HYBRID SEED PRODUCTION IN PIGEONPEA

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I. DISTRIBUTION AND ORIGIN OF PIGEONPEA

The global distribution of pigeonpea, Cajanus cajan (L.) Millspaugh, is wide, covering about 25 countries of Asia and Oceania, 35 of the African continent and 28 countries in the Americas. Two schools of thought are current as to its centre of origin. Purseglove (1968) and Rachie and Roberts (1974) favoured an African origin on the basis of an archaeological find in an ancient Egyptian tomb and the existence of a wild ancestor. Vavilov (1939) considering the range of diversity of the crop proposed an Indian origin despite the paucity of wild ancestors. In a recent review van der Maesen (1990) concluded that floristic, linguistic, and cytological evidences pointed to India being the ancestral home of pigeonpea.

India is the leading pigeonpea producing country, accounting for 90-95% of the pigeonpea cropped area (3 m ha). It is commonly known as Tur or Arhar and the major production areas are Andhra Pradesh, Bihar, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, and Uttar Pradesh. The introduction of short-duration pigeonpea has further expanded the production zone to include major wheat growing areas of Punjab, Haryana, and western Uttar Pradesh. In these regions pigeonpea is grown in rotation with wheat. Productivity of pigeonpea globally as well as in India is around 700 kg ha^{-1}. In order to better this yield level, genetic improvement of the existing cultivars for productive potential and

adaptability to biotic and abiotic stresses would be indispensible.

1. Commercial Cultivars

Structure and floral biology of the pigeonpea flower usually favours self-pollination and, therefore, genetic improvement methods aimed at developing pure lines, as is done in the completely self-pollinating leguminous crops such as soybean, chickpeas, and groundnut have been used in the past. Self-pollination in pigeonpea, however, is not a rule and a considerable degree of natural out-crossing takes place. The commercial pigeonpea varieties in use may be phenotypically "pure but highly unlikely to be pure genotypically.

Out-crossing in pigeonpea depends on pollinator insect population levels, and is variable. Most locations in India encounter 20-50% out-crossing. This feature coupled with the identification of genetic male sterility at ICRISAT Center in 1974 has led to the development of hybrid production technology. Heterotic combinations tested across the nation over the past 15 years in a series of experiments and on-farm trials have revealed not only their superior yield potential, but also a high level of yield stability. Seed production technology has been extensively tested, and found viable from the field operational and economical perspectives.

II. ISOLATION SPECIFICATIONS

Mass transfer of pollen grains from pollinator to male sterile line in pigeonpea is caused by insects. It is reported that over 2 dozen of insect species visit pigeonpea flowers. In most places in India the extent of

natural out-crossing is sufficient to produce abundance of hybrid seeds on the male sterile plants. In order to produce high quality genotypically pure seed isolation of seed production block from other pigeonpea is essential. Our experience at ICRISAT Center has shown that a distance of 300-400 metere is very safe for producing seeds of hybrids as well as male sterile lines.

III. MALE STERILE LINE

A. Characteristics

In pigeonpea male sterility is governed by a single recessive gene pair (ms ms) and, therefore, it should be maintained in a heterozygous (Ms ms) form. The population raised from sib mated (ms ms x Ms ms) seeds will always segregate into fertile and sterile plants in equal proportions.

The male sterile line is characterized by translucent (white) anthers devoid of pollen grains. The short-duration male sterile line ms Prabhat (DT), used in developing the hybrid ICPH 8, is determinate in growth habit and flowers in 60-70 days. It produces flowers and pods in bunches at the top of the plant canopy. The first crop can be harvested in about 110-120 days. It has brown seeds weighing around 6.0 g/100 seeds. This line is capable of producing several flushes of flowers under conducive environmental conditions. Plants are compact and erect and attain a height of about one meter.

B. Identification and Roguing

This is an important operation both for seed multiplication as well a hybrid seed production. Unlike cytoplasmic male sterility, th population raised from the sibbed seeds (obtained from male steril pigeonpea plants) will segregate into fertile and sterile plants an identification of these plants at an appropriate time is essential.

Since fertile and sterile plants are similar in appearance an there is no linked marker, the identification is done visually b examining the first fully developed bud that appears on each plan before it opens. The sterile plants will have white anthers and n pollen grains while the fertile plants will have yellow anthers wit abundance of pollen grains. The flowering in the male sterile line is spread over a 15-20 day period. For the first few days relativel few plants will flower and gradually their proportion will increase i the next 7-10 days.

