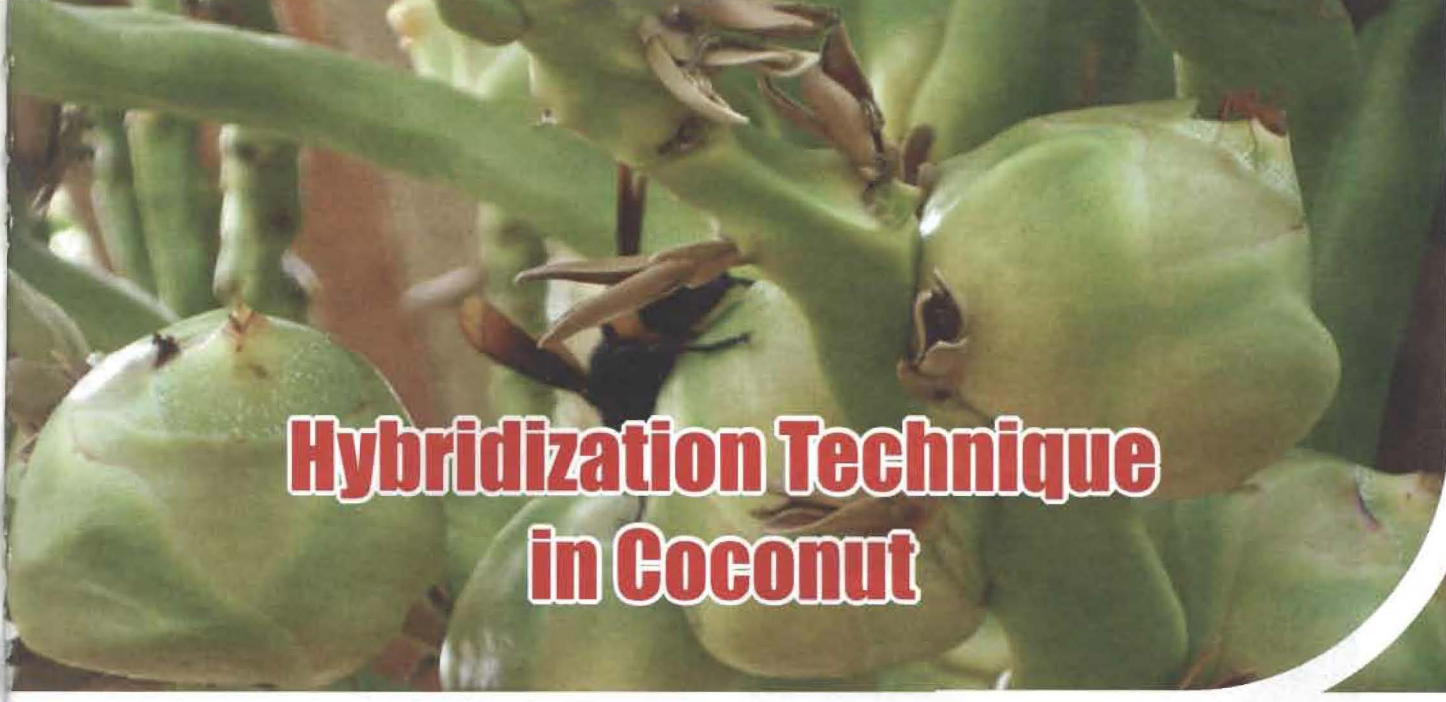

Hybridization Technique in Coconut

Samsudeen, K., Niral, V., Sudha, R., and Ranjini, T. N.
ICAR- CPCRI, Kasargod

Introduction

Manifestation of heterosis or hybrid vigour in a perennial crop like coconut palm was first reported from India in 1937. Hybrid vigour in the nursery for vegetative characters such as height, girth at collar and number of leaves in the seedlings was observed in inter-varietal crosses involving the tall variety as the female parent and the dwarf variety as the male. These seedlings on planting had a rapid growth rate with a higher rate of leaf production, shorter pre-bearing period, high bearing capacity and economic nut characteristics. These findings in India emphasized the importance of hybridization or controlled cross breeding in coconut improvement and have been subsequently adopted as a widely recognized programme in the major coconut growing countries. Considerable work on production, evaluation and mass distribution of seedlings is now in progress in most of the major coconut growing countries. The inter-varietal hybrids produced in these countries for commercial planting were initially Tall x Dwarf and Dwarf x Tall with different parental combinations. Besides, intra-varietal hybrids like Tall x Tall and Dwarf x Dwarf combinations are also under evaluation.

Floral biology

Inflorescence

For any hybridization programme, it is essential to know the floral biology for undertaking effective controlled pollination. The inflorescence of a coconut palm is the 'spadix'. As the coconut palm is monoecious, it produces both male and female flowers on the same inflorescence. A coconut palm on reaching the normal bearing age produces a spadix from each leaf axil. The annual production of spadices, therefore, coincides with the number of leaves produced by the palm that under normal conditions ranges from 12 to 15. However, a few spadices fail to develop under unfavourable circumstances.

