EFFECT OF PLOUGH LAYER DEPTH ON GROWTH AND YIELD OF RICE IN DRY ZONE OF SRI LANKA

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Rice is the staple diet in Sri Lanka and the per capita consumption of rice is 114 kg and the total production was 4.2 million metric tons in 2010[2]. Rice yield levels have not been increased significantly over the last two decades and the country's average yield was hovering while the potential is much higher. A yield increase of rice in Sri Lanka is needed to feed increasing mouths in coming years. Expansion of the area of production, yield improvement, or both are the possible avenues for the increasing rice output. It is well known that Sri Lanka does not have additional lands for cultivation and the only possible way is to improve the yield in present lands. Seventy percent of the country's paddy requirement is supplied from the dry zone of Sri Lanka. However, a declining trend in rice yield has been observed since 1984 in the dry zone[1]. Out of the number of possible causes listed for this yield decline, depletion of the soil productivity is considered as a major cause. The main reason for low soil productivity could be the change in land preparation pattern during last two decades, probably after introduction of the two-wheel tractor in early 1070s. Instead of using the mould board plough for land preparation, at present farmers use rotovator, attached to two-wheel tractor. This primary land preparation method results in a shallow land preparation allowing a shallow plough pan in paddy fields. The shallow plough pan restricts deeper root growth, limiting soil nutrients and water for better plant growth. The present plough pan depth in the dry zone is approximately 10-20 cm and place to place variation could be observed, may due to soil type. The plough pan is very hard in reddish brown earth soil, which is the major soil type in the dry zone. Rice roots have a potential in growing even up to 100 cm depth in loose soil[3] having more access to nutrients and water in sub soil layers[4]. This research was conducted with the objective of investigating the depth of ploughing on growth and yield of rice in the dry zone of Sri Lanka.

A field experiment was conducted at the agricultural farm of the Faculty of Agriculture, Rajarata University in 2011/12 *Yala* season and 2012 *Maha* season. Three treatments were used; T1 (control) - ploughing to a depth of 10-20 cm using a rotovater attached to a two- wheel tractor, T2 - ploughing to a depth of 20-30 cm using a mould board plough attached to a four-wheel tractor and T3 - ploughing to a depth of 30-40 cm using a disc plough attached to a four-wheel tractor. Three treatments were arranged in a RCBD with four replicates. Three months old rice variety BG 300 was broadcasted and crop management was done according to the Department of Agriculture recommendations. Measurement of growth parameters were done at maximum tillering, at commencement of heading, at 50% of flowering and at maturity. Non-destructive measurements of growth parameters such as the plant height, number of tillers, leaf length and breadth per plant were taken. The leaf area was calculated using leaf length and width method[5]. Root depth and total root length were measured in each plot of each treatment at the heading period. Penetration resistance in each plot after ploughing, was measured with the cone penetrometer (Eijkelkamp) to a depth of 0.2 m. The 60^0 angle with a base of 3.14 cm^2 was used. Rice yields were measured at maturity. All statistical tests were done at 5% probability level.

Plant height was significantly different ($p = 0.0041$) among treatments irrespective of the season, where the highest was reported in T3, both at maximum tillering and at 50% of flowering (48.3 and 56.9 cm, respectively). The plant height also was significantly different ($p = 0.0001$) between two seasons, irrespective of the treatment where the highest was recorded in *Yala* season (58.9 cm). Neither, number of tillers per six plants nor the LAI were significantly different ($p = 0.1052$ and 0.8124 respectively) between seasons irrespective of the treatment.

However, number of tillers per six plants and the LAI were significantly different (P=0.001 and 0.0061 respectively) among treatments at both maximum tillering and 50% of flowering, where the T3 having the highest and the T1 having the lowest values. There was no significant seasonal difference of root depth and the total root length (p = 0.9639 and 0.6200 respectively) irrespective of the treatments, a significant variation among treatments could be observed where T3 having the highest root depth (20.5±0.37 cm) and the total root length (316.4 ±0.3 m) and T1 having the lowest root depth (17.5±0.4 cm) and total root length (162.5± 0.25 m) (Table 01). The penetration resistance was significant (p= 0.0009) with the highest value in T1 (0.51±0.02 MPa) and the lowest value in T3 (0.28±0.02 MPa), irrespective of the season. Penetration resistance was significantly high (p= 0.2720) in *Yala* season (0.39±0.01). The reason for high penetration resistance was due to lower soil moisture content with comparatively low rainfall in the *Yala* season. The T3 had significantly lower (p = 0.0009) penetration resistance (0.265 ± 0.023 MPa) compared to other treatments. The main reason for this observation was due to higher ploughing depth, leading to reduced soil compaction.

A significant difference (p= 0.0001) could be observed in the rice yield among different treatments, irrespective of the season (Table 01). The highest rice yield was recorded in T3 (5.05 ± 0.20 t/ha) while the lowest yield in T1 (3.83± 0.20 t/ha). Similarly, a significant difference (p= 0.0004) could be observed in the rice yield between seasons, irrespective of the treatments, where the highest yield was recorded in *Maha* season (4.97 ± 0.11 t/ha) and the lowest in *Yala* season (3.86 ± 0.11 t/ha) (Table 01).

Table 01: Effect of depth of ploughing and season on growth and yield of rice

Season	Depth of ploughing	Plant height, cm/plant		Number of tillers, No/six plants		LAI/plant		RD, cm/ plant	TRL, m/plant	Grain yield, t/ha
		At MT	At FF	At MT	At FF	At MT	At FF			
Yala	T1	49.0±1.1	58.3±1.6	19.8±0.01	18.5±0.02	1.4±0.1	1.8±0.2	17.8±0.2	166.0±15.4	3.3^{a}±0.2
	T2	51.6±1.1	64.3±1.6	19.8±0.01	25.3±0.02	1.4±0.1	2.4±0.2	18.9±0.2	229.7±15.4	3.6^{b}±0.2
	T3	52.6±1.1	65.2±1.6	22.8±0.01	28.0±0.02	1.5±0.1	2.4±0.2	20.5±0.2	323.4±15.4	4.6^{c}±0.2
Maha	T1	42.4±1.2	50.8±1.9	14.8±0.01	18.0±0.02	1.1±0.2	1.6±0.2	17.2±0.6	159.0±32.5	4.4^{d}±0.2
	T2	46.3±1.2	58.2±1.8	16.8±0.01	21.3±0.02	1.4±0.2	2.1±0.2	19.5±0.6	217.8±32.5	5.1^{e}±0.2
	T3	47.7±1.2	62.2±1.8	19.0±0.01	29.8±0.02	1.7±0.2	3.0±0.2	20.5±0.6	309.3±32.5	5.5^{f}±0.2
P		0.0041	0.0041	0.001	0.001	0.0061	0.0061	0.0031	0.0001	0.0001

Same symbol/letter indicates non -significant values and different symbols/letter indicate significant values among different tre atments
LAI – Leaf area index TRL – Total root length MT – Maximum tillering FF – 50% of flowering RD –Root depth

Based on the results, it could be concluded that preparation of paddy soil to a depth of 30-40 cm in dry zone in Sri Lanka results in higher grain yield and maintain favourable soil conditions for rice plant throughout the growing season.

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