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Effect of nursery raising techniques of Boro rice on plant growth and soil physical properties

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ABSTRACT

Four nursery raising techniques namely in open condition, with farm yard manure (FYM) and without FYM, raising nursery in poly house with FYM and without FYM were employed to select optimum nursery growing environment under field condition and its effect on soil physical properties and plant growth was studied. Difference in soil temperature was 4.6^{0}C between poly house and open condition at 5 cm depth irrespective of FYM application. Organic carbon content and water retention were found higher in FYM applied soils. Growth parameters of seedlings were found highly significant under poly house compared to open condition. Number of seedlings survived in nursery under poly house with FYM was highest. Root weight under poly house was 98 per cent higher than open condition. Higher root diameter was observed in open condition over poly house. Root length density, surface density and volume density were higher under poly house. Root shoot ratio was to be found highest in nursery in polyhouse with FYM which was 83 per cent higher than open condition without FYM. Boro rice seedlings under poly house with FYM recorded the highest number and better crop stand than other treatments. Under open condition, FYM application proved to be superior to nursery (Without FYM).

Key words: *boro rice, nursery, poly house, soil physical properties, plant and root growth*

Soil edaphic factors influence the crop growth in several ways. Change of 1^0 C in soil temperature was reported to influence the growth of maize seedling (Walker, 1969). Soils of tropical region experience the extreme temperatures. In summer, the soil temperature is above the optimal level and during winter it is below the optimal level. These extreme conditions pose a lot of stress on crop growth particularly when tropical crop like rice is grown under sub-optimal temperatures. Incorporation of organic matter has several effects on soil physical properties and plant growth. Organic matter added in soil reduces the bulk density of mineral soil because the bulk density of organic matter is less than that of soil displaced by the organic matter (Voorhess *et. al.,* 1981). Under optimum soil conditions, the root growth is most dynamics. Optimum plant growth depends upon optimum root growth. Unfavourable environment affects the root and shoot growth which leads to poor crop stand and poor yield. Different cultural practices imposed on land and soil, tends to modify the root-growing-environment. Boro rice is commonly grown in eastern India including north and north eastern Bihar, West Bengal and Assam where ground water is shallow or the lands are waterlogged and the winter temperature does not fluctuate much. The nursery of high yielding rice of medium duration group (125-135 days) is raised during October-November and the seedlings are transplanted by February. Considerable amount of low-lying areas are existing in Sone command where the waterlogging is common feature up to April-May. These areas are considered as degraded lands and no other crops can be grown. Boro rice cultivation is one of the possible choices to utilize these lands which is not popular in South Bihar due to extreme fluctuating low temperature during winter season (Singh and Singh, 2001). Heavy seedling mortality in the nursery causing insufficient seedlings for main field is the main constraint in Boro rice cultivation in south Bihar. Considering the above conditions, a study was conducted to examine the growth behavior of Boro rice seedlings under different nursery raising techniques and its effect on soil physical properties.

MATERIALS AND METHODS

Field experiment was conducted at the ICAR-RCER research farm, Patna during the winter seasons during 2000-2006 at an elevation of 60m MSL. The climate of the region is hot dry sub-humid. Mean annual air temperature is 25-26°C and mean winter temperature range is 16-18°C and times from 11 to 13°C. Soil temperature regime is hyperthermic. The characteristics of the soil used for the experiment is given in the table 1. Seedlings were raised under four treatments *viz*. open condition without farm yard manure, open condition with farm yard manure, poly house without farm yard manure and Poly house with farm yard manure.

Fields were puddled with and without FYM separately. Seeds of cold tolerant rice variety Gautam was presoaked and broadcasted. Fertilizer was applied at the rate of 1.0:1.0:0.5 kg NPK per 1000 m^2. Iron frame with polythene sheet mounted dome shape poly house was fabricated measuring 5 x 2.5 x 1.5 meter length, breadth and height. Poly houses were fixed in the field sown with rice seeds and the sides were sealed with mud. The nursery was given light irrigation once in 5 days. Leaf area was measured with leaf area meter (Licor Model-LI-3050A). Root samples were collected at transplanting. Seedlings of average growth in a particular treatment were selected and removed along with soil with the help of a spade and kept in water for over night. Soil particles were removed by running water with gentle force. All the roots were removed and the moisture was removed with tissue paper and weighed. Root parameters were measured with Root Length Measuring system (Newman 1966). Calibrated

