Journal of Tropical Agriculture 40 (2002): 59-62

EFFECT OF CULTURAL MANAGEMENT ON ROOT CHARACTERISTICS AND PRODUCTIVITY OF RICE IN LATERITE SOIL

Crop growth and yield are the results of metabolic process and as such variation in yield is to be viewed as the product of variation in the metabolic processes. Cultural and nutritional management alter the rate of metabolic processes through modifying the soil plant environment. As root is the absorbing organ, development of root is evidently an index of the vigour of the above ground portion also. Yoshida (1981) stated that the ideal balance of root shoot ratio is 10 at the maximum tillering (MT) stage. Investigating the effect of iron on rice, Marykutty *et. al* (1993) reported large scale deposition of iron in the roots, worked out to be 2.00 kg ha^{-1} day^{-1}. She also reported that plants on iron toxic soils tended to produce more roots to compensate the inactivation of roots by surface deposition of iron. Information on the influence of root characteristics on growth and productivity of rice is meagre. Hence, an experiment was conducted to study the effect of cultural management on root characteristics and productivity of rice in iron rich laterite soils.

The experiment was laid out at the Agricultural Research Station, Mannuthy during 1995-97. The soil type of the area was laterite sandy clay loam 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 consisted of 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 FYM (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. All the operations were carried out as per the package of practices recommendations (KAU, 1996). Rice variety Jyothi was used as the test variety. Growth attributes were recorded at periodic intervals and yield attributes at harvest. The data were statically analysed (Panse and Sukhatme, 1978) and the results are presented in this paper.

Data presented in Table 1 showed that dry seeding had recorded a larger number of roots as well as higher average length of roots. Dry seeding recorded a mean number of 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. Dry and wet seeding did not differ in the mean length of roots and recorded 60.9 and 50.0 per cent higher mean length of roots compared to transplanting. Digging to a depth of 30 cm significantly increased the mean number of roots and the increase was worked out to 15.8 per cent over digging to a depth of 15 cm.

Increasing the levels of FYM increased the number, average length and maximum length of roots and the increases were statistically significant. The lowest values of these observations were recorded under control and the highest at 10 t FYM ha^{-1}.

Data also showed that (Table 1) dry seeding has given an yield of 11884 kg ha^{-1} biomass partitioned between 6496 kg grain and 5388 kg straw and the improvement in grain yield over transplanting and wet seeding were 37.8 and 40.8 per cent, respectively. Superiority of dry seeding over wet seeding and transplanting has been reported by Bridgit and Mathew (1995).

As different methods of crop establishment have received uniform management practices a high yield in dry seeded crop will mean a higher nutrient use efficiency and vice versa. This can well be explained on the basis of root characteristics viz. root number, average root length and maximum root length. Effectiveness of depth of digging when viewed on the context of plant development showed that digging to a depth of 30 cm instead of 15 cm significantly increased the yield by 621 kg grain and 319 kg straw ha^{-1} over to a depth of 15 cm. 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 also been reported by Mosand *et al.* (1993). Increasing levels of FYM to 10 t ha^{-1} increased the yield and the increase assumed significant level. Here again, the characteristic increase in root number at MT stage, root dry weight at MT and PI stages and shoot dry weight at PI and flowering stages were evident. This confirms that they are definite indices of productivity. Data presented in Table

2 showed that in dry seeding, the root and shoot dry weight increased significantly from MT stage to flowering stage. No significant difference observed between wet seeding and transplanting. March of shoot root ratio from PI to flowering stage showed a decline at PI and flowering stages in dry seeding while it steadily increased in wet seeding and transplanting.

Table 1. Effect of cultural management on root characters and yield of rice

Treatment	Root No./ plant	Maximum root length (cm)	Average root length (cm)	Yield, kg ha^{-1}		
				Grain	Straw	Total biomass
System						
DSR	122.7	10.3	7.4	6496	5388	11884
WSR	67.4	16.1	6.9	4715	3837	8552
TPR	68.8	13.0	4.6	4615	3919	8534
CD (0.05)	11.34	0.879	0.609	425.0	560.0	754.4
Digging						
D15	80.0	13.1	6.3	5086	4220	9308
D30	92.16	13.2	6.2	5465	4541	10009
CD (0.05)	9.16	NS	NS	347	NS	616.0
FYM						
M0	76.0	11.8	5.9	4748	4101	8849
M5	82.2	13.1	6.2	5455	4509	9964
M10	100.6	14.5	6.8	5623	4532	10155
CD (0.05)	11.34	0.879	0.609	425	NS	754.4
CV (%)	19.3	9.86	14.26	8.81	13.98	8.54

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

Table 2. Effect cultural management on plant dry weight, shoot root ratio and root iron content

