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Research Article

Evaluating the Role of Fertilizer and Seed Soaking on Direct Seeded *Aus* Rice Varieties

Sushan Chowhan* and Kamrun Nahar

Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh

***Corresponding Author:** Sushan Chowhan, Adaptive Research and Extension Division, Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh.

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Abstract

Using conservation agriculture strategies is time demanding as intensive crop cultivation has already been started to feed the ever-growing population. Rice requires extensive resources for production. To preserve agroecosystem and sustain rice production it is imperative to consider soil and environmental health. Direct seeded rice (DSR) is a promising technology for rice cultivation which needs less input and resources. *Aus* season of Bangladesh is highly favorable for DSR cultivation. Being a new technology, farmers' lack enough information and knowledge on production technology of direct seeded *aus* rice. Taking into account, the present investigation was implemented to assess the response of some modern *aus* varieties, fertilizer doses and seed soaking methods on the yield attributes under DSR. The experiment was laid in factorial RCBD. Three factors considered in the experiment were- variety, fertilizer dose and seed soaking. Rice varieties chosen were- Binadhan-19 (V_1), Binadhan-21 (V_2), BRRI dhan82 (V_3) and BRRI dhan85 (V_4). Fertilizer doses (% of recommended) were- 80% NPKSZn (T_1), 100% NPKSZn (T_2) and 120% NPKSZn (T_3). Seed soaking methods were dry seeds directly sown without any soaking (S_0) and seeds sown after hydro soaking for 24 hrs (S_{24}). Data on yield and morpho physical attributes were collected randomly from five hills at final harvest. Outcomes revealed, longest panicle in $V_3 \times T_1 \times S_{24}$ (27.14 cm), treatment $V_4 \times T_1 \times S_0$ had most filled grains (236.96) and $V_4 \times T_2 \times S_0$ had least amount of filled grains (101.24) per panicle. Highest grain sterility was observed with $V_2 \times T_3 \times S_0$ (48.17%) and the lowest with treatment $V_4 \times T_1 \times S_0$ (27.40%). Lightest thousand grain weight (TGW) was found in $V_2 \times T_2 \times S_{24}$ (19.59g); whereas, it was 17.45% more in treatment $V_1 \times T_2 \times S_{24}$ (23.73g). Grain yield was maximum with treatment combination $V_4 \times T_1 \times S_0$ (4.78 t/ha) followed by a 7.17% reduction in $V_2 \times T_3 \times S_0$ (4.46 t/ha) and 64% decrease with $V_4 \times T_3 \times S_{24}$ (1.72 t/ha). Late harvesting was seen in $V_4 \times T_3 \times S_{24}$ (112.67 days); while $V_1 \times T_2 \times S_0$ was the earliest (95.00 days). Above findings imply that, BRRI dhan85 and Binadhan-21 might be better with yields in dry-DSR without soaking; but balanced use of fertilizers should be ensured in order to avoid higher grain sterility and yield reduction.

Keywords: Direct Seeded Rice; *Aus*; Binadhan; Seed Soaking; Hydro Soaking; Fertilizer Management

Introduction

Geographical, soil and climatic conditions of Bangladesh permits year-round production of rice. More than half of the country's total population lives in rural area permitting involvement in agriculture and crop related activities. Rice is the common produce in the village area and the market economics is also greatly influenced by this crop. Rice is grown thrice a year in Bangladesh depending on area, land type and season; among them *aus* rice is (one of the rice growing season) cultivated during the dry period (kharif) of the year (March to June) which is mostly rain dependent and requires less fertilizer and irrigation. Though, *aus* rice needs less input but its cultivation is low in terms of land area due to low yield, more pest infestation, unavailability irrigation water [1], long drought periods etc. Besides, market price of rice is very unstable which often creates a scope for less profit to the growers. Earning more profit and reducing production related cost is impossible without applying new technologies of modern crops cultivation [2].

Direct seeded rice (DSR) cultivation is the latest and cost saving technology for *aus* rice cultivation. It's the way of broadcasted sowing or drilling or dibbling of dry or soaked (pregerminated) seeds directly in to the dry or wet or standing water soil surface [3,4]. There are three types of direct seeding system i.e. dry DSR, wet DSR and water seeding [5]. Conventional tillage transplanted rice (CT-TPR) requires more water (up to 40% of the total water for crop production) to prepare land, many labors (25 people ha^{-1} day^{-1}), high amount of fertilizers, pesticides, and have negative effects on soil and environment [6,7]. DSR is a type of conservation agriculture that ensures minimized disturbance of soil, flora, fauna, ecosystem, favors crop rotation and soil cover through crop residues [8]. Additionally, this type of cultivation ensures judicial water use, aids crops against drought, emits less methane [9], prevents plough pan formation in sub-soil [10], easy and time saving, reduces crop duration [11], conducive to mechanization [12] and also increase yield than CT-TPR [13], Besides, farmers can save 56% human labour, 73% machine labour and 25% irrigation water than CT-TPR; thus, DSR can enhance economic earning and save natural resources [14]. TPR and DSR yield increase against DRR (drum seeded rice) were 21.1 and 16.8 percent, respectively. But maximum net return and return per rupee financed were obtained by DSR. [15]. On the other hand, system of rice intensification (SRI) method has higher yield, less seed requirement for seedling and moderate water savings (50%) but it is mostly adapted for rainfed rice as well as wheat, sugarcane and teff crops [16]. SRI was highly successful rice establishment technique in terms of nutrient absorption, usage efficiency and improvement of soil chemical and microbiological properties [17]. Despite many advantages of SRI; farmers preferred DSR due to less labor requirement, minimal special care, management and low costing. Plot selection and preparation, good crop establishment, precise weed, water, pest and fertilizer management are the key prerequisites for successful DSR [6]. Development of short duration, high yielding, water saving, low fertilizer requiring modern *aus* rice varieties along with different integrated approaches of mechanization, pest management and finally cost saving techniques has drawn farmers' interest towards adoption of DSR now a days [18]. During 2019, national total land area under rice production was 1,15,16,553 ha and average milled equivalent yield was 3.16 t/ha [19]. Whereas, the total *aus* production was limited to 27,06,320 ha during 2019-20 [20]. In 2020 Pabna district, produced 29,870 tonnes *aus* rice from a land of 11,910 ha bearing a mean yield of 2.51 t/ha. So, it's clear that yield of *aus* rice is much lower than the national average rice yield. Ishurdi upazila has limited *aus* coverage where suitable land area is about 2,083 ha [21]. Among the *aus* grown rice varieties approximately 85% are modern and 15% are traditional [22].

Yield in DSR is generally less than TPR because of poor crop establishment, higher grain sterility and pest infestation [23]. Moreover, due to imbalanced macro and micro nutrient fertilization management as well as high infiltration rates in DSR reduces overall yield [24]. Therefore, priming (soaking in water) is a major operation in DSR. As seeds are sowed directly, if the seeds are soaked in water up to a certain time it might assist in rapid germination and crop establishment in the field. Presently *aus* farmers do not apply all the recommended agronomic management during DSR cultivation thus they face enormous problems and that ultimately results in poor yield of the modern varieties. Taking these problem(s) in mind the present investigation was implemented to unveil the role of different fertilizer dose with priming application in the seeds of modern *aus* rice varieties and to suggest appropriate management strategy to the *aus* grower community.

