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Studies on Optimising Drill Sown Rice Yield under Irrigation

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Abstract: Results of a three year study (1988–1990) on drill sown irrigated rice at Agricultural Research Station, Mugad, Karnataka showed that the use of 33% higher seed + 33% higher NPK fertilizers, alone or in combination with 10 ton FYM and 20 kg. $ZnSO_4$ per ha increased the grain yield by 23–37% and net returns by 34–50%, when compared with the normal practice (100 kg seeds and 100–50–50kg $N–P_2O_5–K_2O$ per ha). However, the maximum benefit–cost ratio was with 33% higher seeds and 33% higher NPK fertilizers only (3.42).

Introduction

Low water use efficiency of rice does not encourage diversion of more water for rice production from the new irrigation projects. Summer rice under irrigation is being discouraged. But, rice being the principal food crop in India there is need to increase its production to meet the ever growing demand. Thus, the horizontal expansion virtually ruled out the possibility of vertical expansion gains added significance.

The gap between the potential and average yield levels of rice under assured irrigation has narrowed down considerably. The next situation where we can think of vertical yield increase is the tank irrigated area, where rice is drill sown with the onset of monsoon and on accumulation of sufficient water in tanks it is grown as an irrigated crop. Advantage of higher plant population and NPK fertilizers on rice yield were reported by Ramesh *et al* (1988) and Palaniappan (1990). While Moula *et al.* (1988) found good response of rice to higher levels of NPK at different soil fertility levels. Combined application of FYM and NPK also increased the grain and straw yield of rice as per the results of Parameshwar *et al.* (1989). However, the information on the drill sown irrigated rice to various inputs applied, alone or in combination, is lacking. Therefore, the present investigation was undertaken to study the possibility of increasing drill sown rice yield under irrigation.

Material and Methods

A field experiment was conducted at Agricultural Research Station, Mugad, Karnataka in a RBD with four replications during *kharif* season of 1988, 1989 and 1990. The silty clay loam soils had 0.66% organic carbon, 17 and 148 kg/ha available P_2O_5 and K_2O, respectively, with pH 7.1.

The treatments consisted of combination of normal and 33% extra seed rate and NPK fertilizers with or without FYM @ 10 t/ha and $ZnSO_4$ @ 20 kg/ha. Application of only FYM @ 10 t/ha, without NPK fertilizer

with normal seed rate was also included for comparison. There were totally eight treatment combinations. Normal seed rate was 100 kg/ha and NPK fertilizers included 100–50–50 kg N–P_2O_5–K_2O/ha (normal dosage).

During 1988 and 1989 Avinash (140 d) and during 1990 Abhilash (150 d) rice cultivars were used. Basal fertilizers included 50% N and entire P and K, with 25% N each given as top dress at maximum tillering and panicle initiation. FYM and $ZnSO_4$ were applied to soil before sowing. Rainfall was good in the crop period during 1988 and 1990 (1062 and 949 mm, respectively) and therefore sufficient water was available for rice from tillering stage onwards. However, during 1989 due to low rainfall (644 mm) water was not available from the adjacent tank and therefore irrigation could be given from the bore well available just to maintain soil moisture between saturation to field capacity throughout the crop period. This, coupled with heavy brown leaf spot and blast incidence resulted in lower yields during 1989.

Results and Discussion

Yield Components: Number of panicles per square meter was higher with 33% higher population and 33% higher NPK fertilizers, alone or in combination with FYM and $ZnSO_4$ as compared to normal plant stand + normal NPK in all the years (Table 1). Higher productive tillers per m^2 with higher plant population was also reported by Ramesh *et al.* (1988).

Grain Yield : Use of 33% higher seeds and 33% higher NPK fertilizers, alone or in combination with 10 t FYM per ha and 20 kg $ZnSO_4$ per ha, recorded significantly higher grain yield than that in normal plant stand + normal NPK during 1988 and 1990 (Table 1). The former treatments were on par with each other. Higher plant population in combination with higher NPK fertilizers was found to give higher grain yield of rice according to Ramesh *et al.* (1988). While, Palaniappan (1990) reported that the maximum rice yields were obtained with the combination of organic manure, higher plant population and higher N and K fertilizers. However, during 1989, only combination of 33% higher seed rate, 33% higher NPK fertilizers, 10 t FYM and 20 kg $ZnSO_4$ per ha gave significantly higher grain yield than the normal plant stand + normal NPK. Use of FYM might have helped in better retention of moisture in the former practice in his deficit year (Parameswar *et al.*, 1989), which enabled efficient use of higher inputs applied, leading to higher grain yield. Higher grain yield with normal plant stand + normal NPK + FYM @ 10 t/ha compared with the normal plant stand + normal NPK or 33% higher seed rate + 33% higher NPK fertilizers during 1989 also supports the above interpretation.

