Lecture 1-2

History of seed industry of India,Defination of seed and Difference between grain and seed and classes ,types of seed

History of 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.

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	Association of Official Seed Analysts was established for evaluation of seed testing procedures
1939 -1945	In India, temperate vegetable seeds were imported
1942	Seed production of temperate vegetable varieties was started at Quetta (Pakistan), as the seed supplies were cut-off due to World War-II.
1942-1943	Seed production programme started at Katrain (Himachal pradesh) and Kashmir Valley and the Vegetable seed industry made a rapid progress.
1946	All India Vegetable Seed Growers, Merchants and Nurserymen's Association was established.
1947	Supplies of vegetable seeds were cut off from Quetta (Pakistan) after partition of the country.
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 Indian Agricultural Research Institute, New Delhi with a view to intensify the improvement work on temperate vegetables and renamed as IARI, Regional

Station.

1956	Second Five Year Plan started, with an idea to establish 25 acre farm in each Extension Service Block, setting up Seed Testing Stations to ensure vegetable seed quality standards, production of nucleus and foundation seed at block level, and distribution thereof among farmers.
1961	The first Seed Testing laboratory was established in IARI, New Delhi.
1961	The proposed Central Seed Corporation was approved by the Union Cabinet. Rock-Feller Foundation equipped the Seed Testing Laboratory, IARI, and was designated Central Seed Testing Laboratory. Systematic research work on temperate vegetables, sugar beet and chicory was initiated at Kalpa and Solan (Himachal Pradesh).
1961	Seed Multiplication Review Team stressed the need for intensive seed multiplication programmes for crop seeds.
1963	National Seeds Corporation was established to develop Indian Seed Industry.
1963	Scientific seed processing was initiated by NSC
1963-1964	NSC was made responsible for making available foundation seeds of crops including vegetables.
1966	Indian Seeds Act was passed by Government of India with a view to regulate quality of seeds on 29th December.
1967	The first Horticultural Research Institute in the country established by the Indian Council of Agriculture Research was called as Indian Institute of Horticultural Research is a premier Institute conducting basic, strategic, anticipatory and applied research on various aspects of fruits, vegetables, ornamentals, medicinal and aromatic plants and mushrooms.
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
1969	Establishment of Tarai Development Corporation (TDC) with world bank assistance with primary objective of production of quality seeds.
1970	All India Co-ordianted Vegetable Improvement Project (AICVIP) was established at IARI, New Delhi. A Center under AICVIP was stated at IARI, Regional Station, Katrain.
1971	The Central Seed Committee was framed by the Govt. of India to fix genetic purity standards of seeds. First Indian vegetable hybrid - *Pusa Meghadoot* in **Bottle gourd** was developed and released by the IARI, New Delhi.
1971	Indian Society of Seed Technology (ISST) was established to serve an educational link among Seed Technologists
1974	National Seed Project was launched by Govt. of India with the assistance of World Bank to develop seed production infrastructure.
1974-1975	NSC produced a record of 8000 tonnes of vegetable seeds of 28 kinds and 60 varieties. Similar quantity of vegetable seeds was produced by private seed sector.
1976	National commission on Agriculture submitted the report, reviewing all aspects of seed industry, including teaching, training and research. Maharashtra State Seed Corporation Ltd. was started under Companies Act with registered Head Office at Akola.
1983	Enactment of **Seed Control Order-** Seeds was declared an essential commodity.
1985	Y.S.Parmer University of horticulture and forestry was started at Solan
1986	Elevation of status of AICVIP, to the level of Project Directorate of

	Vegetable Research (PDVR).
1988	Announcement of New Seed Policy called New *Liberalized Seed Policy* by Govt. of India on seed development on 16th September. GOI liberalized vegetable seed imports, giving farmers very wide choice of seed. More conducive environment for international seed companies. A specially designed vegetable seed extraction machine (with axial flow) was developed at PAU, Ludhiana. Indian Minimum Seed Certification Standards published by the Central Seed Certification Board, Department of Agriculture and Co-op, Ministry of Agriculture, Govt. of India, New Delhi.
1989	There was 22.27% increase in vegetable production in India (over 1979 –81) Seed Industry sought further incentives / concessions
1992	De-linking of PDVR from IARI and shifted to Varanasi (UP.)
1994	A separate NSP on vegetables was approved and initiated by IIVR (PDVR), Varanasi.
2001	The protection of plant varieties and Farmers' Rights bill was formulated to establish an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants
2002	National Seed Policy – to provide appropriate climate for seed industry, safeguarding the interest of Indian farmers and conservation of agro biodiversity.
2004	The New Seed draft Bill was submitted to address all seed related issue which will replace all other existing Acts regarding seeds.
2005-06	National Horticulture Mission a centrally sponsored scheme was started by Government of India. It provides 100% assistance to the state mission during the Tenth Plan.
2007	Andhra Pradesh Horticultural University was started at West Godavari
2008	University of Horticultural Sciences was started at Bagalkot to promote horticultural studies
2010	National Conference on Production of Quality Seeds and Planting Material – Health Management in Horticultural Crops was held at New Delhi

Defination of seed

Seed is the basic and critical input in crop husbandry, which determines the expected dividends from all other inputs.

Agriculturally seed is the unit of propagation and can be any part of the plant (zygotic seed or vegetative propagules) which has the capability to regenerate into a new plant,but botanically it is defined as matured ripened ovule comprising living embryo embeded in the supporting food storage tissue with a protective coat .

It is primarily responsible for maintaining the physical, physiological and genetic characteristics of any variety / hybrid of any crop.

The differences between seed 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

Classes of seed

1. N**ucleus seed**

Nucleus seed isinitial amount of pure seed of improved variety or notified variety or parental lines of a hybrid produced under supervision of evolver of that variety

Genetically cent percent pure

Does not contain other physical impurities

Nucleus seed produced strictly under isolation so as to avoid both genetically & physical contamination

Nucleus seed should retain original vigour of variety or parental line

2**.Breeder seed**

Progeny of nucleus seed
Supervision -- qualified plant breeder in a research institute of Agricultural University

- Monitored by a joint inspection team of scientists & officials of certification agency & National Seed Corporation

Provide for initial & recurring increase of foundation seed

Genetic purity of breeder seed crop should maintained 100%

- Tag colour: Yellow

3. Foundation seed

o Progeny of breeder seed

o Produced by State Farm Corporation of India,National Seed Corporation, State Seed CorporationUnder technical control of qualified plant breeders or technical officers

- Its production supervised & approved by certification agency
- Genetic purity of foundation seed should maintained 99.5%
- Tag Colour: White .

4.Certified seed

- Progeny of foundation seed
- Its production supervised & approved by certification agency
- Seed of this class is normally produced by State & National Seeds Corporation & Private Seed Companies on farms of progressive growers
- Genetic purity should be 99 %This is commercial seed, which is available to farmers
- Tag Colour: blue

5.Truthful Seed

- Seed produced by private seed companies & Sold under truthful labelsUnder seed act, seed producer & seed seller responsible for seed
- Companies should maintain field & seed standards suggested for quality seed production as per seed act
- Tag colour: Opel green
- Seeds stored in bags

Lecture 3-4

Importance and scope of seed production in India,Principles of seed production

Importance and Scope for vegetable seed production in India

India is the second largest producer of vegetables only next to China. In India vegetables are grown in 6.2 million ha with a production of 94 mt. Our vegetable requirement in the country is estimated at 225 mt by 2020. Substantial increase in yield and quality of vegetable crops depends upon a number of factors viz., quality seed, fertilizers, irrigation and plant protection measures and suitable agronomic practices. Among these use of quality seed plays a pivotal role.

Economically, the cost of seed is less but it is realized only on possession of good quality characters. It is therefore, important to use the seed confirming to the prescribed standards in terms of high genetic and physical purity, physiological and health quality.

In most of the public sectors, the major concentration is on open pollinated varieties of which wheat and rice account for about 60 per cent.

Majority of the promising hybrids of vegetables are from the private sector as they mostly deal with high value, low volume seeds. Thus, private companies have good scope and opportunity to sell seeds, as large area is still being sown with farm saved seeds. Private sector seed companies account for about 67 per cent of seed production and farmers keep their own seed. Government agencies including public sector corporations at the central and state hardly contribute 33 per cent of the total seed requirement. However, the estimated requirement of vegetable seeds at present is about 20,000 t for tropical and subtropical kinds and 200 t for temperate ones, which will constantly increase in the years to come. Among the vegetables, garden pea constitutes 6,000 to 7,000 t, bhendi around 5,000 t, onion 2,500 t.

Annual sale of seed of Indian Seed Industry

Indian Seed Industry ranks 6 in domestic seed sales. Value of the seeds sold in the domestic markets of India is USD 1500 million or Rs.6675 crores. The present value the seeds exported from India is around Rs.111.3 crores. India is at 29th place in export of seeds. This amounts to 0.35% of the world seed exports and 0.12% of the India's agricultural exports.

World: Value of domestic seed markets (top ten countries) – 2010

Country Domestic Market Value

U.S.A 12000
China 6000
France 2370
Brazil 2000
Germany 1950
India 1500
Japan 1250
Italy 715
Argentina 695
Canada 550

The commercial world seed market is assessed at USD 42 billion**.**

(Source: International Seed Federation – 2010.)

India is bestowed with varied agro climatic conditions / zones, experienced and

dedicated farmers, viable seed industry, legislations etc., favouring the production of quality vegetable seeds. Our strengths and the weaknesses in vegetable seed production are as below.

Strength of Indian seed sector

A well developed and knitted seed multiplication and distribution systems linked with several ICAR institutes / SAUs / NSC / SFCI etc.

A network of 20 seed certification agencies at national level central & referral laboratory and 108 notified seed testing laboratories in state level to legally assure the quality seeds moving in the seed market.

Over 6000 varieties & hybrids of different crops suitable for varied agro-climatic conditions were registered in National catalogue. This makes the selection easier for taking up production in a particular area.

Our county is bestowed with varied agro climatic conditions, which can be exploited for taking up seed production of vegetables at any time of the year in one or other part of the country.

Strong Network of Public & of Private stake holders of Seed Industry with Research and Development facilities

A very fast development of private seed companies which are helpful in bridging the gap between demand and supply of vegetable seeds in the country.

Proactive Government Policies and Programmes

Weaknesses

Vegetable seed production in the country has been vulnerable to vagaries of weather resulting in production of poor quality seeds.

Availability of realistic data on actual area under vegetable and requirements of vegetable seeds is inappropriate.

There is no proper planning for cropping system and restriction for planting a particular crop, maintenance of isolation distance is difficult.

Very low or no indents for new improved varieties due to ignorance about the performance of newly developed improved varieties.

Non-availability of adequate nucleus and breeder seeds in the seed production chain.

Problems in lifting of produced seeds against indents.

Seed improvement programmes in India

Support of World Bank to Indian Seed Programme

The world bank supported the Indian seed programme to the amount of US $ .7M in NSP-1, US $ 34.9M in NSP-II, later on huge outlay was also provided under NSP-III to develop infrastructure in SSCA,SSC,NSC/SFCI STL's and NARS. Private companies also benefited from this programme by getting refinance loan from NABARD.

National Efforts on Seed Development

ICAR has strengthened the seed research programme through launching of special project on Promotion of Research and Development efforts on vegetables hybrids during 1992.

Formulation of New Seed Bill 2004.

Establishment of - NSRTC an exclusive seed quality control and Central capacity building centre.

PPV&FR Authority for protection of Intellectual Property Rights on new crop varieties.

Formulation of National Seed Plan - Envisages role of Central, State Govt., ICAR/SAUs, SSCs' to produce more quality seeds.

Launching of National Seed Mission.

Member of OECD, ISTA & ITPGRFA.

61 varieties of 19 crops included in OECD varietal list – July 201.
Breeder Seed Production Programme**:** ICAR has provided revolving fund of Rs.1500 lakhs. The income generated out of revolving funds can be utilized for the development of infrastructure for the breeder seed programmes to make the programme self-sustainable.

Strategies for seed improvement

Exploitation of Hybrid Vigour

It is the best approach for varietal increase in production of crops. The area under hybrids is about 27 per cent while their contribution to yield is 40 per cent.

Description of otified Varieties

The implementation of plant variety protection would necessarily require detailed characterization of all varieties. The variety registration would have on DUS criteria. Efforts are being made to characterize all the crop varieties under seed production chain.

Enhancement of Seed Replacement Rates

The socio-economic status of the farmer does not permit to purchase quality seeds. Therefore the seed replacement rate is very low. The realistic indents and production of breeder seed of different crop varieties by maintaining quality can enhance SRR.
Seed Replacement Rate is the rate at which the farmers replace the seeds instead of using their own seeds.

Seed Replacement Rate of major vegetables

Crop	**SRR (%)**
Brinjal	63.4
Cabbage	100
Cauliflower	86.4
Chilli	83.7
Gourds	73.5
Melons	89.2
Okra	92.4
Tomato	99.3
Beans	62.2
Onion	87.3
Peas	93.5
Others	72

Enhancement of Seed Multiplication Ratio

SMR is nothing but the number of seeds to be produced from a single seed when it is sown and harvested, which can be altered by adoption of proper seed and crop management techniques. However, according to expert group of seeds (1989), the seed multiplication ratios for different crops are as follows.

Crop	**SMR**
Okra	1:100
Tomato	1:400
Brinjal	1:450
Chillies	1:240
Watermelon	1:100
Pumpkin	1:160
Bittergourd	1:41
Bottlegourd	1:99
Ridgegourd	1:83
Cucumber	1:200
French bean	1:9
Clusterbean	1:50
Peas	1:19

Onion 1:171
Radish 1:100
Carrot 1:83

Identification of suitable area for seed production

Diversification of seed production areas in terms of seasons and regions helps in enhancing the seed production. The search for disease free areas is much warranted to maintain seed health and also to check the spread of the disease from one area to another. Dry and cool regions could be used for effective seed storage at much lower cost and lesser risk on account of seed viability. According to Rai (1997) strategies for improvement in seed programmes are

1. Popularization of quality seed
2. Liaison between Scientists and Department of Agriculture
3. Intellectual Property Right
4. Variety Characterization
5. Strengthening of hybrid programme
6. Exploitation of CMS system for reducing cost of hybrid seed
7.Production of disease free
8. Seed processing
9. Packaging and storage
10. Biotechnology and bio-safety
11. Human resource development
12. Seed demand and forecasting
13. Export of seed
14. Five Generation system of seed multiplication (Nucleus – Breeder – Foundation I – Foundation II – Certified) should be strictly followed.
15. Seed Village Scheme need to be promoted.
16. Contract seed production at the farmers' field could be encouraged.
17. Providing incentives and adequate infrastructure facilities like power, irrigation, credit etc., for private seed producers
18. Seed Bank may be established to meet the demand during natural calamities

Principles of seed production

1. Genetic principles

These principles highly depend on genetic characters of seed which can modify its performance in production programme. In seed production genetic characters are evaluated through genetic purity. Hence following principles are to be considered to obtain true to type seeds.

a. Seed production in adopted area

b. Approved seed source and generation system of seed multiplication

Seed source should be from authenticated and approved public or private sector agencies. Always use higher class of seed for production of seeds. (eg. breeder for foundation and foundation for certified seed)

Generation system of seed multiplication

Generation system of seed multiplication is nothing but the production of a particular class of seed from specific class of seed up to certified seed stage. The choice of a proper seed multiplication model is the key to further success of a seed programme. This is basically depends upon,

i. The rate of genetic deterioration
ii. Seed multiplication ratio and
iii. Total seed demand

Based on these factors different seed multiplication models may be derived for

each crop and the seed multiplication agency should decide how quickly the farmers can be supplied with the seed of newly released varieties, after the nucleus seed stock has been handed over to the concerned agency, so that it may replace the old varieties. In view of the basic factors, the chain of seed multiplication models could be,

c. Previous crop requirement

This is very much required to avoid volunteer plants which can interrupt with genetic purity. Hence the land selected should not be grown with same crop of other varieties.

d. Prevention of natural crossing

In sexually propagated crops natural crossing is another most important source of genetic contamination. This occurs due to crossing with undesirable plants, diseased plants and off types. This phenomenon is highly applicable to often and cross pollinated crops. The extend of genetic contamination in seed fields due to natural crossing depends upon the breeding system, isolation distance ,varietals mass, pollinating agent, insect activity, wind velocity ,humidity and temperature.

Table .1: Isolation distance required for the production of foundation and certified seeds of various crops.

