# 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 under rainfed, where water stress at any of the critical growth stage causes sharp decline in yield. The 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 *(MTU-1010). Swarna Shreya* matured at 115 days, recorded higher plant height (126.83 cm), effective tillers/hill[1] (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) than *Shabhagi dhan* and other varieties. The same also produced grain yield 4.16 t $ha^{-1}$ with harvest index (0.56) and total dry matter (538.10 /$m^2$) and it is highest among the other varieties. The *Swarn Shreya* rice produced higher net return Rs. 41,975/ha with a benefit-cost ratio of 1.20 and additional net return Rs. 9735 ha /ha as compared to farmers' practice. 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 *Swarna Shreya* for more productivity, income as well as more tolerant to moisture stress.



**Keywords:** Rice, Moisture Stress tolerant varieties, NICRA, Kalahandi


## Introduction

Rice crop is grown worldwide in varied ecosystems ranging from flood to drought condition (Sheehy *et al*., 2001) and consumed by 60 percent 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 significnat 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 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.

The modern breeders are trying to obtain short duration rice varieties that could mature quickly and are insensitive to day length (Bagchi *et al.,* 2012). Short duration varieties can escape harsh dry spells and provide a 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 major drought-prone regions such as southern and eastern Maharashtra, northern Karnataka, Andhra Pradesh, Orissa, 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., 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.

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 field 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 NICRA project adopted villages *viz.* Pipalpada (19.7079˚N, 83.3652˚E) and Kinipadar (20.1964˚N, 83.5189˚E) of Kalahandi district during Kharif, 2018 and 2019. Fifteen numbers of farmers each having an avg. 0.2 ha of land were selected for studying the evaluation of performance of short duration rice *var. Swarna Shreya, Shahabgai dhan*, *DRR-42* and *Naveen* as compared to the farmers practice *(MTU-1010)* with recommended package of practices. Morphological and physiological studies were conducted for the rice cultivars which are related to yield. The mean maximum and mean 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 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 calculated by following formula

**Harvest index (%) =** Economic yield / Biological Yield

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 were given to farmer and other practices were timely performed by the farmer itself under supervision of Scientists of the Krishi Vigyan Kendra Kalahandi. .



### Yield attributes

The short duration rice variety *Swarna Shreya* matured at 115 days. Plant height as recorded indicated that highest value (128.63c.m) was exhibited by *Swarna Shreya,* followed by *Sahabhagi dhan* (124.93 cm) where 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 genotype 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 *Sahabhagi dhan* (17.53/hill). The lowest number of tillers per hill was recorded from *MTU-1010* (10.63/hill). The differential response of tillering in the genotype could be attributed to its genetic potentiality. These results are in agreement with Sarker *et al.* (2013) and Mishra (2019).

Variation in panicle length among the varieties under drought tolerance was presented in the Table-2, which revealed that maximum panicle length was exhibited by *Swarna Shreya* (28.50 cm) followed by *Sahabhagi dhan* (26.77 cm) where as minimum value of the same was shown 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 tillering in the genotype could be attributed to its genetic potentiality. These results are in agreement with Sarker *et al.,* (2013) and Samanta *et al.* (2015)

The maximum number of panicles/$m^2$ was found in (28.50) followed by *Sahabhagi 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/$m^2$ (Table 2). There was positive correlation with the grain yield. The differential response of tillering in the genotype could be attributed to its genetic potentiality. These results are in agreement with previous researchers (Sarker *et al.,* 2013, Samanta *et al.,* 2015, 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 genotype 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 *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 it was found that there was 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 *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 highly tolerant for grain yield. However, the field data also indicated that considerable progress in yield under stress would be possible by selection for earlier flowering and improved yield potential alone (Fussell *et al*., 1991).

Variation in Straw yield was observed among the cultivars due to the effect of drought data presented in the Table 3 indicated that highest Straw yield (7.34 t/ha) was recorded from *Swarna Shreya* followed by *Sahabhagi dhan* (7.21 t/ha) whereas the lowest yield was recorded from *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 data presented in the Table 2 indicated that highest dry matter content per sq.m (538.1g) was recorded from *Swarna Shreya* followed by *Sahabhagi dhan* (531.17g) whereas the lowest dry matter content per $m^2$ was recorded from *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 Index (HI) of the tested cultivars under drought condition ranged from 05 to 0.6. This highest value of Harvest index was shown in *Swarna Shreya* (0.56) followed by *Sahabhagi dhan* (0.55) whereas the lowest value of the same was shown 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 Rs. 41975/ ha with a benefit:cost ratio 1.20 and additional net return 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 return, the variation 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 | *Swarna Shreya,*<br>*Sahabhagi dhan*<br>*DRR-42*<br>*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 base 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 |
|---|---|---|---|---|---|
| ***Swarna Shreya*** | 128.63 | 19.33 | 305.00 | 28.50 | 128.72 |
| ***Sahabhagi dhan*** | 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 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 |
|---|---|---|---|---|---|---|---|
| ***Swarna Shreya*** | 4.16 | 7.34 | 25.51 | 538.10 | 0.56 | 41975.00 | 1.20 |
| ***Sahabhagi Dhan*** | 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

## 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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