“Breeders, Foundation & Certified Seed Production, Field (isolation distance & rouging) and Seed Standards for Production of”

Introduction to seed and seed quality

“All the flowers of all the tomarrows are in the seeds of today”

- Swedish

proverb.

Seed is the basic and critical input in crop husbandry, which determines theexpected dividends from all other inputs. Agriculturally seed is the unit of propagationand can be any part of the plant (zygotic seed or vegetative propagules) which has thecapability to regenerate into a new plant,but botanically it is defined as matured ripenedovule comprising living embryo embedded in the supporting food storage tissue with aprotective coat. It is primarily responsible for maintaining the physical, physiologicaland genetic characteristics of any variety / hybrid of any crop. The differences betweenseed and commercial grain are as below

Seed	Grain
Should be germinable and vigorous	Need not be
Should be physically and genetically pure	Need not be
Should satisfy all the quality norms	Need not be
Should be free from pest and diseases	Need not be
Seed is the outcome of planned and specific programme	Need not be

History and Development of Vegetable Seed Industry in India:

India is the second largest producer of vegetables, which occupy 6.2 m ha producing about 94 million tonnes with an average productivity of 15 t/ha of fresh vegetables, yet the productivity is not sufficient to provide diet to our growing population. Low productivity of vegetables was observed due to poor availability of quality vegetable seeds. Since ages, Indian framers have been mostly dependent on local varieties and farm saved seeds, whose quality is not assured, this affected the vegetable production drastically. After Independence, greater emphasis was placed on the development of seed programmes during all the Five Year Plans and Annual Plans by Govt. of India. With establishment of AICRP (vegetables), tremendous progress has been made in development of High yielding varieties. It solely depended on the multiplication and distribution of seeds of the newly developed varieties. Originally, vegetable seeds were produced by public sector organization like NSC, SFCI, SSCs, SAUs, ICAR institutes etc., but at present its share is marginal and a large portion of vegetable seed demand in the country is still met by the private seed

companies only. In most of the public sector endeavors, still the major share is of open pollinated varieties. Use of quality seeds of improved varieties/ hybrids of different vegetable crops has witnessed tremendous growth in vegetable productivity and total production. The development of vegetable seed industry in India initiated even before independence and can be tracked as below.

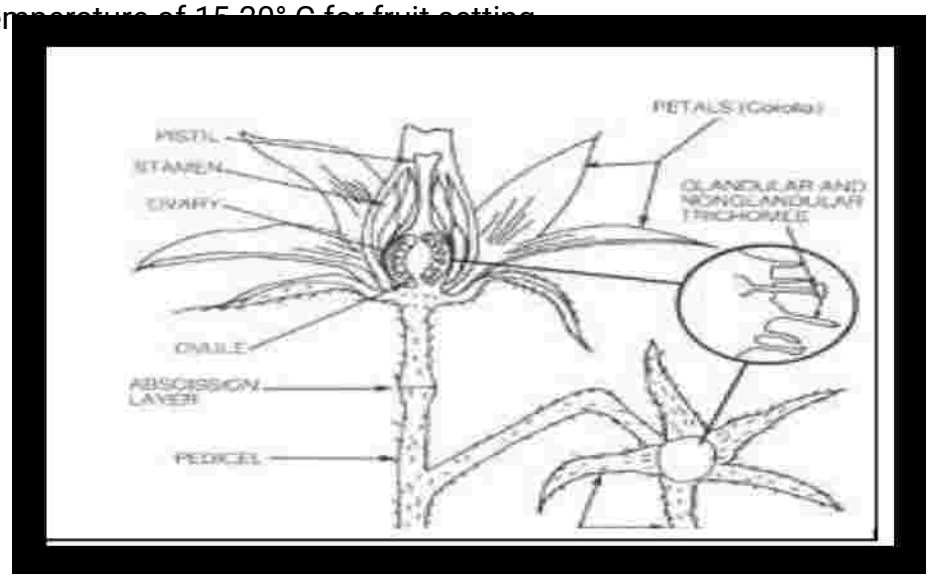
1876	A hand book on seed testing was published The World's first Seed Testing Station was established by Prof.F.Nobbe in Tharandt, Saxony, Germany.
1916	Supply of quality vegetable seeds was introduced by M/s. Sutton and Sons at Kolkata, India.
1924	International Seed Testing Association (ISTA) was established in Norway.
1925 -28	The Royal Commission on Agriculture analyzed (*for the first time*) Indian seed production system and its problems and encouraged supply of quality seeds to the farmers and the private sectors.
1939 -1945	In India, temperate vegetable seeds were imported
1942-1943	Seed production programme started at Katrain (Himachal pradesh) and Kashmir Valley and the Vegetable seed industry made a rapid progress.
1949	Seed production programme was started at Central Vegetable Breeding Station, Katrain, Kullu Valley by Govt. of India. Central Potato Research Institute was established at Shimla to develop varieties and production technology.
1951	First Five Year Plan started with an aim to multiply and distribute seeds.
1955	Central Vegetable Breeding Station, Katrain was transferred to the IndianAgricultural Research Institute, New Delhi with a view to intensify the improvement work on temperate vegetables and renamed as IARI, RegionalStation.
1961	The first Seed Testing laboratory was established in IARI, New Delhi.
1963	National Seeds Corporation was established to develop Indian SeedIndustry.
1966	**Indian Seeds Act** was passed by Government of India with a view toregulate quality of seeds on 29th December.
1967	Seed Plot Techniques in potato was developed for raising healthy seed stocks.
1968	The Seed Rules were framed in India in consultation with ISTA.NSC established its own Seed Testing Laboratory.
1969	**The Seeds Act came** into force throughout the **country on 2nd October with**seed rules
1983	Enactment of **Seed Control Order-** Seeds was declared an essentialcommodity.

Varietal and hybrids seed production in solanaceous vegetables

1. TOMATO (*Solanum lycoperricum L.*)

Botany

Tomato is self pollinated crop. Self fertilization is favoured by the position of receptive stigma within the cone anthers and the normal pendant position of the flower. Anthesis starts at 6.30 a.m. and continues upto 11.00a.m. Anther dehiscence occurs 1-2 days after opening of corolla. Tomato is a typical day neutral plant. It requires temperature of 15-20° C for fruit setting.



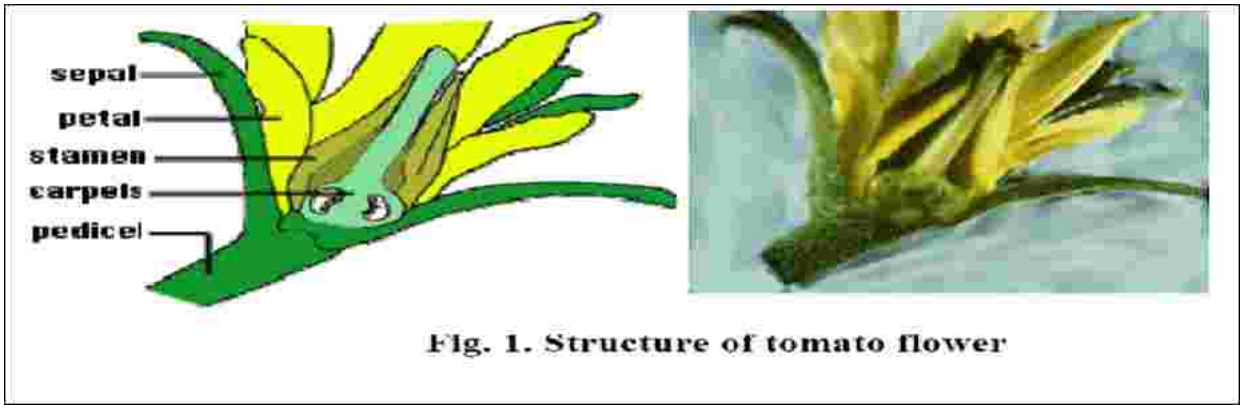


Fig. 1. Structure of tomato flower

Method of seed production: Seed to Seed.

Stages of seed production

Tomato is a self pollinated crop, hence either three or four generation modelcould be adopted as below

Varieties

Breeder seed Foundation Seed Certified SeedBreeder seed

Foundation SeedIFoundation Seed II Certified Seed

Hybrids

Breeder seed Foundation Seed (Multiplication of parental lines)

Certified Seed (Production of F1 hybrids)

Varieties

Indeterminate varieties

Pusa Ruby, Solan Gola, Yaswant (A-2), Sioux, Marglobe, Naveen, Ptom-9301,Shalimar-1, Shalimar-2. Angurlata, Solan Bajr, Solan Sagun, Arka Vikas and ArkaSaurbh.

Determinate varieties

Roma (EC-13513), Rupali, MTH-15, Ptom-18, VL-1, VL-2, HS 101, HS 102, HS110, Pusa Early Dwarf, Pusa Sheetal, Floradade, Arka Meghli, CO.1, CO.2, CO.3(Marutham), PKM.1,Py1,

Hybrids

COTH-1, 2 and 3 Pant, Hybrid-2, Pant Hybrid-10, Kt-4. Pusa Hybrid-l-4, ArkaShreshta, Arka Vardan, Arka Abhijit, Navell 1 &2 (Sandoz), Rupali, Sonali, MTH 6

Season

It is highly suitable both for kharif (May – June) and rabi season (November - December).

Land requirement

Selection of suitable land for tomato seed production is important where theprevious crop should not be the same variety to avoid the contamination due to volunteerplants.

Isolation requirement

For Seed production of tomato, varieties require minimum of 50 M forfoundation seed and 25 M for certified seed. For hybrid seed production, it requiresminimum of 200 M for foundation (parental line increase) and 100 M for certified hybridseeds.

Seed rate:

i) Varietal seed production– 300 to 400 g/ha

ii) F_1 hybrid seed production - Male parent 25 g/ha; Female parent 100 g/ha.

Seed Treatment

The seed required for one hectare are to be inoculated with *Azosprillum.* For this,the seeds should be first mixed with the required quantity of rice gruel and then with 150g of *Azosprillum* after shade drying it can be used for sowing.

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap andcovered with sand. Eight and ten nursery beds will be sufficient to transplant in one acre.Apply 2 kg of DAP 10days before pulling out of seedling.

Transplanting

Transplanting should be done with the seedlings are 20-25 days old, preferably atevening time.

Spacing

It varies with varieties from 60 x 30cm to 60 x 45 cm. and in hybrid seedproduction 90 x 60 cm for female parent and 60 x 45 cm for male parent.

