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UGE 223, COMMERCIAL PLANT BREEDING

Seed Production of Rice

The student should write the important varieties and hybrids that have been released along with their characters, date of release and station from where it is released.

Seed Production of Varieties:

Land requirement: The same crop should not be grown on the same piece of land for the last one season, unless it is the same variety and certified by seed certification agency for its purity. The land requirement should be followed for nursery and the main field.

Isolation Requirement: Paddy is highly self-pollinated crop, however, some cross pollinated does occur. The extent of natural cross-pollination varies from 0-6.8%. For pure seed production the seed fields must be isolated by atleast 3m for both foundation and certified seed production from other varieties and same varieties not confirming to varietal purity.

Source of seed: Obtain appropriate class of the seed from the source approved by seed certification agency.

Brief cultural practices: Paddy can be cultivated as direct sown, puddle seeding or by transplanting. For seed production it is desirable to grow paddy under transplanting system so as to avoid the weed problem. The seed rate required is 30-40 kgs/ha. The spacing adopted is 10x15 cm for early duration varieties and 15x15 and 20x15 for medium and late duration varieties. Transplanting should be done when the seedlings are 3-4 weeks old. Follow all the recommended package of practices and take necessary prophylactic measures so as to raise a good crop.

Rouging: Rouging of offtypes should be done once prior to flowering then at flowering and maturity. Major rouging should be done before flowering. The off types should be identified based on morphological characters such as plant type, plant height, days to flowering, leaf color, flag leaf shape, flag leaf angle, shape of the panicle, color of glumes, color of apiculus etc. rogue out the wild rice plants, plants infested by stem borer and diseased plants such as false smut, paddy bunt etc.

Number of field inspection: the numbers of field inspections required are two and they should be done between flowering and harvesting. During field inspection verification should be done for isolation requirement, volunteer plants, offtypes and diseased plants. The field standards required are as follows;

Harvesting: The crop should be harvested when the grains are hard and yellow with a moisture percentage of 23-24 %. For combine harvesting the moisture percentage should be in the range of 16-18% . The crop is cut at the base with the sickle and the plants are left in the field for 2-3 days. Then they are threshed on clean threshing floor or tarpaulin. After winnowing and cleaning the seed should be dried to safe moisture limits of 13% before storage.

Seed Yield: The seed yields are in the range of 5.0 to 6.0 t/ha depending up on the variety and the management practices adopted.

Hybrid Seed Production

Prof. Yuan Long Ping is the father of hybrid rice in China. The successful development and use of hybrid rice technology in China during 1970's led the way for development and release of rice hybrids in India. In general the hybrid rice gives 1.0 ton more yield than the best variety available. At present more than 10 rice hybrids have been developed in the country from different states. However the first rice hybrid have been developed in the country by ANGRAU. Methods of Hybrid rice seed production

Hybrid rice can be produced by three different methods

1. Three line system: In this method hybrid rice is produced by utilizing cytoplasmic genetic male sterile system. The source of male sterile cytoplasm used is wild abortive. In this method there are three different lines i.e. A-line or male sterile line, B-line or maintainer line and restorer line or R-line. For maintaining A-line it has to be crossed with B-line and for producing hybrid seed

A-line has to be crossed with R-line.

2. Two line system: This method of hybrid rice seed production involves the use of photoperiod sensitive genetic male sterile system or temperature sensitive genetic male sterile system. In this method any normal line can be used as restorer line.

3. By Using chemical emasculants : The chemicals which kills or sterilise the male gamete with little no effect on the normal functioning of the female gamete can be used to emasculate female parental line in hybrid seed production. In China chemical emasculants are commonly used in hybrid seed of rice. In India they are not used commercially for hybrid seed production, but they are used in academic studies. The chemical which can be used as potent gametocides are ethereal, maleic hydrazide, etc.

Hybrid seed production (using three line system)

The hybrid rice seed is produced by utilizing cytoplasmic genetic male sterile system. The source of cytoplasm used is wild abortive. One of the drawbacks of wild abortive cytoplasm is incomplete panicle exertion from the flag leaves. Hybrid seed production involves two steps;

1. Maintenance of parental lines (A-line, B-line and R-line)
2. Commercial hybrid seed production (AxR).

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class. The A-line can be maintained by crossing with B-line in an isolated plot, while in hybrid seed production A-line is crosses with R-line or fertility restorer line. The B-line and the R-line can be maintained just like normal varieties by following the required isolation and field standards. As the maintenance of B-line and R-line is just like normal varieties it is not discussed in detail.