The identification is easy. Unskilled farm labourers can b quickly trained to do this job. It is however an expensive operation Our estimates show that about 200 mandays will be required to rogu one hectare land.

Procedure for Identification

- Start identification when flower buds appear on plant and continue th job till the whole block is completed.
- Remove an unopened fully formed bud and carefully open its petals without injuring the anthers.

- Observe anther color.
- Yellow anthers represent fertile plants. Crush the anthers between thumb and first finger; yellow pollen grains will be seen on the fingers. In case of doubt repeat the process with another bud. The fertile plants should be removed either by uprooting or by cutting at ground level. Uprooting is preferred to avoid growth of tillers or new shoots.
- White anthers represent male sterile plants. The plants need to be retained for seed production. The sterile plants thus identified are tagged by stapling paper markers or tying gunny thread (sutli) pieces to one of the top branches.
- Continue this operation till all the plants are identified.
- It is advisable to recheck the identified plants a few days later. This will help improve the genetic quality of seeds by reducing faults in identification.

C. Seed Production Steps

- Select a well drained ISOLATED field. Prepare land adding a basal fertilizer dose of 100 kg/ha of Di-ammonium phosphate. Make ridges or lines (if planting on flat bed) 60 cm apart.
- Obtain genetically pure (ms ms x Ms ms) seed of male sterile line from a reliable source.
- Plant seeds in rows/ridges 10 cm apart (about 15 kg/ha) preferably in mid-June for central India.
- Keep the field weed free and irrigate as and when necessary.
- Close to flowering stage, starting at one end of the field, mark row numbers 1, 8, 15, 22, 29, 36, 43, 50 ..... These will serve as the pollinator rows and will NOT require ROGUING.

- o The rows in between these, namely, rows 2, 3, 4, 5, 6, 7; or 9, 10, 11, 12, 13, 14; or 16, 17, 18, 19, 20, 21, etc. will be the female rows and in these ROGUING SHOULD BE DONE. When this is done 6 male sterile rows will be sandwitched between 2 pollinator rows (Figure 1).
- o For identification and roguing follow the steps indicated in III (B) on page 4.
- o Pods developed in the pollinator rows should be removed from time to time to extend flowering for a longer period and hence better pod set.
- o Harvest mature pods from the female rows manually and irrigate the field to promote a second crop.
- o In a year besides the main crop 2-3 ratoons can be harvested easily. In the mid-June planted crop first harvesting can be done in October end. The subsequent first and second ratoon crops can be harvested in December and February respectively.
- o At the end of the season, if plant population is good, the seed production block may be retained for the next season.

IV. POLLINATOR LINE

A. Characteristics

The pollen (male) parent of hybrid ICPH 8 is an inbred line ICPL 161. This line is completely fertile. It is a profusely branching semi-spreading line which flowers in about 70-75 days.

B. Seed Production

Seeds of the pollinator line can be multiplied in the same manner as with pure line varieties. Obtain genetically pure seed and grow it on

ridges/rows 60 cms apart in ISOLATION (15 kg/ha). No special treatment is required for seed production.

V. HYBRID

A. Characteristics

ICPH 8 is a high yielding short-duration hybrid maturing in about 140 days. Its high yield and stability has been demonstrated over years at research stations and on-farm trials in diverse agro-climatic conditions. It is indeterminate in growth habit and produces profuse primary and secondary branches. ICPH 8 has also been found to perform well under drought conditions.

B. Seed Production Procedure

- The recommended planting ratio is 1 pollinator to 6 female rows.
- Select a well drained ISOLATED field and prepare it with the addition of a basal fertilizer dose of Di-ammonium phosphate @ 100 kg/ha. Make ridges/lines 60 cm apart.
- Obtain genetically pure seed of the male sterile and pollinator lines from reliable sources.
- Plant the 1st row at one end of the field with the pollinator. Thereafter repeat planting the pollinator at every 7th row. The intra-row spacing should be 10 cm.
- The rows between the pollinator rows should be planted with the male sterile parent at a spacing of 10 cm, i.e., rows 2, 3, 4, 5, 6, 7; 9, 10, 11, 12, 13, 14; 16, 17, 18, 19 and 20 will be MALE STERILE rows.
- Keep the field weed free and irrigate as and when necessary.

- Start ROGUING in the MALE STERILE rows according to the steps outlined under III (B) on page 4.
- After completing the roguing operation it is always good to RE-CHECK the male sterile plants for the correctness of the roguing operation.
- Young pods developed in the pollinator rows should be removed periodically to ensure continuous supply of pollen grains for effective hybridization.