Planting ratio

For hybrid seed production, the female and male parents are normally planted inthe ratio of 12:1 or 12:2.

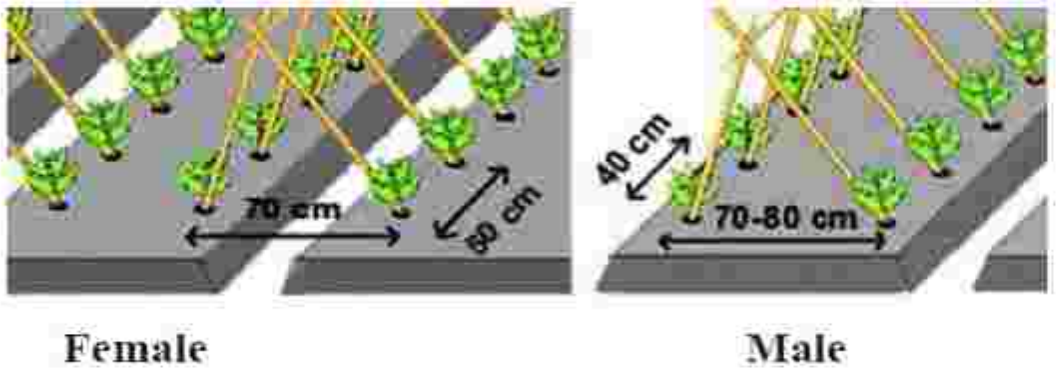


Figure 2. Spacing and staking options for female and male lines

Manuring

After thorough preparation of a field to fine tilth, apply 25 tons of FYM per ha.Apply 100 : 100: 100 Kg of NPK/ha of which, 50% of the N is applied as basal dressingand remaining 50% of N as top dressing in two split doses at just before

flowering andfruit formation stages.

Roguing

The rouging should be done based on the plant characters (determinate /indeterminate), leaf, branching and spreading characters and also based on fruit size,shape and colour. The plants affected by early blight, leaf spot and mosaic (TMV)diseases should be removed from the seed production field.

Specific field requirements

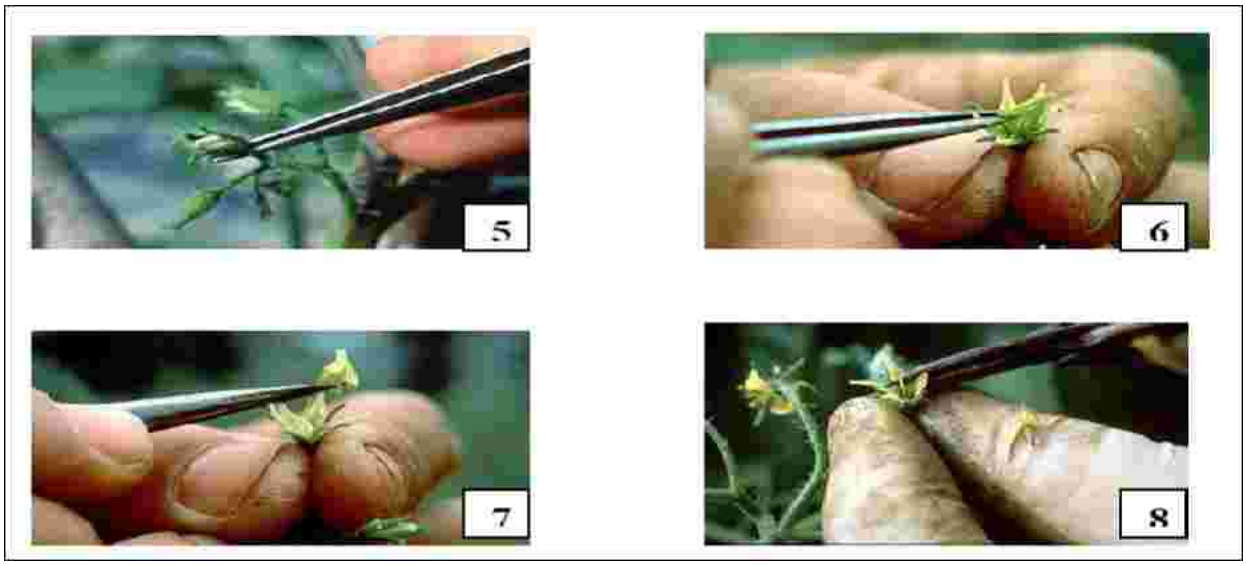
Factors Foundation Certified	Foundation	Certified
Off types – variety (max) 0.1	0.1%	0.2%
Hybrid (max)	0.01%	0.05%
Plants affected by seed borne diseases (max)	0.1%	0.5%

Crossing technique for production of hybrids

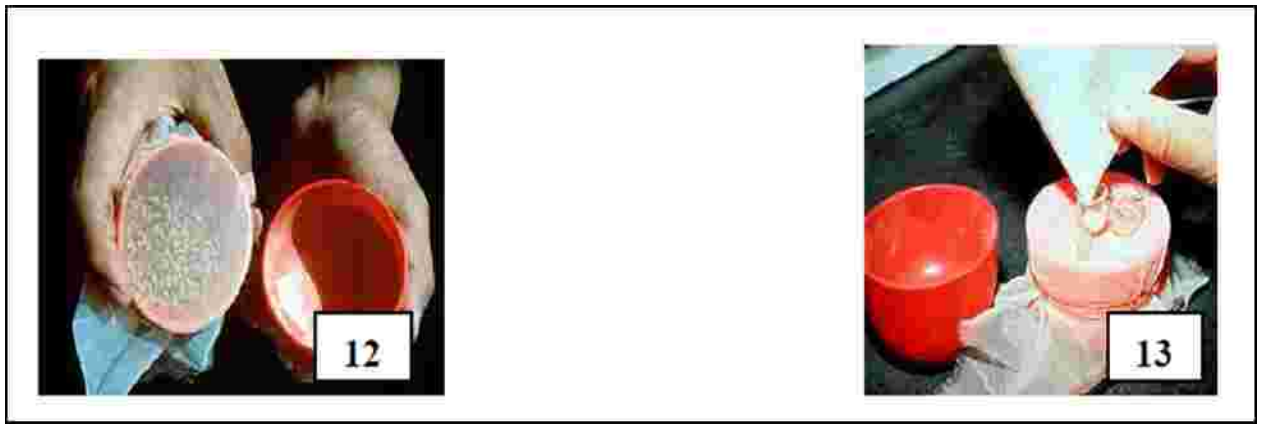
In tomato the hybrid seed production is normally done by 'Emasculation andHand Pollination'. Emasculation is done before the anthers are mature and the stigma hasbecome receptive to minimize accidental self pollination. Thus emasculation is generallydone in the evening, between 4 PM and 6 PM, one day before the anthers are expected todehisce or mature and the stigma is likely to become fully receptive.

Emasculate the bud by hand with the help of needle and forceps. Remove thecalyx, corolla and staminal column or anthers, leaving gynoecium *i.e.*, stigma and styleintact in the flower. Emasculated flowers should be covered immediately with redcoloured paper cover to protect against contamination from foreign pollen and also foreasy identification of emasculated bud during dusting. Remove the red paper cover of theemasculated bud and dust the pollen gently over the stigmatic surface using cotton orcamel brush, etc.,. After dusting, the emasculated flowers are again covered with whiteor other coloured paper cover for two to three days. Pollen collected from one maleflower can be used for dusting 5 to 7 emasculated flowers.

However use of chemical hybridizing agents (MH-1000 ppm) or CMS lines arealso practiced.



Emasculation of tomato: selection of buds, removal of anther cone, andcutting of petal



Pollen is collected, dried, and prepared for making hybrid crosses

Pollination of emasculated flowers

Harvesting and seed extraction

The fruits are harvested after full maturity of the fruit when turn in to red color fruits from first and last one or two harvests should not be used for seed extraction. The fruits from in between 6-7 harvest should be used for seed extraction. The seed viability is depends on the method on which the seeds were extracted and hence, it is

more important to choose proper methods of seed extraction. Before seed extraction, the fruits are to be graded for true to type and selection of medium to large size fruits for getting higher recovery of quality seeds.

Comparison of different seed extraction methods

	Fermentation	Acid	Alkali
Method	Mix fruit pulp with water - 24 - 48 h	HCl @10ml / Kg of pulp - 20-30 minutes	Washing soda @ 900mg/4 l of water- equal volume – overnight soak
Salient features	▪ Low cost. ▪ Unskilled labour. ▪ More time taken. ▪ Low seed recovery (0.5 to 0.6 %) ▪ Dull seed colour. ▪ Seed borne pathogens	▪ Cost is more. ▪ Skilled labour. ▪ Lesser time. ▪ High seed recovery (0.8 to 1 %). ▪ Bright colour market value higher. ▪ Seed borne pathogen removed ▪ Improper washing leads to injury to seeds	▪ Recovery 0.7 to 0.8 per cent. ▪ Luster of the seeds will be lost. ▪ Improper washing leads to injury to seeds

While following acid method we must use only plastic or stainless steelcontainers or cement tank. Care must be taken to avoid the usage of iron or zinccontainers, which will affect the viability potential of the seeds and as well, damage tothe containers due to chemical reaction with acid.

Seed Yield: 100-120 Kg/ha

Seed Standards (variety and hybrid)

Factors	Foundation	Certified
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) no/kg	5/kg	10/kg

Weed seeds (maxi)	None	None
Germination (mini)	70%	70%
Moisture (maxi)	8%	8%
For VP container	6%	6%

BRINJAL (*Solanum melongena* L.)

Botany

Brinjal is often cross pollinated crop. Brinjal flower opens mainly in morning.Anthesis starts at 5.53 a.m. and continues upto 7.35 a.m with peak at 6.05 a.m. Thedehiscences of anthers begin 30 minutes after anthesis. The stigma is receptive from 2days before anthesis and upto 8 days. Brinjal produces 4 types of flowers with differentstyle length. (Long style, short style, medium style and pseudo short style). For seedproduction and better yield, the long and medium style is desirable. To increase theproduction of long and medium style application of more nitrogen or spraying of growthregulators during pre-flowering and flowering stages may be followed.

Method of seed production: Seed to Seed.

Stages of seed production

Breeder seed ▶ Foundation Seed I ▶ Foundation Seed II ▶ Certified Seed.

Varieties

CO.1, CO.2. MDU 1, PKM.1, KKM.1, PLR. 1. AU1, Pusa purple long, Arkanidhi, Pant smart, Arka neelkanth, Arka shrish.

