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RESPONSE OF UPLAND RICE TO DIFFERENTIAL LEVELS OF IRRIGATION, NUTRIENTS AND SEED PRIMING

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INTRODUCTION

Rice, which plays an important role in providing food to the majority of the world population, is cultivated in a wide range of ecosystems. In India, out of the 42.7 million ha of land under rice, about 21.9 percent of the area is exposed to risk prone upland ecology (Mishra, 1999). The productivity of the upland rice is very low because of a host of problems among which soil moisture stress, poor native soil fertility and heavy weed infestations are the important ones. Under upland situation, moisture stress is likely to occur during any of the growth stages of the crop which may adversely affect the growth and yield. The yield of rice under upland situation can be increased by judicious management of production inputs.

MATERIALS AND METHODS

The field was sandy clay loam, having organic carbon 1.7 per cent, pH 4.8 and available N, P_2O_5 and K_2O 238, 32.8 and 160 kg ha-1 respectively. Treatments comparing three irrigation levels [IW/CPE ratio of 1.5(I_1), 1.0(I_2) and rainfed (I_3)], three nutrition levels [20:10:15 (F_1), 40:20:30(F_2) and 60:30:45 (F_3) kg NPK ha-1] and two seed priming levels (1 per cent (S_1) and 2.5 per cent (S_2) KCl) was tried in split split plot design and replicated thrice with irrigation levels in main plots, nutrient management in subplot and seed priming in sub sub plots. Irrigation was given to a depth of 50 mm. Upland rice variety Matta Triveni (PTB -45) was sown at a spacing of 20x10 cm.

The irrigation was scheduled one week after sowing as per the treatment. N was applied in 3 equal splits basal, tillering and panicle initiation. P was applied as basal and K was applied in 2 splits doses- basal and panicle initiation stages. The rice seeds were immersed in one and 2.5 per cent KCl solution for 15 hours and dried under shade before pre-germination.

RESULTS AND DISCUSSION

Yield attributing characters

Results of the study revealed that the levels of irrigation and nutrients exerted significant influence on yield attributes viz., number of productive tillers per hill, length of panicle, weight of panicle, number of spikelets per panicle, number of filled grains per panicle, chaff percentage and test weight. All these characters except length of panicle were profoundly influenced by irrigation treatment. Similarly, levels of nutrition also registered remarkable variation on majority of the characters except on length and weight of the panicle.

Irrigating the crop at an IW /CPE ratio of 1.5 recorded the highest value for all the yield attributing characters. A drastic reduction in all these characters was observed in plants under rainfed condition. It might be due to the high soil moisture tension experienced throughout the crop growth period especially during critical stages which in turn might have restricted the development of reproductive phase of the crop. Extreme reduction in tiller number and leaf area due to moisture stress could have led to a permanent strain in rice crop as observed by Cruz and O' Toole (1984). Rahman and Yoshida (1985) observed that panicle exertion showed an inhibitory effect due to water stress under moisture stress conditions. Lenka and Garnayak (1991) reported that grain sterility is directly related to stress during flowering to panicle ripening. In the present study panicles produced by the plants subjected to rainfed situation failed to emerge out completely and were sterile. The deleterious effect of water deficit on spikelet opening (Ekanayake *et al.*, 1989) would have resulted in high chaff percentage. Similar observations were also recorded by Prasad *et al.* (1992). Sudhakar *et al.* (1989) reported that soil moisture stress during tillering stage resulted in significant reduction in panicle number while stress during development and ripening reduced the percentage of filled grains of rice.

Among the nutrient levels, F_3 recorded the highest value for all the yield attributes. Under upland condition, the nutrient availability is very less because of the rapid mineralization of organic matter, loss of N through leaching and denitrification, P fixation and leaching loss of K. Therefore, to ensure sufficient crop growth and yield, fertilizer application at optimum levels is a pre-requirement. Significantly higher number of panicles at F_3 level of nutrients might be due to the increased tiller production which could have resulted from the efficient utilization of nutrients at higher rates of NPK application. Ghose *et al.* (1960) reported that increased absorption of nutrients at panicle initiation stage favoured increased production of grains per panicle as noticed in the present study. Channabasavanna and Setty (1994) also reported increase in grain number per panicle in rice with higher NPK levels. Roy *et al.* (1980) reported that K stimulated build up and translocation of carbohydrates and grain development which increased the number of filled grains. At higher level of NPK fertilizers, a significant increase in chaff percentage was observed in the present study. With higher fertilizer doses, the vegetative growth was more resulting in high LAI and this might have resulted in mutual shading which affected photosynthesis. The reduced translocation of accumulated starch and decreased photosynthetic activity during the reproductive and ripening stages might have resulted in the production of more number of chaffy grains. It might also be due to the poor partitioning of biomass to panicles at higher levels of fertilizer application. This could be the reason for similar test weight at higher and lower nutritional levels. Deshmukh *et al.* (1988) reported that combined application of major nutrient l3vels resulted in favourable response of yield attributes in rice.