  Pick mature hybrid pods from the male sterile rows manually, provide irrigation to take a ratoon crop.

  Under good field management system besides the main crop within a year 2-3 ratoon crops can be harvested at the interval of 45-50 days.
- At the end of the season, if plant population is good, the seed production nursery can be advanced to the next cropping season.

Note: If large areas are to be planted for seed production, it would be advisable to sub-divide the area into smaller manageable blocks and these blocks should be planted at intervals of 10-15 days. This will ensure staggered flowering hence farm labour can be used more efficiently.

Fig. 1. LAYOUT FOR MALE STERILE MAINTENANCE BLOCK

(In ISOLATION)

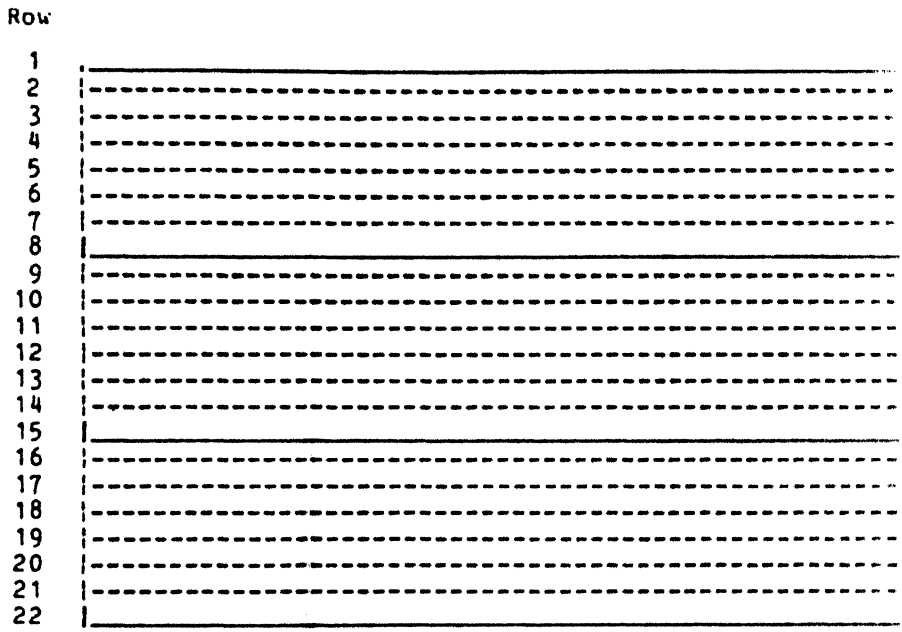
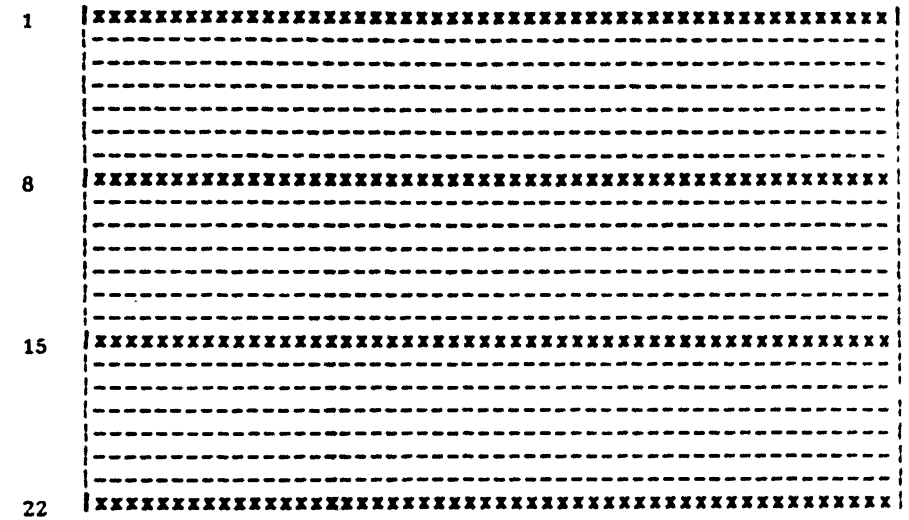


Fig. 2. LAYOUT FOR HYBRID SEED PRODUCTION

(IN ISOLATION)



xx = pollinator
-- = male sterile