

Lecture 14

Red gram (*Cajanus cajan*) ($2n = 22$) Family – Fabaceae

Self pollination is the rule in Red gram and natural crossing extends up to 65 per cent. Therefore it is also known as often cross pollinated crop.

Adaptations for self pollination

1. Bisexual
2. Close proximity of anthers and stigma
3. Simultaneous maturity of anthers and stigma.

Selfing, emasculation and pollination techniques in Red gram

Selfing

Mature flower buds are to be covered with paper bags for one or two days.

Crossing

Hand emasculation followed by artificial cross pollination is essential. Emasculation should be done in the previous day evening and the emasculated buds are protected by covers. Early morning on the next day, pollination is done using pollen collected from the protected flowers of the selected male parents.

Black Gram (*Vigna mungo*) (Diploid, $2n = 22$ & 24) Family – Fabaceae

Self pollination is the rule. Here pollination occurs before flower opening (cleistogamous) in night. Anthesis time 1 am – 4 am. The flower opens in the morning at 7 am. The interval between pollination and opening of flower is 4 hours. This ensures self fertilization.

Selfing, emasculation and pollination techniques in Black gram

Selfing

As in red gram, bagging is done to avoid insect contact.

Crossing

Young unopened bud is kept between thumb and fore fingers of the left hand. The point of dissecting needle is inserted just under the standard petal in an oblique position along the top of the bud. The left side of the standard and wing petal are pushed outward and held with thumb and left hand. The left side of the keel petal is removed with the forceps. The pistil and stigma are then exposed and the anthers are removed with the forceps. Evening emasculation followed by morning pollination gives best results. Pollination is done by gently rubbing anther of male,

inserting the staminal column and closing it with standard and wing petal. Since flower shedding is common, putting better paper bag is avoided. The emasculated flowers are identified with thread wound round. The crossed pod will be smaller in size with two or three seeds only.

Cowpea (*Vigna unguiculata*), Family – Fabaceae (Diploid $2n = 22$ and 24)

Pollination

Highly self pollinated because of Cleistogamy, Close proximity of the anthers and stigma and Simultaneous maturity of anthers and stigma

Selfing

Keeping the plants in insect proof cages will lead to selfing. Covering of individual flower buds will lead to poor pod setting.

Crossing

Select young buds, in an inflorescence and remove all immature buds. Split open the keel petals and remove the stamens one by one holding the filaments. Bring corolla back to position and cover the bud with a folded leaflet. Protection is given by keeping the plants in insect proof cages. Pollination is done on the next day morning by exposing the stigma from the keel petal and brushing it with the pollen collected from the male parent.

Selfing and crossing are the essential procedures in crop improvement process. The exact procedures used to ensure self or cross-pollination of specific plants will depend on the floral structure and normal manner of pollination. Generally effecting cross-pollination in a strictly self-pollinating species is more difficult than vice-versa because for instance preventing self-pollination occurring inside the unopened flowers is cumbersome.

Bengal Gram – *Cicer arietinum* ($2n = 14, 16$), (Channa, Chick Pea), Family – Fabaceae

Chickpea is a self pollinated species with normal out crossing limited to 1.58%. self pollination takes place one or two days before opening up of the flower. The flower open in the morning and close in the afternoon and each flower opens on tow or three successive days. Time of anthesis is 3 AM to 9 AM. For hybridization crossing work should be started when the first pod on the selected plant is already formed. In Northern India, emasculation is done a day prior

to pollination. The pollination is done in the morning hours give better setting. In south India, pollination immediately after emasculation give higher seed setting.

Soybean *Glycine max* (2n = 40), Family – Fabaceae

Flower open early in the morning. The pollen is shed normally shortly before or after the flower opens. But pollen shedding may occur sometimes with in the bud itself. Normally cross pollination does not exceed 1 percent.

Emasculation and crossing

Hand emasculation is the method followed for crop breeding which is tedious since the floral parts are so small and seed set is also less. Emasculation is done in the evening and pollination is done in the morning hours.