Sl.o.	**Name of group (Crops)**	**Isolation in metres**	
		Foundation	**Certified**
1	Cole crops		
	Cabbage	1600	1000
	Cauliflower	1600	1000
	Knol-khol	1600	1000
2	Fruit Vegetables		
	Brinjal	200	100
	Capsicum (chillies)	400	200
	Tomato	50	25
3	Bulbous vegetables		
	Garlic	10	5
	Onion	1000	500
4	Root vegetables		
	Beetroot	1600	800
	Carrot	1000	800
	Radish	1600	1000
5	Tuber vegetables		
	Sweet potato	10	5
	Potato	10	
7	Legume vegetables		
	Indian bean	50	25
	Lima bean	50	25
	Peas	10	5
8	Leafy vegetables		
	Amaranths	400	200
	Coriander	800	400
	Fenugreek	50	25
	-Spinach	1600	1000
9	Cucurbits (All crops)	1000	500

e. Mechanical mixture

Seeds should be physically pure *ie.,* free from other crop seeds or other

varieties of the same crop. It may often takes place at the time of sowing if more than one variety is sown with the same seed drill and also during post harvest handling of seed. Care on prevention is required as these will affect the genetic purity and also population maintenance.

f. Vigorous roughing

Removal of unwanted, non true to type and diseased plants from the seed field is known as roughing. It should be done throughout the life cycle, but much care has to be given prior to the stage at which they could contaminate the seed crop.

g. Adoption of quality control system

Seed must be produced only on adoption of generation system as recommended by Seeds Act 1966 to avoid genetic deterioration.

2. Agronomic principles

The success of Seed production depends on the crop management techniques starting from sowing to harvest. Care on each of the seed agronomic factors influences the seed production programme including seed quality characters. The major agronomical principles are

Selection seed production plot
Preparation of land
Seed treatment
Time of planting
Method of planting
Seed rate and depth of sowing
Nutrition
Irrigation
Weed control
Plant protection
Harvesting conditions

Lecture No. 5-6

Role of climate (Light,humidity,temp.etc) on vegetable seed production

Climatic factors

1. Temperature

Temperature plays a major role in seed production. Seed germination, seed crop growth and maturity of vegetable seeds are influenced by temperature. Too high temperature during seed crop maturity brings forced maturity and poor seed quality. Optimum temperature is required from sowing to the day of harvest.

For *e.g*. cole crops seed production requires low temperature (4-10°C) at initial stage and high temperature (15-20°C) at reproductive stage i.e. during seed development and maturation.

Higher temperatures and strong winds cause desiccation of pollen grains and drying of stigma results in poor seed set and seed quality. High temperature adversely affects seed production due to drying of anthers in lab-lab; flower shedding in tomato and chillies and production of higher percentage of hard seed in leguminous vegetables.

Over wintering (chilling) / vernalization is needed for cabbage, cauliflower, beets, carrots, turnips etc, to have shift from vegetative to reproductive phase which helps in quality seed production.

. In some vegetables, high temperature inhibits development of ovules and fruits and causes shedding of flower buds and young pods / fruits. Higher temperature results in shriveling of seeds lower yield and poor seed quality.

Temperature between 24 - 38°C is most favourable for activities of pollinators particularly bees. Pollinators are an important component in vegetable seed production and without these quality seed production is not possible particularly in cross and often cross-pollinated vegetables.

These pollinators stop working at low (below 20° C) or high temperature (beyond 38° C), heavy rains, strong winds which hampers quality seed production.

2. Humidity

Higher relative humidity more than 90 per cent cause heavy flower drop and during maturation will lead to production of blonded seeds (eg peas,) Relative humidity reduced lesser than 40 per cent leads to production of hard seeds. Flowering, pollination and seed setting in temperate vegetable needs low humidity and dry weather and moderate to low humidity in sub-temperate and tropical vegetable varieties. High humidity and low temperature also encourages production of diseased seeds. Slightly warm dry climate is suitable for production of disease free seed.

3. Rainfall

Excessive rain, apart from affecting pollination, leads to a higher incidence of diseases resulting in mould attack and seed discoloration. Activity of pollinators (bees) is practically nil during rains and when flowers are wet. It may also results in delayed maturity and at the time of maturation leads to pre-germination or sprouting of seeds in standing crops (eg. peas, beans). Strong wind and heavy rainfall at or near harvest may cause heavy seed losses through shattering and also complicate the harvesting operations (e.g. amaranthus). Rain at physiological maturity affects the initial quality and storability

4. Cold

Temperatures below 10°C may not be suitable for tropical crops. It will affect anthesis, pollen germination, pollen fertility delayed growth and maturity, incomplete exertion, reduced filling, choking of panicle and incidence of pest and disease.

5. Wind

Wind is necessary for pollination in wind pollinated crops. Improves seed setting in highly cross pollinated crops like onion and crucifers. At times winds act as a source of

contamination and protection of seed crops has to be done using barriers. . Heavy winds may carry pollen too far or prevent deposition on stigma thus reducing seed set. Dry winds also desiccate pollen resulting in loss of viability and development of hard seeds in legumes. Heavy winds results in lodging and shattering of seeds / pods.

Lecture No.7

Agencies of pollination and Isolation distance in vegetable seed production

ABIOTIC POLLINATION

- **Wind Pollination:** Wind pollination is common in various tree families, members of the Gramineae (grass family) and Chenopodiaceae (goosefoot family). The grass family includes cereal grains and corn, and the goosefoot family includes beets, Swiss chard, spinach, and orach. Cereal grains are mainly self-pollinated, but can be cross-pollinated by the wind.

The pollen of wind-pollinated plants is often very light, and with ridges on the surface to help make the pollen airborne. Members of the goosefoot family have pollen that can be carried long distances by the wind, often at least a mile or more. Plantings of beets or chard grown for seed often have to be separated by three to five mileswhere the seed is grown commercially.

Small-scale seed producers in the Mid-Atlantic and South usually don't have to be concerned about maintaining such large isolation distances since seed production for these crops is not likely to be located in these regions. Nevertheless, because beet and chard pollen is so easily wind-borne it is best to grow only one variety for seed because it is impractical to try to isolate two varieties on one farm. One variety can be grown for seed whi le other varieties can be grown for food as long as the varieties grown for food are not allowed tflower. The likelihood of beets or chard going to seed in neighboring gardens is quite small, and if present at all, would likely be present in negligible quantity.

Corn pollen is heavier and in large-scalecommercial plantings is usually isolated by one mile (sometimes two) in corn-growing regions. Since corn is grown in many areas of the country, it is necessary to scout neighboring gardens and farms for possible sources of contamination. However unlike the Midwest, much of the East has denser vegetation and rolling countryside that provides patches of woods and geographic barriers to the movement of pollen. In addition, many areas of the Mid-Atlantic and South do not have much acreage devoted to growing corn. So for our region of the country, one-half mile separation is usually adequate.

- **Water and Rain Pollination:** This category applies mainly to certain aquatic plants and certain terrestrial plants that have flowers that partially or completely fill up with rainwater. In some cases the pollen is dispersed by rain splash, but most pollen, unless specially adapted, is killed or rendered inactive by water. Though not a common phenomenon, water or rain-pollinated plants have a specialized flower structure and specialized pollen. Water and rain pollination does not apply to commercial vegetable or flower crops, with the exception of black pepper (in the family Piperaceae).

BIOTIC POLLINATION (INSECT POLLINATION)

- **Domesticated bees (honeybees):** Honeybees are not native to North America. They were brought here from Europe with the first colonists who also brought most of our food crops with them.

Though the honeybee is native to the tropical and subtropical parts of the Old World, it has gradually adapted and radiated to cooler climates.

Honeybees are very efficient pollinators and will forage year-round if the temperature permits. Honeybees can communicate to other members of the colony the direction of the pollen source, the distance to the pollen source, and the amount of pollen (to some degree). It is because of this difference that honeybees are more efficient pollinators than bumbles and wild bees.

Honeybees prefer to forage near their hive if pollen and nectar resources are sufficient. Most bees forage within one-eighth mile (or less) from the hive. If weather and resources are favorable, as much as one-fourth of the hive may forage up to a quarter mile. Very few bees will forage as far as a Isolation Distances for Seed Crop mile. This is why the recommended minimum isolation distance for bee-pollinated crops is one-half mile.

Honeybees exhibit a behavior called "flower constancy" - that is they do not visit flower species randomly. Instead of flying from one species of flower to another they tend to focus on one type of

flower at a time.

✎ **Native wild bees:** Due to mite problems in recent years, honeybees have become scarce. Therefore, wild native bees have become significant pollinators of crops, though with less efficiency because of their foraging behavior and more limited numbers.

✂ **Bumblebees:** Bumblebees are the next most efficient pollinator after the European honeybee. Depending on the species, their nests are either underground at the end of a tunnel made by a small mammal, in the unused nest of a bird, at the bottom of a hedge, or in a depression under a thick matting of grass. Bumblebees are colonial insects with a more primitive social organization. Unlike honeybees they are unable to communicate to each other about the location and amounts of pollen in an area. Though they are often efficient pollinators, their numbers are often too few for large-scale pollination. Part of the problem is that their nests have often been destroyed by intensive cultivation. Also use of herbicides has destroyed some of their food sources, and insecticides have destroyed the bees themselves. The practice of small-scale organic agriculture may be helpful in bringing back these pollinators.

One of the problems with bumblebees as pollinators is that they are often too large to get inside some flowers that don't have an open flower structure, so they resort to different behaviors to get at the pollen. One such behavior typical of bumblebees with short tongues is that instead of trying to get into a flower by the usual route, they will sometimes bite a hole in the side of the flower to get at the pollen, thereby completely bypassing the usual pollination mechanism.

Another behavior of bumblebees is that they can sometimes be found hanging upside down on tomato, pepper, and eggplant blossoms, especially tomato where they vibrate the flower, causing the pollen to fall onto the body hairs. This is a case where bumblebees can cause a significant amount of cross-pollination on normally self-pollinated plants. They are not abundant on tomato flowers, but they are present often enough to cause a problem.

✂ **Other native wild bees:** In some parts of the country and in many parts of the world, solitary, semi-social, and gregarious bees are valuable pollinators of certain crops, but because their numbers are limited and because their populations fluctuate erratically it is difficult to rely on them for pollinating crops.

There are about 5,000 species of bees in North America, all grouped in the category of "wild bees". Their population levels have been adversely affected by large-scale agriculture through reduction of habitat and use of agro-chemicals. On the other hand, their populations have been increased by: (1) logging of forests which have allowed growth of flowers, (2) paving of roads which has concentrated moisture along roadsides, (3) introduction of non-native plants ("weeds"), upon which they forage, (4) introduction of certain agricultural crops, and (5) introduction of crops into desert areas with irrigation.

Many of the wild bees tend to specialize in some manner. Some species may forage only at dawn, others feed at dawn and dusk, others forage in the morning or during the day, and a few species are nocturnal. Some are found only in certain types of habitats and some specialize only on certain families of plants, or even on only one species.Isolation Distances for Seed Crops: Principles and Practices

Most people aren't very aware of wild bees, largely because they are small, quiet, relatively unobtrusive, and not brightly colored, except for the relatively large metallic green bees. Many people are familiar with "sweat bees" which will cross-pollinate tomatoes and other vegetable crops.

Many species of wild bees forage just several hundred feet. Some species of wild bees will forage much further than the honeybee. The record foraging distance is 15 miles, reported for the species *Euplusia surianamensis.*

✎ **Butterflies:** Butterflies have a well-developed visual sense and the ability to see certain colors. Flowers pollinated by butterflies are often brightly colored, often red or orange, and are open during

the day. These flowers sometimes have “nectar guides”, colored areas that help guide the butterfly to the source of the nectar which is their food source. Butterflies seem to have a preference for these guiding marks on the flower since they are probably not sensitive to three-dimensional contours. The nectar is usually well hidden in narrow spurs or tubes. The fragrance of butterfly flowers is often weak or absent and the olfactory sense of butterflies is not well developed. Butterflies are generally not well equipped for carrying pollen because their wings are covered with scales rather than hair, though the head and thorax of some butterflies are capable of transporting pollen. The blossoms of some butterfly flowers tend to exclude bees and the placement of the floral reproductive parts favors cross-pollination by butterflies.

✎ **Moths:** Moths have a well-developed olfactory sense and moth pollinated flowers are often heavily perfumed. Peak odor production begins at dusk when moths become active. Though moths do not seem to have a visual sense for color, their night vision is well developed. Moth flowers are often large, tubular, and white, greenish-white, or pale pastel in color. The flowers are often closed during the day and open around dusk. Unlike butterfly flowers that are not well dissected, moth flowers often have deeply dissected lobes or fringed petals that help differentiate the flower against a dark background. Nectar guides are generally absent since color is harder to detect at night, so guidance to the deep nectar tubes is accomplished by the visual contours of the flower. Unlike butterfly flowers where pollen is shed during the day, moth flowers predominately shed their pollen at night.

Moths (especially sphinx moths) are often strong fliers and tend to hover in front of blossoms without alighting, which is contrast to butterflies which alight but do not hover. Their wings are not adapted for carrying pollen, but the hairs on the anterior part of the moth are capable of carrying pollen and causing cross-pollination. Examples of moth-pollinated flowers include evening primroselliferae and the Brassicaceae.

Plants in these families have open exposed nectaries which flies prefer. Because flies are hairy they can pick up and transport significant amounts of pollen, though they do no exhibit flower constancy. In some climates flies are active most of the year, unlike bees which are more demanding in terms of climate and habitat.

and tobacco.

Flies: Flies are important pollinators of some of our vegetable crops, mainly the Umbelliferae and the Brassicaceae. Plants in these families have open exposed nectaries which flies prefer. Because flies are hairy they can pick up and transport significant amounts of pollen, though they do no exhibit flower constancy. In some climates flies are active most of the year, unlike bees which are more demanding in terms of climate and habitat**.**

Isolation of seed crops: The seed crop must be isolated from other contaminating crops. The isolation of a seed crop is usually done by providing distance between seed fields and contaminating fields.

Types of isolation

Physical or distance isolation - expressed is in meters.

Time isolation - taking up of sowing in different dates (*i.e*) 30 days for most of the crops except in crops having indeterminate growth habit.

Barrier isolation - if the above said isolation is not possible we can go for barrier isolation by erecting tall shelter trees.

Physiological isolation - differ in flowering due to change in altitude.

LECTURE NO. 08

FIELD STANDARDS AND SEED STANDARDS

Seed standards consist of the minimum percentage of pure seeds and maximum permissable limit for inert matter, other crop seeds have been prescribed. The maximum permissable limits for objectionable weeds, seeds infected by seed borne diseases hve been prescribed to ensure good seed health.

Field standards of vegetable seed crop are of two types, the first is general requirements which include the isolation distance for foundation and certified seed, and second is the specific requirements comprising of off types, objectionable weeds and plants affected by seed borne diseases.

Seed Standards of Genetic Purity
(a) All certified seed lots shall conform to the following Minimum Standards for genetic purity unless otherwise prescribed:

Class	Standards for Minimum Genetic Purity (%)
	Foundation certified
(i)	Varieties, composites, synthetics &multilines 99.00 98.00 95.00
(ii)	Hybrids 90.00
(iii)	Hybrids of cotton, TPS, muskmelon, brinjal &tomato 85.00
(iv)	Hybrid castor

Example :

Field Standards for Onion

A. General requirements

1. Isolation

Seed fields offered for certification shall be isolated from the contaminants shown in the column 1 of the Table below by the distances specified in columns 2,3,4 and 5 of the said Table:

332

Contaminants	*Minimum distance (meters)*			
	Mother bulb production stage		*Seed production stage*	
	Foundation	*Certified*	*Foundation*	*Certified*
1	2	3	4	5
Fields of other varieties including commercial hybrid of the same variety	5	5	1200	600
Fields of the same hybrid (code designation) not conforming to varietal purity requirements for certification	5	5	1200	600
Fields of the other varieties of different skin color	-	-	1500	750
Fields of the other hybrids having common male parent and conforming to varietal purity requirements for certification	5	5	-	-

B. Specific requirements

Factor	*Maximum permitted (%)**	
	Foundation	*Certified*
1	2	3
*Bulbs not conforming to varietal characteristics	0.010% (by number)	0.050% (by number)
Off-types (umbels) in seed parent at and after flowering	0.010%	0.050%
Off-types (umbels) in pollinator at and after flowering	0.010%	0.050%
Pollen shedding (umbels) in seed parent	0.050%	0.10%

at flowering

Seed Standards

Factor	*Standards for each class*	
	Foundation	*Certified*
Pure seed (minimum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Other crop seeds (maximum)	5/kg	10/kg
Weed seeds (maximum)	5/kg	10/kg
Germination (minimum)	70%	70%
Moisture (maximum)	8.0%	8.0%
For vapour-proof containers (maximum)	6.0%	6.0

Lecture no.9-10

Seed production methods in cole crops

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 required

Seed 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

Redcabbage: Red Acre

Season: Early varieties (Golden acre) second fortnight of July -10th, 25th July

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 pervious 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 levelling. 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 – 18.50c.

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	0.10	0.50
Other crop plants - -		
Objectionable weed plants	-	-
Diseased plants	0.10 *	0.50* *
At and after flowering and maturity stage		

Pest and disease management
Use of insecticides during flowering affects the insect pollinators and will result

in poor seed set. A single soil application of granulated Phorate, Dimethoate @ 18 Kg/ha during early February for control of sucking pests (Aphids) is advisable. In cabbage the major disease is "Damping – off'. Thin sowing and drenching with 150 g of Bavistin in 100 litres of water will control the disease.

Plant protection

Pests

Cut worms

Apply chlorpyriphos 2 ml/lit in the collar region during evening hours for the control of common cutworm - *Agrotis segetum*.

