SEED PRODUCTION AND TECHNOLOGY

Practical Manual

Practical Manual
Course No - EL-AGP 802

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CONTENTS

Introduction

Production of genetically pure and otherwise good quality pedigree seed is an exacting task requiring high technical skills and comparatively heavy financial investment. During seed production strict attention should be given to the maintenance of genetic purity and other qualities of seeds in order to exploit the full dividends by introduction of new superior crop plant varieties. In other words, seed production has to be carried out under standardized and well-organized condition.

A series of booklets have been published on various aspects of seed systems to build the capacity of various field groups who are involved in the efforts to develop entrepreneurship in seed production. This manual has attempted to deal with the production of good quality seeds of rice, maize, seedless cucumber, onion and solanaceous crops. The characteristics of good quality seeds have been defined. Factors influencing seed production and the ways to maintain pure accessions like isolation distance, bagging technique, rouging has been dealt with.

Every farmer in our country needs healthy seeds which are genetically pure, with high seed vigour and good germination percentage. Timely availability of good quality seeds at reasonable price ensures good yield and profit to the farmers. The seeds play an important role in agriculture and acts as a carrier of the genetic potential of varieties. Quality seed production which follows efficient certification procedures plays a major role in the increase of food production of our country. To ensure this, the Government has prescribed standards and has brought in seed production techniques, testing, certification and marketing procedures through the Seeds Act, 1966.

This manual has been written for the final year students of agriculture who want to specialize themselves in seed production of some important crops. It is hoped that the students will be benefitted by this manual

B. C. Saha

Seed Production Technology of Hybrid Rice

Introduction:

Hybrid technology exploits heterosis in crop plants for economic advantage. This phenomenon has benefited agriculture and fascinated geneticists over 100 years for development of superior cultivars in many crops. It covers large acreage for many crops including rice and has fundamentally affected agricultural practices and the seed industry across the world. Rice hybrid is the F1 cross of two genetically distant genotypes, having ability to produce 20-30% more yield than High Yielding Varieties. Hybrid rice (HR) seed production is a profitable venture and offer extra income (Rs. 75000-85000/ha net return) and has additional employment opportunity to~20.0 million rural youths (requires 100-105 extra man days/ha area of seed production). Therefore, this entity has great scope for improvement of livelihood of the nation. Given its yield advantage and economic importance, several hybrids in rice have been commercialized in more than 40 countries, which created a huge seed industry world-wide. Development of hybrids in rice was first initiated in China during early 1970s. In India, it was started in a systematic way by the Indian Council of Agricultural Research (ICAR) involving twelve network centers in 1989. During the period from 1994 to 2020, India has developed and released a total of 127 rice hybrids (38 from public and 89 from private sector) for different durations (115-150 days) and rice ecosystems. At present, hybrid rice area is around 3.5 million hectares, which is about 8.0% of total rice area in India.

Hybrid rice system

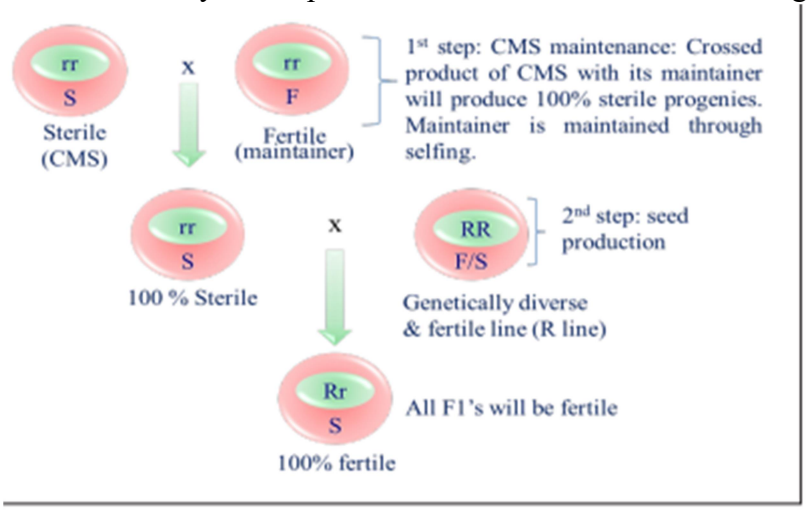
Hybrid is first filial (F1) progeny of genetically diverse parents, developed through allogamous mode of reproduction. In rice, natural out-crossing is very low (ranged only 0.3-3.0 %), hence, commercial HR seed production is very cumbersome and expensive. It needs specific parental lines and best agro-management practices. The discovery of male sterile (MS) system makes this technology very useful in rice. The MS is a crucial genetic tool for HR breeding which excludes tedious and expensive activity i.e. manual emasculation and large scale seed production. Based on availability and their genetic mechanism, two type of MS namely, cytoplasmic male sterile (CMS) and genetic male sterile (GMS) are available for hybrid rice development. The CMS is stable across the ecology and has restorer abundance. Thus, found suitable for hybrid development. Temperature and photoperiod dependent male sterility expression (in GMS) is unstable in tropics, and, therefore, not adopted in India. Based on mechanism of male sterility in rice, there are three types of HR seed production systems, namely CMS based three-line system (involves A, B and R lines), GMS based two-line system (involves A and R lines) and apomixis based one-line system is existing. CMS based three-lines system is extensively utilized (seed parent of >90% of world's hybrids) in HR production. This system involves three parental lines viz., cytoplasmic male sterile line (CMS or 'A'), maintainer (or' B') line and restorer ('R') line for developing hybrids. Hybrid seed production using the CMS system involves the following two steps.

• Maintaining 'A' line (by crossing A line with the B line)

• Production of hybrid seed (by crossing A line with R line)

The 'B' and 'R' lines are multiplied in the same way as inbred lines. Whereas, A-line multiplication and hybrid seed production are different. The above two systems

areschematically presented in the figures 1 & 2.



ure 1: Schematic presentation of hybrid rice seed production technolog

Figure 2. Seed Production plot of Hybrid Rice

Hybrid rice program in India:

Since inception of HR during 1989, the country has released 127 (indica/indica) heterotic (15-20% yield superiority) hybrids for diverse agro-climatic conditions (115-150 days). Besides, more than 100 stable CMS and respective maintainers, indigenously, under diversified genetic and cytoplasmic background. The promising CMS lines like CRMS 8A, CRMS 31A, CRMS 32A, CRMS 53A, CRMS 54A, CRMS 56A, PMS10A, DR8A, PMS 17A, APMS 6A, PUSA 5A, RTN 12A, PUSA6A, etc. are being utilized in HR breeding programs in India and abroad. Remarkably, a medium duration CMS, CRMS 32A having seedling stage cold tolerant is developed indigenously under Kalinga-I cytoplasm is found suitable for breeding hybrids for boro ecology. The hybrids released in India are adaptable to tropical and subtropical ecologies, having unambiguous specificity towards habitat, sustainability and consumer preferences (Table 1). Therefore, to harness maximum potential and benefit, only suitable hybrids should be adopted under recommended condition/area (Table 2).

Table1. Suitability of rice hybrids against biotic and abiotic stresses

S. No.	Stress	Hybrid
1	Rain-fed upland	DRRH-2, Pant Sankar Dhan-1, Pant Sankar Dhan-3, KJTRH-4
2	Saline soil	DRRH-28, Pant Sankar Dhan-3, KRH-2, HRI-148, JRH-8, PHB-71, Rajalaxmi
3	Alkaline soil	Suruchi, PHB-71, JKRH-2000, CRHR-5, DRRH-2, DRRH-44, Rajalaxmi
4	*Boro* season	Rajalaxmi, CRHR-4, CRHR-32, NPH 924-1, PA 6444, Sahyadri, KRH 2, RRX113, RRX336
5	BB resistant	BS 6444G, Arize Prima, Rajalaxmi, Ajay, CR Dhan 701, PRH 10
6	BPH tolerant	Arize AZ 8433 DT

Hybrids like 25P25, 27P31, CRHR 105, CRHR 106, CRHR 150 are heat tolerant in nature, hence, suitable for yield enhancement under heat stress. The hybrids, JKRH 401, US 382, US 312, Indian 200-17, DRRH3, are highly N use efficient, thus, are appropriate for the soil which is poor for N content. Moreover, hybrids, RH 1531, Arize Tej, CRHR 105, CRHR 106 and PNPH 24 are mid-early maturing varieties suitable for water scarcity situation. The coastal and shallow-lowland areas which is sharing ~ 32% of the total rice area but remains low productive, can be benefited by adopting late maturity HR varieties, CRHR 32, Arize Dhani, CRHR 34, CRHR 102, CRHR 103 and Sahyadri 5 (Table 3).