Maintenance of A-line or Hybrid seed Production:

Land requirement: The same crop should not be grown in the same piece of land in the previous one season. The land requirement should be followed for nursery as well for the main field.

Isolation requirement: The hybrid paddy fields should be isolated from the other paddy fields, including commercial hybrids and same hybrid not confirming to varietal purity requirements for certification by atleast 200 meters for seed classes A, B & R-line production and by 100 meters for hybrid seed production (AxR). For hybrid seed production (A x R), if space isolation is a problem we can go for time isolation or barrier isolation. For time isolation the difference between the flowering of seed plot and the contaminating plot should be atleast 4 weeks. When both space and time isolation is not possible we can go for barrier isolation. In barrier isolation a barrier crop which is of 6-8 feet height should be grown around the seed plot for 10 to 10 meters. The commonly used barrier crops are daincha, sugarcane, sorghum etc.

Brief cultural practices: The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are iso-genic and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution. Generally the A-line is sown once while the B-line or R-line is sown three times at an interval of five days.

When both A and R-line are of same duration sowing of A-line should be adjusted with second sowing of R-line. If A and R lines are of different growth duration, the difference in duration should be adjusted with second sowing of R-line. (For example if A-line comes to flowering in 65 days and R-line in 72 days then the difference is 7 days. After second sowing of R-line adjust the sowing of A-line with a gap of 7 days I.e. if First sowing of R-line is done on 1st June, Second sowing on 5th June and third sowing on 10th June, then sowing of A-line should be done on 12th June)

Planting ratio: The row ratio of female and male parental varies from region to region depending on weather conditions and potentiality of parental lines. The commonly adopted planting ratios of male and female are 2:8, 2:6 or 3: 8. Factors influencing the row ratio are;

There can be more than 8 A lines in relation to 2 R-lines,

1. If R-lines are taller than seed parent
2. Have good growth and vigour
3. Have large panicles and
4. Shed a large amount of residual pollen.

The Character of A-line should be

1. It should be shorter than pollen parent
2. Has long duration of floret opening and stigma receptivity
3. Should have wide angle of floret opening and
4. Should have a higher percentage of stigma exertion

Transplanting should be done when the seedlings are 25-28 days old. Before transplanting mix all the B or R-lines sown on three different dates. All the missing hills should be replaced within seven days. The spacing adopted for A-line is 15x15 cm and for B or R-line is 20x15 or 30x15 cm. All the recommended package of practices should be followed to raise a good crop.

Number of Field Inspections: A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stag and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, offtypes, diseased plants, pollen shedders and objectionable weed plants. Actual counts should be taken during second or third field inspection. Fourth or final field inspection

should be done to verify for all the above factors and the offtypes can be identified based on panicle or seed characters.

Foundation class certified class

Offtypes 0.05 % 0.20 %

Pollen shedders 0.05 % 0.10 %

Objectionable weed plants 0.01 % 0.02 %

Diseases plants 0.10 % 0.50 %

(Paddy bunt – *Neovossia horrida*)

Rouging: Rouging should be done in both male and female parental lines. Remove all the offtype and volunteer plants from both male and female parental line. During flowering period rouging should be done daily to remove the pollen shedders from female parental line. The male sterile plants have shriveled anthers and they do not shed pollen while the pollen shedders have yellow colored plumpy anthers, which shed large amount of residual pollen. The off type plants should be identified based on morphological characters like plant height, plant type, flag leaf shape, flag leaf angle and other characters. Remove all the plants, which are infected with stem borer, and diseased plants like paddy bunt.

