Transformation of Plant Physiology Division

The research activities of the plant physiology division are a part of the crop soil water management program area and it is one of the major research division functioning since 1970. This division conducted both basic and applied research and always tries to investigate ‘‘Why and How’’. Studies on growth and development of deep water rice were major research activities of this division during 1970 to 1990. Afterwards, Plant Physiology division conducted research on seedlings age, growth behavior, physiological parameters, photoperiod sensitivity, yield potential of rice plants, N-use efficiency of BRRI varieties and seed physiology. Moreover, this division conducted research on healthy seedling raising technique in Boro season.

Due to changing climatic condition in recent past intensities of different abiotic stresses (salinity, submergence, high temperature, cold and drought) are being increased. As a result, Plant Physiology Division had given emphasis on studying various aspects of abiotic stresses of rice plants for developing stress tolerance rice varieties from 2000 onwards and characterized BRRI gene bank germplasm/ advanced breeding materials towards the development of stress tolerant varieties. Plant Physiology Division has notable contribution on development of abiotic stress tolerance rice variety through physiological characterization of advanced breeding lines. Some BRRI developed abiotic stress tolerant varieties are given below which were identified as stress tolerant by Plant Physiology Division earlier.

Advanced breeding lines	Stress environment	Stress level	Released variety name	Remarks
BR6848-3B-12	Drought	3 weeks	BRRI dhan83	Tolerant at seedling stage
IR77092-2R-B-10	Salinity & Submergence	6-9 dS/m for salinity, 70 cm submergence for 12 days	BRRI dhan78	Suitable for tidal coastal areas of Bangladesh
IR78761-B-SATB1-28-3-24	Salinity	8 dS/m	BRRI dhan73	Tolerant at whole growth period for Aman season
IR82589-B-B-84-3	Drought	3 weeks	BRRI dhan71	Tolerant at reproductive stage for Aman season
BR7100-6-6	Salinity	8 dS/m	BRRI dhan67	Tolerant at reproductive stage for Boro season

IR82635-B-B-75-2	Drought	3 weeks	BRRI dhan66	Tolerant at reproductive stage
IR74371-70-1-1	Drought	14-21 days	BRRI dhan56	Tolerant at reproductive stage
BR7873-5(Nil)-51-HR6	Drought	10-14 days	BRRI dhan57	Drought escaping due to short duration
BR5778-156-1-3-HR14	Salinity	8-10 dS/m	BRRI dhan53	Tolerant at later stage of rice
BR5999-82-3-2-HR1	Salinity	8-10 dS/m	BRRI dhan54	Tolerant at later stage of Aman rice
IR63307-4B -4-3	Salinity	6 dS/m for whole growth period	BRRI dhan47	Very much popular in Southern region (Barisal) for Boro season
BR5828-11-1-4	Salinity	8-10 dS/m	BRRI dhan41	Tolerant at later stage of Aman rice
BR5331-93-2-8-3	Salinity	8-10 dS/m	BRRI dhan40	Tolerant at later stage of Aman rice

Plant Physiology division characterizes rice germplasm for identification of new donors for novel stress tolerance mechanisms for future variety development. Around 2000 germplasm have been screened for different stress tolerance. Among them some promising germplasm are as follows:

Genotype	**Stress environment**	**Stress level**	**Remark**
Acc no. 371, 380, 381, 385, 393, 412, 415, 430, 434,444, 1292,1353, 1434, 1069, 1673, 1630, 1684 and 1819	Drought	Three weeks	Drought tolerant at reproductive stage
Camponi SML, DRR dhan44, HHZ17-DT6-Y1-DT1 and HHZ23-DT16-DT1-DT1	Drought	Three weeks	Using as donor parents for development of drought tolerant variety
Acc no. 97, 102 and 133	Heat	35-38°C for 7 days during anthesis	Heat tolerant at flowering stage
Acc no. 1838, 4096	Submergence	14 days of complete submergence after	Tolerant to 2 weeks under complete submergence.

		transplanting	
Kalo Joma, DGI-349	Submergence	16 days of complete submergence after transplanting	Tolerant to 16 days under complete submergence.
Habigonj Boro –VI, Bhutani dhan, Mineasahi	Cold	Whole growth period	Using as donor parents for development of cold tolerant variety

In 2010, the division started research activities on marker assisted back crossing for development of salt tolerant version of BR11 and BRRI dhan28. Mapping of novel salt tolerance QTLS from Bangladesh coastal Aus rice land race Boilam has done recently. From 2013 marker assisted selection for development of heat tolerant variety are going on. Gene editing technology (CRISPER Cas-9) for improving salt tolerance, blast tolerance and two lines hybrid rice varieties development are ongoing currently.

