A Comparative Study of Different Moisture Stress Tolerant Rice Varieties in Kalahandi District of Odisha

ABSTRACT

Plant growth and productivity of rice is adversely affected by various biotic and abiotic stress factors. Water deficit is one of the major abiotic stresses, which affects crop growth and yield. Majority of rice cultivated areas in south Asia is under rainfed, where water stress at any stages of growth causes sharp decline in yield. The present study was carried out through front line demonstration under a 'National Innovation in Climate Resilient Agriculture' (NICRA) project during kharif seasons of 2018 and 2019 in two villages namely Pipalpada and Kinipadar of Kalahandi district of Odisha with an objective to evaluate the performance of short duration rice varieties viz. Swarna Shreya, Sahabhagidhan, DRR-42 and Naveen as compared to the farmers variety (MTU-1010). Swarna Shreya matured in 115 days and recorded higher plant height (126.83 cm), effective tillers/hill (19.33), length of panicle (28.50 cm), number of panicle/m^2 (305.0), filled grains/panicle (128.72) and 1000 grain weight (25.51 g) over other varieties. This variety also produced the highest grain yield of 4.16 t ha^{-1} with harvest index of 0.56 and total dry matter of 538.10 /m^2. The Swarn Shreya produced higher net return of Rs. 41,975/ha with a benefit-cost ratio of 1.20 and additional net return of Rs. 9735/ha as compared to farmers' variety. The growth and yield performance of Swarna Shreya was found to be satisfactory in spite of occurrence of frequent dry spells during different crop growth stages. Thus, the existing variety, MTU-1010, may be replaced with Swarna Shreya for more productivity, income tolerant during moisture stress conditions.

Keywords: Rice, Stress tolerant varieties, NICRA, Kalahandi

1. INTRODUCTION

Rice crop is grown worldwide in varied ecosystems ranging from flood to drought conditions. However drought has been recognized as the primary constraint to rainfed rice production [1] and it is the most significant abiotic stress that affects rice productivity worldwide and is particularly more frequent in Southeast Asia [2]. Nearly 23 million hectares of rainfed rice cultivating area in South and Southeast Asia, is drought-prone and affecting more than 50% of rice yield [3]. Due to the heterogeneity in the rainfed ecosystem, different types of traditional short duration rice landraces are cultivated by farmers.

The breeders are trying to develop short duration rice varieties that could mature early and are photoinsensitive to day length [4]. Short duration varieties can escape harsh dry spells and provide an opportunity to be harvested within a short period of time. It will enhance production through double cropping. It was reported that growing short duration rice can mitigate methane emission, a greenhouse gas, which contributes to climate change [5]. The traditional rice varieties take about 160-200 days to mature and are highly susceptible to climatic stress [6]. Improved short duration varieties could be harvested in about 110 to 130 days. However, the cultivation of rice is dependent on monsoon rain fall in India. In some parts of India, the failure of the monsoon results in water shortage, resulting in below-average crop yield. This is particularly true in major drought-prone regions such as Southern and Eastern Maharashtra, Northern Karnataka, Andhra Pradesh, Odisha, Gujarat, and Rajasthan [7]. Response to drought stress has been studied widely, and the model plant Arabidopsis has guided the studies on crop plants with genome sequence information for other crops like rice, wheat, maize and sorghum. The value of genes, dynamics of its pathways and interaction of networks for drought tolerance in plants can be judged by evidence from field performance [8]. Developing drought tolerant rice cultivars is considered to be one of the most effective and economic approaches to ensuring food security [9]. A large portion about 70% of area under rice in India is drought prone rainfed, but it has not been exploited to full potential due to lack of suitable drought tolerant or resistant varieties [10]. There is hardly any scope to replace the rice crop considering the precipitation of less than 1500 mm rainfall during the monsoon.

The rice variety Swarn Shreya was developed by ICAR Research Complex for Eastern Region, Patna in collaboration with IRRI, Philippines. It has been released and notified in 2016. Swarna Shreya is drought tolerant aerobic rice variety and recommended for cultivation under aerobic situation in rainfed medium lowland and poorly irrigated areas of Chhattisgarh, Madhya Pradesh and Bihar. Swarna Shreya is a semi-dwarf (105-110 cm) variety which flowers in about 85 days and matures in 115-120 days. Productivity of Swarna Shreya is 2.0-2.5 t/ha under drought and 4.0-4.5 t/ha without stress [11].

Keeping in view with this background and after detailed baseline survey an attempt was made with an objective to evaluate the growth and yield parameters of newly released short duration rice variety cv. Swarna Shreya at farmers' fields of NICRA project adopted villages namely Pipalpada and Kinipadar of Kalahandi district of Odisha.