Methods of increasing out-crossing rate : Paddy is highly self-pollinated crop and the extent of natural cross—pollination is very less. Hence to increase the outcrossing rate certain methods should be followed like Flag leaf clipping, spraying of GA3 and rope pulling.

a. Flag leaf clipping: Flag leaves are taller than panicles and are the main obstacles for pollen dispersal and cross-pollination. Hence the flag leaves should be removed so as to improve cross-pollination and seed set. The flag leaves should be clipped one or two days before heading so that it enhances uniform pollen movement and wide dispersal of pollen grains to give higher seed set. First cut the flag leaf of the main tiller at the flag leaf joint and use it as a guide in clipping the rest of the plants. The flag leaves should be cut to half or 2/3 of the blade from the tip. Do not clip the flag leaves in plants, which are infected with bacterial leaf blight or sheath blight. The cut leaves can infect other plants or contaminating tools used for flag leaf clipping can spread infection. The infected plants may be clipped after completing the clipping of healthy plants.

b. GA3 application: Application of GA3 increases the internode length and the panicles will be fully exerted from the flag leaves. It increases the duration of floret opening and stigma

receptivity. Helps in adjusting the plant height of both the parents. It also increases the growth rate of secondary and tertiary tillers so that they bear productive panicles. Spraying of GA3 should be done twice first when 15-20% of the plants started heading with 40% of the chemical and second at 50% flowering with 60% of the chemical. The dosage required is 50 grams with knapsack sprayer and 25 grams with ultra low volume sprayer. For first spray use 20 g GA3 in 500 litres of water and for second spray use 30 g in 500 litres of water.

c. Rope Pulling: Rope pulling should be done during the peak flowering time, which helps in shaking of the male plants and dispersal of pollen grains. Rope pulling should be done daily during peak flowering stage at 8.30 AM and it should be repeated 3-4 times a day at an interval of half an hour.

Harvesting and threshing : Harvest the male row first and remove them from the field so as to avoid mechanical mixtures. Then harvest the female rows. Precautions should be taken while harvesting not mix male and female plants. Threshing should be done on a clean threshing floor and the seed should be winnowed and dried to safe moisture limits before storage.

Seed Yield: Depending on the management practices adopted and the potentiality of the parental line the seed yield may be in the range of 0.5 to 1.5 t/ha.⁵⁴

Seed Production of Sorghum

Seed Production of open pollinated varieties

Land requirement: Land should be free from volunteer plants, Johnson grass, Sudan grass and other forage types. The same crop should not be grown on the same piece of land in the previous one season unless it is the same variety and certified by certification agency for its purity.

Isolation requirement: sorghum is a self-pollinated crop but cross-pollination up to 8-10 % may occur. In some of the varieties with loose or lax panicle types the extent of natural cross-pollination may go up to 50 %. Hence the seed fields must be isolated from other varieties of grain and dual-purpose sorghum and same variety not conforming to varietal purity by 200m for foundation seed class and 100 m for certified seed class. An isolation of 400 m is required from Johnson grass (*Sorghum halepense*) and other forage sorghums with high tillering and grassy panicles.

Differential blooming for modifying isolation distance are not permitted (i.e. time isolation is not permitted)

Brief Cultural Practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 12-15 kg/ha and the spacing adopted is 45cm between the rows and 15cm between the plants. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Rouging: remove all the offtypes and volunteer plants before they start shedding pollen. The rouged plants must be cut from the bottom or uprooted to prevent regrowth. Offtypes can be identified based on morphological characters like plant height, leaf shape, leaf colour, stem pigmentation, days to flowering etc. Rogue out other related plants like Johnson grass, Sudan grass, forage plants and plants affected by kernel smut and head smut from time to time.

Number of field Inspections: A minimum of three field inspection should be done. First inspection should be done during vegetative stage to determine isolation, volunteer plants and designated diseases etc. Second inspection shall be made during flowering to check isolation, offtypes and other relevant factors. Third inspection shall be made at maturity prior to harvest to verify designated diseases true nature of plants, head and seed.

Foundation class certified class

Offtypes 0.05 % 0.10 %

Diseases plants 0.05 % 0.10 %

(Kernel smut or grain smut and head smut)

Harvesting and threshing : The seed crop must be harvested when it is fully ripe. The harvested heads should be sorted out to remove the diseased or otherwise undesirable. The heads should be dried on the threshing floor or tarpaulin for a couple of days before threshing. Threshing can be done by threshers or manually. The seed should be thoroughly cleaned and dried to 10 % moisture before storage.