Hybrids

COBH1, Arka Navneet (IIHR 22-1 x Supreme), Pusa H-5, Pusa H-6, MHB 10,MHB 39 (Mahyco), Azad Hybrid.

Season

The brinjal seed production can be taken up in the following two seasons.May-June and December- January

Land requirement

The land should be free of volunteer plants.

Isolation

For varieties, 200 M and 100 M of isolation distance is required for foundationand certified seed, respectively. For hybrid seed production minimum of 200 M isolationdistance should be maintained.

Seed rate

Varieties - 400 - 500 g/ha

Hybrids - 200 g/ha (Female)

- 50 g/ha (Male)

Seed treatment

Seed treatment with *Trichoderma viride* @ 4g kg-1 before sowing can bepracticed against the incidence of damping off disease. Drenching of copper oxy chlorideat 0.1% at weekly interval minimize this disease.

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap andcovered with sand. Eight and ten nursery beds will be sufficient to transplant one acre.Apply 2 kg of DAP 10days before pulling out of seedling.

Transplanting

Seedlings are transplanted when they are 30-35 days old (12-15 cm height)preferably in the evening time. Spacing of 75 x 60 cm (non spreading) and90 x 60 cm (spreading) varieties, 90 x 60 cm for female parent and 60 x 45 cm for maleparent of hybrids.

Manuring

The field should be thoroughly ploughed for fine tilth and apply 25 tons ofFYM/ha. The other fertilizer requirement for brinjal variety and hybrid are same asfollowed for tomato seed production.

Roguing

The roguing should be done based on the plant characters, leaf, branching andspreading characters and also based on fruit size, shape and color. The plants affected byphomopsis blight, leaf spot and little leaf virus disease should be removed from the seedproduction field.

Specific Field Standards

Factors	Foundation	Certified
Off types – Variety (max)	0.1%	0.2%
Hybrid (max)	0.01%	0.05%
Designated diseased plant (max)	0.1%	0.5%

Hybrid seed production

The planting ratio of female and male parents adopted for hybrid seed production is normally 5:1 or 6:1.For production of hybrid seeds, crossing programme is done usingemasculation and dusting methods as followed in tomato.

Emasculation and pollination

Emasculation is done in the afternoon hours. Of the four types of flower, onlythe flower buds having long or medium style are emasculated. In brinjal, flowers appearboth as solitary or in cluster, in the noncluster fruited cultivars, generally single flowerin a cluster of 3-5 is long or medium styled. After selecting the long or medium styledbuds, the corolla is opened gently from the side, length of the style is glanced and thenthe anthers are picked off separately by upward pull with the forceps. The emasculatedflowers are protected by thin cotton wool.Using a needle, the anther cone is carefully removed without disturbing the style.These emasculated flowers have to be covered by butter paper bags. Similarly theflowers of male parent from which pollen is going to be collected have to be bagged onthe previous day evening. Next day morning by 6 am the flower buds are collectedbefore opening. Anthers are separated and kept in petridish covered by glass. Thesepetridishes are kept against sunlight to facilitate dehiscence of anthers and release ofpollen grains. The butter paper cover on the emasculated flower is removed and thepollen is transferred to the stigmatic surface with the help of a camel hair brush or bysmearing the dehisced anther on the stigma. A part of sepals of the pollinated flowersare cut with the help of a scissors for identification mark that they are hybridizedflowers. After hand pollination these flowers are rebagged. Since the stigma isreceptive for 4 days, the bags should be removed after about 8-10 days only when thefertilized ovary will prominently seen. After full maturity and ripening of the fruits,seeds are extracted. On an average a quantity of 400 kg of hybrid seeds can be obtainedfrom one hectare.

Male sterile lines

Use of male sterile lines reduces the cost of seed production. In brinjal

functionalmale sterile mutants was also reported. This is at a recessive character determined bysingle gene. It is therefore, easy to transfer this character into desirable standardvarieties to be used as female parent for hybrid seed production.

Harvesting and processing

Harvesting is done when fruits are fully ripe (when the fruits turn into yellowcolour) *i.e.,* 45 days after flowering. The harvested fruits are to be graded for true to typeand off type and fruit borer infested fruits are discarded. The graded fruits are cut in 2-3pieces or whole fruits will be put in a cement tank with water and crushed manually andthen allow it for fermentation for 1-2 days. Then the floating pulp portions are to beremoved, the seeds settled at the bottom should be collected and washed with water andthen the seeds are treated with commercial Hydrochloric acid @ 3-5 ml/kg of seed. Themixture is kept for 10-15 minutes with frequent stirring. Then the treated seeds are to bewashed with water for 3-4 times. Afterwards seeds are dried under shade for 2-3 daysover a tarpaulin and followed by sun drying for 1-2 days to reduce the seed moisturecontent to 8 per cent. Then the seeds are cleaned and graded with BSS 12 sieve. Theprocessed seeds are treated with fungicides or Halogen mixture @ 5g/kg of seed.To upgrade the seed lot water floatation technique and specific gravity gradingare commonly used. Seeds can be stored in aluminium foil pouches by which theviability can be maintained upto 18 months under ambient condition, by dressing theseeds with 2 g of thiram / kg of seed.

Seed Yield: 100-200 Kg/ha

Seed Standards (Variety & Hybrid)

Factors	Foundation & Certified
Pure seed (mini)	98%
Inert matter (maxi)	2%
Other crop seeds (maxi) no/kg	None
Weed seeds (maxi)	None
Germination (mini)	70%
Moisture (maxi)	8%
For VP container (maxi)	6%
Genetic purity required for tomato &	90%

CHILLI (*Capsicum annuum*)

Botany

Cross pollinated vegetable. The flower is protogynous. Flowers open in themorning between

5.00 a.m and 6.00 a.m Anther normally dehisces between 8.00 a.m and11.00 a.m. Pollens are fertile on the day of anthesis and stigma is receptive for about 24hours after flower opening.

Method of seed production: Seed to seed

Stages of seed production

Breeder seed→Foundation seed→Certified seed.

Varieties

Samba Varieties: K1, CO1, Pusa Jwala, PKM1, CO3, K2, Pant C1, G4Gundu Varieties: CO2, G5 (Andhra Jyoti), PMK1, PLR1, CO4Notified Varieties: G5, Chanchal, CO1, CO2, Hot Portugal, Jawhar mirch 218,Jwala, K1, K2, MDU1, Pant C1, Panjab lal , PKM1,Sanauri, Sindhur

Hybrids

KT.1, (Pusa Deepti), Solar Hybrid 1, Solar Hybrid 2. Early Bounty, Indira,Lario, Hira, Bharat.

Season

June-July, February-March, September- October.

Land requirement

There is no land requirement as of previous crops, but the land should be freefrom volunteer plants. Generally areas affected by wilt or root rot may be avoided. Croprotation must be followed to avoid endemic solanaceous pests.

Isolation requirement

Minimum isolation distance of 400 M for foundation and hybrid seed and 200 Mfor certified seed production are necessary.

Seed rate

Seed required for one hectare is 500 g to 1 kg for variety; for hybrids - Female -200 g and male - 50 g.

Seed Treatment

Seeds should be treated with captan @ 2g/kg or *Trichoderma viride* @ 4g /kg ofseed and also seed treatment with *Azospirillium* @ 0.1 % improved the seedling vigour inchilli.

Nursery

Sowing the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap andcovered with sand. Eight and ten nursery beds will be sufficient to transplant one acre.Application of 2 kg of DAP 10 days before pulling out of seedlings.

Transplanting

The seedlings of 30-35 days old are ready for transplanting. Transplanting maybe done on the ridges in the evening.

Foliar spray

To arrest the flower drop, NAA (Planofix) can be sprayed @ 4ml/litre of water.Very light irrigation is also done to arrest the flower drop.

Manuring

Application of 50 tonnes of FYM/ha for irrigated crop. Basal 100:70:70 kg ofNPK and 50 kg of N at 15 days after transplanting and 50 kg N at 45th days aftertransplanting.

Roguing

Field inspection and roughing should be done both for varieties and hybrid atdifferent stages based on the plant height and its stature, flower colour and

podcharacters. The plants affected with leaf blight, anthracnose and viral diseases should beremoved from the seed field.

Specific Field Standards:

Factors	Foundation	Certified
Off types (max)	0.1%	0.2%
Designated diseased plant (max)	0.1%	0.5%

Hybrid seed production

The crossing operation can be performed as per the methods outlined for tomatoand brinjal hybrid seed production. However, hand emasculation and pollination is somewhat difficult since the flowers are minute. Hence use of male sterile lines can also beemployed for hybrid seed production.

Emasculation and Pollination

Emasculation may be done either early in the morning or in the previousafternoon before opening of flower and petals still covering the anthers and stigma. Withthe help of a pair of forceps the petals are parted carefully and the anthers are removedseparately. The emasculated flower buds are protected by thin cotton wad or bag or bythin cloth loosely wrapped around the branch, enclosing leaves and flowers and securelyfastened.Pollen collection is normally done late in the morning. Pollens from thepreviously protected flowers may be collected by a vibrator or after plucking the flowersfrom intended male parents, and gently tapped by finger for the collection of pollens in apetridish or watch glass.The best time of pollination is early morning or late afternoon of the followingday of emasculation. Pollination may be done by touching the freshly dehisced anthersto the stigma by forceps, by dusting pollens over the stigma or by transferring the pollenswith brush or needle very carefully. The petals may be cut off to facilitate pollination.Bagging of the flowers should be done to prevent pollen contamination.

Use of male sterility

Both genic and cytoplasmic – genetic male sterility have been reported. The firstpublic sector hybrid CH 1 was developed at Punjab Agricultural University, Ludhiana byutilizing male sterile in MS – 12. This male sterile line has been developed by utilizingthe male sterile line introduced from France. At IIHR, Bangalore,

three cytoplasmic andgenic male sterile lines have been identified from Korean hybrids and indigenoussources.

Harvesting and processing

Harvesting should be done in different pickings. First and last two pickings canbe harvested for vegetable purpose. The well ripened fruits with deep, red colour aloneshould be collected in each picking. After harvest, fruit rot infected fruits are to bediscarded. The harvested pods are to be dried under shade for one (or) two days and thenunder sun for another 2 or 3 days. Before drying pods are to be selected for true to typeand graded for seed extraction. The seed are extracted from graded dried pods. The podsare taken in gunny bag and beaten with pliable bamboo sticks. The seeds are cleaned bywinnowing and dried to 10% moisture content over tarpaulin. Then seeds are processedwith BSS 8 wiremesh screens. For large scale seed extraction, the TNAU model chilliseed extractor may be used.

