1740	III	2.40
4	PHP 34	100	144	68.3	8.3	1661		
5	UPAS 120(ch)	125	164	99.3	7.7	1599		
6	P-992 (ch)	104	150	99	8.9	1699	IV	
7	AL201(ch)	94	139	99.3	7.7	1585		
Overall mean		109	152	92.4	8.7	1758		

Table 1A: Location-wise performance of short duration hybrids for 100-seed weight (g) and grain yield (Kg/ha) in IHT (E) in North Zone

S. No.	Entry	100-seed weight						Yield (Kg/ha)					
		IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean	IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean
1	IPH 11-1	8.7	10.0	9.2	9.7	10.7	9.7	2172	1817	2225	1748	2352	2063
2	IPH 11-2	9.5	9.0	9.1	10.2	10.5	9.7	2416	1763	1692	1699	2221	1958
3	IPH 11-3	8.7	9.4	8.7	8.8	9.7	9.0	1434	1256	1974	2222	1813	1740
4	PHP 34	7.7	8.7	7.4	7.5	10.5	8.3	702	899	2296	2156	2254	1661
5	UPAS 120(ch)	8.1	7.7	7.1	8.2	7.3	7.7	1644	1493	1666	1559	1633	1599
6	P-992 (ch)	8.5	8.9	8.3	8.4	10.7	8.9	1457	1038	2275	1830	1895	1699
7	AL201(ch)	7.5	6.9	7.0	7.9	9.3	7.7	863	841	1877	2288	2058	1585
Location Mean		8.4	8.6	8.1	8.7	9.8	8.7	1527	1301	2001	1929	2032	1758
CD at 5%								513.6	418.6	241.3	301.0	161.8	
CV(%)								18.9	18.1	6.8	8.8	4.5	

Table 1B: Location-wise performance of short duration hybrids for days to 50% flowering, days to maturity and plant fertility (%) in IHT (E) in North Zone

S. No.	Entry	Days to 50% Flowering						Days to Maturity						Plant Fertility (%)					
		IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean	IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean	IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean
1	IPH 11-1	98	93	126	123	119	112	143	145	166	165	167	157	95	93	84	95	100	92
2	IPH 11-2	107	106	128	129	123	119	145	149	165	163	165	157	94	93	94	95	100	94
3	IPH 11-3	96	98	123	123	120	112	142	142	160	166	168	156	98	97	92	95	100	95
4	PHP 34	91	88	116	103	101	100	136	134	152	148	149	144	48	50	87	88	100	68
5	UPAS 120(ch)	120	114	133	131	127	125	155	158	170	168	170	164	100	100	97	100	100	99
6	P-992 (ch)	94	92	113	114	109	104	140	143	150	158	159	150	100	100	96	100	100	99
7	AL201(ch)	85	83	104	101	97	94	135	137	142	141	141	139	100	100	97	100	100	99
Location Mean		99	96	120	118	114	109	142	144	158	158	160	152	91	90	92	96	91	92

Table 2: Mean performance of short duration hybrids in IHT (E) over the locations in Central Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant Fertility (%)	100-seed weight (g)	Grain Yield (kg/ha)	Ranking	% gain over best check
1	IPH 11-4	91	135	99	9.5	1091		
2	SKNPCH 0821	101	143	96	9.4	1232		
3	SKNPCH 0923	104	145	95	9.7	1585	I	24.80
4	SKNPCH 0924	99	139	85	9.0	1363	II	7.32
5	AKPHE 04295	96	138	95	9.5	1286	III	1.25
6	AKPHE 05002	98	140	97	10.3	1152		
7	AKPHE 05012	93	141	99	9.6	1169		
8	UPAS 120 (Ch)	97	139	100	8.5	919		
9	GTH 1(Ch)	99	142	93	10.2	1270	IV	
10	GT101(Ch)	100	146	100	12	1159		
Overall mean		98	141	96	9.8	1223		

Table 2A: Location-wise performance of short duration hybrids for grain yield (kg/ha) in IHT (E) in Central Zone*

S. No.	Entry	Grain yield (kg/ha)					
		S.K. Nagar	Akola	Badnapur	Rahuri	Bharuch	Mean
1	IPH 11-4	1123	1500	1025	1036	771	1091
2	SKNPCH 0821	1370	1591	856	1386	958	1232
3	SKNPCH 0923	1877	1320	1603	1936	1190	1585
4	SKNPCH 0924	1556	1490	1238	1508	1023	1363
5	AKPHE 04295	1617	1485	1070	1536	723	1286
6	AKPHE 05002	1452	1647	853	933	877	1152
7	AKPHE 05012	1427	1549	721	1236	912	1169
8	UPAS 120 (Ch)	1135	1183	750	939	586	919
9	GTH 1(Ch)	1739	1268	1036	1667	639	1270
10	GT101(Ch)	1623	1127	862	1442	741	1159
Location Mean		1492	1416	1001	1362	842	1223
CD at 5%		429.30	268.18	254.81	473.40	74	
CV%		16.77	11.04	12.36	19.26	5.22	

*Trials were viciated at Jabalpur & Rewa

Table 2B: Location-wise performance of short duration hybrids for days to 50% flowering and maturity in IHT (E) in Central zone*

S. No.	Entry	Days to 50% Flowering						Days to Maturity					
		S.K. Nagar	Akola	Badnapur	Rahuri	Bharuch	Mean	S.K. Nagar	Akola	Badnapur	Rahuri	Bharuch	Mean
1	IPH 11-4	110	81	91	75	99	91	152	124	129	120	152	135
2	SKNPCH 0821	113	99	99	87	109	101	153	135	136	131	159	143
3	SKNPCH 0923	114	99	105	95	108	104	155	125	145	141	158	145
4	SKNPCH 0924	111	93	93	86	110	99	151	129	134	121	159	139
5	AKPHE 04295	111	93	94	83	98	96	152	130	133	122	152	138
6	AKPHE 05002	112	93	92	85	108	98	155	131	136	122	158	140
7	AKPHE 05012	113	85	91	76	100	93	153	134	145	122	152	141
8	UPAS 120 (Ch)	115	95	94	86	96	97	158	132	133	122	150	139
9	GTH 1(Ch)	111	98	97	83	105	99	149	134	137	135	153	142
10	GT101(Ch)	117	96	99	81	106	100	159	130	147	141	154	146
Location Mean		113	93	95	84	104	98	154	130	137	128	155	141

*Trials were viciated at Jabalpur & Rewa

Table 2C: Location-wise performance of short duration hybrids for plant fertility (%) and 100-seed weight (g) in IHT (E) in Central Zone*

S. No.	Entry	Plant Fertility (%)				100-Seed weight (g)					
		S.K. Nagar	Akola	Badnapur	Mean	S.K. Nagar	Akola	Badnapur	Rahuri	Bharuch	Mean
1	IPH 11-4	100	98	100	99	8.7	9.7	10.3	8.8	10.0	9.5
2	SKNPCH 0821	100	88	99	96	7.9	7.8	10.6	9.5	11.0	9.4
3	SKNPCH 0923	100	84	100	95	9.3	7.9	11.0	9.1	11.0	9.7
4	SKNPCH 0924	72	90	92	85	8.7	7.3	9.8	9.4	10.0	9.0
5	AKPHE 04295	91	98	96	95	8.9	8.7	10.1	9.7	10.0	9.5
6	AKPHE 05002	98	94	100	97	10.3	8.9	11.1	9.1	12.0	10.3
7	AKPHE 05012	100	98	100	99	10.0	8.1	9.3	9.4	11.0	9.6
8	UPAS 120 (Ch)	100	100	100	100	8.3	8.3	8.8	8.1	9.0	8.5
9	GTH 1(Ch)	100	80	100	93	10.6	9.2	11.5	8.9	11.0	10.2
10	GT101(Ch)	100	100	100	100	11.6	12.0	12.8	12.1	11.5	12
Location Mean		96	93	99	96	9.4	8.8	10.5	9.4	10.7	9.8

*Trials were viciated at Jabalpur & Rewa

Table 3: Mean performance of short duration hybrids in IHT (E) over the locations in South Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant Fertility (%)	100-seed weight (g)	Grain yield (Kg/ha)	Ranking	% gain over best check
1	AKPHE-04295	75	120	93	8.3	1355		
2	AKPHE-05002	78	124	92	8.9	1653	I	12.67
3	CPH-09-09	77	121	91	9.9	775		
4	CPH-09-12	75	121	91	8.4	478		
5	CPH-09-15	73	118	91	9.3	386		
6	CORG 9701(ch)	74	119	99	8.8	1467	II	
7	UPAS 120 (ch)	77	121	98	6.7	1028		
Overall mean		75	120	94	8.6	1020		

Table 3A: Location-wise performance of short duration hybrids for grain yield (kg/ha) in IHT (E) in South Zone

S. No.	Entry	Grain yield (Kg/ha)			
		Coimbatore*	Gulberga	Warangal*	Mean
1	AKPHE-04295	598	1355	444	1355
2	AKPHE-05002	353	1653	248	1653
3	CPH-09-09	196	775	229	775
4	CPH-09-12	217	478	122	478
5	CPH-09-15	230	386	167	386
6	CORG 9701(ch)	817	1467	307	1467
7	UPAS 120 (ch)	248	1028	444	1028
Location mean		380	1020	280.2	1020
CD (%)		54.04	524.38	96.008	524.38
CV at 5%		7.99	28.90	19.3	28.90

*Data were not considered because mean yield were less than state average yield.

Trials were vicited at ICRSAT and Bagalore. Due to poor plant population and incomplete data Vamban's data were not considered.

Table 3B: Location-wise performance of short duration hybrids for days to 50% flowering and days to maturity in IHT (E) in South Zone

	Entry	Days to 50% Flowering				Days to Maturity			
		Coimbatore	Gulberga	Warangal	Mean	Coimbatore	Gulberga	Warangal	Mean
1	AKPHE-04295	64	81	81	75	118	124	117	120
2	AKPHE-05002	65	83	85	78	121	127	124	124
3	CPH-09-09	63	84	83	77	116	128	118	121
4	CPH-09-12	64	84	77	75	118	129	116	121
5	CPH-09-15	63	84	71	73	116	128	111	118
6	CORG 9701(ch)	70	76	75	74	126	120	112	119
7	UPAS 120 (ch)	68	79	85	77	124	122	117	121
Location mean		65	82	79	75	120	125	116	120

Table 3C: Location-wise performance of short duration hybrids for plant fertility (%) and 100-seed weight in IHT (E) in South Zone

	Entry	Plant fertility (%)		100-seed weight (g)			
		Coimbatore	Mean	Coimbatore	Gulberga	Warangal	Mean
1	AKPHE-04295	93	93	8.9	9.1	7.0	8.3
2	AKPHE-05002	92	92	9.8	9.6	7.4	8.9
3	CPH-09-09	91	91	10.9	10.8	8.0	9.9
4	CPH-09-12	91	91	8.9	8.9	7.4	8.4
5	CPH-09-15	91	91	9.7	10.4	7.8	9.3
6	CORG 9701(ch)	99	99	9.6	9.5	7.3	8.8
7	UPAS 120 (ch)	98	98	6.7	7.0	6.4	6.7
Location mean		94	94	9.3	9.3	7.3	8.6

Table 4: Mean performance of early hybrids in AHT 1 (E) over the locations in North Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant Fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% Gain over best check
1	IPH 10-2	116	160	97	8.3	2052	I	31.28
2	IPH 10-3	115	160	92	8.6	1853	II	18.55
3	UPAS 120 (Ch.)	123	163	100	8.0	1556		
4	Pusa 992 (Ch.)	103	151	100	8.7	1563	III	
5	AL 201 (h.)	96	139	100	7.6	1455		
Overall Mean		111	155	98	8.2	1688		

Table 4A: Location-wise performance of early hybrids for grain yield (Kg/ha) in AHT 1 (E) in North Zone

S. No.	Entry	Grain Yield (Kg/ha)					Mean
		IIPR Kanpur(MF)	IIPR Kanpur (NRF)	IARI New Delhi	PAU Ludhiana	PAU Faridkot	
1	IPH 10-2	2323	2217	1677	1895	2147	2052
2	IPH 10-3	1953	2126	1766	1601	1817	1853
3	UPAS 120 (Ch.)	1590	1460	1655	1373	1703	1556
4	Pusa 992 (Ch.)	1230	1257	2062	1626	1641	1563
5	AL 201 (h.)	671	875	1733	2108	1889	1455
Location Mean		1513	1587	1779	1721	1839	1688
CD at 5%		408.95	439.94	183.18	218	314.12	
CV(%)		14.35	14.73	5.47	6.73	9.1	

Table 4 B: Location-wise performance of early hybrids for days to 50% flowering and days to maturity in AHT 1 (E) in North Zone

S. No.	Entry	Days to 50% Flowering						Days to Maturity					
		IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean	IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean
1	IPH 10-2	105	92	127	130	125	116	147	144	167	170	171	160
2	IPH 10-3	103	98	126	127	123	115	145	144	166	171	173	160
3	UPAS 120 (Ch.)	113	116	132	131	125	123	154	159	168	168	167	163
4	Pusa 992 (Ch.)	93	89	113	112	107	103	146	142	150	160	158	151
5	AL 201 (h.)	87	88	102	102	99	96	136	134	144	141	140	139
Location Mean		100	97	120	120	116	111	146	145	160	162	162	155

Table 4 C: Location-wise performance of early hybrids for 100-seed weight (g) and Plant Fertility (%) in AHT 1 (E) in North Zone

S. No.	Entry	100-seed weight						Plant Fertility (%)					
		IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean	IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean
1	IPH 10-2	8.5	8.5	7.8	8.4	8.3	8.3	98	98	91	99	100	97
2	IPH 10-3	8.9	8.8	7.7	9.1	8.4	8.6	95	96	78	95	97	92
3	UPAS 120 (Ch.)	8.2	7.7	7.0	8.2	8.9	8.0	100	100	100	100	100	100
4	Pusa 992 (Ch.)	8.4	8.3	8.3	8.2	10.2	8.7	100	100	100	100	100	100
5	AL 201 (h.)	7.1	7.8	7.1	7.8	8.2	7.6	100	100	100	100	100	100
Location Mean		8.2	8.2	7.6	8.3	8.8	8.2	98.6	98.8	93.8	98.8	99.4	98

Table 5: Mean performance of early hybrids in AHT 1 (E) over the locations in Central Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant Fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% Gain over best check
1	IPH 10-6	100	142	95	8.4	1194		
2	SKNPCH 0835	103	145	100	10.7	1440	I	4.50
3	AKPHE 04012	98	141	95	9.1	1312		
4	UPAS 120 (C)	101	145	100	8.0	968		
5	GTH 1 (C)	104	142	98	10.4	1378	II	
6	GT 101 (C)	107	146	100	11.8	1125		
Overall Mean		102	144	98	9.7	1236		

Table 5 A: Location-wise performance of early hybrids for 100-seed weight (g) and grain yield (Kg/ha) in AHT 1 (E) in Central Zone

S. No.	Entry	100- Seed weight				Yield (Kg/ha)			
		S K Nagar	Akola	Badnapur	Mean	S K Nagar	Akola	Badnapur	Mean
1	IPH 10-6	8.1	8.3	8.8	8.4	1409	1185	989	1194
2	SKNPCH 0835	11.2	9.3	11.7	10.7	1987	1009	1323	1440
3	AKPHE 04012	8.9	8.6	9.8	9.1	1566	1447	924	1312
4	UPAS 120 (C)	7.4	7.5	9.2	8.0	1041	1028	834	968
5	GTH 1 (C)	10.3	9.7	11.3	10.4	1738	1207	1189	1378
6	GT 101 (C)	12.1	10.7	12.5	11.8	1474	832	1069	1125
Location Mean		9.7	9.0	10.6	9.7	1536	1118	1055	1236
CD at 5%						593	246	307.09	
CV(%)						21.22	12.09	8.92	

Table 5 B: Location-wise performance of early hybrids for days to 50% flowering, days to maturity and plant fertility (%) in AHT 1 (E) in C Z

S. No.	Entry	Days to Flowering				Days to Maturity				% Plant Fertility		
		S K Nagar	Akola	Badnapur	Mean	S K Nagar	Akola	Badnapur	Mean	S K Nagar	Akola	Mean
1	IPH 10-6	110	92	98	100	152	145	129	142	98	92	95
2	SKNPCH 0835	115	110	83	103	154	155	127	145	100	100	100
3	AKPHE 04012	111	89	95	98	152	143	129	141	97	93	95
4	UPAS 120 (C)	113	94	96	101	154	143	139	145	100	100	100
5	GTH 1 (C)	109	97	105	104	151	141	133	142	100	95	98
6	GT 101 (C)	116	96	110	107	157	146	136	146	100	100	100
Location Mean		112	96	98	102	153	146	132	144	99	97	98

Table 6: Mean performance of early hybrids in AHT 1 (E) over the locations in south Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant Fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% Gain over best check
1	SKNPCH 0626	79	130	92	9.1	1194	II	26.62
2	SKNPCH 0835	95	143	-	10.5	576		
3	SKNPCH 0840	86	136	91	9.9	1324	I	40.40
4	AKPHE 04012	79	126	93	9.2	1074	III	13.89
5	CORG 9701 (Ch)	77	125	99	8.9	943	IV	
6	UPAS 120 (Ch)	77	125	100	7.2	611		
Overall Mean		81	130	95	9.1	1025		

