

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 adversely affects crop growth and yield. ~~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 adversely affects crop growth and yield.~~

~~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 adversely affects crop growth and yield. Plant growth and productivity of rice crop is adversely affected by various biotic and abiotic factors. Water deficit is the most critical abiotic factor affecting rice yield in drought-prone areas.~~ Majority of rice cultivated area in south Asia ~~are is~~ under rainfed, where water stress at any of the critical growth stages 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 performances of short duration rice varieties viz. *Swarna Shreya*, *Shahabgai dhan*, *DRR-42* and *Naveen* as compared to the farmers ~~practice-variety~~ (*MTU-1010*). *Swarna Shreya* matured ~~at-in~~ 115 days, ~~and~~ recorded higher plant height (126.83 cm), effective tillers/hill¹ (19.33), length of panicle (28.50 cm), number of panicle/m² (305.0), filled grains/panicle (128.72) and 1000 grain weight (25.51 g) ~~than Shahabgai dhan and over~~ other varieties. ~~The This variety also same 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 /m²) and it is highest among the other varieties.~~ The *Swarna Shreya* ~~rice~~ 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 /ha as compared to farmers' ~~practice-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 ~~by-with~~ *Swarna Shreya* for more productivity, income ~~as well as more tolerant to during~~ moisture stress conditions.

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Keywords: Rice, Moisture ~~Stress-stress~~ tolerant varieties, NICRA, Kalahandi

Introduction

Rice crop is grown worldwide in varied ecosystems ranging from flood to drought conditions (Sheehy *et al.*, 2001) and consumed by 60 per cent of the world population. However drought has been recognized as the primary constraint to rainfed rice production (Datta, *et al.*, 1975) and it is the most ~~signifienat~~ significant abiotic stress that affects rice productivity worldwide and is particularly more frequent in Southeast Asia (Pandey and Shukla, 2015). Nearly 23 million hectares of rainfed rice cultivating area ~~in-in~~ South and Southeast Asia, is drought-prone and affecting more than 50% of rice yield (Rahman and Zhang, 2016). Due to the heterogeneity in the rainfed ecosystem, different types of traditional short duration rice landraces are cultivated by farmers.

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The ~~modern~~ breeders are trying to ~~obtain-develop~~ short duration rice varieties that could mature ~~quickly-early~~ and are photoinsensitive ~~to day length~~ (Bagchi *et al.*, 2012). 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. In addition to that Hasan (2014) reported that growing short duration rice can mitigate methane emission, a greenhouse gas, that contributes to climate change. The traditional rice varieties take about 160-200 days (De Datta, 1981) to mature and are highly susceptible to climatic stress. 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 of in major drought-prone regions such as ~~southern~~ Southern and ~~eastern~~ Eastern Maharashtra, ~~northern~~ Northern Karnataka, Andhra Pradesh, ~~Orissa~~ Odisha, Gujarat, and Rajasthan (Mall *et al.*, 2006). Response to drought stress has been studied widely, and the model plant Arabidopsis has guided the studies on crop plants with genome sequence information viz., for other crops like rice, wheat, maize and sorghum. Since the value of functions of genes, dynamics of pathways and interaction of networks for drought tolerance in plants can only be judged by evidence from field performance (Shanker *et al.*, 2014). Developing drought tolerant rice cultivars is considered to be one of the most effective and economic approaches to ensuring food security (Verma and Srivastava, 2004). 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 (Kumar *et al.*, 2012). There is hardly any scope to replace the rice crop considering the precipitation of less than 1500 mm rainfall during the monsoon season.

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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 farmer's fields of NICRA project adopted villages namely Pipalpada and Kinipadar of Kalahandi district of Odisha.

MATERIALS AND METHODS

Field experiments on short duration rice varieties were conducted at under NICRA project adopted villages viz.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 numbers of farmers each having an average of 0.2 ha of land 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 practice variety, *(MTU-1010)* with recommended package of practices. Morphological and physiological studies were also

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conducted ~~for the rice cultivars which are related to yield~~. The mean maximum and ~~mean~~ minimum temperatures registered in the villages during the year was 35.3°C and 16.4°C respectively. Total of 694.8 and 707.4 mm rainfall ~~were~~ received during 2018 and 2019, respectively ~~during the cropping period erratically~~. 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 ~~performance~~ trials of ~~said~~ 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 (Gardner *et al.*, 1985) and ~~was~~ calculated by ~~using the~~ following formula

$$\text{Harvest index (\%)} = \text{Economic yield} / \text{Biological Yield}$$

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The data were statistically analyzed applying the techniques of analysis of variance and the significance of different sources of variations were tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05 (Cochran and Cox, 1977).

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 ~~data showed that under the demonstrated plot only~~ 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 ~~itself himself~~ under ~~the~~ supervision of Scientists of ~~the~~ Krishi Vigyan Kendra, Kalahandi. .

Yield attributes

The short duration rice variety, *Swarna Shreya*, matured ~~at-in~~ 115 days. Plant height ~~as recorded values~~ indicated that ~~highest value (128.63cm) was exhibited by~~ *Swarna Shreya* ~~exhibited the highest value (128.63cm)~~, followed by *Sahabhazi dhan* (124.93 cm) where~~as~~ the lowest value ~~of the same~~ was shown by *MTU-1010* (105.70 cm) ~~as indicated in~~ (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 (Sarker *et al.*, 2013; Samanta *et al.*, 2015; Mishra, 2019). ~~The total number of effective tillers as recorded indicated that higher number of effective tillers per hill was contributed by Swarna Shreya (19.33/hill) followed by Sahabhazi dhan (17.53/hill).~~ The lowest number of tillers per hill was recorded ~~from-in~~ *MTU-1010* (10.63/hill). The differential response of tillering in the genotypes could be attributed to its genetic potentiality. These results are in agreement with Sarker *et al.* (2013) and Mishra (2019).

