PRACTICAL MANUAL

on

SEED PRODUCTION OF VEGETABLE CROPS

Course No. HVS-508; Credit Hrs. 3(2+1)
For

M.Sc. (Horticulture) Vegetable Science

Ist-year (2nd Semester)

Dr. Saurabh Singh
Dr. Arjun Lal Ola
Dr. Devesh Tiwari

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Department of Vegetable Science

College of Horticulture and Forestry
Rani Lakshmi Bai Central Agricultural University
Jhansi-284003

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CONTENT

Experiment No. 1

Objective: To study about floral biology in vegetable crops (Tomato)

Botanical Name: *Solanum lycopersicum* L.

Chromosome No.: 24

Family: Solanaceae

Inflorescence: Axillary or terminal condensed cymes.

Flower: Pedicellate, bracteate, hermaphrodite, complete, actinomorphic, pentamerous, hypogynous.

Calyx: Sepals 5, gamosepalous, campanulate, sepals free above and fused below, green, hairy, imbricate aestivation, inferior.

Corolla: Petals 5, gamopetalous, campanulate, tube hairy, twisted aestivation, inferior.

Androecium: Stamens 5, polyandrous, epipetalous, alternating with the petals, filaments long, anthers basifixed, dithecous, introrse.

Gynoecium: Bicarpellary, syncarpous, ovary superior, obliquely placed, bilocular; swollen axile placentation; ovules many; style long, slightly, twisted, stigma capitate, bilobed.

Floral formula:

$$\mathbf{Br} \oplus \text{☿} \quad \mathbf{K}_{(5)}\, \overset{\frown}{\mathbf{C}_{(5)}}\, \mathbf{A}_{5}\, \underline{\mathbf{G}_{(2)}}.$$

Emasculation and pollination

Emasculation is usually done one day prior to anthesis/flower opening. At this stage, the sepals have started to separate and the anthers and corolla is beginning to change from light to dark yellow. The stigma is fully receptive at this stage allowing for pollination even immediately after emasculation. Anthers are removed as a group with or without the surrounding corolla, by inserting forceps between the sepals to grip the base of the anthers and / or petals which are then removed by a firm but steady pull. If anthers seem reluctant to part company from flower receptacle as a group, it is advisable to remove a single one first by careful manipulation of the forceps. Following this, the remaining four may be gripped firmly without any fear of damaging the style. Pollen is best applied in experimental crosses by slitting the inside of the anthers of mature flowers of the male parent with the forceps in such a way that a small amount of pollen is collected at the tip of the forceps. This can then be lightly applied to the stigmatic surface and should be visible as a white covering. Forceps should be sterilized by dipping in alcohol or methylated spirit after each pollination. Pollen may be collected in large amounts by inverting the mature flower and tapping pollen into the thumbnail (Watts, 1980). Protection of pollinated flowers by wrapping with cotton or small pollination bags is essential.

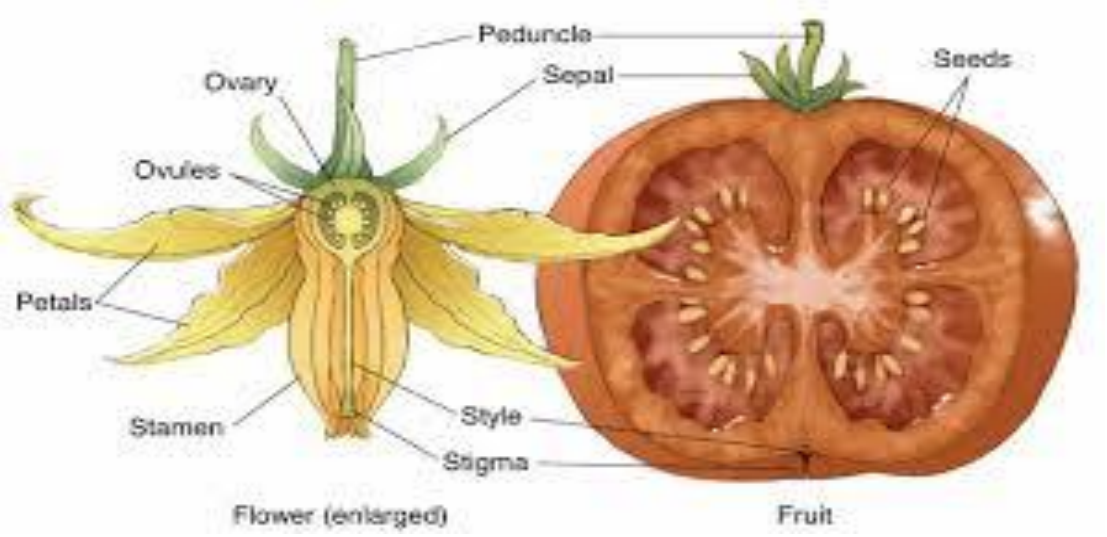
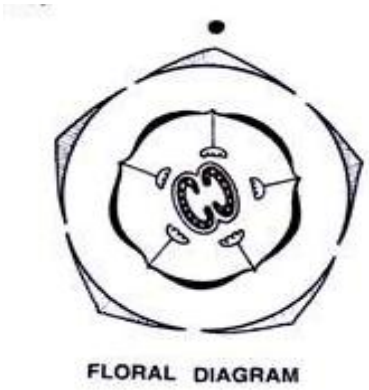


Fig.: Flower structure of tomato.



Exercise

Floral Biology of Chilli

Chromosome numbers:……

Botanical name: ……

Family: ……..

Floral biology of chilli

Emasculation and pollination procedure in chilli

Experiment No. 2

Objective: To study about floral biology of eggplant

Botanical Name: ……. .