Seed Yield: 100 to 200 kg/ha.

Seed Standards (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) no/kg	5/kg	10/kg
Weed seeds (maxi) no/kg	5/kg	10/kg
Germination (mini)	60%	60%
Moisture (maxi)	8%	8%
For VP container (maxi)	6%	6%

Bot

Bhendi is often cross pollinated crop. Anthesis is between 9 and 10 hr and ispreceded by maximum anther dehiscence between 8 and 9 hr. The stigma remainsreceptive on the day of anthesis. Cross pollination to an extent of 12 per cent is due toprotogynous.

Method of seed production

Seed to seed

Stages of seed production

Breeder seed → Foundation seed → Certified seed.

Varieties

CO.1, CO.2, MDU.1, Parbhani Kranti, Arka Anamika, Pusa A-4, Pusa Savani, Punjab-7, JK, Harita, Parbhawa

Hybrids

CO. 3, Mahyco hybrid, Shoba

Season

June-July, September- October and February- March

Land requirement

Select field on which bhendi crop was not grown in the previous season, unlessthe crop was of the same variety and certified. Field should be free from wild bhendi(*Abelmoschus* sp.)

Isolation requirement

Seed field must be isolated from other varieties at least by 400 M for foundationand hybrid seed production and 200 M for certified seed production.

Seed rate

Varieties : 8-10 kg/ha

Hybrids : 4 kg/ha (Female)

: 1 kg/ha (Male)

Main field manuring

Apply 12.5 tons of FYM/ha before ploughing. Apply 150:75:75 kg NPK/ha, ofwhich 50% of the N should be applied as top dressing in two split doses at flowering and10 days later.

Planting ratio

For hybrid seed production, female and male parents are normally planted in theratio of 4:1.

Roguing

Minimum of three inspections for varieties and 4inspections for hybrids should be at 1. Vegetative, 2 & 3.Flowering and 4. Fruit maturity stages. The rougingshould be based on the plant characters, hairyness, fruitcharacter like fruit colour, number of ridges, fruit lengthetc., and the off type and mosaic attacked plants shouldbe removed from the seed field. Wild bhendi if presentshould be removed before flowering.

Specific field standards

Factors	Foundation	Certified
Off types (max)	0.1 %	0.2%
Objectionable weed (max)	None	None

Hybrid seed production

In bhendi, since the flowers are large in size,hand emasculation and pollination is the best suitablemethod for seed production. The emasculation anddusting can be done as per the methods outlined intomato. The male and female parents are raised inblocks at the ratio of 9:1 (Female: Male).

Harvesting and threshing

Fruits should be harvested when they have dried (30-35 days after crossing). The pods which expose hairline crackand turned in to brown colour on drying alone are picked byhand and the seeds are separated manually. Then the seed arecleaned, dried and treated with captan/ thriam. (2g / kg ofseed)

It can be upgraded by water floatation technique (*i.e.* the seed is immersed in a columnof water (1:10 by volume).Stirred well and floaters (9-10%) containing insect damagedand ill-filled seeds are removed. The sinkers blackish olive green in colour that sinksdown to the bottom are separated and dried.In okra, the seed coat colour ranged from green to grey and finally to black. Thediscoloured seeds may not be acceptable as seed for sowing because of poor physicalappearance and high expected incidence of seed borne fungi. The normal green colourseeds have better storage potential.Bhendi seeds dried to 7 per cent moisture, treated with captan (2g kg-1 of seed)and stored in a sealed 700 gauge polyethylene bag could maintain 80 percent germinationup to 24 months of storage.

Processing

Seeds are to be processed with BSS 7 wire mesh sieve.

Seed standards hybrid /varieties

Factors	Foundation	Certified
Pure seed (min)	99%	99%
Inert matter (max)	1%	1%
Other crop seeds (max) no/kg	None	5/kg
Weed seeds (max) no/kg	None	None
Objectionable weed (max)	None	None
Other distinguishable varieties	10/kg	20/kg

BULB CROP

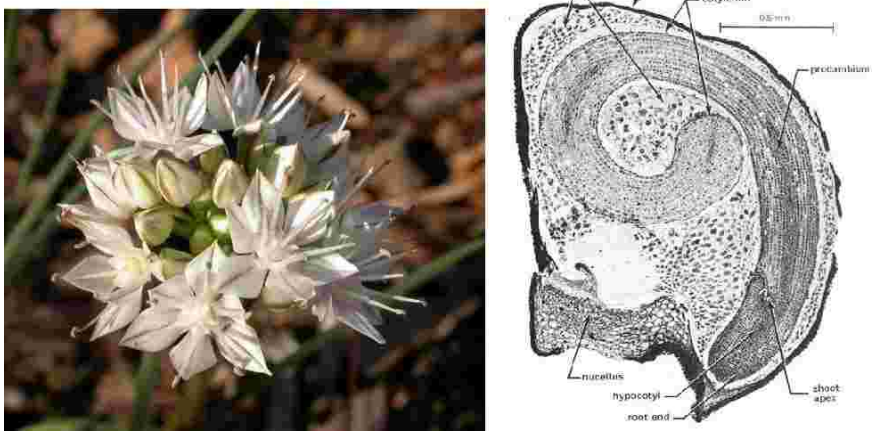
Onion (*Allium cepa*)

Botany

Onion is the biennial crop and takes two full seasons to produce seeds. In the first year bulbs are formed and in the second year stalks are developed and produced seeds. It is a long-day plant. The day length influences bulb onion, but has little effect on induction of seeding. It appears to be day-neutral for seed production. It requires cool conditions during early development of the bulb crop and during early growth of seed stalk. Varieties bolt readily between 10 to15° C. In the early stages of growth, a

good supply of moisture is required and temperatures should be fairly cool. During bulbing,

Harvesting and curing of seed, fairly high temperatures and low humidity is desirable. Seed production is widely adapted to temperate and sub-tropical regions.



Onion flower and Seeds

Stages of seed production: Breeder seed Foundation seed certified seed

Varieties

Bellary Red, Rampur local, Pusa white, Kalyanpur, Red Round Punja 48, Pusared, Pusa Madhvi, Arka Niketan, Arka Kalyani

Season

The optimum sowing season is middle of June to Middle of July in the plains.

Isolation Requirements

Onion is largely cross-pollinated crop with up to 93 per cent natural crossing but some self-pollination does occur. It is chiefly pollinated by honey-bees. For pure seed production, the seed fields must be isolated from fields of other varieties of onion and fields of the same variety not conforming to varietal purity requirements for certification atleast by 1000 meters for foundation seed production and 500 meters for certified seed production.

Method of Seed Production

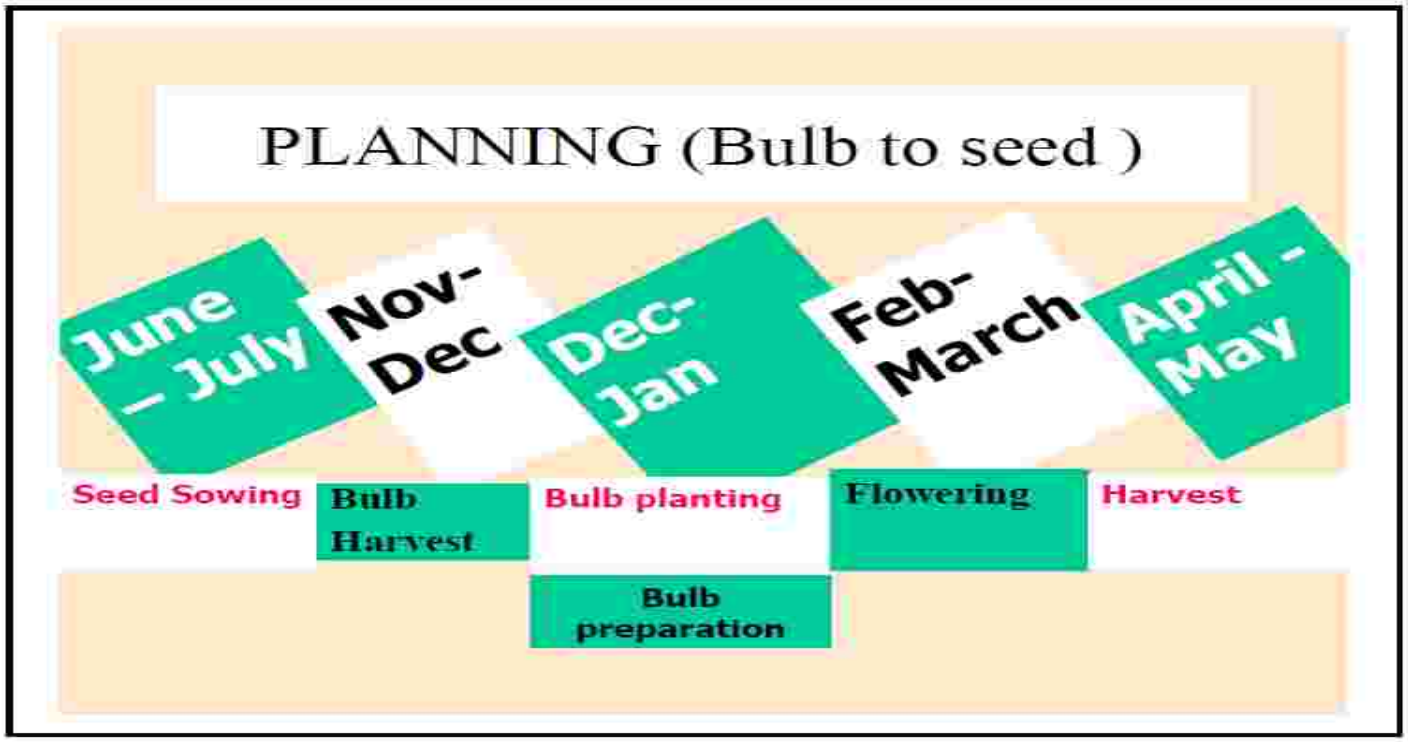
There are two methods of seed production

1. Seed to seed method

In this method, the first season bulb crop is left to over-winter in the field so as to produce seed in the following season.

