Sink improvement for deep water rice

In India, the number of varieties released for semi deep (41–75 cm) and deep water (> 75 cm) ecosystems up to 2000 is only 44 compared to 84 for rainfed upland and 123 for rainfed shallow water (up to 40 cm)[1]. Out of the 44 varieties only four, viz. Nalini, Amulya, Purnendu and Jitendra have been released by the Central Variety Release Committee (CVRC), while the remaining 40 are by the State Variety Release Committees of different States. The reasons for the slow progress in varietal development for the deep-water ecosystem are: (i) harsh, heterogeneous and unpredictable environment, (ii) wide variability in intra and inter locations, (iii) lack of proper testing facility, (iv) lack of suitable donor and (v) inadequate generation of new materials with wide genetic base[2–4].

Due to lack of suitable high yielding varieties (HYVs) possessing tolerance to submergence and elongation ability with rising water levels and in-built resistance to stem borer and sheath blight, farmers continue to grow low-yielding and low-nitrogen-responsive traditional varieties, mostly land races in these type of ecology. Despite their low yield potentiality, they show stability of performance due to the combination of several desirable traits like tolerance to submergence and elongation ability and hence are preferred by the farming community. Out of the 44 varieties released, 18 have been developed from single cross, four from three-way cross, one through mutation breeding and the rest through pure line selection from land races. The varieties developed for this ecology have narrow genetic base due to limited number of parents used in their ancestry.

Efforts for germplasm improvement for the deep-water ecosystem started in the early seventies at Rice Research Station (RRS), Chinsurah, which was subsequently intensified through different projects like eastern India shuttle breeding programme (International Rice Research Institute; IRRI – ICAR collaboration) started in 1992 and A. P. Cess Fund Scheme (ICAR Project) started in 1997. Through shuttle breeding programme, the F_2s were received from IRRI and exposed to real growing condition for generation advancement, assessment and selection following the method suggested by Mallik *et al.*[5]. As a result, the segregating generations were exposed to several abiotic stresses like drought at vegetative stage, flooding of varying depth and duration at different growth stages and biotic stresses like aquatic weeds, pest and diseases *in situ*[6]. One of the parents used for generating such F_2s was generally a locally adapted variety of eastern India like Sabita, Rajshree or Mashuri. Several promising materials having better plant type and improved sink components have been developed[7,8].

Seven such promising entries, viz. CN1231-10-7-6-1, CN1231-16-3-1-1 (IR 73232: IR57519-PMI-4-1-1-3-1/CN846-6-6//IR58910-202-1-3-2-2), CN1233-31-5-1-1, CN1233-12-1-1 (IR73236: IR588 95-PMI-5-1-3-3/Rajshree//Sabita), IR67 624-CN6-1-1-1 (IR40931-33-1-3-2/IR51 089-65-1-1-3//IR43506-UBN-520-1-3-1-1), IR70242-CN36-10-3-2-1 (Kong Phlouk/IR52555-UBN-3-2-1//Sabita), and IR70418-CN11-26-2-1 (IR66295-71-2/IR67016-45-6-3) along with three checks, viz. Sabita, Purnendu and Jitendra were sown on 15 May 2001 at RRS, Chinsurah. The seeds were germinated after the onset of pre-monsoon shower on 25 May. Water started accumulating in the field after the onset of monsoon on 11 June and remained stagnant till harvest. The maximum water depth was 62 cm on 12 September and 70 cm on 11 October, when the crop was mostly in panicle initiation and flowering stages respectively (Figure 1).

Table 1. Yield and yield attributing characters of newly developed entries for deep-water ecosystem