Table 1. Basic characteristics of soil

Soil parameters	Values
Taxonomic class	Vertic Ustochrept
Sand (%)	35
Silt (%)	28
Clay (%)	37
Textural class	clay loam
Bulk density (Mg m^{-3})	1.47
Saturated hydraulic conductivity(cm hr^{-1})	0.31
pH	7.4
EC (dSm^{-1})	0.26
Organic carbon (g kg^{-1})	6.5
Available N (kg ha^{-1})	290
Available P (kg ha^{-1})	14
Available K (kg ha^{-1})	330

soil thermometers were installed in all the treatments at four depth viz. 5, 10, 15 and 20 cm and soil temperature was measured from sowing (November) to uprooting of seedlings (February) at 7 AM. Infiltration rate was measured with double ring infiltrometer and volume expansion was estimated with Keen-Razovaski box. Penetration resistance was measured with hand penetrometer. Soil moisture characteristic curves were developed from water retention against different suctions measured from pressure plate apparatus. Organic carbon was estimated following Walkly and Black (1934) method.

RESULTS AND DISCUSSION

Addition of FYM recorded higher plant height and more number of leaves, both in poly house and open conditions, nevertheless, impact was several fold compared under poly house compared to open condition (Table 2). Number of seedlings survived was highest in poly house with FYM, which was 54 per cent more than T_2 (Open condition without FYM) followed by poly house without FYM and open condition with FYM. Tong *et. al.* (2007) reported that low temperature (17-22^{0}C) reduced the seedling establishment and it was as low as 8% in Cambodian rice cultivars. Leaf area measured was higher in poly house compared to open condition. Similar trend was observed by Sharratt (1991) in Barley when it was grown under green house condition at 5, 10 and 15°C. Root growth of the boro rice seedling showed high variation under different cultural practices. The crop stand and overall growth was superior under poly house over open condition. Root weight under poly house showed 98 per cent higher than open condition, which was statistically significant. Surface area and length of root showed 41 and 86 per cent higher growth over open condition, respectively. Higher root diameter was observed in open condition, which is 20 percent over poly house condition. The density parameters like length density, surface density and volume density were higher under poly house condition to the extent of 86, 50 and 77 percent, respectively. Higher root growth observed under poly house condition except root diameter which might be due suitable soil temperature prevailed in side poly house during winter and the soil temperature was constantly higher under poly house condition. Root weight, surface area, root length and root length density were found significant and also surface density and

Table 2 Plant growth parameters of Boro rice seedlings under different nursery raising techniques

Treatments		Plant Height (cm)	No. of seedlings m^{-2}	No. of leaves	Leaf area (cm^2)	Length (cm)	Growth of root Diameter (cm)	Root/ Surface area (cm^2)	Shoot ratio
Open condition	Without FYM	13.2	1073	3.00	7.90	1318	0.57	855	3.00
	FYM	14.8	1280	3.67	8.34	1518	0.58	1059	4.25
	Mean	14	1177	3.33	8.12	1418	0.58	957	3.63
Poly house condition	Without FYM	24.7	1475	4.33	21.89	1903	0.53	1158	4.83
	FYM	26.7	1548	5.50	23.81	3371	0.43	1548	5.50
	Mean	25.7	1512	4.92	22.85	2637	0.48	1353	5.17
	Factor A								
	CD	0.91**	63.9*	0.20**	0.81**	102.75**	NS	55.1*	0.21*
	Sem	1.58	110.75	0.35	1.40	178.10		95.52	0.36
	Factor B								
	CD	NS	NS	NS	NS	102.75**	NS	5.1*	0.21*
	Sem					178.10		95.52	0.36
	Factor AxB								
	CD	NS	NS	NS	NS	205.62*	NS	NS	NS
	Sem					251.84			

* Significant ** Highly significant

volume density were found highly significant. Root diameter was found non-significant among open and poly house condition. Soil temperature regulation through poly house with or without FYM was more effective as resulted in very less mortality of seedlings.

Addition of FYM has benefited the root growth of boro rice both under open and poly house condition (Table 2). All growth parameters under FYM application were found highly significant over No-FYM. Under open condition, difference in root weight, surface area, root length, root length density, surface density and volume density were found higher at 40,24,16,16,19 and 13 per cent under FYM applied field over No-FYM respectively. Very less difference was observed in root growth between FYM and No-FYM application under poly house condition. Surface area, average diameter, root length, root length density, surface density and volume density were 37, 23, 77, 77, 43 and 14 per cent higher in FYM applied field respectively over No-FYM field. Root shoot ratio was found highest inT_4. It was 83 per cent higher than T_1. Higher temperature and good soil physical conditions might be the reason for both shoot and root growth under poly house with addition of FYM. Addition of FYM in open condition supported more number of seedlings compared to without FYM.