Aphids

The incidence is severe during autumn season. Installation of yellow sticky trap at 12 no/ha to monitor "macropterous" adults. Spray neem oil 3 % or dimethoate 2 ml/lit with 0.5 ml Teepol/lit.

Diamond backmoth

1. Growing mustard as intercrop as 20:1 ratio to attract diamond back moths for oviposition. To avoid the dispersal of the larvae, periodical spraying of mustard crop with insecticide is necessary.
2. Installation of pheromone traps at 12/ha.
3. Spraying of cartap hydrochloride 1 g/lit or *Bacillus thuringiensis 2g/lit at* primordial stage (ETL 2 larvae/plant)
4. Spraying of NSKE 5 % after primordial stage.
5. Release of parasite *Diadegma semiclausum* at 50,000/ha, 60 days after planting.

Diseases

Club root

Seed treatment at 10 g/ kg of seeds or soil application @ 2.5 kg/ha or seedling dip in solution of 5g/ litre with *Pseudomonas fluorescens*. Dipping the seedlings in Carbendazim solution (1 – 2 g/lit) for 2 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit of water. Follow crop rotation. Crucifers should be avoided for three years.

Leaf spots

Spraying of Mancozeb at 2 g/lit or Carbendazim 1 g/lit.

Leaf Blight

Spraying of Mancozeb @ 2.5 g/ litre.

Ring spot

Spraying of Mancozeb 2 g/lit or Carbendzim 1 g/lit or Copper oxychloride 2.5 g/lit.

Downy mildew

Spray combination of Metalaxyl + Mancozeb 2 g/lit 3 sprays at 10 days interval.

Black rot

Dipping the seeds in 100 ppm Streptocycline for 30 minutes. Two sprays with 2 g/lit Copper oxychloride + Streptomycin 100 ppm after planting and head formation.

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 up side 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.

Designated diseases

Black leg, Black rot and Soft rot.

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
3. 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

Stages of seed production: Breeder seed Foundation seedCertified 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 pervious 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 **	0.50	1.0

Pest and disease management

Use of insecticides during flowering affects the insect pollinators and will result in poor seed set. A single soil application of granulated Phorate, Dimethoate @ 18 Kg/ha during early February for control of sucking pests (Aphids) is advisable. In cauliflower the major disease in "Damping – off". Thin showing and drenching with 150 g of Bavistin in 100 liters of water will control the disease.

Plant protection

Pests

Cut Worms: Set up of light trap in summer months. Spray chlorpyriphos 2 ml/lit in the collar region during evening hours.
Aphids: The incidence is severe during autumn season. Installation of yellow sticky trap at 12 no/ha to monitor Macropterous adults (winged adult) is necessary. Spraying of neem oil 3 % or dimethoate 2 ml/lit with 0.5 ml Teepol/lit.
Diamond backmoth
1. Growing mustard as intercrop at 20:1 ratio.
2. Installation of pheromone traps at 12 No/ha.
3. Spraying of cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* 1g/lit at primordial stage (ETL 2 larvae/plant)
4. Spraying of NSKE 5 % after primordial stage.
5. Release of larval parasite *Diadegma semiclausum* (Ichneumonidae: Hymenoptera) at 50,000/ha, 60 days after planting.

Diseases
Club root: Seed treatment at 10 g/ kg of seeds or soil application @ 2.5 kg/ha or seedling dip in solution of 5g/ litre with *Pseudomonas fluorescens*. Dipping the seedlings in Carbendazim solution (1 – 2 g/lit) for two minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit. Follow crop rotation. Crucifers should be avoided for three years.
Leaf Spot: Spraying of Mancozeb at 2 g/lit or Carbendazim 1 g/lit.
Leaf Blight: Spray of Mancozeb @ 2.5 g/ litre.
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.

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 up side 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 very between 500-600 kg/ha and snowball from 300- 500 kg/ha.
Designated diseases: Black leg, Black rot and Soft rot
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%

KNOL-KHOL (Brassica caulorapa Linn.)

It is cross-pollinated crop.
Varieties-Early purple vienna,early white vienna,king of market,white vienna
Seed rate- 1-1.5 kg/ha
Planting-Seed to seed mathod.Seedlings planted at 45x45cm
Field Inspection-minimum three ,before the marketable stage of knobs,when the knobs have formed and at flowering stage
Isolation distance-for foundation seed 1600m ,for certified seed-1000m
Field standards

Contaminants

Maximum permitted (%)

	Foundation	**Certified**
Off types *	0.10	0.50
Plants affected by seed borne diseases **	0.10	0.50
Plants affected by phyllody **	0.50	1.0

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%

Harvesting and yield- At full matuarity harvest the crop in 2-3 lots to avoid shattering
Average seed yield 4-5 q/ha

Broccoli (Braccica oleraceae var.italica)

It is cross-pollinated crop.
Varieties-Ganesh broccoli,
Planting-Seed to seed mathod.Seedlings planted at 45x45cm
Field Inspection-minimum three ,
Isolation distance-for foundation seed 1600m ,for certified seed-1000m

LECTURE : 11 - 12

Seed production methods in solanaceous crops

TOMATO *(Lycopersicum esculentum)*

Tomato *(Lycopersicum esculentum)*belonging to the family Solanaceae is one of the most nutritious and remunerative vegetable crop. It is the world's important vegetable next to potato. The crop is cultivated throughout the year. In northern plains, the crop is cultivated during autumn, spring and summer. In south India, the crop is grown in June – July, October – November and January – February. The optimum season for seed production in southern India is October – December. Nursery raised in late October and transplanted in the first week of December will produce a good seed crop.

Method of seed production

Tomato is a predominantly self-pollinated crop with some amount of natural cross-pollination. The crop should be raised in isolation from the fields of other varieties. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 50 metres for foundation and 25 metres for certified seed production.

Seed production stages

Breeder seed >> Foundation seed >> Certified seed

Land selection

The land selected should not be cultivated with tomato in the previous season and free from volunteer plants. The soil should be fertile, free from soil borne diseases and with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy, free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 200 gm/acre (500 gm/ha). Selected seeds should be treated appropriately to prevent the crop from seed borne diseases.

• Seeds should be soaked in a fermented mixture of buttermilk (3 days old) and water in a 1:4 ratio for six hours and shade dried before sowing. The practice is applicable only for the seeds which are 6 to 12 months old.

• The seeds should be treated with *Trichoderma viride* and *Pseudomonas fluorescens* (@ 5 g/100g of seeds). This will help in the control of early blight and other pathogens.

Nursery preparation and sowing

Seeds are sown in the nursery and then the seedlings are transplanted in the main field. Nursery beds of 2 – 2.5 metre long and 1 – 1.25 metres wide @ 10 numbers per acre (25 numbers per hectare) should be laid to raise the required seedlings. The beds should be raised 15 – 20 cm from the ground level. The bed should be covered with a layer of farmyard manure and sand in equal proportion. Addition of farmyard manure should be @ 4 kg/m_2. Neem cake and groundnut cake (@ 2 kg/cent) can also be added to enrich the nursery soil. Dusting of wood ash on the seedlings in the nursery acts as an insect repellent and protects the young plants from the pest and disease attacks. It also serves as a good source of mineral nutrients.

Treated seeds should be sown in the nursery beds in rows with 3 – 4 cm spacing. Soon after sowing irrigate the beds using a rose can and cover the beds using paddy straw or coconut fronds.

Transplanting
The seedlings are transplanted to the main field 4 –5 weeks after sowing, preferably in the evening. At the time of transplanting the plant should be about 7.5 – 10 cm in height and with a sturdy stem. The roots of the seedlings should be soaked in asafoetida solution (100 gms in 5 litres of water) for 15 – 30 minutes before transplanting. This prevents the soil borne bacterial diseases. After uprooting, the roots of seedlings can also be dipped in cow dung and cow's urine slurry / *Cow Pat Pit / Amrit Pani /Panchagavya* overnight before transplanting in the field. This helps in better root growth and early establishment. The treated seedlings should be transplanted following 75 x 60 (or) 45 x 30 cm spacing. A well prepared seed bed with 4 – 5 ploughing is necessary for transplanting tomato. The seedlings are transplanted on the sides of the ridges.

Nutrient management
Farmyard manure is applied @ 10 tonnes/acre (25 tonnes/ha) during first ploughing and incorporated into the soil. Green manure with crops like sunhemp *(Crotalaria juncea)*, cowpea *(Vigna catjang),* Daincha *(Sesbania aculeata)* and cluster bean *(Cyamopsis tetragonoloba)* can also be used to substitute the farmyard manure. Neem cake should be applied @ 60 – 100 kg/acre (150 - 250 kg/ha) as a basal dose to prevent nematode attack. Top dressing should be given with groundnut cake @ 30 – 40 kg/acre (80-100 kg/ ha) after 40 days of sowing. This will help in increasing the yield as well as the size of the fruits.

Weed management
Weeding during the initial stages of plant growth is very necessary. Manual weeding is most preferred. Weeding at 45 days after transplanting is very critical. The plants require frequent shallow hoeing especially during the first four weeks after transplanting. This facilitates soil aeration for proper root development. Hoeing can be done to loosen the soil after every irrigation. Earthing up should be done twice.

Irrigation
First irrigation is done immediately after sowing. Subsequent irrigation should be done once a week or 10 days depending on the soil moisture. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management
Pests and diseases like white fly, fruit borers, damping off and *Fusarial* wilt affects the crop.

Roguing
Roguing should be done from early vegetative phase upto three fruit stage. The plants that are morphologically different from other plants should be rogued off during vegetative stage. During fruiting stage based on the colour and shape of the fruit the off-types are rogued off. Maximum percentage of off-types permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection
A minimum of three field inspections should be done from flowering to harvesting stage by the Seed Certification Officer. The first inspection is done before flowering, second during flowering and fruiting stage and the third during mature fruit stage or prior to harvest.

Field standards

	Foundation seed	Certified seed
Isolation distance	50 m	25 m
Off-types	0.10%	0.20%
Seed borne diseases affected seeds	0.10%	0.50%

Harvesting
Harvesting is done once the fruits are physiologically mature and turns from green colour to orange or red. The fruits of the lower three hands of each plant is the best for seed extraction. The fruits that should be harvested are those that are ripe just beyond the eating stage.

Seed extraction and processing

- The seeds with the pulp of the mature fruits should be squeezed into a jar and left in a warm spot for two to three days and allowed to ferment. Then the whole mass should be poured through a sieve, and the seeds should be rubbed and washed.
- Alternatively, lemon juice can be used for seed extraction in place of corrosive hydrochloric acid (which is commonly used). The seeds should be treated with the juice @ 20 lemons / kg of wet seeds for 2 - 3 hours.
- Seeds can also be extracted from the ripe fruits by squeezing the fruits on well-spread rice bran (@ 1 kg rice bran for 1 kg seed). After thorough mixing and drying for 24 – 48 hours, the bran is separated from the mixture by hand winnower.
-

Drying and storage
The extracted seeds are dried in the shade for a day or two before storage to attain a moisture level of 8%. The dried seeds should be packed in a cloth or moisture proof containers and stored in a dry and cool place. Under optimum conditions the properly dried seeds can retain the viability for 2 - 3 years.
Seed Yield-1-1.25 q/ha

Seed standards
The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 70% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 2.0%. Moisture %-8%,Weed seed -None,Other **c**rop seed-0.05 %,0.10%

CAPSICUM AND CHILLI
(Capsicum annuum and *Capsicum frutescens)*

Capsicum and Chilli *(Capsicum annuum* and *Capsicum frutescens)* commonly known as sweet pepper and hot pepper are commercially important crops of the family Solanaceae. The seed production can be done throughout the year but spring season is the best to obtain maximum quantity of seeds.

Method of seed production

Capsicum and chilli are often self-pollinated crops, but cross-pollination occurs to the extent of 7 - 36% mainly through insects. Seeds should be allowed to set by self-pollination. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 500 metres for foundation and 250 metres for certified seed production.

Seed production stages

Breeder seed >> Foundation seed >> Certified seed

Land selection

The land selected should be free from volunteer plants and objectionable weeds. There should be at least two years interval between the related crops cultivated in the selected land. The soil should be fertile, free from soil borne diseases and with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 400 gms/acre (1 kg/ha). Selected seeds should be treated appropriately to prevent the crop from seed borne diseases.

- Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases like fruit rot and die back. (or)
- Seeds should be bundled using a thin cotton cloth and soaked in the bio gas slurry for 12 hours prior to the sowing. This will kill all the disease causing microbes and also enhance the seed vigour.
- Treat the seeds with *Trichoderma viride* @ 4 gms / kg of seeds (or)
- Treat the seeds with biofertilizers @ 1 kg/acre of seeds. Mix the biofertlizers with rice gruel and then mix it with seeds. Dry the seeds under shade for 30 minutes before sowing.

Nursery preparation and sowing

Seeds are sown in the nursery and the seedlings are then transplanted to the main field. Nursery beds of 2 – 2.5 metre long and 1 – 1.25 metre wide @ 10 numbers per acre (25 numbers per hectare) should be laid to raise the required seedlings. The beds should be raised 15 – 20 cm from the ground level. The bed should be covered with a layer of farmyard manure and sand in equal proportion. Addition of farmyard manure should be @ 4 kg/m_2. Neem cake and groundnut cake (@ 2 kg/cent) can also be added to enrich the nursery soil. Dusting of wood ash on the seedlings in the nursery acts as an insect repellent and protects the young plants from pest and disease attacks. It also serves as a good source of mineral nutrients.

Treated seeds should be broadcasted or sown in the nursery beds in rows at 2 cm depth with 3 – 4 cm spacing. Soon after sowing irrigate the beds using a rose can and cover the beds using paddy straw or coconut fronds.

Transplanting

The seedlings are transplanted to the main field 4 – 5 weeks after sowing. At the time of

transplanting the seedling should be about 15 – 20 cm tall. The apical buds of the seedlings should be nipped off 10 days before transplanting to enhance the growth of the seedling. The roots of the seedlings should be soaked in asafoetida solution (100 gms in 5 litres of water) for 15 – 30 minutes before transplanting. This prevents soil borne bacterial diseases. After uprooting, the roots of the seedlings can also be dipped in cow dung and cow's urine slurry / *Cow Pat Pit / Amrit Pani / Panchagavya* overnight before transplanting in the field. This helps in better root growth and early establishment.

The treated seedlings should be transplanted to the main field. The spacing followed is 60 x 45 cm for hot pepper and 45 x 30 cm for sweet pepper. The main field should be ploughed thoroughly for 4 - 5 times to get proper tilth before transplanting. The seedlings are transplanted on the sides of the ridges.

Nutrient management

Farmyard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake should be applied @ 60 – 100 kg/acre (150 - 250 kg/ha) as a basal dose to prevent nematode attack. Top dressing should be given with groundnut cake @ 30 – 40 kg/acre (80 – 100 kg/ha) after 40 days of sowing. This will help in increasing the yield as well as the size of the fruits.

Weed management

Weeding is most important during the early stages of the crop. Manual weeding is most preferred. The crop should be hoed once in 15 days from 30th day after transplanting for two times to get proper aeration in the soil. Weeding should be done on 20th and 45th day after transplanting.

Irrigation

First irrigation is done immediately after sowing. Subsequent irrigation should be done once a week or 10 days depending on the soil moisture. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Capsicum and Chilli are commonly affected by pests and diseases like damping off, fruit rot, aphids, whitefly, hoppers, mites etc., during different growth stages of the crop.

Roguing

Roguing should be done from early vegetative phase upto fruiting stage. The off-types are identified based on the morphological characteristics like plant type, shape and colour of the leaves and flowers etc. The plants that are different from other plants and diseased plants should be rogued off periodically. Maximum percentage of offtypes permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from flowering to harvesting stage by the Seed Certification Officer. The first inspection is done before flowering, second during flowering stage and the third during fruiting stage or prior to harvesting.

Field standards

	Foundation seed	**Certified seed**
Isolation distance	500 m	250 m
Off-types	0.10%	0.20%

Seed borne diseases affected seeds	0.10%	0.50%

Harvesting
Harvesting is done once the fruits are physiologically mature and turns from green colour to red. The matured fruits are harvested by hand picking.

Seed extraction and processing
The seeds are extracted from freshly harvested pods or from the dried pods after proper drying. The dried pods are taken in a gunny bag and beaten with a pliable bamboo stick to separate the seeds. The seeds are then cleaned by winnowing. The seeds from the fresh pods should be scraped out and dried in the shade for a few days. Seeds from fresh pods can also be extracted by following methods,

• For large quantities of seeds, the ripe pods along with water should be blended in a lender at slow speed. Pulp will rise to the top and seeds will settle in the bottom. Seeds should be collected after decanting the water.

• The seeds from the matured fruits should be queezed into a jar and left in a warm spot for two to three days and allowed to ferment.Then the whole mass should be poured through a sieve, and the seeds should be rubbed and washed.

• Alternatively, lemon juice can be used for seed extraction in place of corrosive hydrochloric acid (which is commonly used). The seeds should be treated with the juice @ 20 lemons / kg of wet seeds for 2 - 3 hours.