Chromosome No.: ……

Family: ……..

Brinjal belongs to the family Solanaceae and is known under the botanical name *Solanum melongena* L. The family contains 75 genera and over 2000 species, out of which, about 150-200 are tuber bearing and belong to section Tuberarium. The majority of species (about 1800) are non tuber bearing. Cytologica studies have indicated that basic chromosomal number 2n = 24 is same in almost all the varieties and species.

The common brinjal, to which large, round or eggshaped fruited forms belong, are grouped under var. *esculentum*. The long, slender types are included under var. *serpentinum* and the dwarf brinjal plants are put under var. *depressum.*

Growth and Development:

Brinjal seeds germinate one to two weeks after sowing. Seedlings grown in containers are ideal because they allow field planting without disturbing the root system. A main stem with 6-10 leaves develop before the appearance of first flower. Depending on whether the sowing period corresponds to more or less favourable agro-climatic conditions, the first flower appears one and a half to three months after sowing. At the level of each flower, there is dichotomous branching that grows more or less regularly, depending on the species and variety. The sympodia generally consist of two leaves and the axillary bud of the leaf below each flower frequently gives rise to a new branch. Growth and flowering are continuous throughout the life of the plant.

Floral biology:

Emasculation and pollination procedure in eggplant

Flower types in eggplant:

Long styled:

Medium styled

Pseudo short styled

True short styled

Floral diagram of brinjal:

Experiment No. 3

Objective: To study about floral biology of cole crops (Cabbage)

Botanical Name: ……. .

Chromosome No.: ……

Family: ……..

Floral biology: All the cole crops have evolved from common ancestor wild cabbage (*B. oleracea* var. *sylvestris* L.) (Fig. 1). A cabbage flower has four sepals, four petals, six stamens in tetradynamous condition (two short and four long stamens) and a bicarpellary ovary which is superior and has a false septum. Ovules are attached on both the side of septum. Two active nectarines are located between the bases of short stamens and ovary. The buds open under pressure of rapidly growing petals and become fully expanded in about 12 hrs. Flowers are slightly protogynous and cabbage is naturally cross pollinated due to sporophytic self-incompatibility. Pollination is brought about by bees and flies. Bud pollination is effective to achieve selfing. For cross-pollination flower buds expected to open within 1-2 days are emasculated and are pollinated immediately with desired pollen using a brush/ flower stamens.

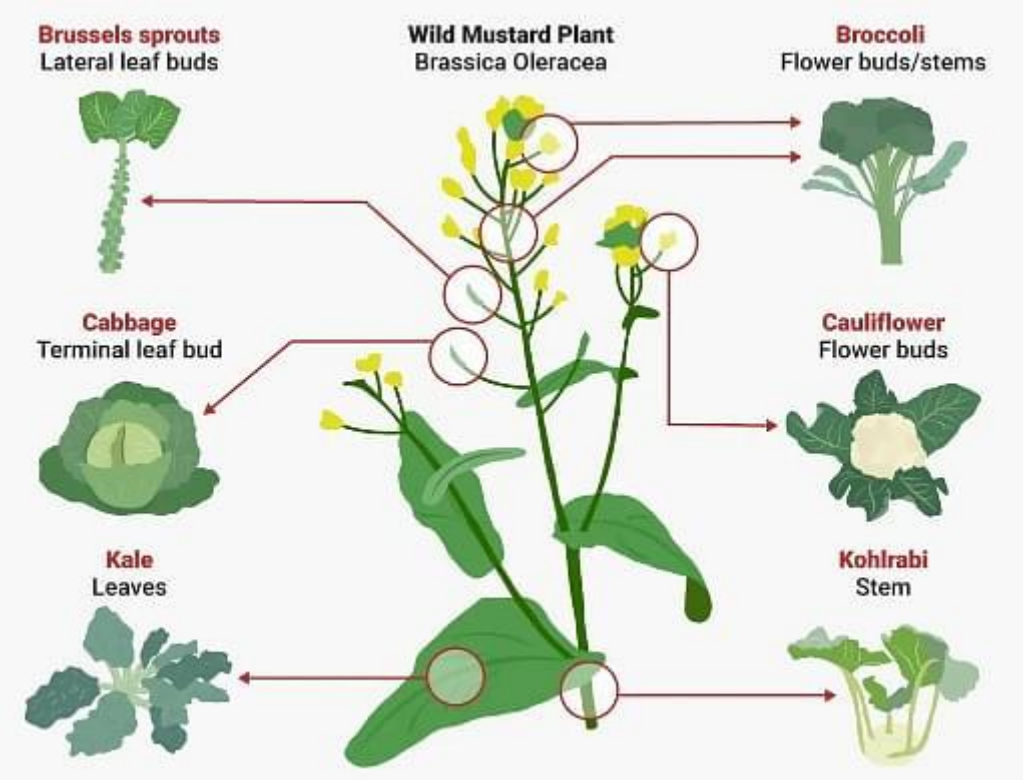


Figure 1: Evolution of cole crops

The shape of the cabbage head can be classified in three groups:

Ballhead (round head). This is most common type. It has a round 6-7 in. (15-17 cm) in diameter. It has smooth white-veined leaves forming firm head.

Conical head (oxheart, sugar loaf). This type has a smaller pointed head.

Drumhead. This type has large flat head.

Examples of cabbage varieties based on head shape:

Round headed:

Conical head:

Drum head:

Bud pollination:

Special consideration for F1 hybrids production plots:

Experiment No. 4

Objective: To study about floral biology of carrot

Botanical Name: ……. .

