JHARKHAND
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A practical manual on Crop Improvement-I (Kharif Crops)

Course Code: 13AP.315

Credits: 2(1+1)

Semester: V

Department of Agriculture,
Jharkhand Rai University, Namkum.

Syllabus for Practical: Crop Improvement-I Kharif crops

Experiment No.	Exercise	
1	To study about Floral Biology, Emasculation and hybridization techniques in Rice, Maize, Sorghum, Pearlmillet, Ragi, Jute, Pigeonpea. Urdbean, Mungbean, Soybean, Groundnut, Seasame, Castor,Cotton	1-50
2	Maintenance breeding of different Kharif crops	51-63
3	Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods.	64-71
4	Study of field techniques for seed production and hybrid seeds production in Rabi crops.	72-77
5	Estimation of heterosis, Inbreeding depression and heritability.	78-83
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Practical - 1

Aim: To study the Floral biology, emasculation and hybridization techniques in different crop species namely Rice, Maize, Sorghum**,** Pearl millet, Ragi, Jute, Pigeonpea. Urdbean, Mungbean, Soybean, Groundnut, Seasame, Castor, Cotton , Cowpea, Tobacco, Brinjal, Okra, and Cucurbitaceous crops.

Rice (*Oryza sativa*):

Common Name-Paddy, Rice
Botanical Name – *Oryza sativa*
Family – Poaceae or Graminaeae
Chromosome Number -2n=24
Mode of Pollination –Self pollination
Origin: Indo-Myanmar region (Southeast Asia)
Related species: O.glabarrima, O.perennis,O.nivara.

Floral Biology:
Rice is a self pollinated crop.

Panicle
i) The inflorescence of rice plant, borne on terminal shoot and thus called as panicle. It is determinate type and at maturity, it is droopy in nature.

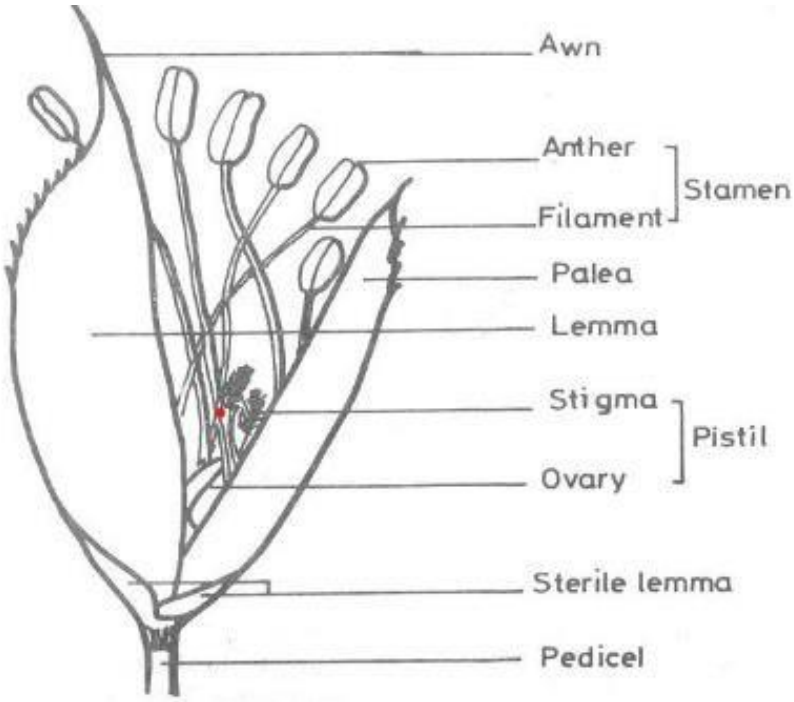

Fig: A flowered rice spikelet

Spikelet

1. A spikelet is the floral unit and consists of two sterile lemmas, a lemma, a palea and the flower.
2. Its parts are:

i. Lemma: It is a 5- nerved hardened bract with a filiform extension (of the middle nerve) known as awn.

ii.. Palea: IT is a 3- nerved bract slightly narrower than lemma.

iii. Androecium: It consists of 6 stamens with two-celled anthers

iv. Gynoecium: A pistil with one ovary and two stigmas. The pistil contains one ovule.

Fruit : Caryopsis

Seed: Albuminous

Floral formula: :% ♂P2 (Lodicules),A3,G(1)

Emasculation and hybridization techniques

Emasculation:

It is done in the afternoon on preveious day or early in the morning on the day of pollination.
The ear just emerged is selected and all spiklets already opened are clipped the spiklets whichare likely to be opened are selected and six anthers from each spiklet is removed with needle and fine pointed forceps. The emasculated ear after examination with lens covered with perforated butter paper bag and labelled.
In mass emasculation method hot water having temperature 42 to 45 0C is carried in thermos flask in the field. The panicle of the proper stage is selected and inserted in the water for 2 to 3 minutes. The flask is unopened spiklets are clipped off.

Pollination:

It is done on next day morning. Matured anthers are collected from protected male parent in
petri dish and dusted on the stigma of emasculated flower with brush and forceps and covered
with butter paper bag to protect natural cross pollination.

Maize (Zea mays)

Common Name -Maize
Botanical Name-Zea mays
Family- Poaceae or Gramineae
Chromosome Number -20
Origin: Southern Mexico and central America
Mode of pollination – Cross pollination

Floral Biology

Maize is a monoceous, diclinous i.e.It has the stamens and pistils are borne on separate inflorescences , but on the same individual plant. The male flower are carried on terminal panicles known as tassel,while the female flowers are on the ear.

Male Inflorescence:
The male inflorescence is called Tassel .
The tassel is terminal with staminate flowers in several roots. Each pairs of flower consist of sessile and pedicillate spiklet. Each spiklet contains two similar glumes. The flower contains membranous palea with three stamens and two lodicules. The pollens remain viable for 18 to 24 hours.

Female inflorescence:
The female inflorescence is a spadex known as cob or ear. It is modified lateral branch developed from lateral bud. The shoot is composed of compressed internodes from which husk rise and terminates in an ear on which the sessile are borne. Spiklets are in pair. Each spiklet having two flowers, the lower one is reduced to lemma and palea is non-functional, while upper one contained knob shaped ovary surrounded by broad lemma and thin palea. One carpel is provided with long silky hair, which behaves as style and style stigma throughout the length.

Fruit: A caryopsis.
Grain: Albuminous

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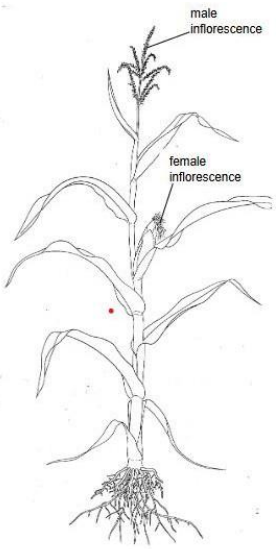


Figure 1: Maize plant showing position of male and female inflorescences

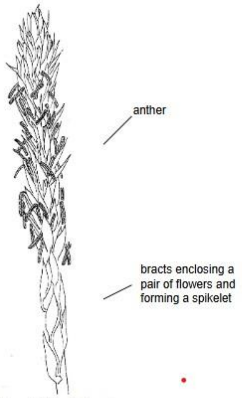


Figure 2: Part of male inflorescence

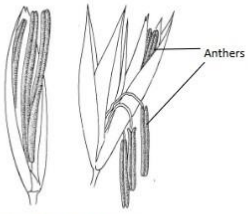


Figure 3: Male flowers

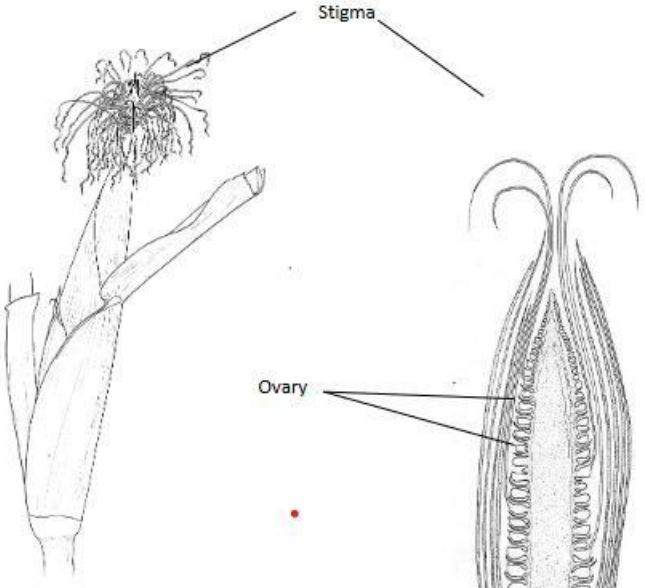


Figure 4: Female inflorescence

Figure 5: Longitudinal section through female inflorescence

Floral Formulae

Male flower:% ♂ P2 (Lodicules),A3,G(0)

Female flower:% ♀ P2 (Lodicules),A3,G(1)

Emasculation:

The tassels of the female plants are removed immediately as soon as appeared. The process is called as detasseling. It is always done in the morning. Ear shoot which emerging from the leaf sheath is bagged 1 to 2 days below the tip of the preveious day of pollination.

The tassels of selected male parents is also covered with bag on following day in the morning between 9.00 to 10.00 a.m. pollens from tassel bag is dusted over the silk of the female cob/eat. The bag covered ear shoot is torn and bag from the male parent may be placed over the cob. Care should be taken to avoid contamination of silk with foreign pollens.

Crossing technique

Female parent

a. Detassel

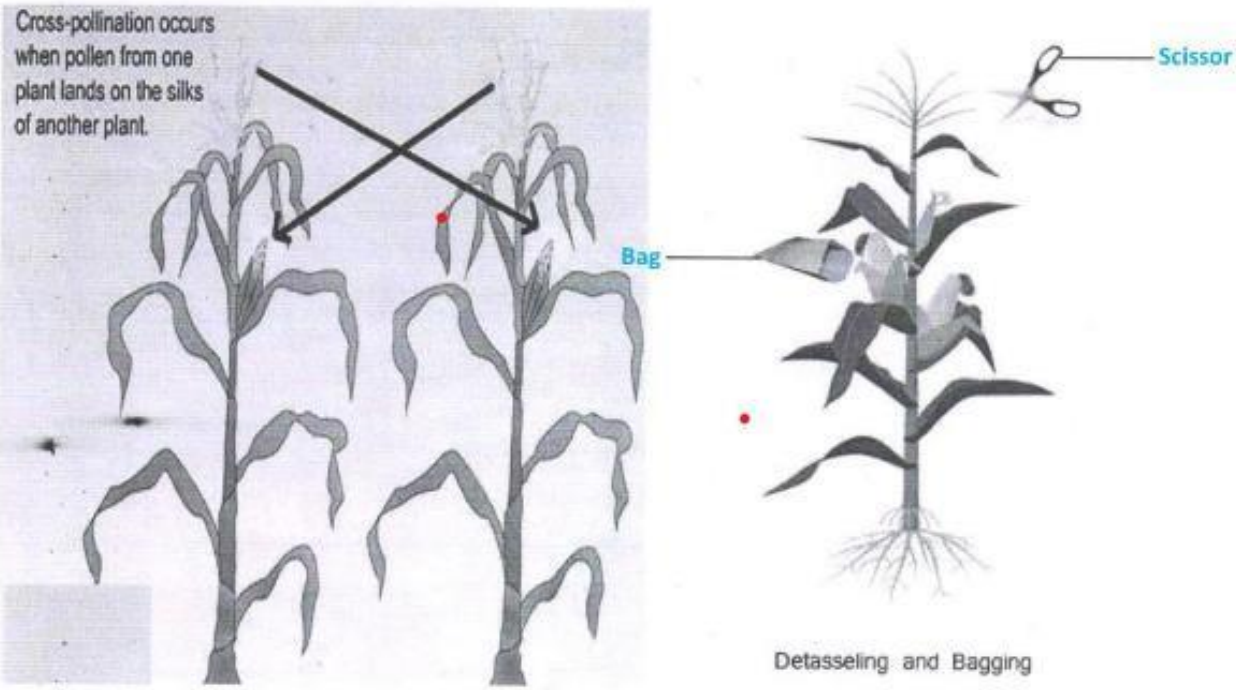
b. Cut the tip of the cob before the silks emerge and cover with a butter paper cover.

Male parent

a. Cover the tassel before anthesis begins or as soon as the tassel emerges.

When the silks emerges in the female parent in the form of a brush, pollination is done by transferring the freshly shed pollen cover form the male parent and inserting it over the cob of the female parent after removing the cover from the cob.

