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Hybrid Seed Production in Rice: Tactic and Concern

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Being most important staple food crop of the world rice is widely cultivated in India under tropic and subtropics conditions. The hybrid rice technology was originated in China in seventieth decade in China. The technology is spread throughout the Asia as potential to achieve higher yield. Among all techniques involved to develop hybrid rice CGMS system was found to be effective and is widely used by the breeders. Development and maintenance of A and B line in three line system is crucial in this programme. Seed production and cultivation practices should be conducted appropriately to enhance yield and quality of hybrid rice.

Introduction

Rice (*Oryza sativa* L.) belongs to the genus *Oryza* of family Poaceae. The genus *Oryza*is known to consist of two cultivated species i.e. Asian rice (*O. sativa,* 2n=24=AA) and African rice (*O. glaberrima,* 2n=24=AA) and 22 wild species (2n=24, 48). About half of the world's population depends on rice for their survival. It is the staple food for two-third of the Indian population. India has the largest area under rice among the rice growing countries in the world and ranks second in production after China.

History of Hybrid Rice Technology in China and India

In 1964, Yuan Long Ping first put forward the idea of utilizing the heterosis in rice and initiated the research on hybrid rice in China. In1970, a pollen abortive wild rice plant (Wild Abortive; WA) was discovered among the plants of common wild rice at Nanhong Farm of Hainan Island of China and the available restorer genes in *indica* rice led the beginning of hybrid rice technology. In 1972, the first group of CMS lines such as *Zhenshan* 97A, V20A were developed by using WA as the donor of male sterile genes by way of successive backcrossing method. In 1976 - First commercial three-line and in 1994 first commercial two-line rice hybrid released in China.

In India, ICAR launched a mission mode project on hybrid rice in December, 1989. IRRI, Philippines collaborated with the project by providing the needed germplasm and technical support. This project was further strengthened with financial support from UNDP and technical support from FAO since September, 1991-1996. Mahyco Research Foundation (MRF), now popularly known as Barwale Foundation provided financial assistance to the hybrid rice project

during 1996-2002 to fill critical gaps which is a good example wherein a private foundation supported a public sector research. In 1994 first time hybrid rice (APHR1, APHR2, MGR1 and KRH1) were released in India. The research network consists of 12 active research centers across the country each with a specific mandate. So far 65 rice hybrids have been released and many identified in the country.

Techniques of Hybrid Rice Seed Production

Since rice is a self pollinated crop, one of the parents to be used as female must be made male sterile through proper technique. Several types of techniques for making female may be tested and developed for hybrid seed production are:

1. Cytoplasmic Genetic Male Sterility (CGMS), also known as three line system
2. Environmental sensitive Genetic Male Sterility (EGMS), also known as two line system
3. Apomixis, also known as One Line System
4. Chemically Induced Male Sterility (CIMS)

Good crop management is necessary for raising a hybrid–rice seed production crop. Hybrid- rice production technology described below may be used as a guideline.

1) Choice of Areas and Growing Season for Seed Production: The areas of seed production should be chosen so as to provide the best possible conditions at flowering and the pollen shedding period. The most suitable condition are, 24-28 ^{o}C day light average temperature, the relative humidity 70-80 percent , the temperature difference between day and night 8-10 ^{o}C and good sunshine. Average day temperatures of more than 30 ^{o}C or less than 23 ^{o}C, continuous rains, or strong wind are generally harmful to flowering, pollination and cross- fèertilization. As a rule, in high temperature with low humidity or in low temperature with high humidity some glue will not open. This lowers the seed yields. The growing of hybrid seed crop should be so adjusted that flowering takes place after the end of high temperature period but before the start of low temperature period.

2) Selection of Seed Fields and Isolation Distance: The selection of prime field plots is necessary. The seed fields should be free of volunteer plants, well leveled, should have fertile soil with good physical and chemical characteristics and well drained.The hybrid paddy fields should be isolated from the other paddy fields, including commercial hybrid of same variety, and same hybrid not conforming to varietal purity requirements for certification at least by 200 meters for foundation seed class (A, B and R line Production) and by 100 meters for hybrid seed production (AX R production).

3) Brief Cultural Practices for hybrid (AXR) Production Nursery: Raising of vigorous seedlings is an important factor for obtaining high seed yields. The root system of vigorous seedlings are flourishing, leaf sheaths have high carbon content and all this contributes to produce green growth and tillering at the lower nodes so that more dry matter is accumulated, leading to more panicles and a high seed setting rate per panicle. It has been observed that tillering at the lower nodes gives more and bigger panicles which helps to achieve the goal of 100 kernels per ear. Prepare the seedling bed with basal manure. Seed rate at 150 kg/ha for the female parent and

100-150 kg/ha for the male parent. At present the appropriate methods for raising seedlings are either to sow under plastic film in the field or in a green house.