Materials and Methods

Experimental site

This trail was conducted during the kharif season of 2020 at BINA Sub-station farm, Ishurdi, Pabna. It was under Agro Ecological Zone (AEZ) 10. Soil of this region is moderately fertile containing low amounts of organic matter having higher cation exchange capacity and lack in N, P, K, B and Zn [25]. An overview of different weather parameters throughout the experiment period is shown in figure 1 and figure 2.

Figure 1: Rainfall and Temperature status during the study period of 2020. (Source: PRC [26]).

Figure 2: Sunshine and Relative humidity data of the trial site at 2020. (Source: PRC [26]).

Crop management

Experimental plot was tilled with power tiller to make the soil loose enough. Debris and weeds were collected and cleaned from the whole plots. Later the plot was levelled with ladder and individual treatment plots were prepared which consisted a size of 2m × 2m i.e. 4m^2 area of a unit plot. As this was a dry DSR experiment thus, seeds were line broadcasted in *joe* (containing enough soil moisture to germinate seeds) condition. Recommended fertilizer dose (Kg/ha) was N= 96, P= 12, K= 60, S= 9 and Zn= 1.40 respectively. Full dose of TSP, Gypsum, Zinc, 1/3rd of MoP was applied as basal dose followed by harrowing. Later 1/3rd of urea, 1/3rd of MoP was applied at 10-12 DAE (days after emergence). Rest 1/3rd of urea and MoP at 25-26 DAE and remaining urea was applied at 36-38 DAE [27,28]. 40g seeds (100 kg/ha) were line broadcasted in each plot (4m^2). After completion of sowing and experiment set, pre-emergence weedicide "Pendimethalin" (Trade name: Nirani plus 33 EC; East west chemicals ltd.) was sprayed at a rate of 3ml/L [29] on next day i.e. 2 DAS (days after sowing). Few hours after spray a light irrigation was given on the next day so that soil does not dries completely. At 20 DAS, Bispyribac sodium (Prune 20WP, Auto Crop Care Limited) + Ethoxysulfuron (Sunrise 150 WG, Bayer CropScience Limited) was combinedly (20g + 10g) sprayed at a rate of 1.5g/L [30,31]. To prevent yellow stem borer infestation Virtako 40 WG (Syngenta Bangladesh Limited) was applied with during the 2nd and 3rd dose of urea application as per the procedure followed by Chowhan., *et al.* [32]. Hand weeding was done two times (35 DAS and 60 DAS) as per the methods described by Ahmed., *et al.* [33], Ahmed and Chauhan [34]. An outline of the experimental plot(s) is displayed in figure 3 and figure 4.

Experimental design

A factorial Randomized complete block design (RCBD) with three replicates was followed to set the experiment. Details of the factors and treatments are mentioned below—

Factor (A): Variety (4)-

V_1= Binadhan-19, V_2= Binadhan-21, V_3= BRRI dhan82, V_4= BRRI dhan85

Factor (B): Fertilizer dose (3) (Kg/ha)-

T_1= 80% recommended NPKSZn (Urea 167.2, TSP 47.432, MoP 64.26, Gypsum 26.66, Zn 3.10)

T_2= 100% recommended NPKSZn (Urea 209, TSP 59.29, MoP 80.32, Gypsum 33.33, Zn 3.88)

T_3= 120% recommended NPKSZn (Urea 250.8, TSP 71.15, MoP 96.38, Gypsum- 40, Zn- 4.66).

Factor (C): Seed soaking (2)-

S_0= Dry seeds (without soaking), S_{24}= Soaking for 24 hrs.

There were 72 treatment combinations thus comprising total 72 unit plots in three replicates.

Observations and analysis

Data on morpho physical and yield attributes were collected at final harvest. Randomly plants were selected from 5 hills and the following data were recorded on- Days to 50% emergence, Days to 90% emergence, Plant population per unit plot (4m^2), Days to 1st flowering, Days to 50% flowering, Days to 90% flowering, Plant height (cm), Number of tillers/hill, Number of non-effective tillers/hill, Number of panicles/hill, Panicle length (cm), Panicle weight (g), Root length (cm^2), Number of filled grains/panicle, Unfilled grains/panicle (%), 1000 grain weight (TGW) (g), Grain yield (t/ha), Straw yield (t/ha) and Days to harvest. Plant population were recorded through hand counting and flowering data were collected from eye observation. Grain yield was adjusted at 14% moisture content to convert the total yield (t/ha). After harvesting the total unit plot straws were sundried till it's color turned yellow and then weighed to calculate the straw yield (t/ha). After that, all gathered data were statistically separately analyzed with ANOVA (analysis of variance) technique through Statistix 10 software [35]. Significance of mean difference was compared by LSD (least significant difference) test [36,37] at 5% level of probability.

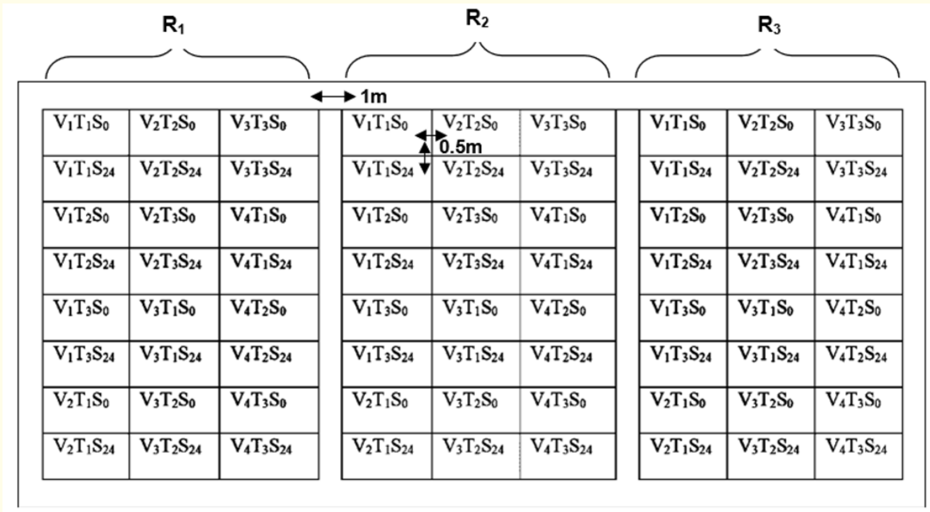

Figure 3: Field layout of the experiment.

Figure 4: Field view of the DSR experiment with individual treatment (yellow lettered) plots at vegetative stage.

Results and Discussion

Days to emergence

Significant deviations were observed in terms of seedling emergence within various treatments (Table 1 and Table 2). With varietal and fertilizer effect, maximum days to 50% (13.5 days) and 90% (18.67 days) emergence was noted with treatment $V_4 \times T_3$. Contrary, least days to 50% (9.33 days) and 90% (14.33 days) emergence was seen with the treatments $V_2 \times T_2$ and $V_1 \times T_1$.

Effect of variety and soaking methods exhibited that, treatment $V_4 \times S_{24}$ took most days to 50% (12.11 days) and 90% (17.67 days) emergence. Whereas, earliest emergence (50% and 90%) was noticed with treatment $V_1 \times S_0$ (9.78 days and 14.44 days).