Variation in soil temperature was observed among different treatments. High difference was noticed between poly house and open condition to the tune of 4.6° C (Fig. 1). Accumulation of incoming radiation raised the ambient temperature and also soil temperature in side the poly house. The average air temperature inside poly hose from November to February was 28.6°C. Though the incoming radiation was less during winter season, poly house tends to accumulate the heat due to greenhouse effect compared to the open condition. Ambient temperatures either open

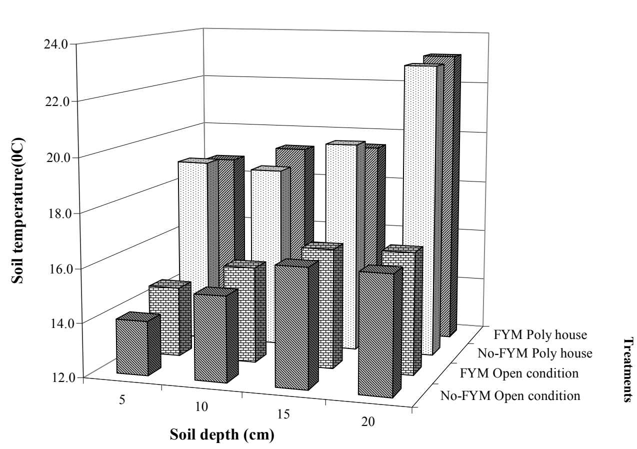

Fig. 1 Effect of nursery raising techniques on soil temperature at different depths

condition or inside the poly house affected the soil temperature differently. Temperature of soil at different layers was higher under poly house when compared to open condition. The thermal conductivity (lambda) increased with increasing moisture content and similarly an increase in moisture content resulted in a gradual acceleration of thermal diffusivity (Magar *et. al*., 1979). Application of FYM maintained higher soil temperature under open condition which supported better growth and crop stand by reducing mortality rate. The average soil temperature from November to February in T_1 and T_2 at 5 cm depth was 14.0 °C and 14.6°C respectively. The difference of 0.6 °C was due to application of FYM. Addition of organics helps in moderating extreme soil temperatures. The average soil temperature in T_3 and T_4 at 5 cm depth inside poly house was 19.0°C and 18.7°C respectively. Higher level of heat in the air inside poly house might have diffused in to the soil which might have maintained high soil temperature thorough out the seedling period. Favourable soil and air temperature was maintained inside poly house than open condition. Under depth wise measurement of soil temperature, the difference was much pronounced in 5 cm followed by 10 cm and at 20 cm depth, the difference was very less in all the four treatments (Subash et al., 2003).

Addition of FYM increased the organic matter and organic carbon content in the soil (Fig. 2). FYM soil maintained lower bulk density through out the nursery season compared to No-FYM soil. Lowest bulk density was recorded after one week of puddling and subsequently it increased with time. It might be due to loosening of soil particles by tillage in the beginning and compaction of soil particles in later time. The maximum bulk density reached at the time of transplanting in both FYM and No-FYM treatments (Fig. 3).The difference in bulk densities between FYM and No-FYM was high and at the time of transplanting the difference was very less. Application of FYM reduced the soil resistance to penetration compared to No-FYM soil (Fig. 4) Penetration resistance decreased with depth. Increasing amount of soil moisture with depth might have decreased the penetration resistance. The soil applied with FYM recorded lower penetration resistance compared to No-FYM soil. Wide difference in penetration resistance was observed in surface soil (0-15 cm) which was 60 and 76 kN cm^{-2} in FYM and No-FYM soils respectively. The difference was

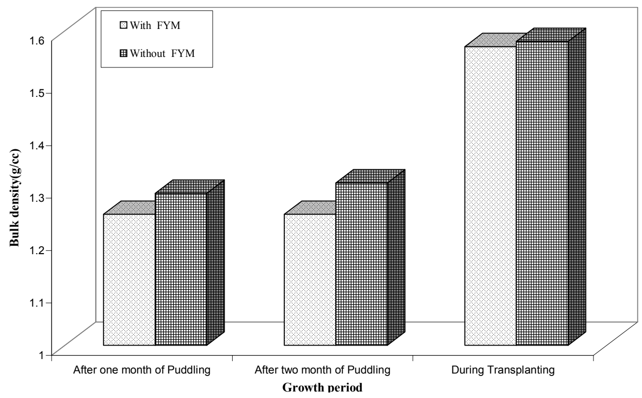

Fig. 3. Effect of organics addition on bulk density during growth period (kg m^{-3})