Table 2: State-wise suitable rice hybrids in India

State	Identified hybrids
U.P.	NDR-2 NDRH-3, KRH-2, PRH-10, PSD3, PSD 1, PHB 71, PA 6444, PRH-122, NUSD-3, Sahyadri-4, ARIZE PRIMA, PAC 835, PACH 837, US 312, 27P61, RH 1531 & 27P63
Bihar	KRH-2, PRH-10, JRH-5,, CRHR-32, US-314, VNR 2375 PLUS, HRI 169, JKRH 3333, PNPH-24, US-312, PAC 835, PACH 837, JKRH-401
Jharkhand	KRH-2, PRH-10, JRH-5,, CRHR-32, US-314, VNR 2375 PLUS, HRI 169, JKRH 3333, PNPH-24, US-312, PAC 835, PACH 837, JKRH-401, BS 6444G
Chhattisgarh	Indira Sona. KRH-2, JRH-4 JRH-5 and JRH-8, PRH-10, PAC 807 , ANKUR 7434, KPH-371, KPH-199, 27P63
Punjab	KRH-2, PRH-10,
Gujrat	KRH-2, PRH-10, CRHR-32
Odisha	KRH-2, Ajay, Rajalaxmi, CR Dhan 701, Sahyadri-1, Sahyadri-2, Sahyadri-3,PAC835, JKRH-2000,PA6444, CRHR 32, Arize Dhani, PAC 837, 27P31, NK 16520, MEPH 126, 28P09, 28P67, 28P41, BIO 799, CNRH 102, 27P36
M.P.	JRH-4. JRH-5,JRH-8, Indira Sona.PRH-10, KRH-2
Maharashtra	Sahyadri-1,Sahyadri-2, Sahyadri-3, KRH-2, PRH-10, DRRH-2
AP	DRRH 1,2,KRH 2, Sahyadri 1, CNRH 3, US 305 , RH 1531, 27P61
Assam	KRH 2, Ajay, Rajalaxmi,PA6444
Kerala	TNRH 1, KRH 2
Karnataka	KRH 2, Sahyadri 1, 2, 3
TN	TNRH 1, KRH 2
WB	KRH-2, Ajay, Rajalaxmi, Sahyadri-1, Sahyadri-2, Sahyadri-3,

Table 3. Hybrids suitable for specific condition/quality

Aerobic condition	PSD 3, Rajalaxmi, PSD 1, Ajay, KRH 2, PRH 122, ADTRH 1, DRRH 44, JKRH 3333, HRI 126,
Early duration	27P31, CRHR 105, 25P25, CRHR 106, (heat tolerant), Indam 200-17, US 382, US 312`, JKRH 401, DRRH3, high N use efficient; RH 1531 and PNPH 24 , Arize Tej drought tolerant; KJTRH-4 and DRRH2 (upland)
Long duration	CRHR 32, Sahyadri 5, CRHR 34, CRHR 100
SRI	KRH 4, TNRH CO-4
Idly making	VNR 2355+
MS grains	27P63, CRHR 32, DRRH 3, 25P25, Suruchi
Aromatic	PRH 10, PRH 122, Indam 200-012 (minor aroma)

Hybrid rice research at NRRI, Cuttack

The ICAR-NRRI is pioneer institute started breeding HR well before during 1979, has acquired requisite genetic materials (CMS viz. V 20A, Yar Ai Zhao A, Wu10A, MS 577A, Pankhari203A, V 41A, Er-Jiu nanA; respective B-lines, and 9 other maintainers; and 13 good restorers) from the International Rice Research Institute, Philippines (NRRI annual report 1981-82).Subsequently, under target oriented inter-disciplinary approach, institute has made commendable progress, could develop three popular hybrids namely Ajay (125-130 days), Rajalaxmi (125-130 days; 168 days under boro) and CR Dhan 701 (140-145 days) for

irrigated and rainfed shallow-lowland ecosystem. Besides, the institute has also developed 57 stable CMS lines (WA, Kalinga-I and O. perennis etc. MS cytoplasm), respective maintainers and >100 good restorers for further HR breeding invigoration. Among the CMS, Annada A (WA), Pusa 33A (WA), Saharsa A, Manipuri A (WA), Kiran A (WA), Moti A (WA), Deepa A (WA), Krishna A (O. perennis), Krishna A (Kalinga I), Padmini A, Mirai (Kalinga I), PS92A and Sahbhagidhan A etc. (Table 4). are more prominent and extensively utilized for hybrid development. The CMS, CRMS31A (WA) and CRMS32A (Kalinga-I) are substantially utilized in varietal development in India. The medium late duration CMS, CRMS24A, CRMS40A and CRMS 56A (>45% outcrossing) are suitable for development of late duration hybrids; and short duration CMS, CRMS8A, CRMS51A, CRMS52A, CRMS53A, CRMS 54A (Figure 2) are useful for hybridization of rain fed-upland area/ ecosystem.

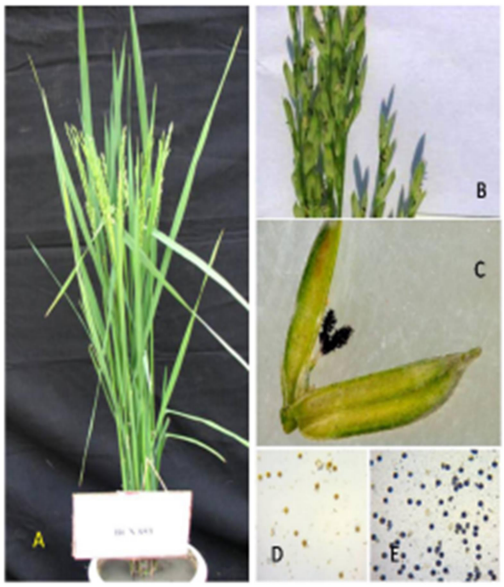


Figure 2: a-CRMS54A, a medium duration, good combiner WA-CMS under genetic background of CR 440 (CRMS 32B/DR8B), b&c-purple color dual stigma exsertion, c-wide angle of opening and > 30% out-crossing.

.

Table 4: List of CMS developed at NRRI, Cuttack

CMS Source	CMS lines developed
WA-CMS	CRMS5A, 6A, 7A, 8A, 10A, 11A, 13A, 15A, 16A, 17A, 18A, 19A, 23A, 24A, 25A, 26A, 27A, 28A, 29A, 30A, 31A, and 34A, 51A, 53A, 55A, 57A
O. perennis	CRMS22A, 35A, 36A
V20B	CRMS20A
Kalinga I	CRMS21A, 32A, 33A, 52A, 55A, 56A
Lalruma	CRMS37A
Miz.21	CRMS 44A, CRMS45A

The hybrid, CR Dhan-701 (IET20852) is late in duration (145 days) recommended for cultivation under irrigated and shallow lowland area of Bihar, Gujarat and Odisha. This is a medium slender (MS) grain hybrid. It can be grown under low-light area, therefore, having

great scope for the states of eastern part of India where low-light during wet season limits potential expression of hybrids/varieties (Figure 3). The Rajalaxmi (125-130 days) is medium duration hybrid, developed utilizing CMS, CRMS32A and released through SVRC-2006/CVRC-2010 for cultivation under irrigated and shallow-lowland area of Odisha and boro area of Assam and Odisha. It has seedling stage cold tolerance, hence suitable for Boro area. Ajay (CRHR-7) is a medium duration hybrid bearing long slender (LS) grains is released for irrigated and shallow-lowland area of Odisha. Given to their remuneration ability and popularity in eastern states, altogether 19 private seed agencies have taken license for commercialization (Table-14).

The institute has made commendable progress towards making HR technology more sustainable and amenable to the farmers. The hybrids, Ajay, Rajalaxmi and CR Dhan-701 have been improved for resistance against bacterial blight which is most devastating disease of rice. The sustainability of hybrids, Ajay and Rajalaxmi is also enhanced against submergence and salinity stress. We could improve outcrossing in seed parents, CRMS31A/B and CRMS32A/B through genomics approach.

Impact of NRRI's hybrids:

The institute has commercialized three hybrids, Ajay, Rajalaxmi and CR Dhan 701 which are very popular among farmers. Based on quantity of F1 seed sold during 2019, these hybrids are estimated to covered ~0.174 mha rice area (Ajay in 0.004 ha, Rajalaxmi in 0.11 mha and CR Dhan 701 in 0.06 mha area) during Kh-2019 over five states namely, Odisha, West Bengal, Bihar, Assam, Gujarat and Tripura which added ~ 0.180 mt rice to national food basket. These hybrids are commercialized under public-private partnership mode, licensed to 19 seed agencies (Table14). During 2009-2021, total 38 memorandum of understandings (MoUs) were signed which added over Rs. 1.9 crores to the institute's revenue, directly as upfront payment.

Hybrid rice seed system:

Hybrid rice is best available option to enhance rice productivity in favorable ecosystem (~50% of total rice acreage is suitable). In India, this venture is dominated by private seed sector where > 300 private seed agencies are involved, amongst ~30 are leading, producing seeds on more than 1000 ha area. The public sector supports this endeavor through technology generation and optimization. Among the public sector agencies, State Seed Corporations of Maharashtra, Karnataka and Uttar Pradesh and National Seed Corporation are taking up hybrid rice seed production on a small scale. Private seed agencies follow centralized contract farming model for hybrid seed production and it works on the agreement between the farmers and private seed company. Contracting companies provide financial support (an incentive of Rs. 45000.0 for field management) to the producer farmers, and buy back the F1 produce at the rate of Rs. 80-90/kg, which are marketed to the growers at the rate of Rs. 350-450/kg (NRRI Technology bulletin-114). Hybrid seed market follows 'distributor/dealer/retailer' network to make the seed available to the farmers. Moreover, because hybridization provides innovators with the ability to recoup their investments in research, hybrid rice represents a technology platform on which both private-sector scientists and entrepreneurs can make profitable and socially beneficial investments. Public-private partnerships for hybrid seed production have been fructified in India by the signing of

memorandums of understanding (MOU) by some companies with few public sector research institutes.

Hybrid rice business scope:

Hybrid rice with remunerative grain yield (1.0-1.5 t/ha more yield, 15000-22000 additional income) and 100% seed replacement rate (SRR), has great scope for hybridizing country's favorable rice area (50% area, ~20 mha) and increase rice production ~20.0 mt. HR seed production is more profitable (Rs. 80000-85000 /ha net income, 70% more than production cost) than of HYVs (~Rs. 15000.0/ha, 18% more than production cost), so, country has great business scope (Rs.10500.00 crores, annually) as we require total 3.0 lakh tones of seeds for covering 20.0 m ha favorable area (NRRI Technology bulletin-114, 2015). Per hectare hybrid rice seed production requires 100-105 additional man days, hence, this venture is able to create additional employment opportunity for over 20 million locales which might be decisive in improving the livelihood of the rice farming community (Table 6).

