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Susmita Gogoi
Subject Matter Specialist, Krishi Vigyan Kendra, Simen Chapori, Dhemaji, Assam, India

Gunjan Gogoi
Senior Scientist and Head, Krishi Vigyan Kendra, Simen Chapori, Dhemaji, Assam, India

Papori Bora
Research Associate, APART, Krishi Vigyan Kendra, Simen Chapori, Dhemaji, Assam, India

Rekhamoni Gogoi
Subject Matter Specialist, Krishi Vigyan Kendra, Simen Chapori, Dhemaji, Assam, India

Neelakshi Bhuyan
Subject Matter Specialist, Krishi Vigyan Kendra, Simen Chapori, Dhemaji, Assam, India

Manoranjan Neog
Director of Extension Education, Assam Agricultural University, Jorhat, Assam, India

Corresponding Author:
Susmita Gogoi
Subject Matter Specialist, Krishi Vigyan Kendra, Simen Chapori, Dhemaji, Assam, India

Farmer's participatory varietal evaluation for growth and yield attributing traits of sali paddy varieties in Dhemaji district of Assam

Susmita Gogoi, Gunjan Gogoi, Papori Bora, Rekhamoni Gogoi, Neelakshi Bhuyan and Manoranjan Neog

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Abstract
A participatory varietal selection trial on winter Rice (*Oryza sativa* L.) was conducted at farmer's field of Dhemaji district of Assam with an objective to identify high yielding promising rice varieties suitable for marginal soils and farmer's interests during Sali season 2022. Four submergence tolerance high yielding winter rice varieties (STRV) along with six local varieties were laid out in randomized complete block design (RCBD) with three replications. Data on various growth and yield parameters revealed that STRV Swarna sub1 produced highest number of grains per panicle (200.00) with filled grain percentage (98.10%), spikelet fertility (96%), grain yield (5.10 t/ha) and harvest index percentage (20.82%). The number of panicles per meter square was highest in STRV Bina dhan11 (445) and the lowest in Bora dhan (148.00). The STRV Ranjit sub1 produced the highest length of panicle (28.33 cm) and total biomass at harvest (26.72 t/ha). All the STRV's and Bas dhan were semi dwarf in nature and non-lodging. The STRV Bina dhan11 and Bas dhan were short duration varieties (120 days physiological maturity) and other eight varieties were long duration varieties (150-155 days). On participatory varietal evaluation, farmers preference score was found maximum in STRV Ranjit sub1 which signifies this variety has some traits (length of panicle, total biomass at harvest) of farmer preference.

Keywords: STRV, participatory varietal selection, promising varieties, RCBD, preference score

Introduction
Rice (*Oryza sativa* L.) is an important staple food of more than half of the world population. It is dominantly produced and consumed in the Asia. *Oryza sativa* L. belonging to Family *Poaceae*, Sub-family *Oryzoideae*, tribe Oryzae with chromosome number 24 i.e. 2n = 24. Rice ranks third most staple crop after Maize and Wheat in world in terms of production (Hussain *et al*. 2014) [5]. Since the beginning of civilization, thousands of rice cultivars have been selected for increasing productivity (Singh *et al*., 2000) [10]. Paddy production generates employment of about 3.5 billion mandays and contributes about 10% to Agricultural GDP in the country (Kumar *et al*., 2018) [9]. Manipulation of genetic resources has contributed much towards meeting rising demands of food for ever escalating world population. The agricultural production and productivity depends largely on the quality of land and sustainable practices and a balance between efficient and productive agricultural enterprise and environmental protection and sustainability is important to make agriculture sector an economically viable venture (Yadav *et al*., 2013) [12]. In late 1960s "Green revolution" boosted yield of cereal crops including rice by the utilization of high yielding short statured varieties with high sink capacity. The impact of green revolution is diminishing due to rising demands of food commodities. The area under rice cultivation is same but population has become manifold. The options available are to enhance yield of rice on per unit area basis (Cassman *et al*., 2003) [2] and development of rice cultivars with high yielding ability which can increase production (IRRI, 1993) [6]. Producing varieties having resistance against biotic and abiotic stress by using conventional and modern biotechnology can increase rice yields to meet world requirement (Khush, 2005) [8].

Rice production has so far kept pace with the growing population, principally due to cultivation of high-yielding, high-input demanding, and semi-dwarf varieties (Gnanamanickam, 2009) [4]. Rice is the world's leading food crop, cultivated over an area of about 161.1 mha (2016–17) with a production of about 480.13 mt. According to the forecast, the government of India has revealed that 2015–16 *kharif* rice production was at around 90.6 mt. Further, it has been stated that total rice planted area 2015–16 *kharif* rice crop stood at around 36.841 mha. It is the most important food crops of India covering over ¼ of the total cropped area (Jamir and Gohain, 2017) [7].

