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Original Research Article

Evaluation of Varieties/Hybrids and Fertilizer Levels for Direct Seeded Rice (DSR) under Thungabhadra Project (TBP) Command Area of Karnataka

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Keywords

DSR, Growth, Yield, Economics, Fertilizer levels, Varieties

A B S T R A C T

An experiment was carried out during Kharif 2013 and 2014 in medium deep black soil to study the effect of different fertilizer levels on different varieties under direct seeded rice at Agricultural Research Station, Gangavathi, University of Agricultural Sciences, Raichur, Karnataka. Pooled data of two years revealed that, grain and straw yield was significantly higher in KRH-4 hybrid (6198 and 7206 kg/ha, respectively). Among the varieties, significantly higher grain and straw yield was recorded with GGV-05-01(5663 and 6120 kg/ha, respectively) as compared to SIRI-1253 (4415 and 5093 kg/ha, respectively), and BPT-5204 (4418 and 4874 kg/ha, respectively). Among fertilizer levels, application of fertilizer as per the farmer's practice (250: 130:130 NPK kg/ha) recorded significantly higher grain and straw yield (5782 and 6170 kg/ha, respectively) which was onpar with the application of 125 per cent recommended dose of fertilizer (5464 and 5991 kg/ha, respectively). With regard to economics, net returns and B: C ratio was significantly higher with KRH-4 hybrid (Rs. 62,749 and 2.61, respectively) and GGV-05-01 (Rs. 61,914 and 2.64, respectively).

Introduction

Rice is the world's most important crop and is a staple food for more than half of the world's population. Worldwide, rice is grown in 161 m ha, with an annual production of about 678.7 m t of paddy. To meet the global rice demand, it is estimated that about 114 million tons of additional milled rice need to be produced by 2035, which is equivalent to an overall increase of 26 per cent in the next 25 years (FAO, 2009). The possibility of expanding the area under rice in the near future is limited. Therefore, this extra rice production needed has to come from a productivity gain. The major challenge is to achieve this gain with less water, labor, and chemicals, thereby ensuring long-term sustainability.

In India, rice is cultivated in a wide range of ecosystems *viz.*, irrigated (21.0 m ha), rainfed lowlands (14.0 m ha), rainfed uplands (6.0 m ha) and flood prone (3.0 m ha). In Karnataka, rice area covered in 13.5 lakh ha occupies 5th place in productivity of rice (3212 kg/ha) in India. In the same way, rice is the important crop of Tungabhadra Project (TBP) command area and known as "rice bowl" of Karnataka. In TBP command area paddy is one of the most cereal crop cultivated to an extent of 3.62 lakh hectares.

In recent decades, we noticed shortage of water for successful cultivation of rice. Indiscriminate and unscientific management of both fertilizers and pesticides are the most common features being followed apart from excess use of water for paddy cultivation in this part of the state.

Relatively little work has targeted for selection and breeding of rice for direct seeding. Generally, rice varieties bred for puddle transplanting are used in direct seeding. The lack of suitable varieties is a major constraint to achieving maximum potential of direct seeding. Much work on fertilizer management in rice has been carried out for puddle transplanted rice but limited work has been conducted in DSR under Thungabhadra project (TBP) command area. In DSR, because of more aerobic conditions and alternate wetting/drying cycles (Kumar *et al.,* 2017), the availability of several nutrients including N and micronutrient such as Fe is likely to be a constraint (Ponnamperuma, 1972). In addition, loss of N due to nitrification/denitrification, volatilization, and leaching is likely to be higher in DSR than in TPR (Davidson, 1991). General recommendations for NPK fertilizers are similar to those in puddled transplanted rice, except that a slightly higher dose of N (25–30 kg ha $^{-1}$) is suggested in DSR (Gathala *et al.,* 2011). Hence, this experiment is planned to evaluate different varieties and fertilizer levels for DSR under Tungabhadra command area of Karnataka.

