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Response of rice varieties to fertilizer levels and nitrogen split applications on growth and yield of direct seeded rice

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Abstract
The experiment was conducted at Agricultural College Farm, Raichur during *kharif* season of 2016 and 2017 to know the response of rice varieties to fertilizer levels and nitrogen split applications on growth and yield of direct seeded rice. Pooled mean of two years indicated that Gangavathi sona (V_1) recorded significantly higher plant height (69.13 cm), dry matter production (40.50 g hill^{-1}), graine yield (4562 kg ha^{-1}), net returns (51745 Rs. ha^{-1}) and B C ratio (1.99) when compared with BPT 5204 (V_2). Among the fertilizer levels, F_3 (200:100: 100 NPK kg ha^{-1}) recorded significantly higher plant height (80.39 cm), dry matter production (41.08 g hill^{-1}), graine yield (4661 kg ha^{-1}) where as net returns (54850 Rs. ha^{-1}) and B C ratio (2.05) was significantly higher with F_2 (150: 75: 75 NPK kg ha^{-1}). Similarly among N-split applications, N_3 (50% N and entire P and K as basal and remaining 50% N in two equal splits at 30 and 60 DAS) recorded significantly higher plant height (69.79 cm), dry matter production (40.74 g hill^{-1}), graine yield (4441 kg ha^{-1}), net returns (50078 Rs. ha^{-1}) and B C ratio (1.96). Hence, on the basis of the results obtained in the pooled data of the two years, variety Gangavathi sona with a fertilizer levels of 200:100: 100 NPK kg ha^{-1} with N-split applications of 50% N and entire P and K as basal and remaining 50% N in two equal splits at 30 and 60 DAS was found to be economical and better option to obtain higher grain yield.

Keywords: Direct seeded rice, varieties, fertilizer levels, nitrogen split applications, growth, yield and economics

Introduction

Rice (*Oryza sativa* L.) is a grain plant belonging to the family poaceae and genus *Oryza*. It is one of the most important food grains produced and consumed all over the world. Global rice demand was 439 million tonnes in 2010 and is expected to rise to 496 million tonnes in 2020 and further increase to 553 million tonnes in 2035 (Anon., 2013) [2]. It is the staple food in Asia but also the single biggest user of freshwater. It is mostly grown under submerged soil conditions and requires more water compared to other crops. It plays a vital role in our food as well as nutritional security for millions of livelihood. Thus, the slogan "Rice is life" by IRRI during 2004 seems to be most appropriate (Chandrasekaran *et al*., 2007) [3]. Rice ranks second to wheat in terms of area harvested but in terms of importance as a food crop, rice provides more calories ha^{-1} than any cereal crop (De Dutta, 1981) [4]. Besides its importance as food, rice provides employment to the largest sector of the rural population in most of the Asia.

Current high yielding rice varieties are only for transplanted rice and little is known about the yield potential and plant type requirements under direct seeding. Promising research findings with the development of cost-efficient, ecologically sound production technologies and rice varieties with higher yield potential will help to make direct seeding an important production system in the rice tract in the command area. Greater fertiliser N efficiency in rice can be achieved by using N efficient varieties, improving timing and application methods and better incorporation of basal N fertiliser application without standing water. Split application of N has been reported to be the best method to improve N fertiliser use efficiency, reduce denitrification losses, synchronize with plant demand, and improve N uptake, straw and grain yield, and harvest index in DSR keeping these points in view the present investigation was undertaken with response of rice varieties to fertilizer levels and nitrogen split applications under direct seeded rice.

Material and Methods

The experiment was conducted at Agricultural College Farm, Raichur on medium black with clay loam texture during *kharif* season of 2016 and 2017. The experiment was carried out in Split-Split plot design. There were two main, three sub plot and three sub sub plot treatments comprising of two varieties [Gangavathi sona (V_1) and BPT 5204 (V_2)] with three fertilizer levels (F_1: 100: 50: 50 NPK kg ha^{-1}, F_2: 150: 75: 75 NPK kg ha^{-1} and F_3: 200: 100: 100 NPK kg ha^{-1}) and three N split applications (N_1: 25% N and entire P and K as basal and remaining 75% N in three equal splits each at 30, 60 and 90 DAS, N_2: 50% N and entire P and K as basal and remaining 50% N in two equal splits at 60 and 90 DAS and N_3: 50% N and entire P and K as basal and remaining 50% N in two equal splits at 30 and 60 DAS). The cost Includes expenditure on seeds, fertilizers, weed management and plant protection chemicals. At maturity, the crop was harvested and plot wise yields were recorded. The data recorded at different stages of crop was subjected to statistical analysis at 5% probability.

