

ONE-LINE HYBRID RICE

One-line hybrid for growing paddy without seeds

Part-1



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Chinese scientist Yuan Longping, "the Father of Hybrid rice- discovered genetic basis of heterosis in rice that substantially provided food security in Asian countries. Rice, being self-pollinated, requires a male sterility system (cytoplasmic and environment-sensitive) to develop 3 and 2 line hybrids. A male sterile line is used as female and grown with a pollen parent to produce hybrid seeds. The seed set on male sterile plants is used to grow commercial hybrid.

Good rice hybrids are developed by crossing two genetically dissimilar parents- give 15-20% more yield than best inbred. Rice scientists are now using new plant type (NPT) background to develop hybrids with enhanced heterosis. However, 3 line seed production system for maintaining A, B and R lines is complicated and expensive--a negative effect of male-sterility inducing cytoplasm exists. There is a need to reduce cost and to increase efficiency of 3-line hybrid seed production system.

Two-line hybrid breeding technology involving EGMS (Environment-Sensitive Genic Male sterility) lines can overcome negative effects of male-sterility. Two line rice hybrids, Liangyou Peijiu gave the highest average yields of 12 t/ha in China- that is higher than three line hybrids. The discovery of EGMS system has reduces cost of hybrid seeds. Two-line hybrid area reached 2.6 million ha in China. However, sudden change of

temperature will influence sterility of EGMS lines.

Heterosis of a hybrid is normally broken due to segregation- farmers could not use their own seeds. Farmers have to buy expensive hybrid seeds every season- seed produced by proficient seed production agencies. Hybrid rice seed production requires more labour than ordinary rice cultivation. It is important to simplify process of hybrid seed production techniques. Production of clonal seeds, called one-line hybrid rice- described by Dr Longping Yuan is a hot topic for research on apomixis breeding.

Apomixis is asexual embryos formation- mature seeds formed from somatic cells within ovary without fertilization and produces seed progeny that is identical clone to mother- could overcome the problem of breaking heterosis in a hybrid. Scientists attempted to solidify hybrid vigor from two different genetic pure lines into clonal rice seed. However, research is still under way in IRRI, and China. Attempts to develop one-line hybrid rice have not been succeeded so far.

Traditional ratoon crop means growth of rice plant from upper portion of stubble left in the field after paddy harvesting. However, ratoon crop grow as a clone of mother plant. Some hybrid varieties having ratooning ability were identified. But, best ratoon hybrid rice gave only 50% yield of main hybrid crop in China. This ratooning process could be repeated only one season. Traditional ratoon crop produces lower yield within 35-40 days after harvesting--not suitable as commercial crop.

We know the constraints of 3 and 2 line hybrids, apomixes rice has not been developed anywhere--traditional ratoon don't perform well. Our research aim is to develop a rice hybrid having better vegetative propagation as like sugarcane. Sugarcane could be ratoon after the first year's harvest. Further, planting

of mature stem cutting can re-grow identical clones. We developed perennial rice BRRI dhan91 through transferring rhizome traits (new tillers from underground part) from a local rice variety.

Supper ratoon BRRI dhan91 is a selection from a very large population (crossing between local indica and modern rice) having rare recombination of major genes. Perennial rice BRRI dhan91 is characterized by fast growth, tall and lodging tolerance, thick internodes, robust stems, more tillering and bio-mass, alive stem at maturity and high stem carbohydrate/sugar content. BRRI dhan91 could be propagated either by ratooning or stem cutting having medium level of yield (4.5 t/ha).

Robust tall variety BRRI dhan91 opens the door of breeding for better ratooning. The modern rice has poor ratooning ability. Attempt was made to develop hybrids by crossing BRRI dhan91 with very high yielding lines (more than 9 t/ha yield, 300-350 grains/panicle). Therefore, evaluate two hybrids (BRH11-9-11-4-5B/BRRI dhan91 and BR9392-6-2-2B/BRRI dhan91) under standard ratoon and vegetative cutting system compared with non-perennial lines showed that superior ratooning ability (or clone) was successfully incorporated in two hybrids.

Selection of hybrid-1 might led to improvement of perennial ratoon growth having better dry matter (12.8 t/ha, heterosis- 33%, lodging tolerance in 170 cm tall plant) and paddy yield (350-400 grains/panicle, panicle length 34 cm, 12.1 t/ha yield, heterosis 25%). Further, research results also demonstrated that 1st, 2nd 3rd and 4th season ratoon of hybrid-1 had almost equal expression of different traits like plant height, dry matter and paddy yield as like its main F1 crop.

Our findings indicating that hybrid-1 is suitable for boro and aman seasons

with perennial growth habit; thus fixed yield heterosis for dry matter and paddy (average 12.1 t/ha yield in boro ratoon crop, average 12.4 t/ha yield in boro main crop) had successfully been transmitted through vegetative ratooning of hybrid-1. In our research- ratoon/cutting of hybrid crop give almost 100% yield (12.1 t/ha) of main crop for next 4 growing seasons.

This technique involves the use of superior ratooning propagation or production of many cuttings/clones of F1 hybrids. Ratoon hybrids maintained all genetic makeup (heterozygosity, fix-heterosis, 12.1 t/ha yield) as like main hybrid crops. Thus, it simplifies the processes of 3 and 2 line hybrid seed production systems. Farmers can harvest paddy from one line hybrids, further could use cuttings/clones for next crop. The technique reduced cost of hybrid seeds production and reducing cost of seed bed preparation ever year.

Superior ratoon hybrid crops give same yield as like main crop. The superior ratooning process could be repeated season after seasons (4-5 times is better) and 4-5 crops could be harvested season wise from one original planting. The yield (average 12.2 t/ha) of ratoon crops don't decreases after each season. Thus, superior ratooning performance of hybrid-1 could be an alternative of apomixes/fix heterosis- suitable as one line hybrid, as propagated by clonal plants without seeds.

One line hybrid rice (as a clone of mother plant) with superior ratooning ability is a great innovation for conventional and hybrid rice breeding. With policy support from the government-strategic research on diverse ratoon hybrid variety development, validating ratoon/stem cutting techniques and farmer's training could be advanced for greater food security in Bangladesh.

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