Seed Yield: Depending up on the potentiality of the variety and the management practices adopted, seed yield may be in the range of 35-40 q/ha.

Hybrid Seed Production

In sorghum hybrid seed is produced by utilizing cytoplasmic genetic male sterile system. The source of male sterile cytoplasm used is Combined kafir. Hybrid seed production involves two steps;

1. Maintenance of parental Lines (A-line, B-line and R-line)
2. Commercial hybrid seed production (AxR)

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class. The A-line can be maintained by crossing with B-line in an isolated plot, while in hybrid seed production A-line is crossed with R-line or fertility restorer line. The B-line and the R-line can be maintained just like normal varieties by following the required isolation and field standards. As the maintenance of B-line and R-line is just like normal varieties it is not discussed in detail.

Seed Production of B-line and R-line: The seed is produced in an isolated plot and it is similar to seed production of open pollinated varieties. However the isolation distance required and the field standards are similar to that of maintenance of A-line.

Maintenance of A-line or Hybrid seed Production (AxR):

Land requirement: Land should be free from volunteer plants, Johnson grass, Sudan grass and other forage types. The same crop should not be grown on the same piece of land in the previous one season unless it is the same variety and certified by certification agency for its purity.

Isolation requirement: The isolation distance for maintenance of A-line (AxB) is 300 m from fields of other varieties of grain and dual purpose sorghum and same variety not confirming to varietal purity and 400 m from Johnson grass, Sudan grass and other forage types. For commercial hybrid seed production (AxR) the isolation distance required is 200 m from fields of other varieties of grain and dual purpose sorghum, and same hybrid not confirming to varietal purity requirements of certification, 5 m from other hybrid seed production plot having the same male parent and 400 m from Johnson grass, Sudan grass and other forage types. Differential blooming dates for modification of isolation distance are not permitted.

Planting ratio: The planting ratio of female to male plants is 4:2 with two rows of male parent all around the field.

Brief cultural practices: The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are isogenic lines and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution.

If there is any difference between the male and female parent for days to flowering the sowing dates should be adjusted for proper synchronization of flowering. The seed rate required is 8.0

kgs/ha of A-line and 4.0 kgs/ha of B or R-line. Other cultural practices similar to commercial crop production should be adopted for raising a good crop.

Cultural manipulation for nicking: Proper synchronization of flowering between A line and R-line is a common problem. In spite of taking the precautions like adjusting the sowing dates some times synchronization may be a problem. If the difference between the male and female parent is less than a week it can be manipulated by cultural practices. The parent which is lagging should be sprayed with 1 per cent urea solution 2-3 times at an interval of 2-3 days or additional irrigation should be given to the Lagging parent. Blowing air by operating empty duster with the mouth directed horizontally to the male ears, will help to disseminate pollen.

Rouging: Before flowering remove all offtypes from both seed parent and pollen rows based on morphological characters. Some of the precautions to be taken while rouging are

1. Start rouging before offtypes, volunteers and pollen shedders in female rows start shedding pollen
2. Out crosses can be easily identified because of their greater height and more vigorous growth and should be removed
3. At flowering rouging should be done every day to remove pollen shedders from female parent rows. The sterile types have only stigma or a pale aborted anthers without pollen, while the fertile ones have yellow colored plumpy anthers which shed large amount of residual pollen.
4. Remove all plants out of their place (i.e. plants in between the lines), and male plants in female rows and vice versa. Special attention should be given at the ends where there is a chance of male seed falling in female rows.
5. Remove other sorghum related plants like Johnson grass, Sudan grass and other forage types from the seed plot and from within the isolation distance.
6. Remove the plants affected by kernel bunt and head smut.
7. Preharvest rouging may be done based on grain and ear characters.

Number of Field Inspections : A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stage and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, offtypes, diseased plants, pollen shedders and objectionable weed plants. Actual

counts should be taken during second or third field inspection. Fourth or final field inspection should be done to verify for all the above factors and the offtypes can be identified based on panicle or seed characters.