Table 6A: Location-wise performance of early hybrids for grain yield (Kg/ha) in AHT 1 (E) in South Zone

S. No.	Entry	Grain Yield (Kg/ha)				
		Coimbatore*	Gulbarga	Warangal*	Banglore	Mean
1	SKNPCH 0626	295	1420	616	967	1194
2	SKNPCH 0835	-	720	348	432	576
3	SKNPCH 0840	398	1448	789	1201	1324
4	AKPHE 04012	403	991	466	1156	1074
5	CORG 9701 (Ch)	607	894	720	993	943
6	UPAS 120 (Ch)	431	541	653	681	611
7	BRG 2 (Loc. Ch)	-	-	-	1436	-
8	GC 11-39 (Ch)	-	1444	-	-	-
Location Mean		427	1066	599	984	1025
CD at 5%		93.84	371.11	126	248.06	
CV(%)		11.67	19.58	11.6	14.17	

*Data not included(Mean yield is less than state average yield and poor plant population)

Table 6 B: Location-wise performance of early hybrids for days to 50% flowering and days to maturity in AHT 1 (E) in South Zone

S. No.	Entry	Days to 50% Flowering					Days to Maturity				
		Coimbatore	Gulbarga	Warangal	Banglore	Mean	Coimbatore	Gulbarga	Warangal	Banglore	Mean
1	SKNPCH 0626	65	86	92	75	79	116	130	133	143	130
2	SKNPCH 0835	-	107	97	81	95	-	150	138	142	143
3	SKNPCH 0840	67	98	97	81	86	117	141	138	148	136
4	AKPHE 04012	68	90	81	77	79	119	132	119	134	126
5	CORG 9701 (Ch)	70	87	76	75	77	122	130	109	140	125
6	UPAS 120 (Ch)	67	89	75	75	77	118	132	109	141	125
Location Mean		67	93	86	77	81	118	136	124	141	130

Table 6 C: Location-wise performance of early hybrids for 100-seed weight (g) and Plant Fertility (%) in AHT 1 (E) in South Zone

S. No.	Entry	100-seed weight					Plant Fertility (%)	
		Coimbatore	Gulbarga	Warangal	Banglore	Mean	Coimbatore	Mean
1	SKNPCH 0626	9.2	8.2	9.1	10.0	9.1	92	92
2	SKNPCH 0835	-	10.0	10.0	11.5	10.5	-	-
3	SKNPCH 0840	11.9	8.1	10.1	9.5	9.9	91	91
4	AKPHE 04012	12.2	8.7	7.3	8.5	9.2	93	93
5	CORG 9701 (Ch)	9.8	9.1	7.2	9.6	8.9	99	99
6	UPAS 120 (Ch)	6.8	7.8	6.6	7.5	7.2	100	100
Location Mean		9.9	8.6	8.4	9.4	9.1	95	95

Table 7: Mean performance of early hybrids in AHT 2 (E) over the locations in North Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant Fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% Gain over best check
1	IPH 09-5	112	157	94	10.3	2038	I	33.90
2	UPAS 120 (Ch.)	123	164	100	7.7	1481		
3	Pusa 992 (Ch.)	103	150	100	8.8	1505		
4	AL 201 (h.)	95	139	100	7.7	1522	II	
Overall Mean		108	152	98.5	8.7	1637		

Table 7 A: Location-wise performance of early hybrids for grain yield (Kg/ha) in AHT 2 (E) in North Zone

S. No.	Entry	Grain Yield (Kg/ha)					Mean
		IIPR Kanpur(MF)	IIPR Kanpur (NRF)	IARI New Delhi	PAU Ludhiana	PAU Faridkot	
1	IPH 09-5	2293	1908	2036	1863	2091	2038
2	UPAS 120 (Ch.)	1582	1347	1739	1111	1625	1481
3	Pusa 992 (Ch.)	1338	1028	2031	1394	1733	1505
4	AL 201 (h.)	750	954	1789	2059	2059	1522
Location Mean		1491	1309	1899	1607	1877	1637
CD at 5%		322.58	407.12	247.20	108	329.32	
CV(%)		10.83	15.56	6.52	3.36	8.78	

Table 7 B: Location-wise performance of early hybrids for days to 50% flowering and days to maturity in AHT 2 (E) in North Zone

S. No.	Entry	Days to 50% Flowering						Days to Maturity					
		IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean	IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean
1	IPH 09-5	94	95	131	122	117	112	143	145	165	165	167	157
2	UPAS 120 (Ch.)	113	111	134	130	125	123	154	159	170	167	169	164
3	Pusa 992 (Ch.)	90	96	112	110	107	103	141	142	149	158	160	150
4	AL 201 (h.)	86	87	102	102	98	95	135	132	145	141	142	139
Location Mean		96	97	120	116	112	108	143	145	157	158	159	152

Table 7 C: Location-wise performance of early hybrids for 100-seed weight (g) and Plant Fertility (%) in AHT 2 (E) in North Zone

S. No.	Entry	100-seed weight						Plant Fertility (%)					
		IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean	IIPR Knp (MF)	IIPR Knp (NRF)	IARI New Delhi	PAU Ldh.	PAU F.kot	Mean
1	IPH 09-5	9.9	10.1	8.8	11.4	11.5	10.3	90	92	91	99	98	94
2	UPAS 120 (Ch.)	8.3	7.5	7.0	8.0	7.9	7.7	100	100	100	100	100	100
3	Pusa 992 (Ch.)	8.2	8.9	8.2	8.1	10.6	8.8	100	100	100	100	100	100
4	AL 201 (h.)	7.6	7.3	6.9	7.9	8.9	7.7	100	100	100	100	100	100
Location Mean		8.5	8.4	7.7	8.8	9.7	8.7	98	98	98	100	99.5	98.5

Table 8 A: Mean performance of medium duration hybrids in IHT (M) over the locations in Central Zone

S. No	Entry	Days to 50 % flowering	Days to maturity	Plant fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% gain over best check
1	SKNPCH 0860	117	169	99	11.5	1156		
2	SKNPCH 0932	110	163	100	10.8	2077	I	19.29
3	AKPHM 10259	110	168	20	10.3	1526		
4	AKPHM 10260	111	167	5	11.8	1784	II	2.46
5	AKPHM 11259	110	162	85	12.1	1773	III	1.83
6	AKPHM 11324	112	166	95	13.2	1763	IV	1.26
7	AKPHM 13344	103	158	97	12.1	1476		
8	ICPH 2740	116	169	98	11.9	1552		
9	ICPH 3359	120	172	85	11.4	1497		
10	ICPH 3477	117	172	95	12.5	1620		
11	ICPH 3762	115	170	95	11.3	1591		
12	Maruthi (Ch)	108	163	100	10.8	1461		
13	Asha (Ch)	117	1170	100	11.6	1498		
14	BSMR 736 (ch)	113	162	100	10.5	1741	IV	
15	Co 6 (ch)	117	165	100	8.9	1632		
Location Mean		113	166	85	11.4	1611		

Table 8 B: Mean performance of medium duration hybrids in IHT (M) over the locations in South Zone

S. No	Entry	Days to 50 % flowering	Days to maturity	Plant fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% gain over best check
1	SKNPCH 0860	100	151	92	9.9	624		
2	SKNPCH 0932	104	155	92	9.9	1093		
3	AKPHM 10259	107	159	90	10.6	1520	I	2.91
4	AKPHM 10260	107	159	90	11.2	1494	II	1.15
5	AKPHM 11259	105	158	93	10.8	1382		
6	AKPHM 11324	110	160	91	11.6	1346		
7	AKPHM 13344	99	151	93	10.6	832		
8	ICPH 2740	110	162	89	11.0	1230		
9	ICPH 3359	114	165	89	10.9	1230		
10	ICPH 3477	112	161	91	11.5	1319		
11	ICPH 3762	108	160	91	10.8	1035		
12	Maruthi (Ch)	108	159	98	10.7	1094		
13	Asha (Ch)	109	161	98	10.3	875		
14	BSMR 736 (ch)	110	162	99	10.2	975		
15	Co 6 (ch)	108	160	100	9.0	1477	III	
Location Mean		107	159	93	10.6	1168		

Table 8 C: Overall mean performance of medium duration hybrids in IHT (M) over the locations in Central & South Zone

S. No	Entry	Days to 50 % flowering	Days to maturity	Plant fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% gain over best check
1	SKNPCH 0860	108	160	97	10.8	920		
2	SKNPCH 0932	107	159	98	10.4	1640	II	4.92
3	AKPHM 10259	109	164	38	10.5	1523		
4	AKPHM 10260	109	163	26	11.5	1655	I	5.89
5	AKPHM 11259	108	160	87	11.5	1599	III	2.30
6	AKPHM 11324	111	163	94	12.5	1578	IV	0.95
7	AKPHM 13344	101	155	98	11.4	1190		
8	ICPH 2740	113	165	96	11.5	1409		
9	ICPH 3359	117	169	86	11.2	1379		
10	ICPH 3477	115	166	94	12.0	1486		
11	ICPH 3762	111	165	94	11.1	1344		
12	Maruthi (Ch)	108	161	99	10.7	1277		
13	Asha (Ch)	113	165	99	11.0	1221		
14	BSMR 736 (ch)	111	162	100	10.3	1400		
15	Co 6 (ch)	113	162	100	9.0	1563	V	
Location Mean		110	163	87	11.0	1414		

Table 8 D: Location-wise performance of medium duration hybrids for grain yield (Kg/ha) in IHT (M) in Central & South Zone

S. No	Entry	Grain Yield (Kg/ha)											Mean		
		S.K. Nagar	Akola	Rahuri	Badnapur	Bharuch	Coimbatore	Patancheru*	Gulberga	Warangal	Bangalore	Vamban**	Overall	CZ	SZ
1	SKNPCH 0860	1281	1046	1633	752.0	1070	494	-	1065	189.0	750	340	920	1156	624
2	SKNPCH 0932	3177	1930	3385	875.8	1018	464	1493	1931	372.0	1606	373	1640	2077	1093
3	AKPHM 10259	1351	1653	2561	985.9	1078	1414	425	1783	727.3	2157	489	1523	1526	1520
4	AKPHM 10260	1655	2208	2759	892.1	1407	1637	1274	2068	410.6	1861	367	1655	1784	1494
5	AKPHM 11259	1556	1766	3054	1276.3	1215	2001	361	1905	419.6	1201	376	1599	1773	1382
6	AKPHM 11324	1595	1507	3285	1282.8	1147	1291	1474	2281	273.6	1539	331	1578	1763	1346
7	AKPHM 13344	1340	1768	2237	938.3	1097	783	-	1521	148.0	875	119	1190	1476	832
8	ICPH 2740	1648	1303	2772	868.9	1171	1272	1919	2072	397.6	1178	372	1409	1552	1230
9	ICPH 3359	1659	1379	2256	907.2	1286	1473	1281	1815	544.0	1090	367	1379	1497	1230
10	ICPH 3477	2034	1117	2530	822.5	1597	1244	1393	1987	614.6	1432	318	1486	1620	1319
11	ICPH 3762	1691	1302	2576	893.4	1495	1029	1170	2028	484.6	597	361	1344	1591	1035
12	Maruthi (Ch)	831	-	2768	1088.9	1157	921	1311	1744	410.6	1299	393	1277	1461.	1094
13	Asha (Ch)	1536	1322	2600	893.7	1139	981	1274	1067	318.3	1136	375	1221	1498	875
14	BSMR 736 (ch)	1748	1555	2896	1307.4	1197	905	1148	1544	207.3	1245	385	1400	1741	975
15	Co 6 (ch)	2011	1523	2289	1135.3	1203	2012	-	1641	1195.0	1062	325	1563	1632	1477
Location Mean		1674	1527	2640	995	1218	1195	-	1763	447	1268	353	1414	1611	1168
CD at 5%		380.65	184.3	976.6	274.03	181	400.26	238.8	261.81	132.87	253	155.22			
CV(%)		13.59	11.25	19.88	9.14	5.9	20.03	32.1	8.88	17.8	12	26.48			

*Not included due to high CV % and incomplete data.

** Not included due to low mean yield as compared to state average yield

Table 8 E: Location-wise performance of medium duration hybrids for days to 50% flowering in IHT (M) in Central & South Zones

S. No.	Entry	Days to 50% Flowering										Mean		
		S.K. Nagar	Akola	Rahuri	Badnapur	Bharuch	Coimbatore	Gulberga	Warangal	Bangalore	Vamban	Overall	CZ	SZ
1	SKNPCH 0860	118	125	110	130	103	98	93	88	88	132	108	117	100
2	SKNPCH 0932	112	124	90	113	109	95	105	100	87	132	107	110	104
3	AKPHM 10259	113	113	100	115	111	95	102	106	89	143	109	110	107
4	AKPHM 10260	114	115	100	117	110	103	106	108	90	129	109	111	107
5	AKPHM 11259	114	114	95	113	113	95	98	110	87	138	108	110	105
6	AKPHM 11324	115	114	104	116	109	99	107	111	90	142	111	112	110
7	AKPHM 13344	115	105	91	107	99	93	91	92	88	130	101	103	99
8	ICPH 2740	120	117	110	125	110	102	105	113	90	142	113	116	110
9	ICPH 3359	123	116	123	127	111	106	106	115	103	139	117	120	114
10	ICPH 3477	115	124	111	125	110	108	111	117	97	129	115	117	112
11	ICPH 3762	118	114	109	124	110	98	105	112	93	132	111	115	108
12	Maruthi (Ch)	114	-	96	113	109	98	117	101	93	129	108	108	108
13	Asha (Ch)	117	126	109	122	112	96	105	110	92	140	113	117	109
14	BSMR 736 (ch)	115	117	104	119	109	98	112	108	89	142	111	113	110
15	Co 6 (ch)	129	125	99	123	111	95	102	122	92	130	113	117	108
Location Mean		117	118	103	119	109	99	104	107	91	135	110	113	107

Table 8 F: Location-wise performance of medium duration hybrids for days to maturity in IHT (M) in Central & South Zones

S. No.	Entry	Days to Maturity										Mean		
		S.K. Nagar	Akola	Rahuri	Badnapur	Bharuch	Coimbatore	Gulberga	Warangal	Bangalore	Vamban	Overall	CZ	SZ
1	SKNPCH 0860	175	170	163	184	152	168	135	131	153	170	160	169	151
2	SKNPCH 0932	167	155	144	190	158	163	147	143	152	172	159	163	155
3	AKPHM 10259	173	165	154	188	162	165	143	150	155	181	164	168	159
4	AKPHM 10260	169	163	154	190	160	170	149	151	156	169	163	167	159
5	AKPHM 11259	166	164	144	176	162	164	141	153	154	177	160	162	158
6	AKPHM 11324	163	169	153	188	158	169	150	155	156	171	163	166	160
7	AKPHM 13344	166	158	144	169	152	159	136	135	158	169	155	158	151
8	ICPH 2740	169	170	157	187	160	170	149	156	153	180	165	169	162
9	ICPH 3359	174	167	162	194	165	173	150	158	168	178	169	172	165
10	ICPH 3477	170	170	162	196	162	175	143	161	159	167	166	172	161
11	ICPH 3762	174	170	161	192	155	167	147	157	157	173	165	170	160
12	Maruthi (Ch)	167	-	154	178	155	168	157	141	161	170	161	163	159
13	Asha (Ch)	170	175	152	186	165	165	146	154	158	181	165	1170	161
14	BSMR 736 (ch)	166	168	156	165	155	169	149	151	158	181	162	162	162
15	Co 6 (ch)	177	161	154	169	162	163	145	165	159	169	162	165	160
Location Mean		170	166	154	183	159	166	167	146	151	157	163	166	159

Table 8 G: Location-wise performance of medium duration hybrids for 100 seed weight (g) in IHT (M) in Central & South Zones

S. No.	Entry	100 Seed Weight (g)									Mean		
		S.K. Nagar	Akola	Rahuri	Badnapur	Bharuch	Coimbatore	Gulberga	Warangal	Bangalore	Overall	CZ	SZ
1	SKNPCH 0860	12.0	9.6	12.0	11.2	13	9.1	9.8	10.1	10.59	10.8	11.5	9.9
2	SKNPCH 0932	12.8	10.6	9.40	11.3	10	8.8	9.7	10.0	11.33	10.4	10.8	9.9
3	AKPHM 10259	12.0	10.6	10.0	10.1	9	9.5	10.4	10.3	12.30	10.5	10.3	10.6
4	AKPHM 10260	13.6	11.6	8.2	12.6	13	10.9	10.3	11.1	12.50	11.5	11.8	11.2
5	AKPHM 11259	13.8	11.1	10.6	11.9	13	10.0	11.2	11.9	10.30	11.5	12.1	10.8
6	AKPHM 11324	13.6	12.6	12.7	13.3	14	10.7	11.6	12.3	11.96	12.5	13.2	11.6
7	AKPHM 13344	13.4	11.3	11.3	12.4	12	10.0	11.4	9.9	11.10	11.4	12.1	10.6
8	ICPH 2740	12.9	11.3	10.6	11.6	13	11.5	9.8	11.5	11.28	11.5	11.9	11.0
9	ICPH 3359	12.5	11.6	9.50	10.6	13	11.8	10.3	10.7	10.88	11.2	11.4	10.9
10	ICPH 3477	13.5	11.3	12.4	13.2	12	13.0	10.4	11.8	10.96	12.0	12.5	11.5
11	ICPH 3762	11.6	10.9	10.2	10.7	13	11.4	9.7	11.3	11.10	11.1	11.3	10.8
12	Maruthi (Ch)	11.4	-	8.8	9.9	13	12.4	9.4	10.1	10.84	10.7	10.8	10.7
13	Asha (Ch)	12.6	11.6	10.7	11.0	12	9.6	9.4	11.3	10.95	11.0	11.6	10.3
14	BSMR 736 (ch)	12.6	9.7	9.5	9.7	11	10.0	8.1	11.0	11.64	10.3	10.5	10.2
15	Co 6 (ch)	10.7	8.9	8.2	8.0	9	8.8	7.5	08.5	11.23	9.0	8.9	9.0
Location Mean		12.6	10.9	10.3	11.2	12	10.5	9.9	10.8	11.2	11.0	11.4	10.6