Chromosome No.: ……

Family: ……..

Floral biology:

The inflorescence of carrot is a compound umbel. A primary umbel can have over 1000 flowers at maturity, whereas secondary, tertiary and quaternary umbels bear fewer flowers. Floral development is centripetal i.e. the flowers to dehisce first are on the outer edges of the outer umbellets. Carrot is protandrous. After straightening of filament, the pollen is shed and stamens quickly fall. After this, the petals open fully and the style elongates. The style is divided into two parts. The petals of petaloid plants are persistent unlike those of brown-anther, male sterile plants. Flowers are epigynous. There are five small sepals, five petals, five stamens and two carpels. Emasculation is laborious and time consuming. As soon as the first bud in an umbel opens, the whole umbel of the female parent is bagged in a muslin/cloth bag. The flowers are removed daily until peak flowering has reached. Anthers are removed from the early opening outer flowers in the outer whorl of umbellets until sufficient flowers are emasculated.

Unopened central florets in the emasculated umbellets and all late flowering umbellets are removed. Thus, only the emasculated flowers are left on the female inflorescence inside the bag. A pollen bearing umbel from previously protected male plant is inserted into the bag of the female parent along with some house-flies to ensure pollination. Daily for a few days in the morning, the male umbel is gently rubbed against the emasculated umbel to enhance artificial cross-pollination.

Sometimes, 1-2 flowering umbels of both the parents are enclosed in the same cloth cage along with some house-flies. Seed from each parent is sown in adjacent rows. The hybrids and the parents could be identified (not always) and necessary roguing done to remove the selfed plants.

Types of Male sterility in carrot

Hybrid seed production procedure in carrot using pt-CMS system

Floral diagram of carrot

Experiment No. 5

Objective: To study about floral biology of radish

Botanical Name: …… .

Chromosome No.: ……

Family: ……..

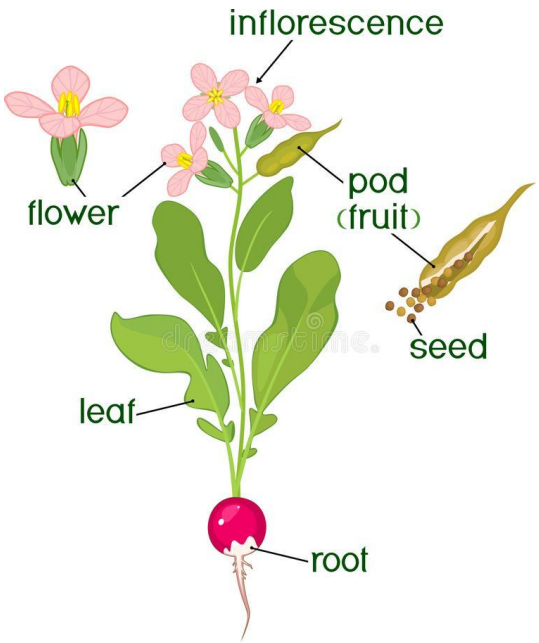
Floral biology:

The edible portion of radish develops from the primary root and hypocotyl the inflorescence is a typical terminal receme of cruciferae. The flowers are small, usually white in colour, sepals (four) are erect and petals (four) are clawed. Radish is cross pollinated due to sporophytic system of self- incompatibility. It shows considerable in breeding depression on selfing. It is entomophilous. It is pollinated mainly by wild honey bees and wild- flower flies. Stigma receptivity is maintained upto four days after anthesis.

Selfing: Selfing can be accomplished by bud-pollination. The flower buds are pollinated two days prior to opening by their own pollen be applying fresh pollen from previously bagged flowers of the same plant. Emasculation is not necessary in bud-pollination. After pollination, the buds are to be protected from foreign pollen by enclosing the particular branch bearing those buds in a muslin cloth bag.

Crossing: In crossing the same technique is used as in bud-pollination except that in the crossing, the buds of the female parent are emasculated a day prior to opening and are pollinated by pollen collected from the flowers of the male parent which were also bagged before opening. The artificial pollination is done by hand by shaking the pollen over the stigma directly from the freshly opened but previously bagged buds of male parent.

Draw the Floral diagram of radish:



Exercise: Root to seed method of seed production in radish

Experiment No. 6

Objective: To study about floral biology of beetroot

Botanical Name: ……. .

Chromosome No.: ……

Family: ……..

The earliest form of domesticated beet was leaf beet. The leaves were eaten and the roots were used for medical purposes only. According to Campbell (1979), this species is believed to have originated from *Beta maritima*, known as sea-beet which is indigenous to Southern Europe. The beetroot is closely related to sugar beet, with which it is cross-compatible. It has the almost unique characteristic (in the vegetable kingdom) of being wind-pollinated like its related species spinach, and is therefore a very prolific pollen producer. It belongs to family Chinopodiaceae. Garden beet is a biennial producing enlarged hypocotyl (roots) and a rossette of leaves in first year and flowers and seed in second year. Enlargement of hypocotyl is due to growth of several concentric vascular cambia which comprise the rings of beet.

Floral biology

It requires cold temperature (4-10°C) treatment for 2 weeks or longer for flower induction. The inflorescence is a large spike. The flowers are small, inconspicuous without corolla, but with green calyx which becomes thicker and covers the seed completely. This forms what is called the beet seed or multi-germ seed which, botanically is a fruit containing usually 2-6 seeds. The true seeds are small, kidney shaped and brown.

Selfing and crossing technique in beetroot:

Floral diagram

Experiment No. 7

Objective: To study about floral biology of onion

Botanical Name: ……. .

Chromosome No.: ……

Family: ……..

