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Assessment of stress tolerant rice (*Oryza sativa* L.) variety under rain fed condition of south east part of Bihar

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Abstract
Drought stress significantly diminished its productivity and threated global food security. The front line demonstration was carried out during Kharif season of 2020-21 and 2021-22 in three villages of the Jamui district of South East part of Bihar. The present study was conducted to assess the performance of drought tolerant rice variety Swarn Shreya and Swarn Shakti as compared to local check Sahbhagi dhan. It was observed that the Rice variety Swarn Shreya recorded higher yield (36.45 q ha^{-1}) compared to all other varieties Swarn Shakti (33.8 q ha^{-1}) and Sahbhagi dhan (29.2 q ha^{-1}). Overall performance of Rice variety Swarn Shreya was better in terms of plant height (101.5), no. of effective tillers m^2 (268.6), spike length (21.5), no. of grains per spike (148.5), test weight (23.0) and produce 24.82% more grain yield as compared to local check Sahbhagi dhan. Highest economic return with B:C ratio (1.7) was also recorded with Swarn Shreya. So, drought tolerant rice variety Sahbhagi dhan can be replaced with Swarn Shreya in rainfed conditions of South East part of Bihar.

Keywords: Swarn Shreya, Swarn shakti, drought tolerant, economic etc.

Introduction
Rice (*Oryza sativa* L.) is the most important staple food crop for more than half of the world's population, including regions of high population density and rapid growth. It provides about 21 percent of the total calorie intake of the world population (Farooq *et al*., 2011) [4]. It is the primary source of calories for about half of mankind and provides around 27 per cent dietry energy, 15 per cent of dietary protein and 3 percent of dietry fat to global population. The area under its cultivation is 167 million hectares producing 770 million tones and a productivity of 4.60 tons/ha in the world (FAOSTAT, 2017) [5]. Rice is a monocotyledonous angiosperm. The genus, to which it belongs, *Oryza*, consists more than 20 species, only two of which are cultivated rice: *Oryza sativa* L., cultivated in South-East Asian countries, and *Oryza glaberrima* L. cultivated in West Africa. Rice was originally cultivated in tropical Asia, the oldest record dating 5000 years BC, but then extended to temperate regions. More than 90% of the world's rice is grown and consumed in Asia, where 60% of the world's population lives. Rice accounts for 35-60% of the caloric intake of three billion Asians. Over 150 m ha of rice is cultivated annually, covering about 10% of the world's arable land. In 1999-2000, this amounted to some 600 mt of rice seed, equal to 386 mt of milled rice. With the world population estimated to increase from 6.2 billion in the year 2000 to about 8.2 billion in the year 2030, the global rice demand will rise to about 765 mt, or 533 mt of milled rice. For almost three decades since the Green Revolution, the rice yield growth rate is only 2.5% per year. The increasing human population increased food consumption, increasing food demands required grain yield enhancements in cereal crops (rice, wheat, barley maize) (Gouda *et al*., 2020) [3]. The country's total rice cultivated area is 43.79 million ha with production of 111.42 million tones and productivity of 2659 kg ha^{-1} (Anonymous 2019). India had over 46 million hectare of land area of cultivation of rice. In financial year 2022 the yield of rice across India was estimated to be approximately 2.8 thousand kilogram per hectare (Statista 2022) [6]. Bihar has around 3.2 million ha of land under Rice.

As per the latest data of food grains production for 2021-22 the state rice production was 77.17 lakh metric tons (Hindustan 2023). It is cultivated under diverse ecological ranging from irrigated to rainfed upland to rainfed lowland to deep water. Drought is the most widespread and damaging of all environmental stress, affecting 23 million hectares of rainfed rice in South and Southeast Asia alone. The frequent occurrence of drought has identified as the key to the low productivity of rice in rainfed ecosystems, particularly in eastern region of India (Kumar *et al*., 2008; Verulkar *et al*., 2010) [11, 18]. In India, out of the total 20.7 m. ha. Rainfed rice area, approximately 16.2 m. ha. Are in eastern India. Farmers faces serious challenges of low income due to different reasons associated with rice production system. Among them, drought is a major abiotic stress that adversely affects the rice growth and production mainly in the rainfed ecosystem (Emam *et al*., 2014) [3]. Eastern states of India accounting for 27.26 million ha rice area, out of which 16.2 million ha is rainfed and nearly 4.28 million ha area is prone to frequent drought (IRRI, 2013) [9]. Rice productivity is generally predicted by its agronomic attributes, such as the number of productive tillers, number of grains per panicle, 1000-grain weight, plant height, panicle length, grain size, and weight (Hua *et al*., 2002) [4]. These agronomics attributes are inherited and regulated through multiple genetics expressions. Most of the modern cultivar's production potential remains stangnant because of the inability to cope with abiotic stress factors, i.e., drought, submergence and salinity (Sabina *et al*., 2010) [14].