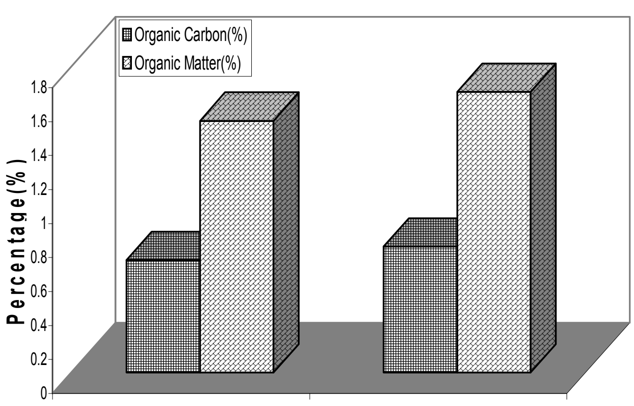

Fig. 2. Organic Carbon and Organic matter status as influenced by addition of farm yard manure

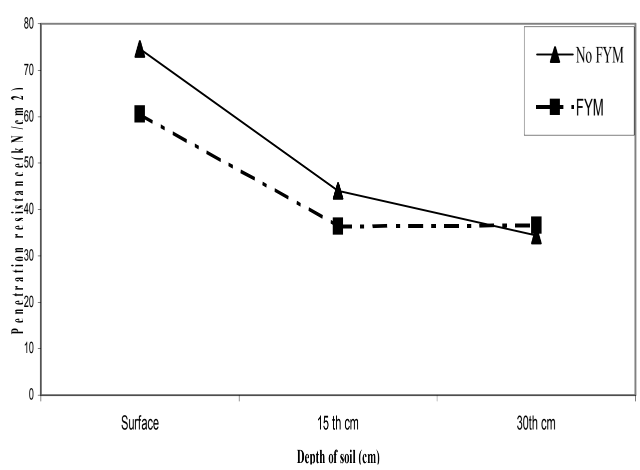

Fig. 4. Effect of organics addition on penetration resistance (kN cm^{-2}) at different depths in Boro rice

decreased with depth. No difference was noticed at the lower depth (30-45 cm). Maximum amount of FYM was retained at the surface and relatively lesser amount at the lower depths might be the reason. Infiltration rate was 8.23 cm hr^{-1} and 11.3 cm ha^{-1} in No-FYM and FYM applied soils. The volume expansions of soil in case of FYM applied soil was 22.98 per cent and in No-FYM soil it was 18.52 per cent. Soil water retention was also increased by addition of FYM (Fig. 5). Water

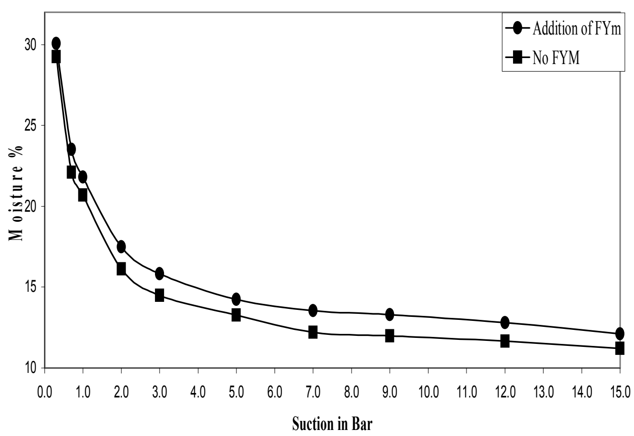

Fig. 5. Soil water retention at different suctions under addition and no addition of farm yard manure

retention was not distinct in the lower suctions. At higher suctions it was evident that the water retentions were reasonably higher. The water retention increased up to 13 per cent due to addition of FYM over No-FYM. Infiltration measurement showed 8.23 cm hr^{-1} in No-FYM plot and 11.3 cm hr^{-1} under FYM added plot.

Nursery raising techniques improved the soil physical conditions and air temperature which provided favourable environment for the better seedling growth of Boro rice over control during winter season. Under fluctuating low temperature of winter season in South Bihar, seedling raising inside poly house with or without farm yard manure proved to be superior over open condition and also FYM application showed better performance. In case of open condition, addition of FYM facilitated more number of seedlings due to less mortality and higher root growth compared to No-FYM.

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