Onion *Allium cepa L*. is an important vegetable crop grown throughout the world. It is a cool season vegetable. It is grown for its bulbs.

Floral biology:

- The flower structure is called an umbel which is an aggregate of many small inflorescences (cymes) of 5 to 10 flowers, each of which opens in a definite order causing flowering to be irregular and to last for two or more weeks.
- Each individual flower contains 6 stamens, 3 carpels united into one pistil and 6 perianth segments.
- The pistil contains 3 locules each of which has 2 ovules.
- The flower also contains nectarines which secrete nectar to attract insects for cross-pollination.
- The flowers are protandrous and anthers shed pollen over a period of 3-4 days prior to the time when full length of style is attained. Anthesis occurs in early morning (6-7 AM).
- Anther dehiscence is between 7.00AM and 5.00 PM and on next day also with peak between 9.30AM and 5.00 PM. Pollen fertility is maximum on the day of anthesis.
- Thus, stigma becomes receptive 3-4 days after shedding of pollen grains and protandry leading to favour cross pollination.

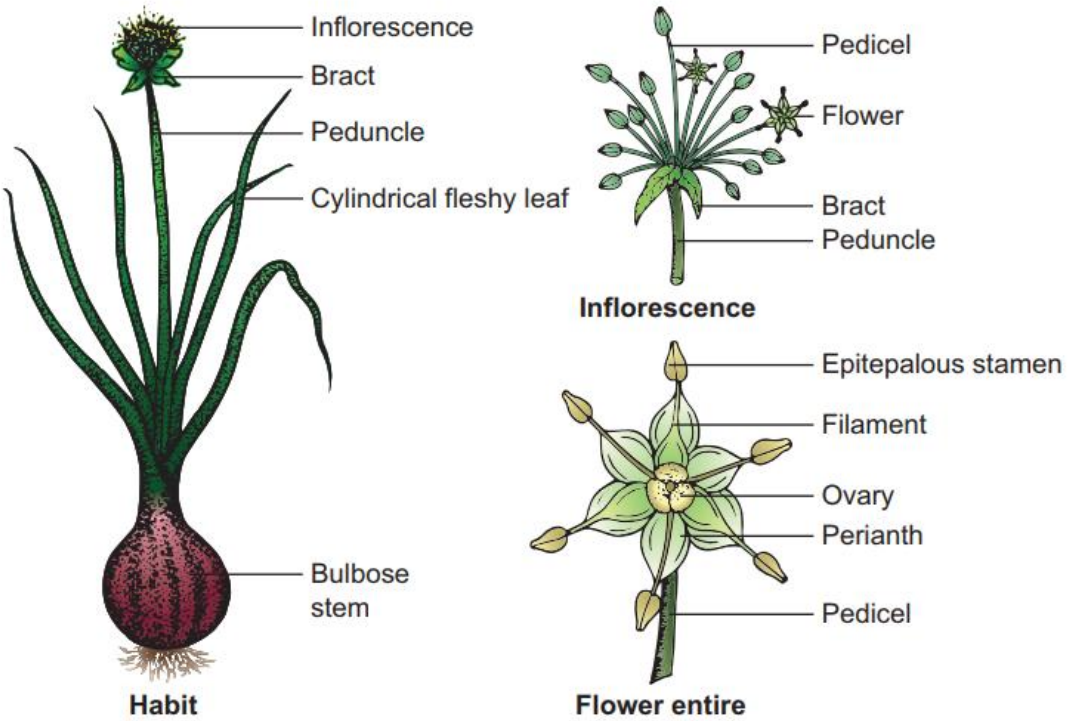


Fig: 1 Botanical description of Onion

Floral diagram of Onion:

Bulb to seed method of onion seed production

Experiment No. 8

Objective: To study about floral biology of pea

Botanical Name: ……. .

Chromosome No.: ……

Family: ……..

Pea plant is a common annual herb cultivated during the winter for the seeds. It is a weak plant and climbs with the help of tendrils. The roots are infected by nitrogen fixing bac-teria and they form characteristic nodules. Leaves are pinnately compound (imparipinnate), where the terminal leaflets are modified into tendrils. The leaf-base is swollen, forming pulvinus. A pair of foliaceous stipules is present.

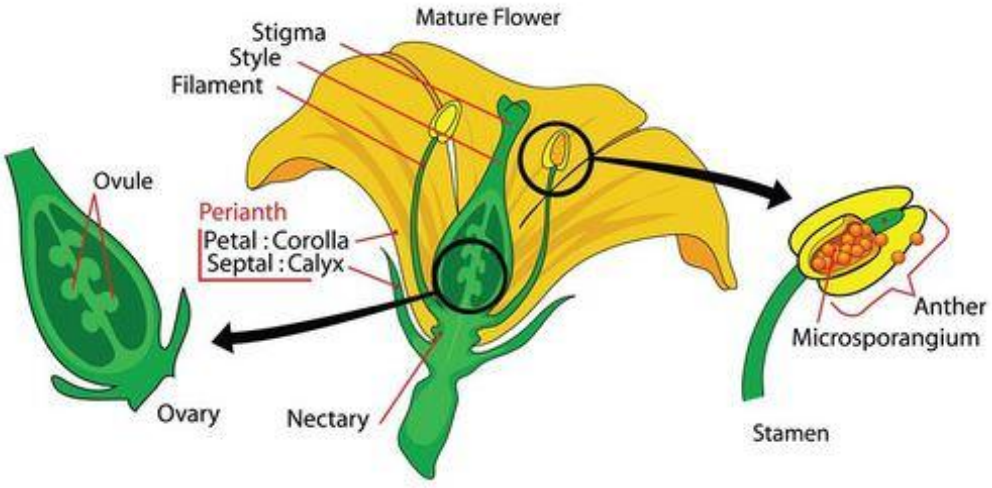
Floral biology: Flowers are lateral, solitary or in racemes. They are complete, irregular, zygomorphic, bisexual and slightly perigynous.
Calyx is composed of five united sepals.