Results and Discussion

Performance of rice varieties

In the current investigation, rice variety, Gangavathi sona (V_1) recorded significantly higher plant height (69.13 cm), dry matter production (40.50 g hill^{-1}), graine yield (4562 kg ha^{-1}), net returns (51745 Rs. ha^{-1}) and B C ratio (1.99) when compared with BPT 5204 (V_2) (Table 1 and 2). The higher yield could be attributed to higher dry matter production and cumulative effect of yield attributes. Indeed, the yield of crop is a function of yield attributes like number of panicles m^{-2}, panicle length, panicle weight and number of grains panicle^{-1} which were higher in Gangavathi sona which ultimately resulted in higher grain and straw yield. The variety BPT 5204 is a poor yielder because of its poor growth and canopy makeup. Similar results were reported by Srilaxmi *et al.* (2005) [18], Veeresh *et al.* (2011) [19] and Singh (2013). Significantly higher net returns and BC ratio was realized with Gangavathi sona (51745 Rs. ha^{-1} and 1.99) over BPT 5204 (39421 Rs. ha^{-1} and 1.75), respectively which was attributed to significantly higher grain yield in Gangavathi sona when compared to BPT-5204. The results corroborated with the findings of Rajesh (2016) [10] where in BPT-5204 recorded significantly lower BC ratio (1.85) when compared to JKPH 3333 and GGV-05-01.

Fertilizer levels and nitrogen split applications

Among the fertilizer levels, F_3 (200:100: 100 NPK kg ha^{-1}) recorded significantly higher plant height (80.39 cm), dry matter production (41.08 g hill^{-1}), graine yield (4661 kg ha^{-1}) which was significantly higher than F_1 (100: 50: 50 NPK kg ha^{-1}) and was on par with F_2 (150: 75: 75 NPK kg ha^{-1}) increase in NPK fertilization from 100: 50: 50 NPK kg ha^{-1} to 200: 100: 100 NPK kg ha^{-1} increased the rice yield significantly because of increased availability of nutrients resulting into better growth of rice, which favorably influenced flowering and ripening which might be the reason for higher grain yield. The results are in conformity with the findings of Mahajan and Timsina (2011) [9], Singh and Tripathi (2007) [14], Sathiya *et al*. (2008) [12], Kundu and Surajit *et al.* (2004) [8] and Ehasnullah *et al.* (2001) [5] where as net returns (54850 Rs. ha^{-1}) and B C ratio (2.05) was significantly higher with F_2 (150: 75: 75 NPK kg ha^{-1}). The higher BC ratio was attributed to least cost incurred for the cultivation of rice. Similar results were also reported by Ikramullah and Mohita (2004) [7], Sharief *et al*. (2000) [13], Singh and Named (2004) [17] who reported higher net returns and BC ratio with higher fertilizer levels.

Among the N-split applications, N_3 (50% N and entire P and K as basal and remaining 50% N in two equal splits at 30 and 60 DAS) recorded significantly higher plant height (69.79 cm), dry matter production (40.74 g hill^{-1}), graine yield (4441 kg ha^{-1}), net returns (50078 Rs. ha^{-1}) and B C ratio (1.96) when compared to N_1 (25% N and entire P and K as basal and remaining 75% N in three equal splits each at 30, 60 and 90 DAS) and was on par with the N_2 (50% N and entire P and K as basal and remaining 50% N in two equal splits at 60 and 90 DAS. The increase in yield under N_3 could be due to efficient N uptake by the plants that led to better photosynthetic rate. The results revealed that delaying application of N at after panicle initiation may drastically reduced rice yield to the extent of 1.44 percent in N_2 and 13.17 per cent in N_1 compared to N_3. This might be due to effective utilization of N at critical stages of crop resulting in better vegetative growth and production of more productive tillers, panicle weight and panicle length which ultimately led to higher grain yield. The results are in accordance with those of Singh and Singh (2005) [15], Sathiya and Ramesh (2009) [11]**,** Hafeez *et al.* (2013) [6] and Amrutha *et al*. (2016) [1] who inferred that the application of nitrogen at 120 kg ha^{-1} in three splits 50% at sowing + 25% at tillering (25 DAS) + 25% at panicle initiation (50 DAS) recorded significantly higher grain and straw yields in rice.

Table 1: Plant height (cm), Dry matter production (g hill^{-1}) and Grain yield (Kg ha^{-1}) of rice at harvest as influenced by varieties, fertilizer levels and nitrogen split applications