2. Bulb to seed method

The bulbs produced in the previous season are lifted, selected, stored and replanted to produce seed in the second year. Mostly the bulb to seed method is used for seed production because of the following advantages over the seed to seed method. a) It permits selections of "true-to-type" and healthy bulbs for seed production. b) Seed yields are comparatively very high. The seed to seed method, however, can be practiced for varieties having a poor keeping quality.



Bulbs to Seed Method

Production and storage of bulbs (first year)

Sowing time (nursery)

Middle of October to middle of November in the plains and April to June in the hills. 1/20 hectare nursery is sufficient for raising seedlings for one hectare.

Seed rate

Eight to ten kg per hectare.

Seed treatment

Soaking of Bellary onion (cv. Rampur Local) seeds with 100 ppm GA_3 for 3 hrs increased the germination (from 50 to 90 per cent) and vigour.

Fertilization

Add 20 tonnes of well-rotted farmyard manure at the time of land preparation and 250 kg super phosphate (single) and 45 kg potassium sulphate at the time of planting. 250 to 375 kg of ammonium sulphate or CAN may be applied as top-dressing in two to three doses during the growing period.

Transplanting

Eight to ten weeks old seedlings are planted in small beds in well-prepared fields.

Spacing: Spacing depends upon variety and bulb size and varies from 10 to 15 cm.

Irrigation

Fortnightly irrigation during winter weekly irrigation during hot weather. Irrigate sparly during maturity.

Interculture

Keep field free from weeds. Frequent inter culture is essential for good bulb development. For controlling weeds, post-emergence application of tenoran at 2 kg per hectare in 800 liters of water, two to three weeks after transplanting is recommended. Oxadiazon one kg active ingredient per hectare has also given for effective control of weeds.

Harvesting and curing of bulbs

Well-matured bulbs should be harvested. Maturity is indicated by the tops drooping just above the bulb, while the leaves are still green. After harvesting, the bulbs should be topped leaving a half inch neck. Before storage, a thorough selection and curing of bulbs should be done. The length of time required for curing depends largely on weather conditions and may take three to four weeks.

Storage

The essentials of successful storage are

a. The bulbs should be well-matured, dried and cured before storage.

b. Storage should be well-ventilated.

c. Storage should be done in shallow trays with perforated bottoms.

d. Storage temperatures should range 0 to 4.5° C until three to four weeks prior to planting, when the temperature should be increased to around 10° C.

Planting of bulbs and seed production (second year)

Time of planting bulbs

The best time for planting bulbs is the second fortnight of October.

Preparation of land

Prepare the field to good tilth. One deep ploughing, followed by three to four harrowings and land levelling are enough.

Seed rate

The seed yield is affected by the size of the bulb. The bigger the bulb size, the higher is the seed yield. However, very large sized bulbs, if used, will need very high seed rate. If bulb size of 2.5 to 3.0 cm diameter, is used for planting, approximately 15 quintals of bulbs per hectare are required.

Fertilization: Same as described for first year.

Method of planting and spacing

Selected bulbs are planted 8 to 10 cm deep in the soil at a distance of 45 x30 cm. The size of beds depends upon the source of irrigation. The sprouted bulbs are planted as such. In unsprouted bulbs, the upper half portion should be removed,

leaving the disc-like stem and roots intact. The removal of the upper tops hastens sprouting.

Foliar application

Foliar application of GA3 (100 ppm) (or) IAA (100 ppm) increase the seed setting per centage.

Interculture

Rouging

First year: It is desirable to begin roguing in the field before bulbs are harvested, since itis then possible to detect any plants having a different foliage colour or plant type or late maturing bulbs. After harvesting, the bulbs should be carefully rogued for colour and such off-types as thick-necks, doubles, bottlenecks, as well as any other types which do not conform to varietal type.

Second year: plant only selected true-to type bulbs and remove plants not conforming tovarietal characters before flowering.

Specific field standard

Field standard	
Other variety bulbs (max.)	0.2%
Off types (max.)	0.2%

Harvesting and processing

The maturity of seed ready for harvest is indicated when (April-May). On full maturity, the seeds turn into black colour. The matured seed bunches are harvested before shattering and dried .under shade. Normally twoto three harvest are required depends up on the maturity of the seed. Harvest the seeds at intervals by cutting the seed head with 10-15 cm of stem attached. The harvested umbels are heaped for a few days for drying before threshing. This helps in proper curing of seedthen the seeds are separated from the capsules byhand threshing or using pliable sticks. The seeds are cleaned, graded by using 10 x 10BSS sieve, dried to 6-8 % moisture content and treated with Bavistin / Thiram @ 2-3 g/kg of seed.

Seed Yield

The average seed yield varies from 850 to 1000 kg per hectare.

Seed standards: (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed (min)	98%	98%
Inert matter (max)	2%	2%
Other crop seeds (max) no/kg	5/kg	10/kg
Weed seeds (max) no/kg	5/kg	10/kg
Germination (min)	70%	70%
Moisture (max)	8%	8%
For VP container (max)	6%	6%

Varietal and hybrid seed production in amaranthus

Amaranthus (*Amaranthus tricolor / A. cruentusl, A. blitum var. oleracea*)

Botany

Amaranthus is self pollinated crop and flowers are protogynous with stigma in pistillate flowers becoming receptive several days before opening of staminate flowers. Arrangements and sequence of anthesis favours a combination of self and cross pollination *viz.,* the maturation takes place from bottom to top. The transfer of pollen among the cymes of same inflorescence is favoured by wind leading to self fertilization. The dehiscence of anthers and release of pollen grains are maximum between 11a.m to 1p.m.

Since it is a monoecious plant bearing both male and female flowers on the same inflorescence and hence it was very important that emasculation was done before anthesis to avoid setting of the female parent in hybridization programme. After emasculation, the flower heads are bagged with butter paper bags.

Varieties

CO-1, CO-2, Chotti Chauli, Badi Chauli, CO-3, CO - 4, CO- 5 Pusa Kirti, Pusa Kiran, Pusa Lal Chaulai,

Isolation Requirement

A minimum isolation distance of 400 meters and 200 meters for foundation seed and certified seed class respectively is required.

Season

February- March, May-June, **Seed rate :** 1.5-2.5 kg per hectare

Method of sowing

Amaranthus seeds are very small and therefore mixed with fine soil or sand for even distribution. Seed crop should be sown in rows 25-30 cm apart. At the time of sowing there should be enough moisture in the field for proper germination.

Manuring

Generally the crop is grown on residual fertility of the previous crop. However when manured, 20-25 tons of FYM per ha may be applied at the time of land preparation. Later on 100 kg Ammonium sulphate per ha may be top dressed between rows just before irrigation.

Irrigation

Irrigation is given once in a week. Flowering and seed filling are the critical stages of irrigation.

Roguing

A minimum of two inspections during vegetative stage followed by flowering stage is to be carried out. Rouge out off types and wild *Amaranthus spp.* from seed fields prior to flowering and during flowering.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Objectionable weed plants	0.010%	0.020%

Harvesting and threshing of seeds

The crop is harvested when most of the leaves turn yellow. The plants after cuttings are left on the threshing floor for few days to dry. When the plants are fully dried the seeds are separated by beating them with sticks. The seeds are then cleaned by winnowing.

Seed yield: 2-3 quintals per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed	95%	95%
Inert matter	5%	5%
Other crop seed	5/kg	10/kg
Total weed seed	10/kg	20/kg
Objectionable weed seed	5/kg	10/kg
ODV	10/kg	20/kg
Germination	70%	70%
Moisture	8%	8%
For VP Container	6%	6%

Vegetable cowpea (*Vigna unguiculata* L.)

Botany

Vegetable cowpea is a self-pollinated crop. The flowers of cowpea are hermaphrodite and opens between 7.00 to 9.00 am. The time of dehiscence of anthers is from 10.00 am to 12.45 pm. The dehiscence takes place before flower opening.

Isolation distance

50 m for foundation seed and 25 m for certified seed production.

Climate and Soil

Vegetable cowpea is a warm season crop and therefore it can be grown both in spring and in rainy seasons in the plains of India. It cannot tolerate cold weather, heavy rainfall and water logging.

Method and time of sowing

The seeds are dropped in the furrow in such a way that maintains distance approximately 10 to 15 cm in the rows which are at 40 to 60 cm apart for rainy season crop whereas summer crop is sown at the row distance of 25 to 30 cm.

Seed rate

The requirement of seed for spring season crop is 20 to 25 kg/ha and for rainy season crop is 12-15 kg/ha.

Manuring

Vegetable cowpea responds well to an addition of manure and fertilizers. Application of 25 to 30 t/ha FYM improves the yield and quality of cowpea. About 20-25 kg nitrogen and whole dose of phosphorus (50-60 kg/ha) and potassium (50-60 kg/ha) are applied in soil during the last field preparation (6.1). Cowpea is highly sensitive to Zn deficiency. Application of 10 to 15 kg zinc sulphate per hectare would be beneficial.

Roguing

The seed crop of cowpea is rogued out for all off-types and diseased plants form the crop before flowering and during flowering. When the pods mature, at this

stage off-types can be detected.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Harvesting

The seed crop of cowpea matures in 75 to 125 days, depending upon the season and the variety. The pods turned into straw colour. Entire plant is harvested at the ground level and are allowed to dry in the field or heaped at one place in threshing floor for drying.

Threshing and winnowing

The dried material is threshed by thresher or trampled. By winnowing all inert matter, chaffy seeds etc. are taken out.

Drying

Cleaned seed of cowpea is spread on tarpaulin for drying till 10 percent moisture remained in seed.

Seed yield

Seed crop of cowpea produces about 10-15 quintals of seed per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None
Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%
For vapour proof container (max.)	8%	8%

French (garden) bean (*Phaseolus vulgaris*)

Botany

The French bean is also known as garden bean, snap bean, kidney bean, haricot bean, navy bean, string bean. French bean flowers are cleistogamous, but they are self-compatible and self-pollinated although some chances of cross-pollination (1.1%)

Isolation distance

Isolation distance of 50 metres for foundation seed and 25 metres for certified seed crop.

Method and time of sowing

French bean can be sown twice in a year, i.e., in January - February and July - September in the plains and March - June in the hills.

Distance of sowing

Bush types are planted at 45-60 cm x 10-15 cm (row x plant) whereas pole types at 100 cm x 22-30 cm.

Nutrition

Nitrogen at higher level decreases nodulation. But nitrogen at low level enhances microbial activity in the soil and plants while phosphorus at double the level than nitrogen required for better up take of nutrient and nodulation. Similarly, potassium plays important role for higher seed yields. Potassium has also been found to induce early flowering.