Fig 1. Inflorescence

The inflorescence develops within a strong, tough, pointed double sheath called spathe. When the spathe is fully grown, the entire structure collectively called the 'spadix' would be about 1 to 1.2m in length and 14 to 16cm in diameter at the broadest point. At this stage, it splits along its underside from top to bottom and releases the inflorescence. This usually

occurs 75 to 90 days after the first appearance of its tip in the leaf axil.

Male flowers

The inflorescence consists of many flower bearing ramifications or spikelets situated on a control axis or peduncle. The number of spikelets varies from 30 to 35. On the spikelets, the male flowers are located at the distal end and the female flowers towards the base. The number of male flowers may vary from 250-300 per spikelet and there may be about 8000 to

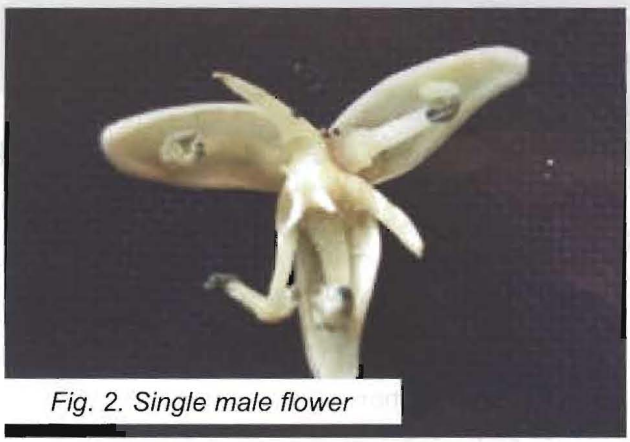

Fig. 2. Single male flower

10000 male flowers per inflorescence. Male flowers have three outer perianth, measuring about 3-5mm, three inner perianth measuring about 15mm, six stamens and a rudimentary pistil.

Male phase

Generally, male flowers are the first to open immediately after splitting of the spadix. The first male flowers to open are those located at the sides of the female flowers and those at the tips of the upper spikelets. Flowering commences from the apex of the spike and extends downwards towards the base. Flowers bloom throughout the day but maximum blooming occurs during 8 and 10 am. After shedding their pollen, the male flowers whither and fall off, usually within two days after their opening. In tall palms, the duration of male phase, that is the time between the opening of the first male flower and shedding of the last male flower is about 18-22 days, depending on the palm's characteristics, the growing conditions and the season.