Corolla is papilionaceous, made up of five free petals. The largest and the outermost one is the standard or vexillum, two lateral petals are wings or alae, and the innermost two, called keel or carina, unite to form a boat-shaped body. Aestivation is vexillary.

Androecium consists of ten stamens, nine united to form a bundle, one remaining free, diadelphous.

Gynoecium is monocarpellary, one-chambered with ovules in two series. Placentation is marginal. Ovary is elongated and superior.

Fruit is a legume dehiscing by both the sutures. Seeds are exalbuminous and germination is hypogeal. The plant is the sporophyte; the gametophytes, represented by pollen tube and embryo-sac, are extremely reduced and depen-dent on the sporophyte



Pea flower structure

Draw the floral diagram of pea:

Emasculation and Pollination techniques in pea:

Experiment No. 9

Objective: To study about floral biology of cucumber

Botanical Name: ……. .

Chromosome No.: ……

Family: ……..

Botany: Annual, taprooted, tendril–bearing, several–stemmed at base, prostrate and climbing on herbs, with unbranched shoots radiating from root crown; monoecious; shoots robust with large, yellow–green, spreading cauline leaves oriented upward, scabrous, puberulent and hirsute, not foul–smelling; tendril 1 per node, arising to 1 side of petiole base, unbranched, to 80 mm long, coiled initially and eventually coiling around support.

Stems: Stems 5–ridged, to 5 mm diameter, tough, with course hairs along ridges.

Leaves Leaves helically alternate, simple and unlobed or weakly lobed, long–petiolate, without stipules; petiole narrowly channeled and ridged, < 25—140 mm long, tough, scabrous, hirsute with enlarged bases; blade ± circular in outline to broadly low 5–lobed, < 45—170 × < 45—170 mm, cordate at base, lobes obtuse to rounded and at tip, ± dentate on margins, pinnately veined with 5 principal veins at base slightly sunken on upper surface and conspicuously raised on lower surface, puberulent and short–hirsute especially along veins.

Inflorescence Inflorescence flowers solitary (pistillate) and several–flowered raceme (staminate), axillary and ascending, unisexual, lacking bracts, short–hirsute to hirsute with larger hairs having bulbous bases; pedicel at anthesis ca. 1.5 mm long, of staminate flowers abscising at base, of pistillate flower increasing in fruit.

Staminate flower Staminate flower radial, 12—14 mm across; hypanthium bell–shaped, ca. 4 × 2.5 mm, green, outer surface densely hirsute, inner surface glabrate; sepals 5, arising from hypanthium, free, lanceolate, 2.5—3 × 0.5 mm, green, short–hirsute to hirsute; corolla 5–lobed, arising from hypanthium, bright yellow, conspicuously veined with ca. 5 raised veins per lobe, lower (outer) surface hirsute and glandular–hairy, inner surface glandular–hairy; tube 1.2—1.4 mm long; lobes spreading, ± ovate, ca. 6 × 2 mm; stamens 3, at top of hypanthium; filaments < 1.5 mm long, greenish; anthers basifixed, dithecal, sacs 1.6—1.9 mm long + a flame–shaped, stigmalike terminal process (together 3 mm long), flame irregularly divided and lobed, sacs short–hairy, longitudinally dehiscent; pollen orange–yellow; pistil absent.

Pistillate flower Pistillate flower radial, 16—19 mm across; hypanthium bell–shaped, 3.5—3.8 × 4 mm, with 0.5 mm cylinder on top of ovary, green, mostly short–hirsute with shaggy hairs having scattered longer hairs with broad bases; sepals 5, arising from hypanthium, barely united at base, at anthesis wide–spreading, narrowly lanceolate, 3.5—4 mm long, green, lower (outer) surface with raised midvein and hirsute; corolla 5–lobed, arising from hypanthium, bright yellow, conspicuously veined with 5 raised veins per lobe, lower (outer) surface hirsute and glandular–hairy, inner surface glandular–hairy; tube 1—1.3 mm long; lobes spreading, ± obovate, 8 × 3.6—4.1 mm; stamens 3, aborted, at midpoint of hypanthium, flanged triangular, ca. 0.8 mm wide; anthers absent; nectary dishlike, shallowly 5–lobed, encircling style base, ± 1.8 mm across, pale light green, glabrous; pistil 1; ovary conspicuously inferior (even in small bud), ellipsoid, at anthesis 8—9 × 5 mm, yellow–green, densely short–hirsute, 3–chambered with many ovules attached to outer wall; style included within hypanthium, to 4 mm long, stalk wedge–shaped, 2.2—2.5 × 0.9 mm, greenish, narrower at base, 3–branched, the branches

reflexed and each 2–lobed (stigmas), saddlebaglike, ca. 1.5 × 1.5 × 0.5 mm; stigmas 6, not twisted, green, coarsely bumpy (not papillate).

Fruit Fruit mature fruits not observed in range, pepo (= indehiscent berry with tougher outer layer), many–seeded, ellipsoid–cylindric.