Characters*	CN1231-10-7-6-1	CN1231-16-3-1-1	CN1233-31-5-1-1	CN1233-12-1-1	IR67624-CN6-1-1-1	IR70242-CN36-10-3-2-1	IR70418-CN11-26-2-1	Sabita (Check)	Jitendra (Check)	Purnendu (Check)	Mean	CD (0.05)
Yield (t/ha)	4.36	3.75	4.43	4.37	4.05	4.68	4.41	3.38	2.21	3.25	3.89	0.74
Effective tiller/plant (no.)	4.0	3.0	4.0	4.0	4.0	3.0	3.0	6.0	5.0	6.0	4.2	1.11
Filled grains/panicle (no.)	261	370	219	297	210	292	313	137	109	217	242.5	68.03
Fertility (%)	78.85	84.28	92.40	66.29	56.30	74.87	79.64	85.09	90.83	61.82	77.04	8.90
PB/panicle (no.)	15	15	14	16	15	15	16	12	11	14	14	1.99
Filled grains on PB (no.)	63	68	79	58	62	72	79	58	54	59	65.20	8.16
Fertility (%) of PB	82.89	90.67	96.34	66.67	77.50	85.71	90.80	92.06	93.10	81.94	85.76	6.76
SB/panicle (no.)	70	83	43	89	71	73	75	31	22	70	62.7	19.5
Filled grains on SB (no.)	198	302	140	239	148	220	234	79	55	158	177.3	63.02
Fertility (%) of SB	77.64	82.79	90.32	66.20	50.51	71.90	76.47	80.61	88.71	56.63	74.20	9.49
PB : SB	1 : 4.67	1 : 5.53	1 : 3.07	1 : 5.56	1 : 4.73	1 : 4.87	1 : 4.69	1 : 2.58	1 : 2	1 : 5	–	–
Filled grains on PB: SB	1 : 3.14	1 : 4.44	1 : 1.77	1 : 4.12	1 : 2.39	1 : 3.05	1 : 2.96	1 : 1.36	1 : 1.02	1 : 2.68	–	–
Test weight (g)	25.80	19.80	31.40	29.40	29.10	30.90	20.50	32.90	32.50	20.00	27.23	4.32
Kernel length (mm)	7.04	5.83	7.46	7.05	7.05	7.32	6.11	7.98	7.60	5.62	6.91	0.67
Kernel breadth (mm)	2.08	2.12	2.24	2.40	2.34	2.36	2.11	2.24	2.33	2.09	2.23	0.21
L/*B* ratio	3.38	2.75	3.33	2.94	3.01	3.10	2.90	3.56	3.26	2.84	3.11	0.38

*PB, Primary branch; SB, Secondary branch; L, Length and B, Breadth.

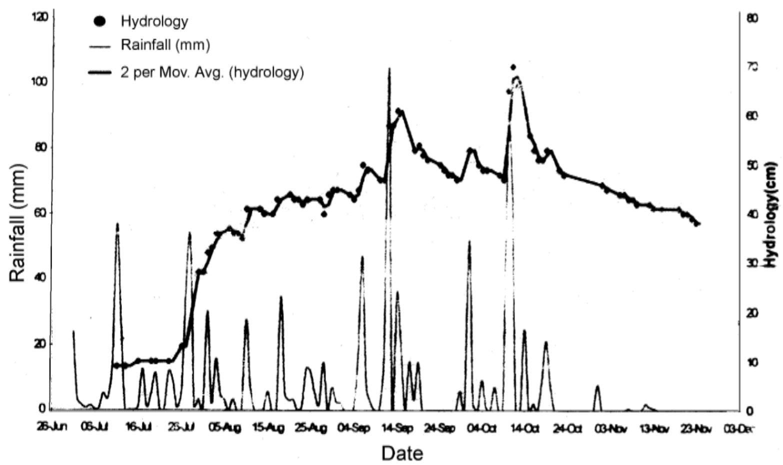

Figure 1. Rainfall and hydrology for advanced breeding material, 2001.

Figure 2 *a–d*. Comparative view of panicles of Sabita and test entries.

Each entry was represented by 20 m^2 plot with three replications. Tillers were tagged after emergence. At maturity, 30 panicles from primary tillers of each entry in each replication were harvested for study of sink components and for yield 5 m^2 areas were harvested for each entry from each replication. The entries were again sown during *kharif* 2002 (wet season) following the same method and the hydrology was almost similar to that shown in Figure 1. Mean data for two years are presented in Table 1.

Sabita and Purnendu are the national checks for semi deep-water ecosystem, while Jitendra is the only deep-water variety released by CVRC. Two lines each of CN 1231 and CN 1233 were selected from IRRI F_2s – IR 73232 and IR 73236 respectively. The mean number of filled grains per panicle was more than 300 in CN1231-16-3-1-1 and IR 70418-CN11-26-2-1 compared to 137 in Sabita and 217 in Purnendu. All the test entries had more number of primary branches (PB) and secondary branches (SB) in the panicles to support more number of grains compared to the checks. Though the fertility percentage was higher in CN1233-31-5-1-1 (92.40%), the number of filled grains per panicle was highest in CN1231-16-3-1-1 (370), which is more important for higher yield. The mean fertility percentage on PB was higher (85.76) than that on SB (74.20). Figure 2 *a–d* represents the comparative view of panicles collected from the main culms of Sabita and the seven test entries.