Materials and Methods

An experiment was conducted during *Kharif* 2013 and 2014, at Agricultural Research Station, Gangavathi, University of Agricultural Sciences, Raichur, Karnataka, India, (situated at 15.6’ N latitude and 76.8’ E longitude with an altitude of 358 m above mean sea level). The soil was medium deep black clay in texture having a pH, EC and OC of 8.33, 1.24 dS/m, and 0.31%, respectively. Total available N, P_2O_5, and K_2O of 163.5, 73.5 and 432.7 kg/ha, respectively. The experiment was laid out in a split plot design with sixteen treatments, *viz.* Varieties/Hybrids: V_1- BPT-5204, V_2-GGV-05-01, V_3- SIRI-1253 and V_4- KRH-4 as main plots and Fertilizer levels: F_1- 75 % recommended dose of fertilizer, F_2- 100 % of recommended dose of fertilizer (150 75:75 NPK kg/ha), F_3- 125% of recommended dose of fertilizer and F_4-Farmer’s practice (250: 130:130 NPK kg/ha) as subplots with three replications. Sowing was done during 2nd fortnight of July in first year (2013) and 1st fortnight of August in second year (2014). Sowing was done by tractor drawn seed cum fertilizer drill with a spacing of 20 cm x 10 cm. Pest and disease management was made as per state recommendation with need based chemicals. NPK was applied in spilt doses as DSR requires less fertilizer during early stage of the crop establishments. About 25% of NPK was applied at the time of sowing and another 25% NPK at 30 DAS. Further, remaining 50% of phosphorous and potassium was applied at 60 DAS. Again 25% nitrogen was top dressed during 75 and 100 DAS. Zinc and iron was supplied through foliar spray for 3 times during early stages of crop growth. Five plants were randomly selected in each plot (5.0 m x 5.0 m) and were tagged for the purpose of recording observations on growth parameters *viz.,* plant height and number of productive tillers at harvest. Yield parameters *viz.,* panicle length, test weight and number of filled grains per panicle. Similarly, paddy from each net plot was harvested and dried. The grains after threshing were weighed and recorded as grain yield per net plot. Further, this net plot grain yield was converted to grain yield per hectare. Such procedure is a typical practice for evaluating rice yield (Kumar *et al.,* 2016, 2017). The cost of inputs that were prevailing at the time of their use was considered for working out the economics of various treatments. Net return per hectare was calculated by deducting the cost of cultivation from gross returns per hectare, gross returns was calculated by using the total income obtained from grain and straw yields and the benefit cost ratio was worked out (Kumar *et al.,* 2016) as follows:

Benefit cost ratio = Gross returns (Rs./ha)/ Cost of cultivation (Rs./ha).

Results and Discussion

Yield and yield attributing characters

Pooled data of two years revealed that grain and straw yield were significantly higher with KRH-4 hybrid (6282 and 6667 kg/ha, respectively) over GGV-05-01, SIRI-1253 and BPT-5204 (Table 1). Among fertilizer levels, application of fertilizer as per the farmer's practice (250: 130:130 NPK kg/ha) recorded significantly higher grain and straw yield (5782 and 6170 kg/ha, respectively) which was on par with the application of 125 per cent recommended dose of fertilizer (5464 and 5991kg/ha, respectively) as compared to 100% and 75% RDF (Table 1).

Generally, less grain and straw yield was recorded during second year (2014) of experimentation. This could be due to delay in sowing of DSR results in less growth and yield parameters finally led to lower yield. This could be attributed to more dry matter production, number productive tiller per m^2, number of grains per panicle and test weight as reported by Kumar *et al.,* (2017).

Similarly, significantly higher panicles per m^2, panicle length number of grains per panicle and test weight were recorded with KRH-4 (309, 22.51 cm, 218.98 and 23.51 g, respectively) followed by GGV-05-01, SIRI-1253 and BPT-5204 (Table 2&3). Among fertilizer levels, application of fertilizer as per the farmer's practice (250: 130:130 NPK kg/ha) recorded significantly higher panicles per m^2, panicle length, number of grains per panicle and test weight (299, 22.0 cm, 236.35 and 21.89 g, respectively) which was on par with the application of 125% RDF (284, 21.63cm 228.18 and 21.16 g, respectively). This could be due to more dry matter production and more productive tillers per m^2. This could also be due to proper sowing time and good performance of medium duration varieties than long duration varieties and availability of higher nutrients in higher doses. The above results are in conformity with the findings of Singh and Singh (1988), Sharma *et al.,* (2005) and Gupta and Seth (2007). The higher yield and yield attributing character were also due to increase in growth attributing characters.

Growth attributing characters

Pooled data of two years revealed that, significantly higher plant height was recorded with KRH-4 (100.85 cm) followed by GGV-05-01 (97.64 cm), SIRI-1253 (82.89 cm) and BPT-5204 (80.54 cm). Among fertilizer levels, application of fertilizer as per the farmer's practice (250:130:130 NPK kg/ha) recorded significantly taller plants (96.14 cm) which was on par with the application of 125 per cent recommended dose of fertilizer (92. 01cm). Whereas, shorter plants were recorded significantly with the application of 75 per cent recommended dose of fertilizer (84.67 cm). Similarly, Hybrid rice-KRH-4 recorded significantly more productive tillers per m^2 (264) over GGV-05-01, SIRI-1253 and BPT-5204.

