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Short Communication

Hybrid ICPH 2740 assures quantum jump in pigeonpea productivity in peninsular India

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ABSTRACT

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important pulse crop of peninsular India and of the 4 m ha grown, this region contributes >70% both in area and production. The productivity of pigeonpea in this region is at around 650 kg/ha, and to smash this low yield plateau, a hybrid technology, based on cytoplasmic nuclear male-sterility (CMS) and natural cross-pollination was evolved at ICRISAT. Among several location-specific hybrids were bred, ICPH 2740 gave out-standing performance in farmers' fields and later released in Telangana for cultivation in 2015 as "*Mannem Konda Kandi*". This wilt and sterility mosaic resistant hybrid was tested in 31 locations over five years exhibited 40.7% superiority over the ruling variety "Asha". In the on-farm trials also, this hybrid recorded yield advantage of 36.2% in four provinces. This paper discusses salient features, performance, and seed technology of the hybrid ICPH 2740.

Key words: CMS, hybrid release, out-crossing, pigeonpea, seed technology

In spite of its great importance in Indian cuisine, pigeonpea remains a crop of subsistence agriculture. The peninsular region, the pigeonpea production hub, contributes>70% in both national area and production with a mean yield of only 650 kg/ha (DAC, 2011). It is believed that any genetic gain in the productivity of pigeonpea in this region will have a significant impact on the national pigeonpea production. In this context, the recently developed hybrid technology (Saxena, 2015) can play a significant role in realizing the goal of self-sufficiency in pigeonpea. ICPH 2740 is the first commercial pigeonpea hybrid released in Telangana state as "*Mannem Konda Kandi*" in 2015. This hybrid has demonstrated a significant yield advantage over the most popular cultivar.Large-scale seed production technology of the hybrid has also been perfected and this paper aims to archive the salient features, performance, and seed production technology of this hybrid.

Hybrid ICPH 2740 was developed by crossing a medium maturing cytoplasmic-nuclear male-sterile (CMS) line ICPA 2047 with a fertility restoring (R-) genotype ICPR 2740 of the same maturity. The female parent (ICPA 2047) of this hybrid was bred by crossing the original CMS line 'ICPA 2039' carrying A_4 cytoplasm of *Cajanus cajanifolius,* a wild relative of pigeonpea (Saxena *et al.*, 2005) with a disease resistant advanced breeding line ICPL 99050. The F_1 hybrid of this cross exhibited 100% male sterility with no trace of pollen grains; and considering its ability to maintain male sterility, a backcross programme was developed using ICPL 99050 as recurrent parent. In each backcross about 200-300 seeds were produced and the progenies were grown inside an insect-proof nylon cage in disease (wilt and sterility mosaic) sick nursery to select resistant male sterile segregants for the next cycle of backcrossing. After three backcrosses involving the resistant plants, the frequency of disease resistant male sterile plants was reasonably high. In the subsequent backcross populations, selection for plant type and yield components such as branching, seed size, seed colour, and pods/plant was also exercised among the male sterile plants. After seven generations of backcrossing and selection, the converted male sterile population was designated as ICPA 2047. Its breeder seed multiplication is being carried out at ICRISAT with isolation distance of at least 500 m. Each year the nucleus seed of ICPA 2047 is being produced by hand pollinating the male sterile plants with its maintainer line under an insect-proof nylon net and a sample of the population was sown in the disease-sick nursery to monitor the disease reaction. The plants of ICPA 2047 are non-determinate, semi-spreading in growth, over 200 cm in height with profuse branching and podding. It is highly resistant to fusarium wilt and sterility mosaic virus. This line flowers in 120- 125 days, has yellow flowers and green pods with dark brown streaks. Its seeds are brown and 100 seeds weigh 10-12 g.

The fertility restoring male parent of the hybrid (ICPR 2740) was developed using bulk-pedigree method from cross C 11 x ICP 1-6. A large (>2500 plants) F_2 population of this cross was grown in the disease sick nursery and the resistant plants were bulk harvested. It flowers in 115 - 125 days and maturity is achieved in 180-190 days. ICPR 2740 is a high yielding and resistant to fusarium wilt and sterility mosaic virus. The fertility restoration of ICPA2047 was

found to be controlled by two independently segregating dominant "*Rf*" genes (Kyu and Saxena, 2011; Sawargaonkar *et al.*, 2012).