The details like date of pollination, parentage and breeding programme to be carried out are clearly written by water proof pencil. The date or pollination will be one day later than the date of tasselling. Pollination should be completed within one week of silk emergence. Isolation distance for maize = 400M



Detasseling and Bagging

Sorghum (Sorghum bicolor L)

Common name – Jowar
Botanical Name – Sorghum bicolor
Family-Poaceae or Gramineae
Chromosome Number-20
Origin: Africa
Related species: S.halepense,
S.sudanensis
Mode of pollination: Often Cross
pollination

Floral Biology:

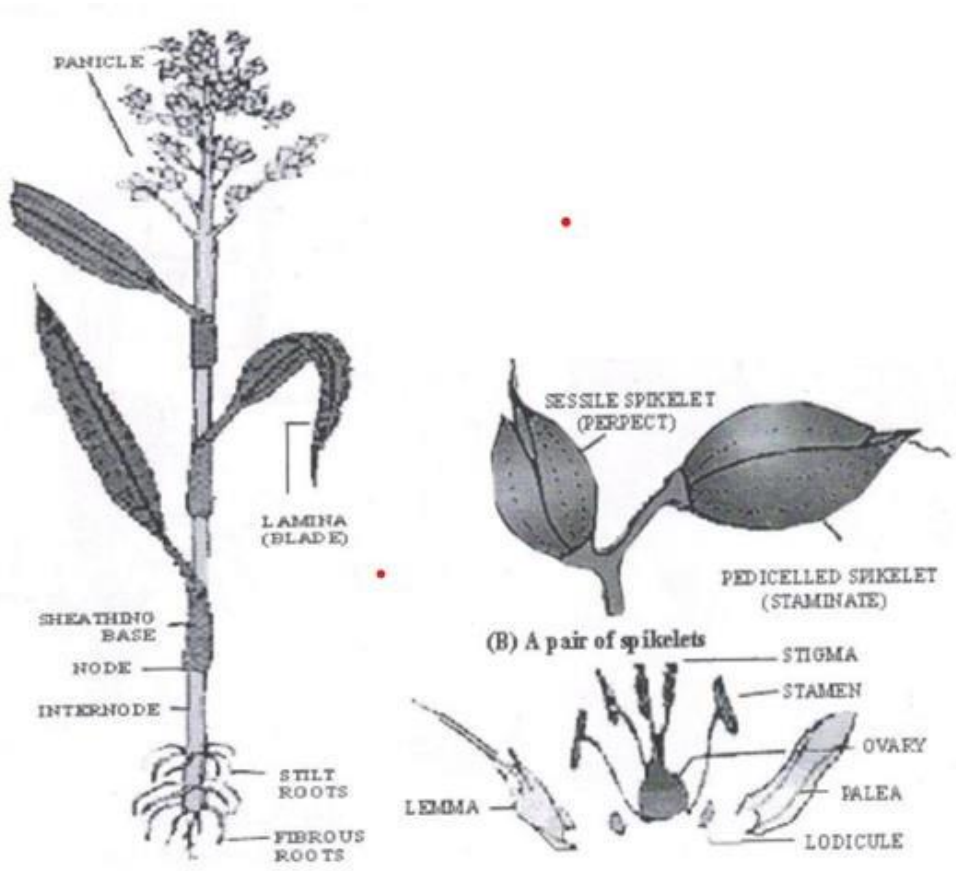
Structure of spikelet and flower: - Each spikelet comprises an axis,the rachilla,which bears two glumes and a number of florets. Within each spikelet, there are usually from 2 to 4 potentially fertile florets. The floret has two sheathing structure, the outer lemma and the inner palea which envelope two lodicules, three stamens and the carpel. Each stamen is made up of a filament and a yellow anther. The Anther is about 3 mm long and has 4 chambers containing numerous pollen grains. The basal part of the carpel, the ovary, is obovate and white in colour with a smooth surface except at the tip, which has numerous unicellular hairs. The ovary contains a single ovule. Much of the pollen grains shed within the floret and the crop is largely self-pollinated.

Inflorescence: Spike of spikelets

Flower : Bracteate, sessile, hermaphrodite, zygomorphic,incomplete

Perianth:2 membranous scales–the lodicules

Androecium: Stamens(3),polyandrous, filament long, anthers Bicelled dorsified when young and versatile when mature.



Gynoecium: Monocarpellary, theoretically tricarpellary, ovary superior, unilocular, single ovule, basal placentation, style short;stigma(2),feathery

Fruit: Caryopsis

Seed: Albuminous.

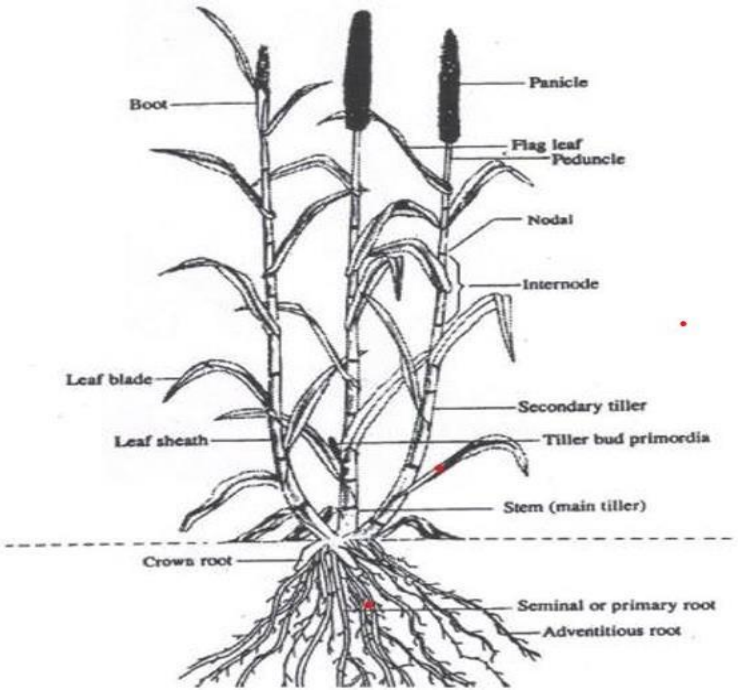
Floral formula: % ♀ P2(lodicules),A3G1

Emasculation and hybridization techniques: Flowering begins in the upper part of the spike and proceeds in both the directions.Flowering on a spike is over within 2-3 days.ForThe spike enclosed in leaf sheath or partially emerged is selected for emasculation.For emasculation roughly ¼ to 1/3 upper part of spike is clipped and afew basal,immature florets are removed .In the remaining 5-6 pairs of florets,the central florets are also removed and the emasculation is carried out in the remaining lateral florets of each spikelets.For this glumes are clipped back and three young immature greenish yellow anthers are removed from each flower.The emasculated spike is covered by a pollination bag. After 1-2 days the stigmas are visible and the emasculated spike is ready for pollination.On the next morning between9.00 to 11.00 a.m. the pollen grain is collected from the desired plant in petri dish and dusted on stigmaof emasculated flower with the help of hair-brush.The spike is covered with bag after pollination and labeled**.**

Bajra (Pannisetum americanum L.)

1. To Study the Emasculation and Hybridization Techniques in Bajra.

Common Name– Bajra
Botanical Name–
Pennisetum americum
Family- Poaceae
Number of Chromosomes- 2n=14
Origin: Sahel Zone of west Africa
Related species:Pennisetum .purpureum

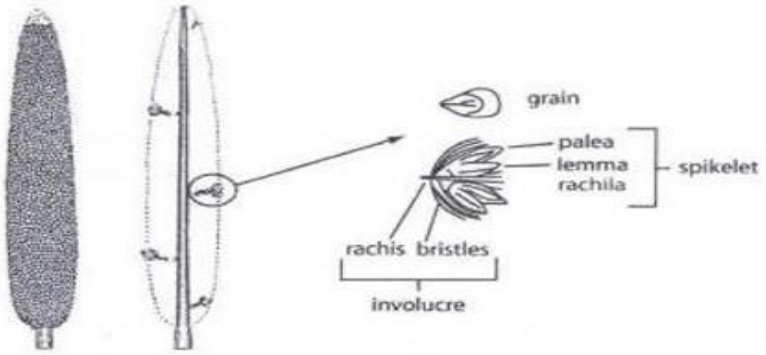


Inflorescence:-Pearl millet inflorescence is a compound terminal spike called panicle and its length generally varies between20-25 cm with a circumference of 7-9 cm. Inflorescence consists of a central rachis covered with soft /short hairs and bears fascicles. A spikelet contain two flowers or florets. The lower floret is staminate and the upper floret is bisexual or hermaphrodite.

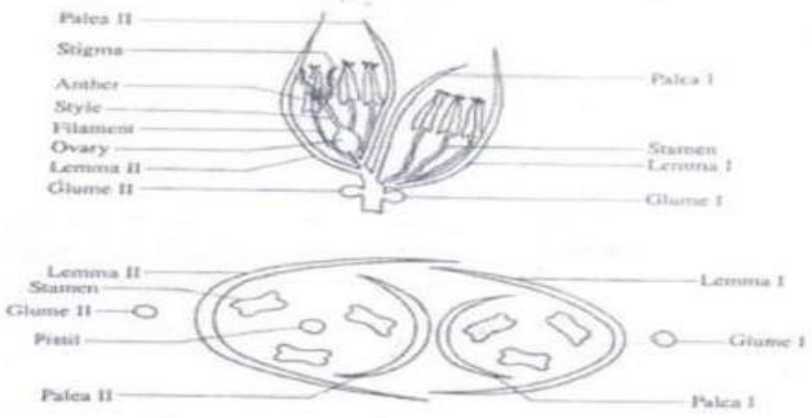
1. Inflorescence of Pearl Millet is called as Panicle.
2. Fascicle is a group of Spikelets .
3. Each spikelet contain 2 flowers.
4. Terminal flower s Bisexual and lower flower is unisexual &male.
5. Each flower contain 3 stamens
6. Bisexual flower contain 1 carpels .

Natural Pollination:-Bajra is naturally cross pollinated .Adaptation for cross pollination is Protogyny.Anthesis commence from 1/3 rd of the apex of spike and proceeds both ways.Stigma emerges first and anthesis is over within 2-3 days.This is followed by the first male phase in which the anthers from the perfect florets emerge out.On the fifth day of anthesis the 2^{nd} male phase begins in which anthers from the staminate florets emerge.Anthesis time is from 8 pm. To 2 am.

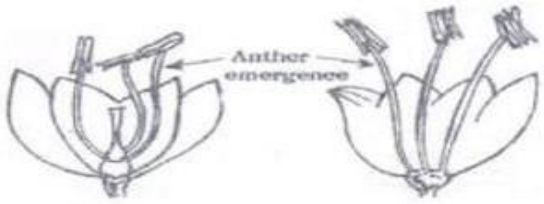
4.Emascuation:-Pearl millet do not require emasculation for making crosses . the female line will be covered before stigma emergence with butter paper bag.Without removing butter bag we can see emergence of stigma**.**



Structure of Panicle



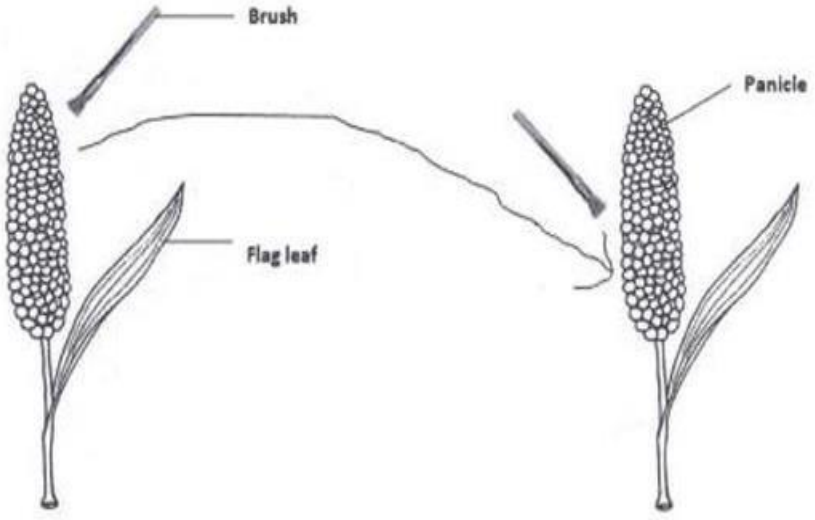
Structure of spikelet



Structure of flowers

Bagging

5. Pollination:- After most of the stigma have emerged. Pollen from desired male parent is collected and dusted on to the female line. Pollination is usually made in the morning. Care should be taken to cover pollen parent previous day with butter paper bag. The crossed heads are labeled. The crossed heads can be collected after 30-35 days.



Male Parent

Female Parent

Ragi/ Finger millet

To Study the Emasculation and Hybridization Techniques in Ragi

Common Name – Ragi/ Finger millet

Botanical Name –Eleusine coracana

Family- Poaceae or Gramineae

Number of Chromosomes -2n=36

This is self pollinated crops . The inflorescence takes 7-8 days to complete anthesis. Time of anthesis 1 am – 5am. In each spike the order of opening is from the top to bottom. In each spikelet the opening of the floret is from the base to top and one floret in each spikelet opens a day.

Floral structure:

Terminal whorl bearing 2 to 10, but averaging 5 or 6 spikes arranged like a birds foot at the top of the peduncle. The lowest spike is separated by 2 to 5 cm from the other spikes and which arise from the same point at the end of the stem. In each finger there are about 70spikelet's, each spikelet having five to seven complete flowers. In the spikelet the flowering proceeds from bottom to top and in a finger the order of flowering is from the top spikelet downward. An ear head contains 1,500 to 3,000 flowers, and the flowering period varies from six or seven to ten days.

Inflorescence types: Top incurved open type incurved type.

Floral biology : Anthesis commences from top spikelet and progress downwards. Each spikelet contains 4 to 6 flowers, the opening of the florets starts from bottom to top. One floret in the spikelet opens per day. Flowering takes place simultaneously in all fingers..Complete emergence of the inflorescence requires 7 -8 days. Depending upon the ear shape Flower opening period will vary; Compact : 2-3 a.m. Fisty : 3-5 a.m. Open : 1-2 a.m. Pollen viability is very short, 10 – 15 min.. Anthers require about 45 minutes for dehiscence after emergence The stigma is receptive for about five minutes after emergence from the glumes Self pollination is the general rule because the period of anthesis is very short. Cross fertilization by wind and insects is less than 1 per cent.

Selfing, Emasculation and pollination techniques

Selfing The panicle before commencing anthesis is covered with paper cover and retained till the blooming is over. Crossing Emasculation and crossing are tedious. However, both hand emasculation and hot water treatments are followed. Hand emasculation is done in the evening and pollination is done very early in the morning i.e., before 6 a.m. Hot water technique of emasculation of florets is also successful. Hot water treatment at 520C for 2 minutes was the best as judged from the percentage of hybrid seed-set. Then the spikelets are pollinated early in the morning.

Approach Method or contact method.

The inflorescence to be opened will be selected and cut with long stalk from the male parent. This is brought to the emasculated flower. The male flower as a whole will be tied round with female flower. Then they are covered with butter paper bag. The cut end of the male inflorescence will be immersed in water kept in a bottle. Natural cross pollination takes place in 2 to 5 days. Marker genes are utilized for identifying the hybrid seedlings in the nursery plot. 60-90% seed set is recorded in both methods.