In case of fertilizer dose and soaking method impact, highest days to 50% (12.17 days) and 90% (17.42 days) emergence was spotted with $T_3 \times S_{24}$. While, treatment $T_2 \times S_0$ emerged in advance in case of 50% (10.00 days) and 90% (14.92 days).

Interaction effect of variety, fertilizer and soaking method demonstrated that, $V_4 \times T_2 \times S_{24}$ treatment had late emergence for 50% (14.00 days) and 90% (20.67 days) than other treatment combinations. Conversely, earliest days to 50% (8.33 days) and 90% (13.00 days) emergence was sighted in treatment combination $V_2 \times T_2 \times S_0$. Disparities in seedling emergence among the treatments might be due to uneven soil moisture, temperature, seed and varietal qualities. It was remarkably noticed that, seeds without soaked gained early emergence than the soaked ones. This occurred may be due to adequate soil moisture in the experimental plots. Yasumoto., *et al.* [38] found that rice seedling emergence was related with sowing time, season, temperature and cultivar type.

Plant population

Desired plant density is an essential factor to ensure optimum growth and quality of the crop. Variety, fertilizer dose and soaking treatments indicated great variation in the number of plants (Table 1 and Table 2) per unit plot area (4m^2). Abundant plant population was observed with the treatment $V_4 \times T_1$ (110.17) and scarce was noted in $V_1 \times T_3$ (73.17) influenced by variety and fertilizer.

Influence variety and soaking disclosed that, $V_3 \times S_0$ had largest plant population (109.67) and treatment $V_1 \times S_{24}$ beard the scantiest number of plants (88.78) followed by $V_4 \times S_{24}$ (88.89) which were statistically identical.

Fertilizer and soaking application effect denoted treatments $T_2 \times S_0$ produced denser (104.70) plants but $T_3 \times S_{24}$ had lighter (82.25) plant in the plot area.

Combined influences revealed that treatment combination $V_3 \times T_2 \times S_0$ gave utmost (123.33) plant population; while treatment $V_4 \times T_3 \times S_{24}$ had the lowest (55.67) population among the combinations. Plant population depended on the germination capability of the seeds as well as the soil moisture conditions. Seed rate might be a factor but all the plots got same amount of seed though plant density differed. These findings are more or less in conformity with Kaur and Singh [39] who concluded, number of plants per unit area is dependent on seed rate.

Days to flowering

Flower initiation were also remarkably varied among the treatments (Table 1 and Table 2). Days to 1st, 50% and 90% flowering were observed late in the treatment $V_4 \times T_2$ (76.17 days, 80.00 days and 84.17 days) and earlier in $V_3 \times T_2$ (68.83 days, 73.67 days and 77.67 days) with variety and fertilizer effect.

Treat.	Days to 50% emergence	Days to 90% emergence	Plant population@ 4m^2	Days to first flowering	Days to 50% flowering	Days to 90% flowering
Variety × Fertilizer dose						
$V_1 \times T_1$	10.00 cd	14.33 c	107.83 ab	72.33 ef	76.17 de	80.17 cd
$V_1 \times T_2$	9.83 d	15.50 c	101.33 ab	73.17 c-f	76.50 cd	81.17 bc
$V_1 \times T_3$	10.50 bcd	15.33 c	73.17 c	73.50 b-e	76.83 bcd	80.83 c
$V_2 \times T_1$	9.83 d	14.50 c	85.17 abc	72.50 def	75.83 def	80.17 cd
$V_2 \times T_2$	9.33 d	15.83 bc	103.17 ab	74.17 a-e	77.17 bcd	81.00 c
$V_2 \times T_3$	12.33 ab	16.33 abc	101.17 ab	75.00 a-d	79.00 ab	82.00 abc
$V_3 \times T_1$	11.17 bcd	15.50 c	94.17 abc	70.83 fg	75.67 def	78.17 d
$V_3 \times T_2$	10.67 bcd	16.67 abc	96.17 abc	68.83 g	73.67 f	77.67 d
$V_3 \times T_3$	10.17 bcd	16.83 abc	108.50 ab	69.50 g	73.83 ef	78.17 d
$V_4 \times T_1$	9.17 d	16.67 abc	110.17 a	76.00 ab	78.83 abc	83.83 a
$V_4 \times T_2$	12.17 abc	18.33 ab	84.50 bc	76.17 a	80.00 a	84.17 a
$V_4 \times T_3$	13.50 a	18.67 a	73.83 c	75.17 abc	80.00 a	83.67 ab
LoS	*	*	*	*	*	*
$LSD_{0.05}$	2.33	2.71	25.53	2.53	2.49	2.51
SEm±	1.16	1.35	12.68	1.26	1.24	1.25
Variety × Soaking method						
$V_1 \times S_0$	9.78 b	14.44 b	99.44 ab	72.22 d	75.56 def	80.00 cd
$V_1 \times S_{24}$	10.44 ab	16.00 ab	88.78 b	73.78 bcd	77.44 bcd	81.44 bc
$V_2 \times S_0$	10.22 ab	15.56 ab	96.67 ab	72.89 cd	76.56 cde	80.44 c
$V_2 \times S_{24}$	10.78 ab	15.56 ab	96.33 ab	74.89 abc	78.11 abc	81.67 bc
$V_3 \times S_0$	10.33 ab	15.78 ab	109.67 a	69.78 e	74.22 f	78.00 d
$V_3 \times S_{24}$	11.00 ab	17.33 a	89.56 ab	69.67 e	74.56 ef	78.00 d
$V_4 \times S_0$	11.11 ab	17.33 a	92.11 ab	75.56 ab	79.11 ab	83.22 ab
$V_4 \times S_{24}$	12.11 a	17.67 a	86.89 b	76.00 a	80.11 a	84.56 a
$LSD_{0.05}$	1.90	2.21	20.85	2.07	2.03	2.05

Treat.	Days to 50% emergence	Days to 90% emergence	Plant population@ 4m²	Days to first flowering	Days to 50% flowering	Days to 90% flowering
LoS	*	*	*	*	*	*
SEm±	0.94	1.10	10.36	1.03	1.01	1.02
Fertilizer dose × Soaking method						
$T_1 \times S_0$	10.00 b	15.83 abc	98.17 ab	72.00 b	75.67 b	79.58 b
$T_1 \times S_{24}$	10.08 b	15.50 bc	100.50 a	73.83 a	77.58 a	81.58 a
$T_2 \times S_0$	10.00 b	14.92 c	104.17 a	72.50 ab	76.08 ab	80.42 ab
$T_2 \times S_{24}$	11.00 ab	17.00 ab	88.42 ab	73.67 ab	77.58 a	81.58 a
$T_3 \times S_0$	11.08 ab	16.58 abc	96.08 ab	73.33 ab	77.33 ab	81.25 ab
$T_3 \times S_{24}$	12.17 a	17.42 a	82.25 b	73.25 ab	77.50 a	81.08 ab
$LSD_{0.05}$	1.65	1.91	18.05	1.79	1.76	1.77
LoS	*	*	*	*	*	*
SEm±	0.82	0.95	8.97	0.89	0.88	0.88
CV	18.69%	14.37%	23.14%	2.98%	2.79%	2.67%

Table 1: Phenology and ontogenetic features of *aus* rice with relation to variety, fertilizer dose and soaking.