Treatment	Root dry weight (g/plant)			Shoot dry weight (g/plant)			Shoot/root			Root iron content at MT (ppm)
	MT	PI	Flg.	MT	PI	Flg.	MT	PI	Flg.	
System										
DSR	1.6	6.3	7.0	7.4	17.8	31.1	5.2	3.2	4.6	10619
WSR	1.2	1.7	1.0	3.7	12.4	12.9	3.3	7.9	13.7	28979
TPR	1.1	1.4	1.3	4.3	14.6	17.6	4.2	11.6	14.6	42504
CD (0.05)	0.32	1.07	1.61	0.97	2.83	4.06	0.89	2.31	2.6	5699
Digging										
D15	1.3	2.9	2.6	5.3	15.1	19.0	4.3	7.4	11.1	26366
D30	1.3	3.4	3.7	5.2	14.9	22.0	4.2	7.7	10.9	28368
CD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
FYM										
MO	1.2	3.8	3.4	4.6	15.0	18.9	4.2	6.6	11.3	26010
M5	1.1	2.6	2.8	4.9	14.0	19.4	4.5	8.7	10.9	27183
M10	1.5	3.0	3.2	5.8	16.0	23.3	4.0	7.4	10.7	28909
CD (0.05)	0.26	0.93	NS	0.66	NS	4.06	NS	NS	2.31	NS
CV (%)	36.85	53.9	56.3	23.4	23.6	29.1	30.9	26.5	26.5	24.17

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 - Nonsignificant; MT - Maximum tillering

Table 3. Interaction between root characters, root iron content and some biometric differentials with yield

Root and biometric differentials	Yield			Root iron content
	Grain	Straw	Total	
Shoot dry weight (Pt-MT)	0.203	0.186	0.206	-
Root dry weight (PI-MT)	0.625**	0.631**	0.665**	-
Total dry weight (PI-MT)	0.422**	0.412	0.442**	-
Shoot dry weight (Flg-PI)	0.609**	0.539**	0.610**	-
Root dry weight (Flg-PI)	0.463**	0.494**	0.506**	-
Total dry weight (PI-MT)	0.629**	0.577**	0.640**	-
Root Nos./Plant	0.748**	0.676**	0.757**	-0.607**
Average root length	0.402	0.358	0.404	-0.565**

Depth of digging did not influence root and shoot dry weight and shoot root ratio significantly. Application of FYM significantly influenced the root dry weight at MT and PI stages, shoot dry weight at MT and flowering stage and shoot root ratio at flowering.

A closer scrutiny of the data showed that the ratios are misleading and the highest ratios are the results of lower number of roots. Hence number of roots and ratios together will be better and shall serve as a morphological index of future realizable yield. Prabhakaran and John (1992) have suggested the feasibility of predicting yield based on early growth. The data also showed that the system of crop establishment significantly influenced the root iron content and dry seeding recorded the lowest value (10619 ppm) and transplanting recorded the maximum value of 42504 ppm.

Depth of digging and application of FYM did nit significantly influence the root iron content. Observations on the morphological parameters showed that deep digging had increased the number of roots at MT, had registered a steady and continuous increase in root dry weight from MT stage and increased the total dry matter accumulation. These had been in identical pattern with that observed in the system, which substantiates that, the root number at PI and post PI accumulation is the two important determinants of the ultimate yield. Exclusive confinement of significant influence of digging on number of roots at MT, root dry weight at PI stage indicated that effect of deep digging on yield was mainly through facilitating root growth, ensuring their survival as well as increasing growth as against wet seeding and transplanting. It would imply that deep digging minimizes the root damage probably by removing some harmful factors affecting the plant by washing them down to some extent. Data presented in Table 3 showed that significant positive correlation between root characteristics and biometric differentials with yield of rice. Maximum correlation was recorded by number of roots per plant with grain yield, straw yield and total biomass followed by difference in total dry weight between flowering and PI stage. The difference in root dry weight between PI and MT and flowering and PI, shoot dry weight difference between flowering and PI, total dry weight difference between PI and MT stage and average root length were also highly correlated with grain yield, straw yield and total biomass.

The significant influence of average root length on yield pointed out that average root length has a significant role in boosting the yield, though it is only second to root number. Elemental composition of root showed that increasing concentration of iron in the root at MT stage appears to be the cause of lowest root number and average root length in the crop. As against 10619 ppm of iron in dry seeded rice, it had been 28979 ppm in wet seeding and 42504 ppm in transplanting. Significant correlation observed between root number and average root length with root iron content confirms that iron content and/or deposition was the predisposing cause of low root development. Significantly increasing iron content from dry seeding to transplanting further indicated that iron deposition is a function of soil moisture regime.

In the light of the above it will be reasonable to assume that deeper digging though reduced the iron content of the root, did not ameliorate the moisture effect and the lower yields in these treatments is the reflection of the inefficiency of this amelioration. Correlation between biometric differentials and yield (Table 3) showed that root number per plant at MT stage is the best index of future yield, which in turn suggest that inhibited root growth and/or root decay is the best index of low yield in laterite soil.

College of Horticulture
Thrissur 680656, Kerala, India

T. K. Bridgit
N. N. Potty

REFERENCES

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

KAU. 1996. *Package of Practices Recommendations: Crops.* Directorate of Extension, Kerala Agricultural University, Trichur, 237p

Marykutty, K. C., Potty, N. N. and Bridgit, T. K. 1993. Varietal variation in root surface deposition of elements by rice in laterite soils. *Proceedings of Fifth Kerala Science Congress,* State Committee on Science, Technology and Environment, Trivandrum, p.441

Mosand, S. S., Kapur, O. C. ans 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

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

Prabhakaran, P. V .and John, R 1992. An alternate approach for the interpretation of data from groups of experiments. *Proceedings of Fifth Kerala Science Congress,* State Committee on Science, Technology and Environment, Trivandrum, p.57-59

Yoshida, S. 1981. *Fundamentals of Rice Crop Research.* IRRI, Manila, Philippines, p 251