Yield of rice can be enhanced by improving fertilization, irrigation management and good pest and disease control. Genotype of a crop has a decisive role towards utilization of these resources and finally production of economic yield. Growth and yield characteristics of genotypes depend on genetic and environmental factors. (Alam *et al*. (2008) [1] reported that among production factors varietal selection at any location has an important role. For successful crop production knowledge of varietal morphological and physiological characteristics is necessary. Therefore, Participatory varietal selection facilitates development of varieties suitable for marginal soils and farmers' interests. Farmers became a part of the variety/genotype selection and testing process in order to incorporate their preferences, which were crucial for the large-scale adoption of the selected variety/genotype (Subedi *et al*. 2018) [11]. The objective of present study was to compare the growth and yield characteristics of different rice varieties under conditions of Dhemaji, Assam and participatory selection of promising rice genotypes to study the genetic variability, character association between yield traits and farmer preference analysis helps in development of best rice varieties for the agro-climatic conditions of the district.

Materials and Methods

The experiment was carried out during *kharif*, 2022 at the farmer's field of Dhemaji district of Assam. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experiment was laid at three different locations i.e., Dhemaji, Dimow and Simenchapori of the district and served as three replications. Each plot consisted of ten varieties randomized and replicated within the Block. The plot size of each variety was 200 m^2 (10m x 20 m) and the total area of one Block was 2000 m^2 (200 m^2x 10 variety). Each variety with the block was separated by 1 meter walking path. Channel of Irrigation of 1 meter also there to provide water during the dry season (Fig.1). For preparation of nursery bed field was puddled twice at an interval of 7 days to destroy germinated rice seeds, weed seeds or any other crop seeds. Seed bed of 15 cm height, 1.50 m width and of convenient length with channels of 0.60 m width in between the seedbeds for irrigation and draining out the excess water was prepared for ten varieties. For transplanting a variety in a block of 200m^2 an area of 20m^2 of seed bed was prepared for each variety. At a rate of 40 kg/ha or 4g/m^2, a total of 800 g seed was sowed for each variety to be transplanted in a total area of 200m^2. Long duration varieties *viz*. Ranjit sub1, Bahadur sub1, Swarna sub1, Joldubi, Boga dhan, Bor dhan and Jahingia were sown in last week of Jun 2023 and two short duration varieties *viz*. Bina dhan11 and Bas dhan were sown in 1st august 2022.

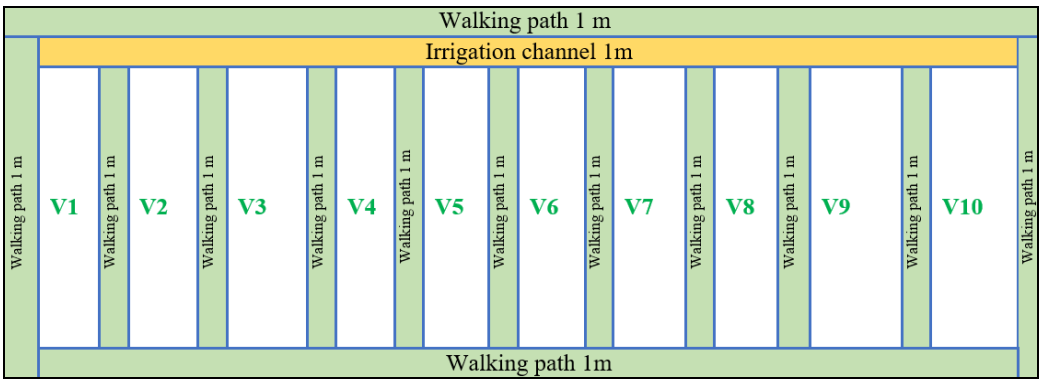

Fig 1: Diagrammatic presentation of experimental plot

The seedlings of long duration varieties after 33 days of sowing were transplanted at a depth of 4-5 cm and a spacing of 20 cm between the row and 20 cm within the row. Seedlings of 21 days of short duration varieties STRV Bina Dhan 11 and local variety Bash Dhan was transplanted with a spacing of 20 x20 cm with a 25 days gap between both long and short varieties to achieve synchronous flowering or maturity at the same period. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop.

Preference analysis through casting votes was conducted when most variety reached around 80% maturity after full maturity/ripening all the 10 varieties were harvested and a participatory varietal evaluation programme was organized among farmers to evaluate the farmer's preference variety based on yield and growth parameters. At first, we collected the farmer basic information and explained the protocol and introduced them with layout. Each plot was provided with bag for collecting ballots. Farmers explained their choices and voted accordingly. Farmers were provided with ten ballots to vote for five best and five worst lines.