Means bearing same letter(s) in a column do not differ significantly at 5% level of probability by LSD. LoS: Level of Significance, SEm: Standard Error Mean, CV: Coefficient of Variation.

Varieties and soaking impact exposed that, $V_4 \times S_{24}$ treatment took longest days to bear 1st, 50% and 90% flowering (76.00 days, 80.11 days and 84.56 days) but, shortest days were seen with treatment $V_3 \times S_0$ (69.78 days, 74.22 days and 78.00 days. Treatment $V_3 \times S_{24}$ also showed statistically identical days to 1st (69.67 days) and 90% (78.00 days) flowering.

Different doses of fertilizer and soaking revealed treatment $T_1 \times S_{24}$ gave late 1st, 50% and 90% flowering (73.83 days, 77.58 days and 81.58 days). Therefore, days to 50% and 90% flowering were also delayed in treatments $T_2 \times S_{24}$ (77.58 days and 81.58 days) followed by $T_3 \times S_{24}$ (77.50 days and 81.08 days); all these were statistically identical.

Treatment	Days to 50% emergence	Days to 90% emergence	Plant population@ 4m²	Days to 1st flowering	Days to 50% flowering	Days to 90% flowering
$V_1 \times T_1 \times S_0$	9.00 ef	13.33 f	119.67 ab	70.67 g-k	74.33 ghi	78.33 ef
$V_1 \times T_2 \times S_0$	11.00 a-f	15.67 c-f	107.33 a-e	72.33 d-j	76.00 d-i	81.00 b-f
$V_1 \times T_3 \times S_0$	9.33 def	14.33 ef	71.33 efg	73.67 a-g	76.33 d-i	80.67 c-f
$V_2 \times T_1 \times S_0$	10.00 def	16.00 b-f	79.00 c-g	71.33 e-k	75.00 f-i	79.33 def
$V_2 \times T_2 \times S_0$	8.33 f	13.00 f	102.00 a-f	72.67 c-i	75.67 e-i	80.00 c-f
$V_2 \times T_3 \times S_0$	12.33 a-d	17.67 a-e	109.00 a-d	74.67 a-e	79.00 a-e	82.00 a-d
$V_3 \times T_1 \times S_0$	11.67 a-e	17.67 a-e	93.67 a-f	71.00 f-k	75.67 e-i	78.33 ef
$V_3 \times T_2 \times S_0$	10.33 c-f	15.00 c-f	123.33 a	69.33 ijk	73.67 hi	77.67 f
$V_3 \times T_3 \times S_0$	9.00 ef	14.67 def	112.00 abc	69.00 jk	73.33 i	78.00 ef
$V_4 \times T_1 \times S_0$	9.33 def	16.33 b-f	100.33 a-f	75.00 a-d	77.67 a-g	82.33 a-d
$V_4 \times T_2 \times S_0$	10.33 c-f	16.00 b-f	84.00 b-g	75.67 a-d	79.00 a-e	83.00 abc
$V_4 \times T_3 \times S_0$	13.67 ab	19.67 ab	92.00 a-f	76.00 abc	80.67 ab	84.33 ab
$V_1 \times T_1 \times S_{24}$	11.00 a-f	17.67 a-e	96.00 a-f	74.00 a-g	78.00 a-f	82.00 a-d
$V_1 \times T_2 \times S_{24}$	8.67 ef	13.96 f	95.33 a-f	74.00 a-g	77.00 c-h	81.33 b-e
$V_1 \times T_3 \times S_{24}$	11.67 a-e	17.33 a-e	75.00 d-g	73.33 b-h	77.33 b-g	81.00 b-f
$V_2 \times T_1 \times S_{24}$	9.67 def	14.67 def	91.33 a-g	73.67 a-g	76.67 c-i	81.00 b-f
$V_2 \times T_2 \times S_{24}$	10.33 c-f	16.00 b-f	104.33 a-f	75.67 a-d	78.67 a-e	82.00 a-d

Treatment	Days to 50% emergence	Days to 90% emergence	Plant population@ 4m²	Days to 1st flowering	Days to 50% flowering	Days to 90% flowering
$V_2 \times T_3 \times S_{24}$	12.33 a-d	16.00 b-f	93.33 a-f	75.33 a-d	79.00 a-e	82.00 a-d
$V_3 \times T_1 \times S_{24}$	10.67 b-f	15.00 c-f	94.67 a-f	70.67 g-k	75.67 e-i	78.00 ef
$V_3 \times T_2 \times S_{24}$	11.00 a-f	18.33 a-d	69.00 fg	68.33 k	73.67 hi	77.67 f
$V_3 \times T_3 \times S_{24}$	11.33 a-f	18.67 abc	105.00 a-f	70.00 h-k	74.33 g-i	78.33 ef
$V_4 \times T_1 \times S_{24}$	9.00 ef	14.67 def	120.00 ab	77.00 a	80.00 abc	85.33 a
$V_4 \times T_2 \times S_{24}$	14.00 a	20.67 a	85.00 b-g	76.67 ab	81.00 a	85.33 a
$V_4 \times T_3 \times S_{24}$	13.33 abc	17.67 a-e	55.67 g	74.33 a-f	79.33 a-d	83.00 abc
$LSD_{0.05}$	3.29	3.83	36.10	3.58	3.53	3.55
LoS	*	*	*	*	*	*
SEm	1.64	1.90	17.94	1.78	1.75	1.76
CV	18.69%	14.37%	23.14%	2.98%	2.79%	2.67%

Table 2: Interact effect of variety, fertilizer dose and soaking method on phenology and ontogenetic features of *aus* rice.

Means bearing same letter(s) in a column do not differ significantly at 5% level of probability by LSD. LoS: Level of significance, SEm: Standard Error Mean, CV: Coefficient of Variation.

Gathered effect of the treatments pointed that, late 1st and 90% flowering was belated in $V_4 \times T_1 \times S_{24}$ (77.00 days and 85.33 days). Hence, $V_4 \times T_2 \times S_{24}$ also delayed 50% and 90% flowering (81.00 days and 85.33 days). Earliest 1st flowering was noticed with $V_3 \times T_2 \times S_{24}$ (68.33 days), 50% flowering in $V_3 \times T_3 \times S_0$ (73.33 days) and 90% flowering in both $V_3 \times T_2 \times S_0$ (77.67 days) and $V_3 \times T_2 \times S_{24}$ (77.67 days) treatment combinations. Flowering is relied on temperature, day length, and genetic character of the cultivar. Here, a mixed result was seen. BRRI dhan85 flowered late BRRI dhan82 flowered early. Treatments with recommended fertilizer dose and soaking application was found to have satisfactory results. Ghosh., *et al.* [40] stated flowering time in rice varieties fluctuated because of planting time and varietal attributes. Which more or less supported the present outcomes.

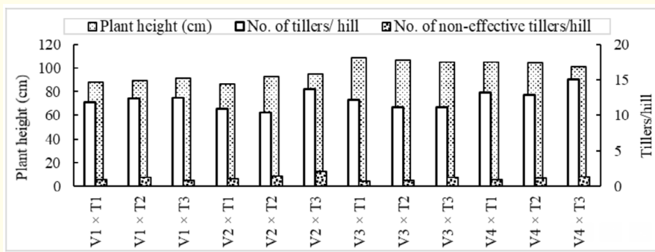

Figure 5: Plant height and tillers/hill as effected by variety and fertilizer.