Table 8 H: Location-wise performance of medium duration hybrids for % plant fertility in IHT (M) in Central & South Zones

S. No.	Entry	% Plant Fertility				Mean		
		S.K. Nagar	Akola	Badnapur	Coimbatore	Overall	CZ	SZ
1	SKNPCH 0860	100	96	100	92	97	99	92
2	SKNPCH 0932	100	100	100	92	98	100	92
3	AKPHM 10259	1	55	5	90	38	20	90
4	AKPHM 10260	4	10	2	90	26	5	90
5	AKPHM 11259	83	87	86	93	87	85	93
6	AKPHM 11324	96	94	94	91	94	95	91
7	AKPHM 13344	100	99	100	93	98	97	93
8	ICPH 2740	100	95	100	89	96	98	89
9	ICPH 3359	100	73	83	89	86	85	89
10	ICPH 3477	100	94	92	91	94	95	91
11	ICPH 3762	100	90	96	91	94	95	91
12	Maruthi (Ch)	100	-	100	98	99	100	98
13	Asha (Ch)	100	100	100	98	99	100	98
14	BSMR 736 (ch)	100	100	100	99	100	100	99
15	Co 6 (ch)	100	100	100	100	100	100	100
Location Mean		86	85	84	93	87	85	93

Table 9: Mean performance of medium duration hybrids in AHT 1(M) in Central Zone

S. No.	Entry	Days to 50 % flowering	Days to maturity	Plant fertility (%)	100-seed weight (g)	Grain yield (kg/ha)	Ranking	% gain over best check
1	SKNPCH 0732	109	168	100	10.2	1328	III	11.12
2	SKNPCH 0935	116	169	100	9.2	1389	II	16.23
3	AKPHM 10178	104	165	57	10.2	1187		
4	AKPHM 10303	105	166	100	11.0	1263	IV	5.69
5	AKPHM 11303	108	168	100	12.3	1618	I	35.39
6	Maruti (ch)	114	169	100	9.6	1136		
7	Asha (ch)	120	170	100	11.1	1087		
8	BSMR 736 (ch)	117	165	100	9.8	1195	V	
9	CO 6 (ch)	123	173	100	8.8	1078		
Overall Mean		111	167	95	10.4	1253		

Table 9A: Locationwise performance of medium duration hybrids for grain yield (Kg/ha) in AHT 1(M) in Central Zone

S. No.	Entry	Grain Yield (Kg/ha)				
		S K Nagar	Akola	Badnapur	Rahuri	Mean
1	SKNPCH 0732	945	1729	909.0	1730	1328
2	SKNPCH 0935	1988	1240	938.1	-	1389
3	AKPHM 10178	1084	1602	868.1	1193	1187
4	AKPHM 10303	923	1691	1319.1	1121	1263
5	AKPHM 11303	1155	2171	1280.1	1868	1618
6	Maruti (ch)	824	1562	1022.9	-	1136
7	Asha (ch)	1155	1506	980.1	709	1087
8	BSMR 736 (ch)	1218	1272	1279.1	1012	1195
9	CO 6 (ch)	1358	790	1087.0	-	1078
10	Vipula (Ch)	-	-	-	3.26	-
Location Mean		1183	1507	1076	1091	1253
CD at 5%		256.22	276.81	511.75	307.47	
CV %		12.51	10.61	10.22	13.68	

Table 9 B: Locationwise performance of medium duration hybrids for days to 50% flowering in AHT 1(M) in Central Zone

S. No.	Entry	Days to 50 % Flowering				
		S K Nagar	Akola	Badnapur	Rahuri	Mean
1	SKNPCH 0732	119	110	115	93	109
2	SKNPCH 0935	117	113	117	*	116
3	AKPHM 10178	117	106	103	92	104
4	AKPHM 10303	120	108	99	92	105
5	AKPHM 11303	119	109	107	97	108
6	Maruti (ch)	118	113	110	*	114
7	Asha (ch)	119	122	119	119	120
8	BSMR 736 (ch)	121	120	119	108	117
9	CO 6 (ch)	133	121	116	*	123
Location Mean		120	113	112	100	111

Table 9 C: Locationwise performance of medium duration hybrids for days to maturity in AHT 1(M) in Central Zone

S. No.	Entry	Days to Maturity				
		S K Nagar	Akola	Badnapur	Rahuri	Mean
1	SKNPCH 0732	171	163	186	154	168
2	SKNPCH 0935	168	162	178	*	169
3	AKPHM 10178	169	163	172	156	165
4	AKPHM 10303	170	162	182	152	166
5	AKPHM 11303	171	162	184	156	168
6	Maruti (ch)	167	165	174	*	169
7	Asha (ch)	170	175	181	156	170
8	BSMR 736 (ch)	170	166	161	163	165
9	CO 6 (ch)	184	165	169	*	173
Location Mean		171	165	176	156	167

Table 9 D: Locationwise performance of medium duration hybrids for 100 seed weight in AHT 1(M) in Central Zone

S. No.	Entry	100 Seed Weight (g)				
		S K Nagar	Akola	Badnapur	Rahuri	Mean
1	SKNPCH 0732	11.1	10.8	10.22	8.60	10.2
2	SKNPCH 0935	9.3	9.3	9.02	*	9.2
3	AKPHM 10178	10.7	9.2	10.75	10.30	10.2
4	AKPHM 10303	11.3	10.1	11.83	10.80	11.0
5	AKPHM 11303	12.4	12.3	11.89	12.70	12.3
6	Maruti (ch)	9.9	9.3	9.54	*	9.6
7	Asha (ch)	11.1	12.5	10.30	10.70	11.1
8	BSMR 736 (ch)	10.1	9.2	10.33	9.80	9.8
9	CO 6 (ch)	10.6	8.0	7.97	*	8.8
Location Mean		10.7	10.1	10.2	10.5	10.4

Table 9 E: Locationwise performance of medium duration hybrids for % plant fertility in AHT 1(M) in Central Zone

S. No.	Entry	% Plant Fertility		
		S K Nagar	Badnapur	Mean
1	SKNPCH 0732	100	100	100
2	SKNPCH 0935	100	100	100
3	AKPHM 10178	52	63	57
4	AKPHM 10303	100	100	100
5	AKPHM 11303	100	100	100
6	Maruti (ch)	100	100	100
7	Asha (ch)	100	100	100
8	BSMR 736 (ch)	100	100	100
9	CO 6 (ch)	100	100	100
Location Mean		95	96	95

Table 10 : Disease reaction of hybrids included in different trials during 2011-12

S. No.	Entry	% wilt at IIPR	% wilt at Gulbarga	% SMD at Bangalore
1	IPH-09-05	15.0	67.64	-
2	AKPHE-04012	95.2	92.00	91.6
3	AKPHE-10178	66.7	92.85	100
4	AKPHE-10303	21.0	93.33	100
5	AKPHE-11303	17.0	-	100
6	IPA 10-2	7.0	-	-
7	IPA 10-3	16.0	-	-
8	ICPL 332	50.0	-	-
9	ICP 2376 (ch) W	-	96.00	-
10	Bahar (Loc. Ch) W	90.5	-	-
11	ICP 8863 (ch) SM	-	-	100

Centre-wise Progress Report

Indian Institute of Pulses Research, Kanpur

Objective No.1: Development of early duration hybrids

In order to develop early duration hybrids fifteen crosses were attempted involving six early maturing CMS lines viz. AL 101 A, UPAS 120 A, PA 163 A, CORG 990047 A, CORG 990052 A and ICP 2039A and 7 restorers viz. 261429 R, 261354 R, 261322 R, 261506 R, 250157R, 250173R, and 250083 R. More than 1000 seeds were harvested from each of the fifteen crosses except hybrid AL 101 A x 261322 R (**Table 1**)

Table 1: Crosses and number of seeds harvested from each of the crosses

S. No.	Hybrids	No. of seeds	S. No.	Hybrids	No. of seeds
1.	UPAS 120 A x 261322 R	1050	9.	PA 163 A x 261345R	2500
2.	UPAS 120 A x 250157 R	3000	10.	PA 163 A x 261429R	1200
3.	AL 101 A x 261322 R	955	11.	ICP 2039 A x 261322	1700
4.	PA 163 A x 261322R	9000	12.	ICP 2039 A x 250173R	1033
5.	UPAS 120 A x 250173	1200	13.	ICP 2039 A x 250157R	2400
6.	CORG 990047A x 250173 R	2000	14.	CORG 990052 A x 250083 R	3500
7.	PA 163 A x 250157R	3300	15.	CORG 990052 A x AK 261506	1750
8.	PA 163 A x 250173R	2300			

Objective No. 2 : Evaluation of hybrids

Three trials viz. IHT (Early), AHT 1 (early) and AHT 2 (Early) of north zone were conducted at two locations, namely at main farm of IIPR and at New Research Farm of the institute for evaluation of early duration hybrids during *kharif* 2011.

(i) **IHT (Early):** In IHT (Early) trial of NZ, 4 hybrids viz. IPH 11-1, IPH 11-2, IPH 11-3, and PHP 34 along with 3 checks viz. UPAS 120, Pusa 992 and AL 201 were evaluated in RBD with three replications. Observations were recorded for plant population, days to 50% flowering, days to maturity, % plant fertility, 100-seed weight and yield (kg/ha) at both the locations.

(A) **Main farm :** At main farm range for days to 50% flowering (**Table 2**) among entries varied from 85 (AL 201) to 120 (UPAS 120) days while days to maturity had a variation from 135 (AL 201) to 155 (UPAS 120) days. In terms of yield UPAS 120 was best among checks. All the four hybrids and remaining two checks were earlier as compared to the best check UPAS 120 in days to maturity. Percent plant fertility of hybrids ranged from 48 (PHP 34) to 98% (IPH 11-3). Three hybrids viz. IPH 11-1 (8.7 g), IPH 11-2 (9.5 g) and IPH 11-3 (8.73 g) and one check Pusa 992 (8.5 g) showed more seed weight as compared to the best check UPAS 120 (8.06 g). **In terms of yield UPAS 120 was the best check with 1644 Kg/ha yield but two hybrids viz. IPH 11-1 (2172 Kg/ha) and IPH 11-2 (2416 Kg/ha) were superior to best check in yield. After observing overall performance IPH 11-2 seems to be the best hybrid followed by IPH 11-1.**

(B) New Research Farm : At new research farm range for days to 50% flowering (**Table 3**) among entries varied from 83 (AL 201) to 114 (UPAS 120) days while days to maturity had a variation from 134 (PHP 34) to 158 (UPAS 120) days. In terms of yield UPAS 120 was best among checks. All the four hybrids and remaining checks were earlier to the best check UPAS 120 in days to 50% flowering and maturity. Percent plant fertility of hybrids ranged from 50 (PHP 34) to 97% (IPH 11-3). All the four hybrids viz. IPH 11-1 (9.9g), IPH 11-2 (9.0g), IPH 11-3 (9.4g) and PHP 34 (8.7g) and one check Pusa 992 (8.9g) showed higher seed weight as compared to the best check UPAS 120 (7.7g). **In terms of yield UPAS 120 was the best check with 1493 Kg/ha yield but two hybrids viz. IPH 11-1 (1817 Kg/ha) and IPH 11-2 (1763 Kg/ha), were superior to best check in yield. After observing overall performance IPH 11-1 seems to be the best hybrid followed by IPH 11-2.**

(ii) AHT 1(Early): In AHT 1 (Early) trial of NZ, two hybrids viz. IPH 10-2 and IPH 10-3 along with 3 checks viz. UPAS 120 and Pusa 992 and AL 201 were evaluated in RBD with three replications. Observations were recorded for plant population, days to 50% flowering, days to maturity, % plant fertility, 100-seed weight and yield (kg/ha) at both the locations.

(A) Main farm : At main farm range for days to 50% flowering (**Table 4**) varied from 87 (Al 201) to 112 (UPAS 120) days while days to maturity had a variation from 136 (Al 201) to 154 (UPAS 120) days. In terms of yield UPAS 120 was best among checks. Both the hybrids IPH 10-2 (147 days) and IPH 10-3 (145 days) were earlier as compared to best check UPAS 120 in days to maturity. Percent plant fertility of IPH 10-2 and IPH 10-3 were 98 and 95% respectively. Hybrids, IPH 10-2 (8.5g) and IPH 10-3 (8.8g) and check Pusa 992 (8.4g) showed higher 100-seed weight as compared with best check UPAS 120 (8.2g). **In terms of yield UPAS 120 was the best check with 1590 Kg/ha but hybrids, IPH 10-2 yielded 2323 Kg/ha showing 46.10% and IPH 10-3 yielded 1953 Kg/ha showing 22.83% superiority in terms of yield over best check UPAS 120.**

(B) New Research Farm : At new research farm range for days to 50% flowering (**Table 5**) varied from 88 (Al 201) to 116 (UPAS 120) days while days to maturity had a variation from 134 (Al 201) to 159 (UPAS 120) days. In terms of yield UPAS 120 was best among checks. Both the hybrids IPH 10-2 (144 days) and IPH 10-3 (144 days) were earlier as compared to best check UPAS 120 in days to maturity. Percent plant fertility of IPH 10-2 and IPH 10-3 were 91 and 96%, respectively. Hybrids IPH 10-2 (8.5g) and IPH 10-3 (8.8g) and check Pusa 992 (8.3g) showed higher 100-seed weight as compared with best check UPAS 120 (7.7g). **In terms of yield UPAS 120 was the best check with 1460 Kg/ha but hybrids IPH 10-2 yielded 2217 Kg/ha showing 51.84% superiority and IPH 10-3 yielded 2126 Kg/ha showing 45.61% superiority in terms of yield over best check UPAS 120.**

(iii) AHT 2 (Early): In AHT 2 (Early) trial of NZ, only one hybrid viz. IPH 09-5 along with 3 checks viz. UPAS 120 and Pusa 992 and AL 201 was evaluated in RBD with three replications. Observations were recorded for plant population, days to 50% flowering, days to maturity, % plant fertility, 100-seed weight and yield (kg/ha) at both the locations.

(A) Main farm : At main farm range for days to 50% flowering (**Table 6**) varied from 86 (Al 201) to 113 (UPAS 120) days while days to maturity had a variation from 135 (Al 201) to 154 (UPAS 120) days. Hybrid IPH 09-5 (143 days) was earlier as compared to best check UPAS 120 in days to maturity. Percent plant fertility of IPH 09-5 was 90%. Hybrid IPH 09-5 (9.8g) showed higher 100-seed weight as compared with best check UPAS 120 (8.3g). **In terms of yield UPAS 120 was the best check with 1581 Kg/ha but hybrid IPH 09-5**

yielded 2293 Kg/ha showing 45.03% superiority in terms of yield over best check UPAS 120.

(B) New Research Farm : At new research farm range for days to 50% flowering (Table 7) varied from 87 (Al 201) to 111 (UPAS 120) days while days to maturity had a variation from 132 (Al 201) to 159 (UPAS 120) days. In terms of yield UPAS 120 was best among checks. Hybrid IPH 09-5 (145 days) was earlier as compared to best check UPAS 120 in days to maturity. Percent plant fertility of IPH 09-5 was 92%. Hybrid IPH 09-5 (10.1g) showed higher 100-seed weight as compared with best check UPAS 120 (7.5g). **In terms of yield (kg/ha) UPAS 120 was the best check with 1347 Kg/ha but hybrid IPH 09-5 yielded 1907 Kg/ha showing 41.57% superiority in terms of yield over best check UPAS 120**

Date of sowing : 26.06.2011

Design : RBD

No. of rows :4/rep.

Number of rep. : 3

Plot size : 9.6 sq.m.

Spacing: 30 x 60 cm

Row length: 4m

No. of plants: 48-52/rep.

Table 2: Evaluation of early hybrids in IHT (Early) at main farm of IIPR

Sl. No.	Entry	Days to 50% flowering	Days to maturity	% plant fertility	100-seed wt. (g)	Yield (Kg/ha)	% Superiority in yield
1	IPH 11-1	98	143	95	8.7	2172	32.11
2	IPH 11-2	107	145	94	9.5	2416	46.95
3	IPH 11-3	96	142	98	8.7	1434	-
4	PHP 34	91	136	48	7.7	702	-
5	UPAS 120 (Ch)	120	155	100	8.0	1644	-
6	Pusa 992 (Ch)	94	140	100	8.5	1457	-
7	AL 201 (Ch)	85	135	100	7.5	863	-

Date of sowing : 18.06.2011

Design : RBD

No. of rows :4/rep.

