JUST AGRICULTURE
multidisciplinary e-Newsletter

Male Sterility Systems in Hybrid Rice

Ashok Kumar
Division of Plant Breeding and Genetics
Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu,
Jammu and Kashmir, India

ARTICLE ID: 074

Abstract

The utilization of population improvement methods in rice only became feasible after the discovery of the male sterile gene through induced mutation of the rice. The initial breeding strategy to produce hybrids relied on three breeding lines known as A line (the male sterile line), B line (responsible to maintain the genetic male sterility of the A line) and R line (used to restore the fertility of the A line and to produce the hybrid seed). The ideal system for these and other cross-pollinated crops would be the one-line method utilizing the apomixis system that allows preserving the right cultivar. Identication and evaluation of male-sterile lines and their restorers, test cross phase to select heterotic combinations and to initiate conversion of maintainer lines into male-sterile lines, back crosses to transfer the cytoplasmic male-sterility to elite maintainer lines, trials to study the combining ability (general and specific) of the parental lines and foundation seed production of all three lines. Production of breeding lines for the three- or two-line methods is still a difficult task for most of the rice breeding programs. Heterosis is the base of the great success in hybrid rice.

Introduction

Hybrid rice accounts for 55% of the total planting acreage of paddy rice in Far East Asia and the annual increased rice production resulting from planting hybrid rice amounts to 20 million metric tons, which can provide a main staple food for 70 million people. Hybrid rice varieties have a yield advantage of 10-20% over the best conventional inbred varieties using similar cultivation conditions. In rice breeding, most agronomic and grain quality traits are controlled by many genes each of, which has a relatively small effect on the overall phenotype. These traits do not show discrete phenotypes, consequently they are often measured and given a quantitative value and are referred to as quantitative traits.

- **Male sterility used in hybrid rice**

(i) Cytoplasmic genetic male sterility

JUST AGRICULTURE
multidisciplinary e-Newsletter

(ii) Environment sensitive genetic male sterility

(iii) Chemically induced male sterility

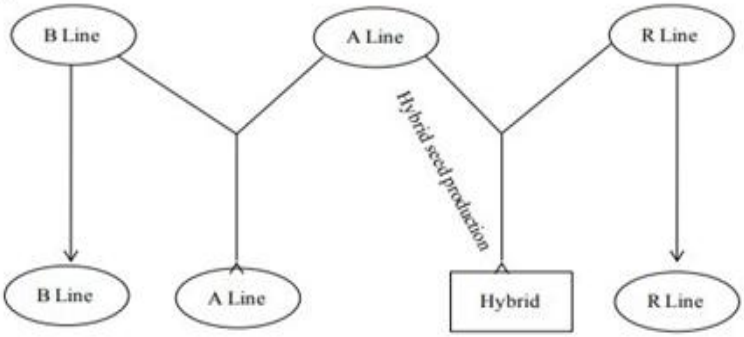
(iv) Transgenic male sterility

(i) Cytoplasmic genetic male sterility

- It is caused by an interaction between genetic factor(s) present in cytoplasm and the nucleus. Absence of a sterility inducing factor either in the cytoplasm or in the nucleus makes a line male fertile.

The three-line hybrid rice system includes the following lines:

- Male sterile line (A line): The cytoplasmic male sterility trait is controlled both cytoplasm and nucleus; this line is used as female in hybrid seed production.
- Maintainer line (B line): This line is used as a pollinator to maintain the male sterility. The maintainer line has viable pollen grains and sets normal seed.
- Restorer line (R line): Any rice cultivar that restores fertility in the F1 when it is crossed to a CMS line.



(ii) Environment sensitive genetic male sterility

This is a genetic male sterility system in which sterility expression is conditioned by environmental factors.

Types of EGMS

There are two types of EGMS which are currently being used in rice:

(a) PGMS - Photoperiod sensitive genetic male sterility

Genetic male sterile lines which respond to the photoperiod or duration of day length for expression of pollen sterility and fertility behavior. Most of the PGMS lines remain male sterile under a long-day (>14 hrs) conditions and revert back to fertility under short-day (< 14 hrs) conditions.