Plant height and tillering dynamics

Plant height of the rice varieties and tiller number per hill was significantly influenced by variety and fertilizer doses (Figure 5). Treatment $V_3 \times T_1$ produced statistically longest (108.67 cm) and $V_2 \times T_1$ shortest (86.39 cm) plant height. Ample number of total tillers (15.06) were seen with $V_4 \times T_3$; whereas treatments $V_2 \times T_1$ and $V_2 \times T_2$ showed meagre tillers (10.94 cm and 10.39 cm). Number of non-effective tillers per hill was highest (2.06) in $V_2 \times T_3$; but statistical identical and lowest number of non-effective tillers were recorded with treatments $V_1 \times T_3$ (0.83) and $V_3 \times T_2$ (0.83).

Varieties with different soaking and fertilizer with various soaking method interaction was detected (Figure 6). Highest plant height was noticed in treatments $V_3 \times S_0$ (106.87 cm) followed by $V_3 \times S_{24}$ (106.67 cm), $V_4 \times S_{24}$ (104.00 cm) and $V_4 \times S_0$ (103.11 cm). Conversely, the lowest was witnessed with treatments $V_1 \times S_0$ (88.33 cm) followed by $V_2 \times S_0$ (90.11 cm), $V_1 \times S_{24}$ (90.59 cm) and $V_2 \times S_{24}$ (92.82 cm). Fertilizer and soaking methods had no significant interactions on plant height; i.e. they all were statistically same.

Maximum total number of tillers per hill (14.48) was obtained from treatment $V_4 \times S_{24}$; while minimum from treatments $V_2 \times S_0$ (10.26); followed by $V_3 \times S_{24}$ (10.78) and $V_1 \times S_0$ (11.03). Fertilizer dose and soaking application collaboration allowed treatment $T_3 \times S_{24}$ to produce profuse number of tillers (13.89) per hill and treatment $T_2 \times S_0$ to generate sparse tillers (10.62). Contrary, number of non-effective tillers per hill was most (1.47) in treatment $T_3 \times S_{24}$

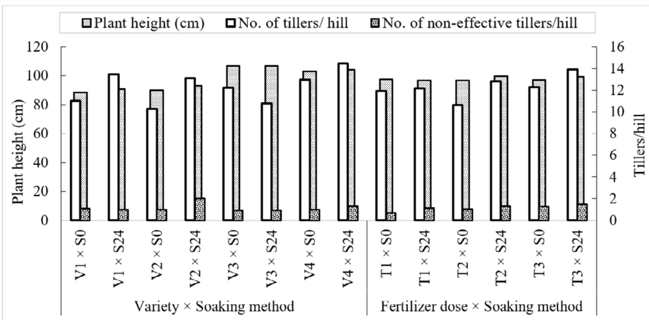

Figure 6: Influence of variety, fertilizer dose and soaking methods on height and tillering.

and least (0.67) in treatment $T_1 \times S_0$ under this collaboration. With varietal and soaking impact, $V_2 \times S_{24}$ treatment gave furthest number (2.00) of non-effective tillers per hill and the lowest (0.92) was attained by $T_3 \times S_{24}$.

Figure 7: Collective effect of variety, fertilizer and seed soaking on height and tillering.

Aggregative effect of variety, fertilizer and soaking had much distinctions on the height and tillering attributes of *aus* rice varieties (Figure 7). Maximum 109.56 cm height was attained from three treatments ($V_3 \times T_1 \times S_0$, $V_3 \times T_2 \times S_0$ and $V_4 \times T_2 \times S_{24}$). On contrary, statistically equal minimum height was also gained from three treatments i.e. $V_2 \times T_1 \times S_0$ (86.33 cm), $V_1 \times T_1 \times S_0$ (86.78 cm) and $V_2 \times T_1 \times S_0$ (86.45 cm); all of them carried the same letter. Maximal number of tillers per hill was recorded in $V_4 \times T_3 \times S_{24}$ (16.56) and fewest were found with treatment $V_2 \times T_2 \times S_0$ (9.00). Treatment $V_2 \times T_3 \times S_{24}$ had the greatest number of non-effective tillers per hill (2.67) and $V_3 \times T_1 \times S_0$ (0.22) treatment had the least. Generally, dwarf plant architecture is desired during the *aus* season as this time faces natural calamities such as heavy wind, rainfall, storm, hail storm etc. Mean plant height of BRRI dhan82 and BRRI dhan85 is 110 cm [41,42]. Average height of Binadhan-19 and Binadhan-21 is around 100 cm [43,44]. Shorter height was might be due to direct seeding cultivation. 80% and 100% recommended fertilizer dose with no priming resulted in longer plant height; but minimum height was might be no priming and low fertilizer application in the plots. Higher fertilizer dose and priming ensured better tillering capability and vice versa. Mohanta., *et al.* [15] alluded that, plant height, number of tillers per m^2 and effective tillers m^{-2} is related to crop establishment, Nitrogen fertilizer management practice in field.

Panicle attributes

Effect of variety-fertilizer, variety-soaking and variety-fertilizer-soaking was significantly influenced on panicle number, panicle length and panicle weight. But these parameters were unaffected by fertilizer-soaking interaction (Table 3, Table 4).

Number of panicles per hill was utmost in treatment $V_4 \times T_3$ (13.72) and lowest in $V_2 \times T_2$ (8.95). In next effect, treatment $V_4 \times S_{24}$ (13.19) attained highest amount of panicles per hill and the least was gained from $V_2 \times S_0$ (9.22). Interaction effect of all the treatments demonstrated that, treatment $V_4 \times T_3 \times S_{24}$ and $V_3 \times T_1 \times S_0$ gave more number of panicles (14.48 and 14.43) than others. Seven treatment combinations showed lesser and statistical identical number of panicles; among them $V_2 \times T_2 \times S_0$ was the least (8.22).

Extended panicle length (26.90 cm) was noticed in treatment $V_3 \times T_1$. While $V_1 \times T_1$ and $V_1 \times T_2$ treatments had narrowed length (22.06 cm and 21.95 cm) panicle. Lengthy panicle (25.85 cm) was seen with treatment $V_3 \times S_0$. Whereas $V_1 \times S_{24}$ and $V_1 \times S_0$ treatments demonstrated reduced sized (22.10 cm and 22.33 cm) panicle. Collaborative effect of all the treatments indicated $V_3 \times T_1 \times S_{24}$ had more elongated (27.14 cm) panicle than others; shortened alike length of panicles were observed in $V_1 \times T_1 \times S_0$ (21.74 cm) and $V_1 \times T_2 \times S_{24}$ (21.78 cm).

Panicle weight was maximum in treatment $V_3 \times T_1$ (10.40 g) and $V_3 \times S_{24}$ (9.39 g). While the minimum was noted with $V_1 \times T_2$ (6.23 g) and $V_1 \times S_{24}$ (6.44 g) treatment.