Number of rep. : 3

Plot size : 9.6 sq.m.

Spacing: 30 x 60 cm

Row length: 4m

No. of plants: 49-52/rep.

Table 3 : Evaluation of early hybrids in IHT (Early) at new research farm of IIPR

Sl. No	Entry	Days to 50% flowering	Days to maturity	% plant fertility	100-seed wt. (g)	Yield (Kg/ha)	% Superiority in yield
1	IPH 11-1	93	145	93	9.9	1817	21.70
2	IPH 11-2	106	149	93	9.0	1763	18.08
3	IPH 11-3	98	142	97	9.3	1256	-
4	PHP 34	88	134	50	8.7	899	-
5	UPAS 120 (Ch)	114	158	100	7.7	1493	-
6	Pusa 992 (Ch)	92	143	100	8.9	1038	-
7	AL 201 (Ch)	83	137	100	6.9	841	-

Date of sowing : 26.06.2011
 Number of rep. : 3
 Row length: 4m

Design : RBD
 Plot size : 14.40 sq.m.
 No. of plants: 75-78/rep.

No. of rows : 6/rep.
 Spacing: 30 x 60 cm

Table 4: Evaluation of early hybrids in AHT 1 (Early) at main farm of IIPR

Sl. No.	Entry	Days to 50% flowering	Days to maturity	% plant fertility	100-seed wt. (g)	Yield (Kg/ha)	% Superiority in yield
1	IPH 10-2	105	147	89	8.5	2323	44.10
2	IPH 10-3	103	145	96	8.8	1953	22.83
3	UPAS 120 (Ch)	113	154	100	8.2	1590	-
4	Pusa 992 (Ch)	93	146	100	8.4	1030	-
5	AL 201 (Ch)	87	136	100	7.1	671	-

Date of sowing : 18.06.2011
 Number of rep. : 3
 Row length: 4m

Design : RBD
 Plot size : 14.40 sq.m.
 No. of plants: 76-78/rep.

No. of rows : 6/rep.

Spacing: 30 x 60 cm

Table 5 : Evaluation of early hybrids in AHT 1 (Early) at new research farm of IIPR

Sl. No.	Entry	Days to 50% flowering	Days to maturity	% plant fertility	100-seed wt. (g)	Yield (Kg/ha)	% Superiority in yield
1	IPH 10-2	92	144	91	8.4	2217	51.84
2	IPH 10-3	98	144	96	8.7	2126	45.61
3	UPAS 120 (Ch)	116	159	100	7.7	1460	-
4	Pusa 992 (Ch)	89	142	100	8.3	1257	-
5	AL 201 (Ch)	88	134	100	7.8	875	-

Date of sowing : 26.06.2011
 Number of rep. : 3
 Row length: 4m

Design : RBD
 Plot size : 19.20 sq.m.
 No. of plants: 98-104/rep.

No. of rows : 8/rep.
 Spacing: 30 x 60 cm

Table 6: Evaluation of early hybrids in AHT 2 (Early) at main farm of IIPR

Sl. No.	Entry	Days to 50% flowering	Days to maturity	% plant fertility	100-seed wt. (g)	Yield (Kg/ha)	% Superiority in yield
1	IPH 09-5	94	143	90	9.8	2293	44.94
2	UPAS 120 (Ch)	113	154	100	8.3	1582	-
3	Pusa 992 (Ch)	90	141	100	8.2	1338	-
4	AL 201 (Ch)	86	135	100	7.6	750	-

Date of sowing : 18.06.2011
Number of rep. : 3
Row length: 4m

Design : RBD
Plot size : 19.20 sq.m.
No. of plants: 95-104/rep.

No. of rows : 8/rep.
Spacing: 30 x 60 cm

Table 7: Evaluation of early hybrids in AHT 2 (Early) at new research farm of IIPR

S. No.	Entry	Days to 50% flowering	Days to maturity	% plant fertility	100-seed wt. (g)	Yield (Kg/ha)	% Superiority in yield
1	IPH 09-5	95	145	86	10.0	1907	41.57
2	UPAS 120 (Ch)	111	159	100	7.5	1347	-
3	Pusa 992 (Ch)	96	142	100	8.8	1028	-
4	AL 201 (Ch)	87	132	100	7.2	953	-

Objective No. 3 To develop molecular markers for testing the purity of hybrids for grow out test.

AT I I P R, Kanpur in order to assess the genetic diversity in existing A, B and R- lines in pigeonpea, genomic-DNA was extracted from 12 A (sterile lines), 12 B (maintainer lines) and 38 R (restorer lines). The 12 A-lines were derived from three different cytoplasms *i.e.* *C. cajanifolius*, *C. scarabaeoides* and *C. sericius*. To start with, PCR optimization was carried out for a total of 196 BAC-end sequences derived SSRs (BES-SSRs) (also known as CcM series). Scorable amplicons were obtained for all the SSRs. However no DNA polymorphism was detected using these SSRs. This may be due narrow genetic base of *Cajanus* and less informative SSR markers used for analysis. In order to address the problem of low marker polymorphism, an extensive survey was performed on availability of SSR marker in public domain in pigeonpea. This search resulted in identification of more than 4000 for pigeonpea. Of these, a total of 150 SSRs were chosen for synthesis and the selection was based on following marker features:

- iv) hyper variable nature or Class II SSRs (having SSR tract length ≥ 20 bp)
- v) higher polymorphism information content (PIC)
- vi) greater resolving power.

PCR profiles were standardized for all newly synthesized 150 SSRs and six SSR markers *viz.* CCB9, CCB10, HASSR4, HASSR5, HASSR6 and Ccttc001 exhibited DNA polymorphism among the A-and R-lines used in the present investigation

Other Programmes:

Programme 1 : Transfer of male sterility & fertility restoring factors in genetically diverse background

In this programme CMS line ICP 2089A was used as female parent for transferring its male sterility to Pusa 992, which was used as male (recurrent parent) parent. Sufficient BC₅F₁ seeds have been harvested. Beside this BC₃F₁ seeds of GT 288A X ICP 88039 (developed last year) were sown and BC₃F₁ generation of this cross was grown. Male parent ICP 88039 was used as recurrent parent for developing backcross (BC₄F₁) with BC₃F₁ of GT 288A X ICP 88039 to transfer the male sterility of GT 288 A in ICP 88039. Sufficient BC₄F₁ seeds have been harvested (Table 8).

Table 8: Different stages of conversion of different lines in CMS background

S.No.	Cross	Stage	No. of seeds harvested
1	GT288 A X ICP88039	BC ₄ F ₁	471
2	ICP 2089 A X PUSA 992	BC ₅ F ₁	329

Programme 2: Identification and development of new restorers

Out of Ninety six crosses attempted in *Kharif* 2010 (Table 9) and grown in *kharif* 2011 none of the crosses produced fertile progeny.

Table 9. Test crosses (F₁ generation) screened for presence of restorers in 2011

S. No.	Cross	S. No.	Cross
1	ICP 84023x P- 9	22	ICP 84023x P-7075
2	ICP 84023x P- 22	23	ICP 84023x DSLR-21
3	ICP 84023x P-129	24	ICP 84023x DSLR-39
4	ICP 84023x P-241	25	ICP 84023x DSLR-42
5	ICP 84023x P-260A	26	ICP 84023x DSLR-43
6	ICP 84023x P-488	27	ICP 84023x DSLR-108
7	ICP 84023x P-593	28	ICP 84023x DSLR-125
8	CP 84023x P-672	29	ICP 84023x DSLR-129
9	ICP 84023x P-928	30	ICP 84023x EC-100465
10	ICP 84023x P-1105	31	ICP 84023x EC-109875
11	ICP 84023x P-1949	32	ICP 84023x EC-109876
12	ICP 84023x P-2455	33	ICP 84023x EC-109878
13	ICP 84023xP-2679	34	ICP 84023x EC-109879
14	ICP 84023x P-2805	35	ICP 84023x EC-109880
15	ICP 84023x P-3691	36	ICP 84023x EC-109887
16	ICP 84023x P-3701	37	ICP 84023x EC-109888
17	ICP 84023x P-4038	38	ICP 84023x EC-109890
18	ICP 84023x P-4227	39	ICP 84023x EC-109914
19	ICP 84023x P-4272	40	ICP 84023x EC-109915
20	ICP 84023x P-4467	41	ICP 84023x Pant A 1
21	ICP 84023x P-5079	42	ICP 84023x Pant A 2
43	ICP 84023x Pant A 3	72	ICP 84023x TT 15-15

44	ICP 84023x AL-13	73	ICP 84023x UQ 12
45	ICP 84023x AL-15	74	ICP 84023x UQ 81
46	ICP 84023x AL-20	75	ICP 84023x UQ 82
47	ICP 84023x AL-287	76	ICP 84023x UQ 83
48	ICP 84023x AL-288	77	ICP 84023x UC 93A
49	ICP 84023x AL-1340	78	ICP 84023x UC 1463
50	ICP 84023x AL-1408	79	ICP 84023x UC 5101
51	ICP 84023x AL-1411	80	ICP 84023x TAM 9-2
52	ICP 84023x AL-1412	81	ICP 84023x TAM 9-17
53	ICP 84023x AL-1413	82	ICP 84023x TAM 9-21
54	ICP 84023x AL-1414	83	ICP 84023x TAM 9-22
55	ICP 84023x AL-1417	84	ICP 84023x Narman
56	ICP 84023x AL-1420	85	ICP 84023x D-45
57	ICP 84023x AL-1421	86	ICP 84023x DL 74-1
58	ICP 84023x AL-1422	87	ICP 84023x R 7-2
59	ICP 84023x AL-1425	88	ICP 84023x R-3
60	ICP 84023x AL-1426	89	ICP 84023x ICP-2143
61	ICP 84023x AL-1427	90	ICP 84023x ICP-6951
62	ICP 84023x AL-1430	91	ICP 84023x ICP-10993
63	ICP 84023x AL-1436	92	ICP 84023x ICP-84031
64	ICP 84023x AL-1437	93	ICP 84023x ICP-88039
65	ICP 84023x AL-1439	94	ICP 84023x ICP-88060
66	ICP 84023x ANN 46	95	ICP 84023x ICP-91052
67	ICP 84023x ANN 54	96	ICP 84023x ICP-99060
68	ICP 84023x S 32		
69	ICP 84023x Pusa 84		
70	ICP 84023x khargone L		
71	ICP 84023x Granula 1		

Programme 3: Maintenance and evaluation of parental (A and R) lines

1. Maintenance of 'A' and 'B' lines: Twenty one A lines of early, mid late and long duration (Table 10) have been maintained by hand pollination for development of hybrids. Maintainer lines of these A lines are being maintained by selfing of single plants under nylon net.

Table 10: CMS line maintained

Sl. No.	Line	Duration	Sl. No.	Line	Duration
1.	ICP 84023A	Early	12.	CORG 990047A	Early
2.	67A	Early	13.	CORG 990052A	Early
3.	PA 163A	Early	14.	ICP 2046A	Early
4.	UPAS 120A	Early	15.	ICP 2043A	Early
5.	GT 33A	Early	16.	ICP 2067A	Early
6.	GT 100A	Early	17.	ICP 2089A	Early
7.	GT 288A	Early	18.	ICP 2039A	Early
8.	GT 290A	Early	19.	Hy 4A	Mid Late
9.	GT 301A	Early	20.	H 28B A	Late
10.	GT 307A	Early	21.	PDA 89-2E-A	Late
11.	GT 308A	Early			

2. Maintenance of restorer lines: Sixty one (34 early, 16 medium and 11 long duration) restorer lines (**Table 11**) have been maintained under strict selfing by covering the single plants with nylon net.

Table 11: Restorers maintained

Sl. No.	Line	Duration	Sl. No.	Line	Duration
1.	250043R	Early	32	AK- 261594	Early
2.	250083R	Early	33	AK- 261622	Early
3.	2500137R	Early	34	AK- 261526	Early
4.	2500157R	Early	35.	GTR 1	Medium
5.	2500159R	Early	36.	GTR 2	Medium
6.	2500165R	Early	37.	GTR 5	Medium
7.	2500167R	Early	38.	GTR 6	Medium
8.	2500173R	Early	39.	GTR 8	Medium
9.	2500189R	Early	40.	GTR 9	Medium
10.	2500204R	Early	41.	GTR 10	Medium
11	AK- 260479	Early	42.	GTR 11	Medium
12	AK- 260748	Early	43.	GTR 22	Medium
13	AK- 260795	Early	44.	GTR 517	Medium
14	AK- 261233	Early	45.	GTR 521	Medium
15	AK- 261243	Early	46	GTR 524	Medium
16	AK- 261264	Early	47.	GTR 526	Medium
17	AK- 261321	Early	48.	GTR 529	Medium
18	AK- 261332	Early	49.	CO 1-R	Medium
19	AK- 261354	Early	50.	CO 2-R	Medium
20	AK- 261394	Early	51.	DPPA 58-7	Late
21	AK- 261409	Early	52.	GAUT 90-1	Late
22	AK- 261411	Early	53.	ICP 41	Late
23	AK- 261514	Early	54.	ICP 2730	Late
24	AK- 261429	Early	55.	ICP 5774	Late
25	AK- 261504	Early	56.	ICP 98-2	Late
26	AK- 261505	Early	57.	ICP 7357	Late
27	AK- 261506	Early	58.	JBP 86 B	Late
28	AK- 261515	Early	59.	JBP 110	Late
29	AK- 261536	Early	60.	MAL 14	Late
30	AK- 261561	Early	61.	WRG 1-2	Late
31	AK- 261581	Early			

Punjab Agricultural University, Ludhiana

Objective No. 1. To develop the CMS- based high yielding hybrids in early duration background

Development of new hybrids :

A total of 261 new experimental hybrids using different male sterile lines namely i.e. ICPA 2089 (80), AL 100A (53), AL 103A (49), AL 105A (39), AL 108A (33), GT 288A (4) and GT 33A (3), were developed during the crop season of 2011 (Table 1). The male sterile line ICPA 2089 belongs to A4 cytoplasm and rest of the male sterile lines belong to A2 cytoplasm. The no. of crossed seed produced is given in Table 1.

Table 1: Experimental hybrids developed during *kharif* 2011

Sr. No.	Hybrid	seeds	Sr.No.	Hybrid	Seeds	Sr. No.	Hybrid	Seeds
1	PHL 754	37	73	PHL 842	10	145	PHL 929	6
2	PHL 755	13	74	PHL 843	13	146	PHL 930	6
3	PHL 756	7	75	PHL 844	9	147	PHL 931	9
4	PHL 757	9	76	PHL 845	22	148	PHL 933	11
5	PHL 758	7	77	PHL 846	13	149	PHL 934	13
6	PHL 759	17	78	PHL 847	27	150	PHL 935	11
7	PHL 760	6	79	PHL 848	6	151	PHL 936	25
8	PHL 762	12	80	PHL 849	8	152	PHL 937	18
9	PHL 763	17	81	PHL 850	5	153	PHL 938	7
10	PHL 764	4	82	PHL 851	4	154	PHL 939	11
11	PHL 765	12	83	PHL 852	16	155	PHL 941	16
12	PHL 766	20	84	PHL 853	9	156	PHL 942	9
13	PHL 767	16	85	PHL 854	19	157	PHL 943	4
14	PHL 768	22	86	PHL 855	14	158	PHL 944	4
15	PHL 769	7	87	PHL 856	7	159	PHL 946	4
16	PHL 770	12	88	PHL 857	20	160	PHL 950	4
17	PHL 772	12	89	PHL 858	25	161	PHL 952	5
18	PHL 774	18	90	PHL 859	13	162	PHL 953	8
19	PHL 775	10	91	PHL 860	15	163	PHL 954	9
20	PHL 776	9	92	PHL 863	8	164	PHL 955	8
21	PHL 777	10	93	PHL 864	4	165	PHL 956	8
22	PHL 778	21	94	PHL 865	17	166	PHL 957	20
23	PHL 779	12	95	PHL 866	11	167	PHL 958	30
24	PHL 780	16	96	PHL 867	14	168	PHL 960	13
25	PHL 782	14	97	PHL 868	13	169	PHL 961	6
26	PHL 783	22	98	PHL 869	18	170	PHL 962	10
27	PHL 784	29	99	PHL 870	34	171	PHL 963	11
28	PHL 785	7	100	PHL 871	17	172	PHL 964	6
29	PHL 787	10	101	PHL 872	25	173	PHL 965	7
30	PHL 788	7	102	PHL 873	18	174	PHL 966	11
31	PHL 789	9	103	PHL 874	25	175	PHL 967	11
32	PHL 790	8	104	PHL 875	9	176	PHL 968	12
33	PHL 791	12	105	PHL 876	11	177	PHL 969	15
34	PHL 792	4	106	PHL 877	15	178	PHL 970	19