Pollen

When the anthers are fully mature, the pollen sacs burst along the two longitudinal slits corresponding to the partitions of the pollen sacs and shed their pollen before the opening of the male flower. The pollen grains are spherical and smooth when fresh but on exposure for a few seconds, turn ellipsoidal with a longitudinal groove in the middle. They measure about 0.063mm in length and 0.020mm in breadth. It is estimated that an inflorescence contains about 180-360 million pollen grains. The pollen output per anther in a flower of a healthy palm is estimated to be 1,11,000-2,21,000 pollen grains. Examination of the pollen grains under the microscope reveals the presence of shrunken pollen grains among the smooth and round pollen grains. The former are infertile and account for about 25% of the pollen grains.

Germination of pollen grain

The germination test of the pollen is a pre-requisite before using the same in pollination. The test is usually done in a solution containing 800mg of Sucrose, 200mg of gelatin and agar in 10ml of distilled water. Pollen with at least 50% germination alone should be selected for pollination.

Female flowers

Unlike the male flowers, the female flowers are comparatively few in number in an inflorescence. They may vary from 20-40 in tall palms. Dwarf palms, generally, carry a large number of female flowers in a spadix than that of tall palms. However, this trait is strongly influenced by the environmental conditions and the age of the palm. Young palms just starting to flower usually have fewer female flowers per inflorescence than mature palms. Palms with large nuts cannot carry many nuts in one spadix as there is just no room for them. Such palms usually have relatively few female flowers whereas the palms with smaller nuts have larger number of female flowers. The cultivar Laccadive Micro, a tall palm from Lakshadweep produces about 160 nuts/palm/year. Some of the spadices of this variety produce as many as 400-500 female flowers each during favourable summer months.

Fig.3 Receptive female flower

At the time of opening of the spathe, the female flower is a small spherical body about 1.3cm in diameter with great resemblance to a small nut and

is popularly known as button. The female flowers, like male flowers, consist of six floral leaves that are thicker, imbricately arranged and tightly folded over the inner parts of the flower completely enveloping the spherical pistil. The ovary is tricarpellate and each carpel has a single ovule. Normally, only one

Fig. 4. Insectes visiting receptive female flowers

ovule develops while the other two either abort or degenerate. But in exceptional cases bicarpellate and even tricarpellate fruits are also produced.

The stigmas are sessile. When the stigmas are receptive, nectar is secreted at the base of the stigmas and at the three pores on the pericarp towards the top of the ovary. When the female flowers become receptive, it opens at the apex and the three stigmas protrude from it like a three-pointed star. Receptivity in tall palms begins about 24 to 26 days after opening of the spathe. In most dwarfs, this period is only 2-7 days and in D x T hybrids and some green dwarfs, it is about 16-21 days.

Female phase

Female phase, which is the interval between the receptive stage of the first female flower and the last female flower, varies with the condition of the palm. However, it is much shorter than the male phase and lasts for about 5-7 days in tall palms and twice as long in some dwarfs.

Interval between male and female phases

The interval between the end of male phase and the beginning of the female phase has an important bearing on the nature of pollination. In the coconut palm, especially in tall variety, there is a distinct gap between the male and the female phases as the female flowers become receptive after all the male flowers in the same spadix have shed their pollen. This makes cross-pollination customary. However, slight chances of self-pollination exist from the succeeding inflorescences (inter-spadix overlapping) especially during the summer season. In dwarf palms and hybrids, the interval between the two phases, is either nil or negligible (intra-spadix overlapping) thereby increasing the chances for self-pollination.

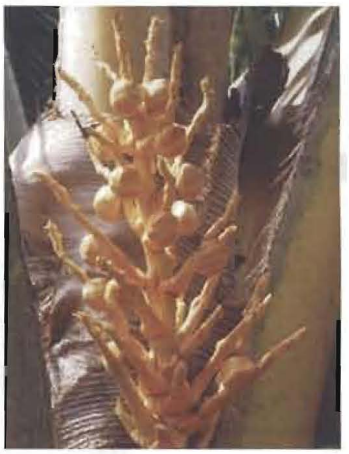

Fig. 5. Emasculated inflorescence

Genetically, dwarfs are considered autogamous (direct self-pollinating), the talls allogamous (cross-pollinating) and the hybrids and a few dwarf types, particularly green dwarfs, capable of uniting both the types. However, overlapping of phases of two successive inflorescences is a characteristic conditioned by the interaction between genotype and the environment.

