Journal of Tropical Agriculture 40 (2002): 14-18

EFFECT OF CULTURAL MANAGEMENT ON YIELD AND YIELD ATTRIBUTES OF RICE IN LATERITE SOIL

T. K. Bridgit and N. N. Potty
College of Horticulture, Thrissur 680656, Kerala, India

Abstract: Studies conducted to analyse the pathway of yield formation as influenced by varying cultural management systems in laterite soils revealed that depth of digging at 15 cm or 30 cm or increasing the levels of farm yard manure beyond 5 t ha^{-1} had only marginal effects on improving the growth and productivity of the plant. Crops under dry seeded condition which did not have reduced soil environment in the early stage manifested better growth as evidenced by higher elongation and more tillers with a steady declining tiller count. Larger numbers of longer roots were another characteristic. As against this, the plants in the reduced environment were comparatively dwarf, tiller production was low but extended beyond maximum tillering and panicle initiation stages and root production was also hindered. The variation in these characters between the two environments worked out to be 46.0 per cent in tiller count and 43.9 per cent in root count. This difference was manifested in the yield levels of 6496 kg ha^{-1} in dry seeded and 4715 and 4615 in wet seeded and transplanted situations.

Key words: Digging, organic manure, rice systems, restricted root production.

INTRODUCTION

High realised yields have been recognised as the product of integration of high yield potential of the genotype and proper and timely management. Yield of rice in laterite soils seldom exceeds 3.0 - 3.5 t ha^{-1}. Failure to yield higher and non-responsiveness to conventional management inputs were found to be due to excess absorption and accumulation of of Fe and Mn in plant (Potty *et al.*, 1992) which suppresses N, P and K use efficiency (Anilakumar *et al.*, 1992), metabolic processes (Bridgit and Potty, 1992) and affect anion-cation balances (Bridgit *et al.*, 1993). Basically cultural management practices will improve the plant establishment, root growth and development. Experimental results suggest that the yield potential for direct seeded rice is similar or higher than transplanted rice (Purushothaman and Morachan, 1994; Bridgit and Mathew, 1995). The degree and kind of land preparation are closely related to the system of crop establishment and moisture availability and tillage practices for land preparation vary with the system. Effect of organic manures on the yield improvement of rice varies differently. Musthafa and Potty (1996) attributed that the yield improvement due to organic manure was by widening of N/Fe ratio in laterite soils and Marykutty *et al.* (1992) reported that the effect was from a balancing effect between K, Ca and Mg. Long-term manurial trial at the RARS, Pattambi showed that even a total substitution of fertilizers with organic manure can not increase the yield beyond 4000 kg ha^{-1} (Anilakumar *et al.* 1993). In order to study the effect of organic manure, digging and system of rice establishment on containing the yield limiting influences and to improve the productivity of rice in laterite soil experiments were carried out during first crop seasons of 1996 and 1997 and the results are presented below:

MATERIALS AND METHODS

Experiments were conducted at the Agricultural Research Station, Mannuthy (10°31'N, 76°13' E). The soil type of the area was lateritic sandy clay loam of Oxisol having organic carbon 0.95%, available P 3.7 kg ha^{-1} and available K 132.2 kg ha^{-1} with a pH of 6.08.

The treatment of the study included combinations of three methods of crop establishment (Dry seeding, wet seeding and transplanting), two depths of digging (15 and 30 cm depth) and three levels of organic manure (0, 5 and 10 t ha^{-1}). The 18 treatment combinations were laid out in RBD with three replications in plots of 20 m^2. Growth attributes were recorded at periodic intervals. Yield attributes and yield were recorded at harvest. The data were statistically analysed (Panse and Sukhatme, 1978) and the results are presented in this paper.