Crossing Emasculation and crossing are tedious. However, both hand emasculation and hot water treatments are followed. Hand emasculation is done in the evening and pollination is done very early in the morning i.e., before 6 a.m. Hot water technique of emasculation of florets is also successful. Hot water treatment at 520C for 2 minutes was the best as judged from the percentage of hybrid seed-set. Then the spikelets are pollinated early in the morning.

To Study the Emasculation and Hybridization Techniques in PIGEON PEA:

Common Name – Red Gram
Botanical Name – *Cajanus cajan*
Family—Fabaceae
Number of Chromosomes -2n=22

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

Floral Morphology: Racemes axillary, rarely branching, peduncle erect with 1 – 3 additional nodes, usually slightly shorter than the leaves, mostly with 2-6 flowers at the tip; bracts about 5 mm long; pedicelsto about 9 mm long; calyx campanulate, lobes triangular or lanceolate, tube glandular and pubescent, the upper lobe bifid, the lower lobe longest; vexillary petal basally inflexed biauriculate, mostly with yellow to reddish striate, bicallose in the target area, glabrous, witha claw, wings slightly obovate, with short auricle; keel apex obtuse, slightly inflexed.
Stamens - 9+1, 15 – 18 mm in length, tapering towards the top; anthers ellipsoid, about 1 mm long, dorsifixed, yellowish, slit longitudinal; pollen 3- colporate, exine areolate; ovary1 chambered; ovary hairy; style long; stigma terminal, simple, Pods linear-oblong, compressed, bi-valved, depressed between the seeds,; upper suture swollen, the lower indistinct; beakdown curved; seeds 1 - 5, compressed, subspherical about 6 x 4 x 1.5 mm, of various colours, hilum linear to oblong to somewhat elliptic, about 3 mm long.

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 artifical 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**.**

Inflorescence: Solitary axillary.

Flower: Bracteate, pedicellate, complete, hermaphrodite, zygomorphic pentamerous, hypogynous.

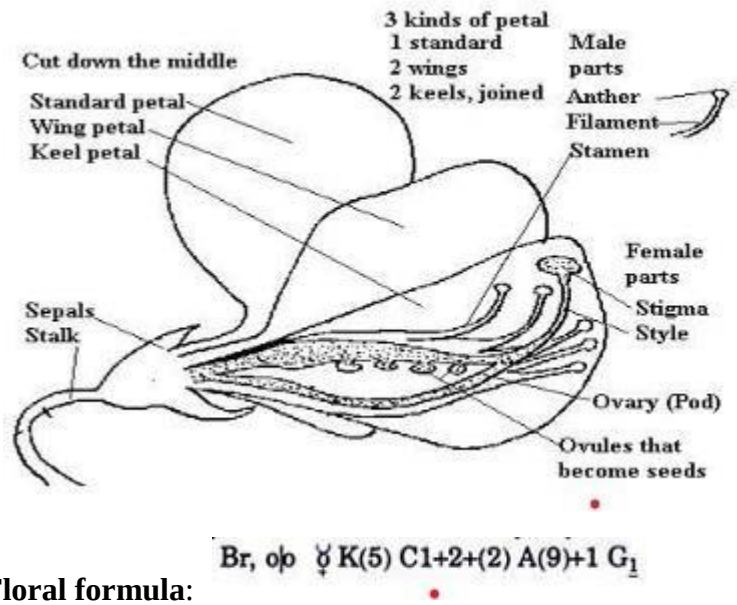
Calyx: Sepals 5, gamosepalous, pentapartite, companulate, odd sepal anterior, imbricate aestivation,green, hairy.

Corolla: Petals 5, polypetalous, papilionaceous, consisting of a large posterior petal – the vexillum or standard, two lateral alae or wings and two inner fused to form a boat shaped structure the keel or carnia, vexillary aestivation.

Androecium: Stamens 10, diadelphous, nine are fused by the lower halves of their filaments to form a tube round the ovary and tenth posterior one free, anthers basifixed, introrse, dithecous, enclosed in the keel.

Gynoecium: Monocarpellary, ovary superior, unilocular, hairy, elongated, laterally compressed, marginal placentation ovules many, style long, stigma hairy.

Fruit: Legume.



Floral formula: Br, o♭ ☿ K(5) C1+2+(2) A(9)+1 $G_{\underline{1}}$

Emasculation and Pollination: For emasculation, the flower bud chosen should have developed to the stage just before anther dehiscence, indicated by extension of petals beyond sepals. Flowers can be emasculated any time. The first step is emasculation is to tear away with the forceps the tip of the sepal from in front of the keel. The fore finger is positioned behind the flower and thumb in front and light pressure is applied. This spread the standard and wings to expose the keel. The exposed keel is slight open by tips of forceps. Pressure can be applied by the thumb and finger on keel for increased exposure of the pistil and stamens. The 10 stamens are pulled out.

Pollen can be obtained throughout the day, preferably from a freshly opened flower. For pollen collection, it is more convenient to pick the male flowers, remove the standard and wings, pull back the keel so that the style protrudes and use the pollen covered styler brush as an applicator to transfer the pollen to the stigma of the emasculated bud. Older flowers and other flower bud not used in crossing and removed the peduncle to increase the pod set after crossing.

Black Gram

To Study the Emasculation and Hybridization Techniques in Black gram

Common Name - Urd-Bean
Botanical Name – Vigna mungo
Family—Fabaceae
Number of Chromosomes -2n=22
Origin: India
Related species: Vigna radiata

Floral Biology: The inflorescence is axillary, any have 2-3 branches. There are e5-6 flowers clustered at the top of short hairy peduncle. bracteoles are linear to lanceolate and longer than calyx. Flowers are bisexual, papilionaceous, small. Calyx includes five sepals and calyx lobes are linear. Corolla (5 petals) is pale yellow. The standard petal is 12-16 mm wide. There are two wings petal is about as long as standard and two keel petals spirally coiled with a terminal horn like appendage. Stamens are diadelphous (9+1) and 10 in number.. Style is spirally twisted.

Flower morphology: Flowers begin to open between 6 to 7 am. Flower is continues for an hour. Flower is remain open till noon & gradually close, being completely closed by 2 to 4pm. Pollination accure at bud stage •Anthers dehisce between 9 pm to 3 am •Petals will shed in the following morning.

Selfing techniques:

(1)It is a self pollinated crop ,the occurrence of natural cross pollination is neglegible i.e less then 5% (2)Natural cross pollination is mainly by insects
(3) In order to ensures 100% selfing, bag the flower before anthesis.

Black gram is a self pollinated crop, there are two methods involved in crossing of black gram

(1) Emasculation
(2)Pollination
(i) Selection of flower bud
(ii) Flower bud should held between fore and thumb finger
(iii) Dissecting needle is inserted just under the standard obliquely along the top of the bud
(iv) The left side standard & left wing are pushed outward away from the bud
(v) The left keel is removed in pieces
(vi) Exposed anthers are removed.

Pollination :

Take out stamen from freshly opened flowers Rubbed anthers again set the stigma of the emasculated bud Pollination should be immediately after emasculation gives good pod set .

Self pollination occurs. 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. . 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.

Mung Bean

To Study the Floral biology,Emasculation and Hybridization Techniques in Mung-Bean:

Common Name – Mung Bean
Botanical Name – Vigna radiata
Family—Fabaceae or leguminosae
Number of Chromosomes -2n=22
Origin: India and Central Asia
Related species:*Vigna mungo*

Floral Biology :

It is an erect sub-erect deep rooted, much branched, somewhat hairy annual herb with the height ranging from 30-130 cm. Leaves are alternate, trifoliate, petiole long, stipules ovate, leaflets ovate upto 12x10 cm• Inflorescence: axillary or terminal raceme with 10-20 flowers crowded on long peduncle.

Flower: hermaphrodite, zygomorphic, either lighter yellowish olive/olive yellow . Flowers are in axilary racemes, peduncle up to 13 cm in length with clusters of 10 12 flowers, corolla yellow in colour sometimes curved, 5-10 cm long. The flower is typical papilionaceous with 5 sepals, 5 petals, 10 diadelphous (9+1 stamens), and monocarpellary ovary with hairy style.

Pods:Immature pods are usually green, mature pods are iron gray/olive gray/snuff brown color, round slander with short & moderate pubescence. Dehisces by both (dorsal & ventral) sutures into two halves. It contains 9-16 seeds .

Seeds: Globular, green, surface has fine wavy ridges. Hilum is white, more or less flat Germination is epigeal.

Anthesis: Self pollinated, sometime cleistogamy is prevalent Cross pollination is 0.5 3% Flower open between 6.00-8.00am, remain till about 11.00am. Close between 2.00-4.00pm.

Emasculation and Pollination:

Emasculation done at 4.00-6.00pm- For emasculation the young bud is keep between thumb & forefinger Point of dissecting needle is inserted, just under the standard in an oblique position along the top of the bud. The left side of standard & wing petal are pushed outwards & held with thumb The left hand of keel is removed in pieces with forceps Pistil & stigma are then exposed & removed with forceps. Pollination done in morning (8-11am): he staminal column having stamens and anthers intact is taken out from the freshly opened flower.collect mature anthers from open flowers & gently pressing the ripe anthers against stigma. Flower may be bagged after pollination until pods are matured. % of flower shed is very high -69% .

Cowpea

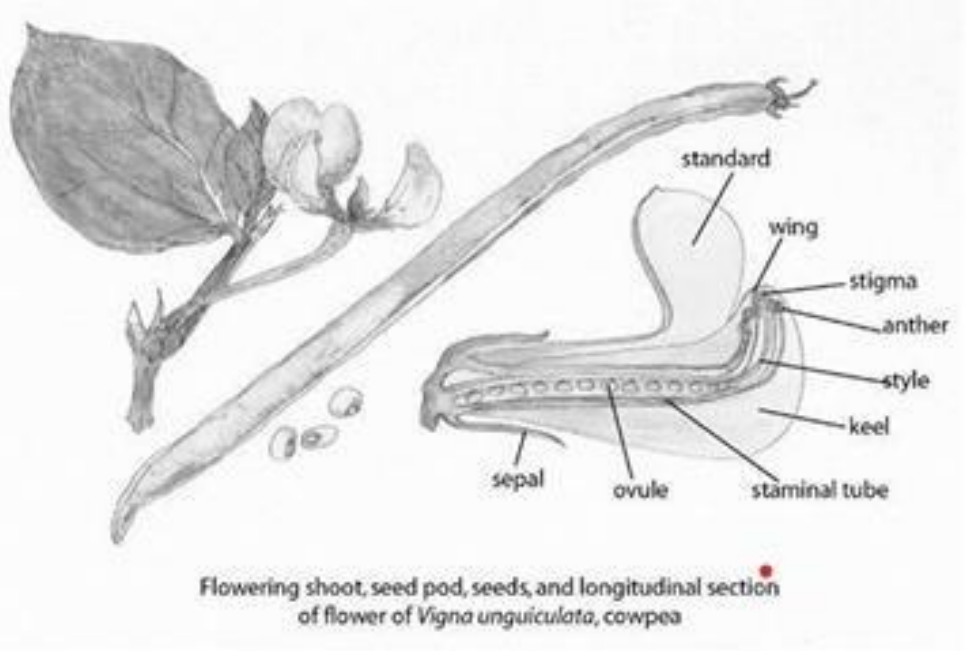
.To Study the Emasculation and Hybridization Techniques in COWPEA:

Botanical Name : Glycine max L.
Chromosome no.-(2n = 40),
Family – Fabaceae
Origin:China
Related species: G.sija,G.tabacina.,G.latifolia

Soybean has a typical papilionaceous flower with a tubular calyx of five unequal lobes. The corolla consists of posterior banner petal, two lateral wing petal, and two anterior keel petals. The keel petals touch each other, but are nor fused. The 10 stamens are in diadelphous pattern (9+1). The single pistil is unicarpellate and has one to four campylotropous ovules.
The style is about half the length of ovary and curves backwards towards the free posterior stamen.
The stigma is capitate. Hairs are present on the pistil and the outer surface of the calyx tube.

Inflorescence is unbranched axillary raceme bearing several flowers at terminal end of peduncle. The peduncle varies from 5 to 60 cm in length and are slightly twisted and ribbed. Calyx is longitudinally ribbed, tubular with 2-15 mm long sub equal lobes. The corolla is papilionaceous with an erect standard petal spreading at the time of flower opening. The pigmentation pattern of corolla varies from white to solid mauve with yellow spots near the base of the standard petal.

The wings are adherent to the boat shaped keel, enclosing the androecium. The stamens are diadelphous (9+1). Anthers are bright yellow.
Ovary is monocarpellary, unilocular with many ovules.