Collective effect of all the factors revealed that, $V_3 \times T_1 \times S_{24}$ treatment gave heaviest (10.49 g) panicle weight and the lightest was seen with treatment $V_1 \times T_2 \times S_{24}$ (5.77 g). BRRI dhan82 and BRRI dhan85 had more number of panicles under low and high fertilizer dose. Presumably BRRI dhan85 was more responsive to fertilizer and priming than other varieties. However, treatments with least panicle numbers produced more panicle length and weight in most interaction effects. Panicle length being a genetic trait might have altered due to crop establish method and nutrient utilization from soil. Panicle weight was increased with panicle length. Jnanesha and Kumar [45] ascribed panicle length relied on crop establishment. Xu., *et al.* [46] reported that panicle number m^{-2} and seed weight is positively related on soil fertility.

Root length

Longest root length was noted in treatments $V_2 \times T_2$ (12.11 cm^2) and $V_2 \times S_{24}$ (12.76 cm^2). Whereas, shortest length was seen with treatments $V_4 \times T_3$ (10.03 cm^2) and $V_4 \times T_3$ (10.39 cm^2). Fertilizer and soaking method gave statistically non-significant result and thus remained unaffected by the factors. Interaction effect of the factors elucidated that, treatment $V_2 \times T_2 \times S_{24}$ had utmost root length (13.50 cm^2) and treatments $V_4 \times T_3 \times S_0$ (9.56 cm^2) and $V_4 \times T_1 \times S_{24}$ (9.59 cm^2) delivered lowest root area (Table 3, Table 4). Binadhan-21 was derived from NERICA-4; which was more tolerant to drought and thereby more root area was noticed. BRRI dhan85 might have the capability to utilize extra fertilizer but Binadhan-21 performed better in recommended dose. Mahajan., *et al.* [47] inferred that, root length in DSR was connected to crop establishment and seed priming methods.

Treat.	Panicles/ hill	Panicle length (cm)	Panicle weight (g)	Root length (cm^2)	Filled grains/ panicle	Unfilled grains/panicle (%)	1000 grain weight (g)
Variety × Fertilizer dose							
$V_1 \times T_1$	10.83 abc	22.06 e	7.03 bcd	11.08 ab	167.43 bcd	33.73 cd	22.56 ab
$V_1 \times T_2$	12.61 ab	21.95 e	6.23 d	12.06 ab	129.38 ef	36.37 a-d	23.40 a
$V_1 \times T_3$	11.61 abc	22.63 de	7.49 bcd	10.54 ab	144.94 c-f	37.69 a-d	21.94 a-d
$V_2 \times T_1$	9.89 bc	23.27 cde	8.81 ab	12.03 ab	174.85 bcd	32.93 cd	21.51 bcd
$V_2 \times T_2$	8.95 c	23.99 bcd	8.51 abc	12.11 a	178.65 bc	39.38 abc	20.44 d
$V_2 \times T_3$	11.67 abc	23.80 cd	8.09 bcd	12.05 ab	141.44 def	44.93 a	21.26 bcd
$V_3 \times T_1$	11.44 abc	26.90 a	10.40 a	10.56 ab	197.49 ab	35.28 bcd	20.46 d
$V_3 \times T_2$	9.78 bc	25.45 ab	8.70 ab	10.23 ab	133.37 ef	39.98 abc	22.26 abc
$V_3 \times T_3$	9.89 bc	25.38 b	7.56 bcd	11.16 ab	153.32 cde	43.09 ab	21.98 a-d
$V_4 \times T_1$	12.22 abc	23.65 cd	6.60 cd	10.65 ab	223.18 a	29.57 d	20.56 cd
$V_4 \times T_2$	11.83 abc	23.74 cd	7.08 bcd	10.64 ab	119.17 f	40.86 abc	20.86 bcd
$V_4 \times T_3$	13.72 a	24.45 bc	7.92 bcd	10.03 b	146.21 c-f	40.47 abc	21.05 bcd
$LSD_{0.05}$	3.36	1.46	1.97	2.07	33.99	8.58	1.79
LoS	*	*	*	*	*	*	*
SEm±	1.67	0.72	0.98	1.03	16.89	4.26	0.89

Treat.	Panicles/ hill	Panicle length (cm)	Panicle weight (g)	Root length (cm^2)	Filled grains/ panicle	Unfilled grains/panicle (%)	1000 grain weight (g)
Variety × Soaking method							
$V_1 \times S_0$	10.89 abc	22.33 c	7.38 bcd	10.82 b	155.59 bc	36.14 ab	22.43 ab
$V_1 \times S_{24}$	12.48 ab	22.10 c	6.44 d	11.63 ab	138.90 cd	35.72 ab	22.83 a
$V_2 \times S_0$	9.22 c	23.16 bc	8.16 abc	11.37 ab	144.97 cd	41.11 a	20.81 c
$V_2 \times S_{24}$	11.11 abc	24.22 b	8.77 ab	12.76 a	184.99 a	37.05 ab	21.32 bc
$V_3 \times S_0$	10.89 abc	25.85 a	8.38 abc	10.39 b	178.20 ab	39.11 ab	21.66 abc
$V_3 \times S_{24}$	9.85 bc	25.96 a	9.39 a	10.90 b	126.89 d	42.52 a	21.47 abc
$V_4 \times S_0$	12.00 ab	23.97 b	7.30 bcd	10.46 b	204.46 a	32.84 b	20.81 c
$V_4 \times S_{24}$	13.19 a	23.92 b	7.10 cd	10.42 b	138.94 cd	38.35 ab	20.83 c
$LSD_{0.05}$	2.74	1.19	1.61	1.69	27.76	7.00	1.46
LoS	*	*	*	*	*	*	*
SEm±	1.36	0.59	0.80	0.84	13.79	3.48	0.72
Fertilizer dose × Soaking method							
$T_1 \times S_0$	11.17	23.77	8.24	10.99	170.77 a	33.40 b	21.06
$T_1 \times S_{24}$	11.03	24.17	8.16	11.16	165.80 a	37.55 b	21.48
$T_2 \times S_0$	10.08	23.66	7.65	10.53	151.33 ab	37.23 b	21.82
$T_2 \times S_{24}$	11.50	23.91	7.60	11.99	173.86 a	35.85 b	21.66
$T_3 \times S_0$	11.00	24.06	7.52	10.76	137.12 b	44.37 a	21.41
$T_3 \times S_{24}$	12.44	24.08	8.01	11.14	155.84 ab	38.72 ab	21.71
$LSD_{0.05}$	2.38	1.03	1.39	1.47	24.04	6.07	1.26
LoS	NS	NS	NS	NS	*	*	NS
SEm±	1.18	0.51	0.69	0.73	11.94	3.01	0.63
CV	25.81%	5.24%	21.53%	16.08%	18.38%	19.50%	7.14%

Table 3: Yield components of *aus* rice influenced by variety, fertilizer dose and soaking.

Means bearing same letter(s) in a column do not differ significantly at 5% level of probability by LSD. LoS: Level of Significance, SEm: Standard Error Mean, NS: Non-significant, CV: Coefficient of Variation.

Grains per panicle and TGW

Consequence of variety-fertilizer, variety-soaking, fertilizer-soaking (except TGW) and variety-fertilizer-soaking (collective interaction) significantly influenced number of grains per panicle and 1000 grain weight (Table 3, Table 4).