	(kg/ha)	P (kg/ha)	K (kg/ha)	FYM (t/ha)
Hills	180	125	100	30
Plains	100	100	50	12.5

Roguing

Roguing is performed at four stages. They are

1. Before flowering

The first roguing is done before flowering. This is based on plant habit, vigour, according to type (bush type or pole type), leaf shape and colour. Besides, severely affected plants by diseases particularly seed borne diseases.

2. At flowering

At this stage, plants are removed on the basis of vigour and flower colour, and plants affected with seed borne diseases.

3. At pod developing stage

At this stage, plants are removed based on pod characters such as pod shape, colour and plants affected with seed borne diseases.

4. At maturity

At this stage, later flowering and late maturing off-types can easily be detected, which are removed.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Harvesting

Harvesting is done when pods are fully ripe and have turned yellow i.e. about to shatter. Crop is harvested manually or by machine. The harvested plants are staked for 7-10 days for drying.

Threshing

Fully dried matter is threshed either by bullock or by threshing machine.

Seed yield

The average seed yield of French bean is about 12 to 18 quintals per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None

Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%
For vapour proof container (max.)	8%	8%

Seed production in Cabbage and Cauliflower

Cabbage (*Brassica oleracea* var. Capitata)

Botany

Cabbage is highly cross-pollinated crop and pollination is entomophilous. Pollen fertility is maximum on the day of anthesis. Stigma is receptive 2-3 days before to the day of anthesis. Anthesis occurs 8.00 -10.00 hr.

Method of seed production

Cabbage requires two seasons to produce seeds. In the first season the heads are produced and in the following season seed production follows. Two methods are followed.

1.	*In-situ* method	- for certified seed production
	(Seed to seed method)	
2.	Transplanting method	- for nucleus seed production
	(Head to seed method)	

In-situ method

In this method, the crop is allowed to over-winter and produce seeds in their original position, where they are first planted.

Transplanting method

In this method the matured plants are uprooted and the outer whorls removed. Then the plants are replanted in a well prepared new field. In cabbage, during seed production, three methods have been followed to facilitate flowering and seed production.

1.Stump method

When the crop in the first season is fully matured, the heads are examined for true to type. The plants with off type heads are removed. Then the heads are cut just below the base by means of a sharp knife, keeping the stem with outer whorl of leaves intact. The deheaded portion of the plant is called 'stump'. The stumps are either left

in-situ or replanted in the second season. After over wintering (dormancy breaking), the buds sprouts from the axis of all the leaves and leaf scars.

Advantage

Gives extra income by way of sale of heads

Crop matures 12-15 days earlier

Seed yield is slightly high

Disadvantage

Flower stalks are decumbent and requires very heavy staking

2.Stump with central core intact method

When the crop is fully matured in first season, off type plants are removed and rejected. Then the heads are chopped on all sides with downward perpendicular cuts in such a way that the central core is not damaged. When the head start bursting after over wintering, two vertical cross cuts are given to the head, taking care that the central growing point is not injured. In the absence of such cuts, the heads burst out irregularly and sometimes the growing tip is broken.

Advantages

Shoots arising from main stem are not decumbent, hence very heavy staking is not requiredSeed yield is high

Disadvantages

The chopped heads cannot be marketed

3.Head intact method

In this method, when the crop is fully mature in first season, the heads are examined for true to type. The plants with off type heads are removed from the field and rejected. The head is kept intact and only a cross cut is given to facilitate the emergence of stalk.

Advantages

Saves time and labour

Very heavy staking is not required

Disadvantages

Seed yield is slightly low as compared to other methods

Stages of seed production: Breeder seed Foundation seed Certified seed

Varieties/ Hybrids

Early: Golden Acre, Pusa Mukta, Chaubatia Early

Mid: Pride of India, Pusa Drum Head, Aru Glory, Green Express

Late: Large Late Drum Head, September, Green Challanger, BSS-50, BSS-32,BSS-44, BSS115, Sri Ganesh Gol

Red cabbage: Red Acre

Season: Early varieties (Golden acre) second fortnight of July -10th, 25thJuly
Medium varieties second fortnight of June – 1st – 15th June
Late varieties first fortnight of June -15th – 30th June

Land requirement

In the hills, select field on which the same kind of crop or any other cole crop was not grown in the previous two years, unless the crop within the previous two years, was field inspected by the certification agency and found not to contain seed born diseases infection beyond the maximum permissible limit.

Isolation requirement

The seed field must be separated from fields of other varieties at least" by 1600 m for foundation class and 1000 m for certified class seed production.

Seed rate:	Early varieties	- 600 g/ha
	Late varieties	- 400 g/ha

Seed treatment

Some seed borne pathogens such as black rot, black leg and alternaria leaf spot start invading the seedlings blight from germination of seed. Pre-drying of seeds at 40 ^{0}C for 24 hr followed by an air treatment at 75 ^{0}C for 5-7 days is an effective method to disinfect cabbage seeds infected by black rot without any seed damage. Hot water treatment to seeds at 50^{0}c for 30 minutes is done to prevent seed-borne

pathogens. Immediately after the treatment, the seeds should be used for sowing within 24 hr. After hot water treatment seed can be treated with a fungicide like Captan before sowing to protect the seedlings from damping – off and downy mildew respectively.

Nursery:

Seeds may be sown on raised nursery beds 15 - 20 cm height in rows with 10 cm spacing. Twenty five nursery beds of 2m x 1m size are enough for one hectare. Thin sowing should be done to avoid damping - off.

Transplanting:

Three to four weeks old seedling (25-30 days old) are transplanted, preferably in the evening with a spacing of 60 x 60 cm for late varieties, 60 x 40 cm for medium varieties and 45 x 45 cm for early varieties .

Transplanting at 2nd fortnight of August for early varieties and 1st week of August for both medium and late varieties are advisable.

Main field manuring

The field should be prepared to fine tilth by deep ploughing, three to four harrowing followed by leveling. Cabbage crop requires heavy manuring. At the time of land preparation, 50-60 t of FYM/ha should be applied. 200-300kg Super phosphate and 90 kg of potash should be applied before transplanting of seedlings. Two doses of 75-100 kg Ammonium sulphate at intervals of 2-3 weeks after transplanting the seedlings should be applied. Another dose of 200-250 kg Ammonium sulphate as surface application at the time of seed stalk emergence.

Staking

After the flower stalks are sufficiently developed, staking is necessary to keep the plants in an upright position.

Foliar spray

50 ppm NAA sprayed twice after two and four weeks of transplanting the cabbage seedlings in the field has beneficial effect on better growth and yield of cabbage varieties. The favourable temperature range for flowering and seed setting is 12.5 – 18.5^{0}c.

Roguing

The first roguing is done at the time of handling the mature heads. All off type plants, diseased or undesirable types are removed at this stage. Second roguing is done before the heads start bursting the loose-leaves poorly heading plants and those having a long stem and heavy frame, most by rogued out at this stage,

subsequent roguing for off types, diseased plants affected by phyllody, black-leg, black rot, soft rot or leaf spot should be done from time to time as required.

Field Standards

Factors	Foundation stage	Certified stage	Remarks
Off-type	1.00	0.50	
Other crop plants	-	-	
Objectionable weed plants	-	-	
Diseased plants	0.10 *	0.50*	* At and after flowering and maturity stage

Harvesting and processing

The harvesting may be done in two lots. Generally the early matured plants are harvested first, when the pods turn into brown colour. After harvesting it is piled up for curing. After 4 to 5 days it is turned upside down and allowed for further curing for 4 to 5 days. Then the pods are threshed with pliable sticks and shifted with hand sifters. Then the seeds are dried to 7% moisture content, cleaned and treated with Bavistin @ 2 g/ Kg of seed.

Seed Yield

The average seed yield varies from 500 to 650 kgs per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	7%	7%
For VP Container(maximum)	5%	5%

Cauliflower (*Brassica oleracea* var. Botrytis)

Botany

Cauliflower is highly cross-pollinated crop due to self-incompatibility. Flower is protogynous in nature. Stigma remains receptive 5 days before and 4 days after opening of the flower. The time taken from pollination to fertilization is 24-48 hours depending upon the temperature. The optimum temperature for fertilization and seed development is 12° C - 18° C. Bees are the major pollinators.

Method of seed production: There are two methods of seed production

1. In situ method (seed to seed method)
2. Transplanting method (Head to seed method)

For seed production, seed to seed method is recommended since the head to seed method in India has not been very successful. In seed to seed method (In situ method) the crop is allowed to over winter and produce seed in the original position, where they are first planted in the seedling stage.

Stages of seed production: Breeder seed ▶ Foundation seed ▶ Certified seed

Varieties

Early: Early Kunwari, Pusa Katki, Early Patna, Pusa Deepali, Pusa Early Synthetic,Pant Gobhi3, Improved Japanese.

Mid season: Pant Shubhra, Pusa Synthetic, Pusa Shubhra, Pusa Aghani, Selection 235S,Hisar No.1, Pusa Himjyoti.

Late: Snowball-16, Pusa Snow ball-1, Pusa Snowball-2, PSK-1, Pusa hybrid -2

Hybrids: Pusa synthetic, Pusa hybrid 1 and 2

Season

In the hills, the last week of August is the optimum sowing time. The seed is sown in a nursery and transplanting should be completed by the end of September. For early varieties (in plains) best season for sowing is the last week of May and transplanting should be completed during first week of July. In hills, sowing should be adjusted that the plants put up the maximum leafy growth by 15th December when the temperature goes down and plants become dormant for which last week of August is optimum and transplanting should be completed by the end of September. The mean temperature of 6.5 to 11° C during February to March is very conducive to curd formation.

Land requirement

In the hills, select field on which the same kind of crop or any other cole crop was not grown in the previous two years, unless the crop within the previous two years, was field inspected by the certification agency and found not to contain seed born diseases infection beyond the maximum permissible limit.

Isolation requirement

Cauliflower is mainly a cross pollinated crop. Pollination is chiefly done by bees. The seed field must be separated from fields of other varieties at least by 1600 m for foundation class and 1000 m for certified class seed production.

Seed rate

375 to 400 g /ha.

Nursery

Seeds may be sown on raised nursery beds 15-20 cm height in rows with 10 cm spacing. Twenty five nursery beds of 2 to 2.65 m x 1 to 1.25 m size are enough for one hectare. Thin sowing should be done to avoid damping - off. Three tonnes of FYM should be applied to nursery bed. DAP spray at 10 to 15 days after germination is important. Apply lime @ 5 t/ha before one month to nursery field and apply Borax and Sodium molybdate @ 4 kg/ha before sowing.