RESULTS AND DISCUSSION

Data presented in Table 1 showed that direct dry seeding registered significant superiority over wet seeding and transplanting in increasing tiller counts at all the stages and height after

Table 1. Effect of cultural management on growth attributes of rice

Treatments	Plant height, cm				Tillers/hill			
	MT	PI	Flg.	Harvest	MT	PI	Flg.	Harvest
System								
DSR	47.9	68.0	87.8	87.0	5.5	10.2	8.5	7.6
WSR	48.4	56.3	74.7	74.0	3.4	4.4	5.0	3.5
TPR	48.6	53.4	73.6	75.0	4.6	5.5	6.0	4.5
CD (0.05)	NS	3.11	2.51	2.96	0.67	0.79	0.75	0.70
Digging								
D15	47.8	60.1	79.2	79.2	4.5	6.7	6.5	5.4
D30	48.8	58.3	78.2	78.4	4.5	6.7	6.5	5.0
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
FYM								
MO	45.7	58.8	77.7	75.7	4.1	6.7	6.5	5.0
M5	49.1	56.7	77.9	79.2	4.8	6.9	6.8	5.6
M10	50.2	62.2	80.7	81.5	4.6	6.5	6.3	5.1
CD (0.05)	2.52	3.11	2.51	2.96	0.67	NS	NS	NS
CV (%)	7.68	7.74	4.69	5.52	22.1	17.38	16.95	19.84

DSR - Dry seeded rice; D15 - 15 cm depth; Flg.- Flowering; WSR - Wet seeded rice; D30 - 30 cm depth; PI - Panicle initiation; TPR - Transplanted rice; FYM - Manure; NS - Non-significant; MT - Maximum tillering

Table 2. Effect of cultural management on root characters and dry matter accumulation of rice

Treatments	Root characters/ plant			Total plant dry weight (g/plant)		
	No. Of roots	Max. root length, cm	Average root length, cm	MT stage	PI stage	Flowering stage
System						
DSR	122.7	10.3	7.4	8.9	24.3	36.3
WSR	67.4	16.1	6.9	4.9	14.1	14.8
TPR	68.8	13.0	4.6	5.4	16.1	18.9
CD (0.05)	11.34	0.879	0.609	0.97	2.91	6.54
Digging						
D15	80.0	13.1	6.3	6.3	18.0	22.2
D30	92.6	13.2	6.2	6.5	18.3	24.5
CD (0.05)	9.16	NS	NS	NS	NS	NS
FYM						
MO	76.0	11.8	5.9	5.9	18.8	23.2
M5	82.2	13.1	6.2	6.0	16.6	21.9
M10	100.6	14.5	6.8	7.3	19.0	24.8
CD (0.05)	11.34	0.879	0.609	0.79	NS	NS
CV (%)	19.30	9.86	14.26	22.4	23,6	30.7

DSR - Dry seeded rice; D15 - 15 cm depth; Flg.- Flowering; WSR - Wet seeded rice; D30 - 30 cm depth; PI -Panicle initiation; TPR - Transplanted rice; FYM - Manure; NS - Non-significant; MT - Maximum tillering

maximum tillering stage. Transplanting recorded the lowest tiller counts. Thus the data showed that irrespective of treatments, grand growth phase in rice in first crop season is confined to between maximum tillering (MT) and flowering stage. The data also showed that the system of cultivation affected the duration and extent of tiller decline. Tiller decline, which balances at various growth stages of the crop (Table 2). The data showed that dry seeding was markedly superior to the other two systems in total accumulation of dry matter at all the stages of observation. Depth of digging and application of FYM did not significantly influence dry matter accumulation except at MT stage wherein FYM at 10 t ha^{-1} significantly increased the dry matter accumulation. Data on yield attributes and yield are presented in Table 3. The data showed that dry seeding significantly increased number of panicles per hill, number of filled grains per panicle and 1000 seed weight. Dry seeding recorded higher yield of grain and straw of 6496 and 5388 kg ha" ' compared to other two systems and the increase were 40.7 and 37.5 per cent over transplanted crop and 37.8 and 40.4 per cent over wet seeded crop. Depth of digging did not show any significant effect on yield attributes. Digging to a depth of 30 cm increased the grain yield by 379 kg ha^{-1} and biomass yield by 705 kg ha^{-1}.