Treatment	Panicles/hill	Panicle length (cm)	Panicle weight (g)	Root length (cm^2)	Filled grains/ panicle	Unfilled grains/ panicle (%)	1000 grain weight (g)
$V_1 \times T_1 \times S_0$	9.00 b	21.74 g	7.15 cde	10.33 bc	190.41 a-d	33.09 c-f	22.32 a-d
$V_1 \times T_2 \times S_0$	12.56 ab	22.13 fg	6.70 cde	11.44 abc	127.04 fgh	37.39 a-f	23.07 ab
$V_1 \times T_3 \times S_0$	11.11 ab	23.12 d-g	8.30 a-e	10.69 abc	149.33 d-g	37.94 a-f	21.91 a-e
$V_2 \times T_1 \times S_0$	8.78 b	22.83 efg	8.39 a-e	11.61 abc	151.49 c-g	36.76 a-f	21.08 b-e
$V_2 \times T_2 \times S_0$	8.22 b	23.09 d-g	8.82 abcd	10.72 abc	167.64 b-f	38.39 a-f	21.29 a-e

Treatment	Panicles/hill	Panicle length (cm)	Panicle weight (g)	Root length (cm^2)	Filled grains/ panicle	Unfilled grains/ panicle (%)	1000 grain weight (g)
$V_2 \times T_3 \times S_0$	10.67 ab	23.55 d-g	7.28 cde	11.78 abc	115.79 gh	48.17 a	20.08 de
$V_3 \times T_1 \times S_0$	14.43 a	26.65 ab	10.30 ab	10.33 bc	186.45 b-e	39.18 a-f	20.34 cde
$V_3 \times T_2 \times S_0$	8.66 b	26.11 abc	8.04 a-e	9.85 bc	209.40 ab	31.73 def	22.12 a-d
$V_3 \times T_3 \times S_0$	9.56 b	24.80 b-e	6.80 cde	10.99 abc	138.75 e-h	46.43 ab	22.51 a-d
$V_4 \times T_1 \times S_0$	12.44 ab	23.85 def	7.14 cde	11.72 abc	236.96 a	27.40 f	20.52 cde
$V_4 \times T_2 \times S_0$	10.89 ab	23.31 d-g	7.08 cde	10.10 bc	101.24 h	41.42 a-d	20.79 b-e
$V_4 \times T_3 \times S_0$	12.67 ab	24.74 b-e	7.69 b-e	9.56 c	144.62 d-h	44.96 abc	21.12 b-e
$V_1 \times T_1 \times S_{24}$	12.66 ab	22.38 fg	6.90 cde	11.83 abc	144.45 d-h	34.36 b-f	22.81 abc
$V_1 \times T_2 \times S_{24}$	12.67 ab	21.78 g	5.77 e	12.67 ab	131.71 fgh	35.34 b-f	23.73 a
$V_1 \times T_3 \times S_{24}$	12.11 ab	22.13 fg	6.67 cde	10.39 bc	140.56 e-h	37.44 a-f	21.97 a-e
$V_2 \times T_1 \times S_{24}$	11.00 ab	23.70 d-g	9.22 abc	12.44 abc	198.20 abc	29.10 ef	21.94 a-e
$V_2 \times T_2 \times S_{24}$	9.67 b	24.91 bcd	8.20 a-e	13.50 a	189.66 a-d	40.36 a-e	19.59 e
$V_2 \times T_3 \times S_{24}$	12.67 ab	24.05 c-f	8.89 abc	12.33 abc	167.09 b-f	41.68 a-d	22.45 a-d
$V_3 \times T_1 \times S_{24}$	8.44 b	27.14 a	10.49 a	10.78 abc	208.53 ab	31.37 def	20.58 b-e
$V_3 \times T_2 \times S_{24}$	10.89 ab	24.78 b-e	9.36 abc	10.61 abc	134.83 fgh	41.19 a-e	22.40 a-d
$V_3 \times T_3 \times S_{24}$	10.22 ab	25.95 abc	8.33 a-e	11.33 abc	167.89 b-f	39.76 a-e	21.44 a-e
$V_4 \times T_1 \times S_{24}$	12.00 ab	23.45 d-g	6.06 de	9.59 c	131.91 fgh	38.78 a-f	20.59 b-e
$V_4 \times T_2 \times S_{24}$	12.78 ab	24.16 c-f	7.08 cde	11.18 abc	137.10 fgh	40.31 a-e	20.92 b-e
$V_4 \times T_3 \times S_{24}$	14.78 a	24.16 c-f	8.15 a-e	10.50 bc	147.81 d-h	35.98 b-f	20.98 b-e
$LSD_{0.05}$	4.75	2.06	2.78	2.93	48.08	12.13	2.53
LoS	*	*	*	*	*	*	*
SEm±	2.36	1.02	1.38	1.46	23.89	6.03	1.25
CV	25.81%	5.24%	21.53%	16.08%	18.38%	19.50%	7.14%

Table 4: Interaction effect of variety, fertilizer dose and soaking method on the yield attributes of *aus* rice.

Means bearing same letter(s) in a column do not differ significantly at 5% level of probability by LSD. LoS: Level of Significance, SEm: Standard Error Mean, CV: Coefficient of Variation.

Number of filled grains per panicle were maximum in treatments $V_4 \times T_1$ (223.18), $V_4 \times S_0$ (204.46) and $T_1 \times S_0$ (170.77). Contrary, minimum was noted with treatments $V_4 \times T_2$ (119.17), $V_3 \times S_{24}$ (126.89) and $T_3 \times S_0$ (137.12). Interaction of factors showed treatment $V_4 \times T_1 \times S_0$ had most (236.96) filled grains and $V_4 \times T_2 \times S_0$ (101.24) had least amount of filled grains per panicle.

Percentage of unfilled grains per panicle was abundant in treatments $V_2 \times T_3$ (44.93%), $V_3 \times S_{24}$ (42.52%) and $T_3 \times S_0$ (44.37%). While scarce grain sterility was observed in treatments $V_4 \times T_1$ (29.57%), $V_4 \times S_0$ (32.84%) and $T_1 \times S_0$ (33.40%). Combined factorial effect demonstrated that greatest sterile grains were produced by treatment $V_2 \times T_3 \times S_0$ (48.17%) and the little sterility was spotted with treatment $V_4 \times T_1 \times S_0$ (27.40%).

1000 grain weight (TGW) was maximum in treatments $V_1 \times T_1$ (23.40 g), $V_1 \times S_{24}$ (22.83 g). Whereas minimum TGW was noticed with treatments $V_2 \times T_2$ (20.44 g), $V_3 \times T_1$ (20.46 g), $V_2 \times S_0$ (20.81 g), $V_4 \times S_0$ (20.81 g) and $V_4 \times S_{24}$ (20.83 g). TGW remained uninfluenced by fertilizer-soaking interaction and gave non-significant result. Aggregative effect of variety-fertilizer-soaking revealed that, heaviest TGW was found with treatment $V_1 \times T_2 \times S_{24}$ (23.73 g) and lightest was seen by $V_2 \times T_2 \times S_{24}$ (19.59 g). Observations disclosed that filled grains were least with more fertilizer and more with less fertilizer. Therefore, high amount of grain sterility indicates that fertilizer management is crucial in DSR production. Normally rice gains 15-20% sterile grains [48]; but in DSR higher sterility was found. Overall, excess fertilizer adversely affected filled and caused more sterile grains. TGW is a varietal trait which reflects the bold or premium quality of the grain. TGW of Binadhan-19 was more and Binadhan-21 was less which represent slender type grain. However, in the experiment TGW might have influenced from nutrient content in soil and weather factors. The impact of the establishment method on filled grains per panicle proved in earlier study [49]. Higher filled grain per panicle was contingent upon vigorous tiller growth with the photosynthates production from flag leave [50]. On the other hand, relatively small sink capacity or deficient source content and export presumably responsible for lower number of filled grains per panicle in DSR [51]. Excess seeding for getting more panicles per m^2 and suppressing weeds [52] is often accompanied by reduced panicle size, 1000 grain weight and higher spikelet sterility.