Sr. No.	Hybrid	Seeds	Sr. No	Hybrid	Seeds	Sr. No.	Hybrid	Seeds
35	PHL 793	13	107	PHL 878	8	179	PHL 971	20
36	PHL 794	4	108	PHL 879	51	180	PHL 972	10
37	PHL 795	10	109	PHL 880	6	181	PHL 973	29
38	PHL 796	7	110	PHL 882	6	182	PHL 974	54
39	PHL 797	5	111	PHL 884	10	183	PHL 975	61
40	PHL 799	5	112	PHL 885	15	184	PHL 976	24
41	PHL 801	9	113	PHL 886	6	185	PHL 977	37
42	PHL 802	13	114	PHL 888	11	186	PHL 978	18
43	PHL 803	7	115	PHL 890	4	187	PHL 979	4
44	PHL 804	6	116	PHL 891	15	188	PHL 980	15
45	PHL 805	11	117	PHL 892	21	189	PHL 981	21
46	PHL 806	11	118	PHL 893	15	190	PHL 982	6
47	PHL 807	5	119	PHL 895	8	191	PHL 983	6
48	PHL 808	4	120	PHL 898	9	192	PHL 984	4
49	PHL 810	23	121	PHL 899	11	193	PHL 988	8
50	PHL 812	7	122	PHL 900	16	194	PHL 989	64
51	PHL 813	4	123	PHL 901	23	195	PHL 990	24
52	PHL 814	12	124	PHL 902	10	196	PHL 992	12
53	PHL 815	9	125	PHL 903	6	197	PHL 993	14
54	PHL 816	7	126	PHL 905	19	198	PHL 994	7
55	PHL 817	7	127	PHL 906	9	199	PHL 995	6
56	PHL 818	5	128	PHL 907	18	200	PHL 997	17
57	PHL 820	11	129	PHL 908	7	201	PHL 998	12
58	PHL 821	7	130	PHL 911	6	202	PHL 999	14
59	PHL 825	6	131	PHL 912	11	203	PHL 1000	5
60	PHL 826	4	132	PHL 913	17	204	PHL 1001	8
61	PHL 828	4	133	PHL 914	32	205	PHL 1002	17
62	PHL 829	16	134	PHL 915	15	206	PHL 1003	11
63	PHL 832	30	135	PHL 916	32	207	PHL 1004	11
64	PHL 833	38	136	PHL 917	17	208	PHL 1005	17
65	PHL 834	11	137	PHL 918	4	209	PHL 1006	22
66	PHL 835	16	138	PHL 919	11	210	PHL 1007	19
67	PHL 836	5	139	PHL 921	4	211	PHL 1008	6
68	PHL 837	32	140	PHL 922	11	212	PHL 1009	7
69	PHL 838	6	141	PHL 923	10	213	PHL 1011	12
70	PHL 839	42	142	PHL 924	4	214	PHL 1012	9
71	PHL 840	22	143	PHL 926	5	215	PHL 1013	12
72	PHL 841	24	144	PHL 927	17	216	PHL 1014	8

In remaining 45 hybrids 2-3 seeds were produced

b) Seed multiplication of early duration hybrids: Four hybrid combinations restoring fertility were multiplied in isolation to obtain seed for multilocation testing in next year (Table 2).

Table 2: Seed multiplied for hybrids

Sr. No.	Hybrid	Seed (g)
1	PHP77	400
2	PHP78	370
3	PHP84	400
4	PHP85	600

Objective No. 2. Evaluation of hybrids for yield and other traits

Table 3 : Observations for hybrids and checks in AHT-II trial (Ludhiana)

S. No.	Variety/ code	Plant Stand	Yield kg/ha	Days to 50% flowering	Days to maturity	Pl. ht (cm)	100-seed wt. (gm)	Seed color	Plant Fertility (%)
1	IPH 09-5	68	1863	122	165	271	11.4	Yellow	99
2	AL 201 (ch)	68	2059	102	141	269	7.9	Yellow	-
3	UPAS120 (ch)	68	1111	130	167	275	8.0	Yellow	-
4	P992(ch)	68	1394	110	158	262	8.1	Yellow	-
	CD (P=0.05)		108						
	CV%		3.36						

Table 3a: Observations for hybrids and checks in AHT-I Trial (Ludhiana)

S. No.	Variety/ code	Plant Stand	Yield kg/ha	Days to 50% flowering	Days to maturity	Pl. ht (cm)	100-seed wt. (gm)	Seed color	Plant Fertility (%)
1	IPH 10-2	45	1895	130	170	277	8.4	Purple	99
2	IPH 10-3	45	1601	127	171	262	9.1	Purple	95
3	AL 201 (ch)	45	2108	102	141	256	7.8	Yellow	-
4	P992(ch)	45	1626	112	160	262	8.2	Yellow	-
5	UPAS120 (ch)	45	1373	131	168	276	8.2	Yellow	-
	CD (P=0.05)		218						
	CV%		6.73						

Table 3 b: Observations for hybrids and checks in IHT (E) trial

S. No.	Variety/ code	Final Plant Stand	Yield kg/ha	Days to 50% flowering	Days to maturity	Pl. ht (cm)	100-seed wt. (gm)	Seed color	Plant Fertility (%)
1	PHP 34	23	2156	103	148	267	7.5	Yellow	88
2	IPH 11-1	23	1748	123	165	290	9.7	Yellow	95
3	IPH 11-2	23	1699	129	163	269	10.2	Yellow	95
4	IPH 11-3	23	2222	123	166	289	8.8	Yellow	95
5	AL 201(ch)	23	2288	101	141	267	7.9	Yellow	-
6	P992 (ch)	23	1830	114	158	258	8.4	Yellow	-
7	UPAS 120 (ch)	23	1569	131	168	295	8.2	Yellow	-
	CD 5%		301						
	CV %		8.77						

Table 4: Pod setting (Mean of 10 plants) and plant fertility in net house

Sr. No.	Entries	No. of self pod set	Plant fertility (%)
1	IPH 09 -5	77	100
2	IPH 10-2	13	100
3	IPH 10-3	38	84
4	IPH 11-1	124	100
5	IPH 11-2	112	100
6	IPH 11-3	61	85
7	PHP-34	131	100
8	UPAS 120	195	100
9	P 992	122	100
10	AL 201	145	100

Objective No. 3. Transfer of male sterility into agronomically superior early backgrounds

Table 5: Cross combinations under sterility conversion programme

S No.	Cross combination	No. of seeds
BC₁F₁		
1	ICPA2089 x AL 242	42
2	ICPA2089 x AL 609-1	46
3	ICPA2089 x AL 1336	8
4	ICPA2089 x AL 1401	16
5	ICPA2089 x AL 1444	11
6	ICPA2089 x AL 1478	13
7	ICPA2089 x H 03-27	30
8	ICPA2089 x H 92-6	9
9	ICPA2089 x H 99-4	8
10	ICPA2089 x H 2001-17	27
11	ICPA2089 x ED 13	4
12	ICPA2089 x P 291	5
13	ICPA2089 x P 292	6
14	ICPA2089 x PA 163	30
BC₄F₁		
1	67A x H2003-29	27
2	67A x H04-23	17
3	67A x AL1489	142
4	67A x AL1520	57
5	67A x AL201	163
6	AL100A x P2002-2	41
7	AL100A x CORG99047	35
8	UPAS 120A x CORG99047	13
BC₆F₁		
1	GT288A X AL1514	36
2	GT288A X AL1571	142
3	GT288A X IC245352	29
4	GT288A X IC345522	86

Objective 4. Testing of early duration experimental hybrids

One hundred and eighteen hybrids developed in 2010 were tested for fertility/ sterility reaction in 2011 to search potential restorers and maintainers (Table 6).

Table 6: Fertility/ sterility reaction of experimental hybrids (2011-12)

S. No.	Hybrid	% fertile plants	M/R	S. No.	Hybrid	% fertile plants	M/R	S. No.	Hybrid	% fertile plants	M/R
1	PHL 636	38		43	PHL 678	22		85	PHL 720	100	R
2	PHL 637	50		44	PHL 679	12		86	PHL 721	100	R
3	PHL 638	36		45	PHL 680	70		87	PHL 722	100	R
4	PHL 639	0	M	46	PHL 681	0	M	88	PHL 723	55	
5	PHL 640	88	R	47	PHL 682	50		89	PHL 724	60	
6	PHL 641	75	R	48	PHL 683	60		90	PHL 725	0	M
7	PHL 642	9		49	PHL 684	0	M	91	PHL 726	40	
8	PHL 643	70		50	PHL 685	0	M	92	PHL 727	0	M
9	PHL 644	40		51	PHL 686	27		93	PHL 728	0	M
10	PHL 645	37		52	PHL 687	40		94	PHL 729	0	M
11	PHL 646	9		53	PHL 688	0	M	95	PHL 730	11	
12	PHL 647	16		54	PHL 689	33		96	PHL 731	0	M
13	PHL 648	50		55	PHL 690	33		97	PHL 732	0	M
14	PHL 649	77	R	56	PHL 691	50		98	PHL 733	0	M
15	PHL 650	0	M	57	PHL 692	66		99	PHL 734	0	M
16	PHL 651	77	R	58	PHL 693	90	R	100	PHL 735	0	M
17	PHL 652	77	R	59	PHL 694	0	M	101	PHL 736	55	
18	PHL 653	38		60	PHL 695	25		102	PHL 737	0	M
19	PHL 654	27		61	PHL 696	27		103	PHL 738	25	
20	PHL 655	87	R	62	PHL 697	12		104	PHL 739	0	M
21	PHL 656	77	R	63	PHL 698	70		105	PHL 740	100	R
22	PHL 657	37		64	PHL 699	0	M	106	PHL 741	0	M
23	PHL 658	0	M	65	PHL 700	10		107	PHL 742	37	
24	PHL 659	80	R	66	PHL 01	0	M	108	PHL 743	0	M
25	PHL 660	50		67	PHL 702	75	R	109	PHL 744	0	M
26	PHL 661	14		68	PHL 703	0	M	110	PHL 745	0	M
27	PHL 662	60		69	PHL 704	100	R	111	PHL 746	100	R
28	PHL 663	20		70	PHL 705	30		112	PHL 747	0	M
29	PHL 664	44		71	PHL 706	41		113	PHL 748	22	
30	PHL 665	66		72	PHL 707	66		114	PHL 749	0	M
31	PHL 666	54		73	PHL 708	37		115	PHL 750	0	M
32	PHL 667	0	M	74	PHL 709	0	M	116	PHL 751	0	M
33	PHL 668	0	M	75	PHL 710	0	M	117	PHL 752	88	R
34	PHL 669	33		76	PHL 711	62		118	PHL 753	0	M
35	PHL 670	87	R	77	PHL 712	40					
36	PHL 671	0	M	78	PHL 713	0	M				
37	PHL 672	40		79	PHL 714	55					
38	PHL 673	40		80	PHL 715	0	M				
39	PHL 674	0	M	81	PHL 716	0	M				
40	PHL 675	70		82	PHL 717	14					
41	PHL 676	66		83	PHL 718	77	R				
42	PHL 677	12		84	PHL 719	0	M				

M : maintainer ; R : Restorer

Table 7: New restorer combinations identified and seed multiplied in off season

Sr. No	Entries	No. of seeds
1	PHL 640	37
2	PHL 643	66
3	PHL 649	46
4	PHL 651	49
5	PHL 652	59
6	PHL 656	33
7	PHL 659	83
8	PHL 662	27
9	PHL 680	20
10	PHL 752	68

Objective 5. Maintenance of early duration CGMS lines in isolation

Following CMS lines were maintained at PAU, Ludhiana during *Kharif* 2011 (Table 8)

Table 8: Maintenance of male sterile lines in isolation

Sr. No.	Male sterile line	Seeds (g.)
1	ICPA2089	900
2	AL100-A	1100
3	AL103-A	1900
Maintenance by hand pollination		
4	AL 102 A	32 seeds
5	AL 104 A	11
6	AL 105 A	85
7	AL 108 A	42
8	GT 33 A	24
9	GT 288 A	88

Objective 5. Purification/ maintenance of parents

Large number of parents involved in maintenance and restoring fertility are being purified on single plant basis.

Indian Agricultural Research Institute, New Delhi

Objectives No.1 : To evaluate already developed CGMS-based hybrids of early maturity group

Three hybrid trials viz., IHT(E), AHT-1 and AHT-2 were conducted at IARI, New Delhi. All the 3 trials were sown on 1-06-2011. The results obtained have been summarized below.

1. Initial Hybrid Trial (IHT) (E) : 4 Hybrids along with 3 checks viz., AL-201, UPAS 120 and Pusa 992 were evaluated in RBD with 3 replications (Table 1A-1E). Out of the 4 hybrids, PHP-34 was earliest in flowering and maturity and was also earlier than UPAS 120 but was late than AL-201 and Pusa 992. Out of the 4 hybrids, PHP-34 had grain yield of 22.9 qt/ha which was higher than all the check varieties. Hybrids IPH-11-1, IPH-11-2 and IPH-11-3 had 100-seed weight greater than all the check varieties.

Days to flowering ranged from 103.6(AL201) to 133.3(UPAS120). Days to maturity ranged from 142(AL201) to 170.3(UPAS120). Hundred seed weight ranged from 6.99(AL201) to 9.15 g/100 seeds(IPH-11-1). Pollen fertility percentage of hybrids ranged from 73.5% (IPH 11-1) to 94.0%(IPH 11-2).

Table 1. Evaluation of hybrids in IHT(E) in North Zone

1A. Days to flowering

S.No	Entries	RI	RII	RIII	Average
1	IPH-11-1	126	127	126	126.3
2	IPH11-2	127	128	128	127.6
3	IPH11-3	124	123	123	123.3
4	PHP-34	116	117	114	115.6
5	AL-201	104	105	102	103.6
6	UPAS120	132	134	134	133.3
7	PUSA992	112	113	115	113.3

1B. Days to Maturity

S.No	Entries	RI	RII	RIII	Average
1	IPH-11-1	167	165	166	166.0
2	IPH11-2	167	164	165	165.3
3	IPH11-3	162	160	159	160.3
4	PHP-34	152	153	150	151.6
5	AL-201	142	144	140	142.0
6	UPAS120	172	170	169	170.3
7	PUSA992	149	150	150	149.6

1C. Hundred Seed weight(g/100 seeds)

S.No	Entries	100 Seed Weight (g)
1	IPH-11-1	9.15
2	IPH11-2	9.12
3	IPH11-3	8.75
4	PHP-34	7.43
5	AL-201	6.99
6	UPAS120	7.11
7	PUSA992	8.32

1D. Pollen Fertility(%)

S.No	Entries	RI	RII	RIII	Average
1	IPH-11-1	77.8	67.9	74.8	73.5
2	IPH11-2	98.8	92.8	90.4	94.0
3	IPH11-3	94.8	89.7	91.5	92.0
4	PHP-34	85.4	89.2	86.5	87.0
5	AL-201	95.8	96.5	97.3	96.5
6	UPAS120	97.4	95.8	96.6	96.6
7	PUSA992	96.5	95.4	97.5	96.4

1E. Grain Yield (qt/ha) (Plot Area : 9 Sq M)

S.No	Entries	RI	RII	RIII	Average
1	IPH-11-1	22.77	23.33	20.66	22.25
2	IPH11-2	18.33	16.11	16.33	16.92
3	IPH11-3	20.00	18.66	20.55	19.74
4	PHP-34	24.44	22.77	21.66	22.93
5	AL-201	16.66	20.0	19.66	18.77
6	UPAS120	17.22	17.22	15.55	16.66
7	PUSA992	24.44	21.60	22.22	22.75

2. Advanced Hybrid Trial-I (AHT-I)

2 Hybrids along with 3 checks viz., AL-201, UPAS 120 and Pusa 992 were evaluated in RBD with 3 replications (Table 2A-2E). Both the hybrids were late in flowering and maturity than the check varieties Pusa 992 and AL201 but were earlier than UPAS120. With respect to grain yield, IPH10-2 hybrid had lower grain yield than Pusa 992 and AL 201. Other hybrid IPH-10-3 had greater yield (17.66qt/ha) than UPAS 120 but had lower yield than Pusa 992. Both the hybrids had smaller 100-seed weight than all the 3 check varieties.

Days to flowering ranged from 102.3(AL201) to 132.3(UPAS120). Days to maturity ranged from 144.0 (AL201) to 168.3(UPAS120). Hundred seed weight ranged from 6.70(IPH 10-3) to 8.30 g/100 seeds (Pusa992). Grain yield ranged from 16.55 (UPAS120)

to 20.62(Pusa 992) qt/ha. In hybrids, days to maturity ranged from 165.6(IPH 10-3) to 167.09(IPH 10-2). Thus, both the hybrids were late in maturity. Pollen fertility percentage of hybrids ranged from 77.8% (IPH 10-3) to 90.8 % (IPH 10-2).