• Seeds can also be extracted from the ripe fruits by squeezing the fruits on well-spread rice bran (@ 1 kg rice bran for 1 kg seed). After thorough mixing and drying for 24 – 48 hours, the bran is separated from the mixture by a hand winnower.

Drying and storage
The extracted seeds should be dried in the shade for a few days before storage to attain a moisture level of 8%. The dried seeds should be packed in cloth bags or moisture proof containers and stored in a dry and cool place. When the seeds are kept under the cold, dark and dry storage conditions, they will remain viable for upto five years.

Seed yield-1-1.25 q/ha

Seed standards
The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 60% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 2.0%. The presence of other crop seeds and weed seeds should not be more than 5/kg for foundation seeds and 10/kg for certified seeds.

BRINJAL / EGGPLANT *(Solanum melongena)*

Brinjal *(Solanum melongena)* commonly called as eggplant is one of the important vegetables of the

family Solanaceae. The seed production can be done throughout the year but the maturity of the fruits should not coincide with rains.

Method of seed production

Brinjal is a self-pollinated crop, but crosspollination occurs to the extent of 5% mainly through insects. Seeds should be allowed to set by self-pollination. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 300 metres for foundation and 150 metres for certified seed production.

Seed production stages

Breeder seed >> Foundation seed >> Certified seed

Land selection

The land selected should be free from volunteer plants and objectionable weeds. The land should be fertile, rich in organic matter with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 160 gms/acre (400 gms/ha). Selected seeds should be treated appropriately to prevent the crop from seed borne diseases.

• Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases like fruit rot and die back. (or)

• Seeds should be bundled using a thin cotton cloth and soaked in the bio gas slurry for 12 hours prior to the sowing. This will kill all the disease causing microbes and also enhance the seed vigour.

• Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

Nursery preparation and sowing

Seeds are sown in the nursery and the seedlings are then transplanted to the main field. Nursery beds of 2 – 2.5 metre long and 1 – 1.25 metre wide @ 10 numbers per acre (25 numbers per hectare) should be laid to raise the required seedlings. The beds should be raised 15 – 20 cm from the ground level.

The bed should be covered with a layer of farmyard manure and sand in equal proportion. Addition of farmyard manure should be @ 4 kg/m^2. Neem cake and groundnut cake (@ 2 kg/cent) can also be added to enrich the nursery soil. Dusting of wood ash on the seedlings in the nursery acts as an insect repellent and protects the young plants from the pest and disease attacks. It also serves as a good source of mineral nutrients.

Treated seeds should be broadcasted or sown in the nursery beds in rows at 2 cm depth with 3 – 4 cm spacing. Soon after sowing irrigate the beds using a rose can and cover the beds using paddy straw or coconut frond at vegetative stage to check the isolation distance,presence of volunteer plants and diseased pants based on the physical appearance and other requirements. The second and third inspections should be done during flowering and fruiting stage and the off-types are identified based on the flower colour, fruit shape etc., and removed.

The third inspection at maturity stage will also estimate the yield.

Field standards

	Foundation seed	**Certified seed**
Isolation distance	200	100 m
Off-types	0.10%	0.20%

Seed borne diseases affected seeds	0.10%	0.20%

Harvesting
Harvesting is done once the fruits are physiologically mature. In brinjal, fruits are allowed to mature beyond the edible stage for seed purpose. The physiological maturity of the fruits is identified by change in colour. The mature fruits of different varieties will vary in colour from yellow to dull purple. The matured fruits are harvested by hand picking and hung in sheds until their colour dulls.

Seed extraction and processing
The selected matured fruits are cut into pieces and crushed to extract the seeds. Then the pulp around the seeds are separated by washing and sieving. In other way, fruits should be cut into cubes and put in to a blender on slow speed with water. The masses and the pulp float on the surface can be removed and the seeds which settle at the bottom should be collected, washed and dried. In general, the extraction process should be done in the morning hours to make sure that the seeds are at least half dried by evening in order to avoid the danger of germination.

Drying and storage
The extracted seeds should be thoroughly washed and dried on a sieve in the shade for a day or so before storage to attain a moisture level of 8%. For longer storage period the seeds should be dried to a moisture level of 6%. The dried seeds should be packed in paper bags and hung for a couple of weeks before storage. If seeds are packed in moisture proof polythene bags (700 gauge polythene bags) and stored in cool dry place it can be stored for a long time.

Seed Yield-1.2-1.5q/ha
Seed standards
The percentage of minimum physical purity of the foundation and certified seeds should be 98% with a minimum of 70% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 2.0%.

Lecture No.13-15

Seed production methods in cucurbits

CUCUMBER *(Cucumis sativus)*

Cucumber *(Cucumis sativus)* belonging to the family Cucurbitaceae is an important and well known summer vegetable variety in India. The seed production can be donein (June - July) and summer (January -February) in North India and during October –November in South India.

Method of s production

Cucumber is a cross-pollinated crop with an extent of 0 – 5% of self–pollination. Seeds should be allowed to set by open-pollination in isolation. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1000 metres for foundation and 500 metres for certified seed production.

Seed production stages

Breeder seed >> Foundation seed >> Certified seed

Land selection

The land selected should be free from volunteerplan ts, wild species and objectionable weeds. The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 1 kg/acre (2.5 kg/ha). Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds. Treated seeds should be sown in the main field ploughed for 3 – 4 times and formed with ridges at 1.5 – 2.5 metres of spacing. The spacing between the plants should be about 60 – 90 cm. Seeds can also be sown in raised mounds @ 5 seeds per mound. Seeds are sown at 2 cm depth and the field should be irrigated before seed sowing. Seedlings of more than three are thinned out 15 days after sowing. If seeds are sown along the furrows, the plants in each pit are reduced to one or two.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. In each sowing pit, farm yard manure or compost @ 1 kg mixed with 100 gms of neem cake is applied as basal manure. One month after sowing apply 500 gms of vermicompost per plant as top dressing.

Intercultural practice

The flower drop in the crop can be controlled by spraying asafoetida solution (125 gms of asafoetida in 1 litre of water) over the plants.

Weed management

Weeding is most important during all growth stages of the crop. The field should be maintained clean by frequent hand weeding. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation is done before sowing. Subsequent irrigation should be done once a week or depending upon the rains. Irrigation during flowering and fruit setting stages are very crucial.

Pest and disease management

Cucumber is commonly affected by pests like fruit fly, aphids and diseases like powdery mildew

and downy mildew at different growth stages.

Roguing

Roguing should be done from early vegetative stage to flowering and fruiting stage. All the offtypes and diseased plants should be rogued off periodically. The off-types are identified based on the morphological characteristics like plant type, leaf shape, flower colour, fruit shape etc. Removal of the off-types during fruit setting stage is helpful in preventing further genetic contamination. The maximum percentage of offtypes permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

A minimum of three field inspections should be done from vegetative to fruit maturity stage by the Seed Certification Officer. The first inspection is conducted during vegetative stage before flowering followed by the second one at flowering and fruiting stage. The final inspection should be scheduled during fruit maturity stage and prior to harvest.

Field standards

	Foundation seed	**Certified seed**
Isolation distance	1000 m	500 m
Off-types	0.10%	0.20%

Harvesting

Harvesting is done once the fruits are physiologically mature. The physiological maturation of the fruits can be identified by change in the colour of fruits from greenish to pale yellow or golden. The matured fruits are harvested by hand picking and stored for a while before the extraction of the seeds.

Seed extraction and processing

The seeds from the harvested fruits are scooped out and collected in a vessel and left for few days to ferment. During this period the jelly around the seeds will be dissolved and the seed borne diseases will be removed. Then the seeds are sieved and washed thoroughly in running water and dried.

Drying and storage

The extracted seeds should be dried for a week or 10 days to attain a moisture level of 7% before storage. Seeds can be stored under closed storage conditions upto ten years. In dry climate under open storage conditions, seeds can be stored for four years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 99% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 1.0%.

Seed yield -1-1.25 q/ha

BITTER GOURD

Bitter gourd (*Memordica charantia* L) is also called as Balsom pear.

Varieties

CO 1, MDU 1, Pusa Visesh, Pusa Do Mausami, VK1 Priya, Arka Harit, Konkan, Preethi

Hybrids

CBGH 1, Pusa Hybrid 1

Season

June-July and January - February.

Sowing

Sowing pre-germinated seeds to maintain optimum field population, the seeds are soaked in water for 24 hours. Then place the seeds in moistened sand and cover the seeds with sand and left for 3 days. Maintain the sand in wet condition. After 3 days the seeds with protruding radicle are separated and used for sowing.

Seed rate

1.8 kg /ha

1.9

Spacing

45 x 45 x 45 cm at 2.5 x 2 m, sowing of three seeds per pit at 2cm depth micropylar end facing upward is favorable for better field emergence.

Manuring

Application of 10 kg FYM per pit

Top dressing

i. Urea 22 g / pit during 1st flowering.

ii. Urea + potash 18 + 5 gm/pit at 20 days after flowering.

iii. Urea 18 gm + potash 5 gm/ pit at 40 days after flowering.

Foliar application

Spraying ethrel 200 ppm from 4 leaves stage onwards at one week interval for four times.

Weeding

Field has to be maintained clean by frequent hand weeding in order to remove objectionable weed species like *Mimordica balsamina* L*., M. cochinchinens* and *M.diocia* ex wild.

Main field maintenance

Each plant has to be provided with stacking 20-25 days after sowing for training the vines over the pandal. Training operation has to be carried out daily until the fruiting stage.

Irrigation

Irrigated the crop before dibbling the seeds and thereafter once in a week.

Roguing

During vegetative, fruit formation and fruit harvest phases, roguing is attempted based on plant characters like height of plant, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and colour.

Plant protection

Pests

Beetles, fruit flies and caterpillars

Spray malathion 50 EC 1ml/lit or dimethoate 30 EC 1ml/lit or methyl demeton 25 EC 1ml/lit or

fenthion 1000 EC 1ml/lit. Avoid copper and sulphur dust since these chemicals cause injury to the plants.

Diseases
Powdery mildew
Spray Dinocap 1ml/lit or Carbendazim 0.5 g/lit.
Downy mildew
Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Harvest
The harvest starts from 60-65 days after sowing and matured fruits can be harvested once in a week. The fruits with yellow or yellowish orange colour should be harvested for seed extraction.

Seed extraction
Fruits are cut longitudinally and the seeds are removed along with mucilaginous material and then the seeds are washed with water.

Drying
The seeds are dried under shade for one or 2 days followed by drying under sun to reduce the moisture content 7-8% for storing in cloth bag and 6% for moisture vapour proof containers.

Grading
For grading the seeds BSS 4 x 4 size sieves are used

Storage
Seed treating chemicals captan or thiram 4 gm /kg of seeds or halogen mixture @ 5 g/kg of seeds is recommended.
Seed standards
The percentage of minimum physical purity of foundation and certified seeds should be 99% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 1.0%.
Seed yield -2.5-3.5 q/ha

PUMPKIN (*Cucurbita moschata*)

Varieties
CO 1, CO 2
Season
January – February and June – July

Spacing
After proper ploughing, at a spacing of 2.5 x 2 m distance take pits having 45 cm length, width and height.

Manuring
Ten days after that, apply 10 kg FYM and urea 30 g, super phosphate 72 g and potash 19 g per pit. Then mix the above nutrients with soil and fill the pits and level them.

Sowing
Seed required for one ha (1kg/ha) may be treated with fungicides before sowing. Then five seeds may be sown in a pit at equal distance.

Growth regulator spray
Spraying of ethrel at 200 ppm for four times starting from four leaves stage and at weekly intervals (i.e. 2.0 ml of ethrel in 10 lit of water) is recommended.

Top dressing
Apply 22g urea / pit 30 days after sowing as top dressing.

Plant protection

Red pumpkin beetle - Spray methyl demeton 1 ml/lit.
Powdery mildew - Spray carbendazim 0.1 %.
Yellow vein mosaic - White flies spread this disease. To control the insect vector spray monocrotophos or chlorpyriphos 2 ml plus 2 ml neem oil per lit of water.

Roguing
During vegetative, fruit formation and fruit harvest phases, roguing is attempted based on plant characters like height of plant, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and colour. Plants showing symptoms of yellow mosaic are also removed.

Harvesting
Maturity index in pumpkin is change in fruit colour to orange or pale yellow colour. The harvests will be done in different pickings in pumpkin. Fruits confirming the genetic purity with medium to large size fruits should alone be used for seed extraction.

Seed extraction method
Fruits weighing less than 1.5 kg should be rejected and can be sold out in the market as vegetable. Seed extraction is easy in pumpkin. First cut the fruits into two halves by crosswise. Then remove the seed by scraping and wash with water.

Seed cleaning and processing
After proper drying seed processing should be done using BSS 4 wire mesh sieve or 16/64″ round perforated metal sieves.

Seed treatment
Prior to storage, seeds are mixed with Carbendazim 4g/kg or halogen mixture at 5g / kg and stored with moisture content of 6-8% in moisture vapour proof containers like thick polythene bag of 700 gauge or in tin / plastic containers that are sealed tightly. In case of short term storage (4-6 months) cloth or gunny will be sufficient.

Seed standards
The percentage of minimum physical purity of foundation and certified seeds should be 99% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 1.0%.
Seed yield -3-3.5 q/ha

Water melon(Citrullus lanatus)

It is a cross pollinated crop
Varieties-Arka jyoti,Asahi yamoto,Durgapur kesar,Durgapur meetha,Arka manik,Sugar baby
Seed rate-6-8 kg/ha
Planting-Pit method at a distance of 2x1.5m
Rouging-Before flowering,flowering and immature stageu,mature fruit stage
Field inspection -minimum three
Field sstandards

	Foundation seed	**Certified seed**
Isolation distance	800 m	400 m
Off-types	0.10%	0.20%

Seed standards
The percentage of minimum physical purity of foundation and certified seeds should be 99% with a minimum of 60% of germination capacity and 7% of moisture content. The presence of inert matter should not exceed 1.0%.
Seed yield -2.5-3 q/ha

Lecture No.16-17

Seed production in leafy vegetable (Fenugreek,amaranthus,palak)

Fenugreek (*Trigonella foenum-graecum* L.)

Botany
Fenugreek is a self pollinated and quick growing crop produces bright orange to

yellow flowers. The pods are sickle shaped containing small deeply furrowed seed. The flowers open between 6.00 and 9.00 am. The stigma becomes receptive 12 hour before and the anthers also dehisce before the flower actually opens.

Method of seed production

Stages of seed production: Breeder seed Foundation seed Certified seed

Varieties : CO1, Rajendra Kanti, RMT-1, Lam Sel.1, Hissar Sonali

Isolation: Foundation Seed 50 m; Certified seed 25 m

Climate and Soil: It has a wide adaptability and is successfully cultivated both in the tropics as well as temperate regions. It is tolerant to frost and freezing weather. It does well in places receiving moderate or low rainfall areas but not in heavy rainfall area. It can be grown on a wide variety of soil but clayey loam is relatively better. The optimum soil pH should be 6.0 to 7.0 for its better growth and development.

Land preparation and sowing: Land is prepared by ploughing thrice and beds of uniform size are prepared. Broadcasting the seed in the bed and raking the surface to cover the seeds is normally followed. But, line sowing is advocated in rows at 20 to 25 cm apart which facilitates the intercultural operations.

Season: Sowing in the plains is generally taken up in September to November while in the hills, it is grown from March. Approximately 20 to 25 kg of seed is required for one hectare and the seed takes about 6-8 days to complete its germination.

Manures and fertilizers: Besides 15 tones of farmyard manure, a fertilizer dose of 25 kg N, 25 Kg P_2O_5 and 50 kg K_2O per ha is recommended. Half of the N dose and the entire quantity of P and K are applied basally and the remaining half N is applied 30 days after sowing.

Irrigation: First irrigation is given immediately after sowing and subsequent irrigation is applied at 7 to 10 days interval.

Inter cultivation: Hoeing the weeding during the early stages of plant growth is required to encourage proper growth. Thinning may be done on 20 to 30 days to keep the distance between the plants at 10 to 15 cm and to retain 1 to 2 plants per hill.

Rouging: The offtypes should be removed both at flowering and at maturity stage. The plants of *melilotus spp* should also be removed from the field prior to harvest.

Field standards

Factors	**Foundation seed**	**Certified seed**
Isolation distance (m)	50	25
No. of field inspection -	2	2
Offtypes (%) -	0.10	0.20
Inseparable other cropplants (%)	-	- -
Objectionable weedplants (%)-	0.01	0.02
Plant / affected by designated diseases (%)	-	- -

Harvest: Fenugreek seeds attained physiological maturity 45 days after anthesis when the seed moisture content was around 20 per cent. Harvesting should be done when the lower leaves start shedding and the pods have become yellowish. Harvesting should be done by cutting the plants with sickles. Delay in harvesting leads to shattering and lose of seeds. The harvested plants are tied in bundles and allowed to dry for 4-6 days. Threshing should be done on clean floor or tarpaulin. The seeds are separated by beating followed by winnowing or by the use of mechanical thresher.

grading is done with 6/64” round perforated metal sieve.

Seed yield: 1200 – 1500 kg/ha.

