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Prospects of Pigeonpea Hybrid in Sustainable Agriculture

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The hybrids represent a breakthrough in enhancing productivity in pigeonpea by focusing a heterosis and thus improving yield *per se.* Despite the success of releasing high yielding GMS based hybrid, they are not adopted effectively due to high cost of seed production. The development of the CMS system in pigeon pea was a great achievement and has provided a platform for enhancing the pace of research and development of hybrid pigeon pea. The presence of high level of realized heterosis in farmer's fields has opened the way for commercialization of hybrid pigeon pea technology.

Introduction

In the protein-rich group of crops, red gram or pigeonpea [*Cajanus cajan* (L.) Millsp.] occupies an important place among rainfed resource poor farmers because it provides quality food, fuel wood, and fodder. Its soil rejuvenation qualities such as release of soil-bound phosphorous, fixation of atmospheric nitrogen, recycling of soil nutrients, and addition of organic matter and other nutrients make pigeonpea an ideal crop of sustainable agriculture in the tropical and sub-tropical regions of India. India is the major pigeonpea growing country and it accounts for 36.3 lakh hectare area and 27.6 lakh tonnes annual production with productivity of 760 kg per hectare (Anonymous, 2012).

Why We Need Hybrids in Pigeonpea?

The pigeonpea area, production and productivity trends in India in last five decades showed that there was about 2% increase in the area per year but the yield levels were stagnated around 600-700 kg per hectare. The best remedy is to increase productivity by breaking yield plateau through development of hybrids.

Advent of Hybrid Pigeonpea Technology

The concept of developing commercial hybrids in pigeonpea was developed at ICRISAT in 1974, when a source of genetic male-sterility (GMS) was identified.

The Production Constraint

The removal of 50 % of the fertile plants from seed production plot at the stage of flowering is time consuming and costly. Inadequate knowledge of the seed growers regarding multiple seed production (Dalvi *et al.*, 2010)

How to Overcome the Production Constraint

To overcome the production constraint, an efficient cytoplasmic - nuclear male-sterility (CMS) system was planned. The development of two good CMS sources one at ICRISAT (Saxena *et al.*, 2005) and another at Gujarat Agriculture University (Tikka *et al.*, 1997) were done. The former

CMS was derived from *C. cajanifolius* and designated as A_4 system; while the later source was derived from *C. scarabaoides* and designated as A_2 system.

GMS-based Pigeonpea Hybrids - The Starter Technology

There is existence of considerable magnitude of heterosis in Pigeonpea for seed yield (Solomon *et al.*, 1957). An elaborate search for a male-sterility system was made in the germplasm and a breakthrough was achieved by Reddy *et al.* (1978), who reported plants with translucent anthers, which turned out to be a stable (ms_1) GMS source. Five years later, Saxena *et al.* (1983) reported another nonallelic (ms_2) source of GMS that was characterized by brown anthers. As a result, first GMS based hybrid ICPH 8 was released (Saxena *et al.*, 1992).

Development of CMS Systems - a Breakthrough

The development of CMS became imperative. The strategy was to induce CMS by placing pigeonpea genome in wild cytoplasm through hybridization. Out of seven systems of sterile cytoplasms A_2 and A_4 systems have been found effective because of their stability under various agro-climatic zones and availability of good maintainers and fertility restorers.

Performance of hybrid

On an average ICPH 2433 and ICPH 2431 produced 2996 kg/ha and 2838 kg/ha seed yield, respectively, which were superior over control cultivar UPAS 120 (c) (2245 kg/ha) by a margin of 33% and 26 % respectively (Saxena *et al*. 2006). Further ICPH 2470 matured in 125 days and produced 3205 kg/ha seed yield giving 77.5 % yield advantage over the check. These hybrids also have acceptable seed size and produced the highest number of pods. From this trial, three hybrids ICPH 2470, ICPH 2438 and ICPH 2429 have been selected for further testing. Saxena and Nadarajan (2010) reported that all the hybrids had high levels of resistance to wilt and sterility mosaic diseases. The best hybrid was ICPH 3371 with 3013 kg/ ha yield (62% gain) and no disease incidence. Saxena *et al*. (2013) found maximum yield ranging from 1333 to 3040 kg/ha in some districts of Madhya Pradesh predicting that Madhya Pradesh will be a good site for hybrid seed production.

CMS Based World's First Hybrid GTH 1

The first CGMS based pigeonpea hybrid, GTH 1 was developed at SDAU, SK Nagar, by utilizing the cytoplasm of the wild species of *Cajanus scarabaoides* which was released by ICAR in 2004 for cultivation in Gujarat state and central zones of India. This hybrid showed yield superiority over local varieties to the extent ranging from 23 to 37 %. It gave yield superiority of 54.70% over the best GMS hybrid AKPH 4101 (1183 kg/ ha) and 32% yield superiority over the best local variety, GT 101 (1330 kg/ ha). It is also proved to be best suited under intercrop and gave the highest yield advantage (93%) over pure line control variety as inter crop with soybean (Saxena and Nadarajan, 2010).

Advantages of Hybrids

1) Increase grain yield
2) Enhance seedling vigour
3) Reduced seed rates
4) Greater drought tolerance
5) Greater disease resistance

Conclusion

The hybrids represent a breakthrough in enhancing productivity in pigeonpea by focusing a heterosis and thus improving yield *per se*. Despite the success of releasing high yielding GMS based hybrid, they are not adopted effectively due to high cost of seed production. The development of the CMS system in pigeon pea was a great achievement and has provided a platform for enhancing the pace of research and development of hybrid pigeonpea. The presence of high level of realized heterosis in farmer's fields has opened the way for commercialization of hybrid pigeonpea technology.

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