Transplanting

Transplant the seedlings at 35-40 days old preferably at evening time with the spacing of 60 x 45 cm (for early varieties in plains) or 90 x 60 cm for late variety and irrigate immediately after transplanting.

Main field manuring

The field should be prepared to fine tilth by deep ploughing and three to four harrowing followed by levelling. Cauliflower crop requires heavy manuring. Apply 50-60 tons of FYM/ha at the time of land preparation.

Foliar application

NAA @ 40 ppm sprayed at 30 days after curd initiation was superior in increasing the yield and quality of seed.

Roguing

Minimum of four inspections are required viz., pre-marketable stage, initiation of curd stage, curd formed stage and flowering stage. Roguing should be done based on the curd size, shape and colour, when fully developed. Off type plants with poor curd formation and plants affect by designated diseases like black leg, black rot, soft rot, leaf spot and phyllody should be removed during roguing.

First roguing is done after curd formation. Plants forming loose ricey, fuzzy and buttons are rejected. Blind, deformed and diseased plants are also rejected. Second roguing is done after bolting but before flowering, plants with peripheral and uniform bolting are kept for seed production. Early and late bolters are also rejected.

Field standard

Contaminants	Maximum permitted (%)	
	Foundation	Certified

Off types *	0.10	0.20
Plants affected by seed borne diseases **	0.10	0.50
Plants affected by phyllody **	0.1	0.5

Blanching: Blanching refers to covering of curds. A perfect curd of flower is pure white.It is necessary to exclude sunlight to obtain this. The common practice is to bring the outer leaves up over the curd and tie them with a twine or rubber band. By using a different coloured twine each day. It is easy at the time of harvest to select those tied earlier.

Scooping

Scooping central portion of curd when it is fully formed helps in the early emergence of flower stalks in hills. Scooping is normally not required for seed production in plains. Scooping curd pruning and half curd removal were effective in increasing the seed yield. However, scooping of curd was best compared to other methods.

Harvesting and processing:

The ripened fruit is called siliqua. Harvesting may be done in two lots. Heavy bearing may topple the plants, hence staking may be done wherever necessary. Wind belts can also be erected if needed. Generally the early matured plants are harvested first, when the siliqua turn in to brown colour. Delayed harvest results into seed shattering and bird damage. Hence, 2-3 harvestings are required. About 50 days are needed for pod maturity after fertilization. Seeds of early types are ready for harvesting in December - January and in February- March for North Indian Plains. However, snowball types are ready for harvesting by June. As harvesting is done when bottom siliqua turn brown followed by yellowing of the top siliqua, curing is necessary for ripening the late maturing siliqua. After harvesting, plants are piled up for curing. After 4 to 5 days it is turned upside down and for further curing for 4 to 5 days. The siliqua are threshed with pliable sticks and cleaned. Then the seeds are dried to 7% moisture content, cleaned and treated with Bavistin @ 2 g / Kg of seed.

Seed yield of Indian cauliflower may vary between 500-600 kg/ha and snowball from300- 500 kg/ha.

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination (minimum)	65%	65%
Moisture (maximum) (normal container)	7%	7%
For VP Container(maximum)	5%	5%

Hybrid seed production in Cauliflower

1.Manual emasculation and pollination

Initially the method was adopted for producing F1 hybrids. Since much labour is involved, which results in lesser quantity of seed and escalades production cost. Hence, it is not practicable on commercial scale.

2. Hand pollination without emasculation

Where male sterility is available, the process of emasculation is eliminated. Male sterility is the absence of non-function of pollen in platns, which can be used for commercial hybrid seed production. In cole crops, male sterility is controlled plants by a single recessive gene ms which is mutated from the fertile gene Ms. Male sterile plants are female fertile but their flowers and anthers are slightly smaller than those of male fertile one.

3. Cytoplasmic male sterility

Cytoplasmic male sterility has not apparently been found in cauliflower, but it has been introduced from several sources. Pearson crossed *Brassica oleracea* with *Brassicanigra* and derived male sterile material. This character was bred into broccoli and laterinto cauliflower.

Free insect pollination

Free insect pollination is feasible to produce F1 hybrids under natural conditions. But this can only be used when self incompatible lines are available.

Self Incompatibility

It is genetically controlled physiological hinderance to self-fruitfulness or self fertilization. Cauliflower, broccoli and other Brassica vegetables posses homomorphic sporophytic incompatability controlled by one locus with multiple alleles. The sporophytic system, which operates in these crops, are utilized in making single, double and triple cross hybrids for commercial seed production. Production of hybrid seed involves.

1. Selection of parents development of homozygous self-incompatible lines by inbreeding and their maintenance.
2. Making diallel or top crosses using these incompatible lines
3. Testing of F1 hybrids in replicated trials along with parents and check cultivars
4. Production of F1 hybrid seed of the recommended F1 hybrid on the basis of trial using self- incompatible under local conditions.

Seed production in carrot and radish

Carrot (*Dauccus carota* L.)

Botany

Cross pollination is due to protandrous flowers. Anthesis takes place in the

morning hours. The stigma becomes receptive on the fifth day after flower open and remains active for 8 days, but better fruit sets are from pollination on 6 to 11 days after flower opening. The inflorescence is a compound umbel.

Flowering

The individual carrot flowers, in common with most other species in *Umbelliferae*, are borne on terminal branches in compound umbels. There is a distinctorder of flowering, which relates to umbel position. The first umbel to flower is the primary (sometimes referred to as the 'king' umbel) that is terminal to the main stalk. Branches from the main stalk from secondary umbels, and subsequent branches from these form tertiary umbels. Quaternary branches and umbels may also be formed.

Pollination and Pollinating Insects

Individual carrot flowers are normally protandrous and much crosspollination occurs between plants in a seed crop. However because of the extended flowering period resulting from several successive umbels per plant and the succession of flowers on individual umbels, the possibility of self-pollination always remains.

Occurrence of pollinating honeybees, efficient pollinators are frequently scarce on carrot crops because other crops species were flowering in the vicinity at the same time. Several insect genera in *Dymenoptera, Diptera*&*Coleoptera* are extremely important pollinators of carrot seed crops, in the absence of bees.An adequate presence of pollinating insects improves both seed yield and seed quality. Where natural insect pollinator populations are low placing honeybee colonies would be advantageous.

Seed production

The seed production is taken in the hills for European types and in the plains for Asiatic types. European types require high chilling of 4-7° C for a period of about 2 months. The summer and low rainfall of hills especially during flowering and seed setting stages are beneficial.

Method of seed production

1. Seed to seed (In situ method), 2. Root to seed (Transplanting of cut root)

Stages of seed production Breeder seed → Foundation seed → Certified seed

Varieties

Ooty 1, Pusa kesar, Zeno, Panvers, American beauty, Imperator

Hybrids

Pusa hybrid-1

Season

The ideal season for sowing to take up seed production is July-August

Land requirement

There are no specific requirements, but the land should be free of volunteer plants.

Isolation requirement

The minimum isolation distance required for carrot seed production is at least 1000 m for foundation and 800 m for certified seed production. Because of the high possibility of cross pollination, isolation distances for commercial seed crops should be 1000 m. For nucleus seed the distance should be at least 1600 m. In areas that specialize in carrot seed production the different cultivars within the same type can be zoned; this minimizes cross pollination between the different types. Cultivated carrots cross pollinate very readily with the wild carrot and this must be taken into account whenchoosing sites for seed production. Contamination of seed crops by wild carrot pollen is a major reason for genetic deterioration of seed stocks in some areas.

Seed production methods

There are two methods of seed production.

Seed to seed method:

The crop is sown as per climatic conditions of the area. For temperate varieties in Himachal Pradesh sowing is done in the month of October and November. Crop is left in the field for flowering and seedling. The roots cannot be inspected (or) rogued.

Seed rate

2-3 kg/ha. Row spacing of 50-90 cm are used with a sowing rate of 2-3 kg per hectare. Soaking seeds in water for 72 h with a change of water every 24 h leached off the inhibitors will improve germination.

Root to seed method

This system is similar to raising carrot crop for fresh roots as far as timings are concerned but the plants (steckling) are raised in beds and transplanted in the spring. Depending on local customs and winter conditions and stecklings are either left in situ during winter or lifted in the late autumn and stored until replanting in the spring.

The transplanted steckling rows are 75 cm apart with 30 cm between plants. The seed. Raising stecklings that are later transplanted from their beds offer the opportunity for roguing plants with undesirable root or foliage characters while lifting and planting.

Roguing

Minimum of 3 field inspections should be done at 20-30 days after sowing, when roots are lifted and replanted and flowering stages. Roguing should be done based on the root colour, shape, skin colour, flesh colour of the root and bolting characters and removed.

Field standards

Contaminants	Minimum distance (meters)			
	Mother root production stage foundation certified		Seed production stage Foundation certified	
Field of other varieties	5	5	1000	800
Fields of the same variety not conforming to vareital purity requirements for certification	5	5	1000	800

Seed to seed production

Very little if any roguing can be done when the crop is grown on without lifting. But plants bolting early and those with a typical foliage characters should be removed. If the crop is lifted and replanted it is rogued as described below for root to seed, but very little confirmation of root type can be done.

Root to seed production

During the first year growing season. a) Remove plants displaying typical foliage, remove plants bolting in the root development stage. b) After the roots have been lifted inspect for trueness to type, according to root shape, colour and size, discard roots showing poor colour, green shoulder, incorrect colour, off coloured shoulders (purple, green), split or fanged roots or those with rough surfaces.

Hybrid seed production in carrot

The production of hybrid seed by hand emasculation and pollination is not possible commercially as the flowers are very small and single pollination gives only one or two seeds. In carrot, the inflorescence is compound umbel.

Sufficient buds in the female parent at peak stage of flowering are emasculated and the remaining young ones are removed. Then a cloth / paper bag is placed over the umbel of male parent and shaken to dislodge the pollen onto the sides of the bag. This bag is then used to enclose the emasculated umbel of the female parent. Apart from this, daily for a few days in the morning, the male umbel is gently rubbed over the female to ensure cross pollination. Sometimes when the pollen parent possesses some dominant marker gene with the help of which the hybrids can be distinguished in the seedling stage, it is not necessary to emasculate the flowers.

