



Evaluation of Short Duration Drought Tolerant Rice Varieties in Drought Prone Areas of Subarnapur District of Odisha

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Authors' contributions

This work has been carried out in the aegis of KVK Subarnapur with the collaboration among all the authors. Author SP has designed the study, performed the statistical analysis, wrote the manuscript. Author FHR edited the whole manuscript. Authors SS, GP and JS managed the literature searches and arranged the bibliography of the paper. All authors have read and approved the final manuscript.

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ABSTRACT

A study was conducted in farmer's field through technology demonstrations during Kharif season of 2018 and 2019 in Subarnapur district of Odisha to recommend the most suited short duration drought tolerant upland rice variety particular to the locality. Six different varieties like Sahabghagi dhan, Mandakini, Jogesh, DRR-44, and DRR-42 & Khandagiri were taken with four replications in Randomized Block Design in both years. Technology demonstration included not only the improved short duration varieties, but also a package of good agronomic practices viz. line sowing, seed treatment with Bavistin, proper fertilization with dose @ 80:40:40 NPK/ha, pre emergence herbicide application with pretilachlor, needful manual weeding and need based plant protection chemicals. The results of demonstration showed that farmers could increase rice productivity notably by

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adopting improved variety *Sahabhazi dhan* and *DRR-44*. These varieties recorded higher grain yields of 64% and 46%, respectively, and fetched a sum return of Rs 25620 and Rs 25275 over farmers' local variety *Khandagiri*.

Keywords: *Technology demonstration; drought; Sahabhadhan; yield, rice; water productivity.*

1. INTRODUCTION

Rice is the staple crop of Odisha with a total coverage of 4.0 million hectares which is about 65 % of the total cultivable area of the state. Area under rice crop in Subarnapur district of the state is 121300 hectares with productivity of 9.80 q/ha. Rice is a versatile crop having maturity duration varying from 80 days to 180 days that can be grown under wide range of climatic conditions including water stagnation to aerobic condition. Achieving self-reliance in rice production and maintaining price stability are important objectives in low-income countries because of the importance of this crop in providing national food security and income for low-income people [1]. Developing drought tolerant rice cultivars is considered to be one of the most effective and economic approaches for ensuring food security particularly in drought prone areas like Badmal, Dipapali and Ganjathapar villages of Subarnapur. About 70% of area under rice in India is drought prone rain-fed, but it has not been exploited to full potential due to lack of suitable drought tolerant or resistant varieties [2]. There is hardly any scope to replace the rice crop considering the precipitation of less than 1500 mm rainfall during the monsoon season. However, multiple cropping system including short duration rice varieties and intensive crop management may enhance the land use efficiency, water use efficiency and increase the production level if sowing of rabi crops are made in advance with respect to water availability [3]. Apart from this, rice crop is mostly affected by the changing climate scenario; consequently productivity of rice is severely affected by terminal heat stress and drought. So, immediate attention with respect to climate mitigation and adaption strategy is the need of the hour for sustained productivity. Hence, it is imperative to introduce a short duration high yielding rice variety in existing rice-based cropping system in west central table land zone of Odisha. If the farmers are able to harvest their kharif rice 25-30 days earlier than usual time then they could be able to sow their next crop in time during rabi. The new improved technologies will eventually lead to the farmers to discontinue the use of old varieties and to adopt new ones [4]. Keeping these facts in view,

different drought tolerant varieties have been demonstrated in three drought prone villages named Badmal, Dipapali, Ganjathapar of Subarnapur district of Odisha.

2. MATERIALS AND METHODS

The study was carried out through demonstration during kharif season of 2018 and 2019 at Badamal, Dipapali and Ganjathapar villages in Subarnapur district under west central table land zone of Odisha with an objective to assess and recommend the most suited variety of short duration paddy cv. *Sahabhazi dhan*, *Mandakini*, *Jogesh*, *DRR-44* and *DRR-42* as compared to the farmers local variety i.e. *Khandagiri* as control. The experimental site lies in 83° 52' 34.4'' E longitudes and 20°50'54.1'' N latitude. Climate of the region is fairly hot and dry spells during monsoon and the average rainfall in both years during the study period from June to September was 1438 mm. The mean maximum and mean minimum temperature registered in both years was 34°C and 24°C, and 38°C and 26°C respectively. Crops in kharif experienced moisture stress twice of 4 days and 6 days duration coinciding with active tillering stage during July 2019. The soil of the experimental site was neutral in reaction (pH 6.5-7.3).