Plant protection: Root rot (*Rhizoctonia solani*) is a serious disease and can be controlled by soil application of Neem cake @ 150 kg/ha and seed treatment with *Trichoderma viride* @ 4g/kg and drenching with carbendazim 0.05% first at the onset of the disease

and another after one month.

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)	10/kg	20/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	8%	8%
For VP Container(maximum)	6%	6%

Palak(Beta vulgaris var.benghalensis)

Family-Chenopodiaceae

It is a cross pollinated crop.
Varieties-All green,Jobner green,Pusa Jyoti,Pusa Harit
Seed rate-10-12 kg/ha

Rouging-The offtypes,diseased plants and early bolters should be removed.Rouging should be done on the basis of leaf characters,stalk characters and disease infection.
Field inspection-A minlimum three inspection to be made at pre-flowering,flowering and ripening of seeds stage.

Field standards

Factors	Foundation seed	Certified seed
Isolation distance (m)	1600	1000
No. of field inspection -	2	2
Offtypes (%) -	0.10	0.20
Inseparable other cropplants (%)	-	- -
Objectionable weedplants (%)-	-	-
Plant / affected by designated diseases (%)		

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	96%	96%
Inert matter (maximum)	4%	4%
Other crop seed (maximum) (no./kg)	0.10	0.20
Total weed seed (maximum) (no./kg)	0.10	0.20
Germination(minimum)	60%	60%
Moisture (maximum) (normal container)	9%	9%

Harvesting and yield-Harvest the crop after 150-180 daysof sowing at full ripe stage and alloe to dry in open on the floor.
Average seed yield-15-18 q/ha

AMARANTH *(Amaranthus sp.)*

Amaranth *(Amaranthus sp.)* is a widely used leafy vegetable belonging to the family Amaranthaceae. In India it isbeing cultivated throughout the year. This short duration crop is well suited for crop rotation. The seed production of this crop can be taken up in February – March as a summer crop and as rainy season crop in June – July.

Method of seed production

Amaranth is a cross-pollinated crop. Crosspollination occurs mainly by wind. Seeds are allowed to set by open pollination under isolation. To maintain the varietal purity an isolation distance of 200 metres for certified and 400 metres for foundation seed production is necessary from the fields of other varieties and of the same variety not conforming to the varietal purity requirements of certification and wild *Amaranth*.

Seed production stages

Breeder seed è Foundation seed è Certified seed

Land selection

The land selected should be free from other species of *Amaranth* including wild *Amaranth*. The land should be fertile with proper drainage facility.

Seed selection and sowing

Certified seeds of good quality should be obtained from an authentic source. Seeds should be healthy with good germination percentage. Remove the off coloured and out sized seeds. Seed rate is 800 gms/acre (2 kg/ha) for direct sowing and 400 gms/acre (1 kg/ha) for long transplanted crop.

The selected seeds should be soaked in hot water (70_oC) for one minute or in 50_oC water for 12 hours or at 4_oC for seven days to break the dormancy of the seeds. Treat the seeds with the powder form of *Trichoderma viride* @ 4 gms/kg of seeds or *Pseudomonas* @ 10 gms/ kg of seeds. Seed treatment with *Trichoderma* or *Pseudomonas* protects the crop from disease causing microorganisms.

Treated seeds should be broadcasted @ 2 gms/sq. metre in seed beds prepared with one ploughing and 2 – 3 harrowing followed by levelling. Usually seed beds of 2 x 1.5 metre size are formed. Seeds are mixed with 20 kg of fine sand and broadcasted uniformly on the beds. After sowing the seeds are covered with a thin layer of sand or soil.

The seedlings should be transplanted after three weeks in the main field. Mostly the crop is sown directly. A spacing of 30 x 30 cm is maintained for seed crop. In transplanted method, seedlings are planted in rows of 60 – 80 cm apart with a spacing of 40 – 50 cm between the plants.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days aftersowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafoetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. For rainfed cultivation replace the neem cake with pungam cake and apply all the above mentioned inputs only when the soil is wet.

Weed management

Hoeing and weeding should be done as and when it is needed. The field should be maintained without weeds and other contaminants.

Irrigation

The first irrigation is done immediately after sowing and the second irrigation is done 3 days

after sowing. After this, the field is irrigated once a week. Irrigation during flowering and seed filling stages are very critical.

Important operations

After four weeks of transplanting till flowering nick off the apical buds to promote the secondary shoots.

Pest and disease management

Amaranth is commonly affected by pests and disease like weevil, aphids, yellow mosaic virus and white rust. The management measures for these pests and diseases are provided in

Roguing

Roguing should be done at a regular interval.A minimum of three Roguing should be done. The off-types are clearly identified by morphological characteristics like leaf type, colour and pigmentation and rogued off. The maximum percentage of off-types not confirming to the varietal characteristics permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production. The maximum percentage of objectionable weeds permitted at the final inspection is 0.010% for foundation seed production and 0.020% for certified seed production.

Field inspection

A minimum of two inspections should be done from vegetative stage to flowering stage by the Seed Certification Officer. The first inspection is done before flowering followed by the second during flowering stage to determine isolation, off-types, volunteer plants and diseased plants and to estimate the yield.

Field standards

	Foundation seed	**Certifiedseed**
Isolation distance	400 m	200 m
Off-types	0.10%	0.20%
Objectionable weed seeds	0.01%	0.02%

Harvesting

The seeds reach the physiological maturity in 25 days after flowering. Harvesting takes place soon after the maturation of seeds. The physiological maturation of the glumes and seeds are identified by colour change from green to brown and green to shiny black, respectively. Seed heads (glumes) nearing maturation should be harvested now and then, since seeds tend to drop from the fully matured glumes.

Threshing and processing

Harvested seed heads are dried under the sun light to attain a moisture level of 15%. After this, using a pliable bamboo stick the glumes are beaten to shed the seeds. The separated seeds are then cleaned to remove the debris. Winnowing is avoided since the seeds are very small and less in weight. To separate the debris from the seeds, the seeds should be heaped in a bowl and tossed. The debris will collect at the top and can be blown away. Then the seeds are graded using BSS 22 x 22 wire mesh sieve.

Drying and storage

Processed and graded seeds are further dried for safe storage. Seeds should be dried to attain a safemoisture content of 8%. Seeds can be stored for upto five years under open storage conditions.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 95% with minimum germination capacity of 70%.The maximum moisture content should be 8%. The presence of inert material should not exceed 5%.

Lecture No.18-21

Seed production methods in beans and peas
French bean

Bean *(Phaseolus vulgaris)* belonging to the family Leguminosae is a commercially important vegetable variety. It is one of the widely cultivated vegetable varieties. The seed production of this crop can be taken up in July – September and January – February in plains and in hills during September – November (in south India) and end of October in North

India.

Method of seed production

Bean is a self-pollinated crop. Cross-pollination occurs very rarely since self-pollination takes place before the opening of the flowers. To maintain the varietal purity an isolation distance of 25 metres for certified and 50 metres for foundation seed production is necessary from the fields of other varieties and of the same variety not conforming to the varietal purity requirements of certification.

Seed production stages

Breeder seed è Foundation seed è Certified seed

Land selection

The land selected should not be cultivated with other variety of the same crop in the previous season and should be free of volunteer plants. The land should be fertile with neutral pH. The soil should be light with proper drainage facility.

Seed selection and sowing

Certified seeds of good quality should be obtained from an authentic source. Seeds should be healthy with good germination percentage. Remove the off coloured and out sized seeds. The seed rate varies depending on the variety. It is 26 kg/acre (65 kg/ha) for bushy variety and 10 – 14 kg/acre (25 - 35 kg/ha) for pole varieties. Treat the seeds with powder form of *Trichoderma viride* @ 4 gms/kg or *Pseudomonas* @ 10 gms/ kg of seeds. Seed treatment with *Trichoderma* or *Pseudomonas* protects the crops from disease causing microorganisms. Seeds can be soaked in diluted panchagavyam for 20 minutes and dried before treating with *Trichoderma* or *Pseudomonas*. After treating the seeds with these bio-control agents treat them with biofertilizer *Rhizobium* @ 600 gms/acre of seeds 24 hours before sowing to facilitate natural nitrogen fixation by plants. Mix *Rhizobium* in rice gruel and then mix it with seeds. Seeds should be dried under the shade for 15 minutes and then sown. Treated seeds are sown in double row of 30 cm apart with 1.5 metre distance between each pair of rows in a land prepared to fine tilth. Seeds should be sown in line method at a depth of 4 – 5 cm.A spacing of 60 x 10 - 30 cm should be followed for getting high yield and quality seeds.

Nutrient management

Farm yard manure @ 10 – 20 tonnes/acre (25 - 50 tonnes/ha) should be applied at the time of land preparation incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms ofasafoetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. For rainfed cultivation replace the neem cake with pungam cake and apply all the above mentioned inputs only when the soil is wet.

Weed management

The first hand weeding is done in 20 days after sowing followed by the second weeding in 40 days after sowing. Weeding is not required after 60 days of sowing. If needed, then manual weeding should be done.

Irrigation

Irrigation is very important factor for good yield of seeds with high quality. The first irrigation is done immediately after sowing and the second irrigation is done 2 – 3 days after sowing. After this, the field is irrigated once in 8 – 10 days. Irrigation during flowering and pod filling stages are very critical.

Important operations

The shoot apex of the plants should be nipped off in 65 days after sowing in pole variety to increase the seed yield.

Pest and disease management
The pests and diseases like aphids, pod borer, yellow mosaic virus, stem blight, root rot and powdery mildew affects the bean crop at different growth stages.
Roguing
Roguing should be done from vegetative stage to harvesting stage. The off-types and volunteer plants are removed based on the morphological characteristics like plant type, leaf, flower and pod colour etc. Off-types and diseased plants affected by leaf spot, stem blight, yellow mosaic virus should be removed from the seed field to maintain healthy crops. Plants of early and late flowering types should also be removed.
Field inspection
A minimum of two inspections should be done from flowering to fruiting stage by the Seed Certification Officer. The first inspection is done before flowering followed by the second during flowering and fruiting stage to determine isolation, off-types, volunteer plants and diseased plants etc.
Harvesting
The crop reaches the physiological maturity in 80 days after flowering. Harvesting takes place soon after the maturation of the seeds.Physiological maturation of the pods can be identified by change of colour from green to yellow. Matured pods should be harvested in two to three pickings. Harvest should not coincidewith rains, because it will result in off coloured and dimpled seeds. Delay in harvesting will result in shattering of pods.
Threshing and processing
Harvested pods are dried under the sun light to attain a moisture content of 15 – 18%. Then the dried pods are beaten with pliable bamboo stick to separate the seeds. The seeds should then be cleaned by winnowing. Seeds are graded using 19/64" round perforated metal sieve. Seeds of different colour and sizes should be removed.
Drying and storage
Processed and graded seeds are further dried for 2 – 3 days under the mild sun light between 9 – 11 am and 2 – 4 pm to attain a moisture content of 8 – 10% for safe storage. Coating seeds with edible oil will prevent weevil infestation during storage. Seeds can also be treated with activated clay @ 1 kg/100 kg of seeds to control bruchid infestation. Under appropriate storage conditions, bean seeds can be stored for three years.
Seed standards
The percentage of maximum physical purity of foundation and certified seeds should be 98%

with minimum germination capacity of 75%. The maximum moisture content should be 9%. The presence of inert material should not exceed 2%.

Peas (Pisum sativum L.)

It is self a pollinated crop.
Varieties-Arkel,early gaint,Azad P-1,P-29,Hara Bonna,Bonneville,Pant uphar
Seed rate-100kg/ha
Field inspection-Minimum three
Isolation d istance-Foundation seed-50m,certified seed-25m
Seed standards
The percentage of maximum physical purity of foundation and certified seeds should be 98%

with minimum germination capacity of 75%. The maximum moisture content should be 9%. The presence of inert material should not exceed 2%.
Harvesting and yield-Harvesting is done when the pods are fully ripe and plants starts drying
Average seed yield-15-20 q/ha

Dolichos bean(Dolichos lab lab Linn.)

It is self pollinated crop
Varieties-Pusa early prolific ,Arka jay,Arka vijay,Konkan Bhushan,Phule Suruchi
Seed rate-20-30kg/ha
Field inspection-Minimum two
Isolation d istance-Foundation seed-50m,certified seed-25m
Seed standards
The percentage of maximum physical purity of foundation and certified seeds should be 98%

with minimum germination capacity of 75%. The maximum moisture content should be 9%. The presence of inert material should not exceed 2%.
Harvesting and yield-The fully ripe pods should be pickedfrom time to time and allowed to dry in open sunlight .
Average seed yield-8-10q/ha

Lecture No.22-23

Seed Production methods in Bulb crops

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.
Stages of seed production: Breeder seed Foundation seed certified seed
Varieties
Bellary Red, Rampur local, Pusa white, Kalyanpur, Red Round Punja 48, Pusa red, 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.

Insect and disease control

Insect: Onion thrips

Spray malathion 50 EC at 600 to 700 ml per hectare or thiodan 35 EC at 600 to 700 ml per hectare. Three to four applications may be required. Onion maggot can be controlled by spraying with sevimol.

Diseases: Damping-off

Use treated seed. In cases of seedlings mortality, drench nursery with 0.3 per cent captan or thiram or dithane Z-78 at weekly intervals.

Purple blotch

Spray with copper fungicides such as blitox 50 at 0.2 per cent.

Plant protection - Pests

Thrips and onion fly

Methyl demeton 25 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or monocrotophos 36 WSC 1 ml/lit with Teepol 0.5 ml/lit.

Cutworm

Drench the soil with chlorpyriphos @ 2 ml/lit.

Diseases

Leaf spot

Spray Mancozeb 2 gm/lit or Copper oxychloride 2.5 gm/lit. Add Teepol 0.5 ml/lit of spray fluid.

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

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

Interculture
Insect and disease control:- Same as described for first year.
Roguing
First year: It is desirable to begin roguing in the field before bulbs are harvested, since it is 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 to varietal characters before flowering.

Specific field standard

Field standard
Other variety bulbs (max.) 0.20%, 0.50%
Off types (max.) 0.20%, 0.50%
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 two to 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 seed then the seeds are separated from the capsules by hand threshing or using pliable sticks. The seeds are cleaned, graded by using 10 x 10 BSS 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%

Lecture No.24-25

Seed production in tuber crops

Potato

(*Solanum tuberosum*)

Potato has special seed production problems as the quality characteristics of seed potatoes are influenced by a number of factors and important amongst them are the diseases and pests namely, viruses, fungi, bacteria and nematodes. Once the seed tuber is infected by the pathogens, especially viruses which enter through the plant system, the plant growth therefore declines and the yield reduces progressively. It is therefore,

important that seed stocks should not only be genetically pure but also should be in right physiological condition and disease free at the time of planting. Seed production technology developed for seed potato production, thus aims at producing disease free, genetically pure seed. There are now two independent channels of seed production for hills and plains.

Hill seed: The seed produced in hills (2500 metres above sea level) at suitable locations is called 'Hill Seed'.
Plain seed: The seed produced in plains at suitable locations is called 'plain seed'.
Northern plains have emerged as an important source of potato seed production. The low aphid plains seed is in right physiological condition at the planting time and yields higher than the traditional hill grown seed.
Once healthy seed potatoes are introduced into the system of growing them during low Aphid period accompanied by a systematic insecticide application, roguingand removal of haulms before the aphids attain critical number and the re-growth is checked, the health standards for the seed crop could be maintained for a number of generations. This system of seed potato production has been designated as 'Seed Plot Technique'.

Stages of seed production
For seed multiplication and certification purposes following stages are recognized. BS - FS I - FS II - CS I – CS II.
CS II: This is done in case of those varieties which have a low rate of multiplication and in years of shortage of seeds.

Land requirements
A crop of seed potato shall not be eligible for certification if grown on land infested with wart and/or cyst forming nematodes; or brown rot or non-cyst forming nematodes within the previous three years; and common scab. Preference should be given to two to three years crop rotation.

Isolation requirements
A minimum isolation distance of 5 m for foundation and certified seed class should be provided all around a seed field to separate it from fields of other varieties, and fields of the same variety not conforming to varietal purity and health requirements for certification.
Time of Sowing
The sowing should be done from 20th September (when rainfall is low) or 25th September up to 15th October. Delayed plantings will result in poor yields.
Seed rate
Seed rate depends upon tuber size. Twenty five to 30 qtls of seed potato per hectare will be sufficient if the usual sized tubers (4 to 6 cm) are used.
All size of tubers like large, medium and small may be utilized as seed, but the medium size (25 – 55 mm or 25-75 g) often called as seed size performs better than other size grades as seed material.

Fertilization
125:80:100 kg NPK with 25t FYM/ha. Apply all phosphorus, potash and half of the nitrogen at the time of sowing. The remaining half of nitrogen should be applied about thirty five days after sowing, or when the plants are about to 30 cm height. For best results, the fertilizers should be placed either 5 cm below the tubers or on the sides.