2. MATERIALS AND METHODS

Field experiments on short duration rice varieties were conducted under NICRA project adopted villages i.e. Pipalpada (19.7079˚N, 83.3652˚E) and Kinipadar (20.1964˚N, 83.5189˚E) of Kalahandi district of Odisha during kharif, 2018 and 2019. Fifteen farmers having an average of 0.2 ha of land each were selected for studying the evaluation of performance of short duration rice varieties Swarna Shreya, Shahabgai dhan, DRR-42 and Naveen as compared to the farmers' variety MTU-1010 with recommended package of practices. Morphological and physiological studies were also conducted. The mean maximum and minimum temperature registered in the villages during the year was 35.3^{o}C and 16.4^{o}C respectively. Total of 694.8 and 707.4 mm rainfall were received during 2018 and 2019 respectively. The soil of the experimental site was neutral in reaction (pH 7.18), sandy loam texture with medium organic carbon content (0.51 %), medium in nitrogen (294.3 kg /ha), low in phosphorus (31.6 kg/ha) and medium in potassium (26.7 kg/ha) contents. The trials of varieties were replicated three times in a randomized block design. Observations on different growth and yield parameters were taken and economic analysis was done by calculating cost of cultivation, gross return, net return and B: C ratio. Final crop yield (grain and straw) were recorded and the gross return were calculated on the basis of prevailing market price of the produce. Harvest index is the relationship between economic yield and biological yield. It was calculated by using the following formula [12]. Harvest index (%) = Economic yield / Biological yield. The data were statistically analyzed by using software SAS version 3.0.

3. RESULTS AND DISSCUSSION

The major differences were observed between demonstration package and farmer's practices with respect to recommended varieties, seed treatment, method of sowing, fertilizer dose, method of fertilizer application, weed management and plant protection measures (Table 1). The recommended varieties, seed treating culture, herbicide and plant protection chemicals of demonstrated plot were given to farmer and other practices were timely performed by the farmer himself under the supervision of Scientists of Krishi Vigyan Kendra Kalahandi.

The short duration rice variety Swarna Shreya matured in 115 days. Plant height values indicated that Swarna Shreya exhibited the highest value (128.63 cm), followed by Sahabhagidhan (124.93 cm) whereas the lowest value was shown by MTU-1010 (105.70 cm)

(Table 2). The differential response of tillering in the genotypes could be attributed to its genetic potentiality. These results are in agreement with previous investigators [13, 14, 15]. The lowest number of tillers per hill was recorded in MTU-1010 (10.63/hill). The differential response of tillering in the genotypes could be attributed to its genetic potentiality. These results are also in accordance with previous researchers [13, 14].

Variation in panicle length among the varieties under drought was presented in the Table 2. The data revealed that maximum panicle length was exhibited by Swarna Shreya (28.50 cm) followed by Sahabhagidhan (26.77 cm) whereas minimum value was recorded by MTU-1010 (18.53 cm). It was also noted that the panicle length is positively correlated with the yield. The differential response of genotypes to tillering in the genotype could be attributed to this variation. These results are in agreement with previous researchers [13, 15].

The maximum number of panicles/m^2 was found in (28.50) followed by Sahabhagidhan (26.77 cm) whereas the lowest value was observed in MTU-1010 (18.53). There was significant difference among the cultivars as regard to number of panicles/m^2 (Table 2). The differential response of tillering in the genotypes could be attributed to its genetic potentiality. These results are in accordance with previous researchers [13, 14, 15].

Among the cultivars the filled grains/panicle was highest in Swarna Shreya (128.72/panicle) which was significant greater than others varieties. On the contrary MTU-1010 significant lower value (115.93/panicle) of the same than other genotypes. Significantly difference among the varieties as record to filled grains was noted. The differential response of tillering in the genotype could be attributed to its genetic potentiality. Similar finding were also recorded by previous investigators [14, 15].

Comparison of 1000 seed weight among the genotypes indicated that highest value was recorded in Swarna Shreya (25.51g) followed by Sahabhagidhan (24.32 g) whereas the minimum value was exhibited by MTU-1010 (22.19 g). Further it is also observed that this trait is having positive correlation with grain yield. This might be due to the production of higher number of effective tillers /plant and number of grains/ panicle. These findings were in conformity with previous researchers [16].

Variation in grain yield was observed among the cultivars due to the effect of drought. The data presented in the Table 3 indicated that highest grain yield (4.16 t/ha) was recorded in Swarna Shreya followed by Sahabhagidhan (4.02 t/ha) whereas the lowest yield was recorded in MTU-1010 (3.52 t/ha) which was significantly lower than other cultivars. This might be due to the production of higher number of effective tillers/ plant and number of grains /panicle. These results were in conformity with findings of other [16]. Comparison across the farmer's field indicated that the genotype, Swarna Shreya is highly tolerant to drought for grain yield. The field data also indicated that considerable progress in yield under stress would be possible by selecting early flowering [17].