Rice has three sensitive growth stages concerning drought stress: early seedling, vegetative, and anthesis (reproductive) (Singh *et al*., 2012). Water scarcity in the early seedling stage reduces drought stress, leading to unbalanced and poor stand establishment (Vibhuti *et al*., 2015) [19]. Drought stress interrupted active seed germination, causing osmotic imbalance, membrane impairment, decreased respiration and ATP production (Kadam *et al*., 2017) [10]. Water constraint during the vegetative period causes delayed panicle initation, followed by late maturity (Singh *et al*., 2012) [16], directly correlated with yield decline. The most damaging impact of drought stress on grain yield appears to be during the reproductive growth stage. However, plants tend to recover during the vegetative growth phase, but recovery from the drought stress during the flowering phase is more complicated (Alam Khan, 2012 Xangsayasane *et al*., 2014) [1, 20]. Generally, drought is induced at one specific stage to select tolerant genotypes. However, in rainfed conditions, the occurrence of drought is not stage specific it can occur at any development stage of rice (seedling, vegetative and reproductive) due to greater temporal variability and long break between showers. In rainfed areas, upon failure of rain or a long spell between two rains, drought stress can occur at seedling, vegetative and reproductive stages of the rice, it can be intermittent drought depending upon the rainfall pattern and distribution (Kumar *et al*., 2011) [11]. Among all these, drought at the reproductive stage has been identified as the most detrimental to grain yield. Moreover, in most rainfed regions, the probability of occurrence of terminal reproductive-stage drought is high due to the early withdrawal of monsoon rains (Kumar *et al*., 2008) [11]. The eastern region comprises of Bihar, Eastrn Uttar Pradesh, Odisha, West Bengal, Jharkhand, Chhattisgarh and plains of Assam, represents 21.85% geographical area of the country and supports to 33.65% of country,s production (Bhatt *et al*., 2011) [2]. Eastern India according for 71.84 million ha geographical area and 27.26 million ha rice area which nearly 4.28 million ha rice araea is prone to frequent drought

Table 1: Geographical areas, rice area and drought prone

States	Geographical areas (m ha)	Rice area (MHA)	Drought prone rice area (m ha)	% Rice drought prone area
Bihar	9.41	3.20	0.725	23
Eastern UP	8.64	5.92	0.985	17
West Bengal	8.87	5.94	0.956	16
Assam	7.84	2.50	0.221	9
Odisha	15.57	4.35	0.631	14
Jharkhand	7.97	1.67	0.243	15
Chhattisgarh	13.51	3.66	0.521	14
Eastern India	71.84	27.26	4.281	16

Source: IRRI (2013) [9]

Keeping the above point in view a front line demonstration were conducted to evaluate the performance of drought tolerance Rice variety Swarn Shreya and Swarn Shakti with recommended package and practices in Jamui district.