Table 2. Evaluation of hybrids in AHT -1 in North Zone

2A. Days to Flowering

S.No	Entries	RI	RII	RIII	Average
1	Pusa 992	114	114	112	113.3
2	AL 201	104	102	101	102.3
3	UPAS120	134	132	131	132.3
4	IPH 10-2	128	126	126	126.6
5	IPH10-3	126	126	126	126.0

2B. Days to Maturity

S.No	Entries	RI	RII	RIII	Average
1	Pusa 992	148	150	151	149.6
2	AL 201	142	146	144	144.0
3	UPAS120	170	168	167	168.3
4	IPH 10-2	170	166	165	167.0
5	IPH10-3	167	166	164	165.6

2C. Hundred Seed weight(g/100 seeds)

S.No	Entries	100 Seed Weight (g)
1	Pusa 992	8.30
2	AL 201	7.12
3	UPAS120	7.02
4	IPH 10-2	7.79
5	IPH10-3	7.70

2 D. Pollen Fertility(%)

S.No	Entries	RI	RII	RIII	Average
1	Pusa 992	97.4	98.5	96.7	97.5
2	AL 201	96.6	95.6	96.1	96.1
3	UPAS120	98.5	96.8	95.7	97.0
4	IPH 10-2	86.3	92.8	93.3	90.8
5	IPH10-3	77.8	78.6	77.2	77.8

2E. Grain Yield (qt/ha) (Plot Area : 15 Sq M)

S.No	Entries	RI	RII	RIII	Average
1	Pusa 992	20.00	20.00	21.86	20.62
2	AL 201	17.33	16.00	18.66	17.33
3	UPAS120	15.66	16.66	17.33	16.55
4	IPH 10-2	15.66	17.66	17.00	16.77
5	IPH10-3	18.33	17.66	17.00	17.66

3. Advanced Hybrid Trial-II (AHT-II) : One Hybrid along with 3 checks viz., AL-201, UPAS120 and Pusa 992 were evaluated in RBD with 3 replications (Table 3A-3E). Hybrid IPH 9-5 was late in flowering as well as maturity than check varieties AL201 and Pusa 992 but was earlier than UPAS 120. Hybrid IPH 9-5 had higher grain yield (20.36 qt/ha) than AL 201 and UPAS 120. However, hybrid had greater 100-seed weight than all the three check varieties.

Days to flowering ranged from 102.0(AL201) to 134.0(UPAS120). Days to maturity ranged from 144.6 (AL201) to 170.3(UPAS120). Hundred seed weight ranged from 6.98(AL201) to 8.80 g/100 seeds (IPH 9-5). Grain yield ranged from 17.39 (UPAS120) to 20.31(Pusa 992) qt/ha. Days to maturity of hybrid (IPH 9-5) were 165.3. Thus, hybrid was late in maturity as compared to checks. Pollen fertility percentage in hybrid was 90.6 % (IPH 9-5).

Table 3. Evaluation of hybrids in AHT-2 in North Zone

3A. Days to Flowering

S.No	Entries	RI	RII	RIII	Average
1	AL 201	104	100	102	102.0
2	Pusa992	113	112	112	112.3
3	IPH 9-5	131	132	130	131.0
4	UPAS120	135	132	135	134.0

3 B. Days to Maturity

S.No	Entries	RI	RII	RIII	Average
1	AL 201	144	146	144	144.6
2	Pusa 992	150	148	149	149.0
3	IPH 9-5	165	166	165	165.3
4	UPAS120	169	170	172	170.3

3C. Hundred Seed weight (g/100 seeds)

S.No	Entries	100 Seed Weight (g)
1	AL 201	6.98
2	Pusa 992	8.21
3	IPH 9-5	8.80
4	UPAS120	7.02

3D. Pollen Fertility(%)

S.No	Entries	RI	RII	RIII	Average
1	AL 201	97.1	95.4	96.8	96.4
2	Pusa 992	97.6	98.5	97.4	97.8
3	IPH 9-5	87.3	94.0	90.6	90.6
4	UPAS120	96.4	97.5	96.7	96.8

3E. Grain Yield (qt/ha) (Plot Area : 21 Sq M)

S.No	Entries	RI	RII	RIII	Average
1	AL 201	18.57	17.28	17.81	17.88
2	Pusa992	20.47	19.52	20.95	20.31
3	IPH 9-5	20.62	20.00	20.47	20.36
4	UPAS120	16.90	19.52	15.76	17.39

Objective No. 2: To produce new high yielding CGMS-based hybrids in early maturity group

74 test hybrids (Table 4) between early generation BC lines of good combiners (in A₂ and A₄ cytoplasm) as A lines and the 6 restorers were attempted. These hybrids shall be evaluated in augmented trials next season for male fertility restoration, earliness and heterosis for grain yield.

Table 4 . Crosses attempted between good combiner A lines and R line

SNo.	A Line	Cytoplasm	R line	No of Crosses
1	PUSA855	A ₂	GTR-9, IPR-260479, IPR-260748, IPR-6141, AKPR-100,	5
2	PUSA991	A ₂	GTR-9, AKPR-100, IPR-260479, IPR-260748, IPR-26141	5
3	PUSA992	A ₂	GTR-9,GTR-11, AKPR-100,IPR-260479, IPR-260748, IPR-26141	6
4	UPAS120	A ₂	GTR-9, AKPR-100, IPR-260479, IPR-260748, IPR-26141	5
5	Pusa Dwarf	A ₂	GTR-9, AKPR-100, IPR-260479, IPR-260748, IPR-26141	5
6	PUSA 2001-2	A ₂	GTR-9, AKPR-100, IPR-260479, IPR-260748, IPR-26141	5
7	Pusa 2002	A ₂	GTR-9, AKPR-100,AKPR-417,IPR-260479, IPR-260748, IPR-26141,	6
8	Sel.141-47-1	A ₂	GTR-9, AKPR-100, IPR-260479, IPR-260748, IPR-26141	5
9	HDM04-1	A ₂	GTR-9, AKPR-100, IPR-260479, IPR-260748, IPR-26141	5
10	73-18-10	A ₂	IPR-260479, IPR-260748, IPR-26141	3
11	MS04A	A ₂	GTR-9	1

12	MS10A	A ₂	GTR-9,AKPR-100	2
13	AKPR100	A ₂	GTR9	1
14	GT288A	A ₂	GTR9,	1
15	GT33A	A ₂	GTR-9, AKPR-100, IPR-260479, IPR-260748, IPR-26141	5
16	GT290A	A ₂	GTR9, IPR-260479, IPR-260748, IPR-26141	4
17	UPAS120	A ₄	ICPR-2438	1
18	HDM04-1	A ₄	ICPR-2438	1
19	H2004-1	A ₄	ICPR-2438	1
20	AL201	A ₄	ICPR-2438	1
21	AL1518	A ₄	ICPR-2438	1
22	PUSA 2006- 2-1	A ₄	ICPR-2438	1
23	PUSA991	A ₄	ICPR-2438	1
24	PUSA2001-1	A ₄	ICPR2438	1
25	PUSA60N82- 1	A ₄	ICPR-2438	1
26	141-97	A ₄	ICPR-2438	1
Total				74

4 test hybrids (Table 5) between early generation BC lines of good combiners as A lines and the 2 restorers GTR 9 and AKPR 100 were evaluated for male fertility restoration and duration. In all the 4 hybrids male fertility was completely restored. Two hybrids (PUSA 9A X GTR 9 & PUSA 9A X AKPR100) had medium maturity as the parental line Pusa9A was of long duration maturity group. Other two hybrids (PUSA 992A X GTR 9 & PUSA 992A X AKPR100) also restored complete male fertility and were matured by November end. These hybrids were highly heterotic. Hybrid seed of these crosses shall be generated in more quantity in next season after confirmation of male fertility restoration and short duration.

Table 5. Crosses evaluated in Augmented Trial for Male Fertility

Restoration (MFR) & Earliness.

SN	Cross	Cytoplasm	Male Fertility Restoration	Duration
1	PUSA 9A X GTR9	A ₂	Restored	Medium
2	PUSA 9A X AKPR 100	A ₂	Restored	Medium
3	PUSA 992A X GTR 9	A ₂	Restored	Early
4	PUSA 992A X AKPR 100	A ₂	Restored	Early

Objective No. 3 : To develop molecular markers for testing the purity of hybrids for grow out test.

Leaf samples from all the available A, B and R lines were collected and DNA was extracted for studying diversity at molecular level amongst the A and R lines. SSR analysis shall be carried out using available SSR markers.

SD Agricultural University, S K Nagar

Objective No. 1 : Evaluation of already developed newly developed CGMS based hybrids of Early and Medium Group

1. INITIAL HYBRID TRIAL (E) CZ

IHT (E) comprised seven test hybrids contributed by different stations at Sardarkrushinagar. They were tested against three checks inclusive GTH 1. At Sardarkrushinagar, all the test hybrids evinced good visual plant fertility. Similarly all the test hybrids noticed good pollen fertility as per I₂ +KI test. Significant differences were observed for grain yield among the hybrids. Only one SKNPCH 0923 (1877 kg/ha) yielded higher than the best check GTH 1 (1739 kg/ha) by 7.0 per cent.

2. ADVANCED HYBRID TRIAL 1 (E) CZ

AHT (E) comprised three test hybrids contributed by Sardarkrushinagar. It was tested against three checks inclusive GTH 1 at Sardarkrushinagar. Non Significant difference was observed for grain yield among the hybrids at sardarkrushinagar. At Sardarkrushinagar, test hybrid evinced good visual plant fertility. As well as it noticed good pollen fertility as per I₂ +KI test. Test hybrid SKNPCH 0835 (1987 kg/ha) yielded higher than the best check GTH 1 (1738 kg/ha) by 14.32 per cent.

3. INITIAL HYBRID TRIAL (M) CZ

IHT (M) comprised 11 test hybrids contributed by different stations at Sardarkrushinagar. They were tested against four checks (Co-6, BSMR736, Maruthi and Asha). Most of hybrids evinced good visual plant fertility except AKPHM 10259, and AKPHM 10260. Similarly fertile hybrids noticed good pollen fertility as per I₂ +KI test except AKPHM 10259, and AKPHM 10260. Significant differences were observed for grain yield among the hybrids. Only two hybrids SKNPCH 0932 (3177 kg/ha) and ICPH 3477 (2034 kg/ha) yielded higher than the best check Co6 (2011 kg/ha).

4. ADVANCED HYBRID TRIAL 1 (M) CZ

AHT (M) comprised 5 test hybrids contributed by different stations at Sardarkrushinagar. They were tested against five checks (Co-6, BSMR736, Maruthi, BDN-2 and Asha). Most of hybrids evinced good visual plant fertility except AKPHM 10178 exhibited partial fertility. Similarly fertile hybrids noticed good pollen fertility as per I₂ +KI test except AKPHM 10178. Significant differences were observed for grain yield among the hybrids. Only one hybrid SKNPCH 0935 (1988 kg/ha) yielded higher than the best check Co6 (1358 kg/ha).

Objective No.2 : Development of Molecular markers for testing the purity of hybrids for GOT

1.DNA extraction protocol was standardized. (Fig. 1)



Fig 1 DNA

2. Out of the 40 microsatellite primers (Table 1) that were analyzed; three primers viz. CcM0021, CcM0030 and CCB9 were selected for further analysis on account of their palpable polymorphism between the parents and their hybrid. They amplified DNA fragments in the size range of 30 to 300 with 33.3 to 50 % percent polymorphism. These three primers viz. CcM0021, CcM0030 and CCB9 produced three unique bands in parents and their hybrid. Out of this one band of size 190bp produced by CcM0030 was conspicuous from hybrid seed identification point of view. This band was not present in female parent GT 288A but was present in male parent GTR 11. The band was conspicuously present in hybrid GTH 1 too that could facilitate in identifying the veracity of the hybrid seed produced on GT 288A with GTR 11. The other two bands of size 150bp and 300bp produced by CcM0021 and CCB9, respectively, though could distinguish male GTR 11 and female GT 288A, yet they were of little importance for identification of hybrid seed of GTH 1 as the band was present both in female GT 288A and hybrid GTH 1 (Figure 1 & 3). However, these two peculiar bands can be used to distinguish male GTR 11 and female GT 288A parental materials.

Table 1 :SSR Primers Tested for GOT

SN	SSR primer	SN	SSR primer	SN	SSR primer	SN	SSR primer
1.	CcM0030	11.	CC mo 173	21.	CcM0248	31.	MaSSR-07a
2.	CcM0021	12.	CC mo 176	22.	CcM0252	32.	OSR1
3.	OSR28	13.	CC mo 179	23.	CC mo 208	33.	OSR6
4.	CCtta004	14.	CC mo 181	24.	CcM0246	34.	CCB4
5.	OSR20	15.	CC mo 183	25.	CcM0248	35.	CCtta002
6.	OSR9B	16.	CC mo 185	26.	CcM0252	36.	RM283
7.	CCB7	17.	CC mo 193	27.	CC mo 208	37.	PP4
8.	CC mo 133	18.	CC mo 195	28.	CcM0257	38.	MaSSR-24
9.	CC mo 134	19.	CC mo 208	29.	RM272	39.	OSR14
10.	CC mo 137	20.	CcM0246	30.	PP7	40.	CcM0031

Thus the hybrid seed harvested from female in seed production plot can be distinguished on the basis of 190bp male specific band attributable to CcM0030 microsatellite marker. The high

discriminating power of SSR markers and inexpensive setup may be used as an added asset for affordable field based fingerprinting of parents (GT 288 A & GTR 11) and their hybrid GTH 1 for assessing genetic purity. The information of molecular fingerprinting of the CGMS line, restorer line and the hybrid assumes significance both for protecting Plant Breeders' Rights as also ensuring genetic purity of seed in each component line. Therefore, it is concluded that microsatellite marker technology can be a useful tool for ascertaining genetic purity of the pigeonpea hybrid GTH1 at juvenile stage.

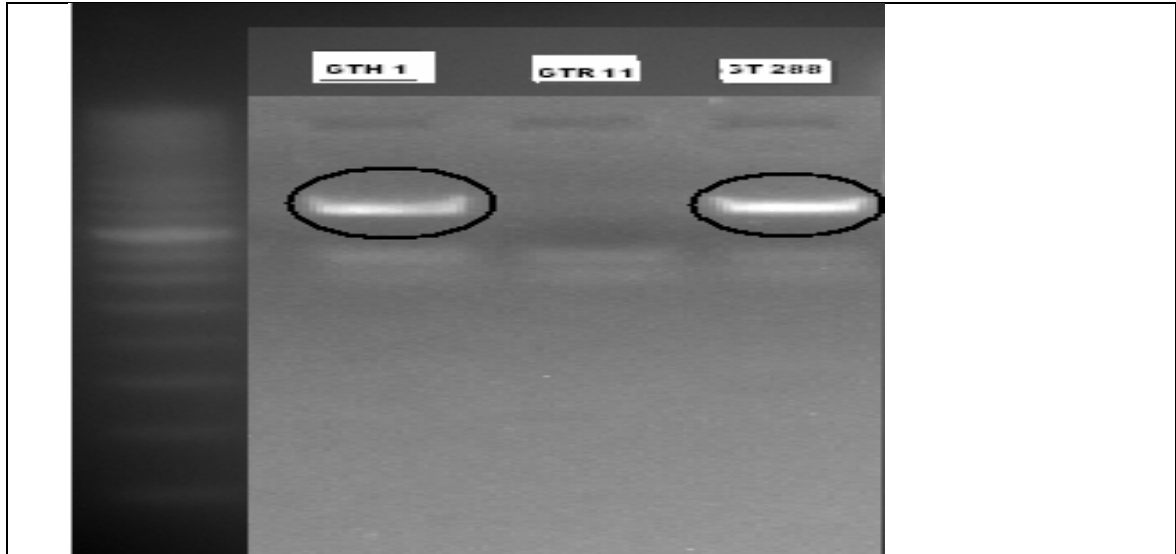


Fig. 2 CCB9

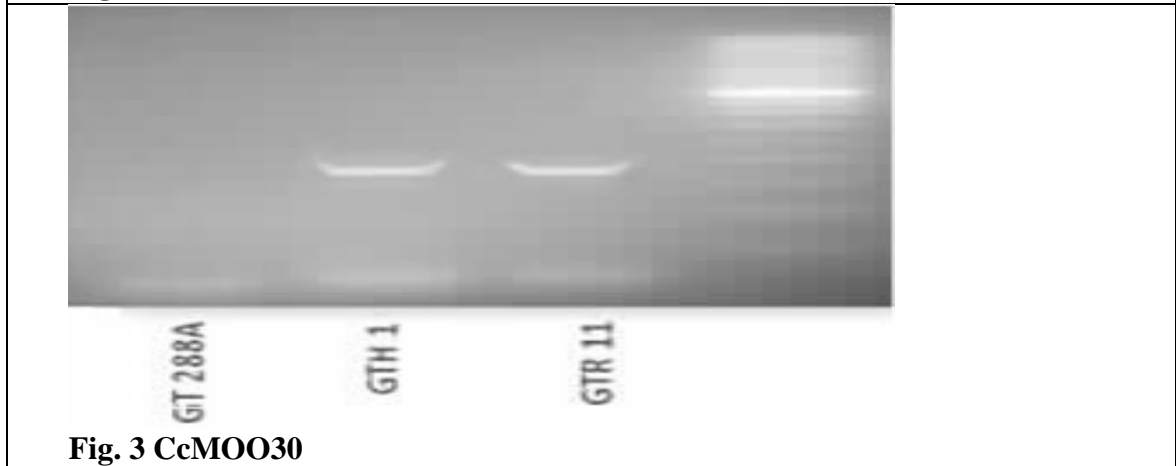


Fig. 3 CcMOO30

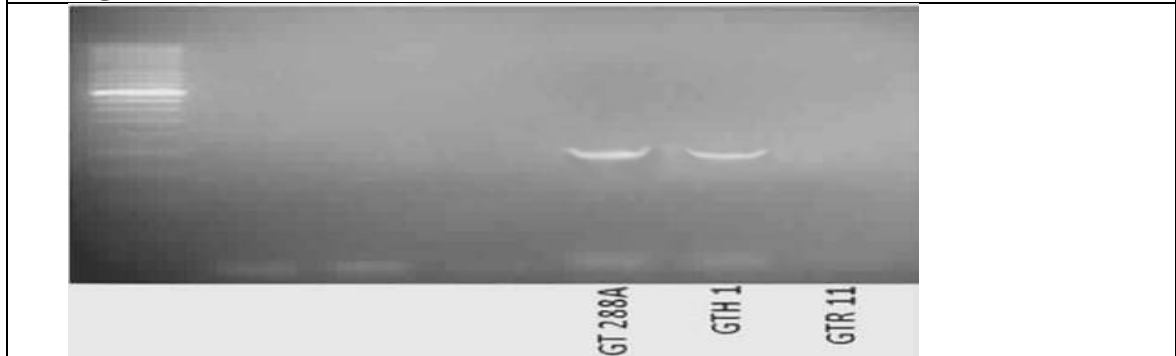


Fig 4 CcMOO21

Objective No. 3 : Build Human Resource capacity for production of hybrids and hybrid seed through training.