Table 1. Effect of irrigation, nutrients and seed priming on number of productive tillers hill^{-1}, length of panicle (cm) and weight of panicle (g)

Treatment	Number of productive tillers hill-1	Length of panicle (cm)	Weight of panicle (g)
Irrigation			
I_1	11.22	19.83	2.33
I_2	8.94	19.056	2.03
I_3	5.8	15.78	0.89
$F_{(2,4)}$	15.297	5.046	36.514**
CD	2.715	-	0.493
Nutrients			
F_1	7.7	17.056	1.585
F_2	8.11	18.83	1.84
F_3	10.22	18.8	1.82
$F_{(2,16)}$	6.426**	1.111	2.144
CD	1.615	-	-
Seed priming			
S_1	8.3	18.78	1.78
S_2	9	17.67	1.72
$F_{(1,34)}$	0.954	1.365	0.219
CD	-	-	-

Table 2. Effect of irrigation, nutrients and seed priming on number of spikelets panicle -1, number of filled grains panicle -1 and chaff percentage

Treatment	Number of spike lets panicle $^{-1}$	Number of filled grains panicle^{-1}	Chaff percentage
Irrigation			
I_1	119	101	14
I_2	116	101	13
I_3	91	42	63
$F_{(2,4)}$	6.771*	43.8**	511.67**
CD	22.82	20.69	4.97
Nutrients			
F_1	91	71	25.55
F_2	115	87	30.11
F_3	120	89	34.39
$F_{(2,16)}$	14.923**	7.649**	10.764**
CD	12.121	10.231	4.031
Seed priming			
S_1	109	79	32.07
S_2	109	85	27.96
$F_{(1,34)}$	0.001	1.539	5.421*
CD	-	-	3.584

Table 3. Effect of irrigation, nutrients and seed priming on thousand grain weight(g), grain yield(kg ha^{-1}) and straw yield (kg ha^{-1})

Treatment	Thousand grain weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Irrigation			
I_1	22.44	2675.9	7004
I_2	21.58	2144.6	6640
I_3	17.07	370.8	4700
$F_{(2,4)}$	990.5**	2163.2**	44.4**
CD	0.351	101.8	73.7
Nutrients			
F_1	19.76	1299.4	5070
F_2	20.65	1798.2	6180
F_3	20.68	2093.7	7120
$F_{(2,16)}$	83.5**	53.1**	4.4*
CD	0.154	165.1	142.7
Seed priming			
S_1	20.29	1736.4	6007
S_2	20.3	1724.5	6240
$F_{(1,34)}$	0.194	0.036	0.25
CD	-	-	-

Yield

The data pertaining to grain and straw yields are presented in Table 1 to 3. The results clearly indicated that the irrigation treatment significantly influenced both the grain and straw yields. The rainfed treatment (I_3) gave only meager yield due to the moisture stress experienced at different growth stages especially during the reproductive phase of the crop. The influence of irrigation was very mush evident and the maximum yield was obtained when the crop was irrigated at an IW/CPE ratio of 1.5 (I_1). The highest level of irrigation recorded an yield increase of 24.8 per cent in grain yield and 5.4 per cent in straw yield over I_2 (IW/CPE = 1.0). The reduction in crop yield at rainfed and lesser irrigated treatment might be due to the severe and mild moisture stress experienced by the crop. Under the moisture stress situation increased soil mechanical resistance and poor root growth may occur. Philips (1996) reported that under unsaturated soil moisture environment a vapour gap would be formed around the roots by their turgour pressure under water stress. Such a gap if ever present would reduce the availability of nutrients to the roots probably due to lesser contact between roots and soil particles causing drastic reduction in uptake of nutrients and dry matter production. This might be the major reason for lower yield of crop with high moisture stress. The increase in grain yield in irrigated plots is due to the concomitant increase of the yield attributes at higher levels of irrigation Lee *et al.* (1985) indicated that soil moisture stress reduced the number of spikelets per panicle and filled grain percentage resulting in yield reduction up to 50 per cent in rice. It was reported that yield reduction under moisture stress was mainly due to the increased number of unfilled grains per panicle rather than reduction in panicle number per unit area. Similar trend was also observed by Sheela (1993). The increased straw yield with increasing levels of irrigation is attributed to the combined effect of plant height, tiller production and DMP, which were favorably influenced by irrigation levels. The stunted growth, poor tiller production coupled with extremely low leaf area might have resulted straw yield in the control treatment. This finding is in agreement with the studies of Singh and Singh (1993) and Pant *et al.* (1987).

The variation in nutrition also explicitly influenced the grain and straw yields. The NPK level at 60:30:45 kg ha^{-1} (F_3) produced 16.43 and 15.3 per cent increase in grain yield and straw yield respectively as compared to the Package of Practices (POP) recommended dose of 40:20:30 kg ha^{-1} (F_2), while yield increase of F_2 over F_1 (20:10:15 kg ha^{-1}) was 38.28 per cent in grain yield and 21.89 per cent in straw yield. Higher uptake of major nutrients due to increased application of these nutrients might have contributed to the enhancement of yield attributing characters which in turn improved the grain yield. These findings are in agreement with the studies of Sharma and Choubey (1986) and Sheela (1993). A similar trend was observed in straw yield also. The data presented on growth characters clearly indicated that higher NPK levels had positive influence on plant height, tiller number, LAI and DMP which have a direct bearing on straw yield. These findings are in corroboration with the reports of Singh *et al.* (1998).

The impact of seed priming either alone or in combination with the levels of irrigation on nutrients was not significant on the grain or straw yield.

The results of the study indicates that under higher levels of NPK application crop needs frequent irrigation. The better expression of higher levels of nutrition with high level of irrigation was well documented in all major field crops. It is also evident from the result that under situations of lesser irrigation (I_2) the present POP recommendation is optimum. At rain fed treatment the grain and straw yields were on par with each other at lower and higher levels of NPK.

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