Yield and duration

Ample yield was gained from treatment $V_4 \times T_1$ (4.42 t/ha) followed by $V_2 \times T_3$ (4.34 t/ha). The lowest was yielded by treatments $V_3 \times T_2$ (2.70 t/ha) followed by $V_3 \times T_1$ (2.72 t/ha). Straw yield was most in $V_3 \times T_1$ (5.10 t/ha) and least in treatment $V_1 \times T_3$ (2.72 t/ha). In case of duration, treatment $V_4 \times T_3$ took maximum days (111.67 days); contrary treatment $V_1 \times T_2$ was harvested at 96.83 days (Figure 8). Here, more straw yield resulted less grain yield and vice versa; but Binadhan-21 with 120% and BRRI dhan85 with 80% recommended fertilizer dose performed better. Chowhan., *et al.* [44] found mean grain, straw and duration of Binadhan-21 under dibbling seeded was found 4.30 t/ha, 4.80 t/ha and 101 days. In TPR Chowhan., *et al.* [22] reported grain, straw and field duration of Binadhan-19 was 4.37 t/ha, 5.05 t/ha and 99.33 days. Deviation of yield and duration might be for difference in crop establishment method.

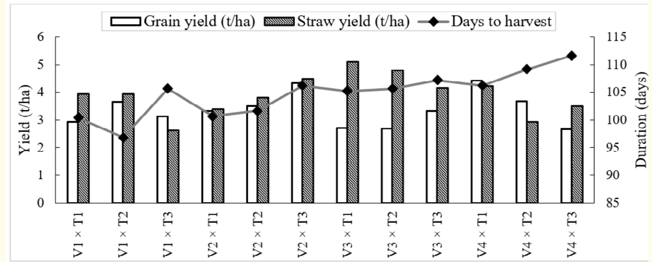

Figure 8: Yield and maturity duration influenced by variety and fertilizer dose.

In terms of variety-soaking interaction, treatment $V_4 \times S_0$ yielded most (4.09 t/ha) followed by $V_4 \times S_0$ (3.84 t/ha). Minimum and alike yield was obtained in $V_3 \times S_{24}$ (3.84 t/ha) and $V_3 \times S_0$ (3.01 t/ha). Straw yield was highest in $V_3 \times S_0$ (4.93 t/ha) and the lowest (3.51 t/ha) was obtained from treatments $V_1 \times S_0$, $V_1 \times S_{24}$ and $V_4 \times S_{24}$. Treatment $V_4 \times S_{24}$ was harvested late (109.67 days) and $V_1 \times S_0$ was harvested at the earliest (99.89 days) (Figure 8).

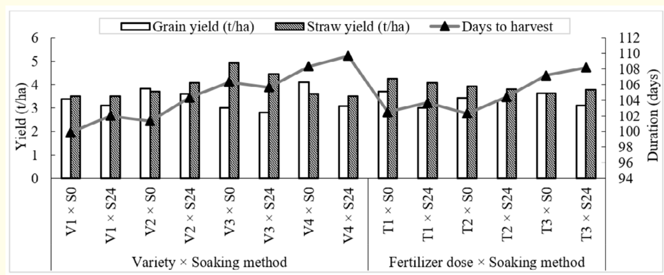

Figure 9: Yield and maturity of DSR as effected by variety, fertilizer dose and soaking methods.

Fertilizer dose-soaking effect exhibited, treatment $T_1 \times S_0$ produced abundant yield (3.70 t/ha) and $T_1 \times S_{24}$ least yield (3.01 t/ha) among the treatments. Straw yield was non-significant hence no effect was spotted. But maturity duration was significantly influenced and maximum was found with treatment $T_3 \times S_{24}$ (108.17 days) and the minimum was seen with $T_2 \times S_0$ (102.25 days) followed by $T_1 \times S_0$ (102.50 days) treatment (Figure 9). Best yield was obtained without seed priming. This may have occurred for enough soil moisture and favorable rapid germination factors. Duration of crop was more or less alike according to BRRI [42] and Chowhan., *et al.* [22].

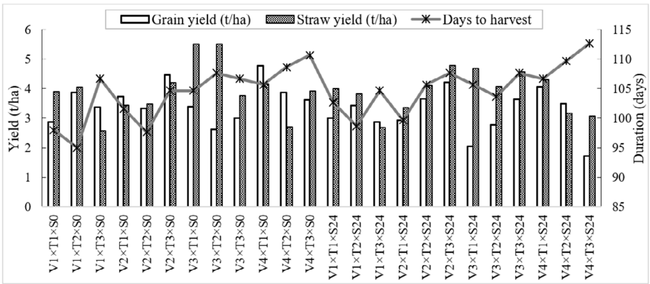

Figure 10: Interaction of variety, fertilizer dose and soaking method on yield and maturity of DSR.

Interaction effect of variety-fertilizer-soaking method alluded that, utmost grain yielded from treatment combination $V_4 \times T_1 \times S_0$ (4.78 t/ha) followed by $V_2 \times T_3 \times S_0$ (4.46 t/ha). Minimal grain yielded from $V_4 \times T_3 \times S_{24}$ (1.72 t/ha). Statistically identical and maximal straw yield was noted with treatment $V_3 \times T_1 \times S_0$ (5.52 t/ha) followed by $V_3 \times T_2 \times S_0$ (5.52 t/ha) and lowest was found with $V_1 \times T_3 \times S_0$ (2.57 t/ha) treatment. Longest days to harvest was needed in $V_4 \times T_3 \times S_{24}$ (112.67 days); while $V_1 \times T_2 \times S_0$ was harvested at shortest (95.00 days) period (Figure 10). Abbas., *et al* [53] concluded fertilization technique influenced yield, yield attributes and nutrient uptake in DSR. Ghosh., *et al.* [54] compared fifteen *aus* rice varieties under irrigated and rainfed state and mentioned, grain yield under rainfed condition reduced between 3.59% to 17.06% and a reduction of harvest index ranged from 0.26% to 4.71%.

Figure 11: Treatment plots of aus rice varieties at early flowering, grain filling and harvesting stage.

Conclusions

Investigation results suggest that BRRI dhan85 and Binadhan-21 with no hydro soaking along with 80% recommended fertilizer dose gave optimum grain and straw yield. But, Binadhan-21 was more fertilizer responsive than BRRI dhan85 in terms of biological yield. Overall, it was remarkably noticed that application of more fertilizers resulted increased grain sterility, vegetative growth and maturity duration. As this trial covered a limited time and area further trials are necessary to justify the role of different fertilizer doses on the yield and related attributes under dry-DSR system.

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