Method of sowing
Whole tubers should be used for planting. Tubers should be under sprouting (sprouts 0.5 to 1 cm long) for quick emergence. After 15th October when the temperature goes down, cut tubers can also be used for planting. Care must be taken that each piece to be used for planting has two or three emerging eyes and weighs at least 40 gm. By this practice the seed rate is reduced considerably. Plant the tubers 3 to 4 cm deep in the soil having adequate moisture. Row to row spacing at 60 cm and tuber to tuber spacing at 15 to 20 cm is recommended.

Irrigation
Potato requires light and frequent irrigation. First irrigation should follow immediately after emergence. Subsequent irrigations should be given at proper intervals. Restrict the irrigation after the crop has tuber raised well. Withhold irrigation by the third week of December i.e., ten to fifteen days before cutting of haulms.

Interculture
Keep the field free from weeds. At least one earthing up is a must. It should be done when plants attains the height of 15 cm.

Haulm cutting
The practice of haulm cutting is adopted as a precautionary measure to avoid chances of viral disease transmission through the vectors like aphids. The haulms must be cut by the end of December, or at the latest by the first week of January before the aphid population reaches the critical stage (20 aphids per hundred compound leaves). No re-growth should be allowed.

Roguing: Very careful roguing is required for producing a high quality crop of seed potato. The roguing is to be done at the following stages.

First roguing: First roguing should be done 25 days after sowing to remove:
a) All virus affected plants and b) All plants apparently belonging to other varieties and which can be identified from foliage.

Second roguing: It should be done when the crop is fully grown. This would be about 50 to 60 days after sowing. At this time tubers are formed and therefore, while roguing, only the upper portion of plant, but all the tubers belonging to the plant should be removed carefully. Also at this stage the virus affected plant as well as off type, should be removed.

Third roguing: This is the third and final roguing and should be done just before cutting the foliage. Foliage should not be cut unless this roguing has been completed. At this stage, all virus affected plant and off type plants, along with their tubers have to be very carefully removed.

Harvesting
a. The crop is ready for harvest ten to fifteen days after haulm cutting when the skin of tuber has hardened. Premature harvesting causes handling problems, as the soft skin gets easily peeled of and further such tubers cannot withstand long transportation and storage.
b. At the time of potato digging, the moisture in soil should be optimum for obtaining clean tubers.
c. The harvesting of seed potatoes can be done by any of the equipment available in

the market for this purpose. Every effort should be made to avoid cuts, bruises, etc. After harvesting, tubers should not be left exposed to the hot sun for a prolonged period (not more than an hour). It should be immediately lifted and carried to an airy shed and kept in piles (height 1 m, width 3 m) for 7 to 10 days so that the superficial moisture evaporates and further hardening of skin is achieved. If sheds are not available, piles may be made in field and covered with dry haulms.

Sorting and Grading

When the potatoes are properly cured, grading should be done. A single grade from 3.0 to 5.5 cm is being made at present for `Plain Seed' by hand grading. While grading, the shape, colour, depth of eyes, etc. of tubers should be critically examined and off types discarded. In addition to off types, the tubers with cuts, bruises, cracks or otherwise mechanically damaged or showing visible symptoms of late blight, dry rot, charcoal rot, wet rot, scab, black scruf, etc. should invariably be removed.

Seed standards

Size of seed tuber: 4-6cm x 2.5 to 3.5cm in diameter; weight: 20-40g

Packing

After sorting and grading the seed potatoes should be put in clean jute-hessian bags (50 kg size) and the bags appropriately labeled.

Storage

Soon after packing, the seed potatoes should be moved to the end use areas for cold storage. If the ambient temperatures are above 32°C, the seed potato should first be kept in pre-cooling chambers, or in a cool place for preconditioning, and then stored in cold storage at temperatures from 2.2 to 3.3° C and 75 to 80 % relative humidity. Periodic inspection of seed stocks in cold storage is necessary, to ensure that stocks are keeping good. Turning of bags during rainy season helps in improving aeration.

Potato is traditionally grown vegetatively through seed tubers. This results in continuous accumulation and increase of various tuber borne diseases in seed tubers and consequent reduction in crop yields. To overcome these problems a new potato production technology making use of **True Potato Seed (TPS)** as planting material for raising the crop has been developed. TPS can serve as a cheap and highly productive planting material for raising commercial potato crop, especially in areas where good quality seed tubers at reasonable prices and in adequate quantities are not available. The major advantages of this technology over the traditional seed tuber technology are as follows:

1. Unlike the seed potato production which is confined to northern India only, the TPS can be produced in all potato growing regions.
2. The crop raised through TPS is almost disease free as most of the diseases get filtered out during TPS production.
3. The TPS being very small, can be stored and transported easily, whereas the seed tubers are bulky hence the storage and transport are expensive.
4. TPS provides a low cost potato production technology where only about 50 g TPS is required for sowing in about 375 m_2 area for producing seedling tubers enough for planting one hectare next year. About 150 g TPS/ha is required if the commercial crop is to be raised in the first year itself by transplanting seedlings in field.

The TPS technology involves two major steps *viz.,*

(a) Production of hybrid seeds and

(b) Its used as planting material for raising the commercial crop.

Two high yielding TPS hybrids *viz.,* TPS C-3 and HPS 1/13 have been recommended for commercial use.

Hybrids and their parents
TPS C-3 **:** JTH/C.107 X JEX/A 680-16
(Female x Male)
HPS 1/13 **:** MF.1 x TPS-13
(Female x Male)

Production of Hybrid TPS
The hybrid TPS can be produced both in the hills, where the crop is grown during long summer days and also in the plains where the crop is grown in winters. Whereas, in the hills the crop flowers natural and hybridization for seed production can be done easily; in the plains, however, additional light has to be provided to induce flowering in the crop. In northern plains, where the winters are severe, the parental lines need to be planted either about 15-20 days before optimum time of the planting of the crop, or the planting is delayed till the second week of November so that the flowering time does not coincide with the severe winter period. Delayed planting of parental lines should not be done in frost prone areas.

Following steps are involved in the production of hybrid True Potato Seed (TPS)

1. If the TPS parents are planted in the plains, there is generally need to provide extra light for about 5 hours at the end of the day to prolong the day length and get proper flowering. Arrangements can be made for providing light from 150 W sodium vapour lamp (one for about every 100 sq.m). Light arrangement is not required if the parents are planted (in April/May) in the northern hills during summer crop season.
2. Plant male and female parental lines (TPS-13 as male and MF-1 as female for producing hybrid TIPS HIPS V13, and JEX/A 680-16 as male and JTH/C-107 as female for producing hybrid TPS of C-2) in two separate but adjacent blocks. The area required for planting male block is generally kept at about 1/4 to 1/6 of the female block, depending on pollen producing ability of the male parent.
3. Plant the male block about a week before planting female block during the main crop season in the plains. Follow the spacing of 60 x 20.cm.
4. In the female block, prepare beds of three rows each. For this, draw 3 rows at 50 cm inter-row distance leaving 80 cm walking space between two adjacent beds. Plant tubers at 15 cm intra-row distance.
5. Use about 30 g size seed tubers or the seed pieces for planting female block. After germination, trim the plants in female block to retain a single stem per plant.
6. Follow all other cultural and plant protection practices for potato crop.
7. In the plains, after the germination is complete, switch on the light in hybridization block in the evening before sunset for a period of 5 hours every day. This will facilitate rapid plant growth and flowering in the parental material.

Hybridization
When the parental material comes to flowering, follow the steps given below to produce hybrid TPS

i. Trim the flower bunches in the female plants to retain only 6-8 large size buds per bunch. Very small buds, old flowers and berries if any, should be removed from the bunches and prepared for pollination next day.
ii. Collect flowers from the male parent in the evening preceding the day of pollination. Only just opened flowers with anthers that are about to shed pollen or the large size buds, which would open next day, should be collected.
iii. Spread flowers of the male parent on a sheet of paper placed on the table at room temperature and use them for extracting pollen next morning.

iv. Extract the pollen in a small dish by shaking anthers using electric buzzer or manually.
v. Pollinate the flowers of the female parent by dipping the stigma in pollen or applying pollen to the stigma using a brush. Do the first pollination between 8-10 AM and re-pollinate the flowers at the same time next day. Continue the process of pollinationtill the flowering period of the crop is over. Usually there are two flushes of flowers during the crop period.
vi. Store the left over pollen in small vials, keep the vials in desiccators and place the desiccators in refrigerator at 6-10° C for the use of next day, if necessary. It is advisable to use fresh pollen for pollination every day.
vii. Provide support (use sticks) to the stems of female plants.
viii. After berries are formed, the berry bunches should be covered with thin muslin cloth bags of about 8 x 12 cm size.

Seed extraction and storage

i. Collect well developed berries about 50-55 days after pollination, keep them in trays and allow them to ripen at room temperature for a period of about 2 weeks.
ii. Mash the soft ripe berries.
iii. After mashing the berries, separate out the TPS with a high pressure water source. Treat the seed and pulp mass with 10% hydrochloric acid (HCI) with continuous stirring for 20 minutes. Wash the seeds with water at least 3-4 times to ensure complete removal of HCl.
iv. Immediately after washing, surface disinfect the seeds by soaking in 0.05% solution of Sodium hypochlorite for 10 minutes and again wash with clean water to ensure that there is no sodium hypochlorite solution on seed.
v. Spread the seed in a thin layer on muslin cloth stretched over a wooden frame and keep the frames in a well ventilated room preferably under fan for 24 hrs, in shade. TPS can be safely dried in any type of low moisture environment i.e. forced air oven, fan etc. Temperatures above 30^0C should be avoided during the initial seed drying period. Thereafter, seeds can be safely dried under temperatures not exceeding 40^0C + 5^0C.
vi. Expose the shade dried seeds to warm sun for about ½ hr to reduce the moisture content.
vii. Keep the seeds in a moisture proof container along with silica gel bags and store them at low temperatures. The seeds may be kept in polythene lined aluminum foil covers or double polythene bags or tin cans, sealed and stored in desiccators kept in refrigerator at 6-10^0C or even at room temperature during the winters.

Yield -200 -250 q/ha seed tubers

Plant protection

Pests

ematodes: Growing potato year after year in the same field should be avoided. Crop rotation with vegetables and green manure may be followed. Application of carbofuran 3 G (1.0 kg a.i.) 33 kg/ha in furrows while seeding has to be done. For cyst nematode resistant variety Kufri Swarna, application of half dose of the above nematicide is enough.
Biological control of nematodes: Applicaton of *Pseudomonas fluorescens* at 10 kg/ha.
Aphids: Spray of methyl demeton 25 EC or dimethoate 30 EC 2 ml/lit.
Cut worms
1. Installation of light trap during summer to attract adult moths.
2. Soil drenching at collar region of the plants in evening hours with chlorpyriphos or

endosulfan 2ml/lit a day after planting.

White grub

1. Summer ploughing to expose the pupae and adults.
2. Quinalphos 5 D at 25 kg/ha 10 days after first summer rains.
3. In endemic areas application of phorate 10 G at 25 kg/ha during autumn season (August - October) is recommended.

Potato tuber moth

2. Installation of pheromone traps at 20 No/ha.
3. Earth up at 60 days after planting to avoid potato tuber moth egg laying in the exposed tubers.
4. Foliar spraying of NSKE 5 % or quinalphos 20 EC 2 ml/lit (ETL 5 % leaf damage).
5. Seed tubers treated with quinalphos @ 1 kg/100 kg of tubers.

Diseases

Late blight: Spraying of Mancozeb 2 g/lit or Chlorothalonil 2 g/lit on 45, 60 and 75 days after planting. Growing of late blight resistant varieties like Kufri Jyothi, Kufri Malar and Kufri Thangam.

Brown rot: Proper drainage facilities are important. Affected plants are removed and destroyed.

Early blight: Spraying of Mancozeb 2 g/lit or Chlorothalonil 2 g/lit at 45, 60 and 75 days after planting.

Virus diseases: Virus free potato seeds should be used. Virus affected plants are rogued regularly. The aphid vectors are controlled by spraying of Dimethoate or Methyl demeton 2 ml/ha.

Lecture no.26-27

Seed production methods in root crops

RADISH *(Raphanus sativus)*

Radish *(Raphanus sativus)* belonging to the family Brassicaceae is one of the common root

crops widely cultivated all over India. The seed production can be done during September – October in autumn and during March in spring season. Seed production can also be taken up during summer season.

Method of seed production

Radish is a highly cross-pollinated crop and self-pollination occurs to the extent of 0 - 5%. Cross-pollination mainly occurs through bees and other flies. Seeds should be allowed to set by cross-pollination in isolation.

Seed production is done by seed to seed or root to seed method. In seed to seed method, the matured roots are left to produce flowers and seeds in the place where seeds are sown initially. It is used for certified seed production alone.

In root to seed method, roots at edible maturity should be uprooted and the roots of true to varietal characteristics should be selected and transplanted to the well prepared field after proper trimming of roots and shoots.

Breeder seeds and foundation seeds are produced by this method. The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 1600 metres for foundation and 1000 metres for certified seed production.

Seed production stages

Breeder seed >> Foundation seed >> Certified seed

Land selection

The land selected should not be cultivated with same crop for the past two seasons. If cultivated it should be inspected by the certification agency and found not to contain any soil borne diseases. The land should be fertile with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 400 gms/acre (10 kg/ha). The selected seeds should be soaked in warm water for 30 minutes before sowing. This helps in the softening of the seeds. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.

The treated seeds are sown directly in the field ploughed for 3 – 4 times and formed into ridges. Well prepared soil of soft and smooth texture will enhance the germination and growth of the plant. Seeds are sown in ridges about 60 – 70 seeds per metre of row at 1.5 – 2.5 cm depth. After thinning the intra row spacing should be 5 – 10 cm. In replanting method, the mother roots are pulled out carefully without damage to the roots and selected based on the typical characteristics. Before replanting the shoot and the root parts are trimmed to 2/3 and ½ to ¾, respectively. The roots (also known as stecklings – roots used for replanting for seed production) are planted at a required spacing of 45 x 45 cm.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafoetida per acre (35 kg neem cake +

600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed.

Weed management
Weeding at regular intervals is very important for the seed crop. The first weeding can be done15 – 20 days after seed sowing / replanting. Periodical removal of objectionable weeds should be done.

Irrigation
Regular irrigation is a must for optimum yield. First irrigation is done at the time of sowing / replanting. Subsequent irrigation should be done at an interval of 10 - 15 days. Irrigation should be stopped when lower few pods start drying. Irrigation should be done 3- 4 days before uprooting.

Pest and disease management
Radish commonly affected by pest and diseases like aphids, radish mosaic virus and Alternaria blight. The management measures for the same are provided in Appendix – 1.

Roguing
Roguing should be done in all growth stages like vegetative stage, flowering stage, stock formation stage and pod formation stage. All the off-types, diseased plants, plants with thin roots, plants coming to early flowering etc., should be rogued off. The maximum percentage of offtypes and roots not confirming to the varietal characteristics permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production. The maximum percentage of plants with seed borne diseases permitted at final inspection is 0.10% for foundation seed production and 0.50% for certified seed production.

Field inspection
In radish a minimum of three field inspections should be done during the mother root production stage and seed production stage. In mother root production stage, two inspections should be done. The first inspection at 20 – 30 days after sowing to check isolation, off-types and other factors and the second inspection at uprooting of roots to determine the true characteristics of the roots. In seed production stage an inspection is scheduled during the flowering stage to check isolation, off-types, designated diseases and other relevant factors.

Field standards

	Foundation seed	**Certified seed**
Isolation distance	1600 m	1000 m
Off-types	0.10%	0.20%
Plants affected by seed borne diseases	0.10%	0.50%

Harvesting
Harvesting is done once the pods are physiologically mature. The physiologically mature pods are in pearl brown colour. The matured pods should be harvested by hand picking and hung in an open space for further drying.

Seed extraction and processing
The dried pods are crushed to separate the seeds, since the pods do not shatter. The separated seeds should be cleaned using gauged screens.

Drying and storage
The extracted seeds should be dried under the shade for a week or two to attain a moisture level of 6% before storage. Seeds can be stored in cloth bags or 700 gauge polythene bags. Under suitable storage conditions the seeds can be stored for about four years.

Seed standards
The percentage of minimum physical purity of foundation and certified seeds should be 98% with a minimum of 70% of germination capacity and 6% of moisture content. The presence of inert matter should not exceed 2.0%.
Seed yield-6-8 q/ha

CARROT *(Daucus carota)*

Carrot *(Daucus carota)* is one of the most important and widely used root vegetable belonging to the family Umbelliferae. The seed production can be done during September – October in plains and in hills the sowing takes place in June and roots are replanted during the first week of October.

Method of seed production
Carrot is a cross-pollinated crop and selfpollinationoccurs to the extent of 0 - 5%. Crosspollination is mainly through insects. Seeds should be allowed to set by cross-pollination in isolation. Seed production is done by seed to seed and root to seed method. In seed to seed method, the matured roots are left to produce flowers and seeds in the place where seeds are sown initially. In root to seed method, roots at edible maturity should be uprooted and the roots of true to varietal characteristics should be selected and transplanted to the well prepared field after proper trimming of roots and shoots. This root to seed method is preferred for seed production in carrot since the root rot infection is high in seed to seed method of seed production.
The isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to varietal purity requirements for certification is 1000 metres for foundation and 800 metres for certified seed production. During mother root production an isolation of 5 metres should be followed.