Floral diagram of cucumber:

Hybrid seed production methods in cucumber:

Experiment No. 10

Objective: To study about self-incompatibility in hybrid seed production of vegetables

Self-incompatible pollen grains fail to germinate on the stigma of the flower that produced them. If some pollen grains do germinate, pollen tubes fail to enter the stigma. In many species, the pollen tubes enter the style, but they grow too slowly to effect fertilization before the flower drops. Sometimes, fertilization is effected, but the embryo degenerates at a very early stage. Self-incompatibility appears to be a biochemical reaction, but the precise nature of these reactions is not clearly understood. The genetic control of incompatibility reactions is relatively simple.

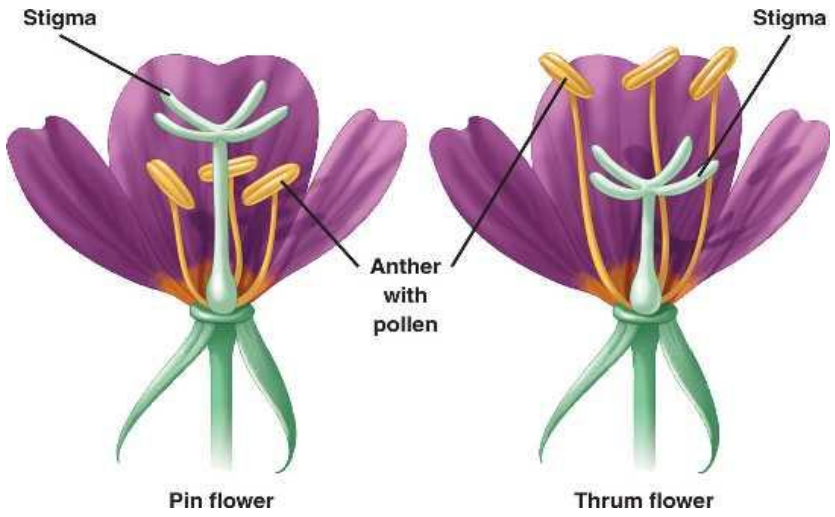
Lewis (1954) has suggested various classifications of self-incompatibility; a relatively simple classification is as follows

1. Heteromorphic System
2. Homomorphic System

a. Gametophytic Control

b. Sporophytic Control.

Heteromorphic self-incompatibility: In this case there is difference in the morphology of the flowers. For example in Primula sp there are two types of distyly flowers namely PIN and THRUM. They are born in different plants.



Homomorphic System: In the homomorphic system, incompatibility is not associated with morphological differences among flowers. The incompatibility reaction of pollen may be controlled by the genotype of the plant on which it is produced or by its own genotype.

Sporophytic System In the sporophytic system also, the self-incompatibility is governed by a single gene, S, with multiple alleles; more than 30 alleles are known in Brassica oleracea.

In general, the number of S alleles is considerably larger in the gametophytic than in the sporophytic system. The incompatibility reaction of pollen is governed by the genotype of the plant on which the pollen is produced, and not by the genotype of the pollen.

Exercise:

Hybrid seed production methods using SSI in cole vegetables:

Single cross hybrids:

Double cross Hybrids:

Top cross hybrids:

Methods to overcome self-incompatibility in Brassica vegetables:

Experiment No. 11

Objective: To study role of roguing in seed production of vegetable crops

Principle

The purity of hybrid seeds used in commercial production must be more than 98%. To meet this requirement, the purity of the restorer and CMS lines must be more than 99%. Therefore, in addition to ensuring strict isolation, it is necessary to remove all rogues from the seed production plots. Roguing is the removal of undesirable rice plants from the hybrid seed production plots. Undesirable same crop plants are those plants either in A or R line rows that differ from plants that are true to type. Roguing helps to prevent the off-types from cross pollinating the true to type A line plants and thus enhancing the purity of hybrid seed.

The undesirable plants come from many sources. They may be voluntary plants from the previous crop. Contamination due to improper isolation also results in the occurrence of off-types. Admixing during the process of harvesting, threshing, packing and handling are also other sources from which the off-types occurred. Therefore, due care is to be taken to remove the off-types during the cropping season.

Roguing can be done at any time during the crop stage. Off-type rogues can be removed whenever they are identified – earlier the better. The most important stages for roguing are at maximum tillering, flowering and just before harvesting.

1. Roguing at vegetative stage:

We can identify the off-types by their morphological differences from the true to type plants. Therefore, it is essential to know the characteristic features of parental lines, which help in easy identification of rogues and efficient roguing. As a basic step, any plant found outside the rows has to be removed as they may be volunteer plants. Remove all those plants which are either too tall or too short than the seed or pollen parent. We can also identify the off-type plants by difference in their leaf blade size, shape and leaf sheath colour.

2. Roguing at flowering:

Roguing at flowering is extremely important as it is the stage when we can identify many off-types which look similar to the parental lines during the early stages of growth. All the off-type plants that flower very early or very late are to be removed. The plants which differ from parental line plants in respect of leaf size, shape, angle, panicle shape, size and pigmentation are to be carefully removed. Plants in the A line should not have fertile pollen. The off-types in A lines can also be distinguished from their fully open flowers. Care should be taken to remove the plants which are highly infested from pests and diseases.

3. Roguing just before harvest:

This is the last opportunity to keep away the off- types in order to maintain high purity. Before harvesting, the plants in A line rows are to be thoroughly checked and those plants which show

normal seed set are to be removed. It is necessary to remove all the off-types that have different grain characters as compared to that of A line plants. The grain size, shape, colour and pigmentation of A line plants have to be critically examined for effective rouging.

