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HYBRID RICE CULTIVATION IN INDIA

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ABSTRACT

Rice requirement will be 350 million tonnes more by 2020 than what we are producing today as demand for rice is 800 million tonnes by 2020 and this increase should be achieved sustainably with less land, labour, water and pesticldes. To meet the growing demand of rice in coming years, there has been a significant research effort in breaking yield plateauing through genetic approaches. In this endeavor, hybrid rice technology has been introduced in the recent years in India. Usually hybrid varieties released recently have been reported to have an extra grain yield advantage of 1-1.5 t/ha over the best promising local variety in a given location. For exploiting the full heterotic potential, it is indispensable to develop a suitable production package practices for hybrid rice cultivation.

KEY WORDS: Hybrid Rice, A-Line, R-Line, CMS Line

INTRODUCTION

Rice is staple food for 3.5 billion worldwide and 480 million tons of milled-rice is produced annually. China and India alone account for >50% of the rice grown and consumed. Rice provides up to 50% of calories for millions living in poverty and therefore critical for global food security. Hybrid refers to first filial generation (F1) or first generation progeny obtained b crossing two genetically diverse parents. To obtain hybris seed in rice; we use cytoplasmic male sterile (CMS) line as female parent which is called as A-line. Since rice is a self pollinated crop, bisexual plant as female parent would lead to self fertilization. As it is tedious and labourious to do emasculation manually, we go for CMS lines as female parents. The fertility restoring line known as R-line is used as male parent or pollinator. Although there are two line and three line systems available in production of hybrid seed, at present three lines method, using cytoplasmic male sterility system, is widely used. In this system, three lines (parents) are involved in hybrid seed production. These parents are:

- **A line:** The cytoplasmic male sterile line used as female parent is called A-line. It is male sterile and is maintained by crossing with B-line.
- **B line:** It is also called maintainer line and is used as pollen parent to A-line to maintain its male sterility. Both A-line and B-line are isogenic to each other expect for male sterility. This line is maintained by growing in isolation, atleast 5 m away from any rice variety.
- **R line:** This line is also called as Restorer line or pollinator line as it is used in hybrid seed production by crossing it with A-line in a standard row ratio. It is also maintained by growing in isolation, at least 5 m away from any rice variety.. If all the isolation requirements are strictly followed, the hybrid seed produced will be >99.8% pure. Therefore, utmost care has to be taken while producing the hybrid seed. Hybrid seed production technology is different from the technology for normal varietal seed production. Farmer has to purchase fresh hybrid seed every

year/ season. The hybrid seed should have the purity of about 99 %. The persons engaged in hybrid seed production should be well trained in various steps involved in hybrid seed production.

Following are the requirements for hybrid seed production in rice.

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 (An 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...

TRANSPLANTING

In R-lines with short duration, seedlings of 20-30 days old with 5-7 leaves and 2-3 tillers stage should be used for transplanting while for long duration varieties 30- 35 days old with 5.5-7 leaves and 2-3 tillers should be used.

PLANTING RATIO

2:10-12 female lines to male ratio have to be maintained; and the row spacing should be 10×10 cm for male parent and 20×15 cm for female parent. One seedling should be planted per hill.

ROW DIRECTION

Row direction should be nearly perpendicular to prevailing winds at flowering so as to ensure equal amount of sunlight and good aeration to both the parents so that there will be more cross pollination.

FERTILIZER MANAGEMENT

The response of hybrids to nitrogen varies due to their basic ability to accumulate more dry matter during vegetative and after heading periods whereas inbred rice depends basically on the accumulation of assimilates before heading. The influence of incremental doses of nitrogen was significant upto150kg N/ha.

N-Management

Application of 120-150 kg N/ha in 3spilts as 1/2basal+1/4max.tillering+1/4booting results in highest grain yield. The N application coinciding with flowering improved the grain yield as well as nutrient uptake which resulted in improved grain filling on account of the delayed senescence. However interaction effects between water management practices and time and methods of N application were found significant.

Methods to Enhance the N Use Efficiency

- Placement of fertilizer at root zone
- Spilt application of fertilizer

- Use of urease inhibitors and controlled release nitrogen
- Use of coated fertilizers
- Conjuctive use of organic manures with granulated fertilizers.

Optimum dose of 120kg N+60 kg p_2o_5+50 kg k_2o per ha combination found to be the balanced package in terms of nutrient response. Mean grain yield increased linearly with increasing levels of nutrients. Mean over locations added p responded well only upto 60kg p_2o_5/ha.

Apart from NPK fertilization, need based application of zinc and sulphur may be taken up. While most of the P, K, Zn, and S fertilizers are applied as basal dose along 1/3rd of the N requirement incorporated in soil, the remaining should be applied in two spilt doses at tillering and P.I stages. Top dressing of P fertilizer at tillering and K fertilizer at P.I and N application at booting is also reported to be beneficial in seed production plots to get plumpy seeds. Generally N delays panicle development and K and P promote the panicle.