The tested high yielding variety *Sahabhazi dhan* was released from Central Rice Research Institute (CRRI) in 2009 can be suitably direct sown or transplanted in rain-fed upland ecosystem and tolerant to drought and resistant to leaf blast, moderately resistant to brown spot, sheath rot, stem borer, leaf folder. *Mandakini* (100 days) was released from Orissa University of Agriculture and Technology (OUAT) in 2010. It is resistant to gall midge, leaf folder, and whorl maggot and moderately resistant to rice tungro virus. It also shows resistance to lodging, shattering withstands late sown conditions. *Jogesh* (90 days) was released from OUAT in 2005 which is tolerant to moisture stress condition and is resistant to brown spot, sheath blight, neck blast and moderately resistant to sheath blight, blast and bacterial leaf blight. *DRR 44* (110 days) was released in the year 2014 from Indian Institute of Rice Research (IIRR),

Hyderabad. It is characterised by very high yield under limited water condition. It is an early medium duration drought tolerant, high yielding and long slender grain variety suited both for transplanted & direct seeded. It also shows resistance to blast. *DRR 42* (110 days) was also released from IIRR, Hyderabad in the year 2015. It shows resistance to blast and Brown Plant hopper (BPH). It is drought tolerant and high yielding variety.

The treatments with six varieties were replicated four times in a randomized block design. Twelve different farmers each having 0.04 hectare of land cultivated all the six varieties with recommended package of practices. 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. Available soil nutrients as well as nutrient content were determined following the standard procedures [5]. Water productivity (rain water productivity) was expressed as kilogram of rice yield obtained per mm of rain water received. 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 [6]. It was calculated by using the following formula;

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

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 [7].

Different parameters in technology demonstration package and farmers' practices are the recommended varieties, seed treatment, and method of sowing, fertilizer dose, weed management and plant protection measures which are presented in Table 1.

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

Analysis of pooled data (Table 2) indicated that the yield attributing characters like number of panicles /m², number of tillers / m², number of

filled grains /panicle, panicle length, 1000 grain weight were recorded highest in *Sahabhazi dhan* whereas significantly lower no of panicle / m², number of tillers/ m², number of filled grains /panicle, panicle length, 1000 grain weight were observed in local check *i.e. Khandagiri* attributing to their genetic variability, varietal difference and environmental adaptability. The differential response of tillering in the genotype could be attributed to its genetic potentiality. These results are in agreement with [8] and [9]. However, *DRR-44* also performed well in comparison to the rest of the varieties apart from *Sahabhazi dhan* which was most suited for the region.

3.2 Yield

An economic analysis of the pooled data (Table 3) revealed that *Sahabhazi dhan* produced higher grain yield 39.98 q/ha which is 64% higher yield than *Khandagiri*. This may be attributed to high vegetative biomass production, large panicles and high tillering capacity in some cases [10]. The trend of straw yields of two varieties was similar with grain yields. *Sahabhazi dhan* recorded the higher straw yield in comparison to *Khandagiri*. These results are in conformity with [11]. Water productivity was also higher (2.78 kg grain per mm of rain water received) in *Sahabhazi dhan* as compared to farmers practice owing to its higher grain yield probably due to more drought tolerance capacity [12]. *DRR-44* showed higher grain and straw yield followed by *DRR-42*, *Mandakini*, and *Jogesh* probably due to genetic potential and higher tillering ability, higher panicle length, more number of grains per panicle which is in the line with the findings of [13].

3.3 Economics

The comparative profitability of rice cultivation with adoption of improved technology and farmers practices is presented in Table 4. The adoption of improved Variety under demonstration recorded higher average gross return (Rs. 50220/ha), net return (Rs. 25620/ha) and B: C ratio (2.04) compared to farmers practice where gross return (Rs. 28342/ha), net return (Rs 40512/ha) and B: C ratio (1.42). 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 [14]. These findings are also similar with the findings of [15].

Table 1. Details of technology demonstrations and existing farmers' practices

S.N. No particulars		Existing farmer practices		Technology demonstration			
1	Variety	<i>Khandagiri</i>	<i>Sahabhagi dhan</i>	<i>Mandakini</i>	<i>Jogesh</i>	<i>DRR-44</i>	<i>DRR-42</i>
2	Time of Sowing	3rd week of July	2nd week of July	2nd week of July	2nd week of July	2nd week of July	2nd week of July
3	Method of Sowing	Broadcasting	Line transplanting				
4	Seed rate	50 kg/ha	25 kg/ha	40 kg/ha	45 kg/ha	30 kg/ha	40 kg/ha
5	Seed treatment	No seed treatment	Seed treatment with Bavistin				
6	Fertilizer dose	Imbalanced use of fertilizer	80:40:40 NPK/ha + well decomposed FYM @ 1t/ha	80:40:40 NPK/ha + well decomposed FYM @ 1t/ha	80:40:40 NPK/ha + well decomposed FYM @ 1t/ha	80:40:40 NPK/ha + well decomposed FYM @ 1t/ha	80:40:40 NPK/ha + well decomposed FYM @ 1t/ha
7	Weed management	No use of herbicide	Use of herbicide pretilachlor @ 1 kg a.i./ha on 3DAT & Hand weeding	Use of herbicide pretilachlor @ 1 kg a.i./ha on 3DAT & Hand weeding	Use of herbicide pretilachlor @ 1 kg a.i./ha on 3DAT & Hand weeding	Use of herbicide pretilachlor @ 1 kg a.i./ha on 3DAT & Hand weeding	Use of herbicide pretilachlor @ 1 kg a.i./ha on 3DAT & Hand weeding
8	Plant Protection	Non- judicious use of plant protection chemicals	Need base plant protection measures				