Training for Maintenance breeding of field crops was organized on 16-17 Dec 2011. Total 40 participants (Table 2) were trained for Seed production and Maintenance of A, B and R lines of CGMS based pigeonpea hybrids.

Table 2: Participants and their no. who attended the training

S. No.	Participants	No.
1	SAU's Participants	30
2	KVK's Participants	05
3	Department of Agril. Govt. of Gujarat	05
4	Resource persons	15
	Total	55

Tamil Nadu Agriculture University, Coimbatore

Objective No.1: To evaluate already developed CGMS based hybrids of early and medium maturity groups

Early duration

In early duration, two hybrid trials *viz.*, IHT (E) and AHT-1(E) were raised on 13.09.2011. IHT (E) was evaluated with five entries and two zonal checks *viz.*, CORG 9701 and UPAS 120. Four hybrids were evaluated along with two checks in AHT-1(E). The results are furnished in Tables 1 and 2.

Medium duration

One medium duration hybrid trial was raised with 11+5 entries on 17.08.2011. The detailed report is given in Table 3.

Objective No.2: To produce new high yielding hybrids in early and medium maturity groups

Early duration

Preliminary Yield Trial (Hybrid)

A Preliminary Yield Trial (Hybrid) was raised (Table 1) with ten early hybrids and two checks. The crop was raised on 27.05.2011.

Table 1: Performance of hybrids in preliminary yield trials at TNAU

S.No	Entries	DFP	% Pollen fertility	Yield / plot (kg / 12 sq.m)	Duration
1	CPH 09-09	72	93.2	1.850	120
2	CPH 09-12	75	90.2	1.965	118
3	CPH 09-15	70	92.5	1.500	120
4	CPH 08-05	71	90.8	1.690	125
5	CORG9701 (check)	75	99.8	1.725	135

Test cross progenies

Sixty cross combinations produced during summer 2011 were evaluated for fertility restoration and maintenance. Out of these sixty combinations three combinations *viz.*, Co 5 A₂ x AF 284, Co(Rg) 7 A₂ x Co 5 and PA 325 A₂ x CRG 5 recorded 90.5,93.6 and 94.2 per cent pollen fertility. These hybrids will be resynthesised and forwarded for evaluation during 2012-2013.

Crossing block

To develop new cross combinations in early duration five CGMS based male sterile lines *viz.*, Co(Rg)7 A₂, Co 5 A₂, Co(Rg)7 A₄, PA 325 A₂ and Pusa 2006-1 A₂ (developed in Department of Pulses, TNAU) were raised along with fourteen male parents *viz.*, PA 327, H-05-61, BRG 10-01, SKNP 0706, Pusa 2010/02-2, ASJ 136, SKNP 0718, BDN 2004-3, RVKP 260, PA 382, BRG 10-02, AL 1778, AL 1702 and NTL 505. Crosses were made and the crossed seeds were collected for further evaluation.

Medium duration

Testcross progenies

Ninety six new cross combinations produced during *kharif* 2010 were raised to identify the restoring and maintaining combinations. Pollen fertility studies revealed that thirteen combinations were s fertile hybrids and four combinations were complete maintainers. The crop is at maturity stage. At the time of harvest, pod setting will be estimated.

Crossing block

In order to develop new hybrids in medium duration, six CGMS based male sterile lines *viz.*, ICPA 2043, ICPA 2047, ICPA 2049, ICPA 2051, ICPA 2092 (received from ICRISAT, Pattancheru) and Hy 4A (received from IIPR, Kanpur) and eight male parents *viz.*, BSMR 736, Maruthi, Asha, Lakshmi, Riccha, G-11, Balwan and one local type were raised in a crossing block. Crossing was done and crossed seeds were collected for further evaluation.

Transfer of male sterile sources to agronomically superior backgrounds:

Male sterile line with 100 per cent sterility is the backbone for any hybrid breeding programme. To attain this task, best maintaining combinations in test cross progenies lot are used for conversion in both early and medium durations.

Early duration

In early duration **eight** combinations are in BC₆F₁, **three** combinations are in BC₅F₁ and **three** combinations are in BC₃F₁ stage (Table 2). They were sown under insect proof net on 13.09.2011 for further advancement in generation. The detailed list of progenies is furnished in the following table.

Table 2: Early duration backcross progenies

S. No.	Stage	Backcross progenies
1	BC ₆ F ₁	CRG 990052 A x ICPR 2434
2	BC ₆ F ₁	ICPA 2039 x AS 36
3	BC ₆ F ₁	ICPA 2052 x AF 284
4	BC ₆ F ₁	GT 100 A x ICPR 2363
5	BC ₆ F ₁	GT 288 A x Co 2 R
6	BC ₆ F ₁	GT 288 A x AF 284
7	BC ₆ F ₁	GT 288 A x ICPR 2363
8	BC ₆ F ₁	CRG 990047A x TAT 93 – 47
9	BC ₅ F ₁	CRG 990047A x CRG 9060
10	BC ₅ F ₁	CRG 990047A x AF 284
11	BC ₅ F ₁	GT 33 A x ICPR 2363
12	BC ₃ F ₁	CRG 990047 A x ICPL 88034
13	BC ₃ F ₁	CRG 990052 A x AL 1514
14	BC ₃ F ₁	ICPA 2155 x ICPL 86020

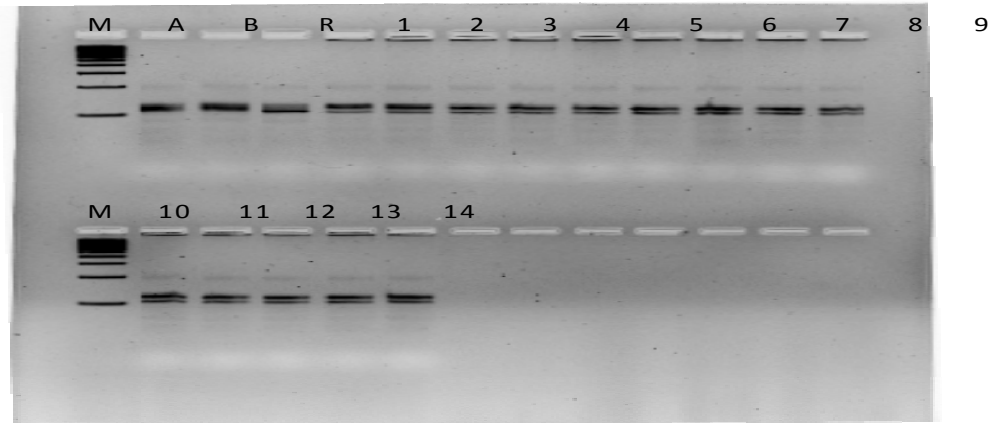
Medium duration

Sixteen combinations of BC₅F₁ stage and four combinations of BC₃F₁ stage (Table 3) were raised during *kharif* 2011 and backcrossed with their respective recurrent parent and seeds were collected for further evaluation. The list of progenies is furnished in the following table.

Table 3: Medium duration backcross progenies

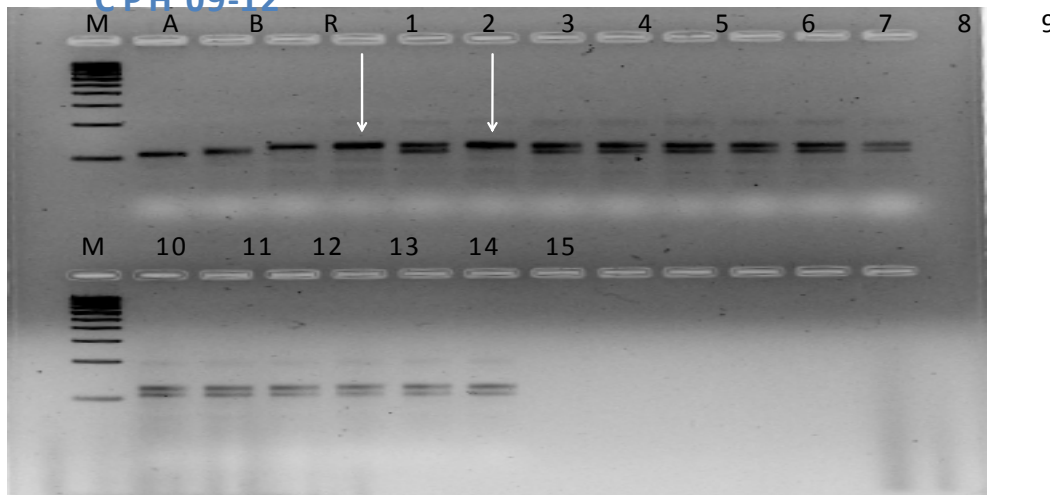
S. No.	Stage	Backcross progenies
1	BC ₃ F ₁	CRG 990047 A x VBN 2
2	BC ₃ F ₁	CRG 990047 A x ICP 7035
3	BC ₃ F ₁	CRG 990047 A x Co 6
4	BC ₃ F ₁	CRG 990052 A x VBN 2
5	BC ₃ F ₁	CRG 990052 A X ICP 7035
6	BC ₃ F ₁	CRG 990052 A X CO 6
7	BC ₃ F ₁	GT 301 A X CO 6
8	BC ₃ F ₁	GT 304 A X CO 6
9	BC ₃ F ₁	GT 307 A X CO 6
10	BC ₃ F ₁	GT 308 A X CO 6
11	BC ₃ F ₁	GT 309 A X CO 6
12	BC ₃ F ₁	Hy 4 A X CO 6
13	BC ₃ F ₁	GT 301 A X VBN 2
14	BC ₃ F ₁	GT 304 A X VBN 2
15	BC ₃ F ₁	GT 307 A X VBN 2
16	BC ₃ F ₁	GT 308 A X VBN 2
17	BC ₃ F ₁	ICPA 2047 X BSMR 579
18	BC ₃ F ₁	ICPA 2047 X ICP 11953
19	BC ₃ F ₁	ICPA 2048 X BSMR 539
20	BC ₃ F ₁	ICPA 2092 X Co 6

**Polymorphic SSR profile of CcM 0494 for
CPH 09-03**



M: 100bp ladder, A : ICPA 2043, B : ICPB 2043, R : CO 25R and 14 hand Crossed F₁ plants

**Polymorphic SSR profile of CcM 0494 for
CPH 09-12**



M: 100bp ladder, A : ICPA 2155, B : ICPB 2155, R : PA 128R and 15 hand crossed

F₁ plants

Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola

Objective No. 1: Hybrid Evaluation Program

Under hybrid evaluation program, four trials (Table 1) were from national program.

Table 1: Trials conducted for evaluation of early and medium duration hybrids

Sr. No.	Trial Name	Locations	Design/Rep.	Plot size (m ²) Gross/Net	Spacing (cm)	Date of sowing	Rows	Entries
1	IHT-Early	Akola	RBD/3	$\frac{3.0 \times 4.0}{3.0 \times 3.6}$	75X30	09.07.11	4	10 (7+3Ch)
2	IHT-Medium	Akola	RBD/3	$\frac{3.6 \times 5.0}{3.6 \times 4.0}$	90X50	09.07.11	4	15(11+4Ch)
3	AHT-I (Early)	Akola	RBD/3	$\frac{4.5 \times 4.0}{4.5 \times 3.4}$	75X30	09.07.11	6	6(3+3Ch)
4	AHT-I (Medium)	Akola	RBD/3	$\frac{3.6 \times 5.0}{3.6 \times 4.0}$	90X50	09.07.11	6	9(5+4Ch)
5	SMHT (Early)	Akola, Badnapur, Rahuri,	RBD/3	$\frac{2.4 \times 4.0}{2.4 \times 3.6}$	60X20	11.07.11	4	10(7+3Ch)
6	SMHT (Medium)	Akola, Badnapur, Rahuri	RBD/3	$\frac{3.6 \times 4.0}{3.6 \times 3.6}$	90X30	10.07.11	4	16(11+5Ch)
7	PYT- I (Medium)	Akola	RBD/2	$\frac{1.2 \times 4.0}{1.2 \times 3.6}$	60X20	14.07.11	2	22(20+2Ch)
8	PYT- II(Medium)	Akola	RBD/2	$\frac{1.2 \times 4.0}{1.2 \times 3.6}$	60X20	14.07.11	2	25(23+2Ch)
9	Augmented (Early)	Akola	Augmented	0.60 x 3.6	60X20	14.07.11	1	34(31+3Ch)
10	Augmented (Medium)	Akola	Augmented	0.60 x 3.6	60X20	14.07.11	1	50(47+3Ch)

Objective No.2: Development of new hybrids

Total 94 crosses were made during 2011-12 on various CMS lines (Table 2) and detailed list of crosses is given in Appendix-II. The number of seeds harvested from different crosses varied from 20 to 2537 (Table 3).

Table 2: Crosses effected using different CMS lines

Duration	CMS	No.of crosses effected
Early	1. GT-288A	02
	2. AK-120-1 A	14
	3. GT-290A	10
	4. AKCMS-1A	10
Medium early	1. AKWR-627 A	08
	2. AK 120-2 A	13
	3. GT-33A	17
Medium	1. AKV-2A	02
	2. AKV-9A	02
	3. AKSMR-736A	11
	4. AKSMR-854A	05
Total		94

Table 3: Details of seed produced for different hybrids on different CMS for testing during 2011 *kharif*

CMS	No. of hybrid seeds produced						Total
	>2000	>1000to 2000	500 to 1000	100 to 500	50 to 100	<50	
Early hybrids							
GT-288A	-	1	1	-	-	-	02
AK-120-1A	-	3	1	9	2	-	15
GT-290A				5	3	1	09
AKCMS-1A				5	4	1	10
Total	-	4	2	19	9	2	36
Mid early							
AKWR-627 A	1	4	1	1	-	1	08
AK-120-2A	1	2	1	7	1	1	13
GT-33A	2	3	1	8	1	2	17
Total	4	9	3	16	2	4	38
Medium							
AKV -2A	-	-	1	-	-	-	01
AKV -9A	-	-	2	-	-	-	02
AKSMR-736A	6	2	1	-	2	1	12
AKSMR-854A	-	2	1	2	-	-	05
Total	6	4	5	2	2	1	20

Objective No. 3: CMS Diversification programme

For diversification of CMS on *C. scarabaeoides* cytoplasm backcrosses with respective recurring parent were carried forward to next generation (Table 4).

Table 4: Backcross generations for diversification of CMS and seed available.

Agronomic base	Grown in	Advanced to	No. of sibs produced	No. of seeds of each sib produced	CMS Fixed
AKT-8811	BC ₁₁	BC ₁₂	1	12	
ICP-7	BC ₈	BC ₉	2	5,5	
C-11	BC ₆	BC ₇	5	55,58,16,27,20	AKCMS-1110
AKTG-1	BC ₆	BC ₇	4	9,17,35,6	
AKTG-2	BC ₆	BC ₇	2	47,32	
AKTG-3	BC ₆	BC ₇	3	32,70,16	
JKM-198	BC ₃	BC ₄	2	27,28	AKCMS 1102
AKT-221030	BC ₃	BC ₄	3	18,4,15	AKCMS 1104
AKT-222521	BC ₃	BC ₄	1	23	
AKT-222560	BC ₃	BC ₄	2	29,22	
AKT-262629	BC ₃	BC ₄	3	17,19,1	AKCMS 1105
AKT-262986	BC ₃	BC ₄	1	13	AKCMS 1106
AKT-263008	BC ₄	BC ₅	4	17,2,13,6	

Two GMS lines (Table 5) have been back crossed with sterile plants of CMS lines as given below.

Table 5: Lines being converted into male sterile lines

Sr. No.	CMS line	Grown in	Adv. to	Sibs	Seed Available	
1	AKMS-4	BC ₃	BC ₄	2	17,10	AKCMS 1109
2	AKMS-2	BC ₃	BC ₄	2	5,16	AKCMS 1108

Germplasm lines (Table 6) carrying seedling marker / dwarfing traits have been used for development of new CMS with the respective trait by BC method.