Table 6: agribusiness opportunity in hybrid rice seed industry

Area coverage of hybrid during-2020	3 m.ha.
Seed requirement for 3m.ha @ 15.0 kg/ha	45000 tons
Cost of seed: (@ Rs. 3.5 lakhs/ton)	Rs.1575.0crores
Scope for hybrid rice in the country	20m.ha
Seed requirement for 20m.ha	3 .0 lakh tons
Cost of seed : (@ Rs.3.5 lakhs/ton)	Rs.10500.0 crores
Area required for seed production for 3m.ha. (@ 1.5t/ha producibility):	30,000ha.
Employment opportunity: 100-105 additional man days	2.0 crores man days

*Extra employment opportunity: seed industry, processing, marketing and distribution

Isolation:

Rice pollen grains are very tiny and light in weight and thus can travel very far with low speed of wind. In order to ensure the purity of hybrid seed and avoid pollination by unwanted rice varieties, the seed production plots should be strictly isolated. There are several methods available, any of which can be practiced to avoid the unwanted pollination.

Figure 4: Space isolation

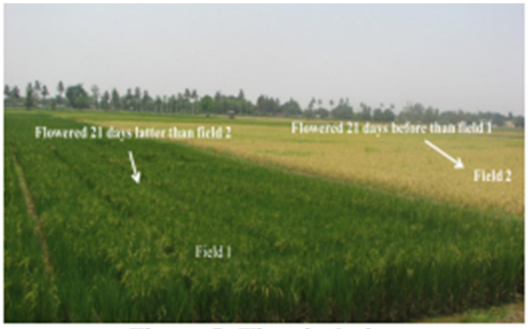


Figure 5: Time isolation

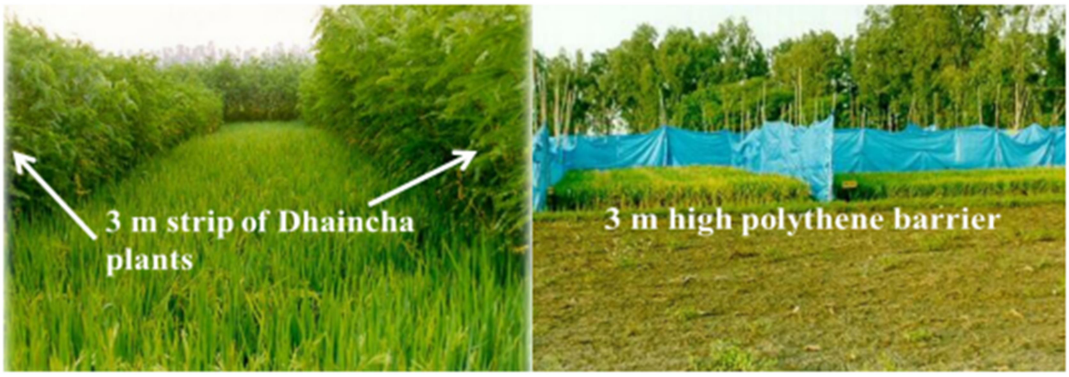


Figure 6: Physical barrier

(Different types of isolation)

Factors influencing male female row ratio:

The ratio of pollen parent (R line) to seed parent (A line) is determined by the characteristics of the parental lines.

• Height of the pollinator

• Growth and vigor of the pollinator

• Size of the panicles and amount of residual pollen

• Duration and angle of floret opening in CMS lines

• Stigma exsertion of CMS line

Rouging:

The purity of hybrid rice seeds used in commercial production must be more than 98%. To meet this requirement, the purity of the restorer and CMS lines must be more than 99%. Therefore, in addition to ensuring strict isolation, it is necessary to remove all rogues from the seed production plots. Roguing is the removal of undesirable rice plants from the hybrid seed production plots. Undesirable rice plants are those plants either in A or R line rows that differ from plants that are true to type. Roguing helps to prevent the off-types from cross-pollinating the true to type A line plants and thus enhancing the purity of hybrid seed. The undesirable plants come from many sources. They may be voluntary plants from the previous crop. Contamination due to improper isolation also results in the occurrence of off-types. Admixing during the process of harvesting, threshing, packing and handling is also possible

for which the off-types occur. Therefore, due care is to be taken to remove the off-types during the cropping season. Roguing can be done at any time during the crop stage. Off-type rogues can be removed whenever they are identified-earlier the better. The important stages for roguing are maximum tillering, flowering and just before harvesting.

Harvesting threshing and processing:

From the point of view of maintaining high purity, extreme care is needed while harvesting, threshing and processing of the hybrid rice plots.

Harvesting: All R line rows are to be harvested first. The R line harvest is to be removed and kept in a safe place separately. The left over R line panicles in the field should also be removed. After R line harvesting, a final roguing in seed parent has to be done carefully, removing the plants showing more than 70% seed setting. Then the seed parent plants are to be harvested.

Threshing:

During threshing, the 'A' line parent and 'R' line parent harvests must be kept separate from each other. The A and R lines should be threshed separately. Before threshing, all the threshing equipments, threshing floor and tarpaulin to be thoroughly cleaned. New gunny bags are to be used for storing the seeds. Two labels for each bag need to be prepared– one to place inside the bag and one to attach to the bag outside. Each label should contain the following information.

• Name and Address

• Name of the parent

• Name of the location

• Season and year

• Date of harvest

Yield: By following the appropriate hybrid seed production procedure, farmers can get 1.5-2.5 ton/ha hybrid seed yield (with an average of 2.0 tonnes/ha).

Seed drying and storage: Hybrid seed must be dried up to 12-13% moisture content and stored in cool place. Less moisture helps the seed to maintain their longevity, vigor and health for a longer period.

Points to remember

• Never use the harvested hybrid rice grains for raising the next crop.

• Apply N in four equal splits at basal, 21DAT, PI and panicle emergence.

• Apply K in two splits 3/4th in basal and 1/4th at PI.

• Nursery sowing should be very thin (20gms/sqm) to get robust seedlings.

Transplant only one or two seedlings /hill at 15cmx15cm or15cm x20cm. Note: Always use fresh hybrid seeds, avoid hybrid rice product of own field for next year sowing.

Hybrid Seed Production of Maize

Introduction

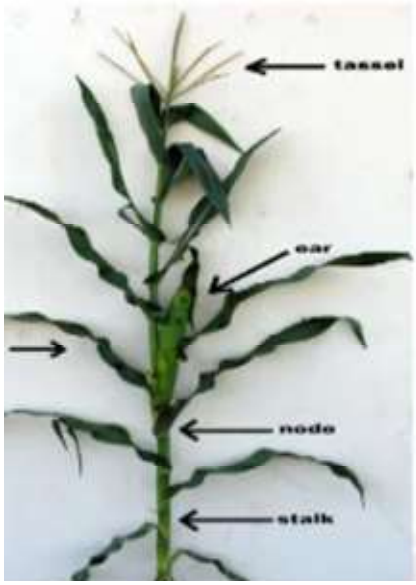
Hybrid maize seed production involves deliberately crossing a female parent population with a male parent in isolated fields. Thus, from the very start of hybrid seed production, the identity and arrangement of the two parent populations determine the outcome. Each hybrid variety is composed of a specific combination of a female (seed bearing) and male (pollen providing) parents. The field management of the two parents is also important and requires attention to timing of planting, elimination of off-types, removal of tassels from the females before pollen shedding, separate harvesting of the female seed and careful shelling and processing of the seed to maintain seed quality. The sequentially dependent nature of the process means that any errors in earlier stages have a significant impact on following stages and major errors or problems can result in complete failure or rejection of the crop.

This manual provides a guide to maize hybrid seed production, with particular reference to field procedures, so that seed growers and seed companies can cost-effectively obtain productive and quality seed suitable for farmers.

Botanical Description of maize plant:

Kingdom	Plantae	
Subkingdom	Tracheobionta	Vascular plant
Superdivision	Spermatophyta	Seed plant
Division	Magnoliophyta	Flowering plant
Class	Liliopsida	Monocotyledon
Subclass	Commelinidae	
Order	Cyperales	
Family	Poaceae	Grass family
Genus	Zea	
Species	*Zea mays*	
Sunspecies	*Z. Mays supsp. mays*	

Plant Morphology of Maize

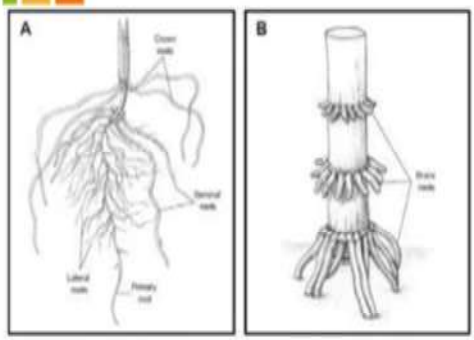


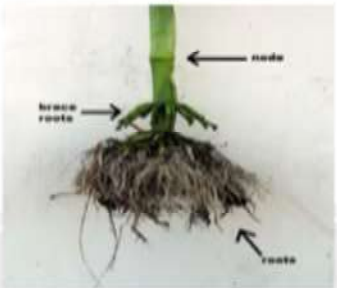
- 1 to 4 meter tall
- Approximately 30 leaves
- A erect stalk- like structure
- Is a meristem
- Sheath surrounding the stalk
- Expanded blade by blade joint or collar
- Has nodes and internodes

Leaves Morphology of Maize

- Leaves are broad and a single leaf.
- Leaves are arranged in two vertical rows on the opposite sides of an axis. (distichous)
- Long, large, alternate, parallel veins