Groundnut (*Arachis hypogaea*) (2n = 40), Family – Fabaceae

Self pollination is the rule in groundnut. Anthesis commences at 6 am and continues upto 8 am. Anther dehisces two hours prior to opening of the flower. Twenty four hours before anthesis, the buds are very small. During the day, elongation of calyx, proceeds slowly but process gets accelerated during night.

Selfing

Since cleistogamous condition prevails in groundnut, selfing is most easy in this crop. Usually covering is unnecessary and difficult. Keeping the plants in insect proof cages will ensure self pollination.

Crossing

Mature flower buds which are ready to open in the next day are selected and emasculated in the evening. They can be easily identified by the size and length of calyx tube. The flower bud of groundnut is of crescent shape, being bulged on one side and slightly depressed on the other. The keel petal is located on the bulged side and the standard is present on the depressed side. For emasculation, hold the bud between the thumb and the index finger of the left hand and with the help of a razor blade in the right hand; make a cut on the depressed side at two-thirds the length below the tip so as to cut the standard and a portion of the wing petals. Then gently pull the calyx and corolla by holding at the tip of the flower bud. By doing this, the sepals and the petals except the keel would be removed, with the help of the fine forceps gently liberate the bundle of stamens and the pistil from the keel and nip off the anthers.

With a hand lens, examine the tips of filaments so as to ensure complete removal of the anthers. Take a piece of straw tube (used for sipping cool drinks), 4 to 5 cm long and close one side opening by bending the tip. Cover the emasculated flower bud with the straw tube by slowly inserting calyx tube into it. This would ensure perfect protection to the stigma from any natural cross pollination. The next morning take out the straw tube, dust the stigma with the desired pollen and reinsert the tube. Pollination between 7 and 8 am was found to give more success. If the stigma is found dry, pollinate after smearing it with 2 per cent sucrose solution.

Next day early morning between 7 am and 11 am pollen is collected from mature yellow anthers of the selected male parent and dusted on the receptive stigma. For cross pollination, the selected male flower is held between thumb and the middle finger after the standard and wing petals are removed. The flower with keel protruding is taken to the stigma of the emasculated flower. A gentle push on gently keel by the finger forces lumps of pollen grains of the cover the entire stigmatic surface. Five to seven days after pollination successful crosses will produce gynophores (pegs) with the dried flowers at their tips. These are then introduced into small wire rings of 4 mm diameter which are marked for respective crosses.

Sesame (*Sesamum indicum*) ($2n = 26$), Family – Pedaliaceae

Gingelly is a self pollinated (Autogamous) crop. In some varieties cross pollination also takes place to a limited extend of 5-6 per cent. Very high cross pollination between 14 and 65 per cent has been recorded in a few varieties in India. Hence, the crop can be classified as *often cross pollinated*. Cross pollination may occur due to wind and bee activities. On a bright clear day, the flowers open between 5 and 7 am. In the mature flower bud, just before the flower opens, the four unripe anthers are much below the stigma which at this stage is not receptive. The anthers begin to burst longitudinally after 4am in the next day and commence to liberate their pollen. At this time, the stigma becomes receptive. The plant comes to flowering 4 weeks after sowing.

Selfing

1. **Tieing with thread:** Selfing can be effected by tieing the corolla of the unopened flower which is selected in the previous day evening itself.
2. **Smearing of semi-solid clay:** Selfing can be done by smearing a speck of semi-solid clay, on the upper portion of tubular petals of unopened flowers. The clay while on drying does not allow the tubular petals to open and hence self pollination is the rule.

This method is cheap and less time consuming one. This method is not effective during rainy days. During rainy days, fevicol may be applied on young flower bud to ensure selfing.