The best vote denotes the superior characters possessed by the genotypes to fit under local conditions while worst denotes the inferior character (Dhungana *et al*, 2022) [3]. Then preference score for men and women was computed independently from counted positive and negative ballots collected in each ballot box. Independent count was because of men and women may have common and different varietal preference and needs based on gender roles and socio-economic status. Therefore, their opinions should be considered in varietal improvement. Preference Index was calculated by

$$\text{Preference Index} = \frac{(\text{Total positive votes}) - (\text{Total negative votes})}{\text{Total votes caste}}$$

The data on both yield and growth parameters were recorded and were subjected to ANOVA as an randomized block design and preference analysis was done on CGIAR model (CIAT, 1993).

Results and Discussion

Growth attributing character: The study on plant height and tiller's numbers revealed that STRV Bina dhan 11, Ranjit sub 1, Bahadur sub 1, Swarna sub 1and local *Bas dhan* are semi-dwarf and nonlodging in nature whereas local varieties *Joldubi*, *Boga Dhan*, *Bor dhan*, *Bora dhan* and *Jahingia* are taller and prone to lodging (Table 1). The numbers of tillers per plant as well as per meter square was the highest in Bina dhan 11(456.00) followed by *Bas dhan* (444.00) and Ranjit sub 1(369.00). The lowest no. of tillers per plant per meter square was in *Bora dhan* (155.00) followed by *Boga dhan* (192.00).

Table 1: The plant height and tiller's number of selected ten (10) sali rice varieties

Variety code	Variety Name	Plant height(cm)	No. of tillers/m2
V1	Bina Dhan 11	72.33	**456.00**
V2	Ranjit sub 1	113.00	369.00
V3	Bahadur sub 1	98.67	304.00
V4	Swarna sub 1	90.67	280.00
V5	*Bas dhan*	63.00	444.00
V6	*Joldubi*	175.33	330.00
V7	*Boga dhan*	154.00	192.00
V8	*Bor dhan*	128.00	297.00
V9	*Bora dhan*	120.00	155.00
V10	*Jahingia*	121.67	320.00
	Mean	113.67	314.70
	SD (P)	32.81	90.60
	SEM	10.95	30.20
	CV (%)	28.87	28.78

Yield and yield attributing character

The number of panicles per meter square was recorded the highest in Bina dhan 11 (445.00) followed by *Bas dhan* (430.00) which was the lowest in *Bora dhan* (148.00) and *Boga dhan* (184.00) considered as yield attributing character (Table 2). But the length of the panicle was recorded the highest in Ranjit sub 1(28.33 cm) followed by *Joldubi* (25.33) and *Jahingia* (25.00) and the lowest in *Bas dhan* (19.67). The number of grains per panicle was highest in Swarna sub 1(200.00) followed by Bahadur sub 1 (199.33) and Ranjit sub 1(199.00) and was lowest in *Jahingia* (90.00). The filled grain percentage was the highest in Swarna sub 1 (98.10) followed by Bahadur sub 1 (97.16) and the lowest in *Joldubi* (90.01). Similarly, the percentage of spikelet fertility was found highest in Swarna sub 1 (96.00) followed by Ranjit sub 1(94.00) and lowest in *Joldubi* (74.00). Whereas, the test weight or weight of 1000 grain was the highest in *Bor dhan* (23.00g) followed by Swarna sub 1(22.00g) and *Joldubi* (22.00g) and was lowest in *Bora dhan* (18.00g). Finally, the grain yield was recorded the highest in Swarna sub 1 (5.10 t/ha) followed by Bahadur sub1 (4.90 t/ha), Ranjit sub1 (4.45 t/ha) and Bina dhan 11(4.40 t/ha) and was the lowest in *Bora dhan* (3.20 t/ha). The total biomass at harvest was highest in Ranjit sub 1 (26.72 t/ha) followed by Swarna sub1 (24.50 t/ha) and was lowest in *Bas dhan* (21.45 t/ha). The harvest index percentage was highest in Swarna sub 1 (20.82%) followed by Bahadur sub1 (20.68%) and was lowest in *Bora dhan* (14.12%).

Table 2: Yield and yield attributes of selected ten (10) sali rice varieties.