Exercise:

Roguing stages in Cole crops:

Roguing stages in bulb crops:

Roguing stages in root crops:

Rouguing stages in tomato:

Experiment No. 12

Objective: To study tetrazolium test and hydrogen peroxide test for seed viability

Introduction: Normally seed germination test requires long time for estimating seed viability. However for immediate estimation of viability the quick methods can be used which are often referred to as quick tests. They can be classified as:

* Chemical tests
* Growth tests
* Appearance tests

Chemical tests: This includes the following tests

1. **Tetrazolium or TZ test:** This is also called Topographical Tetrazolium Test (TTZ) because only specific areas of the seed can be examined rather than just general evidence of viability.

It is one of the most commonly practiced biochemical staining quick tests.

Usefulness of TZ test:

- This is generally conducted on the samples showing low germination to verify germination test results.
- It determines viability of dormant seeds those would otherwise require months of chilling or other long duration pre-treatment to overcome dormancy.
- It enables to evaluate the causes for low germination such as empty seeds, dormancy, dead or dying tissues, mechanical injury, pre-sprouting and inadequate germination test procedures.

Materials required: Beakers, distilled water, 2,3,5 – triphenyl tetrazolium chloride , blade / knife

Procedure: Put the seeds in water for soaking in a beaker for 20 hours. Then removed the soaked seeds. Cut or puncture the seed coat to facilitate entry of the tetrazolium solution. Immerse these punctured seeds in 0.5 – 1.0 % aqueous solution of tetrazolium chloride and place them in the dark at 30 ^{o} C for 48 hours. Then remove seeds from the solution after 48 hours and interpret the results. The seeds with completely stained (red) embryos and other tissues such as live but not germinable, abnormal seeds etc. are scored as viable. The viability per cent can be calculated by the formula as mentioned below:

$$\text{Viability per cent} = \frac{\text{Number of viable seeds}}{\text{Total number of seeds}} \times 100$$

Advantage :

- This is a rapid and quick test.

Disadvantages :

- Penetration of TZ solution is difficult in some hard coated seeds.
- There is a lack of uniformity of staining.

- Failure to detect seeds that will germinate abnormally.
- It fails to detect seeds infected by fungi which may stain because of the metabolic activity of the fungi.
- Failure to detect immature seeds though they may stain normally because they contain living cells. These seeds would give poor results in a germination test.
- There is always a difficulty in interpretation of different degrees of staining.

2. Hydrogen peroxide test (H_2O_2) :

Materials: Hydrogen peroxide, petri dishes/germination trays, germinator, distilled water

Procedure: Seeds are soaked overnight in 1 % solution of hydrogen peroxide. The seed coat is then cut open to expose the radicle tip and seeds are put back into 1 % hydrogen peroxide solution in dark at alternating temperature of 20 ^{o} C and 30 ^{o} C. Counting and refreshment of H_2O_2 is done after 3-4 days and final assessment after 7 or 8 days.

Score: Radicle growth of 5 mm or more is scored as "evident"

- 0-5 mm slight
- No growth means non-viable or empty seeds.

The test is quicker but less reliable.

Exercise:

Seed viability testing methods in tomato:

Experiment No. 13

Objective: To study the method of harvesting in seed production

Method of harvesting

Hand Picking

Mechanical harvesting

Harvesting of different crop at their Maturity indices

Crop	Maturity indices	Remarks
Dried Seeds		
Amaranth	Yellowish browning of inflorescence	Prone to shattering
Onion	Seeds become black on ripening in silver colored capsules.10% heads exposed black seeds.	Prone to shattering
Carrot	Second and 3rd order head turn brown	Shattering on delayed harvest
Radish	Pods become brown and parchment like	Do not shatter easily
Turnip	Plants turn to brown parchment colour	Prone to shattering
Coriander	Plants turn to light yellow or brown in colour	Prone to shattering
Peas	Pods become parchment like	Do not shatter easily
Beans	Earliest pods dry & parchment like and remaining have turned yellow	Over maturity leads to shattering and cotyledon cracking
Wet fleshly fruits		
Brinjal	Fruit turn to straw yellow colour	Wet seed extraction (fermentation, acid, alkali)
Tomato	Skin colour turn to red and the fruits are softened	Wet seed extraction (fermentation)
Cucumber	Fruit become yellowish brown in colour, and stalk adjacent to the fruit withers for confirming actual seed maturity.	Seed extraction - scooping, (acid, alkali, fermentation))
Watermelon	Tendrils wither on fruit bearing shoot. Skin colour of the fruit resting on the soil is pale yellow and gives dull sound on thumping.	

Squash, Pumpkin	Rind becomes hard & its colour changes from green to yellow/ orange or golden yellow to straw colour	
True potato seed (TPS)	Berries of potato becomes green to straw coloured and soft	
Bitter gourd	Fruit pulp and seed becomes red and light brown respectively	Seeds are separated manually and washed
Fruits dried before extraction		
Chilli	Green colour changes to red or yellow	Dry method of seed extraction
Bottle and Sponge gourd	Rind becomes hard and colour changes to light brown or yellow	
Vegetatively propagated materials		
Colocasia	Drying and dieing of petiole and leaves	Skin becomes tough, uproot
Zinger	Drying and falling down of pseudo-stem turning brown	Select healthy, disease free rhizomes
Turmeric	Drying and falling down of stem turning brown	Select healthy, disease free rhizomes
Garlic	The stem get dry and change in colour from green to brown	
Seed potato	Haulms get dry, droop down turn dark brown in colour	Delay leads to spoilage of seed tubes.