Pollination

There is so far no consensus on the major agency responsible for pollination in coconut. Both wind and insects are considered to have equally important role as carriers in pollination. After fertilization, it takes about 11 to 12 months for the flower to develop to maturity. The unfertilized female flowers turn brown and fall from the inflorescence. A number of fertilized flowers also fail to develop properly and they too are shed. Generally, not more than 25 to 40 percent of the female flowers reach maturity.

Commercial production of hybrids

Emasculation

The first step in hybridization is the removal of male flowers from the inflorescence of the female parent to avoid self-pollination. This is called 'emasculation'. A coconut inflorescence has hundreds of male flowers and few female flowers. All the male flowers are to be removed well before the female flowers come to receptivity. To avoid any chance of contamination it is better to do the emasculation as soon as the inflorescence opens on the first day itself. This is done either by removing the individual male flowers by hand or by cutting the spikelets (with knife or secateur) about 4 to 5 cm away from the uppermost female flowers and removing the remaining male flowers by hand.

1 Fig. 6. Crushing mature male flowers

2 Fig 7 Drying male flowers in incubator

3 Fig. 8. Dried male flowers

4 Fig.9. Drying male flowers in fluid bed

5 Fig.10. Manual sieving of male dried flowers

6 Fig.11. Sieving of dried male flowers

7 Fig. 12. Pollen and talc for preparation of pollen-talc mixture

8 Fig 13 Processed pollen stored in desicator

Pollen collection and processing

In coconut inflorescences, the male flowers on the top and middle spikelets produce more fertile pollen compared to those on the lower spikelets. Therefore, collection of pollen from male flowers of lower spikelets is to be avoided. Maturity of the male flowers is indicated by the appearance of a bluish green tinge at the tip of the anthers. Collection of pollen from an inflorescence between 6 to 8 days after opening is recommended. The method of pollen collection is described in table 1.

A pollen drying equipment called 'Fluid-sero-culture' is available, which processes pollen within 4 hrs and thus can be used on the same day. The instrument is used for drying pollen by exposing the fresh male flowers to hot air. The air temperature and the speed can be regulated. At 40^0C, the pollen can be dried in about four hours. This is especially useful in seed gardens where a large quantity of pollen is required every day.

Pollination

Unlike emasculation and pollen processing, the pollination technique to be used in a garden depends on the type of plantation. When the female parents are scattered in a garden and one inter-planted with different types of tall cultivars 'controlled hand pollination' technique is to be used. This method involves bagging of emasculated bunches for the entire period of female phase and pollinating with desired pollen. The same procedure is also to be followed in the production of T x D hybrids. However, this method is not amenable for commercial production of hybrids as it is tedious and time consuming.

The plantations of pure blocks of dwarf and dwarfs inter-planted with a single tall cultivar are suitable for commercial production of coconut hybrids. The former is more suitable than the latter, as when the talls and dwarfs are inter-planted only a single hybrid combination can be produced in that garden without bagging. In this case, all the inflorescence in dwarf palms is to be emasculated so that only pollen from tall is available in the garden. All the nuts collected form the dwarfs after emasculation will be hybrid nuts (D x T). However, to increase the setting percentage, assisted pollination with the tall pollen is advisable. In the plantations of pure blocks of dwarfs more flexibility is possible. Depending on the need, by changing the pollen in the assisted pollination technique, different combinations of hybrids can be produced. However, assisted pollination is mandatory in the pure blocks of dwarf, while it is optional in blocks inter-planted with talls. As the procedure is simple, it is very easy to produce a large number of hybrids from this (pure blocks of dwarfs) type of gardens.