Flowering shoot, seed pod, seeds, and longitudinal section of flower of *Vigna unguiculata*, cowpea

Emasculation and pollination: Cowpea flowers are large and showy. Mostly flowers open between 7 and 9 am. Though the flowers open late in the morning, the dehiscence of anthers is much earlier. It may vary from 10 pm to 0.45 am. Since the dehiscence of anthers is much in advance of blooming the emasculation needs to be carried out in mature flower buds in the preceding evening. The bud likely to bloom the next day is selected for emasculation. The bud is held between thumb and forefinger with the keel side upper most. A needle is run along the ridge where the two edges of standard unite. One

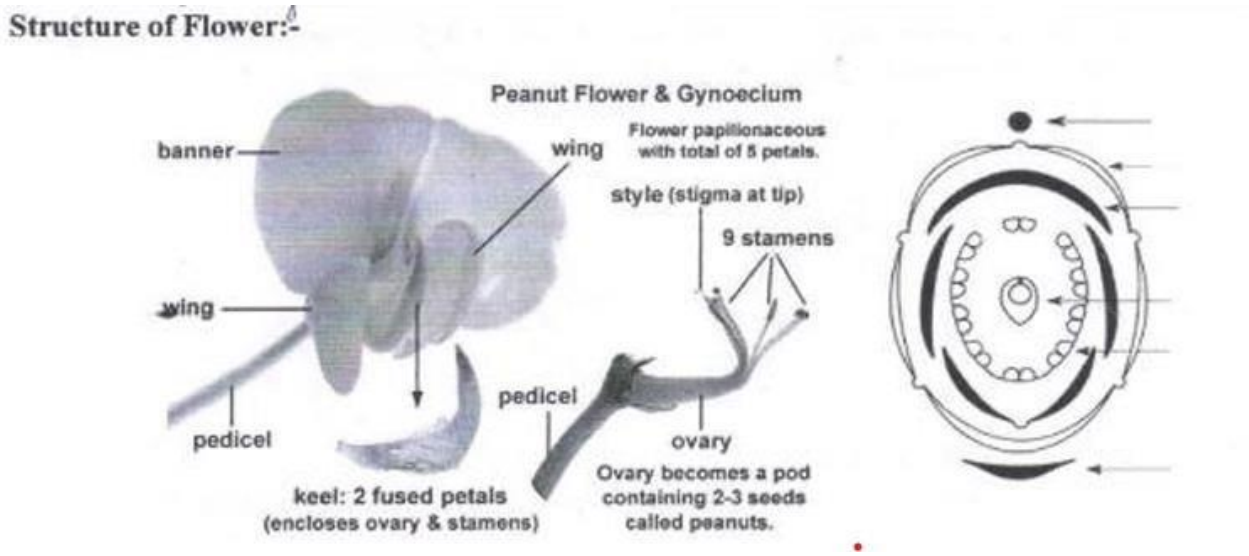
side of standard is brought down and secured in position with thumb. Same thing is done with one of the wings. After this, the exposed keel is slit on the exposed side about 1/16 inch of stigma. A section of keel is also brought down and secured in position under the end of thumb.

Now 10 stamens are seen. They are removed with pointed forceps. Pollination is done the next morning from a freshly opened flower. The standard and wing of male flower are removed. By slight depression of the keel stigma covered with pollen grains protrudes out. Open flowers are collected from male parent. Corolla is removed and the emasculated flower bud stigma is brushed with the anthers of male flowers whose corollas are already removed. In event of a successful pollination, pod is visible in about seven days.

Groundnut

To Study the Floral Biology, Emasculation and Hybridization Techniques in Groundnut.

Common Name – Groundnut
Botanical Name - Arachis hypogea
Family - Papilionaceae
Number of chromosomes - 2n = 14



Floral Biology:

It is an annual ,herbaceous legume which is adapted for cold climate.It is a self pollinated crop due to cleistogamy.Its flower emerges from leaf axis as a pair.Its flower has Vaxillary aestivation . Each flower contains 10 stamens. Carpels are enclosed within two petals.Hence these flowers always show self pollination.

Emasculation and Pollination technique:

Emasculation:Emasculation is done to prevent self pollination.First of all select a healthy floral bud.Mostly we select the inflorescence close to the surface.Now select the floral bud close to the stem.Use 1st or 2nd budon inflorescence.Floral bud must be used in pointed bud stage.Now remove sepals from selected floral buds.For this hold the floral buds by the uuse of thumb and 1st finger and carefully remove 2-3 sepals that cover the keel.Now separate and fold up the vaxillum and wings backward with the help of pointed end of forceps.Now make a cut within both keels with the help of forceps.Now press sepals at the base which result in separation of 9+1 stamens from the gynoecium.Now remove 10 stamens with the help of forceps.carefully that pollens donot burst out from the anthers .Style must remain unbroken .It can be bent ,delicate and broak easily.Now carefully join both keels and adjust vaxillum and wings in their previous position.

Bagging: We cover the floral buds by butter paper bag immediately after emasculation .

Pollination:If floral bud emasculated at morning time ,then pollination must be done in evening time of the same day.First of all select the male parent plant .Now select the freshly open flower and collect yellowish orange colour pollens and anther with the help of forceps or needles.Now remove the butter paper bag from eemasculated flower. And touch the end of forcep or needle with stigma.As a result some of the pollens are placed on stigma. Now reclose the both keels and recover the flower with butter paper bag.Now remove the nerrby flowers or buds by the use of scissors so that hybridized floral buds can grow and develop easily without mechanical barrier.Before changing the

pollen donor the needle or forcep must be deeped in 95% alchol to avoid any contamination.

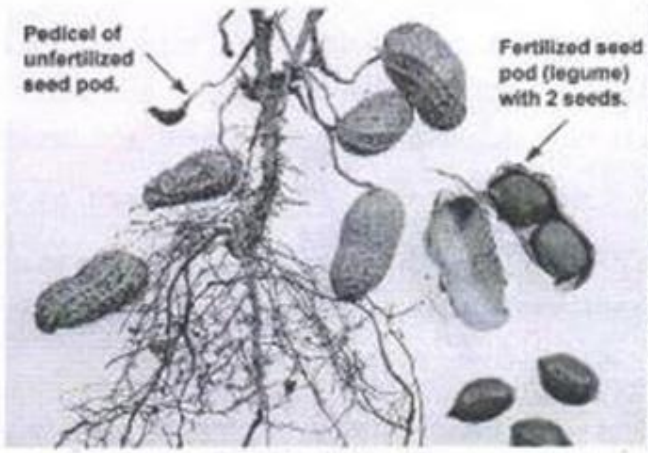
Tagging: All the information about hybridization experiment is write down on a piece of paper and bind it on the pedicel of hybridized floral buds.So that two hybridized floral buds can be identified easily.
Tag is a rectangular piece of paper size of 2*3 cm which carry following points.

1. Date of emasculation.
2. Plaant number plot number
3. Name of male and female parents.

Data collection:The following characters must be noted:

1. Effective nodes per plant
2. Effective pods per nodes
3. Total number of hybridized flower.

Seed collection:After hybridization the plant look afer till the maturity.Once pod get formed they procedes towards the maturation.Hand pick the matured legumes and collect their seeds.Now dryup and store these hybrid seeds.



Seed collection


Hybrid plants obtaining

SESAME

To Study the Floral Biology, Emasculation and Hybridization Techniques in sesame.
Botanical name :Sesamum indicum L.
Family:Pedaliaceae
Chromosome number: 2n=26
Origin: India
Related species: Sesamum radiatum, Sesamum alatum and Sesamum angustifolium.

Floral Characteristics

The flowers are complete, gamopetalous, zygomorphic and with a short stalk. The calyx has five fused sepals. One of the petals serves as a landing platform for the visiting insects. The tubular corolla is white, with a lobe upwards and the other downwards. The androceum is didynamous with four stamens, in pairs, one lower than the other, epipetalous, fused at the base of the upper lip of the corolla tube, and anthers longitudinal dehiscence. Anthers are yellowish and 1 mm in length. The pollen grain is yellowish; gynoecium is bicarpelar, with bilocular ovary and axile placentation. ovary is superior and green, and the style is filiform, ending in a bifid stigma.

Fruit:Loculicidal capsul,short beak

Seed:Small ,smooth,black or white.

Floral formula: ♂ K(5) C(5) A4 G(2)

Emasculation and pollination: The crop come to flowering 3-5 weeks after sowing. 2-3 flowers open in acropetal succession. Flower opening is between 5-8am. Anthers while growing starts bursting and start to dehisce between 2-4 am. Stigma became receptive at the same time as anther dehisce and remain receptive till 8 am. It is predominantly self-pollinated. Emasculation is done in the previous evening between 5-6 pm. It is done by just pulling out the corolla as such by holding it at the tip and protected by covering with paper bag. Pollination is done in the next morning.

Castor

Name of crop	:	Castor
Botanical name	:	*Ricinus communis* L.
Family	:	Euphorbiaceae
Chromosome number	:	2n = 4x = 20
Center of origin	:	Abyssinia (Ethiopia)
Mode of pollination		Cross polination
Out crossing percentage	:	5-46 %
Related wild species	:	*Ricinus perciens, Ricinus chinesis, Ricinus maxicanus*

Monoecious (M) flower

Pistillate flower

nterspersed staminate

Fig. 10.4 Sex revertent

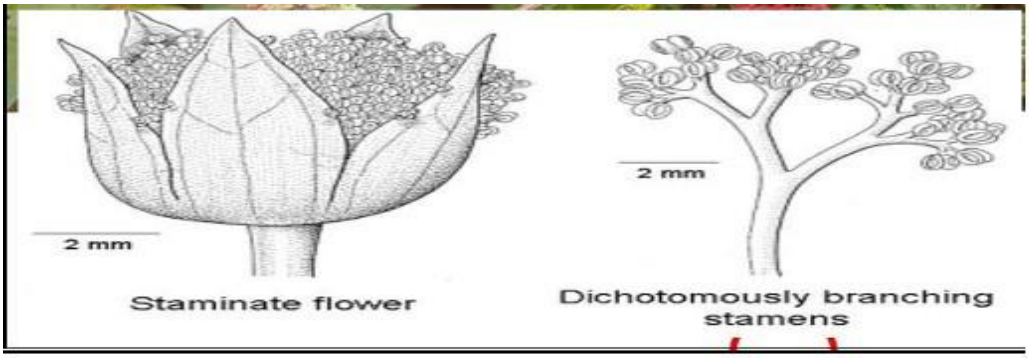


Fig. 10.5 Dichotomous branching: It means the branches form as a result of an equal division of a terminal bud (i.e., a bud formed at the apex of a stem) into two equal branches that are not derived from axillary buds.

EMASCULATION AND HYBRIDIZATION METHODS OF CASTOR;

Chromosome no:2n=202n=20

Castor is a cross pollinated crop, protogynous and wind pollinated. Leaves are large
palmately lobed. Inflorescences are borne terminally on the main and lateral branches.
INFLORESCENCE: The main stem ends in raceme, which is the first or primary raceme.After the first raceme appears, 2 or 3 branches arise at the nodes immediately below it. Each of these branches terminates in racemes after 4 or more nodes have formed which are known as secondary racemes. Branches arise from the nodes just beneath secondary racemes,ultimately terminating in tertiary racemes. This sequence of development (indeterminate growth habit) continues.The racemes of castor are monoecious with the pistillate flowers on the upper 30-50% and
staminate flowers on the lower part of the inflorescence. The proportion of pistillate and staminate flowers among the racemes varies a great deal both within and among genotypes. It is influenced by the environment of the plant, genotypes & nutrition.

Tobacco

TO STUDY ABOUT FLORAL BIOLOGY , EMASCULATION AND HYBRIDIZATION METHODS OF TOBACCO.

Botanical name : Nicotiana tabacum L.
Family : Solanaceae
Chromosome number : 2n=48
Origin : America
Related species: Nicotiana affinis, N acuminata, N.alata, N.attenuata, N.benthamiana.

Tobacco is normally self pollinated ,although as much as 4 to 10 % of cross pollination occurs from pollen carried by insects.Most of the tobacco varieties flower between 55-80 days after planting.

Floral characteristics

Inflorescence: Racemose;terminal or axillary raceme.
Flower : Complete,bisexual ,actinomorphic,hypogynous.
Calyx : Five sepals,gamosepalous,valvate aestivation.
Androecium: Five stamens,epipetalous;anthers basifixed.
Gynoecium: Syncarpous, bicarpellery, bilocular, superiorovary, axile placentation.
Fruit: Berry/capsule.
Seed: Numerous,endospermous

.

Floral formula and floral diagram:

⊕♀ K(5) C(5) A5 G(2),

Floral bioogy: The inflorescence of tobacco is a terminal raceme.The flowers are pedicellate and hermaphrodite .Calyx contain five sepals.Corolla contain five petals. The stamens are five in number. It has superior ovary. It is self pollinated crop but 4-10, of cross pollination occurs due to insects.There for it is groped into often cross pollinated crop. Pollens are viable for 24 hr. Stigma is receptive one day before and after flower opening.

Selfing technique:Covering entire inflorescence with paper bag will ensure the selfing technique.

Emasculation and Pollination.:Crossing technique:It involves emasculation followed by pollination.For emasculation select the unopened flowers with pink colour tip and anthers are removed with five pointed forceps after tearing petals .Collect the pollen grain from matured flowers and dust it on the emasculated flower .Bag the pollinated flower and then tag it.

COTTON

To study about floral Biology, Emasculation and hybridization technique.

Botanical name :Gossipium arboreum L.(Desi cotton)
Gossipium hirsutum L. (American cotton)
Family : Malvacea
Chromosome number : 2n=26,52
Origin : Gossipium arboretum-Asia (Old World)
Gossipium hirsutum-merica (New world)
Related species : G.anomalum, G.thurberii, G.tomentosum,

Floral characteristics

Inflorescence :Solitary in leaf axil,sometimes axillary cymose.

Flower:The flower are zygomorphic extra-axillary terminal and solitary.Each flower is subtended by involucres of usually 3 unequal leaf like bracts which may be free ,as in the case of American cotton or united as in the case of the Asiatic cotton.The flower is bisexual,complete,regular,pentamerous ,hypogynous and actinomorphic.

Epicalyx:The epicalyx consists of three persistent,modified leafy bracts.
Calyx:The calys has three persistant ,shallow cap like sepals with variable lobs.
Corolla:The Corolla is tubular and consists of 5 petals alternating with the calyx lobes.The petals may be white ,creamy white,light yellow or purple.

Androecium:The stamens are numerous and united to form a tubular sheath,which surrounds the pistil ,except for the exposed portion of the style and stigma.The stamens are monodelphous and epipetalous.

Gynoecium::The gynoecium consists of 3-5 carpels.Each carpel has a syncarpous style passing through the stamina tube.The ovary is 3-5 locular and the placentation is exile.

Floral bud:Floral bud isenclosed in and protected by ,three triangular bracts.The whole structure is called a “SQUARE” within the bud are the five petals of the corolla,wrapped tightly around one another.