In 2020, high throughput Phenotyping technique has been introduced in this division for rapid screening of rice genotypes against various abiotic stress. Research on C4 rice has been started recently.

Plant Physiology Division has important contribution in developing crop management technology for farmers. Some technologies developed by Plant Physiology Division are given below:

(1) Healthy seedling raising technique in Boro season at cold prone areas: During cold spell seedbed is covered by transparent polythene sheet with the help of a structure made by bamboo at daytime after 4-6 hours of sun rise to sunset followed by uncovering at night. It increases seedbed temperature inside the cover through green house effect which is used by seedling for better growth. Standing water (3-5cm) in seedbed can reduce seedling mortality due to higher (three times) specific heat of water than soil. Transplanting should be avoided during severe cold spell.

(2) Mitigation of sterility problem of rice: For avoiding sterility problem in short duration (145 days) Boro rice, seed should not be sown before 15 November. Sowing seed of such

varieties on third week of November onwards and transplanting 40-45 days old seedlings would allow to solve the sterility problem

(3) Mitigation of flash flood damage of Boro rice: Flash flood (mid April- May) damage at maturity of Boro rice in Haor areas could be avoided by sowing seed of long duration (160 days) and short duration (145 days) varieties on first week and mid November respectively. Seedling age should not be more than 40 days old. However, Boro rice is submerged at premature stage if early flash flood occurred at last week of March to first week April. It is possible to avoid early flash flood by using short duration (135 days) and reproductive stage cold tolerant rice varieties.

(4) Mitigation of sterility caused by high temperature: Sterility due to high temperature at reproductive stage during Boro season can be avoided by transplanting 40-45 days old seedlings of long duration varieties during first to second weeks of November. Standing water and/ or water spray also help to reduce high temperature stress.

(5) Fertilizer management in T Aman rice after recession of flood water: Rice plants damaged by flood at vegetative stage can recover faster by applying 2nd top dress of urea and all amount of MOP after recession of flood water.

Various kinds of knowledge/ information have been generated by Plant Physiology Division for advancement of science. Some of them are given below:

- BRRI dhan54 was found strong photoperiod-sensitive variety and its relative photoperiod sensitivity (97%) very close to Nizersail (100%). It is most suitable variety for late planting in T aman season.
- Seeding in October should be avoided for escaping cold injury. But when needed to transplant from October seeded seedlings, 55-65 days old seedlings of short duration variety like BRRI dhan28 should be transplanted.
- Rice seedlings from November seeded seedbed can produce more grain yield than October. In the case of November seeding, short duration variety like BRRI dhan28 yielded higher by transplanting 40-50 days old seedlings. While higher yield obtained from BRRI dhan29 with 45-65 days old seedlings.

- During Boro season, critical low temperature is 12-13 °C at agronomic PI and booting stage, while critical high temperature is 28-29 °C. Rice yield is reduced if temperature prevails below or above critical temperature.
- Photosensitive varieties suffer more by flash flood.
- Transpirations rate at flowering stage is relatively much higher than that at tillering stage of plant.
- Grain yield is highly correlated with harvest index and the amount of total biomass production of a variety. Harvest Index played greater role than biomass production in late T Aman cultivation.
- Small leaf area index in rice is a constraint to achieve a high grain yield.
- Rice stem and leaf sheath played the highest role for carbohydrate reserve.
- The grain yield is not affected when water stress occurs at early tillering stage. Water stress at booting stage reduced internode elongation, increased spikelet degeneration and sterility.
- Transplanted seedlings require at least four week for recovery during Boro season if planting is done in January.
- Rice gave higher yield at around temperature of 22 °C during reproductive stage, in the T. Aman season. Grain yield decreased abruptly with minimum temperature below 20 °C at reproductive stage.
- In case of August planting grain yield of transplanted rice was statistically similar with line sowing, while in September planting transplanting method gave higher grain yield.
- Rice yield can be increased by rice -azolla dual culture.