Monetary returns : Net returns were maximum with 33% higher seeds + 33% higher NPK fertilizers followed by those with addition of FYM and $ZnSO_4$ along with 33% higher seeds and 33% higher NPK fertilizers during 1988 and 1990. These were markedly higher when compared with those in normal plant stand + normal NPK. However during 1989, only combination of 33% higher seeds+ 33% higher NPK + FYM + $ZnSO_4$ recorded higher net returns than normal plant stand + normal NPK (Table 2). Benefit cost ratio was also maximum with only 33% higher seeds and 33% higher NPK fertilizers during 1988 and 1990, which however, was maximum with the combination of 33% higher seeds + 33% higher NPK fertilizers + FYM + $ZnSO_4$ during 1989 (Table 2).

In field experiments on farmer's fields under restricted irrigation water (need based), Venkateswarlu and Sankaranarayana Rao (1988) also found that a higher population of 6.66 lakh/ha along with 60–30–20 kg N–P_2O_5–K_2O per ha in *kharif* was profitable with high BCR.

The average of three years' data indicated that an increase is possible in the

Table 1. Effect of plant population, NPK fertilizers, FYM and $ZnSO_4$ on panicles per square meter and grain yield

Treatment	Panicles/m²				Grain yield (t/ha)			
	1988	1989	1990	Mean	1988	1989	1990	Mean
Normal plant stand+ normal NPK	321	272	229	274	6.750	2.870	4.642	4.754
33% extra plant stand+ normal NPK	382	352	277	337	7.150	2.980	5.267	5.132
Normal plant stand + 33% extra NPK	339	289	277	302	7.060	2.450	5.206	4.905
33% extra plant stand + 33% extra NPK	362	327	374	354	8.160	2.570	6.763	5.831
Normal plant stand + normal NPK + FYM @ 10 t/ha	366	333	268	322	6.780	3.140	5.235	5.052
Normal plant stand + normal NPK + $ZnSO_4$ @ 20 kg/ha	342	316	308	322	7.620	2.400	5.734	5.251
33% extra plant stand + 33% extra NPK + FYM @ 10 t/ha + $ZnSO_4$ @ 20 kg/ha	347	415	404	389	8.340	4.450	6.754	6.515
Normal plant stand + no NPK + FYM @ 10 t/ha	314	271	217	267	5.330	1.450	3.833	3.538
CD (P = 0.05)	28	46	83	–	1.110	0.770	1.016	–

grain yield of drill sown irrigated rice upto 23 and 37% and an increase in net returns upto 34 and 50% with the use of 33% higher seeds + 33% higher NPK fertilizers, alone or in combination with 10 t FYM and 20 kg $ZnSO_4$ per ha, respectively, when compared with the normal plant stand + normal NPK.

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Table 2. Net returns from rice and benefit cost ratio as affected by plant population, NPK fertilizers, FYM and $ZnSO_4$

Treatment	Net returns (Rs ha^{-1})				Benefit cost ratio			
	1988	1989	1990	Mean	1988	1989	1990	Mean
Normal plant stand + normal NPK	12711	1185	7652	7183	4.65	1.16	3.20	3.00
33% extra plant stand + normal NPK	14068	1986	9401	8485	4.85	1.27	3.58	3.23
Normal Plant stand + 33% extra NPK	13463	28	8932	7474	4.55	1.00	3.36	2.97
33% extra plant stand + 33% extra NPK	15960	272	12602	9611	5.03	1.04	4.19	3.42
Normal plant stand + normal NPK + FYM @ 10 t/ha	11952	1365	8220	7179	3.70	1.16	2.86	2.57
Normal plant stand + normal NPK + $ZnSO_4$ @ 20 kg/ha	14755	–251	10176	8227	4.95	0.96	3.72	3.21
33% extra plant stand + 33% extra NPK + FYM @ 10 t/ha + $ZnSO_4$ @ 20 kg/ha	15687	4908	11726	10774	4.05	1.55	3.28	2.96
Normal plant stand + no NPK + FYM @ 10 t/ha	9565	–2889	5910	4195	3.77	0.60	2.72	2.36

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