Seed production stages
Breeder seed è Foundation seed è Certified seed

Land selection
The land selected should be free from volunteer plants. The soil should be fertile and soft with good drainage facility. Since carrot is a cross-pollinated crop the land should be with pronounced isolation distance.

Seed selection and treatment
Certified seeds should be obtained from an authorised source. Seeds should be healthy and free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 1.5 kg/acre (4 kg/ha). The selected seeds should be soaked in water for 72 hours and water should be changed every 24 hours. This method will remove all the germination inhibitors and improve germination. Seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit

the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds.
The treated seeds are sown directly in the field ploughed for 3 – 4 times and formed into ridges or beds of convenient size. Well prepared soil of soft and smooth texture will enhance the germination and growth of the plant. Seeds are mixed with fine sand to facilitate uniform distribution and sown in ridges at 1.5 – 2.5 cm depth. After thinning the intra row spacing should be 5 – 10 cm. In replanting method, the mother roots are pulled out carefully without damage to the roots and selected based on the typical characteristics. Before replanting the shoot and the root parts are trimmed to 2/3 and ½ to ¾, respectively. The roots (also known as stecklings – roots used for replanting for seed production) are planted at a required spacing of 60 x 30 cm.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafoetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed.

Weed management

Weeding at regular intervals is very important for the seed crop. The first weeding can be done 15 – 20 days after seed sowing / replanting. Periodical removal of objectionable weeds should be done.

Irrigation

Regular irrigation is a must to maintain a moisture content of 60 – 80%. First irrigation is done at the time of sowing / replanting. Subsequent irrigation should be done at an interval of 10 - 15 days. In replanted method, first irrigation is done soon after the replanting followed by second irrigation 4 - 5 days after planting. Frequency of the irrigation depends on the moisture content of the soil. Irrigation should be stopped when lower few pods start drying. Irrigation should be done 3 - 4 days before uprooting.

Pest and disease management

Diseases like Alternaria blight and powdery mildew are commonly affecting the crop. The management measures for these diseases are provided in Appendix – 1.

Roguing

Roguing should be done in all growth stages like vegetative stage, flowering stage, stock formation stage and pod formation stage. All the off-types, diseased plants, plants with thin roots, plants coming to early flowering etc., should be rogued off. The maximum percentage of off-types and roots not confirming to varietal characteristics permitted at the final inspection is 0.10% for foundation seed production and 0.20% for certified seed production.

Field inspection

In carrot a minimum of six field inspections should be done during the mother root production stage and seed production stage. In mother root production stage, two inspections should be done. The first inspection at 20 – 30 days after sowing to check isolation, off-types and other factors and second inspection at the time of uprooting the roots to determine the true characteristics of the roots. In seed production stage four inspections are scheduled during the pre flowering stage followed by two inspections at flowering stage and fourth one during maturity stage to check isolation, off-types, designated diseases, varietal characteristics and other relevant factors.

Field standards

	Foundationseed	**Certified seed**
Isolation distance	1000 m	800 m
Off-types	0.10 %	0.20%

Roots not confirming to varietal0 characteristics (by numbers)	0.10%	0.20%

Harvesting

Harvesting is done once the seed heads are physiologically mature. The physiologically mature seed heads will turn from green to brown colour. The matured seed heads should be harvested at once and dried further.

Seed extraction and processing

The dried pods are crushed to separate the seeds, since the pods do not shatter. The separated seeds should be cleaned using BSS 12 wire mesh sieve.

Drying and storage

The extracted seeds should be dried under the shade for a week or two to attain a moisture level of 8% before storage. Seeds can be stored in cloth bags or 700 gauge polythene bags. Under suitable storage conditions the seeds can be stored for about four years.

Seed standards

The percentage of minimum physical purity of foundation and certified seeds should be 95% with a minimum of 60% of germination capacity and 8% of moisture content. The presence of inert matter should not exceed 5.0%.

Seed yield-6-7 q/ha

Lecture no.28-29

Seed extraction,drying ,processing and storage of seed

Seed extraction :

The selected fruits are harvested for seed in the same way that is picked for the market. The seeds extraction from wet / flash fruits can be done by the following methods.

1. Manual method
2. Fermentation method
3. Mechanical method
4. Chemical method

5. Juice and seed extraction method

1. Manual Method

(a) Maceration e.g., watermelon, (b) Crushing e.g., brinjal, (c) Scraping e.g., cucumber (d) Separated e.g., muskmelon, (e) Scooping e.g., pumpkins and (f) Extraction e.g., squashes.

1.1. Dry Extraction

Dry extraction is done either manually or mechanically. Manual extraction is by beating with pliable bamboo stick or by beating against a hard surface. Threshers (LCT) are used for mechanical extraction. In this method care should be taken to avoid mechanical injury.

1.2. Wet Extraction

It is normally practiced in fleshy fruits of vegetables like tomato, brinjal, bittergourd, snakegourd and ashgourd. Among these, extraction is easier in brinjal and ashgourd as the fleshy pulp's interference is less. Seeds are separated with pulp and are washed with adequate water and for removing the sliminess; seeds are washed with 0.1% HCI for 2-3 minutes. In chillies, dry extraction using curry powder grinder is preferable than soaking in water and squeezing off the fruit rind. In tomato seed extraction is done either by fermentation method or acid method. Alkali method (Na_2CO_3) and citric acid method are also available but are not practiced widely.

3. Fermentation Method

Fruits with pulp and seed are squeezed and kept as such for 24-48 hours. The seeds will settle down. Decayed pulp and immatured seed will float. The settled seeds are washed with more of water. The seeds are shade dried and then sun dried before using. Care should be taken to avoid germination of seed during fermentation. The seeds will be dull in colour.

4. Chemical method

i. Alkali method

This method is relatively safe and can be used for small quantities of seed in cooler temperate areas where the fermentation method is not used. The pulp containing the extracted tomato seed is mixed with an equal volume of a ten per cent solution of sodium carbonate (washing soda). The mixture is left for up to 48 hours at room temperature and after washed out in a sieve and subsequently dried. This method is not suitable for commercial seed production as sodium carbonate tends to darken the testa of the seed.

ii. Acid method

Acid method is often favoured by large commercial seed producers as it produces a very bright clean seed. Addition of 30ml of hydrochloric acid per litre of seed and pulp mixture, stirred properly and left for half an hour then the seeds are washed thoroughly with water, sieved and dried. The benefits of this method are (i) seed extraction and drying is done on the same day, (ii) higher seed recovery, (iii) the problems of low and high temperatures are avoided, (iv) discoloured seed resulting from fermentation is entirely avoided and (v) remove external seed borne pathogens.

Drying principles and methods

Seed Drying means …

Removal or elimination of moisture from the seed to the required level is called drying. Drying of seeds is done by following methods:

1. Sun drying(Natural Drying)
2. Forced air drying (Mechanical drying)
3. Use of desiccants (Chemical) for drying

1. Natural Drying (or) Sun drying

Here the seeds are uniformly spread over clean dried yard and allowed for drying

to the required moisture level. The seeds should not be dried under hot sun during 12.00 noon to 2.00 pm as it causes damage to seeds by UV rays. This method depends on weather conditions, which are unpredictable one.

Advantages

Easy process
Cheap method
Requires no additional equipment
Does not require any expenditure on electricity or fuel

Disadvantages

More chance for mechanical admixture
Seed loss is more while drying due to insects, birds and animals.
Takes long time for drying.
Uneven drying.
High weather risk and damage due to sudden rain or heavy wind.

2. Mechanical drying (or) artificial drying

Forced air is used for seed drying by the following three means.

a. Natural air drying: Natural air is blown upon the seeds using suitable air blower for drying. Continuous drying is possible in this method. In modern seed godowns provisions are made to forcible circulation of air with the help of electric blower or fan**.** If the outer air is comparatively dry, this method is followed. So it is possible only during dry months.

b. Drying with supplemental heat: Small quantity of heat is applied to raise the air temperature to 10-20^0 F for reducing the relative humidity of air used for drying. In this, drying is performed quickly due to use of dry air, but continuous drying for long period affects seed quality.

c. Heated air Drying: The air is heated considerably as much as by 100^0 F (40^0 C) and used for drying the seeds. Very quickly the seeds get dried. The seeds should not be continuously dried as it causes damage to seed. High moisture seeds should be dried by this method.

Advantages

Quick method
Perfect drying is possible even under unfavourable weather condition.
Seed loss is minimized.

Disadvantages

Requires specialized equipment and machine, which is costly.
Care should be taken while drying the seed using hot air, as it causes damage to the seed.
Tempering is to be followed while drying the seed in this method.

TYPES OF DRIER

Metal bin drier
Vegetable seed drier
Batch drier

Here the seeds are placed in a metal bin and the heated air is blown in to the bin through the perforations made at the bottom of the bin. In this uniform drying of all layer is not possible for which decide the thickness of the seed layer to be taken to the bin and also have to stir the seed manually or mechanically at regular intervals.

Vegetable seed drier

In this drier, the seeds are separated over the bottom screen seed trays which are kept inside chamber or cabin. The heated air is passed to dry the seed. The heat is generated by electrical source and the air is passed through trays. Here uniform drying is possible.

Batch-Drier

In bin batch dryers, the seed is placed in a (usually round) bin, and ambient or slightly heated air is blown through it by a fan. The maximum thickness of the seed layer in the bin depends on the initial moisture content, the type of seed, the air temperature and RH and fan horse power. To obtain a uniform airflow through the seeds, a full perforated floor is required.

A layer of seed 0.8 to1.0 m at 20% moisture can be dried to 14% within 24 hrs without affecting germination at 30-35^{0}C and 50-60%RH air at a rate of 5-8m^3 per minute per m^3 of seed.

After the seed in a bin has reached the acceptable average moisture content, a moisture gradient will remain from the top to the bottom of the seed. The surface layer will have a moisture content above the average and the bottom layer of the bin will be lower than average. Thus, proper mixing of the seeds is essential before further storage or packaging. This can be addressed by installing one or more grain stirrers to mix the entire content of a bin for 3-12 hours.

Wagon Batch- Dryer

A seed transport wagon can be transformed into a wagon batch-dryer by equipping it with a plenum, a perforated floor, and a fan/heater unit coupled with a canvas transition to the wagon. The drying principles of a wagon batch dryer and a bin batch dryer are similar. Wagon batch dryers are most frequently used for drying fragile seeds such as large-seeded legumes (eg. field or garden beans and peanuts). The recommended air flow rate for the ambient –air wagon drying of a 1.5m layer of peanut seeds is 0.25m^3 of air per m^2 of floor area.

3. Use of seed desiccants (Chemical drying)

In this method silica gel or fused calcium chloride ($CaCl_2$) is used to absorb the moisture from the seed and its surrounding environment.

Silica gel is of two types, as

i) Indicator type

ii) Non-indicator type

iii) - Active ingredient in Silica gel is Lithium chloride, which is responsible for drying process. Silica gel can absorb moisture upto 15 per cent of its weight. So to get very low moisture content we can use this, which is not possible in mechanical driers.

- Indicator type will be blue in colour and on absorbing moisture, this turns to pink colour. So we can remove this and reuse after dehydration. Non – indicator type will be white in colour and remains same (white) even after absorption of moisture content. So there is no indication in this type. But this can also be reused after dehydration.
- Calcium chloride is used for most of the vegetable and flower seeds of breeding material. Here the quantity needed is more. It can absorb 10 per cent of its weight.
- The method is suitable for drying small quantities of seeds only. It is a sophisticated and costlier method.

Advantages

Less time consuming

Drying rate is uniform

Disadvantages

It cannot be used in large scale

A skilled person is required to monitor the operation

The rate of drying the seed depends upon the following factors:

The moisture content of the seed

The existing relative humidity and temperature of the environment

Depth of spread of seeds

Rate of air blow

Drying temperature

Size and capacity of the drier and
Kind of seeds

Seed processing

Seed processing is a vital part of the total technology involved in making available high quality seed. It assures the end users, seeds of high quality with minimum adulteration. In Agriculture, the term seed processing includes cleaning, drying, seed treatment, packaging and storage. Seed processing may be understood to 'comprise all the operations after harvest that aim at maximizing seed viability, vigour and health.

Purposes of seed processing

To lower the cost of further processes likes storage including transport. This is achieved by reducing the bulk of the seed lot by cleaning debris and by removing empty or fractured seed (pre cleaning)

1. To increase the longevity of seeds; by drying seeds to safe moisture content and treating with protective chemicals
2. To reduce the variability in vigour by invigorating the seeds and removing the low vigour seeds
3. To improve the uniformity in seed shape or size by grading or by pelleting.

Principles and objectives

The quality of seed is improved during processing in two ways

1. Separation of other tree seeds or inert matter and
2. Upgrading or the elimination of poor quality seeds.

The ultimate goal of seed processing is to obtain the maximum percentage of pure seed with maximum germination potential.

The threshed produce is heterogeneous in nature. Processing brings homogeneity in the produce. This homogeneity helps in obtaining uniformity in the field. Processing of seeds is carried out in approved (By Director of Seed Certification) seed processing plants

Requirement in seed processing

1. There should be complete separation.
2. There should be minimum seed loss.
3. Upgrading should be possible for any particular quality.
4. There should be have more efficiency.
5. It should have only minimum requirement.

Types of materials removed during seed processing

1. Inert materials
2. Common weed seeds
3. Noxious weed seeds
4. Deteriorated seeds
5. Damaged seeds
6. Other crop seeds
7. Other variety seeds
8. Off-size seeds

Sequence of operation in seed processing

1. Sequences of operations are based on characteristics of seed such as shape, size, weight, length, surface structure, colour and moisture content. Because each crop seed possesses individually seed structure. Therefore, sequence of operation will be applied proper equipments. However, sequences of operation in seed processing are drying, receiving, pre-cleaning, conditioning, cleaning, separating or upgrading, treating (Drying), weighting, bagging and storage or shipping.

Seed storage

Seed storage is preservation of seed with initial quality until it is needed for planting. The ability of seed to tolerate moisture loss allows the seed to maintain the viability in dry state. Storage starts in the mother plant itself when it attains physiological maturity. After harvesting the seeds are either stored in ware houses or in transit or in retail shops. During the old age days, the farmers were used farm saved seeds in little quantity, but introduction of high yielding varieties and hybrids and modernization of agriculture necessitated the development of storage techniques to preserve the seeds. The practice of storing the seeds starts from the ancient days itself, following simple and cheap techniques eg. Placing the seeds in salt, red earth treatment to red gram etc. But the same practices are not hold good for the present day agriculture, because

- large quantity to be stored
- exchange of varieties and species
- exchange of genes

The type of material to be stored decides the techniques to be followed for safe storage. Now a days storage technique changed from ordinary godown storage to cryogenic tank storage and even gene storage.

Stages of Seed Storage

- The seeds are considered to be in storage from the moment they reach physiological maturity until they germinate or until they are thrown away because they are dead or otherwise worthless.
- The entire storage period can be conveniently divided into following stages.
- Storage on plants (physiological maturity until harvest).
- Harvest, until processed and stored in a warehouse.
- In - storage (warehouses)
- In transit (Railway wagons, trucks, carts, railway sheds etc.).
- In retail store
- On the user's farm.

Purpose of seed storage

Storage is needed to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted.

Objective of seed storage

To maintain initial seed quality viz., germination, physical purity, vigour etc., all along the storage period by providing suitable or even better conditions

Types of storage

1. Storage at ambient temperature and humidity

Seeds can be stored in piles, single layers, sacks or open containers, under shelter against rain, well ventilated and protected from rodents and store at least for several months.

2. Dry storage with control of moisture content but not temperature

Orthodox seeds will retain viability longer, when dried to low moisture content (48%) and then stored in a sealed container or in a room in which humidity is controlled, than when stored in equilibrium with ambient air humidity. Cool condition is especially favourable.

3. Dry storage with control of both moisture content and temperature

This is recommended for many orthodox species which have periodicity of seeding but which are planted annually in large scale afforestation projects. A combination of 4-8% moisture content and 0 to 5° temperature will maintain viability for 5 years or more.

4. Dry storage for long-term gene conservation

Long-term conservation of gene resources of orthodox agricultural seeds is -18°C temperature and 5±11% moisture content

5. Moist storage without control of moisture content of temperature

Suitable for storage of recalcitrant seeds, for a few months over winter. Seeds may be stored in heaps on the ground, in shallow pits, in well drained soils or in layers in well ventilated sheds, often covered or mixed with leaves, moist sand, peat or other porous materials. The aim is to maintain moist and cool conditions, with good aeration to avoid overheating which may result from the relatively high rates of respiration associated with moist storage. This may be accomplished by regular turning of the heaps.

6. Moist cold storage, with control of temperature

This method implies controlled low temperature just above freezing or less commonly, just below freezing. Moisture can be controlled within approximate limits by adding moist media e.g., sand, peat or a mixture of both to the seed, in proportions of one part media to 1 part seed by volume, and re-moistening periodically or more accurately by controlling the relative humidity of the store. This method is much applicable to temperate recalcitrant genera.