V x F x N		Plant height (cm)				Dry matter production (g hill^{-1})				Grain yield (Kg ha^{-1})			
		N_1	N_2	N_3	V x F	N_1	N_2	N_3	V x F	N_1	N_2	N_3	V x F
V_1	F_1	42.88	44.40	46.95	44.74	38.31	38.80	39.10	38.74	3239	3841	4069	3716
	F_2	71.95	83.10	84.18	79.75	40.09	41.18	41.92	41.06	4666	5284	4805	4918
	F_3	81.53	82.56	84.57	82.89	40.54	41.90	42.68	41.71	4618	5042	5496	5052
V_2	F_1	37.78	42.15	43.18	41.04	38.20	38.25	38.48	38.31	2852	3102	3463	3139
	F_2	73.97	77.87	79.76	77.20	40.01	40.32	40.97	40.43	4091	4510	4570	4390
	F_3	74.43	79.15	80.09	77.89	39.93	40.18	41.28	40.46	4075	4489	4243	4269
N		62.44	63.76	68.21	69.79	39.51	40.10	40.74		3924	4378	4441	
V × N									V				V
V_1		64.14	65.46	70.02	71.90	39.65	40.63	41.23	40.50	4175	4722	4790	4562
V_2		60.74	62.06	66.39	67.67	39.38	39.58	40.24	39.74	3673	4034	4092	3933
F × N									F				F
F_1		39.02	40.33	43.28	45.06	38.26	38.53	38.79	38.52	3046	3471	3766	3428
F_2		71.64	72.96	80.49	81.97	40.05	40.75	41.44	40.75	4379	4897	4688	4654
F_3		76.67	77.98	80.86	82.33	40.24	41.04	41.98	41.08	4347	4766	4869	4661

Interactions	S.Em.±	C.D. (0.05)	S.Em.±	C.D. (0.05)	S.Em.±	C.D. (0.05)
V	0.46	3.04	0.05	0.31	41	266
F	1.14	4.19	0.25	0.82	101	333
V × F	1.61	NS	0.36	NS	144	NS
N	0.75	1.76	0.23	0.68	98	290
V × N	1.07	NS	0.33	NS	140	NS
F × N	1.31	NS	0.40	NS	171	NS
V × F × N	1.85	NS	0.57	NS	243	NS

Main Plot: Varieties: V_1 - GGV-05-01 (Gangavathi sona) V_2 - BPT 5204
Sub plot: Fertilizer levels: F_1: 100: 50: 50 NPK kg ha^{-1} F_2: 150: 75: 75 NPK kg ha^{-1} F_3: 200: 100: 100 NPK kg ha^{-1}
Sub–sub plot: N split applications : N_1: 25% N and entire P and K as basal and remaining 75% N in three equal splits each at 30, 60 and 90 DAS.
N_2: 50% N and entire P and K as basal and remaining 50% N in two equal splits at 60 and 90 DAS.
N_3: 50% N and entire P and K as basal and remaining 50% N in two equal splits at 30 and 60 DAS.

Table 2: Net returns (Rs.ha^{-1}) and B C ratio of rice as influenced by varieties, fertilizer levels and nitrogen split applications

V x F x N		**Net returns (Rs. ha^{-1})**				**B C ratio**			
		N_1	**N_2**	**N_3**	**V x F**	**N_1**	**N_2**	**N_3**	**V x F**
V_1	F_1	24113	37943	43091	35049	1.48	1.76	1.87	1.70
	F_2	53879	68076	57306	59753	2.03	2.31	2.10	2.15
	F_3	50472	60305	70519	60432	1.92	2.11	2.30	2.11
V_2	F_1	16692	22749	31055	23499	1.33	1.46	1.62	1.47
	F_2	42862	52798	54178	49946	1.81	2.01	2.04	1.96
	F_3	40159	49981	44315	44819	1.73	1.92	1.81	1.82
N		38030	48642	50078		1.72	1.93	1.96	
V × N					V				V
V_1		42821	55441	56972	51745	1.81	2.06	2.09	1.99
V_2		33238	41843	43183	39421	1.63	1.80	1.82	1.75
F × N					F				F
F_1		20403	30346	37073	29274	1.41	1.61	1.74	1.59
F_2		48370	60437	55742	54850	1.92	2.16	2.07	2.05
F_3		45316	55143	57417	52625	1.83	2.01	2.06	1.97
Interactions		S.Em.±		C.D. (0.05)		S.Em.±		C.D. (0.05)	
V		936		5776		0.03		0.16	
F		2253		7338		0.02		0.06	
V × F		3186		NS		0.03		NS	
N		2187		6386		0.02		0.06	
V × N		3093		NS		0.03		NS	
F × N		3789		NS		0.04		NS	
V × F × N		5358		NS		0.05		NS	

Main Plot: Varieties: V_1 - GGV-05-01 (Gangavathi sona) V_2 - BPT 5204
Sub plot: Fertilizer levels: F_1: 100: 50: 50 NPK kg ha^{-1} F_2: 150: 75: 75 NPK kg ha^{-1} F_3: 200: 100: 100 NPK kg ha^{-1}
Sub–sub plot: N split applications: N_1: 25% N and entire P and K as basal and remaining 75% N in three equal splits each at 30, 60 and 90 DAS.
N_2: 50% N and entire P and K as basal and remaining 50% N in two equal splits at 60 and 90 DAS.
N_3: 50% N and entire P and K as basal and remaining 50% N in two equal splits at 30 and 60 DAS.

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