Root Morphology of Maize





- Fibrous root
- Brace root

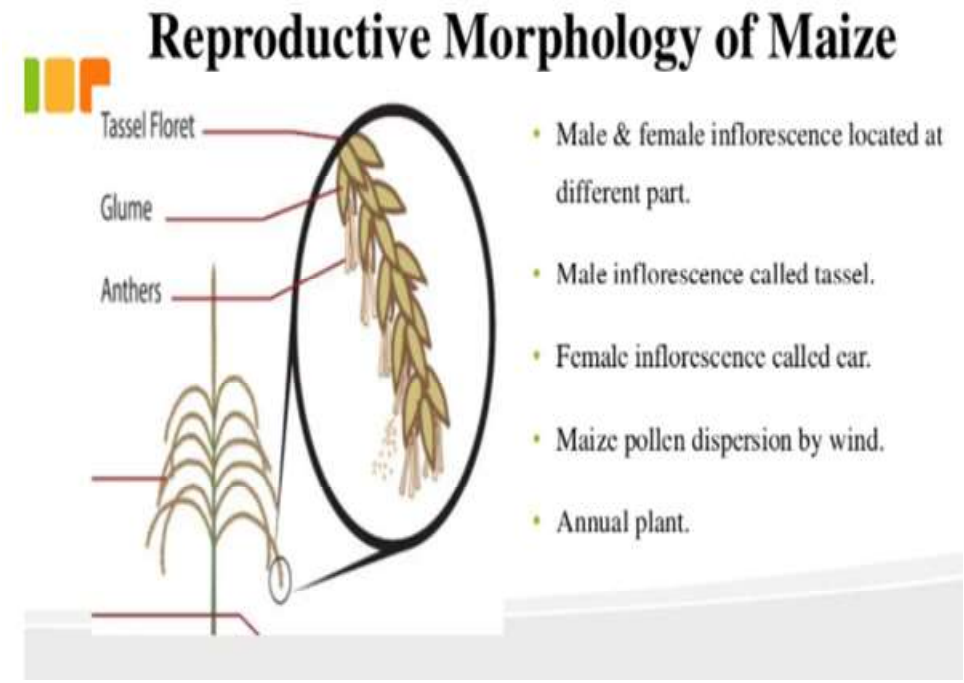
~ form at the bottom of the stalk.

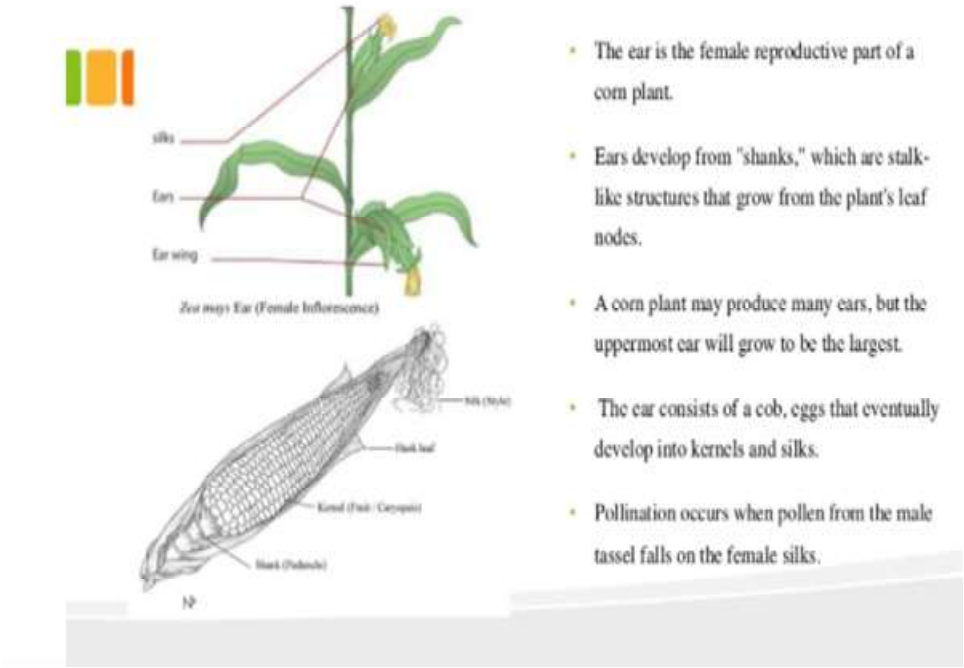
~ support the plant and scavenge top levels of soil for moisture and nutrients.

- Seminal root

~ nodal roots originate from scutellar node.

~ sustain seedling development by virtue water intake.

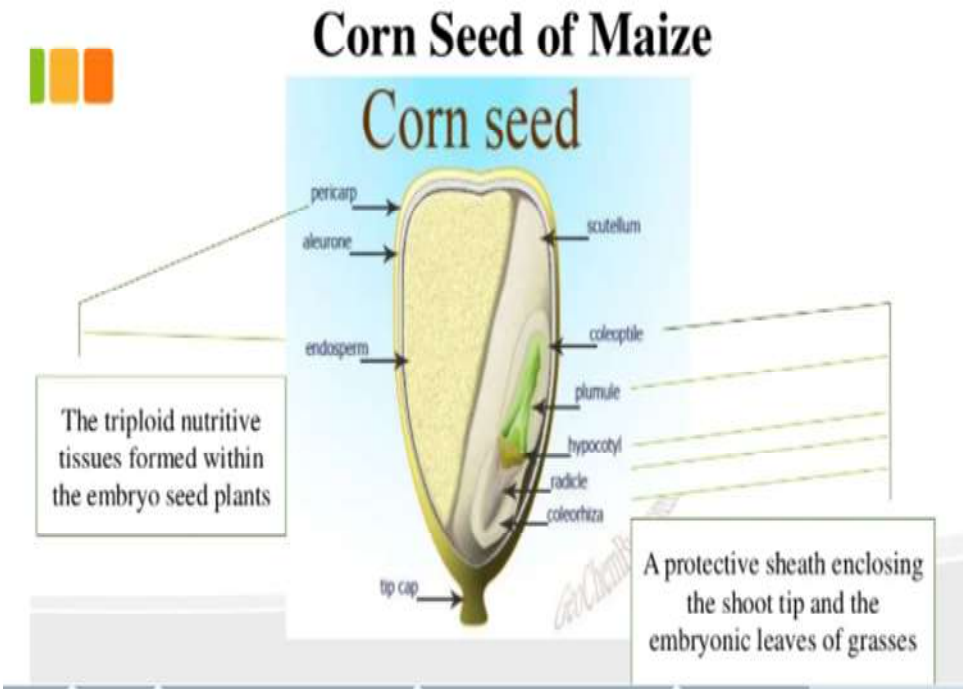




Its structure and function

Structure	Function
Stamen	Pollen producing reproductive organ which are referred to as androecium
Stalk	Also known as filament, the part of the stamen the anther develop
Anther	The terminal part of a stamen which the pollens are produced

Style	Slender part of the pistil, situated between the ovary and stigma.
Stigma	The receptive apex of the pistil of a flower on which pollen is deposited
Sheath	Part of leaf originating from the node and running parallel to the culm or stem
ligule	A membrane located between the culm and leaf blade



Flint corn

CLASSIFICATION OF MAIZE TYPES

1. **Dent corn** (*Zea mays var identata sturt*):- This is the most common type. Dent formation on the top of the kernel having yellow or white colour. The depression or dent in the corn of the seed is the result of rapid drying and shrinkage. Of the soft starch.

2. Flint corn (*Zea mays var indurate sturt*):- It is widely grown and cultivated in India. Endosperm of kernel is soft and starchy in the centre and completely enclosed by a very hard outer layer. The kernel is rounded on the top. The colour may be white or yellow.

3. Popcorn (*Zea mays var verta sturt*):- It possess exceptional qualities. Size of kernels is small but the endosperm is hard. When they are heated, the pressure build up within the kernel suddenly results in an explosion and the grain is turn out. Grains are used for human consumption and is the basis of popcorn confectionery.

4. Flour corn (*Zea mays var anylacea sturt*):- It possess a soft endosperm. Kernels are soft. They are like fruit kernels in shape.

5. Sweet corn *(Zea mays var Saceharata sturt)*:- The sugar and starch makes the major component of the endosperm that results in sweetish taste of the kernels before they attain the maturity and after maturity, the kernels become wrinkled. The cobs are picked up green for canning and table purpose.

6. Pod corn *(Zea mays var tunicate kulesh)*:- Each kernel is enclosed in pod. It is a primitive type of corn and hence of no importance.

7. Waxy corn *(Zea mays var ceratina Kulesh):-* The endosperm of the kernel when cut or broken gives a waxy appearance. It produces the starch similar to tapioca starch for making adhesive for articles.

Dent Corn

Waxy Maize

What is a maize hybrid?

Simply put, a maize hybrid results from the fertilization of one maize plant by another genetically un-related plant. The plant that bears the seed is called the female or seed parent, while the plant that provides the pollen to fertilize the female is called the male or pollen parent. In other words, the female plant is crossed with the male plant to produce hybrid seed. This seed bears a unique genetic make-up from the female and male parents and will produce a plant with particular characteristics. Plant breeders produce the female and male parents of each hybrid to generate progeny with particular characteristics, such as plant maturity, disease resistance, grain color, food processing quality and so on. It is this unique hybrid seed that farmers will sow in their fields. When a farmer purchases a particular hybrid, he or she expects the seed to perform in the field as designated by the variety description.