Floral formula: Epi(3-8) ⊕ ♀ ♂ K(5) C5 A∞ G(5-∞)

Anthesis and pollination There is much variation in case of flower opening. Asiatic cottons open between 8 and 10 AM. American cottons open much earlier. Temperature affects the flower opening. After flower opening the cream yellow colour corolla turns pink within a day and later changes to red. The receptivity of the stigma is 8 to 10 AM.

C. Selfing

Cotton is an example for often cross pollinated crop. Selfing is done by sealing the flower bud by using thread, paper clips, wet clay or mud and other devices to prevent entry of insects responsible for cross pollination.

Selfing method

A mature flower bud is selected and the corolla is tied with a piece of thread. In order to keep the threads in position apply a bit of wet clay over the knot. This will avoid contamination of the stigmatic surface by foreign pollen.

Paper cover method

A small paper cover is put over the mature flower bud before anthesis and kept for 2-3 days.

D. Emasculation and crossing

Emasculation is done by removing the staminal column by giving a cut with thumb nail. Emasculation is done in the evening usually a day before flower opening. Immediately after emasculation the flower is covered with colour butter paper bag for easy identification next day morning.

Crossing

Doak's method

A mature flower bud is selected from which the corolla is removed and total staminal column is peeled off by making a narrow cut at the lower portion of flower bud. Care should be taken not to injure the ovary. Pollen from the male flower is dusted on the emasculated flower by rubbing the staminal column of the male parent. Immediately after pollination the flower is covered with white butter paper bag and proper labelling is also done. This method is known as Doak's method.

Soda straw method

The upper part of the corolla is removed from the mature flower bud by making a circular cut at the top. Then a small piece of soda straw is inserted over the stigma, so that the stigmatic region is separated from the anthers. The tip of the straw is bent to close the opening. Next morning a few mature anthers collected from the male parent are crushed and dropped into the soda

straw and cross pollination is effected. Alternatively, well matured male flower is taken to the emasculated flower and anthers are wiped over the stigma. Pollens from one flower is sufficient to pollinate four emasculated flowers. After crossing, cover the flowers with white cover.

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BRINJAL

To study the Floral biology, Emasculation and Hybridization techniques in Brinjal.

Botanical name:Solanum melongenaL.
Chromosome number:2n=24
Family :Solanaceae
Origin:Indo-Burma region
Related species: Solanum cerasiferum, Solanum incanum

Floral Biology:

Brinjal flowers are large, violet coloured and solitary or in clusters of two or more.
Flower consists of calyx: sepals 5, united, persistent;

Corolla: petals 5, united, usually cup shaped;

Androecium: stamens 5, alternate with corolla;

Gynoecium: carpels are united, ovary superior. The hypogynus gynoecium is syncarp located obliquely in relation to the median.

In most varieties the perfect flowers are borne singly and opposite the leaves. In brinjal, heterostyly is a common feature.

Four types of flowers have been reported depending on the length of styles, viz.

(i) long-styled with large ovary,
(ii) Medium-styled with medium size ovary,
(iii) Pseudoshort-styled with rudimentary ovary and
(iv) True short-styled with very rudimentary ovary.

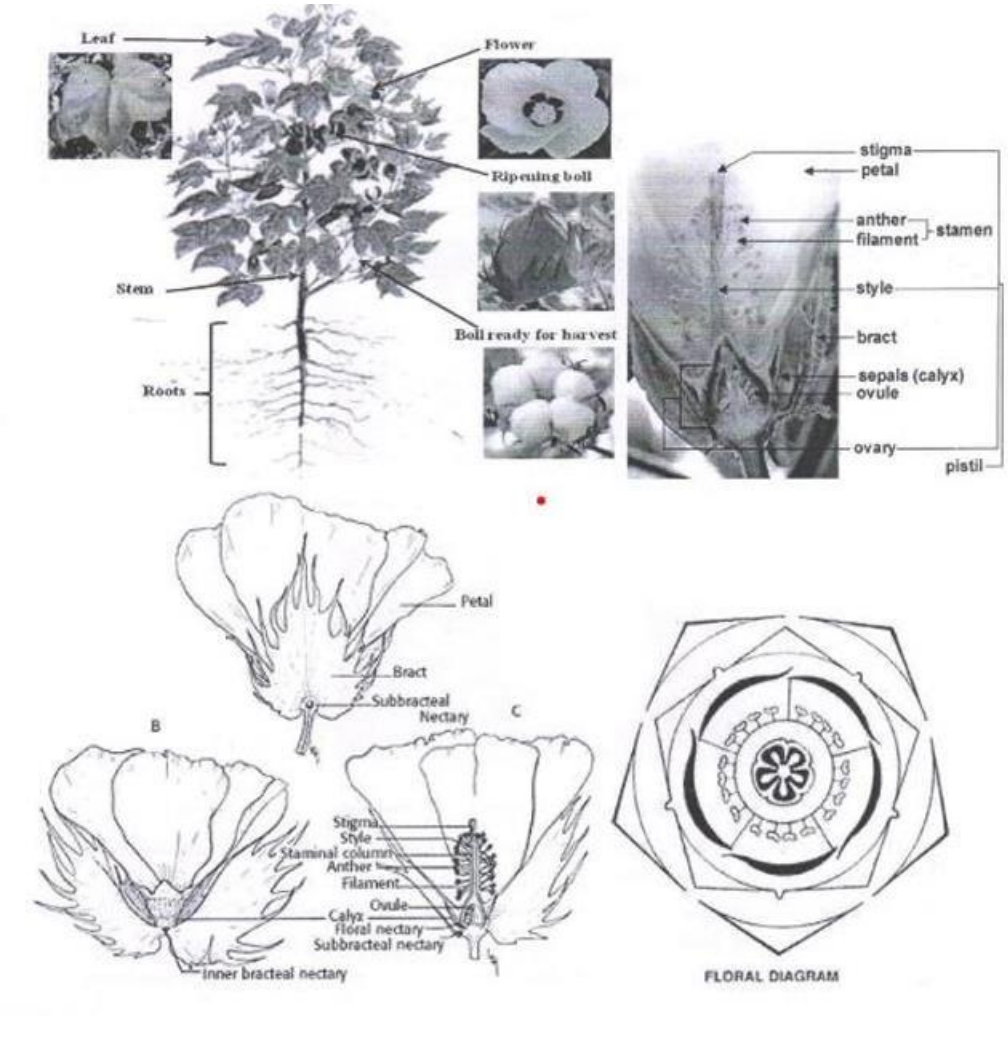
It has been reported that long and medium-styled flowers produce fruits whereas pseudo-short and short-styled flowers do not set any fruits. Further, chances of cross pollination are more in long style flowers. The percentage of long and medium styled flowers is a varietal character.

Fruit setting of long styled flowers varies from 70% to 86.7% in different varieties. In medium styled flowers, fruit set ranges from 12.5% to 55.6%.

All varieties have flowers with different style length. The position of the stigma in relation to stamens varies with the cultivars and can also vary in different flowers of same cultivar.

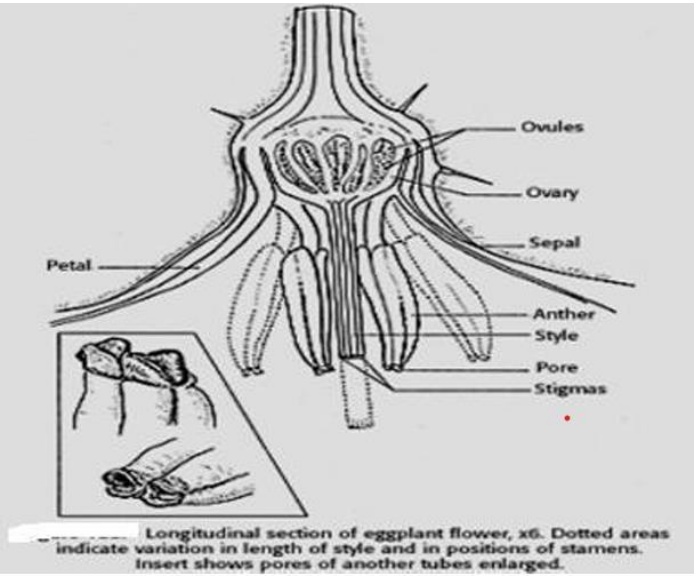
Stigmas are either found above, on the same level as or below the stamens and the highest percentage of fruit set is found where the stigma is above the stamens.
In short-styled flowers the androecium is fertile but the stigma is smaller with under developed papillae and lower sugar content than that in long-styled flowers.

There is no pollen germination on the stigma or penetration of pollen tube into short styles.



Emasculation and pollination: Flowers generally emerge 40-45 days after transplanting. The anthesis and dehiscence in brinjal are mainly influenced by

the daylight, temperature and humidity and therefore the exact timing for every area should be determined by observation and experience. Usually anthesis starts from 6 to 7.30 AM and continues up to 11 AM Peak time for anthesis is 8.30 to 10.30 AM The pollen dehiscence starts from 9.30 to 10 AM Stigma receptivity is highest during anthesis. The receptivity of the stigma could be observed from the plump and sticky appearance which gradually turns brown with the loss of receptivity. The stamens dehisce at the same time stigma is receptive so that self-pollination is a rule, although there is some cross pollination by insects also. The period of effective receptivity ranges from a day prior to flower opening. Pollen is most fertile immediately after the anther dehiscence. Pollen remains viable for a day. Opening of anthers is mostly by pore or slit at or near the apex. Repeated pollination and pollen from different plants increases both fruit and seed set. For emasculation, use sharp use sharp pointed forceps to force open the selected bud. Then slpit open the anthers and remove them. Collect the pollen from male parent during early morning hours and pollinate the stigma.



Longitudinal section of eggplant flower, x6. Dotted areas indicate variation in length of style and in positions of stamens. Insert shows pores of another tubes enlarged.

OKRA

Botanical name: Abelmoschus esculentus L.
Chromosome number: 2n=72
Family: Solanaceae
Centre of origin : Hindustan centre of origin
Related species: Abelmoschus longifolius, Abelmoschus officinalis, Abelmoschus tuburcutatus.

Floral biology:

The flowers are borne vertically, and its axillary and solitary, on a peduncle 2.0 – 2.5 cm long. The flowers are about 2 inches in diameter, with five white to yellow petals with a red or purple spot at the base of each petal. The flowers were almost actinomorphic. The perianth consisted of 5 sepals and 5 distinct petals. The androecium consisted of very many monadelphous stamens which bears filaments. The gynoecium was a single pistil consisting of several carpels, and a superior ovary. The calyx, corolla and stamens are fused together at the base and fell off as one piece after anthesis.

Emasculation and pollination:

flower buds are initiated at 22 26 days and the first flower opened 41-48 days after sowing. Once, initiated flowering continues for 40-60 days.

Anthesis was observed between 6 a.m. and 10 a.m. Anthers dehisce before flower opening, and hence self-pollination may occur at anthesis. The dehiscence of anthers is transverse and complete dehiscence occurs in 5-10 minutes. flower opening was initiated between the hours of 6:00am - 6:30am and closes between 11:30am -12:00 pm.

At anthesis, self-fertilization is far from complete and only a few ovules are then fertilized. Ovules continue to be fertilized during the morning and allogamy may be possible. The possibility of allogamy decreases rapidly and

a pollen grain deposited on the style after midday has no impact on progeny. In okra, stigmas are exposed to allow pollination at anthesis, and only anthers in the upper ring come into contact with stigmas.

Hand emasculation is done by giving a slight ring cut at the base. Remove the anthers with care and bag the flower. Pollen from freshly opened bud are collected in the morning and dusted directly on the emasculated stigma with the help of camel hair brush. Then cover the flower with butter paper.

PRACTICAL 2:

Aim: TO STUDY THE MAINTENANCE BREEDING OF FIELD CROPS.

Maintenance breeding deals with principles and method of breeder seed or nucleus seed production and maintenance. Breeding procedure followed to maintain the genetic purity of the variety or parents of hybrid.

Activities of plant Breeding

1. Varietal maintenance:It deals with continuous fresh supply annually of breeder seed which used to start another cyce of seed multiplication .
2. Seed multiplication:It deals with multiplication of successive generation of various categories of seed.It regulated by seed certification agencies and breeders.
3. Varietal development:It makes use of various plant breeding method to develop new variety.

Features of maintenance breeding

1. Continuous breeder seed production of released variety means fresh breeder seed production.
2. It also undertake breeder seed production of parental line of released variety.
3. Genetic purity,Physical purity and germination are main point taken into account.
4. Seed health also taken .
5. Breeder and foundation seed is use as base material for starting MBP.
6. It prevents varietal deterioration by mutation, cross pollination.

Maintenance of Nucleus and Breeder seed

Methods of maintaining nucleus and breeder seed can be divided into two groupds.

A. Maintenance of newly released varieties.
   a. Nucleus seed
   b. Breeder seed
B. Maintenance of established varieties.
   a. Breeder seed.

I . Maintenance of Nucleus seed of newly released variety.:-

i. Selection and sampling of the variety.

- Newly released variety are selected for nucleus seed production.These variety used as base material.
- These samples provide a beginning for purifying new varieties and for possible increase and distribution to farmaers.
- Not more than 15 new vvarieties in any one crop at a station should be sampled in one year .

ii. Table examination of samples

- Minimum 200plants should be threshed separately.
- And examined in piles on the table .Discard the off type.
- Left over seeds are now ready to be sown in a variety purification nursery called as nucleus.

iii . Locating and seedling of nucleus seed.

- Each nucleus seed should be grown in area in which this new variety is released in the event of its release.
- The land must not have had a crop of the same kind in the previous year.

IV . Inspection of nucleus seed plots and removal of off types:

- The nucleus plot should be examined critically from the seedling stage until maturity.
- Differences in the habit of early plant growth ,other traits,disease reaction shus should be critically examined.
- If a plot differs distinctly from the average in the pre-heading stage of growth,it should be removed before heading.