Table.1 Grain and straw yield of rice as influenced by different fertilizer levels and varieties/hybrids

Treatments	Grain yield (kg/ha)			Straw yield (kg/ha)		
	2013	2014	Pooled	2013	2014	Pooled
Varieties/Hybrids						
V_1	5116	3721	4418	5692	4056	4874
V_2	6261	5065	5663	6815	5425	6120
V_3	5350	3481	4415	6441	3746	5093
V_4	6830	5733	6282	7240	6095	6667
SEm±	**182**	**29**	**80**	**106**	**41**	**55**
C.D at 5 %	**541**	**86**	**237**	**317**	**123**	**164**
Fertilizer levels						
F_1	5139	4035	4587	5837	4351	5094
F_2	5696	4396	5046	6299	4698	5499
F_3	6078	4650	5464	6783	5300	5991
F_4	6645	4919	5782	7268	5472	6170
SEm±	**185**	**98**	**125**	**162**	**101**	**90**
C.D at 5 %	**608**	**321**	**398**	**483**	**301**	**269**
Interaction						
SEm±	**454**	**240**	**282**	**397**	**247**	**221**
C.D at 5 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table.2 Yield parameters of rice as influenced by different fertilizer levels and varieties/hybrids

Treatments	No. of panicles/m^2			Panicle length (cm)		
	2013	2014	Pooled	2013	2014	Pooled
Main plots (M)						
V1- BPT-5204	268	229	248	20.15	17.55	18.85
V2- GGV-05-01	296	276	286	23.25	21.66	22.46
V3- SIRI-1253	288	230	259	22.34	19.88	21.11
V4- KRH-4	330	288	309	23.24	21.78	22.51
SEm±	**10.70**	**5.80**	**4.00**	**0.25**	**0.14**	**0.10**
C.D. @ 5%	**48.16**	**26.11**	**17.99**	**0.74**	**0.42**	**0.30**
Sub plots (F)						
F1- 75% RDF	265	239	252	22.30	19.18	20.74
F2- 100% RDF	284	250	267	21.40	19.71	20.56
F3- 125% RDF	308	260	284	22.56	20.70	21.63
F4- FP (250:130:130 NPK Kg/ha)	325	273	299	22.72	21.28	22.00
SEm±	**6.53**	**4.09**	**4.20**	**0.25**	**0.34**	**0.21**
C.D. @ 5%	**25.99**	**22.56**	**23.15**	**0.74**	**1.00**	**0.61**
Interactions (V X F)						
SEm±	**15.99**	**10.03**	**10.29**	**0.61**	**0.82**	**0.50**
C.D. @ 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

V_1- BPT-5204 V_2- GGV-05-01 V_3- SIRI-1253 V_4- KRH-4

F_1- 75 % RDF, F_2- 100 % RDF (150 75:75 NPK kg/ha) F_3- 125% RDF F_4- Farmer's practice (250: 130:130 NPK kg/ha)

Table.3 Yield parameters of rice as influenced by different fertilizer levels and varieties/hybrids

Treatments	No. of grains per panicle			Test weight (g)		
	2013	2014	Pooled	2013	2014	Pooled
Varieties/Hybrids						
V_1	187.34	161.51	174.43	19.75	17.71	18.73
V_2	240.17	255.31	247.74	20.48	20.70	20.59
V_3	229.98	210.78	220.38	20.32	19.51	19.91
V_4	225.69	212.28	218.98	24.42	22.60	23.51
SEm±	**5.92**	**5.05**	**4.48**	**0.16**	**0.12**	**0.09**
C.D at 5 %	**17.63**	**15.05**	**13.36**	**0.49**	**0.36**	**0.28**
Fertilizer levels						
F_1	198.06	188.26	193.16	19.82	18.58	19.20
F_2	216.64	207.03	211.84	21.18	19.81	20.50
F_3	229.20	226.17	228.18	21.68	20.63	21.16
F_4	244.28	228.41	236.35	22.28	21.49	21.89
SEm±	**5.93**	**5.16**	**3.67**	**0.29**	**0.32**	**0.23**
C.D at 5 %	**17.68**	**15.37**	**10.95**	**0.88**	**0.96**	**0.69**
Interaction						
SEm±	**14.53**	**12.64**	**9.00**	**0.72**	**0.79**	**0.57**
C.D at 5 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table.4 Growth parameters of rice as influenced by different fertilizer levels and varieties/hybrids