With maize, there are a number of possible kinds of hybrids, such as single-cross, three-way, double cross and top-cross hybrids. These hybrids differ in their parental composition but, in all cases, the hybrid seed sold to farmers is a cross between two parents – a female and a male. Since maize has separate male and female plant parts, it is relatively easy to make a cross between two plants. In a hybrid seed production field, male and female parents are planted in sequential row patterns, usually with three-to-six times the number of female plants or rows to a single male plant or row. The male flower (tassel) of the female plant is removed (detasseled) before pollen shed, so that the only source of pollen for the female flower (the cob or ear) on the female plants is the tassels on the male plants (Figure 1). Detasseling of the female is necessary to prevent any pollen from the female pollinating the female silks. If this occurs, known as "female-selfing," the result is a significant loss of seed quality that will clearly be seen in a crop grown from the seed. Female-selfing **is to be avoided at all costs.**

The ratio of the number of female rows to male rows in the field is usually on the order of 3:1 for single-crosses and three-ways but may extend to 8:1 for double-cross hybrids (Figure 2).

The actual ratio that is planted depends on a number of factors, but principally on the pollen production of the male, the height of the male tassel relative to the female silk and the size of the female plant. Furthermore, the timing of pollen shed of the male and silking of the female must coincide. If the male and female plants are known to flower at different times, adjustment in the sowing dates of each component will be required to ensure flowering synchrony of the two parents. The hybrid seed that is useful to farmers is harvested from the female plants. Plants and seeds from the male rows are usually discarded before harvest to avoid mixing of seed from the parents.

With this preliminary description of maize hybrid seed production, it is clear that numerous key factors determine the success and quality of hybrid seed production, including the following:

• Female and male parent identity, purity and identity preservation.

• Ratio of female to male rows in the seed field.

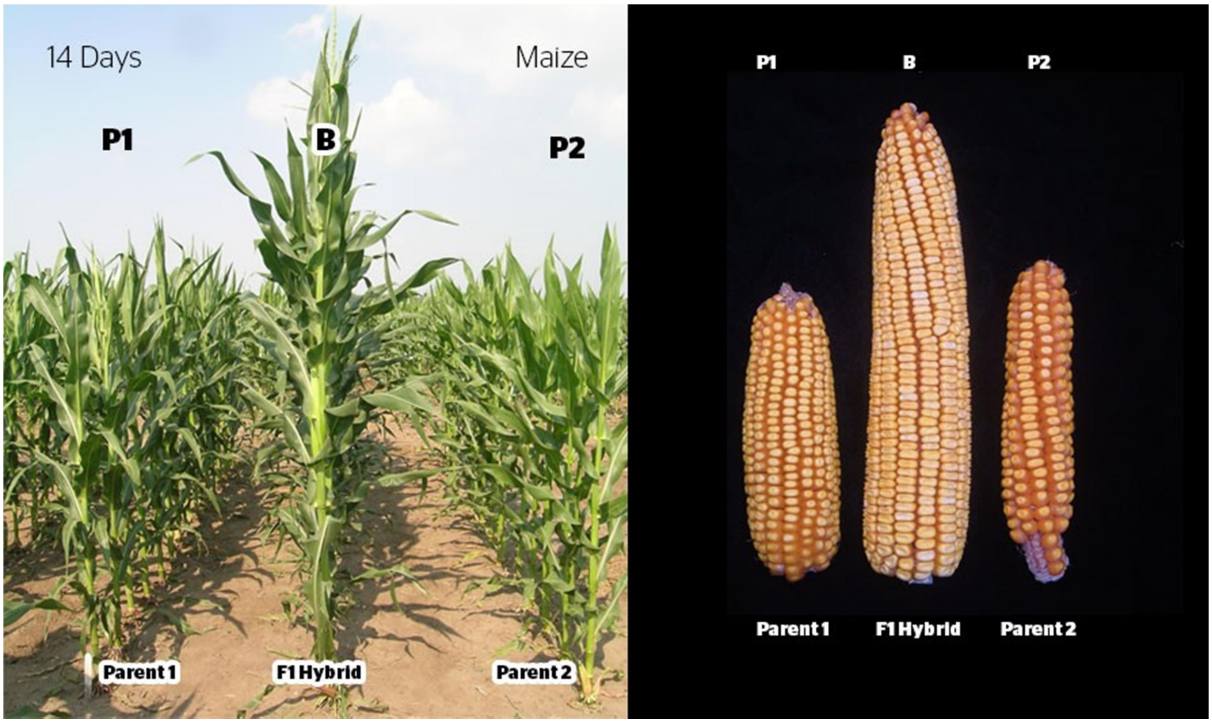
• Timing of planting of the female and male plants.

• Timely removal of the tassels from the female plants before they shed pollen and before silk emergence.

• Timing of female silk emergence relative to male pollen shed.

• Avoidance of contamination of female silks with unwanted pollen, particularly from females, off type males and foreign pollen.

• Avoidance of seed mixtures between and within the male and female plants.



Hybrid performance and heterosis

Heterosis is expressed when two genetically unrelated parents are crossed to create a hybrid

Mid-parent heterosis (%) = [(F1-MP)/MP] x 100

Better-parent heterosis (%) = [(F1-BP)/BP] x 100

• F1 = performance of the hybrid

• MP = Mid performance of the parents of the hybrid

• BP = Performance of the better parent of the hybrid

How do we form hybrids?

1. Crossing two or more unrelated inbred lines

2. Crossing an open-pollinated variety, or a synthetic to an unrelated inbred line

3. Crossing two unrelated open-pollinated varieties, or synthetics, or populations

Types of Maize Hybrids

Conventional Maize Hybrids

(Involve inbred parents) – Single Cross (A x B)

– Three-Way Cross ((A x B) x C)

– Double-Cross ((A x B) x (C x D))

Non-Conventional-Low Cost Hybrids

– Top-Cross (Variety x Inbred) –

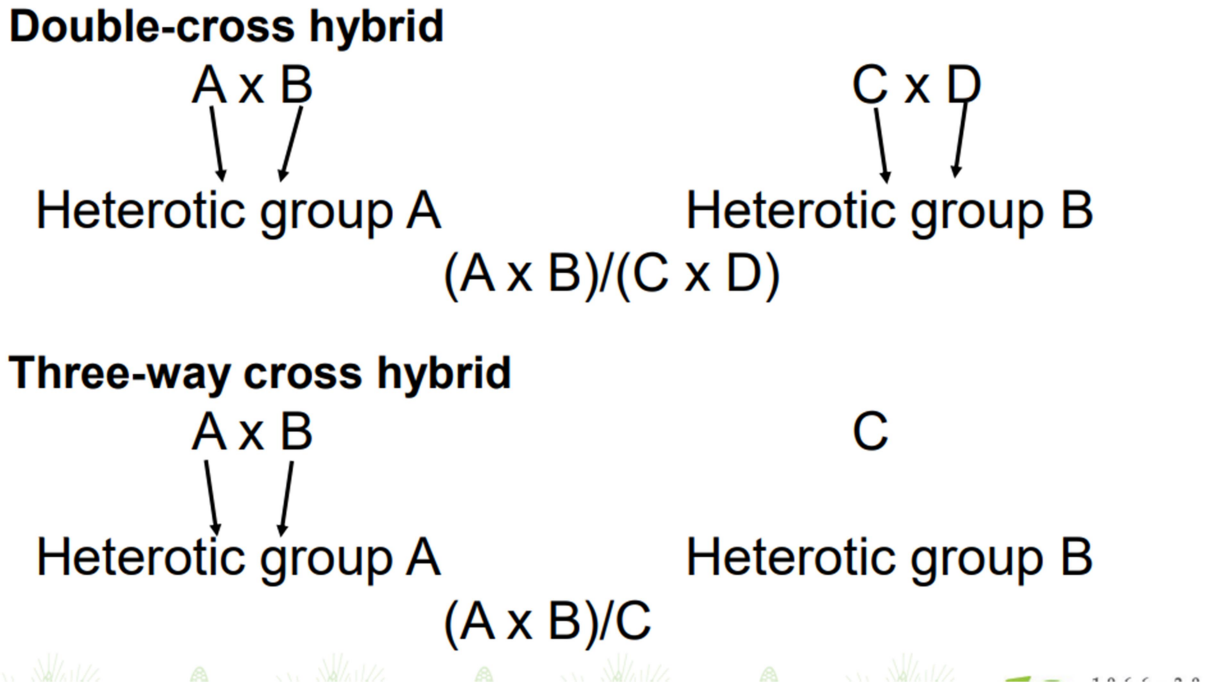
Double Top-Cross (Single Cross x Variety) –

Variety cross (Variety A x Variety B) –

Synthetic cross (Synthetic A x Synthetic B) –

Population cross (Population A x Population B)

Evaluate the best inbred lines to produce different types of hybrids



Conventional Maize Hybrids

Three-Way Cross Hybrid –

This is a cross between a single-cross (A x B) hybrid as a seed parent and an unrelated inbred line (C) as a pollen parent (A x B) x C)

Double-Cross Hybrid –

Produced by crossing two different single crosses [(A x B) x (C x D)], permitting breeders to bring more different desirable traits together into one hybrid than is possible in a single cross

Non-Conventional-Low Cost Hybrids

Top-Cross Hybrid –

It is a crossing between an open-pollinated variety (OPV) or synthetic (SYN) and an inbred line

(OPV x A or SYN x A).

Variety-Cross, Synthetic-cross and Population-cross Hybrids –

It is produced by crossing tow unrelated open-pollinated varieties, synthetics or populations

(VAR A x VAR B or SYN A x SYN B or POPA x POPB).

Target Production and Marketing Environment and Farmers Needs

– Adaptation to prevalent climatic conditions

– Resistance to major diseases and insect pests

– Resistance to parasitic plants (Striga hermonthica) –

Tolerance to drought and low soil nitrogen

– Resistance to stalk and root lodging (good stand ability)

– Cost of seed production and purchasing power of the growers

- **Double cross hybrid:**
- It is a cross between two single crosses.
- It is a cross between 2 hybrids (A x B) x (C x D)
- (A x B) single cross hybrid will be produced by detasseling A and by crossing with B

  (C x D) hybrid will be produced by detasseling C and crossing with D.
- Then (A x B) will be detasselled and crossed with (C x D) hybrid.