V . Harvesting and threshing of nucleus seed

- Each remaining plot,of which there should be at least 180 plant progeny out of the original 200 should be harvested individually with a sicle and tied in a bundle.
- The total bundles of each nucleus should be labeled and stored until the current years yield test for traits are obtained.
- Discard if found unworthy
- After threshing seed should cleaned in Fanning mill and placed in pile on seed table.Examine it for Uniformity of seed appearance ,Discard off type .Remain are bulk together and stored as breeder seed stock.

Maintenance of Breeder seed of newly released varieties:-

I . Selection of field:-

I . Breeder ‘s stock seeed from the nucleus should be sown on the clean ,fertile land ,which did not grow a crop of the same kind in the previous year.Space required for seeding breedr stock is about 1.2 ha in wheat and 3 ha. In transplanted rice..

ii. The fied should properly isolated.

iii. Agronomic practices:-

The best farm procedures shoud be used in the sowing,raising and harvesting of breeder's stock.

iv. Sowing:-Seeding done in such a way:

- Best use of the limited amount of seed available.
- Row spacing should be sufficient for examination of plant.

V . Sowing:- Seedling done in such a way:

- Best use of the limited amount of seed available,
- Row spacing should be sufficient for examination of plant.

Vi . Roguing:

All unworthy plants of the variety should be pulled and removed like diseased ,mechanical mixture etc.,The rouging shoud be done before flowering as well as after flowering for the nucleus/breeder's stock seed.

Vii . Harvesting the breeder 's stock:

- The equipment used must be cean and free seeds of any other varieties. This cleanli ness should be extended to cards and bags as well as threshing machine it self.the seed shoud now be about 99.9 percent pure as to variety.A portion of this breeder seeds should be retained by the breeders for the next cycle.Remaining distributed for F/S production.

Maintenance of Breeder seed of establishe released varieties:-

I. By raising the crop in Isolation:

The breeder's seed of local varieties could be maintained by growing them in isolated plots and by rouging during various stages of crop growth.

Method of handling of the breeder seed crop is same as breeder's seed of newly released varieties.

II. By bulk selection method

- In this method 2000-2500 plants typical of the variety are selected ,harvested ,and threshed separately.
- The seeds from each plant are examined and any pile which shows off –type are discarded.
- The remaining piles of seed are bulked to constitute the breeder's seed .The other practices of handling remain the same.

7. Carry-over seed:-
   - The breeder must carry at least enough seed to safeguaaard against the loss of variety if there is a complete failure during the foundation seed multiplication phase.
   - In addition ,the breeder should further safeguard variety by arranging ,to have a portion of the seed originally released stored under the ideal condition.

Maintenance of records and registers:

Crop improvement programmes are of long duration, conducted at more than one research station and involve the participation of scientific and supporting staff of several disciplines. The plant breeder has to observe and evaluate thousands of plants in several replications and multi locational trials every year. There will be numerous strains under each species.
A systematic record keeping of all breeding activities carried out over years and locations is necessary to provide individual identity to seed lots held in the store and the breeding plots in the field. Unless complete, simple, accurate

and easily retrievable record sare maintained, evaluation of the breeding material is impossible.

Most of the records kept at various stations are concerned with origin and pedigree of seed which are described below.

Origin of seed: Each seed lot of a breeding material has an origin. For example, an origin & depicted as Hyd.13K-4001 relates to the harvest of plot number4001 sown at Hyderabad station during Kharif season of year 2012. Standard abbreviations are used for each research station. Last two digits of the year denote the year. Crop seasons are Kharif (crop sown in April-July) Rabi (crop sown in October– December) and Zaid (spring) (Crops own in February–March) abbreviated to K, R &Z respectively. A set of plot numbers are used for each type of yield trial. Plot numbers used in one location in one crop season in a year are not duplicated elsewhere. These plot numbers of a plot, of a given location, become the origin of the following crop season. Seed lots harvested are tagged using this number.

Pedigree of seed

Pedigree of breeding materials describes its complete past breeding history.

It has two major components

i) Name of the parental variety in an abbreviated form
ii) Detailed breeding programme executed in each generation it was grown.

Following the name of the parental variety, a specific research station code may be added to identify the station where the breeding programme was initiated. The pedigree also provides information on the number of

generations of self-pollination, sib pollination or selection carried out. For example, the pedigree of an inbred line in maize depicted as ‘Cuba 11J–A46 denotes the following. The inbred line was derived from Cuba11J by self-pollination at Delhi center (Station code A). The 46th self-pollinated plant was selected which was later maintained by sib pollination for the next three generations.

Types of records:

1. Accession Register
2. Germplasm bank
3. Descriptive blank register
4. Cropping programme
5. Single plant selection register
6. Field Note books
7. Row test 8. Replicated row test
9. Preliminary/Initial yield evaluation trial
10. Comparative yield/yield evaluation trial
11. Multiplication I, II trials
12. Quality observations note book
13. Record of crosses
14. F1 generation
15. F2 segregation generation note book

There are different types of records such as accession record, project book, planting plan, planting list, record book for crosses and field book. The records have to be complete such that any new plant breeder on studying them can understand the entire breeding material available.

1. Accession record:

This is an important and continuing permanent record which provides information on all material received and tested. For every crop there is a separate crop-wise accession book. One line of each double page of the accession book is given to one variety. There are eight columns on each double page. These show accession number, name of variety, date of receiving material, source/origin of seed, source number and complete address of seed donor, pedigree record, seed description & remarks respectively.

Numbering or assigning an accession number starts with every year. Last two figures of the year (eg.13 for the year 2013) in which the variety was first recorded is subscribed to the previous identifying number. Proforma for accession register:

1	Accession number
2	Name /variety
3	Date of receipt
4	Source of seed
5	Source number
6	Pedigree record
7	Description of the material
8	How disposed and to whom sent
9	Feedback information
10	Remark

2. Project book / Basic record:

Every project is separately numbered and its name, objective, plan and duration are written on a specific page of the project book. It records the purpose and procedure of the complete breeding programme.

3. Breeding book: A separate breeding book is maintained in the research station for each crop season. It has planting plans or sowing plans for each experimental field giving location and other details. Planting plan is the elaborate plan of a breeding block or nursery which is made well in advance of the sowing time. Planting plan contains number of replications size of plots, row and planting distances, number of plants and location of check rows and check plots. Every row or plot in the

4. block can be identified by a row or plot number. Breeding book, in addition to sowing plan, lists the pedigree and origin of seed as well.

5. Planting list: Planting list or planting schedule contains the information regarding the location of varieties in different plots. It records sowing time, starting of germination etc. which is transferred to field note book afterwards.
6. Record diary for crosses: The detailed information regarding each cross is separately recorded under different heads. Name of the cross, objective, number of female heads used number of F1 seeds obtained, number of seeds sown and plants harvested in F1, F2 and advanced generations etc. is given. The criterion of selection is also mentioned.
7. Field book: Field books are permanent records made on standard notebooks. They are always taken to the yield by the plant breeder for recording daily observations. For yield tests, printed sheets containing column headings with important characters' row-wise may be bound together and used. Numbering and labelling the material

For numbering selections, crosses, introductions and mutants notations I, II, III and M respectively may be used.

I– 13-18
II– 13-1608
III- 3-4251
M- 13-5172

The first symbol denotes whether it is as election, cross, mutant etc. The second number denotes the year in which selection, cross etc. were

made. The third number indicates the number of the particular plant selected After emasculation & artificial cross pollination, the tag labelled on the female parent must read as follows.

No. of crossing
Name of female parent x Name of male parent
Date of emasculation
Date of pollination
Initials of breeder

A standard form of a field note book

Each field note book should contain the following information

A. Yield trials
1. First Page:
a. Number and title of the project
b. Season of raising the crop
c. Unit under which the trial is being conducted

2. Second page:
a. A full plan of the field showing the location of the trial with approach path
b. North /East direction should be specified

3. Third page:

a. Plan of the experiment

b. Experiment details

Name of the experiment

Season

Number of varieties

Design of the experiment

Replication

Size of the plot (Block/plot/row etc

Spacing (between rows and within the row in cm)

Date of sowing

Date of harvest

Name of the investigator

4. Fourth page:

a. Detail of cultural practices followed for the plot / field

b. Dates of ploughing

c. Date of layout of the trial 11 d. Date of layout of the trial e. Fertilizer schedule adopted Basal⎫ Top dressing⎫ Irrigation schedules with date, from life irrigation onwards⎫

5. Fifth page onwards: One page for each variant per replication is allotted. The following information have to be recorded in each page.

a) Date of germination

b) Date of gap filling

c) Initial stand on

d) Date of first flowering

e) Date of 50%l flowering
f) Date of harvest g) Final stand h) Wet weight of grain i) Wet weight of haulms/straw etc. j) Dry weight of produce after cleaning k) Yield per ha in kg The page will also have additional information on observations about the variant, recorded by the breeder in relation to the object of the project. The fifth page will also contain the following information and their modification depending upon the crop. eg. Rice –number of tillers, date of ear head emergence etc., Sesame-number of branches, days to first flowering etc..

B. Generation Study

This field note book will contain in addition to details as per A (i), (ii), (iii) and (iv) the third page will contain the following information.

a. Plan of the segregating generation
b. Details of the generation
1. Name of the generation⎫
2. Number of crosses⎫
3. Details of the cross number,
4. Details of parents,
5. Number of families,
6. Number of seeds sown
7. Length of row⎫
8. Spacing (cm)⎫
9. Date of sowing
10. Date of harvest
11. Name of the principle investigator

Practical – 3

Aim: Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods

1. Pedigree Method: Record of the ancestry of an individual selected plant for various generations is known as pedigree. A selection method, which is used in segregating population of self pollinated species and keeps proper record of plants and progeny selected in each generation is known as pedigree breeding. This method is widely used for the development of varieties in self-pollinated crops. In this method individual plants are selected till the progenies become homozygous. Selection for plants in the desired combination of characters is started in the F2 generation and continued in succeeding generations until genetic purity is reached. The method is as follows (Fig. 9):

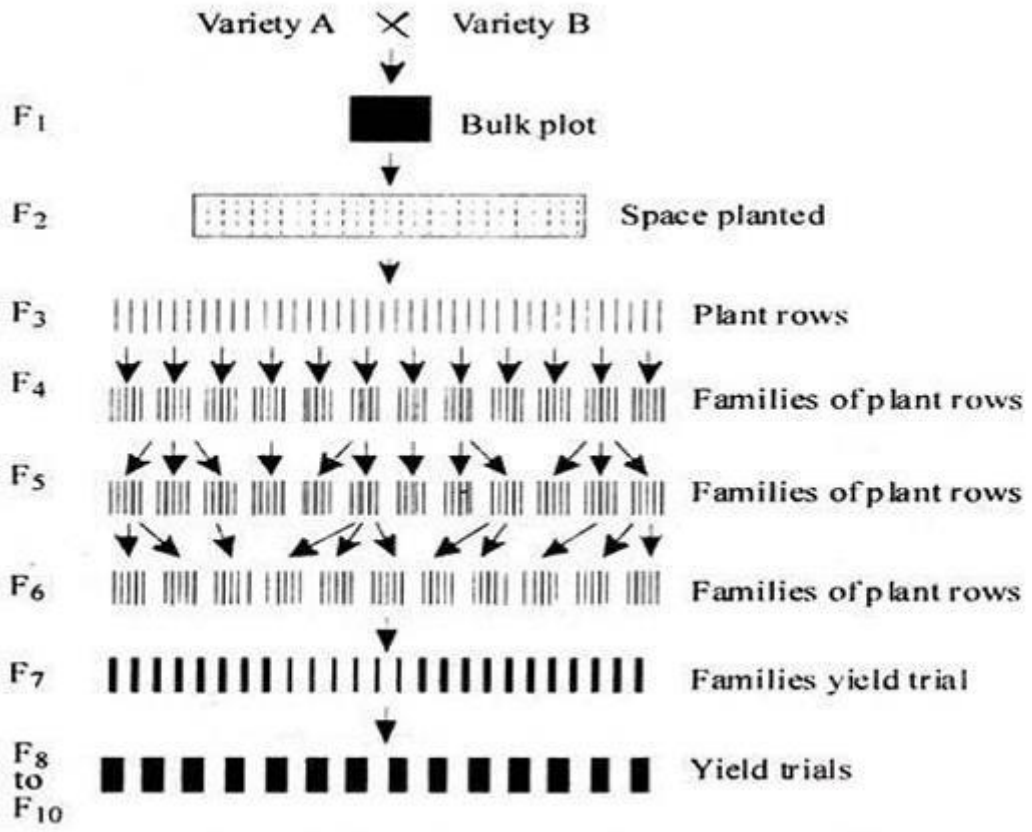


Fig. 9. Different steps involved in pedigree method.

I Year: Plants are chosen for hybridization and F1 seeds are produced.

II Year (F1 generation): F1 plants are space planted to produce maximum number of F2 seeds (see Fig. 9).

III Year (F2 generation): 2000-10000 F2 plants are space planted. About 200-500 desirable superior plants are selected.

IV Year (F3 generation): Selected superior plants in III year are space planted to study the individual plant. 3 to 5 best plants in these rows are selected and harvested (F4)

V Year and VI Year (F4, F5 generation): 28 Process is continued as in F3 generation. Normally 20-50 families may be retained at the end of F5 generation.

VII Year (F6 generation): Due to successive self-pollination most of the lines become homozygous and uniform. The plants uniform in desired characters are harvested and the seed, bulked together to constitute the variety.

VIII Year (F7 generation): Preliminary yield trials are conducted.

IX to XI year (F8 – F10 generation): Trials of superior lines are confirmed. During the testing period observations are made on height, tendency to lodge, maturity, disease resistance and quality.

XII to XIII Year (F10, F11 generation): Seeds are multiplied and distributed to the farmers.

Merits:

(i) It is the quickest method.
(ii) Plant breeders can also obtain the genetic information.
(iii) There are chances of recovering transgenic segregation by this method.