4) Sowing and Transplanting: The proper sowing time is dictated by the number of days required from sowing time to panicle formation. The sowing should be so adjusted that the crop comes to panicle stage soon after the end of high temperature period. Seedlings with healthy tillers are the basis for increased panicle size. For hybrid seed production, the seedlings of both parents should be standardized. Seedlings of the male parent for short duration varieties should be 20-30 days old with 5.5-7 leaves and 2-3 tillers and for long duration varieties 30-35 days old with 5.5-7 leaves and 2-3 tillers.

5) Planting Ratio: The ratio of female and male lines is generally kept at 2:10-12, and row spacing 10X10 cm for male parent and 20X 15 cm for female parent. Two seedlings are planted per hill. Both parents should receive good aeration and equal amounts of sunlight. Row direction should be nearly perpendicular to prevailing winds at flowering to ensure more cross-pollination.

6) Water and Nutrient Management: Good water management is very important for regulating water, fertilizer , air and temperature of soil. Give shallow irrigation at the transplanting and tillering stages. In soils where water permeability is poor the field must not be allowed to remain under water for too long so that root growth could be drained the booting stage. During heading, if the air temperature is above 35 0 C, water should be applied during the day and drained – off at night so as too decrease soil temperature. Adequate fertilization in necessary, in general a seed field with moderate fertility should be treated with 200 kg N, 50 kg P, and 150 kg K per ha, 90 percent applied as a basal dose and 10 percent after panicle differentiation.

7) Synchronization of Flowering: Synchronizing the flowering of both parents is the key to increased yields. Technical measures such as staggering seedling dates of the male and females parents, sowing the male parents three times to extend the time pollen is available, and predicting and adjusting flowering dates may be adopted. Actual practices would have to be standardized for each hybrid and the locations selected for the hybrid seed production.

i) Staggered Sowing of Male Parents: Seedling date is usually determined by leaf age, effective accumulated temperature (EAT), and growth duration. In general, the period from initial to full heading of a CMS line is 4-6 days longer than for a restorer line. The first sowing of the male parent establishes the dates for second and third sowing. The second sowing is done when the leaf emergence on the first sowing is 1:1 the third sowing when the leaf emergence is 2:1. The second sowing is the main parent. The planting ratio for sowing at different dates is 1:2:1.

ii) By Fertilizer Application: Beginning about 30 days beforeheading, 3 or 4 random samples of the main culm of both parents are taken every 3 days. Young panicle development is compared under magnification. During the first three stages of panicle differentiation, treat the earlier developing parent with quick releasing N fertilizer, and spray the later developing parent with Potassium dihydrogen phosphate. This adjusts development differences of 4-5 days.

iii) By Water Management: During later stages of panicle differentiation, draining water from the field will delay male parent panicle development, higher standing water will speed panicle development.

Methods of Improving Seed Setting

i) Supplementary Pollination (Rope Pulling): On calm days during anthesis, supplementary pollination can be carried out. Panicles of the restorer lines are shaken by pulling a long nylon rope (5mm diameter) back and forth every 30 minutes until no pollen remains on the restore line. This methodoften used on even topography and regularly shaped plot. In hilly, uneven topography with small, irregular plots, a bamboo pole may be used.

ii) Leaf Clipping : Leaves taller than the panicles are the main obstacles to cross pollination. Clipping leaves 1-2 days before initial heading increases the probability of pollination and out crossing rate. The blade of flag leaf is cut back ½ to 1/3 from the top. Spraying seed parent with 75 gm GA3/ha 60 ppm or more 2 or 3 times increases panicle exertion and help increased seed setting.

iii) Roguing: The seed field should be free of rogues. Remove off- type plants in both the parents first before the onset off flowering stage and then soon after emergence of the panicle. Rogue out the plants of maintainer line, if any and the semi-sterile plants in the seed parent as often as necessary.

iv) Harvesting of Seed Crop: Harvest male rows first to avoid chances of mechanical admixture.

Concerns of Hybrid Rice Technology

1. Farmers may not use their own seed from one year to next year hence they have to purchase fresh seed every year.
2. Seed cost is almost 2.5 times higher for hybrids than of conventional high yielding varieties.
3. Hybrid rice seed production technology is both labour and knowledge intensive.
4. Majority of the hybrids developed till date are lacking in quality traits.
5. Unpredictable environmental condition may affect sterility expression during seed production resulting to seed purity problems.
6. Hybrids require more doses of fertilizers for higher gain.

Conclusion

Hybrid seed production in rice is best option to feed growing population and to solve food security objective of India. Though the hybrid rice is not much popular in present scenario, its potential has put concentrated the breeders for research and innovation in this regard. Various research stations in India and abroad has engaged to produce and commercialized hybrid rice. The practical concerns like lack of fertility restorer source may be important setback to proceed further; but huge genetic diversity of rice throughout the world make it possible to explore new alternatives.