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Variation in panicle length among the varieties under drought ~~tolerance~~ was presented in the Table-2, ~~which-The data~~ revealed that maximum panicle length was exhibited by *Swarna Shreya* (28.50 cm) followed by *Sahabhazi dhan* (26.77 cm) where as minimum value ~~of the same~~ was ~~shown-recorded~~ by *MTU-1010* (18.53 cm). Significant difference among the genotypes was not exhibited. 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 ~~its genetic potentiality~~ ~~this variation~~. These results are in agreement with Sarker *et al.*, (2013) and Samanta *et al.* (2015).

The maximum number of panicles/m² was found in *Swarna Shreya* (28.50) followed by *Sahabhazi dhan* (26.77 cm) where as the lowest value ~~of the same~~ was observed in *MTU-1010* (18.53). There was significant difference among the cultivars as regard to number of panicles/m² (Table 2). There was positive correlation with the grain yield. The differential response of tillering in the genotypes could be attributed to its genetic potentiality. These results are in agreement with previous researchers ~~(like~~ Sarker *et al.*, 2013, Samanta *et al.*, 2015, ~~and~~ Mishra 2019).

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 genotypes could be attributed to its genetic potentiality. These results are in agreement with Samanta *et al.* (2015) and Mishra (2019)

Comparison of 1000 seed weight among the genotypes indicated that highest value was recorded ~~from in~~ *Swarna Shreya* (25.51g) followed by *Sahabhagi dhan* (24.32 g) where as the minimum value ~~of the same~~ was exhibited by *MTU-1010* (22.19 g). ~~From the Table 3~~ ~~Further, it is also observed that was found that there was 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 results were in conformity with Tripathi *et al.* (2013).

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 ~~from in~~ *Swarna Shreya* followed by *Sahabhagi dhan* (4.02 t/ha) whereas the lowest yield was recorded from *MTU-1010* (3.52t/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 Tripathi *at el.* (2013). Comparison across the farmer's field indicated that the genotype, *Swarna shreya*, ~~emerged as is~~ highly tolerant ~~for grain yield to drought. However, the~~ field data also indicated that considerable progress in yield under stress would be possible by ~~selection selecting for earlier~~ early flowering ~~and improved yield potential alone~~ (Fussell *et al.*, 1991).

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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 ~~S~~ straw yield (7.34 t/ha) was recorded ~~from in~~ *Swarna Shreya* followed by *Sahabhagi dhan* (7.21 t/ha) whereas the lowest yield was recorded ~~from 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 Tripathi *et al.* (2013).

Variation in total dry matter/sq. meter (TDM~~-/-~~sq.m) was observed among the cultivars due to the effect of drought ~~and the~~ data ~~is~~ presented in ~~the~~ Table 2 ~~which~~ indicated that highest dry matter content per sq.m (538.1g) was recorded ~~from in~~ *Swarna Shreya* followed by *Sahabhagi dhan* (531.17g) whereas the lowest dry matter content per m² was recorded ~~from 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 Tripathi *et al.* (2013).

Data presented in Table 3 reflected that the ~~Harvest-harvest Index-index~~ (HI) of the tested cultivars under drought condition ranged from 0.51 to 0.56. ~~This~~ The highest value of ~~Harvest-harvest~~ index was shown in *Swarna Shreya* (0.56) followed by *Sahabhagi dhan* (0.55) whereas the lowest value ~~of the same~~ was ~~shown-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. These results were in conformity with Tripathi *et al.* (2013).

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. Mitra *et al.* (2014) also reported the advantages of growing newly introduced variety over the traditional with higher returns, the ~~variation~~ deviation in net return and benefit-cost ratio may ~~be~~ attributed to the variation in the price of agri inputs and produce. These finding are also similar with the findings of Nirmala *et al.* (2012).

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	<i>Swarna Shreya</i> , <i>Sahabhagi dhan</i> <i>DRR-42</i> <i>Naveen</i>
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 demonstrated in Kalahandi district of odisha

Treatments	Plant Height (cm)	No. of effective tillers /hill	No. of panicles / sq.m	Panicle length (cm)	Filled Grains /Panicle
<i>Swarna Shreya</i>	128.63	19.33	305.00	28.50	128.72
<i>Sahabhagi dhan</i>	124.93	17.53	291.00	26.77	124.30
<i>DRR-42</i>	120.20	14.73	275.00	22.17	120.26
<i>Naveen</i>	117.93	11.80	252.67	20.97	118.81
<i>MTU-1010 (FP)</i>	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 demonstrated in Kalahandi district of Odisha

Treatments	Yield (t ha ⁻¹)	Straw Yield(t ha ⁻¹)	1000 grain weight	TDM m ⁻² (g)	HI	Net Return	B:C ratio
<i>Swarna Shreya</i>	4.16	7.34	25.51	538.10	0.56	41975.00	1.20
<i>Sahabhagi Dhan</i>	4.02	7.21	24.32	531.17	0.55	39395.00	1.11
<i>DRR-42</i>	3.89	7.14	23.72	519.97	0.54	36878.33	1.16
<i>Naveen</i>	3.73	6.94	23.45	512.57	0.53	34076.67	1.02
<i>MTU-1010 (FP)</i>	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

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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