Foundation class certified class

Offtypes 0.05 % 0.10 %

Pollen shedders 0.05 % 0.10 %

Diseases plants 0.05 % 0.10 %

(kernel smut or grain smut and head smut)

Harvesting and threshing: Harvest the male rows first and keep their heads separate to avoid mixture male and female seed. Then harvest the female parental line and thresh it separately.

Precautions may be taken while harvesting and threshing to avoid mechanical mixtures.

Seed Yield: the seed yield may be in the range of 4-6 q/ha depending on the parent line and the cultural practices adopted.

Seed Production of Maize

Open Pollinated varieties (Synthetic's and Composites):

Land requirement: No specific land requirements are there for maize seed production, however the field should be free from volunteer plants and have good drainage facility.

Isolation distance: Maize is a highly cross pollinated crop, therefore for pure seed production the fields of maize should be isolated from other varieties of maize and same varieties not conforming to varietal purity by 400 m and 200 m foundation and certified seed production reciprocally.

Brief Cultural Practices: obtain appropriate class of the seed from the source approved by seed certification agency. Seed rate required is 15 kgs/ha and the spacing adopted is 60-70 cm between the rows and 20 cm between the plants in a row. The recommended package of practices should be adopted for raising a good crop.

No of Field inspections: A minimum of two field inspections shall be made in such a way that one is conducted before flowering and the other during flowering stage so as to check for isolation distance, offtypes, designated diseases and other relevant factors.

Rouging: Not much rouging is required in open pollinated varieties as they have broad genetic base and are phenotypically uniform for most of the characters. However rouging for offtypes

such as very tall or dwarf should be completed before pollen shedding. Remove malformed and diseased plants affected by stalk rot from time to time. At harvest sorting should be done remove off-colored and off-textured ears.

Harvesting of maize ears: Maize ears can be harvested at high moisture content (30-35 %) when artificial heated air drying facilities are available, otherwise harvest the crop when the seed moisture content is 15-16 %. After harvest sort out all off-type maize ears, particularly those showing different colour and texture and the diseased ears before placing them in bins for drying.

Shelling: After drying, the ears are once again examined and any offtypes or diseased ears are removed before shelling. The certification standards require bin inspection of maize ears before shelling. Therefore shelling should be undertaken after taking the approval from seed certification agency.

Seed Yield: Depending upon the management practices adopted and the potentiality of the variety the yield may be in the range of 25-30 q/ha.

Hybrid seed production

In maize we are having single cross, double cross and three-way cross hybrids. Maintenance of parental lines/inbred lines and single cross seed production is considered as foundation seed class and commercial hybrid seed production or double cross seed production or three-way cross seed production as certified seed production.

Maintenance of Parental lines/ Inbred lines:

Land requirement: same as open [pollinated varieties.

Isolation requirement: 400 m of isolation is required from other maize varieties and hybrids with same kernel colour and texture as that of the seed parent and 600 m from other maize varieties and hybrids with different kernel colour and texture. In case where space isolation is a problem we can go for time isolation. Time isolation is provided 5% or more plants in the seed field should not be with receptive silks when more than 0.1% of plants in the contaminating field is shedding pollen.

Brief Cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 15 kgs /ha and the recommended cultural practices should be followed as that for raising a commercial crop.

Number of field inspections : A minimum of four field inspections shall be made in such a way that first field inspection is done before flowering stage and the remaining three during flowering stage to verify isolation distance, offtypes and other relevant factors.

Offtypes plants that have shed or are shedding 0.20 % pollen when 5.0 % or more of the plants in the seed field have receptive silks.

Rouging: the inbred lines are true breeding strains and rigorous rouging should be done to remove offtypes before they shed pollen. Remove tall and vigorous growing plants from the knee-high stage onwards. At preflowering stage rogue out offtypes based on morphological characters such as leaf shape, tassel color and silk color. Final rouging should be done to remove disease - affected plants.

Harvesting & Shelling: Similar to open pollinated varieties.

Seed Yield: depending upon the yield potentiality and the management practices adopted the yield may be around 5-6 Q/ha.

Single cross seed production:

The single cross seed is produced by crossing two specific inbred lines by following a planting ratio of 2 lines of male parent and 4 lines of female parent in alternate rows with 4-6 male parents around the seed production plot. The female parent has to be detasselled before shedding pollen to ensure cross -pollination with male line. The seed harvested from female rows is the single cross hybrid seed.