Variety code	Variety Name	Panicle per sq. m (Nos)	Length of panicle (cm)	Grains per panicle (Nos)	Filled grain (%)	Spikelet fertility (%)	Test wt.1000 grain wt.(g)	Grain yield (t/ha)	Total biomass at harvest (t/ha)	Harvest Index (%)
V1	Bina dhan 11	**445.00**	21.67	186.67	95.17	89.00	21.00	4.40	22.32	19.71
V2	Ranjit sub1	360.00	**28.33**	199.00	96.64	94.00	19.00	4.45	**26.72**	16.65
V3	Bahadur sub1	295.00	22.00	199.33	97.16	92.00	21.00	4.90	23.70	20.68
V4	Swarna sub1	300.00	23.00	**200.00**	**98.10**	**96.00**	22.00	**5.10**	24.50	**20.82**
V5	*Bas dhan*	430.00	19.67	167.00	93.41	89.00	19.00	3.60	21.45	16.78
V6	*Joldubi*	320.00	25.33	190.00	90.01	74.00	22.00	3.60	22.66	15.89
V7	*Boga dhan*	184.00	24.00	193.67	90.11	93.00	21.00	3.50	22.31	15.69
V8	*Bor dhan*	288.00	21.67	113.33	96.17	90.00	**23.00**	3.40	23.53	14.45
V9	*Bora dhan*	148.00	23.67	195.00	92.93	81.00	18.00	3.20	22.66	14.12
V10	*Jahingia*	307.00	25.00	90.00	93.70	92.00	19.00	3.60	22.82	15.78
	Mean	307.70	23.43	173.40	94.34	89.00	20.5	3.98	23.27	17.06
	SD (P)	88.37	2.30	37.37	2.67	6.30	1.56	0.64	1.40	2.49
	SEM	27.97	0.73	11.83	0.84	1.99	0.49	0.20	0.44	0.78
	CV (%)	28.72	9.82	21.55	2.83	7.08	7.61	16.10	6.02	14.82

Farmer Preference analysis

The preference score of ten (10) sali rice varieties through the participatory varietal evaluation was studied (Table 3). The male positive preference score was highest in Ranjit sub1(20) and the female positive preference score was highest in Swarna sub1(12) due to high yield, spikelet fertility, length of panicle, total filled grain, submergence tolerance, nonlodging characteristics and total biomass at the time of harvest. The male negative preference score was highest in *Bora dhan* and the female negative score was highest in *Boga dhan* and *Bor dhan* (9) due to low in yield and all other yield attributes. The preference index was highest in Ranjit sub1 (0.0628) and ranked 1 followed

by Swarna sub 1 (0.0342) ranked 2, Bahadur sub 1 (0.02) ranked 3 and both Bina dhan 11 and *Bas dhan* (0.0114) occupied rank 4 in preference ranking. The preference scores were negative in all other long duration local rice varieties and which was the lowest in *Bor dhan* (-0.0484) ranked 9. However, though the grain yield was maximum in Swarna sub 1 but the preference index was highest in Ranjit sub 1 on participatory varietal selection which may be due to appreance of the grain. From the study on yield attributes, yield and preference analysis it was observed that the performance of four high yielding submergence tolerant varieties Swarna sub 1, Ranjit sub 1, Bahadur sub 1 and Bina dhan 11 were higher than the local rice varieties.

Table 3: The preference ranking of tested varieties

Variety code	Variety Name	Positive		Total	Negative		Total	PI**	Rank
		Male	Female	PS*	Male	Female	PS		
V1	Bina dhan11	11	7	18	8	6	14	0.0114	4
V2	Ranjit sub1	20	8	28	4	2	6	0.0628	1
V3	Bahadur sub1	15	8	23	8	8	16	0.02	3
V4	Swarna sub1	12	12	24	8	4	12	0.0342	2
V5	*Bas dhan*	15	6	21	14	3	17	0.0114	4
V6	*Joldubi*	15	3	18	12	8	20	-0.0057	5
V7	*Boga dhan*	8	2	10	12	9	21	-0.0314	7
V8	*Bor dhan*	6	4	10	18	9	27	-0.0485	9
V9	*Bora dhan*	8	5	13	20	5	25	-0.0342	8
V10	*Jahingia*	5	5	10	11	6	17	-0.02	6
	Total Ballots	115	60	175	115	60	175		

*Preference Score; ** Preference index

Conclusion

The present study concluded that the selection of proper variety is possible through directly participation of the farmers and could be done within the season. Also, the results here provide very good evidence that involving farmers in the selection stage of variety development would prove effective and efficient in identifying farmer preferred varieties to replace the old varieties. Farmers are the end users of a variety, so the decision of the farmers while judging the variety should be given due consideration because widespread adoption of the variety is in fact determined by the farmers' willingness to grow the variety. Swarna sub1 is the highest yielding Sali rice variety and Ranjit sub1 is the farmers 1st preferred and 3rd high yielding Sali rice variety. In this way we can conclude, Farmer not only focus on grain yield but also on maturity days, submergence characteristics, lodging characteristics, plant performance and other yield components. As a researcher, we found that the four high yielding and submergence tolerant Sali rice variety *viz*. Swarna sub1, Ranjit sub1, Bahadur sub1 and Bina dhan11 are suitable to the soils and weather condition of the district and also having other growth and yield traits of farmer's interest.

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