Table 2. Growth and yield attributing parameters of different rice varieties demonstration (Pooled data of two years)

Variety	Plant height (cm)	No. of tillers/ sq.m	No. of panicle / sq.m	No. of filled grains /panicle	Panicle length (cm)	Test weight of 1000 grain (g)
<i>Sahabhagidhan</i>	80.35	297.0	224.17	128.30	24.026	23.24
<i>Mandakini</i>	78.62	272.0	213.50	120.86	19.431	21.42
<i>Jogesh</i>	79.65	264.2	210.29	117.49	19.582	20.88
<i>DRR-44</i>	81.25	295.8	219.37	125.67	19.836	22.54
<i>DRR-42</i>	81.75	276.0	215.82	123.76	22.237	21.78
<i>Khandagiri</i>	79.90	262.5	202.14	112.50	19.416	20.27
SEm +	NS	3.80	5.02	2.97	0.432	0.827
CD at 5%	NS	11.40	15.12	8.94	1.30	2.49

Table 3. Yield and water productivity of different rice varieties demonstration (Pooled data of two years)

Variety	Grain yield (q/ha)	Straw yield (q/ha)	Crop seasonal rainfall (mm)	Water productivity (kg/mm)
<i>Sahabhazi dhan</i>	39.98	41.58	1438	2.78
<i>Mandakini</i>	31.20	32.83	1438	2.16
<i>Jogesh</i>	30.53	30.66	1438	2.12
<i>DRR-44</i>	39.27	39.46	1438	2.73
<i>DRR-42</i>	36.80	37.38	1438	2.55
<i>Khandagiri</i>	25.960	28.79	1438	1.80
SEm +	2.35	2.93	-	-
CD at 5%	7.09	8.84	-	-

Table 4. Cost of cultivation and return of different rice varieties demonstration (Pooled data of two years)

Variety	Grain : Straw ratio	Cost of Cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Return (Rs./ha)	Benefit : cost ratio
<i>Sahabhazi dhan</i>	0.96	24600	50220	25620	2.04
<i>Mandakini</i>	0.95	25220	42220	17000	1.67
<i>Jogesh</i>	1.00	34256	50029	15773	1.46
<i>DRR-44</i>	1.00	28220	53475	25275	1.90
<i>DRR-42</i>	1.01	25400	44320	18920	1.74
<i>Khandagiri</i>	0.90	28342	40512	12170	1.42

4. CONCLUSION

The cultivation of *Sahabhazi dhan* was found to be more productive and can replace the existing farmers' practice i.e. *Khandagiri* since it fits to the existing farming system for higher productivity and income and also it had been appreciated by the farmers due to its drought tolerance and higher tillering capacity. *DRR-44* also suits well to the practice without much compromise to yield in comparison to local variety *Khandagiri*. The productive gain under demonstration over farmers' practices created awareness and motivated the other farmers to adopt improved production technology of paddy in the district. Favourable benefit cost ratio is self explanatory of economic viability of the demonstration and persuaded the farmers for adoption of intervention imparted. Both from the view point of crop intensification drive as well as climate change, there is a need to have rice varieties which could mature early without much adverse effect on yield. Growing short duration varieties of rice has other advantages like fitting other catch crops in between like green gram, black gram, tuber crops. It has been reported that, adoption of short duration rice varieties is one of the strategies to mitigate emission of methane and nitrous oxide which are greenhouse gases.

Since, rice crop is said to be one of the major contributing factors to global warming [16]. So growing short duration varieties is one way of reducing such emissions. Short duration varieties would also reduce exposure of crops to pests such as wild animals thereby reducing probability of crop damage due to shortened cropping period. Apart from this, introduction of different crops in between short duration rice variety also provides a scope of extra income by safeguarding the crop against aberrant weather. Thus, more emphasis must be given on the development and release of short maturing climate resilient varieties.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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