Example - N9044S and N5088S

(b) TGMS - Thermo sensitive Genetic Male Sterility

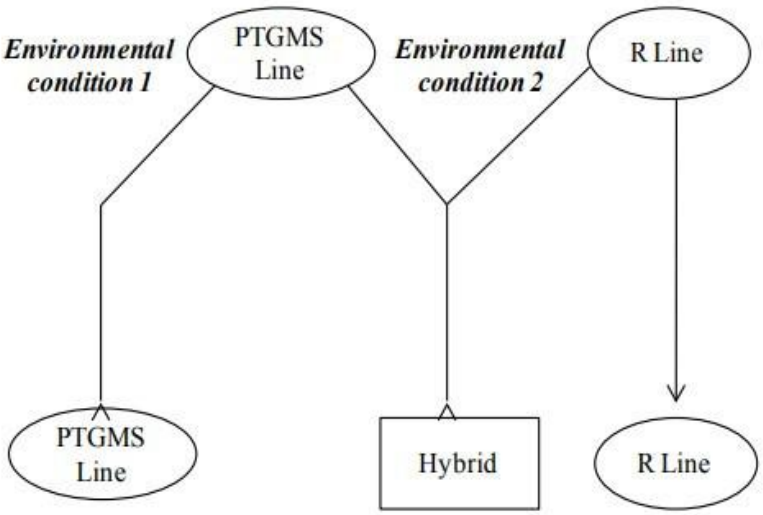
JUST AGRICULTURE
multidisciplinary e-Newsletter

Genetic male sterile lines whose male sterility/fertility alteration is conditioned by different temperature scheme. Most of the TGMS lines remain male sterile at a high temperature (>23.3°C) and they revert back to fertility at a lower temperature (<23.3°C). The critical sterility/fertility points vary from genotype to genotype.

Example - Norin PL12, ID24, IR32364

Two-line system hybrid rice

- Male sterile line: nuclear gene(s) and environmental conditions such as photoperiod and/or temperature control male sterility. Male sterile lines can be EGMS (environmental-conditioned genic male sterile), PGMS (photoperiod-sensitive genic male sterile), TGMS Thermo-sensitive genic male sterile) or PTGMS (photoperiod- and thermo-sensitive genic male sterile) lines.
- Restorer line (R line): any rice cultivar that restores fertility in the F1 when it is crossed to the male sterile line



(iii) Chemical Induced Male Sterility:

This non-genetic method of inducing male sterility involves the use of chemical called hybridizing agents (CHA) or gametocides.

❖ **The ideal gametocides should :**

✓ Selectively induce male sterility without adversely affecting the female fertility.

✓ Have systemic effects so as to sterilize both early and late panicles.

✓ Have a broad range of effectively in order to withstand adverse environmental conditions.

JUST AGRICULTURE
multidisciplinary e-Newsletter

✓ Have minimum side effects on plant growth and panicle development.

Eg. MG1 and MG2 (Mostly used in rice)

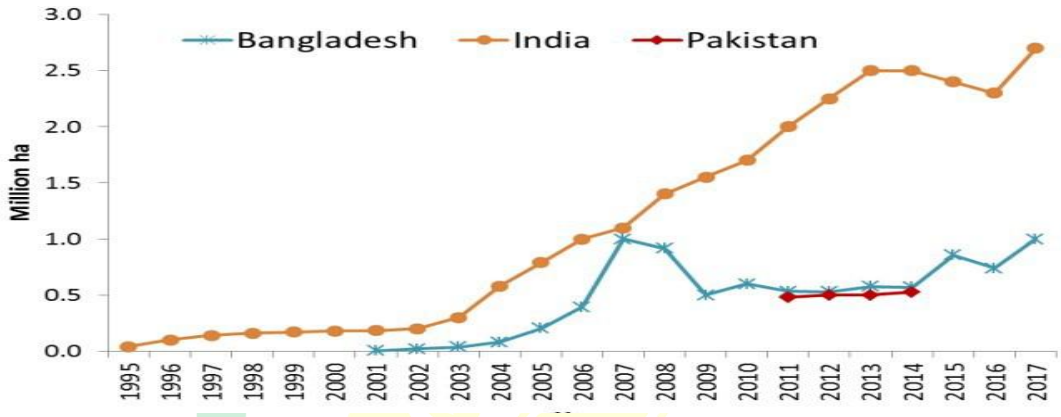
❖ **For developing hybrids by using gametocides :**

✓ The female line should have a synchronous flowering habit

✓ The line should respond to chemical treatment

✓ The parents should possess good outcrossing traits

❖ **Area under Hybrid Rice in Asia**



It is estimated that around 3+ Million Hectares is under Hybrid Rice cultivation in India in 2016 which is around **7%** of the total Rice cropped area in India.

Importance of Hybrid Rice

❖ Rice is the staple food of more than 60 % of the world population.

❖ Rice hybrids have shown 15-20 % higher yield potential than inbred rice varieties under farmers field conditions.

❖ Hybrids have shown their ability to perform better under adverse condition of drought and salinity.

❖ Rice hybrids increases profitability at the household level and will help in achieving food security at the national level.