Table 6 : Germplasm lines possessing marker traits being converted into male sterile lines

Marker trait	No. of progenies	Grown in	Advanced to	No. of sibs produced	Total seeds of all sibs produced
Ovate leaf	22	BC ₅	BC ₆	65	1664
Sesame leaf	12	BC ₃	BC ₄	48	1219
Obcordifoliate leaf	10	BC ₃	BC ₄	5	86
Small leaf	15	BC ₃	BC ₄	60	1532
Gigas leaf	01	BC ₃	BC ₄	1	4
Dwarf 30 cm	09	BC ₃	BC ₄	36	920
Dwarf 45 cm	33	BC ₃	BC ₄	106	2230
Dwarf 60 cm	18	BC ₃	BC ₄	35	756
Dwarf 90 cm	04	BC ₃	BC ₄	4	73

Objective No.4. Maintenance of Parental Lines and hybrids

Table 7 a: Seed production of A line (CMS Maintenance programme)

CMS Line	No. of Sib	Quantity of seed	Bulk seed available
GT-288 A	11	70,35,40,80,210,195,44,172,62,47,90	650
AK-120-1A	10	113,150,40,167,60,216,44,150,310,151	1400
GT-290 A	8	145,125,180,205,165,150,120,170	645
AKWR-627 A	12	77,53,60,110,42,85,4,15,130,5,3,83,24	1100
AK-120-2A	12	219,55,215,200,300,156,100,1,60,277,265,200,218	1500
GT-33 A	6	90,50,295,68,16,57	1800
AKV-2 A	6	65,40,110,115,130,83	200
A KV-4 A	5	180,100,72,124,88,61	160
AKV-8 A	5	150,50,82,70,69	130

AKV-9 A	9	138,88,48,75,28,74,35,81,60	400
AKSMR-736 A	15	60,55,40,150,84,20,150,200,52 ,125,112,75,100,45,110	2500
AKSMR-854 A	7	80,73,80,30,13,9,50	2200
AKCMS-81A	8	40,20,17,13,18,13,9,20	700
AKCMS-82-1A	6	142,63,60,60,42,175	400
AKCMS-82-2A	2	40,60	300
AKCMS-83A	7	22,59,50,20,80,57,50	50
AKCMS-84A	3	39,13,52,	180
AKCMS-85A	2	20,35	100
AKCMS-87A (AKT 8811)	4	50,10,5,9	150
AKCMS-88A (AKT 8811)	3	5,20,3	60
AKCMS-89A (ICP-7)	5	60,10,155,10,13	90
AKCMS-90A (ICP-7)	2	27,24	60
AKCMS-91A (AKTG-1)	5	130,40,110,15,100	550
AKCMS-92A (AKTG-2)	8	70,150,80,20,85,102,65,100	450
AKCMS-93A (AKTG-3)	6	4,130,125,20,50,30	1800
AKCMS-94A (SKP 0631)	2	38,20	500
AKCMS-95A (AKGMS21)	4	76,100,95,111	550
AKCMS-96A (AKGMS 23)	1	15	-
AKCMS-97A (AKGMS 134)	3	17,25,23	-
AKCMS-1101A (C11)	2	24,34	-
AKCMS 80 (AKT 8811)	--	Wilt susceptible. Hence rejected	--

Table 7 b: CMS lines based on *C. cajanifolius* received from ICRASAT in Kh 2011.

Sib Line	No. of Lines grown	Remarks	Seed harvest
ICPA2047- 45	10	Not a single line was bred true for true ms	Rejected
ICPA2047-04	10	Not a single line was bred true for true ms	Rejected

ICPA2047-44	22	17 lines bred true with all ms plants. 20 (A x B) sibs developed	210
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Table 8 :Seed production of wilt resistant A lines in Wilt sick plot

CMS Line	No. of Sib	Quantity of seed
GT-288 A	5	29,87,109,100,94
AK-120-1A	4	31,9,12,11
GT-290 A	4	40,46,66,54
AKWR-627 A	5	50,110,35,71,105
AK-120-2A	5	12,80,64,52,70
GT-33 A	5	91,46,108,93,63
AKV-4 A	5	85,68,15,80,42
AKV-8 A	2	15,8
AKSMR-736 A	5	118,81,63,15,63
AKSMR-854 A	5	143,80,95,17,80
AKCMS-81A	3	91,79,18
AKCMS-1A	5	95,34,35,25,20
AKCMS-12A	3	24,3,3

Table 9 : Seed production of Restorers (under net house)

Sr. No.	AKPR	Weight (gm)
1	AKPR-2	360
2	AKPR-12	300
3	AKPR-57	230
4	AKPR-178 (E)	390
5	AKPR-178 (M)	1000
6	AKPR-207	500
7	AKPR-215	500
8	AKPR-249	500
9	AKPR-259	500
10	AKPR-260	500
11	AKPR-261	500
12	AKPR-277	380
13	AKPR-292	190
14	AKPR-295	120
15	AKPR-303	900
16	AKPR-319	75
17	AKPR-324	500
18	AKPR-331	120
19	AKPR-334	370
20	AKPR-335	500
21	AKPR-345	370
22	AKPR-344	610
23	AKPR-359	400
24	AKPR-364	330
25	AKPR-372	250

26	AKPR-402	130
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Table 10: New restorers developed from established varieties

Sr. No.	AKPR	Variety	Plot nos.	Seed harvested (g) Open pollinated	Seed harvested (g) Selfed
1	501	Asha-8	110596	200	--
2		Asha -8	110597	250	--
3		Asha08	110597	178	--
4	502	Asha-9	110644	158	150
5	503	Asha-10	110580,	230	--
6		Asha-10	110581	260	--
7		Asha-10	110645 to 110647	200	250
8	504	AKT 8811-1	110582	250	--
9		AKT 8811-1	110583	200	--
10		AKT 8811-1	110653	250	100
11	505	BDN-2	110593	200	--
12		BDN-2	110594	250	--
13		BDN-2	110595	200	--
14		BDN-2	110606	250	--
15		BDN-2	110607	250	--
16		BDN-2	110608	250	--
17		BDN-2	110609	200	--
18		BDN-2	110648-110652	200	250
19	506	BDN-1	110610	250	--
20		BDN-1	110611	250	--
21		BDN-1	110612	200	--
22	507	ICP-8863	110585	200	--
23		ICP-8863	110586	200	--
24		ICP-8863	110587	200	--
25		ICP-8863	110654-657	200	200
26	508	BWR 23	110620	250	--
27		BWR 23	110621	250	--
28		BWR 23	110622	250	--
29		BWR 23	110623	200	--
30		BWR 23	110624	200	--
31		BWR 23	110625	200	--
32	509	Hyderabad-185	110635	200	--
33		Hyderabad-185	110636	200	--
34	510	AKT 221030	110590	200	--
35	511	TAT 9629	110642	200	--
36	512	Oval leaf	1106292	200	--
37		Oval leaf	110630	200	--
38		Oval leaf	110631	200	--
39		Oval leaf	110632	200	--
40	513	Unifoliate Lanceolate	110628	200	--
41	514	Unifoliate	110633	200	--

42	515	Unifoliate Oval	110638	200	--
43		Unifoliate Oval	110639	200	--

Table 11: Seed production of promising hybrids and parental lines under isolation during 2011-12

Sr. No.	Particulars	Plot size (m ²)	Yield (kg/plot)	Yield (kg/ha)	Place
A.	Hybrid seed				
1	AKPHM-10178	520	16.0	308	College of Horticulture, Akola
2	AKPHM-10303	200	9.9	495	ZARS, Yavatmal
3	AKPHM-11303	200	6.5	325	ZARS, Yavatmal
4	AKPHE-05-02	220	9.0	409	ATS Selsura, Wardha
5	AKPHM-10259	110	0.2	18	ATS, Warud, Yavatmal
6	AKPHM-11259	110	1.0	91	ATS, Warud, Yavatmal
7	ICPH-2740	2000	68.0	340	CDF, Wani rambhapur
B.	Male sterile lines (AxB)				
1	AKMS-04A	510	0.6	12	Cotton Research Unit, Akola
2	AKMS-11A	1090	4.0	37	Oilseeds Research Unit, Akola
3	AKMS-10A	1090	9.4	86	Cotton Research Unit, Akola
4	ICPA-2047A	3000	1.5	5	AHDS, Akola
C.	Maintainer line (B)				
1	AKMS-04B	510	0.60	12	Cotton Research Unit, Akola
2	AKMS-11B	1090	13.0	119	Oilseeds Research Unit, Akola
3	AKMS-10B	1090	10.0	92	Cotton Research Unit, Akola
4	ICPB-2047B	3000	0.70	2	AHDS, Akola
D.	Restorer lines ®				
1	AKPR-178	520	8.0	154	College of Horticulture, Akola
2	AKPR-303	200	14.5	725	ZARS, Yavatmal
3	AKPR-002	220	4.0	182	ATS Selsura, Wardha
4	AKPR-259	110	1.2	109	ATS, Warud, Yavatmal
5	ICPR-2740	2000	25.0	125	CDF, Wani rambhapur

**Objective No. 5: Development of New Restorer for different sources for
CMS lines based on *Cajanus scarabaeoides* source**

Fertility Restorer test carried out in the Kharif-2011 from the crosses made between CMS lines & suspected new restorer source single plant selected from following 24 different genotypes were used for fertility restorer identification on GT-33-A and *C. scarabaeoides* source.

Table 12: Fertility Restorer test for new restorers of CMS based on *C. scarabaeoides*

Sr. No.	Female used for FR test	Source line	No. of SPS used for hybrid	Hybrid Seed available
Varieties				
1	AKSMR-736A	Asha-9	1	150
		Asha-10	3	100,157,79
2	AKCMS-81A	BDN-2	2	50,35
		ICP-8863	1	50
3	AK-120-1A	BDN-2	4	13,27,21,19
4	AKWR-627A	BDN-2	5	36,31,32,40,23
5	AK-120-2A	AKT-221030	3	41,21,27
Variety X Restorer				
6	GT-288-A	JKM-198	3	182,102,88
7	AK-120-1A	AKT-222521	6	170,188,57,60,82,49
FR test			Purification of AKPR 178	
8	GT-33-A	AKPR-178	17	77,65,19,34,43,13,21,27,29,72, 17,34,23,43,12,9,11
9	AKWR-627-A	AKPR-178	19	55,35,70,105,76,85,80,101,52,65, 77,109,34,104,83,89,73,61,92

ICRISAT, Patancheru, Hyderabad

Objective No.1: To evaluate already developed CGMS-based hybrids of early and medium-maturity groups

Activity: The already produced high yielding experimental hybrids of early and medium maturity group are being evaluated at several locations of different agro-ecological zones (North Zone, Central Zone and South Zone) of India in initial hybrid trials (IHT) and advance hybrid trials 1 (AHT 1).

Under this activity, 20 hybrids and appropriate checks were evaluated in three trials. Of these, nine hybrids belonged to short-duration and 11 hybrids to medium-duration group. The short-duration trials were abandoned due to severe wilt disease (Fig 1). In medium-duration trial (IHT 1) 11 hybrids and 5 checks were evaluated. These hybrids were diverse for flowering, ranging from 91-124 days and hence, valid comparisons could not be made with uniform check. Hybrids ICPH 2740 (Fig 2) and AKPHM 11324, performed better over control Asha (Fig 3) with respectively 51% and 16 % superiority over the check (Table 1). Due to earliness hybrids SKNPCH 0932 and AKPHM 11259 were not considered for calculating mean and other parameters.

Objective No. 2: To produce new high yielding CGMS-based hybrids in early and medium maturity groups

Activity 1: For production of high yielding and stable hybrids, agronomically superior and disease resistant restorers will be crossed to agronomically superior and disease resistant CGMS lines possessing good combining ability.

A total of 82 hybrids were made by hand pollinations during 2011 cropping season. This included 57 promising hybrids (which were reconstituted) and 25 new combinations. All the hybrids will be evaluated in station trials in 2012. In the hybrid combinations the number of harvested seeds ranged from 500-1000; and the parents used in hybridization were resistant to *Fusarium* wilt and sterility mosaic diseases, besides had high yield.

Activity 2: These hybrids will be evaluated in station trials along with best local check and promising hybrids will be evaluated in initial and advance multi-locational hybrid trials in different agro-ecological zones (North Zone, Central Zone and South Zone) of India.

A total of 72 medium-duration hybrids were evaluated in seven station trials at ICRISAT, Patancheru. These hybrids were developed by crossing seven CMS lines with 28 new pigeonpea lines. The lines consisted of germplasm collections, advanced lines and field collections from different locations. These trials were sown in four meter length, six row/plots with a spacing of 75 x 50 cm in Vertisols. The trials were given 100 kg DAP as basal dose and were irrigated. Based on the superiority, disease reaction, eight medium-duration disease resistant promising hybrids were selected for further testing (Table 2).

Objective 3: To develop molecular markers for testing the purity of hybrids for grow out test.

This activity was not allocated to ICRISAT Center.

Objective 4: To build human resource capacity for production of hybrids and hybrid seed through training

Activity: Training programmes for hybrid production methodologies and hybrid seed production technology will be organized every year for farming community, extension personnels, and private and public seed companies.

A total of 336 persons including Seed officers, Agriculture Officers, and farmers of Ranchi, Maharastra and Odisha States were trained in hybrid seed production technology. In this program 42 officers from NSC were also trained in pigeonpea hybrid seed production activities during 2011 season.

Agricultural Research Station Badnapur

Objective No.1: Evaluation of Hybrids

1. Initial Hybrid Trial (IHT) Early

All the entries for yield were statistically significant. SKNPCH 0923 had given highest grain yield (1603 kg/ha) followed by SKNPCH 0924 (1238 kg/ha). The lowest grain yield had been revealed by entry AKPHE 05012 (721 kg/ha).

2. Advanced Hybrid Trial 1 (AHT 1) (Early)

The grain yield differences were statistically significant. The hybrid SKNPCH 0835 had given highest grain yield (1323 kg/ha) followed by check GTH1 (1189 kg/ha). The lowest grain yield had been revealed by entry UPAS 120 (834 kg/ha).

3. Initial Hybrid Trial (IHT) Medium

In this trial, the results revealed that all the entries were statistically significant for yield. Among the hybrid, the hybrid AKPHM 11324 had given highest grain yield (1283 kg/ha) followed by hybrid AKPHM 11259 (1276 kg/ha). The lowest grain yield had been recorded by hybrid SKNPCH 0860 (752 kg/ha). None of the hybrids had given highest yield increase i.e. standard heterosis over best check BSMR 736 (1307 kg/ha) .

4. Advanced Hybrid Trial 1 (AHT 1) Medium

The results revealed that all the entries were statistically significant for yield. The hybrid AKPHM 10303 had given highest grain yield (1319 kg/ha) followed by hybrid AKPHM 11303 (1280 kg/ha) over best check BSMR 736 (1279 kg/ha). The lowest grain yield had been recorded by hybrid AKPHM 10178 (868 kg/ha).

Objective No.2: Development of new hybrids

Following CMS based experimental hybrids were made (Table 1).

Table 1: Crosses attempted to develop new hybrids

Sr. No.	Cross
1	BDN 2004-4 A x BDNHR 1
2	BSMR 736 A X BDNHR 1
3	ICPA 2043 A X BSMR 853
4	ICPA 2043 A X BDN 708
5	ICPA 2043 A X BDN 2
6	BSMR 736 A x BPG 33
7	BSMR 736 A x BPG 41
8	BSMR 736 A x ICP 14701
9	BSMR 736 A x BDN 2004-4
10	BSMR 736 A x BDNHR 22-1

Objective No.3 : Diversification of CMS lines and identification of new restorer lines

The following new lines (Table 2) having good agronomic characters are diversified into sterile cytoplasm (*C. scarabaeoides* and *C. cajanifolius*).

Table 2: Lines used for conversion into male sterility

Sr. No.	Cross
1	(BSMR 736 A x BDN 2004-1) X(BDN 2004-1)
2	(BSMR 736 A x BDN 2004-3) X(BDN 2004-3)
3	(BSMR 736 A x BDN 708) X(BDN 708)
4	(BSMR 736 A x BSMR 853) X(BSMR 853)
5	(BSMR 736 A x BDN 2010) X(BDN 2010)
6	(BSMR 736 A x BDN 2) X(BDN 2)
7	(BSMR 736 A x SKNP 0632) X(SKNP 0632)
8	(ICPA 2043 x BDN 2004-1) X(BDN 2004-1)
9	(ICPA 2043 x BDN 2004-2) X(BDN 2004-2)
10	(ICPA 2043 x ICG 15-43) X(ICG 15-43)
11	(ICPA 2043 x ICG 15-45) X(ICG 15-45)
12	(GT 288 A x BDN 2004-2) X(BDN 2004-2)

However, in the conversion programme, BSMR 736 found stable for sterility and other characters hence utilized in crossing programme as female.

The 15 stable restorer plants of different crosses having 80-100 % fertility (tested in *kharif* 2011-12) are confirmed for their restoration behavior. These plants of will be forwarded in next generation to further confirmation for restoration and selection.