the daily observer
We stand for people's rights
Date: 08.07.2019 Page: 04

BRRI dhan91: Climate resilient paddy

A S M MASUDUZZAMAN

Recently 'National Seed Board' approved one high yielding tall (190 cm) Deep Water Rice (DWR) variety BRRI dhan91 as developed by BRRI- suitable for semi-deep flooded areas having 1.0- 1.5 t/ha yield advantage over local variety. BRRI scientists has successfully incorporated SUB1 gene and high yielding traits into tall BRRI dhan91 for better adaptation in semi- deep flooded conditions.

Due to the climate change, threat of extreme flooding or threat of drought is too much in million hectares of land. However, the targeted areas for BRRI dhan91 are shallow flooded up to 1 meter. In those areas, no crops other than DWR are possible to grow. Multi-stress tolerant BRRI dhan91 is a variety resilient to climate change - which gave higher yield under early drought and shallow flooding condition.

Prime Minister Sheikh Hasina is committed to the development of agriculture sector and she has shown keen interest in deep water rice breeding programme of BRRI. The Honorable Prime Minister mentioned her preference of local deep water rice: Laxmidigha and Khoia-motor in diet. Director General of BRRI has undertaken a strong DWR breeding programme following directions from Honorable Prime Minister.

The Director General of BRRI mentioned that BRRI dhan91 is first DWR variety in Bangladesh it could survive in one meter depth for its moderate level of elongation and could tolerate submergence of 10-12 days. He said that till now vast areas remain fallow in those regions. It could give 1.0 t/ha more yield than local DWR variety. Thus, 0.50 million hectares of semi deep flooded lands could be shifted in to BRRI dhan91 to give additional 0.50 million tons of paddy.

BRRI dhan91 is a versatile genotype and that could be grown in wide ranges of area from drought prone to semi deep flooded areas. It has early stage drought tolerance for its vigorous root system. Tolerance to flooding is attributed by two mechanisms: submergence tolerance for 10-12 days and elongation ability. It could give 2.5 to 3.0 t/ha yield under semi deep conditions and 4.5 to 5.5 t/ha yield under rain-fed conditions.

Direct dry seeding of DWR is done after the first rainfall in May, early June and crops could be harvested within early November. Culm is stronger; flag leaf is deep green and erect. The grain is medium bold and cooked rice is non-sticky. Growth duration is 152-156 days. Farmers could harvest the crop 10-15 days earlier than local varieties.

Tillakkachari was used in hybridization with BRRI dhan41 for incorporating both submergence tolerance and elongation in BRRI dhan91 through conventional breeding. Innovative findings showed the higher expression of both SUBA2 and SUBC2 genes that confer both submergence tolerance and elongation in Tillakkachari.

Developing a modern tall DWR was a great challenge. IRRI stated that tallness is negatively correlated with higher yield- it is difficult to develop tall and lodging tolerance high yielding varieties. IRRI bred semi-dwarf rice with sd-1 allele having reduced Gibberillic Acid (GA) synthesis and shorter plant height could give a higher yield. However, recent studies claimed that reduced plant height of semi-dwarf rice limits dry matter production - thus restricts scopes of breeding for further yield increase.

In contrast, Sd-1 allele in tall DWR encode higher amount of GA- responsible for stem elongation, lodging and lower yield. However, tallness is needed for high dry matter and for storing greater source in stems. Ultimately, more bio-mass yield is needed for better partitioning of source into sink. But, a tall plant is susceptible to lodging. It will capture less solar energy.

How could yield be enhanced in tall DWR plant? Combining tallness, strong stems and lodging tolerance is a new dimension of research. The stems are very strong- having 1.9 meter height in contrast with 1.0 meter height of semi-dwarf rice. Enhanced lodging tolerance of tall BRRI dhan91 was achieved by incorporating bamboo-like thick lower culms, short lower internodes, leaf sheath tightly covering as well as higher carbohydrate contents. This is a great success.