The test weight (1000 grain weight) of the entries varied from 19.80 g for CN 1231-16-3-1-1 to 32.90 g for Sabita. Out of the seven test entries, four had long slender grains with the *L*/*B* ratio of kernel more than 3 and the remaining three had medium-slender grains. There is an increasing demand for varieties with improved grain quality, preferably medium-slender to long-slender grain types which are sold at a higher price. Therefore, the elite lines identified, which combine high yield with better grain type are likely to be accepted by the farmers.

The new cultures identified through evaluation test are semi tall (140–145 cm), with moderate tillering ability (3–4 effective tillers per hill), possess stiff straw and have high yield potentiality (3.75–4.68 t ha^{-1}), while the present deep-water varieties like Sabita, Purnendu and Jitendra are tall (170–180 cm), susceptible to lodging and have low yield potential

($2.21–3.38\ t\ ha^{-1}$) with inferior sink capacity. The entries are being multiplied for nomination to the national programme for wide testing.

They have diverse genetic base involving 15 to 20 different parents from various countries like India, Thailand, Sri Lanka, Cambodia, Vietnam and Myanmar. They also possess resistant genes inherited from *Oryza nivara* and many useful genes for biotic, abiotic stresses and superior grain quality from different land races. For example, IR 73232 has a parent like Khao Dawk Mali, Benong, Pa Chiam, Bhasamanik, Fortuna, FR 13A, Arikarai, Milek Kunning and Mudgo; IR 73236 has Gam Pai, Tadukan, Vellaikar, Kitchili Samba, Tsai Yuan Chung and Marong Paroc as parents; parents like Arikarai, Niaw Sampatong, Eravapandi, Seraupbesar 15, Tetep, Cina and Latisail are included in IR 67624; IR 70242 has land races like Kong Phlouk, Rathu, Heenati, Marong Paroc, Sinawpagh, Nahng Mon S4, Tsai Yung Chung, Thekkan, Eravapandi, Cina and Latisail in its parentage and land races like Basmati, CRM6, Chow Sung, Seraupbesar 15, Mudgo, Slo 17, Gam Pai 15 and improved Sabarmati were found in the ancestry of IR 70418.

IR 36 is the most adapted, stable and successful variety developed at IRRI for irrigated ecosystem and grown widely in many rice-growing countries by virtue of its wider genetic base, inherited from 18 different parents from 11 countries. Therefore, it is not surprising to note that the promising cultures identified during the present investigation with inherent high yield potential due to increased sink capacity and diverse genetic base, are expected to show greater adaptability and stability of performance under varied heterogeneous, harsh and unpredictable environments of deep-water ecology. Future breeding programmes for any unfavourable ecosystem may follow this direction.

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Spongy tissue in Alphonso mango – significance of *in situ* seed germination events

Alphonso, the most delicious variety of mango (*Mangifera indica* L.) known for its excellent texture, taste and aroma, accounts for nearly 60% of the mango export trade from India. However, the export trade is plagued by incidence of a physiological disorder known as 'spongy tissue' (internal breakdown), characterized by unripe, acidic, pale yellow/white, corky tissue with or without air pockets associated with an unacceptable off-flavour in certain regions of the mesocarp (pulp) adjacent to the endocarp (stone). Fruits affected by this disorder do not show any external symptoms and the malady is detected only after cutting the fruits open, posing a challenge for quality control in export. Spongy tissue occurrence is more prevalent in the coastal Konkan region of Maharashtra, the natural habitat of this variety, than in other inland regions of India[1].

Extensive investigations have been carried out over the past five decades to understand the cause of this disorder, without success[2,3]. The reasons attributed to the incidence of this disorder include factors as diverse as ecological, nutritional, environmental, microbial, physiological and biochemical. However, the problem has remained unsolved since all these studies were confined to measuring the effects rather than the cause of the malady. Past investigations on the physiological and biochemical aspects confined to the fruit mesocarp failed to provide any clue on the nature of the malady. Our preliminary observations revealed that spongy tissue incidence was closely associated with physiological status of the seed during fruit maturation. The seed from spongy-tissue-affected fruits showed faster and higher rate of germination, while a small percentage (2) of fruits even exhibited vivipary. Incidentally, flesh breakdown in mango cv. Tommy Atkins that is similar to spongy tissue in Alphonso mango, was attributed to the disconnection of vascular strands (funiculus) between peduncle and endocarp (stone), even while the fruit was attached to the tree, making it dependent on the mesocarp for its supplies[4]. This led us to believe that the seed could play a key role in spongy tissue formation, thus making a paradigm shift from the earlier thinking.