Among the yield attributes number of filled grains as well as percentage of filling were significantly affected. Application of FYM at 10 t ha^{-1} recorded the highest number. Organic manure @ 10 t ha^{-1} significantly increased grain yield and total biomass which was on par with FYM @ 5 t ha^{-1} and both were significantly superior to control. Organic manures are soil ameliorants and sources of plant nutrients. Application of FYM @ 10 t ha^{-1} significantly influenced growth attributes, yield attributes like filled grains per panicle as well as percentage of filling. Physiologically, filling is a function of translocation and the high yield obtained due to application of FYM is possibly due to the result of facilitated translocation.

A perusal of the data thus indicated that one of the causes of low yield of rice in wet seeding and transplanting may be due to the poor development of rice roots. Poor morphological development and low dry matter accumulation shall thus be a direct function of the ramification of the root system, which in turn decides the nutrient removing power of the plant. The results thus show that root number per plant at MT stage is the best index of future yield, which in turn suggests that inhibited root growth and or root decay is the best index of low yield. Conversely it means that unfavourable nutrient ratios affect yield by affecting root growth

These results thus reveal that deep digging or increased levels of application of organic manure are not the panacea to rectify the low yield conditions of laterite soils. Morphological development is the expression of metabolic process as well as their rate. A significant superiority manifested in the tiller count, height and dry weight during the phases of crop growth pointed out that the higher yield in dry seeding has been due to the higher metabolic activity through better morphological development throughout the growth of the plant. The fact that higher number of grains per panicle in dry seeded crop, points out to the significance of early growth leading to higher number of tillers and panicles per hill. Mureta (1969) have reported that the number of florets is the most important parameter in deciding higher yield. Thus the very low yield in wet seeded and transplanted rice is due to the combined effect of low productive tillers, grain weight and percentage of filling.

ACKNOWLEDGEMENT

This paper forms part of the Ph. D. thesis submitted by the first author to the Kerala Agricultural University. The senior author is grateful to the CSIR for providing Senior Research Fellowship for the programme.

REFERENCES

Anilakumar, K., Potty, N. N. and Bridgit, T. K. 1992. Nutritional inhibition of rice productivity in laterite soil. *Oryza* 29: 37-39

Anilakumar, K., Johnkutty, I. and Joseph, K. 1993. Long-term effect of continuous fertilization by organic and inorganic sources on rice productivity. *J. trop. Agric.* 31: 204-209

Bridgit, T. K., Potty, N. N., Marykutty, K. C. and Anilakumar, K. 1993. Anionic relation to iron in rice culture in laterite soils. *Proceedings of the Fifth Kerala Science Congress.* State Committee on Science, Technology and Environment, Trivandrum, p.140-141

Table 3. Effect of cultural management on yield attributes and yield of rice

Treatments	Yield attributes				Yield (kg/ha)			Grain/ straw ratio
	Panicles/ hill	Filled grains/ panicle	1000grain weight, g	Filling %	Grain	Straw	Total biomass	
System								
DSR	7.6	87.9	32.4	83.4	6496	5388	11884	1.18
WSR	3.4	83.4	30.9	79.3	4715	3837	8582	1.24
TPR	4.4	76.9	31.2	72.3	4615	3919	8534	1.20
CD (0.05)	0.78	4.26	0.080	2.35	425.0	560.0	754.4	NS
Digging								
D15	5.2	82.4	31.3	77.8	5086	4222	9308	1.20
D30	5.0	83.0	31.7	79.0	5465	4541	10006	1.21
CD (0.05)	NS	NS	NS	NS	347.0	NS	616.0	NS
FYM								
MO	4.8	79.4	31.3	77.0	4748	4101	8851	1.14
M5	5.6	79.2	31.5	77.6	5455	4509	9963	1.22
M10	5.1	89.4	31.7	80.4	5623	4532	10155	1.25
CD (0.05)	NS	4.26	NS	2.35	425.0	NS	754.4	NS
CV (%)	22.45	5.68	3.77	4.42	8.81	13.98	8.54	14.46

DSR - Dry seeded rice; D15 - 15 cm depth; Flg.- Flowering; WSR - Wet seeded rice; D30 - 30 cm depth; PI -Panicle initiation; TPR - Transplanted rice; FYM - Manure; NS - Non-significant; MT - Maximum tillering

extended from panicle initiation (PI) to harvest in dry seeding was confined to between flowering and harvest in other treatments. The magnitude of tiller decline was lowest in other treatments. However, the early superiority of dry seeding in tiller production was retained to the end. Method of land preparation did not significantly influence plant height and tiller counts.