- Double top crosses :
- The first generation resulting from the crossing of a single cross with an open pollinated variety. : (A x B) x variety :
- So, (Ax B) will be detasselled and crossed with a variety

- Season - November- December, Mid July, Jan-Feb and Sep- Oct
- Isolation distance
- 1. Inbreds 400 m - 2. Single cross hybrid 400 m

- **Spacing**
- Seeds are sown in ridges and furrows
- Hybrids : 75 x 20 cm
- Seed rate : Female : 8 -10 kg/ ha
- Male : 3 -4 kg/ ha
- Spacing : Female : 75 x 20
- Male :45 x 30 cm

- Planting ratio
- Single cross 4:2
- Double cross 6:2
- Three way cross 6:2
- Border rows :4 rows

- **Fertilizer**
- NPK kg / ha : 200 : 100 : 100
- Basal : 100 : 100 : 50
- 1st Top : 50 : 0 : 0 (20th day -vegetative phase)
  2nd Top : 50 : 0 : 50 (Boot leaf stage at 45 days)
- Foliar : DAP 2% at 50% flowering
- In Zn deficient soil : $ZnSO_4$ @ 25 kg/ ha

- **Roguing**
- Should be done periodically based on position of cob, colour of silk, arrangements of seeds in cob, leaves etc.

- Number of inspections : Four (By Seed certification officers)
- One : Before flowering
- Three : During flowering

- Harvesting
- Harvest the crop when the moisture content falls to 20%
- Harvest male lines first and remove them from the field and then harvest the female lines.

Producing Seeds of Seedless Cucumber

Cucumbers have a mild, refreshing taste and high water content. They can help relieve dehydration and are pleasant to eat in hot weather. People eat cucumber as a savory food, but it is a fruit. It also features in some beauty products. It is one of the most popular vegetables and growing cucumbers from seed, is a rewarding experience that can be done all year long. It helps to keep hydrated and to stay regular and avoid constipation. The vitamin k helps blood clot and keep our bones healthy. It contains vitamin a that helps to improve vision and the immune system of our body.

Actually the english cucumbers are called as seedless but the truth is they do have seeds. They're just smaller and thinner than regular cucumber seeds so you can chew right through them. Smaller seeds mean less water so they're the perfect choice for salad. As the seeds of seed-less cucumber contain less water they do not/cannot germinate

These seedless cucumbers are truly “parthenocarpic,” which means flowers will transition into fruit production without any pollination. However, if pollen gets in the flower from a nearby standard pickle field, the fruit will develop with seedsformation of male flowers can be stimulated by the spray of silver thiosulfate. However the varieties might be f1's, also the f2 so, one may expect segregants in the next generations. Spray ag no3 (300 ppm) @ 3-4 leaf stage and 15 days after 1st spray. By this one may get 10% of male flower in seedless cucumber, if its gynocecious line, or if it is monoecious line you can directly self it

SEED RATE AND SEED TREATMENT:

Sow the cucumber seeds during June or January to April. About 3 kg of cucumber seeds are required for a hectare. Treat the cucumber seeds with pseudomonas fluorescens

10 grams/kg or Trichoderma viride 4 grams/kg or Carbendazim 2 grams/kg of seeds before sowing.

SOWING METHOD:

The cucumber seed is sown by method of dibbling at a distance of 1.5 m to 2.5 m (row to row) x 60 cm to 90 cm. (Plant to plant). Two to three cucumber seeds are sown in each pit. Layout in Ring and basing method is preferred.

After planting the cucumber seeds, keep the soil moist for 7-10 days. Cucumbers prefer full sun light. Keep the soil moist, but not soggy. About 8-12 weeks after planting the cucumber seeds, they are ready to harvest.

Sowing of seeds and aftercare:

- Plant the seeds in late March or early April, or when the soil temperature reaches 55-60 degrees F.
- Keep the plants watered and moist, and remove weeds from around them daily.
- The cucumber plants will start to grow their true leaves after 3-4 weeks, which is a sign that they're well-established in your soil. Continue watering until the leaves are fully developed and open up. Pay attention to the plant's progress by noting differences in color: dark green is a sign of a healthy plant.
- After 8 weeks since planting, you can expect to see blooming begin. Flowering typically occurs around 40 days after planting, but there's no way to definitively predict it, since this process is heavily controlled by weather & soil nutrients.
- The blossoms are where the cucumbers grow. If you have too many flowers, you may remove some of them to help the plant focus on growing the cucumbers. Cucumber fruits should be picked when they are of medium green color.

Manures and Fertilisers:

Apply FYM 40 t/ha as basal and 35 kg of n/ha at 30 days after sowing. Apply azospirillum and phosphobacteria 2 kg/ha and pseudomonoas 2.5 kg/ha along with fym 50 kg and neem cake @ 100 kg/ha before last ploughing. 25 kg p/ha 50 kg n, should be given ½ n and full phosphorus should be given at the time of sowing and remaining half n should be given 30 days after sowing of seeds.

Pests and diseases:

The main disease in cucumber farming is downy mildew and it can be controlled by applying mancozeb or chlorothalonil 2 g/lit twice at 12 days interval. Main pest is fruit fly and it can be controlled by 1) picking the affected cucumbers and destroy them.2) neem oil @ 3.0 % as foliar application as need based.

Yield: 8 to 10 t/ha in 80 to 90 days for salad and the average yield is about 10 to 15 quintals/ha. However, one may harvest 1.5 quintals of seeds (of seedless cucumber) from one hectare of land with proper management and care.

- **Drying**
- Seeds are dried to 12% moisture content. Seed treatment
- **Seed Treatment:**
- Treat the seeds, with 8% moisture content, either with captan or thiram 75% W.P. @ 70 g/100 kg with 0.5 litre of water.
- Treated seeds can be stored for 1 year in cloth bag.
- **Seed yield** : 2.5 - 3.6 t/ha

Hybrid seed production in Solanaceous Fruit vegetables

Introduction:

- India is the second largest populous country after China with an estimated population of 1.31 billion.
- It is estimated that Indian population will be the highest (1.7 billion) in the world by 2050
- In India per capita land resources (0.121 hectare) are decreasing day by day.

*India is 2nd largest producer of vegetables in the world. Production 163 millions tones.(NHB 2015)

*Major reason for lower productivity in India is due to limited availability of high quality seeds of released hybrids

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- **Why to go for Hybrid Varieties in solanaceous crops?**
- High yield
- Early maturity
- Abiotic stress resistance
- Disease resistance
- Uniformity
- Quality
- Transportability
- Shelf life

What are hybrids?

- An offspring of homozygous parents differing in one or more genes, more generally an offspring of a cross between unrelated strains.

Types of Hybrids:

- **Single cross hybrid (A x B)**
- Three way cross hybrid (A x B) x C

- Double cross hybrid (Ax B) x (C x D)
    - Top cross hybrid (Inbred x OP Variety

Seed Production in Solanaceous Fruit vegetables

Solanaceae family vegetables(2n= 2X =24 ,) suitable for hybrid production

- 1. Tomato (Lycopersicum esculentum), S. America(origin)
- 2. Ch illi(Capsicum annum) ,Tropical America
- 3. Capsicum(C. annum var frutescens) The Andean Region of South America i
- 4. Brinjal (Solanum melongena) : Origin -India

Characteristics of the family of Solanaceae

- Persistent calyx
- Flower: small to medium & perfect
- Fruit: berry with many seeds.
- Pollination: Self- or often cross-pollinated

Reasons for commercial exploitation of Solanaceous hybrids

- It is easy for emasculation and pollination.
- Availability of pollen grains in abundance.
- Large number of seeds obtained per pollination/cross.
- Manifestation of heterosis for yield and its component characters.
- Highly profitable price obtained from the seeds.

Good response of F1 is better to cultural practices, inputs and environment

Steps for Development of Hybrids

1. Collection of inbred lines

*Testing of combining ability of inbreds

a) General Combining Ability of inbreds

b) Specific Combining Ability of the crosses

*Production of F1 hybrids depending on sca

Single cross & Top cross

- **Hybrid seed production of Brinjal**

Floral biology of Brinjal
Anthesis: - starts from 7 a.m. to 11 a.m.
Dehiscence: 8 a.m. to 10 a.m. Stigma receptivity at the time of anthesis.

Heterostyly : -

- Long style with big size ovary
- Medium style with medium size ovary
- Pseudo short style with rudimentary ovary

True short style with very rudimentary ovary

Emasculation & Pollination

Flower buds about one to two days away from opening should be chosen for emasculation.

Pollen collection and pollination: Pollens can be collected by putting the anthers in vial along with small iron balls for giving beating effect.

Pollen grains are taken in Petridis and then transferred to stigma of female flower with the help of brush, needle or match stick. Before pollination, stigmatic surface should be checked for presence of foreign pollen.

Emasculation & Pollination in Brinjal

The process of removing the stamens (5-7 in brinjal) by forceps is called emasculation . Emasculated female parents are bagged in butter paper or muslin cloth bag.

As, the pollen grains in the anthers of brinjal are released through apical pores, anther is held perpendicular to the stigma surface, keeping the apical pores of the anther opposite to the stigma surface. The forceps are tapped and the yellow coloured powder of pollen mass is dusted on the stigma. This process of dusting pollen grains on the stigma is known as pollination .Pollinated bags are again bagged

Male sterile lines of brinjal for hybrid seed production.