Materials and Methods

The present study was carried out by the Krishi Vigyan Kendra, Jamui (Bihar Animal Sciences University, Patna) in Kharif season at farmers field of six villages of Jamui district. during Kharif season of 2020 – 2021 and 2021 - 2022. All 18 front line demonstrations on stress tolerant Rice variety Swarn Shakti and Swarn Shreya were conducted in nine acre area along with control plots (FP) as local check (Rice variety Sahbhagi) during both the years in adopted villages i.e. Malayapur, Navdeha and Kairakado village. Six farmers from each village was selected for demonstration. Before conducting front line demonstration a list of farmers was prepared from group meeting and specific skill training was imparted to the selected farmers regarding different aspects of cultivation etc. were followed as suggested by Choudhary (1999) and Venkatta kumar *et al.* (2010). The soil of the experimental site is characterized as sandy loam in texture (60% sand, 26% silt and 13% clay), low water holding capacity, slightly acidic in soil reaction (pH 6.95), non-saline conductivity (0.25 dsm^{-1}), medium in organic carbon with low available water, medium available phosphorus and potassium were 278 kg ha^{-1}, 27.5 kg ha^{-1}, and 155 kg ha^{-1}. During kharif season 2020 – 21 and 2021-22 a total of 672.5mm and 743.2 mm rainfall were recorded. Rice nursery was raised by broadcasting of the seeds on beds @ 25 kg ha^{-1}. Transplanting was done using 21 – 25 days old seedlings were uprooted and transplanted @ 2 seedlings hill-1 about 2 – 3 cm deep in soil at 20 X 15 cm spacing manually in demonstrated plot. A fertilizer dose of 40 kg ha^{-1}, P_2O_5 (phosphorus) and 20 kg ha^{-1} K_2O were applied as basal dose at the time of transplanting in the form of single super phosphate and murate of potash respectively. Nitrigen 80 kg ha^{-1} was applied in three equal splits *viz*., as basal at the time of transplanting, maximum tillering and panicle initation stage respectively. For control of weeds pyrazosulfuron @ 25 gram ai.

ha^{-1} was applied within 2 – 3 days of transplanting in both years. Field day was organised at demonstration plots to disseminate the message at large scale. The demonstration farmers were facilitated by KVK Scientists in performing like seed treatment, transplanting, herbicide spraying, fertilizer application and harvesting etc. The traditional practices were maintained in case of local checks. The data were collected from both demonstrated plots as well as control plots (FP). The field observation were taken from demonstration plot and farmers plot as well. Parameters like Plant height, No. of effective tillers, Panicle length, No. of grains per panicle, Grain and Straw yield. The crop was harvested manually with the help of sickles. The crop was harvested manually with the help of sickles. After harvesting of the crop in each demonstration plots as well as local check (FP), threshing, cleaning and drying of the grain was done and weight of the grain and straw, and expressed as quintal ha^{-1}.

Table (2): Difference between FLD plots and Local Check (Farmers Practice)

S. No.	Particulars	Demonstration plot (Swarn Shakti)	Demonstration plot (Swarn Shreya)	Local Check (FP)
01.	Variety	Improved Variety	Improved Variety	Sahbhagi
02.	Seed Rate	25 kg ha^{-1}	25 kg ha^{-1}	30 - 35 kg ha^{-1}
03.	Seed treatment	Treatment with Fungicide and Insecticide	Treatment with Fungicide and Insecticide	No seed treatment
04.	Method of Transplanting	Line Transplanting	Line Transplanting	
05.	Weed management	Pre- emergence herbicide pyrazosulfuron @ 25 gram ai. ha^{-1}	Pre- emergence herbicide pyrazosulfuron @ 25 gram ai. ha^{-1}	01 Manual weeding
06.	Fertilizer	80:40:20 (N:P:K)	80:40:20 (N:P:K)	Imbalance dose and excess use of nitrogenous fertilizer
07.	Weed management	Pyrazosulfuron @ 25 g ha^{-1}	Pyrazosulfuron @ 25 g ha^{-1}	Manual weeding
08.	Plant Protection	Carbofuron 3G @ 25 kg ha^{-1} at 35 DAT	Carbofuron 3G @ 25 kg ha^{-1} at 35 DAT	Need based
09.	Plant Protection	Need Based		Improper measures
10.	Technical Guidance	Time to Time		Nil

Result and Discussion

The analysis of data provided various results which are presented in table and discussed below

Table 3: Growth and yield attributes as influenced by Rice varieties.