Demerits: Maintenance of accurate pedigree record is not easy. It takes much time. Selected material becomes so large that handling of the same becomes very difficult. Success of this method depends upon the skill of the breeder.

Mass pedigree method: It is a modified form of pedigree method in which segregating material is handled by bulk (mass) method when

conditions are unfavorable for selection and by pedigree method when conditions are favourable for selection.

2. Bulk Method or Breeding: A selection procedure which is used in segregating population of self-.pollinated species in which material is grown in bulk plot from F2to F5 with or without selection, next generation is grown from bulk seed and individual plant selection is practiced in F6 or later generations is called bulk method or breeding.

This method is also known as the mass or population method. Nilsson-Eule of Sweden was first to use the bulk method and it is in use ever since. This method differs from the pedigree method in that no selection is practiced in F2-F5 generations (Fig. 10).

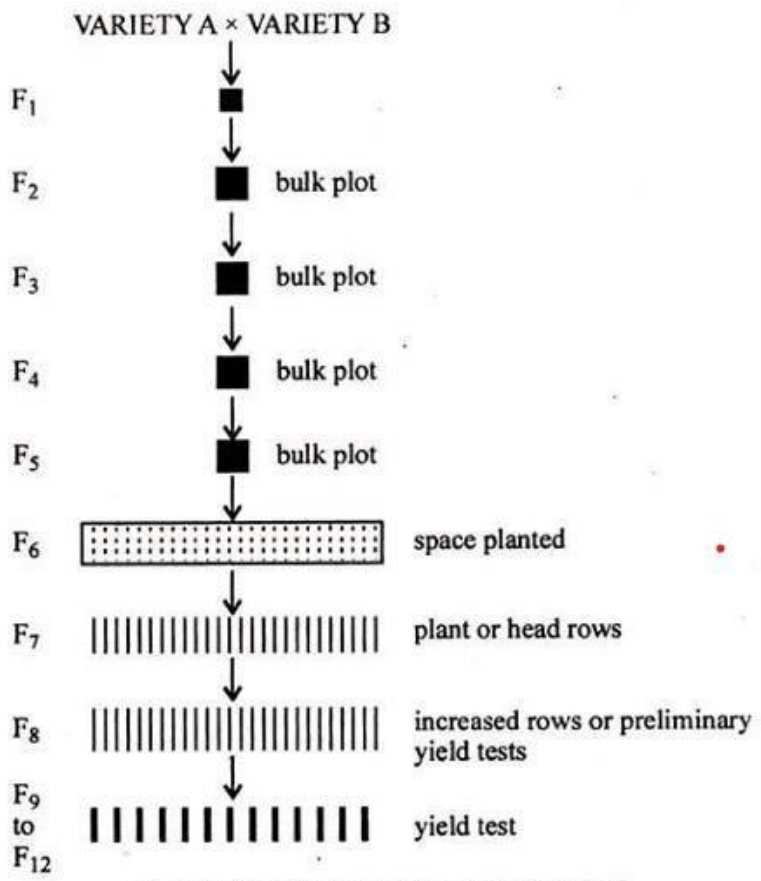


Fig. 10. Procedure of Bulk breeding method.

The method is as follows:

I Year: Plants are chosen for hybridization and F1 seeds are produced.

II Year (F1 generation): 50-100 F1 plants are grown and their F2 seeds are harvested in bulk,

III Year (F2 generation): F2 plants are grown and their F2 seeds are harvested in bulk.

IV Year (F3 generation): F3 plants are grown and their F4 seeds are harvested in bulk.

V Year (F4 generation): FA plants are grown and their F5 seeds are harvested in bulk.
VI Year (F5 generation): F5 plants are grown and their F6 seeds are harvested in bulk. (The process may be repeated until the desired period of homozygosity is achieved. In general bulk period is allowed up to F5 generation)
VII Year (F6 generation): Seeds are space planted and single plant selection is done (F7generation). VIII Year (F7 generation): The progeny of each single plant is grown separately and superior progeny are selected and isolated (F8).
IX Year (F8 generation): Preliminary yield test are conducted (F9).
X-XII Year (F9-F12 generations): Multi-locations field trials are carried out, best performing strain is multiplied for seed distribution.

Merits:

(i) The bulk method is simple, convenient, inexpensive and less labour consuming (no pedigree record is to be kept).
(ii) During early segregating generations, very little work and attention is needed, which gives the breeder more time to concentrate on other breeding projects.
(iii) Selection is done by nature only and it increases the frequency of superior types in the population.
(iv) This method is suitable for studies on the survival of genes and genotypes in populations.

Demerits:

(i) This method takes much longer time to develop a new variety.

(ii) The breeder is enable to exercise his skill and judgement in selection and therefore the method is less satisfying to him.

(iii) Information on the inheritance of characters cannot be obtained.

(iv) This method is totally dependent on natural selection to select the superior types. These types may not be necessarily the best yielding types.

3. Single Seed Descent Method: This method was suggested by Goulden (1939) for advancing segregating generation of self-pollinated crops. A breeding procedure used with segregating populations of self-pollinated species in which plants are advanced by single seeds from one generation to the next is referred to as single seed descent method. The procedure is as follows (Fig. 11):

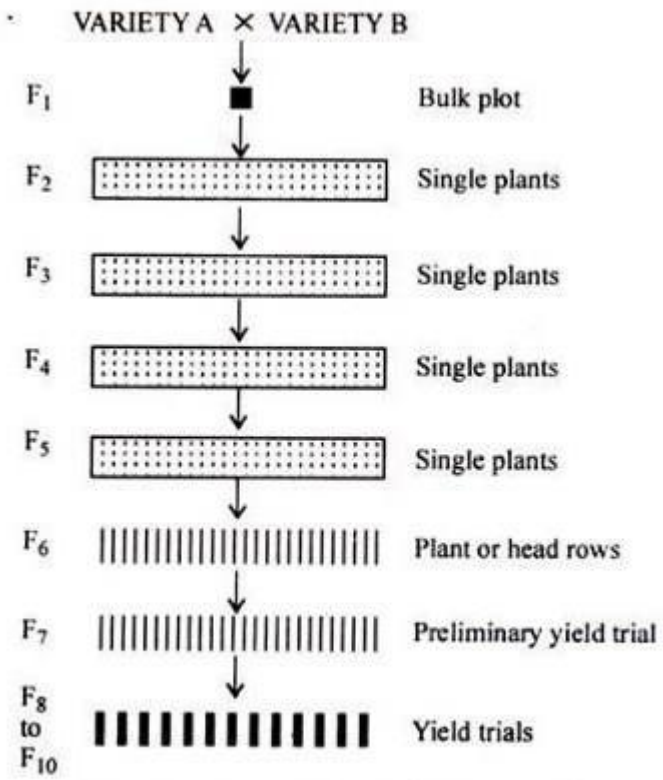


Fig. 11. Single seed-descent method of selection.

Practical -4

Aim: Study of field techniques for seed production and hybrid seeds production in Khaif crops

Guidelines for hybrid seed production in crops

Seed

Any plant part which is used for commercial multiplication of a crop is called seed. In strict sense, seed is the product of fertilized ovule that consists of embryo, seed coat and cotyledon(s).The seed of a released and popular variety produced by scientific method is referred to as improved seed or quality seed.

Variety

Variety refers to a genotype which has been released for commercial cultivation either by state or central variety released committee. Improved seed plays an important role in maximizing the production and productivity of field crops. This exercise deals with production of hybrid/parental seeds and seed standards for various classes in different crops.

The following steps should commonly be followed while seed production in any crop.

Selection of seed plot: Land should be free of volunteer plants, weeds, soil borne diseases and pests. Soil structure should be suitable to the crop grown for seed production. Soil should be fairly deep, fertile and well drained. While selecting seed plot, care should be taken to remove perennial plants from the field bunds and fencing. Avoid seed production in areas and situations which are not suitable or not recommended for cultivation of that crop variety.

Selection of seed or seed source:

Source of seed is the main factor for success of seed production. The seed should be selected of an appropriate class, e.g. Foundation seed for certified seed production. It should be procured from authentic/recognized agencies like SAUs, State Seed Corporation, etc. Ascertain the quality of source seed from the tag issued by the Seed Certification Agency. Preserve bill, seed label/tag and seed container until harvesting of the crop and receiving seed testing report from seed testing laboratory.

Isolation distance:

The minimum separation distance between two crops or crop species or between two varieties of same crop to avoid a chance of cross pollination is known as isolation distance. The main principle in any seed production is to control cross pollination. Controlling pollination involves restricting pollen movement from both, within and outside the population. The extent of cross pollination mainly depends on the direction and velocity of wind which is primary source of pollen contamination. Therefore, proper/required isolation distance should be kept to avoid the pollen contamination. Different crops have different isolation distance

Planting time, planting ratio and seed rate:

Adequate pollen source and synchrony in flowering between maleand female lines are very important for successful hybrid seed production. The crop should be planted as per recommended time of planting to avail adequate supply of male flower to pollinate female flower. Depending on the initial

moisture status and moisture holding capacity of soil, give one or two irrigation after sowing for seedling establishment for uniform plant stand. Seed rate and ratio of male: female lines should be maintained. It differs from crop to crop (Table 11.1).

Rouging: Rouging is vital step of seed production. This depends on genetic purity of sown seed. Seed producer must be familiar with diagnostic characters and some of the morphological traits of variety/parental lines for hybrids, used as guidelines in identification during rouging operation in seed plot. Time to time rouging should be done to remove unwanted, diseases affected, opened flower and dissimilar plants.
Generally rouging should be done at
1) before flowering time,
2) flowering time,
3) after flowering time and
4) at harvesting time.

Fertilizers: Recommended dose of fertilizers should be applied for raising good crop. Irrigations: Assured irrigation facility must be available for seed production plot. As and when required, irrigation should be given to harvest maximum seed yield from the crop grown for seed production. Plant protection measures: As and when required, recommended plant protection measures should be taken 37 to save the crop from the attack of insect, pest and diseases.

Harvesting, drying, threshing and storage: Harvesting is very important operation in seed production because more chances of mechanical mixture during this operation. Therefore, supervision on labours is very essential

during this operation. When crop reaches at physiological maturity, it should be harvested. Proper drying and threshing should be done. Seed should be stored at proper moisture content under dry and cool condition. (Table 11.2).

(A) Minimum field standards (for self and open pollinated varieties)

Crop	Class of seed	Minimum		Maximum permissible level percentage			
		Isolation distance (m)	No. of inspection	Off types	Inseparable other crop plants	Objection able weed plants	Plants/head affected by disease
Paddy	FS	3	2	0.05	-	0.01	-
	CS	3	2	0.20	-	0.02	-
Wheat	FS	3	2	0.05	0.01	-	0.10
	CS	3	2	0.20	0.05	-	0.50
Maize (OPV)	FS	400	2	1.0	-	-	-
	CS	200	2	1.0	-	-	-
Sorghum (OPV)	FS	200	3	0.05	-	-	0.05
	CS	100	3	0.10	-	-	0.10
Pearl millet	FS	400	3	0.05	-	-	0.05
	CS	200	3	0.10	-	-	0.10
Pegionpea	FS	200	2	0.10	-	-	-
	CS	100	2	0.20	-	-	-
Castor	FS	300	2	0.10	-	-	-
	CS	150	2	0.20	-	-	-
Groundnut	FS	3	2	0.10	-	-	-
	CS	3	2	0.20	-	-	-
Mustard	FS	50* 100	3	0.10	*For self compatible & self incompatible types, respectively		0.5
	CS	25*, 50	3	0.50	-	-	0.10
Cotton	FS	50	2	0.10	-	-	-
	CS	30	2	0.20	-	-	-
Maize	FS	400, 600*	4	0.20**	*Pollen shedding. **Seed borne disease (for hybrid)		

(B) Minimum field standards for hybrid varieties)

Crop	Class of seed	Minimum		Maximum permissible level percentage				Remarks
		Isolation distance (m)	No. of inspection	Off types	Inseparable other crop plants	Objectionable weed plants	Plants/ head affected by diseases	
Maize	CS	200. 300	4	0.50	-	-	1.0. 2.0	-
Sorghum	CS	200. 400	4	0.10	0.10	0.10	-	-
Pearl millet	FS	1000	4	0.5	0.05	0.05. 0.02	-	DM ergotted heads
	CS	200	4	0.10	0.10	1.0. 0.04**	-	
Cotton	FS	50	3	0.50	-	-	-	-
	CS	30	4	0.10	-	-	-	-
Castor	FS	300	4	0.50	Male 1.0	Female 1.0	Monocious plant	-
	CS	150	4	1.0	2.0	2.0	2.0	-

Table 11.2: The seed standards for different crops (Minimum seed standards for field crops)

Crop	Class of seed	Minimum					Maximum permissible limit						Remark
		Germination	Pure seed	Inert matter	Other crop seed	Weed seed	Objectionable weeds No/kg	Disease seeds (% by number)	ODV seeds No/kg	Moisture		Other as specified	
										Ordinary pack	Vapour proof pack		
Paddy	FS	80	98	2	10	10	2	0.10	10	13	8	2*	maximum husk less seeds %
	CS	80	98	2	20	20	5	0.05	20	13	8	2	OW: wild rice
Wheat	FS	85	98	2	10	10	2	0.05*	-	12	8	-	SBD: karnel bunt
	CS	85	98	2	20	20	5	0.25*	-	12	8	-	
Maize	FS	90	98	2	5	None	-	-	10	12	8	1.0*	Max. off type ears with off coloured kernels % after harvest.
OPV&Composite	CS	90	98	2	5	None	-	-	20	12	8	1.0*	
Inbred	FS	80	98	2	5	None	-	-	5	12	8	0.2*	
Hybrid	CS	90	98	2	10	None	-	-	10	12	8	0.5*	
Sorgum	FS	75	98	2	10	10	-	0.02*	-	12	8	-	Ergotted seeds scerotia
	CS	75	98	2	10	10	-	0.04*	20	12	8		
Bajra	FS	75	98	2	10	10	-	0.02*	-	12	8	-	Ergotted seeds scerotia
	CS	75	98	2	10	10	-	0.04*	-	12	8	-	
Pigionpea	CS	75	98	2	10	10			20	9	8		
Castor (variety)	FS	70	98	2	None	None	-	-	5	8	5	-	
	CS	70	98	2	"	"	-	-	10	8	5	-	
Hybrid	FS	70	98	2	"	"	-	-	5	8	5	95*	Genetic purity in grow out test
	CS	70	98	2	"	"	-	-	10	8	5	85*	
Ground nut	FS	70	96	4	"	"	-	-	-	9*	5*		For hard shelled kernels
	CS	70	96	4	"	"	-	-	-	9*	5*		For hard shelled kenels
Mustard	FS	85	97	3	10	10	5*	-	10	8	5		Argenomr mexicana.
	CS	85	97	3	20	20	20	10*	-	20	8	5	
Cotton (variety)	FS	65	98	2	5	5	-	-	-	10	6	-	

Practical -5

Aim: Estimation of heterosis, inbreeding depression and heritability

Heterosis : It may be defined as the superiority of F1,Hybrid over both its parents in terms of yield or some other characters. Heterosis or Hybrid vigour describes the superior performance of heterozygous hybrid individual compared with their homozygous parental inbred lines.