In addition, BRRI dhan91 has much higher photosynthetic area for its long (44 cm) and wide flag leaves, robust green stems, higher number of tillers/hill and better canopy arrangement. Morphological features are: erect, long and thicker upper leaves, as well thicker culms for higher solar energy capture. Higher photosynthetic surface areas with more chlorophyll pigments in leaves and robust stems could absorb more light energy.

Research findings shows that BRRI dhan91 has about four times more stem carbohydrate and double dry matter than other rice. This is a success of C3 rice breeding - previous study shows that C3 rice is less efficient in gathering more CO2 than C4 grasses. Thus, more carbohydrate and enzymes are synthesized in its robust stems compared with other C3 rice.

At maturity stage- tall local DWR have higher GA3 synthesis and lower carbohydrate reserve for rapid depletion of carbohydrate. Thus, lower carbohydrate: GA3 ratio local DWR indicates maturity stage yellowing of leaves (chlorophyll loss due to higher GA3 effect), early leaf senescence and plant death. In contrast, tall stems of BRRI dhan91 are alive and green at maturity-indicated higher ratio of carbohydrate: GA3.

This higher carbohydrate: GA3 ratio of tall BRRI dhan91 indicates much more synthesis of carbohydrate and its less degeneration- even at maturity in presence of high amount GA3. Finally we find mature green plant with tallness and lodging tolerance without any adverse effect of GA3. At maturity, very limited leaf chlorosis occurs in BRRI dhan91 compared to local DWR. This variety has increased photosynthetic duration with strong green stems at maturity.

Perennial rice BRRI dhan91 is long-lived. This C3 perennial rice is capable of storing more carbohydrates as like C4 grasses- thus its stems are robust. Robust mature stem cutting could provide sufficient carbohydrate that might play a role on its vegetative propagation and super ratooning ability. New crops from stem cuttings in soil could give better yield (4.5 t/ha) as like main crop. This technique could reduce cost of seeds of farmers.

The grains of this variety do not suffer from source limitation and sterility at maturity. Seed reserve, nutrient and protein (9.6%) are much better. Harvest index (HI) of 0.33 of tall BRRI dhan91 is double than local DWR. Having 11 t/ha biomass with harvest index of 0.33- tall BRRI dhan91 has achieved yield of 5.5 t/ha. A satisfactory higher yield under rain-fed conditions was found with higher number (160--170) of filled grains/panicle, long (30 cm) panicle, higher number (14-15) of tillers/plant.

Genetic gains of BRRI dhan91 were achieved in traits: strong stems, stem carbohydrate; chlorophyll content, root systems, late senescence and biomass. The research success lies on: more dry matter yield and very deep green leaf with increased photosynthetic efficiency. As lodging has been protected--a tall plant with more biomass contributed for better partitioning to yields. However, the challenge is that even by increasing tallness, lodging tolerance and dry matter - harvest index (0.33) of BRRI dhan91 could not be increased up to the mark (0.53).

High quality of more dry straw (about 11 t/ha) were produced from tall and robust BRRI dhan91- could be used as quality cattle feed. As like other perennial grasses- biomass characteristics of perennial rice BRRI dhan91 displays many beneficial attributes (green and robust stems during harvest) as energy crop. BRRI dhan91 with C3 plus photosynthetic pathway could be evaluated for efficient and low cost bio-fuel extraction.

A new recombination of major beneficial genes in BRRI dhan91 might enhance photosynthesis, dry matter, grain yield and vegetative propagation ability. This genotype could be a novel gene source of many useful physiological traits. The government could give priority on strategic research for QTL mapping and molecular studies of major physiological traits for improvement of yield and adaptation.

Agriculture Secretary Md Nasiruzzaman emphasized for taking efforts by BRRI to spread BRRI dhan91 in semi deep flooded areas. He suggested for up-scaling of this variety by the participation of farmers, personnel from BRRI and DAE. A sub-project under Delta Plan 2100 of the government could be undertaken by the Ministry of agriculture based on deep water rice farming system model-including BRRI dhan91, fish and duck culture for raising productivity in semi-deep flooded (Boro/Robi crop - DWR/fallow pattern) haor areas.

The writer is a Chief Scientific Officer, Bangladesh Rice Research Institute