Plants of ICPH 2740 are non-determinate with profuse secondary and tertiary branches, photo-sensitive, and respond positively to wider spacing. Its flowers are yellow with light red streaks and produce green pods with brown streaks. Plant height ranges between 204-235 cm. It takes about 115-122 days to flower and its maturity is achieved in 180-190 days. Seed size varies from 10.9 to 11.3 g/100 seeds with brown seed coat and 18.4% protein. The recommended seed rate of ICPH 2740 under intercropping is 5-6 kg/ha. The major adaptation areas for the hybrid are those with deep black cotton soils of Madhya Pradesh, Maharashtra, Andhra Pradesh, Odisha and Karnataka states. This hybrid when evaluated in disease sick nursery, recorded high levels of resistance to fusarium wilt (9% mortality) and sterility mosaic virus (2% mortality). Sawargaonkar (2011) studied some key quality (protein, milling and organoleptic) traits of ICPH 2740 and found that the hybrid was more or less at par with control cv. Asha. Multi-locations evaluation of ICPH 2740 over five years produced on average 2792 kg/ha yield (Table 1) with a range of 2207 - 3652 kg/ha and mean standard heterosis of 40.7%. The hybrid was also comparable with control for maturity, seed size, seed colour, and seeds/ pod; and these traits helped in its quick acceptance by farmers, millers, and consumers. The on farm-average productivity of this hybrid over 47 on-farm trials conducted in different parts of Telangana State was 1999 kg/ha yield with 39% yield advantage over the most popular variety Asha while in other states such as Gujarat , Maharastra and Madhya Pradesh, it was ranged from 1633 to 1814 kg/ha with a yield 23-66% over control (Table 2).

In pigeonpea partial natural out-crossing (25-30%) is a common event and it is mediated by a variety of nectarivore insects (Saxena *et al.*, 1990). Therefore for quality seed production of parents and hybrid, a safe isolation distance (500 m) is essential. At ICRISAT for breeder seed production of ICPB 2047 (maintainer) and ICPR 2740 (restorer) large (24 m x 50 m x 2 m) bee-proof nylon cages are used. For large-scale breeder seed production of female parent (A x B) and certified seed production of hybrid (A x R), the parental lines are sown in isolation using a female: male row ratio of 6:1. The details of seed production technology are available in Saxena (2006). In general, rouging of the off-type plants is done at seedling, flowering, and early podding stages. The available plants descriptors can also be used for effective rouging.

Table 1: Yield and other key traits recorded in ICPH 2740 and the control cv. Asha and in multi- location trials (n=31).

Trait	Genotype	Range	Mean
Yield (kg/ha)	Hybrid	2407 – 3652	2792
	Control	1582 – 2247	1985
100-seed wt. (gm)	Hybrid	10.4 - 11.3	10.9
	Control	10.5 - 11.2	10.9
Maturity (days)	Hybrid	149 - 188	175
	Control	179 - 190	177
Flowering (days)	Hybrid	115 - 129	122
	Control	116 - 133	125
Plant height (cm)	Hybrid	204 - 235	217
	Control	181 - 215	203
Seeds/pod	Hybrid	3.8 - 4.0	3.9
	Control	3.8 - 3.9	3.8

Since the recommended seed rate for a commercial hybrid crop is low (5-6 kg/ha), one hectare of seed production programme will easily cater the needs of 200 ha of the commercial crop. The seed–to-seed ratio of about 1: 200 is considered very healthy, competitive, and profitable to seed producers. The control of genetic purity of hybrid seed is of prime importance and in most crops it is assessed through standard 'Grow-out Test' using simply inherited, easily identifiable dominant morphological trait of the male parent. In pigeonpea such tests will take more time due to its long duration and photo-sensitive nature. Therefore to overcome this constraint, a simple, rapid, and cost effective genetic marker based seed testing technology was developed at the Genomics Laboratory at ICRISAT (Bohra *et al*., 2012). This simple sequence repeat (SSR) marker based hybrid "purity testing kit" is highly accurate and consumes far less time. This seed testing hit is to both public and private seed organizations at no cost basis.

Demand for pigeonpea in India is ever increasing and the scope for area expansion is limited, therefore attention is now focused on increasing it's per unit productivity. This can be achieved only by adopting a proven technology like hybrids. A beginning in this direction has already been made through the release of hybrid ICPH 2740; soon it will be notified for the entire country. This hybrid was bred to meet the farmers' needs in peninsular India for deep Vertisols with high water-holding capacity. The magnitude of realized heterosis for yield and its economics in pigeonpea is more or less similar to those of other crops (Singhal, 2013), the cultivation of ICPH 2740 can now be promoted at commercial level. Now a grower-friendly hybrid seed production technology with high seed-to-seed ratio is available and over 1500 farmers, seed producers and seed inspectors have been trained by ICRISAT and ICAR. The release of this hybrid with 30-40% yield advantage is a milestone in pigeonpea and it will encourage breeders to develop new high yielding hybrids for different agro-ecological conditions and production

Table 2. Yield (kg/ha) of hybrid ICPH 2740 and control variety Asha in the on-farm trials conducted in four Indian states

State	Trials	Hybrid	Control	Gain %
Madhya Pradesh	13	1814	1217	66
Maharashtra	179	1772	1437	23
Telangana	47	1999	1439	39
Gujarat	40	1633	1209	35
Total/Mean	**279**	**1804**	**1325**	**36.2**

systems. Also, considering and additional income from hybrid cultivation, its increased adoption cannot be denied. According to the estimation of ICRISAT and ARS, Palem in 2016 about 700 tonnes seed of ICPH 2740 will be available in market to replace over 140,000 ha of traditional pigeonpea cultivars and it will add over 70,000 tonnes of additional grains to benefit the farmers.

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