Variation in straw yield was observed among the cultivars due to the effect of drought. The data presented in the Table 3 indicated that highest straw yield (7.34 t/ha) was recorded in Swarna Shreya followed by Sahabhagidhan (7.21 t/ha) whereas the lowest yield was recorded in MTU-1010 (6.78 t/ha) which was significantly lower than other cultivars. This might be due to the production of higher number of effective tillers/ plant and number of grains/panicle. These results were in conformity with previous researchers [16].

Variation in total dry matter/sq. meter was observed among the cultivars due to the effect of drought and the data is presented in Table 2 which indicated that highest dry matter content per square meter (538.1g) was recorded in Swarna Shreya followed by Sahabhagidhan (531.17g) whereas the lowest dry matter content per m^2 was recorded in MTU-1010 (501.77g), which was significantly lower than other cultivars. This might be due to the production of higher number of effective tillers /plant and number of grains/ panicle. These results were in conformity with previous researchers [16].

Data presented in Table 3 reflected that the harvest index (HI) of the tested cultivars under drought condition ranged from 0.51 to 0.65. The highest value of harvest index was shown in Swarna Shreya (0.56) followed by Sahabhagidhan (0.55) whereas the lowest value was noted in MTU-1010 (0.51). This might be due to the production of higher number of effective tillers/plant and number of grains/panicle. Similar findings were also observed by previous researchers [16].

An analysis on economics (Table 3) revealed that Swarna Shreya recorded higher net return of Rs. 41975/ ha with a benefit cost ratio of 1.20 and additional net return of Rs. 9735 /ha as compared to farmers practice. Other investigators also [18] also reported the

advantages of growing newly introduced variety over the traditional with higher returns, the deviation in net return and benefit-cost ratio may attribute to the variation in the price of agri inputs and produce. These finding are in accordance with previous researchers [19].

Table 1. Comparison of improved demonstration package against the existing farmer practices

Sl. No.	Particulars	Existing farmer practices	Improved Practices on Demonstration
1.	Variety	MTU-1010	Swarna Shreya, Sahabhagidhan DRR-42 Naveen
2.	Time of Sowing	2 nd week of June	2 nd week of June
3.	Method of Sowing	Broadcasting	Line transplanting
4.	Seed rate	50 kg	50 kg
5.	Seed treatment	No seed treatment	Seed treatment with Carbendazime+Mencozeb
6.	Fertilizer dose	Imbalanced use of fertilizer	80:40:40 NPK/ha
7.	Weed management	No use of herbicide	Hand weeding & use of herbicide
8.	Plant Protection	Injudicious use of plant protection chemicals	Need based plant protection measures

Table 2. Growth and yield attributing traits of various moisture stress tolerant rice varieties.

Varieties	Plant Height (cm)	No. of effective tillers /hill	No. of panicles / sq.m	Panicle length (cm)	Filled Grains /Panicle
Swarna Shreya	128.63	19.33	305.00	28.50	128.72
Sahabhagidhan	124.93	17.53	291.00	26.77	124.30
DRR-42	120.20	14.73	275.00	22.17	120.26
Naveen	117.93	11.80	252.67	20.97	118.81
MTU-1010 (FP)	105.70	10.63	233.33	18.53	115.93
Mean	119.48	14.81	271.40	23.39	121.60
SE(m)±	0.10	0.09	0.41	0.18	0.24
CD(0.05)	0.32	0.28	1.35	0.60	0.79
CV(%)	0.14	1.01	0.26	1.36	0.35

FP – Farmers' practice i.e. Control

Table 3. Yield of various moisture stress tolerant rice varieties.

Varieties	Yield (t ha^{-1})	Straw Yield(t ha^{-1})	1000 grain weight	TDM m^{-2}(g)	HI	Net Return	B:C ratio
Swarna Shreya	4.16	7.34	25.51	538.10	0.56	41975.00	1.20
Sahabhagidhan	4.02	7.21	24.32	531.17	0.55	39395.00	1.11
DRR-42	3.89	7.14	23.72	519.97	0.54	36878.33	1.16
Naveen	3.73	6.94	23.45	512.57	0.53	34076.67	1.02
MTU-1010 (FP)	3.52	6.78	22.19	501.77	0.51	32240.00	1.01
Mean	3.86	7.08	23.84	520.71	0.54	36913.00	1.01
SE(m)±	0.06	0.08	0.11	0.24	0.00	63.99	0.06
CD(0.05)	0.18	0.26	0.37	0.78	0.02	208.65	0.18
CV(%)	2.50	1.95	0.82	0.08	1.56	0.30	8.86

FP – Farmers' practice i.e. Control

4. CONCLUSION

This study revealed that drought tolerant variety Swarna Shreya produced higher yield with more tillering capacity and resistance to drought. Overall, the performance of this FLD results suggested that it has the potential for increase knowledge of the farmer as well as showed high level at satisfaction MTU-1010 may be replaced with moisture stress tolerant variety Swarna Shreya because of higher productivity, income and drought tolerant capacity. Drought tolerant variety Swarna Shreya was found to be suitable since it fits well to the existing farming situation and also it had been appreciated by the farmers.

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