Increasing levels of farmyard manure significantly increased the height of plant at all stages and tiller counts at MT. Application of FYM @ 10 t ha^{-1} was superior and increase in plant height over control were 8.6, 5.8, 4.3 and 7.7 per cent at MT, PI, flowering and harvest while the increase in tiller count at MT was 12.2 per cent. Differences in tiller count on the subsequent stages were not significant.

With regard to root characteristics (Table 2), it may be seen that dry seeding had recorded a large number of roots (122.7 roots/plant), which was 78.3 per cent higher than that of wet seeding which had produced the lowest number of roots. Wet seeding and transplanting did not significantly differ in number of roots. Mean length of root was also higher in dry seeding and was significantly superior to transplanting. Dry seeding and wet seeding did not significantly differ in the mean length of roots though it was significantly superior to transplanting.

Digging to a depth of 30 cm significantly increased the number of roots per plant. Increasing depth of digging naturally increases the soil volume for root ramification, which in turn facilitates better nutrient absorption, plant growth and yield. Increase in yield due to deep digging in rice has been reported by Mosand *et al.* (1993).

Increasing levels of FYM increased the number; average length and maximum length of roots and these increases were statistically significant. The lower values of these observations were recorded under control and the increases in number, average length and maximum length of roots were 8.2, 11.0 and 5.1 per cent when FYM was applied @ 5 t ha^{-1} and 32.4, 22.9 and 15.3 per cent when the level of FYM was raised to 10 t ha^{-1}.

System of crop establishment had a significant influence on dry weight of plant and their

Bridgit, T. K. and Potty, N. N. 1992. Chlorophyll content in rice and its significance. *Proceedings of the 4th Kerala Science Congress.* State Committee on Science, Technology and Environment, Trivandrum, p.229-230

Bridgit, T. K. and Mathew, J. 1995. Differential response of rice to coated and enlarged urea forms under wet seeded and transplanted systems. 1RRI Discussion Paper Series No. 10, Constraints, Opportunities and Innovations for Wet Seeded Rice (Ed. Moody, K.), IRRI, Manila, Philippines p.219-230

Marykutty, K. C., Potty, N. N., Anilakumar, K. and Bridgit, T. K. 1992. Stress influence of nutrient ratios on rice productivity. *Proceedings of National Seminar on Plant Physiology.* Rajasthan Agricultural University, Durgapura, Jaipur. p.69

Mosand, S.S., Kapur, O. C. and Jaggi, R. C. 1993. Effect of tillage and nitrogenous fertilizers on water use and yield of rainfed maize on sloping and level lands. *J. Indian Soc. Soil Sci.* 41: 426-429

Mureta, Y. 1969. Physiological response to nitrogen in plants. *Physiological Aspects of Crop Yield.* American Society of Agronomy. *Crop Sci. Soc. Am.* Madison, Wisconsin, 512p

Musthafa, K. and Potty, N.N. 1996. Yield limiting influences in rice in soils of lateritic origin. Proceedings of 8th Kerala Science Congress, State Committee on Science, Technology and Environment, Trivandrum . p. 114-116

Panse, V. G. and Sukhatme, P. V. 1978. *Statistical Methods for Agricultural Workers.* 3rd edn., 1CAR, New Delhi, p.347

Purushothaman, S. and Morachen, Y. B. 1974. Response of IR-8 to direct seeding and transplanting at three levels of nitrogen. *Madras agric.* J. 61: 285-288