Hybrid seed production

In the heterosis breeding programme 3 lines are used, namely the male sterile line (A), male fertile sister line (B) and the pollinator line (C) that is male fertile has a good combining ability with the male sterile line. The male sterile and pollinator lines are grown in alternate rows of 4:1 or 8:2 and the hybrid seed is harvested from female line only.

Manuring

First season: A light does of 20-25 tons of FYM per ha should be applied before field preparation.

Nitrogen - 75 kg/ha (35 kg basal + 35 kg top dressing)
Phosphorus - 50 kg/ha (basal)
Potash - 50 kg/ha (basal)

Second season (During transplanting)

Farm yard manure -10 to 15 tons /ha

Nitrogen - 50 kg (25 kg at pre-bolting + 25 kg before flowering)

Phosphorus - 50 kg (basal).

Supplementary pollination

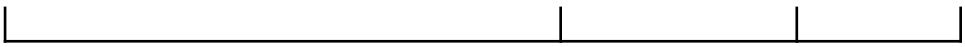
Since the honey bees are important pollinating agents. It is advisable to placebeehives in the large seed fields or near by the field to increase the pollination. It isnecessary when the temperature is below 15°C. Spraying of 150 ppm NAA at boltingstage also improved the seed setting percentage

Harvesting and processing

The crop matures unevenly. Seeds are harvested when the secondary umbels (heads) are fully matured (brown) and the tertiary umbels are beginning to turn brown. Hence 2 to 3 picking may often be necessary. After drying seed heads are threshed, cleaned and rubbed by hand to remove the bristles. The seeds are dried to 8% moisture content and treated with Bavistin @ 2 g per kg of seed.Size grading of seeds with BSS 12 wire mesh sieve or density grading at 0.5 inches of water pressure found to be optimum to upgrade carrot seeds.

Seed standards: (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed (minimum)	95%	95%
Inert matter (maximum)	5%	5%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	60%	60%
Moisture (maximum) (normal container)	8%	8%
For VP Container(maximum)	7%	7%



SEED PRODUCTION OF CUCURBITACEOUS VEGETABLES

Land Requirements: There are no land requirements as to previous crop, but the land should be free of volunteer plants. Generally the soil should be well drained and aerated.

Isolation Requirements: Most of the cucurbits are monoecious in character and a few are dioecious. A number of **hermaphrodite and andromonoecious** cultivars are also available in some crops. Pollination is largely done by insects. For pure seed production and isolation distance all around seed field is necessary to separate it from fields of other varieties, fields of the same variety not conforming to varietal purity requirements for certification, from wild cucurbit species, and to separate musk melon from long melon and vice versa, and pumpkin from summer and winter squashes and vice versa as follows

Class Minimum distance (meters)

Foundation - 1000

Certified - 500

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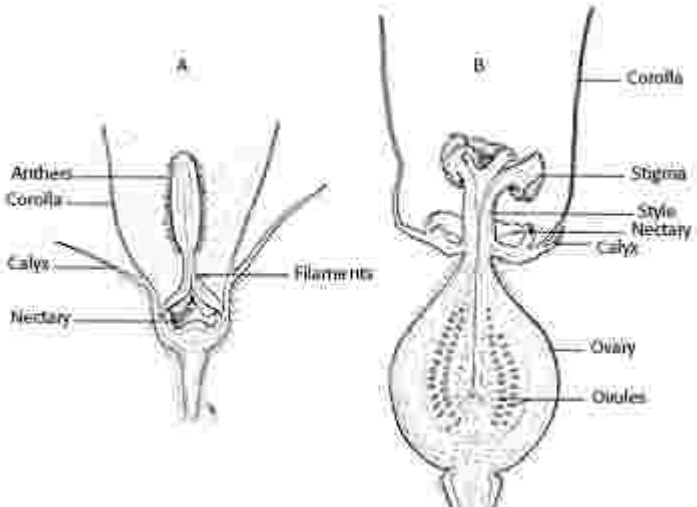
Flower structure in cucurbits



GENETIC PURITY AND SEED HEALTH STANDARDS FOR CUCURBITS

Factors		Minimum permitted level(%)
	FS	CS
Open pollinated variety		
Off-type	0.10	0.2
Objectional weed plant	None	None
Hybrids		
Off-type in seed parent	0.01	0.05
Off-type in pollen parent	None	0.05
Pollen shedders in seed parent	-	0.10
Seed borne diseases ***		
Muskmelon *	0.1	0.20
Summer squash **	0.1	0.5

Cucumber mosaic virus ,** Cucumber mosaic virus, watermelon mosaic virus

SEED CERTIFICATION STANDARDS IN INDIA FOR CUCURBITS

Factors		Minimum permitted level (%)
Foundation seed		Certified seed
Pure seed (minimum)	98	95
Inert matter (maximum)	2	5
other crop seed (maximum)	None	None
Weed seed (maximum)	None	None
Other objectional varieties (only forhybrids)	5/kg	10/kg
Germination (minimum)	60	60
Moisture for ordinary pack (maximum)	7.0	7.0
Moisture for vapour proof pack (maximum)	6.0	6.0

Seed production details in Cucurbitaceous vegetables

Particulars	Bittergourd	Snakegourd	Ribbedgourd	Ashgourd / Pumpkin
Isolation	Foundation seed 1000 m and certified seed 500 m			
Season	June - July and Feb – March			

Varieties	CO1, MDU1, Coimbatore long green & long white	CO1, CO2, PKM1, MDU1	CO1, CO2, PKM 1	CO1, CO2
Seed rate / ha	2.5	2.5	2.5	2.5 / 1.0
female flower increased by	Spraying of Ethrel 200 - 250 ppm at two true leaf stage and after a week of 1st spray			
Spacing (cm)	Take pits of size 45x45x45 cm at 2.5x2.0 m distance			
Fertilizers / (NPK g/pit)	6:12:6	12:24:12	9:15:9	6:12:6
Physiological maturity	Change of fruit colour in any part or 1/3 of fruit tip to yellow to red	Complete drying of fruits	Change of fruit colour to orange brown in pumpkin and ashy coating and metallic sound in ashgourd	
Processing	Hand picking	Hand picking	BSS 4 wire mesh sieve	16/64 round perforated sieve
Fruit to seed recovery (%)	30	15-16	13-14	1.0-1.3
Seed yield (kg/ha)	120-150	220-250	200-250	120-150

Techniques of Hybrid Seed Production in cucurbits

i. Hand emasculation and hand pollination

This technique is frequently used for melon seed production. In this species, andromonoecious lines are common and they must be emasculated and hand pollinated if used as the female parent for producing hybrid seed. This method has

also been used for some watermelon and cucumber hybrids. This technique is applicable for limited scale production, since lot of trained labour are required in pinching, pollen collection and hand pollination.

ii. Hand emasculation and pollination by insect

The male flowers from female lines are pinched off day before of anthesis regularly, which honeybees and other insects (voluntary) uses as a pollinating agents. The male and female are grown in alternate rows. The fruit set on female lines are of hybrid and harvested for seed extraction. The planting ratio varies within the crops e.g. summer squash 3:1 and 4:1 in muskmelon and cucumber but depend upon the population of bees in plot. This technique is also used in bottle gourd, pumpkin, muskmelon, cucumber, summer squash and bitter gourd for hybrid seed production.

iii. Use of genetic male sterility system

Genetic male sterility system has been utilized for commercial hybrid production in muskmelon. The genetic male sterility in muskmelon is controlled bysingle recessive gene (msms). For hybrid seen production, the male sterile line is used as female parent. Since genetic male sterile line is maintained in heterozygous forms, 50% fertile plants are to be removed at flowering. The other 50% having non-dehiscent empty anther are retained in female rows. The female and male are grown in 4:1 ratio. However, to maintain the good plant population in female rows it is suggested that seed parent should be sown with double seed rate. It is also advised that female line seedling should be raised in polythene bags and transplanted at flower appearance in order to avoid the fertile plants in female rows. The pollination is done by honey bees and 1 to 2 medium sizes hives are good enough to ensure the good pollination and fruit set at female row.

The male sterile line is maintained in heterozygous form by crossing with maintainer line under adequate isolation distance or under cover.

iv. Use of gynoecious sex form

The gynoecious sex form has been commercially exploited in hybrid seed production of cucumber. For hybrid seed production female and male rows are planted in 4:1 ratio. The female (seed parent) bear only female flowers and pollination in done by insect (honeybee). To ensure the good fruit and seed recovery, the sufficient population of honeybee 1 to 1½ colony of medium size has to be kept

at the boundary of seed production plot to boost the amount of crossing. The parental lines i.e. male parent maintained by selfing (mixed pollination) and rouge out undesirable plants before contamination take place. The female lines i.e. gynoecious lines maintained by inducing the staminate flower through the sprays of silver nitrate 200 ppm at two to four true leaf stage and then selfing is carried out. It was observed that 10-11 male flowers appear per 100 nodes.

The performance of gynoecious lines is unstable under high temperature and long photo period conditions because of their thermo-specific responses for gynoecious stability. That is why the gynoecious cucumber did not receive much attention in the tropical countries. However, few true breeding tropical gynoecious lines in cucumber and muskmelon have been developed at IARI. As a result of development of true breeding line, muskmelon hybrid Pusa Rasraj was developed. These homozygous gynoecious lines are maintained by using GA

3, 1500ppm or silver nitrate 200-300 ppm or sodium thio sulphate 400 ppm to induce staminate flowers at two and four true leaf stage. Homozygous lines are planted in strict field isolation. The gynoecious lines are crossed with monoecious male parent to produce F1 hybrid.

v. Hybrid seed production through chemical sex expression

The hybrid seed can also be produce in cucurbits by the application of chemicals for attaining the sex of cucurbits. Specific chemicals are known to induce femaleness and maleness as desired. The spraying of ethrel (2-choloro-ethyl-phosphonic acid) 200-300 ppm at two and four true leaf stage and another at flowering is useful for inducing the pistilate flower successively in first few nodes on the female in bottle gourd, pumpkin and squash for F1 seed production. The row of male parent is grown side by the side of female and natural cross pollination is allowed. In the absence of insect, hand pollination is possible when two sexes are separate. Four to five fruit set at initial nodes are sufficient for hybrid seed. The complete suppression of male flowers in squash can be achieved by applying ethrel at higher concentration (400-500 ppm) twice.

The other chemicals like GA3, (10-25 ppm) in cucumber, MH-(100 ppm), ethephon (600 ppm) in squash induces female flowers.