Land requirement and isolation requirement: same as maintenance of inbred lines.

Depending on the differences in duration adjust the sowing dates of male and female inbred line. Necessary precaution may be taken to avoid mixing of male and female lines. The male lines have to be marked on both the ends by a label or tag or by sowing the seed of other crops like sannhemp or daincha.

Cultural Practices: The seed rate required is 10 kgs/ha for female parent and 5 kgs/ha for male parent. After adjusting the sowing dates the recommended package of practices should be followed.

Number of field inspections : A minimum of four field inspections shall be made in such a way that first field inspection is done before flowering stage and the remaining three during flowering stage to verify isolation distance, offtypes and other relevant factors.

Foundation class

Offtypes plants that have shed or are shedding 0.20 % pollen when 5.0 % or more of the plants in the seed field have receptive silks.

Shedding tassels in female parent any inspection 0.50 % During flowering when 5.0% or more of the plants

In the seed parent have receptive silks Total pollen shedding tassels including tassels that 1.00 % Have shed pollen fro all three inspections conduce during flowering on different dates.

Detasselling : when Cms line is not used the seed parent has to be detasselled so that it will be fertilized by the pollen from the male parent. Removal of the tassel from the female parent before shedding pollen is called as detasselling. For detasselling hold the stalk by left hand and take a firm grip of the entire tassel in the right hand and pull it gently to detassel.

Precautions to taken while detasselling

1. Remove all tassels from seed parent before they shed pollen.
2. Detasselling should be done when the tassel is completely out of the flag leaf but before anthers shed pollen
3. Remove the entire tassel
4. Avoid immature detasselling as they cause injury to the top leaves.
5. Once detasselling starts in the field it must be repeated daily in all weather conditions at a fixed time. Detasselling should be done from the same side every day in case of large fields.
6. Precaution may be taken not to detassel in male rows.
7. Lodged plants in female rows must be detasselled as they are likely to pass unnoticed during detasselling.
8. After detasselling drop the tassel immediately on the ground and they should not be carried till the end of the row as they contaminate receptive silks.

Rouging: Rouging should be done both in male and female parental lines. Remove the offtypes from both male and female parental lines before they start shedding pollen. Shedding tassels should not be there in female rows. Offtypes can be identified based on morphological characters like plant height, leaf shape, tassel and silk color etc. remove all the plants affected with stalk rot and other diseases.

Harvesting and shelling : Harvest the male rows first and remove them from the field to avoid mechanical mixtures. Then harvest the female rows. After harvesting sorting should be done to

remove off-colored, off textured and diseased ear heads. Before shelling approval should be taken from the seed certification agency.

Seed Yield: average seed yield of a single cross varies from 4-6 Q/ha.

Double cross hybrid seed production / Commercial hybrid seed production

The double cross hybrid seed is produced by using high yielding single cross as the female parent. The planting ration adopted is 2 line of male parent and 6 lines of female parent. The female single cross has to be detasselled before pollen shedding to ensure cross-pollination with male parent (single cross).

Land requirement: Same as open pollinated variety Isolation requirement: 200 m From any maize with same kernel color and texture of seed parent 300 m From maize with different kernel color or texture of that of seed parent 5 m From other hybrid seed production plot having same male parent.

Differential blooming dates are permitted for modifying isolation distance provided 5% or more plants of the seed parent should not have receptive silks when more than 0.5% pf plants in the contaminating field shed pollen. Or

Distance less than 200 m may be modified by planting additional border rows of male parent if the kernel color and texture of the contaminating maize are same as that of seed parent.

For area upto 4 hectares and with decrease in isolation distance by 12.5 m an additional border row of male parent should be planted.

1. Border rows must be planted in continuation to the seed field at the same time and with same seed rate and spacing.
2. Seed fields having diagonal exposure to the contaminating field should be planted with border rows in both the directions of exposure.
3. Natural barriers like thick trees and buildings cannot be substitute the border rows.
4. when two seed fields with different pollinators are within the isolation distance both are to be provided with border rows.
5. Modification of isolation distance with boarder rows is not permitted if the contaminating field parent is of different kernel color or texture if it is popcorn or sweet corn