7. Cryopreservation

It is also called as cryogenic storage. Seeds are placed in liquid nitrogen at -196°C. Seeds are actually placed into the gaseous phase of the liquid nitrogen -150°C for easy handling and safety. Metabolic reactions come to a virtual standstill at the temperature of liquid nitrogen and the cells will remain in an unaltered state until the tissues are removed from the liquid nitrogen and defrosted. Therefore, little detrimental physiological activity takes place at these temperatures, which prolongs the storage life of seeds. It is not practical for commercial seed storage, but is useful to store the valuable germplasm.

Maintenance of viability in storage

· Store well mature seeds
· Store normal coloured seeds
· Seeds should be free from mechanical injury
· Seeds should be free from storage fungi or micro organisms 5. Seeds should not have met with adverse conditions during maturation 10. Storage godown should be fumigated to control storage insects, periodically
· Storage environment or godown should be dry and cool.
· Seeds should be dried to optimum moisture content
· Required R.H. and temperature should be maintained during storage.
· Seeds should be treated with fungicides before storage
· Suitable packaging materials should be used for packing.

Factors influencing seed storage

1. Biotic
2. A biotic

1. Biotic factors

a. Factors related to seed
- Genetic make up of seed
- Initial seed quality
- Provenance
- Seed moisture content

b. Other biotic
- Insects
- Fungi
- Rodents
- Mishandling during sampling, testing

2. Abiotic factors

- Temperature
- Relative humidity

- Seed store sanitation
- Gaseous atmosphere
- Packaging material
- Seed treatment

Lecture No.30

Seed testing for germination,viability and purity

Seed testing

Seed testing is the cornerstone of all other seed technologies. It is the means by which we measure the viability and all the physical factors that regulate the use and maintenance of seeds. Seed tests tell if a crop of seeds is worth collecting, if handling procedures are correct, and how many potential seedlings are available for regeneration. Seed testing is the science of evaluating the planting value of seed. Seed quality in India is legally controlled by the Seed Act, 1966.

The seed Act is enforced by Govt. of India through the Central Ministry of Agriculture and Co-operation and State Department of Agriculture. According to this Act all the seeds of notified varieties / kinds when sold to farmers must meet the minimum standard of germination, genetic purity and physical purity. The seed should be packed in a suitable container and a label has to be affixed on the container. Information about germination, physical purity, variety, date of test and name of the seed producer has to be given on the label. The germination as given on the label is valid for 9 months and after which it has to be revalidated.

Objectives

1. To determine their quality, that is, their suitability for planting.
2. To identify seed quality problems and their probable cause.
3. To determine the need for drying and processing and specific procedures that should be used.
4. To determine if seed meets established quality standards or labelling specifications.
5. To establish quality and provide a basis for price and consumer discrimination among lots in the market.

Seed germination test

Principle

Germination tests shall be conducted with a pure seed fraction. A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of seed and size of containers of substrate. The test is conducted under favourable conditions of moisture, temperature, suitable substratum and light if necessary. No pretreatment to the seed is given except for those recommended by ISTA.

Materials required

A. Substratum

The substratum serves as moisture reservoir and provides a surface or medium for which the seeds can germinate and the seedlings grow. The commonly used substrata are sand, paper and soil.

I. Sand

a. Size of sand particle

Sand particles should not be too large or too small. The sand particles should pass thorough 0.80 mm sieve and retained by 0.05 mm sieve.

b. Toxicity

Sand should not have any toxic material or any pathogen. If there is presence of any pathogen, found, then the sand should be sterilized in an autoclave.

c. Germination Tray

When we use the sand, germination trays are used to carry out the test. The normal size of the tray is 22.5 x 22.5 x 4 cm. They tray may either zinc or stainless steel.

B. Method of seed placement

1. Seeds in sand(s)

Seeds are planted in a uniform layer of moist sand and then covered to a depth of 1 cm to 2 cm with sand.

2. Top of sand (TS)

Seeds are pressed into the surface of the sand

C. Spacing

We must give equal spacing on all sides to facilitate normal growth of seedling and to avoid entangling of seed and spread of disease. Spacing should be 1-5 times the width or diameter of the seed.

D. Water

The amount of water to be added to the sand will depend on size of the seed. For cereals, except maize, the sand can be moistened to 50% of its water holding capacity. For large seeded legumes and maize sand is moistened to 60% water holding capacity.

II. Paper

Most widely used paper substrates are filter paper, blotter or towel (kraft paper). It should be have capillary movement of water, at vertical direction (30 mm rise / min.). It should be free from toxic substances and free from fungi or bacteria. It should \ hold sufficient moisture during the period of test. The texture should be such that the roots of germinating seedlings will grow on and not into the paper.

A. Methods

a. Top of Paper (TP)

Seeds are placed on one or more layers of moist filter paper or blotter paper in petridishes. These petridishes are covered with lid and placed inside the germination cabinet. This is suitable of those seeds which require light.

a. **Between paper (BP)**

The seeds are placed between two layers of paper

b. Roll towel method

The seeds are placed between two layers of paper and rolled in towels. The rolled towels are placed in a water source and kept in germinator or germination room.

c. Inclined plate method

Germination on glass plate with germination paper and kept at an angle of 45^0C.

III. SOIL

Should be non-caking, free from large particles. It must be free from weed seeds, bacteria, fungi, nematode and other toxic substances. Soil is not recommended for reuse.

B. TEMPERATURE

Normally most of the seeds germinate between 20-30^0 C.

LIGHT

Light requirement seeds should provided with light eg.lettuce

C. LIGHT

Light requirement seeds should provided with light eg. Lettuce

Germination apparatus

1. Germination Cabinet / Germinator

This is called chamber where in temperature and relative humidity is controlled. We can maintain the required temperature

2. Room germinator

It works with same principle of germinator. This is a modified chamber of larger one and the worker can enter into it and evaluate the seedlings. Provisions are made to maintain the temperature and relative humidity. This is used widely in practice.

3. Counting Board

This is used for accurate counting and spacing of seeds. This consists of 2 plates. The basal one is stationary and top one is movable. Both top and basal plates are having uniform number of holes viz., 50/100, when the plates are in different position. After taking the sample, the top plate is pulled in such a way that the holes are in one line so that the fixed number of seeds falls on the substratum.

4. Vacuum Counter

Consists of a head, pipe and wall. There are plates of 50 or 100 holes which can be fitted to the head. When vacuum is created the plate absorbs seeds and once the vacuum is released the seeds fall on the substrate.

5. Impression Board

Made of plastic / wood with 50 or 100 holes/pins. Here the knobs are arranged in equal length and space. By giving impression on the sand it makes uniform depth and spacing for seed.

D. Seedling Evaluation

ISTA classified the seedlings into different categories based on the development of essential structures

CATEGORIES OF SEEDLINGS

1. Normal seedlings
2. Abnormal seedlings
3. Hard seeds
4. Fresh ungerminated seeds
5. Dead seeds

Purity analysis and germination test for seeds

Purity analysis

The purity test is the first test to be made. Seed samples can contain impurities such as weed seeds, seeds of other crop species, detached seed structures, leaf particles and other material. The object of purity analysis is to determine the composition of the sample being tested by weight. To do this, a purity test is conducted, in which the working sample is separated into the following component parts:

i) **Pure seed** refers to the species under consideration. In addition to mature, undamaged seed, it includes, undersized, shriveled, immature and germinated seeds, provided they can be definitely identified as the species under consideration, more over it includes pieces resulting from breakage that are more than one half their original size

Pure seeds includes the following:

a. Intact seeds

b. Achenes and similar fruits like caryopsis, schizocarpand mericarp with or without pedicel, perianth and whether they contain true seed unless it is apparent and when difficult to identify.

c. Pieces of seeds, achenes, mericarp and caryopsis resulting from breakage that is more than half the original size (Half seed rule). However, seeds of Leguminosae, Cruciferae and Coniferae are considered as inert matter if their seed coat is removed.
d. Clusters of Beta or pieces of such clusters with or without seeds that are retained by 200 x 300 mm sieve.
e. Florets and caryopsis of Grammae.

Instruments

1. Seed blower

It is used to remove the light weighted inert matter from the seeds. Working sample is kept at the lower portion of the tube and the required uniform upward flow of air is regulated upto prescribed period of time. Lighter matter is separated from the sample by air flow and settle down in the partition provided in the tube of the blower. The tube is removed and inert matter is collected.

2. Diapanascope

The purity work board is provided with light source in the background which facilitates easy separation of different component. It also helps better distinguishing of red pericarp from white pericarp and short bold grains long slender grains from medium types.

The percentage by weight of each of the component parts shall be calculated to one decimal place. Percentage must be based on the sum of the weight of the components not on the original weight of the working sample, but the sum of the weights of the components must be compared with the original weight as a check against loss of material or other error. The result shall be reported to one decimal place and the percentage of all components must total 100. Components of less than 0.05% shall be reported as Trace. If the purity is less than the standard retirement the certification department will reject the seed.

Lecture no.31

Seed production methods in spice crops

CORIANDER *(Coriandrum sativum)*

Coriander *(Coriandrum sativum)* is one of the most important condiments belonging to the family Umbelliferae. The seed production can be done in rabi season. Best sowing time for seed production is mid October – mid November.

Method of seed production

Coriander is a cross-pollinated crop and selfpollination occurs to the extent of 0 - 5%. Crosspollination is mainly through insects. Seeds should be allowed to set by cross-pollination in isolation. The minimum isolation distance maintained between the fields of other varieties and the fields of the same variety not conforming to the varietal purity requirements for certification is 200 metres for foundation and 100 metres for certified seed production.

Seed production stages

Breeder seed è Foundation seed è Certified seed

Land selection

The land selected should be free from volunteer plants. The soil should be fertile and soft with good drainage facility.

Seed selection and treatment

Certified seeds should be obtained from an authorised source. Seeds should be healthy, free from disease and pest infection. Remove the broken, coloured seeds and use uniformly graded seeds. Seed rate is 8 kg/acre (20 kg/ha). The selected seeds should be split into two halves by rubbing before sowing. The selected seeds should be soaked in a solution of cow's urine (1 part cow's urine + 5 parts of water) for 30 minutes prior to the sowing. This will inhibit the seed borne diseases. Treat the seeds with *Trichoderma viride* @ 4 gms/kg of seeds. The treated seeds are sown directly in the field ploughed for 3 – 4 times and formed into ridges at 1.5 – 2.5 cm depth. Well prepared soil of soft and smooth texture will enhance the germination and growth of the plant. Seeds are sown in rows at a spacing of 30 cm apart.

Nutrient management

Farm yard manure or compost is applied @ 10 tonnes/acre (25 tonnes/ha) before last ploughing and incorporated into the soil. Neem cake @ 30 kg/acre (75 kg/ha) and vermicompost @ 250 kg/acre (600 kg/ha) should be applied as basal manure. Enriched vermicompost (2 kg *Azospirillum*, 2 kg *Phosphobacterium* and 2 litres *Panchagavya* mixed with 250 kg vermicompost

and kept covered for a week and then used) @ 250 kg/acre (600 kg/ha) should be applied 20 – 25 days after sowing as first top dressing. Second top dressing should be done 40 – 45 days after sowing using neem cake 15 kg and vermicompost 250 kg mixed with 200 gms of asafoetida per acre (35 kg neem cake + 600 kg vermicompost mixed with 500 gms of asafoetida per hectare). During flower initiation stage 10% tender coconut solution (1 litre tender coconut water + 9 litres of water) should be sprayed. For rainfed cultivation replace the neem cake with pungam cake and apply all the above mentioned inputs only when the soil is wet.

Weed management

Weeding at regular intervals is very important for the seed crop in the earlier stages. In rainfed crop the first weeding is done 25 – 30 days -after sowing and in irrigated crop it is done in 40 – 45 days after sowing. Periodical removal of objectionable weeds should be done.

Irrigation

First irrigation should be done before sowing. Subsequent irrigation should be done at an interval of 10 - 15 days. Frequency of the irrigation depends on the moisture content of the soil. Irrigation during flowering and seed setting is a must.

Pest and disease management

Coriander crop is commonly affected by the pests and diseases like blight, powdery mildew, wilt and aphids at different growth stages.

Roguing

Roguing should be done in all growth stages from vegetative stage to harvesting stage. All the off-types, diseased plants, plants with thin roots, plants comes to early flowering etc., should be rogued off. The maximum percentage of offtypes permitted at the final inspection is 0.10% for foundation seed production and 0.50% for certified seed production.

Field inspection

In coriander a minimum of three field inspections should be done. The first inspection is done before flowering within 45 days of planting followed by the second one during 50% flowering to check the isolation, volunteer plants, off-types and other relevant factors. The third inspection is scheduled at the time of maturity and prior to harvest to check the varietal characteristics of the plant and other factors.

Field standards

	Foundation seed	**Certified seed**
Isolationdistance	200m	100m
Off-types	0.10%	0.50%

Harvesting

Harvesting is done once the seeds are physiologically mature. The matured seeds will turn to yellowish green and hard. The physiologically mature seeds should be harvested successively since the minimum pressure or disturbance will make the matured seeds to fall.

Seed extraction and processing

The harvested plants are dried under the sun. After drying the plants are threshed by hand and seeds are removed. The removed seeds are cleaned further by winnowing.

Drying and storage

The extracted and cleaned seeds should be dried under the sun to attain a moisture level of 10% before storage. Under suitable storage conditions the seeds can be stored for about three years.

Seed standards

The percentage of minimum physical purity of the foundation and certified seeds should be 97% with a minimum of 65% of germination capacity and 10% of moisture content. The presence of inert matter should not exceed 3.0%. Presence of seeds of other crops are permitted at the maximum of 10/kg for foundation and 20/kg for certified seeds.

Lecture 32

Seed Act / Legislation

Introduction

The seed is an important agricultural input and it plays vital role in increasing production and productivity. There is a need to safeguard the farmers with the supply of genetically pure and quality seeds. Any new variety produced by the Scientist has to be multiplied many times to meet the needs of the farmers. In order **to ensure the availability of quality seeds**, **Government of India has enacted Seeds Act, 1966 and Seed rules, 1968. The seed (Control) order, 1983 was** promulgated under essential commodities act, 1955 in order to ensure the production, marketing and equal distribution of the seeds.

Seeds Act, 1966

The object of Seed Act is to regulate the quality of certain notified kind / varieties of seeds for sale and for matters connected therewith. The seed act passed by the Indian Parliament in 1966 was designed to create a 'Climate' in which the seeds man could operate effectively and to make good quality seed available to cultivators. **Seeds rule** under the act was **notified in September 1968** and **the act was implemented entirely in October, 1969**. This act extent to the whole of India and it has **25 sections.**

Seed legislation could broadly be divided into two groups

1. Sanctioning legislation

Sanctioning legislation authorizes formation of Advisory bodies, Seed Certification Agencies, Seed Testing laboratories, Foundation and Certified Seed Programmes, Recognition of Seed certification Agencies of Foreign countries Appellate authorities etc.

2. Regulatory legislation

Regulatory Legislation controls the quality of seeds sold in the market including suitable agencies for regulating the seed quality. On quality control basis, the Seeds Act could conveniently be divided into the following:

I. Minimum limit and labelling of the notified kind / varieties of seed

a. Power to notify the kind / variety
b. Labelling provisions
c. Seed testing
d. Seed analyst
e. Seed inspectors
f. Penalty
g. General provisions

II. Seed Certification

III. Restriction of Import and Export of Seeds

1. Minimum limits and labelling

Quality control as envisaged in the Act is to be achieved through pre and post marketing control, voluntary certification and compulsory labelling of the seeds of notified kind / varieties.

(a) Power to notify the kind / varieties

New varieties evolved by the State Agricultural Universities and ICAR institutes are notified and released /notified respectively under section 5 of the seeds act in consultation with the central seed committee and its sub committees constitute under section 3 and 3(5) of the Seeds Act. As on date more than 2500 varieties and 130 varieties were notified and denotified under this section. List of varieties notified and denotified from 1969 to 2005 are compiled and made available in the form of a book called **catalogue of varieties notified and denotified** under section 5 of the Seeds Act. Functions of the Central Seed Committee and its sub-committee are defined in Clauses 3 and 4 of part II of seed rule.

(b) Labelling provision

Minimum limits for germination, physical purity and genetic purity of varieties / hybrids for crops have been prescribed and notified for labelling seeds of notified kind / varieties under section 6(a) of the Seeds Act. Size of the label, colour of the label and content of the label were also notified under sub clause (b) of Section 6 of Seeds Act. Colour of the label is opal green and size of the label is 10 cm x 15 cm or proportionate thereof. Responsibility for making labelling content of mark or label, manner of marking, false / misleading statement on label etc, are defined under clause 7,8,9,10,11 and 12 of part V of seeds rule.

Section 7 of the act regulates the sale of notified kind or varieties. Accordingly no person shall keep for sale, offer to sell, barter or otherwise supply any seed of any notified kind or variety, after the dates recorded on the container mark or label as the date unto which the seed may expected to retain the germination not less than prescribed under clause (a) of section 6 of the Act.