Use of male sterility: Male sterile lines of brinjal for hybrid seed production

- Female lines : Fruit set %

BCB-11	85.4
BCB-18	89.6
BCB-34	90.4
UGA-1MS	82.6

ADVANTAGES OF MALE STERILITY

- Advantages : High crossing success of 82.6% could be achieved in UGA-1 MS
- Average estimated natural hybridization was only 7.5%. So , in avoiding emasculation it is suggested to utilize the functional male sterile line UGA-1 MS in hybrid development.

Hazra et al. (2003)

Seed extraction

- The harvested fruits are stored for three to four days. Seeds are extracted by cutting, crushing or macerating with a mechanical extractor. In small seed production, dry extraction of seed is used, however, this is time consuming and laborious.

Kachru (1992)

F_1 HYBRID BRINJAL

F1 Hybrids in Brinjal Public Sector

GAU (Anand) : ABH-1(SR), ABH-2(SR)

IARI (New Delhi) : Pusa Hybrid-5, Pusa Hybrid-6,Pusa Hybrid-9

IIHR (Banglore) : Arka Navneet, Arka Aanand

NDUAT (Faizabad) : NDBH-1, NDBH-6

GBPUA&T : Pant Hybrid 1

F1 HYBRID BRINJAL

F1 Hybrids in Brinjal Private Sector

- **Ankur : ARBH-201, AHB-2, AHB-4**

  Indo-American : Suphal
- MAHYCO : MHB-1, MHB-2, MHB-10, MHB-11, MHB-56
- Sumex ` : Sumex 9, Sumex 19
- Sungrow : Kanhaya, Navkiran
- Century : Nisha, Vardaan, Shiva

Practical tips for hybrid seed production

- Fermentation method of seed extraction gives better seed recovery, however acid and alkali extraction can be employed where temperature is too low. Planting ratio of male to female lines in hybrid seed production plot of brinjal can be increased to 1 : 10 Axial flow vegetable seed extractor can be used economically in **brinjal**

- Minimum isolation distance of 225 m in **chilli** is safe for hybrid seed production under north Indian conditions. Fully ripe fruits should be used for seed extraction in chilli. Pollination with mixed pollen of many plants is preferable in sweet pepper .Manual seed extraction is easy and safety in **sweet pepper**. Seed production cost can be reduced by using male sterility system or androcides in all these crops

2. Exploitation of Male sterility

- Hybrid seed production through GMS line is more attractive because of the ease in seed multiplication of MS line. Seeds of GMS line can be multiplied in environment where it expresses male fertility while hybrid seeds can be produced in other environment where it expresses male sterility.

Hybrids released in tomato by private & public sectors

PRIVATE SECTOR:

- Rupali -Indo-American Hybrid Seeds Co.
- Amogh-Namdhari Seeds Pvt.Ltd.Bangalore

PUBLIC SECTOR

- Pusa Hybrid-1 , Pusa Hybrid-2,Pusa Hybrid-4, Pusa Hybrid-8 ,--IARI, New Delhi
- Arka Shreshta, ArkaVardan, Arka SamratArka Vishal, Arka Ananya, ArkaRakshak -IIHR, Bangalore
- Solan Sindhur, Solan Garima, Solan Sagun---UHF, Nauni, Solan

Harvest and Post Harvest Operations:

The time required from flowering to market-fruit size is about 3-4 weeks, but fruit can be harvested and eaten at any earlier stage of the development. Fruit should be harvested while it still glossy with a desirable color. When the color dulls, the seeds become dark and the flesh becomes spongy and bitter. At market maturity, the fruit stem is tough and hard, so a sharp knife or hand-pruning clipper is needed to remove the fruit from the plants. The calyx and a short piece of the stem are left on the fruit, but care should be taken to prevent the stem from injuring other fruits in the package. Eggplant yields are

commonly in the range of 30 to 40 tons/ha of marketable fruit, although higher yields can be achieved. With the normal annual cropping practice, 6 to 12 marketable fruit may be expected per plant for the large-fruited type, weighing in the range of 300 to 400 gm each. The elongated oriental varieties may produce twice of that many fruit quantity, with individual fruit weighing in the range of 100 to 150 gm each. Eggplant does not have a long storage life and should be marketed immediately after harvest. The fruit should be handled and packed carefully to avoid puncture or abrasion damage to the skin. Fruit are packed in a fiberboard carton or a special crate or other containers. Eggplant can be stored safely for 7 to 10 days at 7° to 10° C and 90-95% relative humidity. It is subject to chilling injury when stored at temperatures below 7° C for several days.

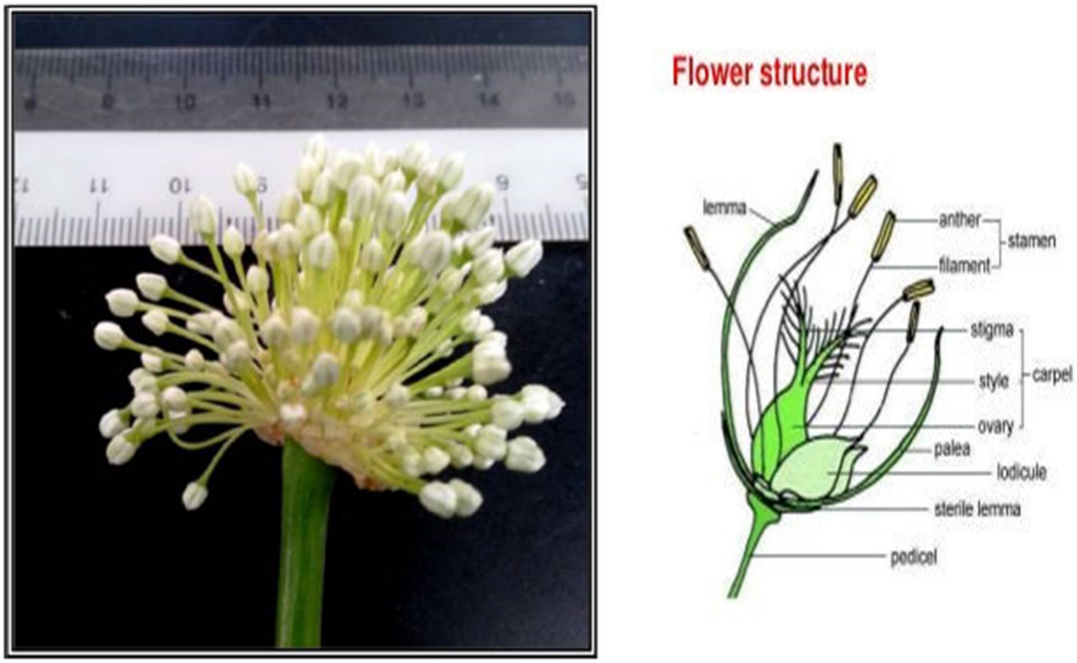
Hybrid Seed Production in Onion

Onion, Allium cepa L., is grown worldwide for its fleshy bulbs which are used as food and medicinal purposes. Based upon global review of the major vegetables, onion ranks second to tomato in area under cultivation. Isolation of male sterility in cv. 'Italian Red' onion led to the development of many hybrid cultivars for various geoecological regions. Although the development of onion hybrid cultivars started in the early 1930s, popularity of onion hybrid varieties is still continuing. In fact, almost two-third of onion varieties in catalogues of major seed companies are listed under hybrid category. First we shall deal with the floral characteristics, male sterility, production of hybrid onion and method for onion seed production.

Seed Production plot of onion

Onion (Allium cepa L.) is most important vegetable crops grown and consume in India. Onion is used as salad and is cooked in various way in curries, fried, boiled, used in soup making, pickles etc. It is used as fresh and dehydrated forms and has many medicinal properties. Onion is export oriented crops earning valuable foreign exchange for the country. Onion is normally produced from seeds except multiplier onions where production is taken up vegetatively from bulblets. Onion is grown in Kharif, late Kharif and Rabi seasons. While looking into the average production per hectare and productivity, it is quite low compared to other countries. Among the several constraints have been found to be responsible for restricting onion production and productivity in our country, non-availability of quality seed or planting material and suitable F1 hybrids in adequate quantities is important. Status of requirements and supply of quality seed of onion and garlic in India : The estimated requirement of quality seed of onion and garlic is about 12169.6 ton (assuming seed rate 10 kg/ha) and out of that only 9.6 per cent of the demand is cratered by public sectors organizations viz., NHRDF, NSC, ICAR institutes (IARI and IIHR) and SAU's). The most of

the demands of the quality seed was either meet by private sectors or unorganized program or own saved seed. Therefore, it is becomes important to increase the supply of quality seed through the efficient use of the technology. On the other hand sincere efforts should be made for the developed and release of hybrids.



Flowers of onion

Potential areas for seed production:

In India, the short day types of onion is cultivated on large scale in the northern plains, central and southern part of the country except higher hills where the long day types onion varieties like brown Spanish and yellow Spanish etc. are grown over a limited area. The major areas for onion seed production are in Maharashtra, Gujrat and Karnataka. Therefore, the seed production of the short day types of onion is done in central part of the country particularly in Mandore and Khandawa region of MP, Nasik and Pune of MS and Rajkoat district of Gujarat. However, Northern state like Punjab, Haryana and Rajasthan are not preferred by the seed industry due the severe attack of *Stemphylium* and purple blotch and lower seed yield but there is a potential for seed production in north under delayed planting. Method of seed production of onion: The seed production onion is very difficult phenomena. Seed producers should be well conversant with good cultural practices required for bulb production, variety, method of seed production, seed cleaning, packing and storage etc. There are two methods of onion seed production in practice:

Seed or in situ or annual method:

The bulb is as such left and allow bolting and flowering in the same field where transplanting was earlier done. The seeds are sown in the nursery from June to August and transplanting is done from August to October. Bolting starts in January February and seeds are ready for

harvesting by mid May. The seeds of onion varieties like Agrifound dark red, Balwant-780, Arka Kalyan and other Kharif varieties are produced by this method. Low cost of seed production, early maturity and no need to store bulbs are the merits of this method. Comparatively poor yield, and poor quality of seed, is produced by this method.