	Table 1
1.	Cut the portion of the spikelets containing mature male flowers.
2.	Separate the male flowers from the spikelets.
3.	Place the male flowers between folds of thick paper and gently crush them with the help of a rolling pin (crushing is done only for separating the perianth parts and should not damage / break the anthers).
4.	Keep the crushed male flowers in an oven at 390 (+/- 10C) for 24hrs.
5.	Sieve to separate the pollen from the debris (use 0.2 mm mesh sieve).
6.	Test the germination as mentioned earlier. Only pollen with at least 50% germination should be used for pollination.
7.	Collect pollen in glass vials and store in desiccators over fused calcium chloride. Pollen so stored can be used for 10-15 days.
8.	When longer duration of storage is required, seal the glass vials and store them in deep freezer (- 200C). This pollen can be used upto 3 months.
9.	Dilute pollen with neutral talc powder in 1:9 proportion before use. If pollen is available in large quantity, the ratio can be 1:2 or 1:8. When the pollen stored in deep freezer is to be used, first allow it to stand at room temperature before diluting.

For effective and speedy pollination, a simple device has been developed. It consist of a polythene squeeze bottle, a rubber tube and bamboo pole. The squeeze bottle is tied at the end of a bamboo pole (or aluminum rod) of 2 to 3m length. A rubber tube with a rubber bulb at one end is connected to the bottle just below the neck. When the rubber tube is pressed, it injects air into the squeeze bottle and in turn, the pollen-talc mixture present inside the bottle is released as a cloud. When the receptive male flowers are to be pollinated, the nozzle of the bottle is placed near the inflorescence and the rubber tube is pressed. The pollen-talc mixture released will cover the inflorescence effecting the pollination. The process is repeated on the 1st, 3rd and 5th day starting from the day when the first female flower comes to receptivity. When the stigmas turn brown and black the female flower is no longer receptive. By this method most of the dwarf palms can be pollinated from the ground level. Even the few dwarf palms, which are taller, can be reached with the help of a small ladder. As the laborious process of tree climbing can be avoided, a single pollinator can attend to about 150 trees a day. The setting percentage is very high (about 50%) when compared to that in nature (20-25%).

References: ● *Chowdappa P., Niral V., Jerard B.A. and Samsudeen K. (Eds.) (2017) Coconut. Daya Publishing House, A Division of Astral International Pvt. Ltd. New Delhi, India. 440p.* ●*Patel, J.S. (1937) Coconut breeding. Proc. Assoc. Econ. Biol.5: 1-16.* ■

CDB celebrates World Coconut Day celebration at Bhubaneswar

In India, every year World Coconut day is celebrated under the aegis of Coconut Development Board. Coconut Development Board is celebrating this year's World Coconut Day at Kalinga Institute of Industrial Technology, Bhubaneswar Odisha on 2nd September 2019.

Shri. Narendra Singh Tomar, Hon'ble Minister for Agriculture and Farmers Welfare, Government of India will be the Chief Guest and Dr. Arun Kumar Sahoo, Hon'ble Minister for Agriculture and Farmers' Empowerment, Government of Odisha will be the Guest of Honour. Shri. Sanjay Agarwal IAS, Secretary, Dept. of Agriculture, Cooperation & Farmers Welfare, Government of India will preside over.

All coconut growing countries in the Asia and Pacific region observe 2nd September as World Coconut Day every year. The foundation day of the International Coconut Community (ICC) an intergovernmental organization is observed as the World Coconut Day in the member countries. The objective of observing coconut day is to create increased awareness and importance of coconut and help focus national and international attention to this crop. The theme announced by ICC for World Coconut 2019 is 'Coconut for Family Wellness'.

Around 500 coconut farmers from all coconut growing states and senior officials from the Department of Agriculture/ Horticulture and Agricultural Universities will attend the programme at Bhubaneshwar. A technical session will also be held as part of the programme. Coconut Development Board is organising programmes across the country in all coconut growing states to celebrate the coconut day. An exhibition of value added products and coconut handicrafts will also be held as part of the programme.