Treatments	Plant height (cm)			No. of productive tillers/m^2		
	2013	2014	Pooled	2013	2014	Pooled
Varieties/Hybrids						
V_1	85.93	75.15	80.54	215	222	219
V_2	97.27	98.02	97.64	220	221	221
V_3	82.86	82.92	82.89	256	227	242
V_4	97.79	103.92	100.85	263	265	264
SEm±	**1.07**	**1.18**	**0.94**	**1.78**	**1.92**	**1.94**
C.D at 5 %	**3.17**	**3.52**	**2.79**	**5.02**	**5.41**	**5.82**
Fertilizer levels						
F_1	83.78	85.55	84.67	201	202	201
F_2	88.77	89.45	89.11	224	225	225
F_3	93.52	90.50	92.01	267	277	272
F_4	97.78	94.50	96.14	272	286	279
SEm±	**1.35**	**1.04**	**0.86**	**4.16**	**3.83**	**2.75**
C.D at 5 %	**4.03**	**3.11**	**2.57**	**12.5**	**11.5**	**8.25**
Interaction						
SEm±	**3.32**	**2.55**	**2.11**	**7.13**	**7.68**	**7.51**
C.D at 5 %	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

V_1- BPT-5204 V_2- GGV-05-01 V_3- SIRI-1253 V_4- KRH-4
F_1- 75 % RDF, F_2- 100 % RDF (150 75:75 NPK kg/ha) F_3- 125% RDF F_4- Farmer's practice (250: 130:130 NPK kg/ha)

Table.5 Economics of rice as influenced by different fertilizer levels and varieties/hybrids (Pooled data)

Factors	Cost of cultivation (Rs/ha)	Gross Returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
Varieties				
V_1	37977	83947	45971	2.22
V_2	37977	99890	61914	2.64
V_3	37977	83894	45918	2.22
V_4	39075	101824	62749	2.61
SEm±	**-**	**1380**	**1380**	**0.04**
C.D at 5 %	**-**	**4112**	**4112**	**0.10**
Fertilizer levels				
F_1	34000	81638	47638	2.40
F_2	35580	89771	54192	2.41
F_3	37800	95406	57606	2.52
F_4	45625	102740	57115	2.25
SEm±	**-**	**2345**	**1990**	**0.05**
C.D at 5 %	**-**	**7332**	**5931**	**0.15**

V_1- BPT-5204 V_2- GGV-05-01 V_3- SIRI-1253 V_4- KRH-4

F_1- 75 % RDF, F_2- 100 % RDF (150 75:75 NPK kg/ha) F_3- 125% RDF F_4- Farmer's practice (250: 130:130 NPK kg/ha)

Among fertilizer levels, application of fertilizer as per the farmer's practice (250: 130:130 NPK kg/ha) recorded significantly more productive tillers per m^2 (279) which was on par with the application of 125 per cent recommended dose of fertilizer (272). This may be due to higher soil available nitrogen, phosphorus and potassium nutrients for plant growth. Similar results were also reported by Beecher *et al.,* (2006), Wilson *et al.,* (1998), Fukai S (2002) and Bollich *et al.,* (1994).

Economics of direct seeded rice

Economics of direct seeded rice *viz*., cost of cultivation, gross returns, net returns and B: C ratio were significantly influenced by different varieties and fertilizer levels (Table 5). KRH-4 hybrid recorded significantly higher net returns (Rs. 62,749/ha) and benefit cost ratio (2.61) which was on par with GGV-05-01 as compared to SIRI-1253 and BPT-5204. Among fertilizer levels, application of fertilizer as per the farmer's practice (250: 130:130 NPK kg/ha) recorded significantly higher net returns (Rs. 57,115/ha) and benefit cost ratio (2.25) and which was on par with the application of 125 per cent recommended dose of fertilizer (Rs. 57,606/ha and 2.52, respectively). This may be due to higher grain and straw yield of crop. Similar results were reported by Pandey and Velasco (2002).

Experimental results are concluded that, hybrid rice KRH-4 is well suited for direct seeded rice with 25 % more recommended dose of fertilizer in Thungabhadra project (TBP) command area. Among the varieties, GGV-05-01 (Gangavathi sona) also suited for direct seeded rice with 25% more RDF.

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