In first top dressing, at the beginning of panicle initiation stage, a moderate dose of 70 kg urea is normally applied for getting elongation of filament and to increase the viability of pollen. Second top dressing at pollen maturity stage, a dose of 70kg urea+70kg Kcl will be applied normally to have optimum number of developed spikelets in the panicle.

WATER MANAGEMENT

Optimum water management is of great importance in modern rice cultivation as it influences growth and grain production. Stagnation/decline in the grain yield of rice in some potential growing areas is often stated due to improper water management.

Hybrid rice varieties were not much influenced by water management practices such as continuous submergence and cyclic submergence indicating cyclic submergence is as good as continuous submergence in *kharif* season.

The field should be irrigated and drained according to the development of different growth stages. Normally transplanting is being done in the leveled field under saturated or thin film of water. Shallow depth of water (2-3cms) has to be maintained soon after the transplanting for 3days. At later stages, saturation of soil for 5 days is good enough for obtaining white roots. After white roots formation, a shallow submergence has to be maintained (2-3 cms) upto third stage of panicle development. Soon after this stage, a deep submergence has to be restored (5 cms) upto fifth stage of panicle development. From 6th stage of panicle initiation to heading, intermittent irrigations will be sufficient. After the heading to grain filling stage, a shallow submergence is desirable. From grain filling stage to7 days before harvest, intermittent irrigations are quite enough for obtaining normal seed set. Water has to be drained out atleast 7 days before harvest. If water is high during maximum flowering stage, irrigation water depth may be raised to 5 cms. The optimum water temperatures are 20^0 c at tillering and 25^0c at heading. Water temperature should not rise more than 31^0c at any of the crop growth stages. (Anonymous, 2010)

SYNCHRONIZATION OF FLOWERING

The key to success for increases yields in hybrid rice cultivation is synchronizing the flowering of both parents. Practices such as staggered seeding dates of A and R lines, sowing of male parents 3 times more as that of female parents

to supply sufficient pollen to the female plants may be adopted. Actual practices would have to be standardized for each hybrid and the locations selected for the hybrid seed production.

- **Staggered Sowing of Male Parents**: Seeding 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.
- **By Fertilizer Application**: If any one parent is showing lesser growth than the other parent then potassium dihydrogen phosphate should be sprayed to later developing parent which will adjusts the growth difference of 4-5 days.
- **By Water Management**: Draining water from the field during later stages of panicle differentiation, will delay male parent panicle development where as higher standing water will speed up panicle development.

MEASURES TO BE TAKEN FOR IMPROVED SEED SETTING

Supplementary Pollination (Rope Pulling)

In order to ensure 100% pollination, supplementary pollination can be carried out during anthesis. Panicles of the restorer lines are shaken by pulling along nylon rope (5 mm diameter) back and forth every 30minutes until no pollen remains on the restorer line. This method if often used on even topography and regularly shaped plots. In hilly, uneven topography with small, irregular plots, a bamboo pole may be used.

Leaf Clipping

Clipping of leaves 1-2 days prior to initial heading should be practiced as it increases the probability of pollination. Leaves taller than panicles are the main obstacles for pollination, removal of which increases out crossing rate. The blade of flag leaf is cut back ½ to 1/3 from the top.

GA3 Spray

To increase panicle exertion and increased seed set, spray GA3 @ 45 g/ha at 5.0% heading in two split doses on consecutive days to seed parent.

ROGUING

Removal of off-type plants (rouges) in both the parents should be done twice, first before the onset of flowering stage and secondly after emergence of the panicle. Semi sterile plants in seed plant have to be removed.

HARVESTING

Male rows should be harvested first to avoid mechanical mixture of seed.

YIELD

5-15 Quintals/ha

CONCLUSIONS

- Seed rate : Seed parent - 15 kg/ha, Pollen parent - 4kg/ha
- Nursery: Sparse seeding to ensure multitillered (M-5) seedlings in 25 days.
- Row ratio: 2B: 6A, for CMS multiplication, 2R: 8A, for hybrid seed production.
- Number of seedlings: Two seedlings/hill for seed parent, three seedlings/hill for pollen parent.
- Spacing: B/R to B/R 30 cm; B/R to A 30 cm; A to A 15 cm
- N significant response:150 kg N/ha
- N application-3splits :
  - 50% basal
  - 25% tillering
  - 25% booting.

N application coinciding with flowering improved the grain yield as well as nutrient uptake which resulted in improved grain filling on account of delayed senescence.

- GA 3 application: 45 g/ha at 5.0% heading in two split doses on consecutive days.
- Supplementary: Twice a day at peak anthesis during pollination flowering phase.
- Rouging : During vegetative phase based on morphological characters and twice during and after flowering based on floral characters etc.
- Seed yield: 1.5-2.0 tons per ha

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