Bulb to seed method or biennial method:

In this method, bulbs are lifted from field after proper selection they are replanted in the field. High yield and quality seeds are produced by this method. But it takes more time and losses of bulb during storage and also cost of seed production is more. In this method, the seed is sown in raised bed at 4-5 cm spacing for raising the seedling. The seedlings of 12-15 cm length are transplanted and this height attained 7-8 weeks after the seed sowing. Thus, 8-10 kg seed ha-1 is sown. The seedlings are transplanted in previously developed beds in 15x10 cm spacing. The herbicides (Stomp) is sprayed within 3 days of the transplanting and followed by irrigation to check the growth of the weeds in early crop growth stage. The recommended cultural practices followed to raise healthy bulb crop.

The bulb are lifted when the 75 per cent plant show neck fall/top die down. The bulbs are dried/cured under naturally ventilated place then neck is trimmed leaving 2-3 cm attached with bulb. The bulbs are roughed at this stage based upon the colour, shape and size. The damaged, twin bulbs and long necked bulbs if any are discarded. The medium size bulbs weighing (50-80 g) bulbs are selected and stored. The bulbs are examined again before replanting in the following season.

One hectare of bulbs from the first year will plant 3-5 ha for the seed production,. The bulbs selected for seed production and usually referred to as mother bulbs. However, the area coverage is greatly affected by storage method and losses occur during storage. The storage temperature also influences seed yield. The temperature ranging from 4.5 to 14 0C with an optimum of about 12 0C is the best for the storage of mother bulbs that are to be planted for seed production. The plants from such bulbs produce early and heavy yield than those grown from bulbs that have been stored at higher or lower temperature. The roots of the bulbs should be left intact after harvest.

The 1\3rd part of the bulb is cut before planting to examine the number of glumes, which is related to the compactness, and shape of the bulbs. More the number of glumes flatten the shape and poor the storability. To avoid rotting due to fungal infection of the bulb in field, Bavistin 10 g in 10 lit of water is used for dipping the bulbs before planting. This should be practice in NS/BS seed production.

F1 hybrid onion seed production:

The production of hybrid onion seeds is a little bit difficult than OP seed. In case of hybrid, both male and female parent are required. The usual ratio of male: female rows are 1:4 or 1:8. The pattern and ratio depend upon mechanization and the amount of pollen grains produced by male parent. Remove off-type plants with male fertile flowers in male sterile female parent. Seed produced on male parent are harvested first to avoid mixing. The other practices for raising of mother bulb and further multiplication etc are same as that for production of open-pollinated varieties. Seed production of multiplier onion : Healthy and uniform bulb-lets are selected and used for planting. The planting details including cultural practices followed for production of planting materials are same as that for production of bulb for consumption.

The details of package of practices, seed certification standards and other operation are given below in details:

Climatic requirements:

Temperature throughout the year and day length during the season set broad limits to the areas that are suitable for seed production. When seeds are produced from bulbs that have been raised during the preceding year, the length of growing season that is required for the crop is relatively short. The long days early in the season which are characteristic of high latitude favour rapid bulbing rather than flowering. Cool temperature, over the considerable period of time usually while bulbs are in storage or over wintering in the field conditions the plant for seed stalk formation. Temperatures of 4.5-14.50C is favorable for conditioning. It is important to have hot and dry weather during the harvesting, curing and threshing of seeds.

Land requirement:

Select fields in which an onion was not grown in the previous year unless it is the same variety and certified by seed certification agency for its purity. The soil should be rich in organic matter and have good water holding capacity. The pH of soil between is 6-7 suitable for good crop.

Land preparation:

The field is ploughed to a fine tilth by ploughing by tractor drawn implement or deshies plough. Planking should be done for proper leveling. The field is divided into beds and channels

Time of planting:

Mid of October to mid November is the best time of planting/sowing. Around 2000 square meters of nursery is sufficient to plant one hectare onion crop. The time of planting has great impact over the seed yield and incidence of the disease. Whenever the seed crop is planted in first fortnight of October is subjected to the heavy incidence of diseases and resulting poor seed yield.

Bulb weight and size of onion:

Bulb size 2.5- 3.0 cm diameter – 15 q of bulbs /ha Bulb size 3.0 – 4.0 cm diameter – 40 - 50 q of bulbs ha. The bulb weight has markedly influenced the seed production in onion. The increases in bulb weight an increased the seed yield. Although an increase in wt. and size of bulb results in higher seed yield, but very large size bulbs (< 90 g) if used will need a very high seed rate (60 q/ha) which is not economical. Large size bulbs (3-4 cm diameter) and weighing < 90 g may seed yield 10.00 q/ha. **Transplanting :**

8-10 weeks old seedlings are planted in small seed beds in well prepared fields by following a spacing of 45* 30cm depending upon the bulb size and type of soil.

Isolation requirement:

Onion is largely cross-pollinated crop with up to 93 per cent natural crossing. It is chiefly pollinated by honeybees. For pure seed production the seed fields should be isolated by at least 1000 m for foundation seed production and 500 m for certified seed production.

However, the maximum permissible limit for bulb not confirming to the varietal characteristics is 0.10 percent and 0.20 percent (by numbers) for foundation and certified seed during mother bulb production. The maximum permissible limit of off- types is 0.1 per cent and 0.2 per cent for FS and CS at and after flowering during seed production. Onion seed crop must also is isolated from any flowering multipliers types of onion and shallots.

Manures and fertilizers :

20-25 tonnes of FYM/ ha is required to use at the time of field preparation. The requirement of nutrients depends on soil type, region of growing, variety etc. About 100 kg of nitrogen, 60kg of P2 O5 and 50 kg 0f K2O /ha is recommended in general. The whole quantity of phosphorus, potash and half of nitrogen should be mixed in soil before planting. The rest half dose of nitrogen should be given as topdressing in two equal split doses, first dose should be applied 30 days after planting whereas second 45 days after planting.

The ratio of N: P: K applied during seedbed preparation should be 1: 2:2 but the nitrogen ratio can be increased according to the status of the soil. During, mother bulb production the deficiency of copper or manganese should not be allowed. The deficiency of copper is indicated by bulbs of poor colour with this, fragile scales that come off in handling. Therefore, the application of 80-120 kg powdered copper sulphate control the deficiency.

Irrigation :

High soil moisture in the seedling year performed high seed yields. Water stress during bulb sprouting and beginnings of the anthesis reduce the number of umbels and flowers/plant. However, in practice, the soil surface should not be continuously wet because it will predispose the crop to infection to root rot/damping off. The methods of irrigation also greatly influence the seed yield and seed quality of onion. Onion and garlic are shallow rooted crops. Drip method of irrigation can give higher seed yield and seed vigour index than the surface irrigation

Field Inspection:

A minimum of two field inspections shall be made as follows: –The first inspection shall be made after transplantation of seedlings in order to determine isolation, volunteer plants, off types including bolters and other relevant factors. – The seed inspection shall be made after the bulbs have been lifted to verify true characters of bulbs.

Rouging of seed crop :

First year : It is desirable to begin rouging in the field before bulbs are harvested, look for plants having different foliage or plant type or late maturing bulbs. After harvesting, the bulbs should be rouged for colour and such off type's thick necks, doubles, bottlenecks or any other type. Second year : Plant only selected true to type bulbs and remove plants not confirming to varietal characters before flowering.

Harvesting and curing of bulbs:

Well-matured bulbs should be harvested. When seed inside capsules become black and 20-25 per cent black seed are exposed the umbel should be cut with 10-15 cm stem attached. Maturity is also indicated by the tops drooping just above the bulb, while the leaves are still

green. After harvesting the bulbs should be topped leaving an half-inch neck. Before storage a through selection and curing of bulbs should be done. The length of time required for curing depends on weather conditions and may take 3-4 weeks.

Threshing, cleaning and seed extraction:

Seed is ready for harvest when first formed seed in the heads get blackened. 2-3 pickings are necessary to harvest the heads. Seed heads after harvest are thoroughly dried with air circulation. Heads are threshed either by rubbing with hands manually or by movement of bullocks or tractor on seed umbels or heads. Seed is cleaned by using hand winnower and fans. Dipping of seeds in water for cleaning, in no case is done for more than 2-3 minutes as otherwise the germination is affected adversely. Upgrading is further done on gravity separator.

Storage of bulbs:

The essentials of successful storage are:–The bulbs should be well matured dried and cured before storage. –Storage should be well ventilated. –Storage should be done in shallow trays with perforated bottoms –Storage temperatures should be 0-4.50C until three to 4 weeks prior to planting. Then it is increased to 100C.

Drying, packaging and storage of seed : The onion seeds are short lived. For safe storage, seeds of onion are dried to a level of about 6 per cent moisture and then packed in aluminium foil or tins which are moisture proof. Seeds are then stored in air-conditioned and dehumified store having temperature of 16-200C and relative humidity of 30-40 per cent.

Disease and pest : Purple blotch, stemphylium blight and Colletotricum blight are the major disease in onion. Spraying of Mancozeb (0.25%) or chlorothalonil (0.20%) along with sticker found effective both seed and bulb crops trichoderma viride@ 1250g per hectare with FYM if applied in soil before planting is effective against basal rot in seed crop. Thrips is major insect pest in onion. Application of cyper-methrine 25 EC @ 0.01 per cent or delta-methrine @0.01 per cent is recommended for control of thrips.

Seed yield :

The seed yield of onion is 2.5-4.0 q/ha depending upon variety and the regions where they are grown.