Methods for Estimation of Heterosis Heterosis is estimated in three different ways,

1. Mid parent heterosis
2. Better parent heterosis
3. Standard heterosis

1) Mid Parent heterosis

When the heterosis is estimated over the mid parent i.e. mean value or average of the two parents is known as mid parent heterosis. It is also known as average heterosis or relative heterosis and calculated by using formula.

$$\text{1) Relative heterosis–overmid parental value} = \frac{F1\text{-}MP}{MP} \times 100$$

Where $F1$ is the mean value of $F1$ and MP is the mean value of two parental involved in the cross.

2) Better Parent Heterosis: When the heterosis is estimated over the better parent is known as better parent heterosis. It is also known as heterobeltiosis and calculated by using formula:

$$\text{2) Heterobeltiosis–overbetterparent} = \frac{F1\text{-}BP}{BP} \times 100$$

Where BP is the mean value of the better parents of the particular cross.

The term heterobeltiosis was used by Bitzer et al (1968) to describe the improvement of heterozygote over the better parent of the cross.

1. Economic heterosis: It refers to the superiority of F1 over the standard commercial check variety.

$$\text{Economic/ useful heterosis–over commercial cultivar} = \frac{F1\text{-}CC}{CC} \times 100$$

Where CC is the mean value of the local commercial cultivar.

3) Standard Heterosis: It refers to the superiority of F1 over the standard commercial check variety. It is also called as economic heterosis or useful heterosis and calculated by using formula.

$$\text{Standard heterosis–overstandardhybrid variety} = \frac{F1\text{-}SH}{SH} \times 100$$

Where SH is the mean value of the standard (local commercial) hybrid.

Heterosis leads to increase in yield, reproductive ability, adaptability, disease and insect resistance, general vigour, quality etc. For most of the characters, the desirable heterosis is positive. But for some characters like earliness, height in cereals and toxic substances are negative heterosis.Among these heterosis Economic heterosis and Standard heterosis is useful to plant breeder.

Heritability:-Amount of phenotypic (observable) variation in a population that is attributable to individual genetic differnces.it is the ratio of variation due to differences between genotypes to the total phenotypic variation for a character or trait in a population.

a) Narrow sense heritability:-

$H^2 = V_A/V_P$

h^2 = heritability

VA = Additive variance

VP= Phenotypic variance

b}The broad sense heritability ,from different materials,is estimated in different ways .From replicated data of several genotypes,heritability is calculated as follows.

$h^2 = Vg/Vp$

h^2 = heritability

Vg = Genetic variance

VP= Phenotypic variance

Inbreeding depression

Inbreeding depression is the reduced biological fitness in a given population as a result of inbreeding, or breeding of related individuals. Population biological fitness refers to an organism's ability to survive and perpetuate its genetic material. Inbreeding depression is often the result of a population bottleneck. In general, the higher the genetic variation or gene poolwithin a breeding population, the less likely it is to suffer from inbreeding depression.

Inbreeding depression seems to be present in most groups of organisms, but varies across mating systems. Hermaphroditic species often exhibit lower degrees of inbreeding depression than outcrossing species, as repeated generations of selfing is thought to purge deleterious alleles from populations. For example, the outcrossing nematode (roundworm) Caenorhabditis remanei has been demonstrated to suffer severely from inbreeding depression, unlike its hermaphroditic relative C. elegans, which experiences outbreeding depression. be zero (meaning sterile or unviable offspring).

An example of inbreeding depression is shown to the right. In this case, a is the recessive allele which has negative effects. In order for the a phenotype to become active, the gene must end up as homozygous aa because in the geneotype Aa, the A takes dominance over the a and the a does not have any effect. Due to their reduced phenotypic expression and their consequent reduced selection, recessive genes are, more often than not, detrimental phenotypes by causing the organism to be less fit to its natural environment. Another mechanism responsible for inbreeding depression is the fitness advantage of heterozygosity, which is known as overdominance. This can lead to reduced fitness of a population with many homozygous genotypes, even if

they are not deleterious or recessive. Here, even the dominant alleles result in reduced fitness if present homozygously . Currently, it is not known which of the two mechanisms is more prevalent in nature.

For practical applications, e.g. in livestock breeding, the former is thought to be more significant – it may yield completely unviable offspring (meaning outright failure of a pedigree), while the latter can only result in relatively reduced fitness.

$$\text{Inbreeding depression} = \frac{F1 - F2}{F2} \times 100$$

Practical – 6

Aim: To study about the layout for field experiments.

Layout for Field Experiments

The basic objective of plant breeding is the ultimate crop improvement. It results in development of high yielding varieties hybrids etc., over the existing cultivars and so on. The performances of the new varieties are confirmed from the results obtained from the field experiments. To be explained scientifically the field experiments are laid out following certain rules and the data thus collected are analyzed statistically. The steps involved in this process are explained here under.

Any designing of experiments involves three major steps.

1. Selection of experimental units

The objects on which the treatments are applied is known as experimental units. Eg. Plots in the field, plant, etc.,

2. Fixing of treatments

The objects of comparison are known as treatments. Eg. Varieties, spacing etc.,

3. Arrangement of treatments in the experimental Units

It comprises of three basic principles of design

Replication: repetition of treatments

Randomization: unbiased allocation of treatments to the experimental units

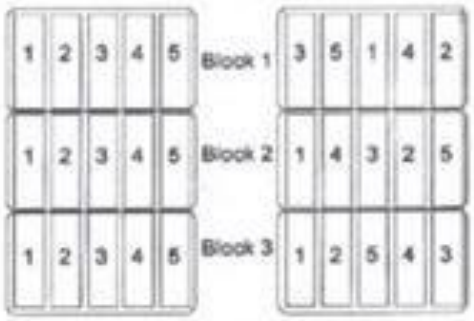


Fig. 1. Test plots on the left are not randomized. Plots on the right are randomized. The numbers (1-5) represent the five treatments in this test

Local control: minimizing the effect of heterogeneity of the experimental units

The objective of replication, randomization and local control is to minimize the Experimental Error (EE). EE is nothing but differences in the responses from the experimental unit to experimental unit under similar environments.Apart from these, EE can be reduced further by proper selection of the experimental units and choosing of most appropriate experimental design for a given number of treatment.

Types of basic experimental designs

1. Completely Randomized Design (CRD)

2. Randomized Block Design (RBD)

3. Latin Square Design (LSD)

Among these, RBD is the widely used design.

Laying Out of RBD

A. **The experimental material (field) is divided first into blocks** consisting of homogenous (uniform) experimental units. Each block is divided into number of treatments equal to the total number of treatments.

B. Randomization should be taken within each block and the treatments are applied following the random number table.

C. Collection and analysis of data: After the collection of data from the individual experimental unit (treatments) ANOVA (Analysis of Variance) table is formed.

The significance of the ANOVA table is that it indicates the sources of variation exhibited by the treatments, the magnitude of variation derived from different sources and their worthiness (significant/ non significant).

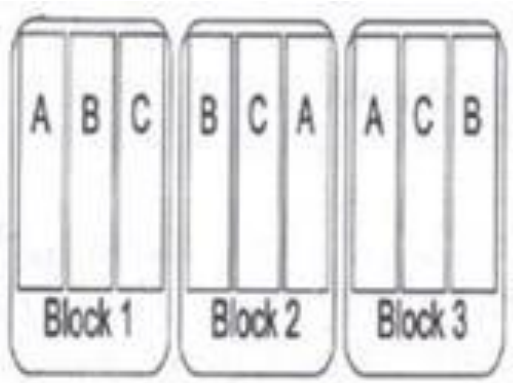


Fig. 2. An easy way to arrange blocks is to put them side by side across the field. Letters represent different treatments.

D. Computation of Critical Difference (CD)

Critical Difference is the difference between the treatment means, which places the treatments statistically as well as significantly apart. Otherwise if the difference of two treatments mean is less than CD it can be concluded both the treatments are on par.

RT : Row trial

Row trial is generally conducted in F3 and F4, when the seeds are not sufficient for replication with individual plant progeny rows. Each row consists of about 20 or more plants. Individual plants with desirable characteristics are selected from superior progeny rows. Pest, Disease and lodging susceptible progenies with undesirable characteristics are eliminated.

RRT – Replicated Row Trial

It is generally conducted from F3 generation onwards. Depending on availability of seeds, 3-4 more rows are grown for each progeny to facilitate

comparison among progenies adopting suitable replications. Families, which have become reasonably homozygous may be harvested in bulk. From those

families showing segregation, single plants are selected for characters under study. The breeder has to visually assess the yielding potential of progenies and reject the inferior ones in the field and the yield potential has to be assessed in the laboratory for confirmation.

PYT – Preliminary Yield Trial or Initial Yield Evaluation Trial (IYET)

It is conducted from F5 generation onwards. Preliminary yield trial with three or more replications are conduct to evaluated the comparative performance of the culture and to identity the superior cultures among them. The cultures are evaluated for plant height, lodging, pest and disease resistance, flowering time, duration and yield, etc., Quality tests may also be carried out. Standard commercial varieties must be included as checks for comparison. Ten to fifteen outstanding cultures, if superior to checks, would be advanced to the Advanced yield trails.

AYT – Advanced Yield Trial

Advanced Yield Trial is conducted from F8 generation on wards. The superior cultures identified from Preliminary Yield Trial are tested in Replicated Yield Trial. In this trial, the cultures are evaluated for yield, pest, disease and lodging resistance, duration, quality, etc.

MLT - Multi Location Trial

Multi location trial is conducted from F13 onwards for 3 years by the

Research Station Scientists. Multi Location Trial are useful for suitability studies i.e. whether a particular culture is able to perform well in all the locations or not and whether the particular culture out yields all the other cultures developed by research stations and the check variety evaluated simultaneously. Based on the evaluation, superior and stable performing culture will be promoted to ART.

ART – Adaptive Research Trial

It is conducted after MLT for 3 years by the Department of Agriculture. Nearly 3-4 cultures are tested and based on the performance of 3 Years in the farmers field, the best culture over the check may be proposed to SVRC (State Variety Release Committee) for releasing.

If the SVRC finds that the cultivar is suitable for any particular area or through out the state, then the variety is released and is notified by the State Department of Agriculture.

Practical –7

Aim: Study of quality characters, study of donor parents for different characters.

COMMON NAME	SCIENTIFIC NAME	CHARACTER NO.	QUALITY CHARACTERS
Rice	*Oriyza sativa*	2n=24	• Grain size and shape • Texture of endosperm • Quality of starch in endosperm • Aroma and cooling quality • Milling out form
Wheat	*Triticum aestivum*	2n=14 2n=28 2n=24	• Glutamin content • Dough • Flour quality • Water holding capacity of humus
Maize	*Zea mays*	2n=20	• Protein content • Protein in grain is 20% balanced one
Pegion pea	*Cajanus caja*	2n=22	• Protein content(23%)
Soyabean	*Glysine max*	2n=20	• Protein content(42-45%)
Green gram	*Vigna radiata*	2n=22	• Methionine (high)
Black gram	*Vigna mungo*	2n=22	• Protein content (24-27%) • Methionine
Ground nut	*Arachis hypogeae*	2n=20	• Protrin content(45-55%) • High oil content • Kernel • High selfing
Sesamum	*Sesamum indicum*	2n=42	• High oil content
Sunflower	*Helianthus annus*	2n=34	• High oil content (46-54%)
Mustard	*Brassica compestris*	2n=20	• High oil content (40-45%) • Protein content (30-41%)
Chili	*Capsicum annum*	2n=24	• Fruit length • Ascorbic acid content • Capsacino content
Okra	*Ablmoscnus esculentus*	2n=130	• Pod length, seed / pod test weight
Cucumber	*Cucumis sativa*	2n=14	• Shape of fruit firmness of fruits
Chrysanthemum	*Chrysanthemum monifolium*	2n=13	• Flowering quality, average flower weight, flower diameter

Gerbera	*Gerbera*	2n=50	• Colour of flower leaf and leaf area no. of flowers/plant shelf life of flowers buckers production capacity
Mango	*Mangifera indica*	2n=40	• Self life of fruit high ascorbic acid %
Guava	*Psidium guajava*	2n=22	• Colour, flower, texture, taste of fruit
Rose	*Rosa sp*	2n=14	• Large flower bud maximum bud diameter, no. of petals/flowers
Papaya	*Carica papaya*	2n=18	• TSS, pH, ascorbic acid
Banana	*Musa sp*	2n=22	• Fresh appearance of ------ fruit self like, shape of fruit at---- pedicel
Tomato	*Solanum lycopersicum Lycopersicum esculantum*	2n=24	• Fruit uniformity

Practical -8

Aim:Visit to seed production plots

Practical -9

Aim:Visit to AICRP plots of different field crops.