Variety	Plant Height (cm)	No. of effective tillers	Panicle length (cm)	No. of grains $panicle^{-1}$	Test weight (g)	Grain yield q ha^{-1}	Straw yield q ha^{-1}	Harvest index
Swarn Shakti	96.6	245.2	20.4	145.2	22.2	33.8	50.5	40.09
Swarn Shreya	101.5	268.6	21.5	148.5	23	36.45	54.2	40.29
Shabhi dhan	95.5	214.6	19.6	136.7	21.5	29.2	46.8	38.42
F- test	S	S	S	S	S	S	S	NS
Sed+	0.84	0.29	0.46	0.16	0.3	0.54	0.39	0.26
CD (P=0.5)	2.43	0.88	1.38	0.47	0.92	1.6	1.19	0.8

Rice variety Swarn Shreya produced higher plant height (101.5 cm), more no. of effective tillers (286.5), panicle length (21.5 cm), no. of grains per panicle (148.5), test weight (23.0), grain (36.45 q ha^{-1}) and straw yield (54.2 q ha^{-1}). Rice variety Swarn Shreya significantly influenced the yield attributing characters of rice and found to be significantly superior than Rice variety Swarn Shakti and Sahbhagi (S.R. Das *et al*., 2021) [17], harvest index was found to be non significant. Where as Swarn Shakti and Sahbhagi gave a yield of 33.8 q ha^{-1} and 29.2 q ha^{-1} with plant height of 96.6 cm and 95.5, number of effective tillers of 245.2 and 214.6, panicle length of 20.4 cm and 19.6 cm, number of grains per panicle of 145.2 and 136.7 and test weight of 22.2 g and 21.5 g respectively. The higher value of rice variety Swarn Shreya has showed excellent performance at farmers field under rainfed situations with 24.82% higher than Sahbagi dhan (FP). The major difference were observed between demonstration technology and farmers practice were optimum seed rate, line transplanting, balance dose of fertilizer and plant protection measure. These difference with more stress tolerant capacity of Swarn Shreya (Malik et. al., 2020) [12] could exhibit superior performance. Rice plant respond to drought through alternation in morphological, physiological and metabolic traits. Understanding of physiological and biochemical mechanism that enable plants to adapt to water deficit and maintain growth and productivity during stress. The genotypes, which produced higher number of effective tillers m2, longer panicle length and higher number of grains per panicle also showed higher grain yield in rice, similarly results have been reported earlier by (Malik *et al*., 2020, Mangaraj *et al*., 2012) [12].

Table 4: Economics of different Rice varieties.

Variety	Cost of Cultivation Rs. ha^{-1}	Gross Return Rs. ha^{-1}	Net Return Rs. ha^{-1}	B:C ratio
Swarn Shakti	27,600	68,952	41352	1.5
Swarn Shreya	27,600	74,358	46,758	1.7
Shabhi dhan	26,500	59,568	33,068	1.2

Economics

The inputs and outputs prices of commodities prevailed during demonstrations were taken of calculating cost of cultivation, net returns and benefit cost ratio in table (4). The demonstration of

Swarn Shreya and Swarn Shakti under recommended package and practices was calculated both of Rs. 27,600 per ha. against farmers practice(Sahbhagi) of Rs. 26,500 per ha. Demonstrated technology Swarn Shreya gave higher net returns of Rs. 46,758 per ha. as compared to Swarn Shakti and Sahbhahi dhan of Rs. 41,352 and Rs. 33,068 per ha respectively. The more benefit cost ratio was calculated with demonstrated technology (Swarn Shreya 1.7) as compared to Swarn Shakti (1.5) and Sahbhagi dhan (1.2). This may be due to higher yields obtained under improved practices compared to farmers practices. Though the cost of cultivation was higher with demonstrated technology but higher economics return was also obtained with this practices (Swarn Shreya) because of increase of yield by 24.82%, whereas increased cost of cultivation was less i.e. 4.1% as compared to Sahbhagi dhan (S.R. Das *et al*. 2021 and Malik *et al*., 2020) [17, 12]. was also reported higher economics return with Swarn Shreya as compared to Sahbhagi dhan.

Conclusion

It was concluded that drought tolerant Rice variety Swarn Shreya recorded highest grain yield followed by Swarn Shakti and Shabhagi dhan. Rice variety Swarn Shreya was also gave more economic return to the farmers. So, rice variety Sahbhagi dhan may be replaced with Swarn Shreya for more production and higher economics return for farmers of South East part of Bihar in changing rainfall scenario.

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