Crossing

Soda- straw method

The emasculation technique in sesame is easy for crossing due to epipetalous nature of the stamens. The flower bud which is expected to open in the next day morning is selected in the previous day evening between 3 P.M. and 6 P.M. and emasculated by just removing the corolla tube in which the stamens are attached. Then, the emasculated flower buds are covered with a piece of soda-straw tube, bent at the top in order to avoid contamination from foreign pollens. During the next day morning, between 7 A.M. and 9.A.M., pollen from the desired male parents were dusted gently on the surface of the stigmas of the emasculated flower buds after removing the soda-straw and again covered. The unemasculated flowers are removed in the female parent. Individual crossed flowers are tagged with coloured thread for the identification of crossed capsules. Different coloured threads are used for different type of crosses.

Sunflower (*Helianthus annuus*) (2n = 20), Family - Astraceae

Sunflower is highly *cross pollinated* crop mainly through insects (*Entomophily*) and to a limited extent by wind (Anemophily). The flower opening starts from outside of the head and proceeds towards centre. The head takes 5-10 days for complete blooming depend on size of head and season. Anthesis occurs between 5 to 8 A.M. Pollen viable for 12 hours. Stigma is receptive for 2-3 days. The staminal filaments elongate rapidly and the anthers appear above the top of the corolla. Anthers dehisce early than maturity of stigma. (*Protoandry*). In this crop, the cross pollination occurs due to protandry, limited area of stigmatic surfaces for receptivity, ray floret colour attracts insects and abundance of sweet secretions in the disc florets.

Selfing

The flower head is protected with a suitable cover before the commencement of anthesis in any of the florets and the cover is retained till fertilization is over in all the florets. Artificial self pollination with pollen collected from the same flower or another flower of the same plant using a soft brush will enhance seed settings.

Crossing

i. Hand Emasculation

Emasculation is done in the early morning by removing the anthers of the disc florets in 2 to 3 whorls with forceps and the other florets in the head are removed. About 9-10 am the pollens from desired male parent are collected and dusted on the emasculated head. This process is continued for 2 to 3 days.

ii. Without emasculation

In sunflower, head emasculation is difficult. Considering this difficulty, the heads are pollinated without emasculation. On the basis of hybrid vigour, plants are distinguished from the selfed plants. The presence of marker genes for identifying hybrids is also utilised effectively.

iii. Chemical induction of male sterility.

This is achieved by spraying of 100ppm GA (Gametocide) during bud-initiation stage consecutively for three days in the morning.

Pollination is carried out by collecting pollen from heads which are already bagged prior to flowering. Pollen may be collected from flowering heads into paper bags. Pollination is done in the morning by applying the freshly collected pollen by a small piece of cotton, a hair brush or through fine cloth bag. After each cross, care must be taken to avoid contamination by wiping the hands with alcohol.

Castor (*Ricinus communis*) (2n = 20), Family – Euphorbiaceae

Cross pollination is the rule in this crop. It is mainly wind pollinated. But insect activity is also seen to some extent since the young leaves just below the inflorescence exude copious nectar at the time of flower opening cause insect pollination. Unisexual flowers, protogynous, elevated position of female flower in the inflorescence, mechanisms to promote wind pollination and nectar glands to attract insect promotes cross pollination. Here male flowers open first (*protoandry*). After one or two days of male flowers opening, female flowers open. However, *protogyny* is also reported. The opening is between 4.30 and 5.00 A.M. Pollen grains are viable for a 2 days and stigma is receptive for 3 days. Each candle takes 10-12 days to complete flowering.

Selfing

The whole inflorescence is protected with not yet opened are selected. From the selected inflorescence all the male flowers are removed and the female flowers protected with a suitable cover. Artificial cross pollination is done when the stigmas of the retained female flowers become receptive by rubbing the anthers of male flowers collected from the selected male parent. During the rain day old bags are to be replaced with new bags to avoid fungal attack, and free air movement.

Crossing

1. **Emasculation:** It can be achieved by removing or rubbing off the staminate flowers by finger and thumb.
2. **Crossing:** Pollen grains are collected from the desired male parent and are dusted on the stigma of the female parent. Again the inflorescence is covered.