Experiment No. 14

Objective: To study the method of seed extraction in vegetable crops

Mechanical seed threshing/extraction:

Threshing involves beating or rubbing the plant material to detach the seed from its pod or fruit. The detached seed is then winnowed to remove chaff, straw and other light material from the seed. Seed has to be extracted from dry seed heads (e.g. onion, lettuce, brassicas), dried fruits (chilli, pepper and gourds) or from fleshy fruits like tomato, cucumbers and melons in which the seeds are wet at the time of extraction. Threshing may be carried out by flailing, beating or rolling the seed containing material to separate it from other plant debris or straw. It may be performed manually, with animals or mechanically. Hand threshing is simplest and can be a cheaper method if sufficient labour is available. Seeds may be hand rubbed, beaten against a solid wall or on the ground with sickel or flail. Thickness or depth or the plant material being threshed should be sufficient to avoid damage to the seeds.

A. Hand threshing for dry seed separation

B. Beating

C. Flailing

D. Rolling

E. Walked on

Seed extraction from wet or flashy fruits: The seeds extraction from wet / flash fruits can be done by the following methods.

A. Manual Method

Manual Method	**Crop**
Maceration	watermelon
Crushing	brinjal
Scraping	cucumber
Separated	muskmelon
Scooping	pumpkins and
Extraction	squashes

B. **Dry Extraction**

C. Wet Extraction

Fermentation Method

Chemical method

A. Alkali method

B. Acid method

Experiment No. 15

Objective: To study about the purity analysis of seed sample

Principle To perform purity analysis, the working sample is kept over the purity work board at the base end. A small quantity of sample is brought to the middle of the board and split into two basic components as pure seed and inert matter. The inert matter is further divided as pieces of seeds less than 1/2 the original size, stones, pieces of leaves, weed seeds, other crop seed etc. The pure seed is further divided into pure seed and other distinct variety (ODV) etc. The pure seed and inert matter are weighed upto three decimals and percentage worked out. The weed seed, OCS, ODV are counted and reported as number per kg.

Method

1. The working sample

2. Weighing the working sample

Weight of the working sample in gram	The no. of decimal places Required	Example
< 1	4	0.7534
1- 9.999	3	7.534
10 - 99.99	2	75.34
100 - 999.9	1	753.4
1000 or more	0	753.4

3. Purity separation

Pure seed

Other crop seed

Weed seed

Inert matter

4. Method of purity separation

5. Calculation All the four components must be weighed to the required no. of decimal places. The percentages of the components are determined as follows.

$$\textbf{\%of component} = \frac{\text{Weight of individual component}}{\text{Total weight of all components}} \times 100$$

If there is a gain or loss between the weight of the original samples and the sum of all the four components is in excess of one percent, another analysis should be made.

5. Determination of other crop seeds & weed seeds by number /kg

6. Equipments used for purity analysis

Seed standards for physical purity

S.No.	Crop	Class	
		Foundation Seed (%)	Certified Seed (%)
1.	Bhindi	99.0	99.0
2..	Others	98.0	98.0

3	Tomato
4	Brinjal
5	Cauliflower
6	Cabbage
7	Potato
8	Carrot
9	Radish
10	Pea
11	French bean
12	Onion
13	Leek
14	Lettuce
15	Spinach
16	Palak
17	Amaranth
18	Yams
19	Dolichos bean
20	Cucumber
21	Muskmelon
22	Watermelon

Experiment No. 16

Objective: To Study the seed production in okra

Botanical Description

Okra *Abelmoschus esculentus* L. (Moench), is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. This crop is suitable for cultivation as a garden crop as well as on large commercial farms. Okra is mainly propagated by seeds and has duration of 90-100 days. It is generally an annual plant. Its stem is robust, erect, variable in branching and varying from 0.5 to 4.0 metres in height. Leaves are alternate and usually palmately five lobed, whereas the flower is axillary and solitary. Okra plants are characterized by indeterminate growth. Flowering is continuous but highly dependent upon biotic and abiotic stress. The plant usually bears its first flower one to two months after sowing. The fruit is a capsule and grows quickly after flowering. The greatest increase in fruit length, height and diameter occurs during 4th to 6th day after pollination. It is at this stage that fruit is most often plucked for consumption. The okra pods are harvested when immature and high in mucilage, but before becoming highly fibrous. Generally the fibre production in the fruit starts from 6th day onwards of fruit formation and a sudden increase in fibre content from 9th day is observed (Nath, 1976). Okra plants continue to flower and to fruit for an indefinite time, depending upon the variety, the season and soil moisture and fertility. Infact the regular harvesting stimulates continued fruiting, so much that it may be necessary to harvest every day in climates where growth is especially vigorous.

Botanical name:

Family:

Chromosome numbers:

Floral biology:

The okra flowers are 4-8 cm in diameter, with five white to yellow petals, often with a red or purple spot at the base of each petal and the flower withers within one day. The flower structure combines hermaphroditism and self compatibility. Flower bud appears in the axil of each leaf, above 6th to 8th leaf depending upon the cultivar. The crown of the stem at this time bears 3-4 underdeveloped flowers but later on during the period of profuse flowering of the plant there may be as many as 10 undeveloped flowers on a single crown. As the stem elongates, the lower most flower buds open into flowers. There may be a period of 2, 3 or more days between the time of development of each flower but never does more than one flower appear on a single stem. A flower bud takes about 22-26 days from initiation to full bloom. The style is surrounded by a staminal column which may bear more than 100 anthers. The pollen may come in contact with the stigmas through a lengthening of the staminal column or through insect foraging

(Thakur and Arora, 1986). Thus the flowers of okra are self fertile. The pollen grain is large with many pores, and every pore is a potential tube source; therefore, many tubes can develop from one pollen grain (Purewal and Randhawa, 1947).

Seed production methods in Okra:

Experiment No. 17

Objective: Visit to commercial seed production farm

Location:

Crop:

Student experience