

Original Research Article

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Effect of Conservation Tillage Practices and Cultivars on Growth, Yield and Economics of Rice

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ABSTRACT

A field experiment was conducted at Tamil Nadu Rice Research Institute, Aduthurai during Kuruvai, 2013 to study the effect of conservation tillage practices and cultivars on growth, yield and economics of rice. The experiments were laid out in strip plot design with three replications. The main plot treatments comprised of three levels of conservation tillage practices (conventional tillage, zero tillage and minimum tillage) and two rice cultivars (Hybrid (CORH - 3) and high yielding variety (ADT - 43)) were assigned to sub plots. The results revealed that the among different conservation tillage practices, higher growth, yield parameters, yield, net return and BC ratio were registered under conventional tillage practices. This was followed by minimum and zero tillage practices. Between rice cultivars tested, CORH-3 recorded higher growth, yield parameters, yield, net return and BC ratio than ADT - 43. Hence, it was concluded that rice cultivar CORH-3 cultivated under conventional tillage recorded higher growth, yield, net return and BC ratio.

Keywords

Rice, Conservation tillage practices, Growth, Yield, Economics

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Introduction

Rice (*Oryza sativa* L.) is the staple food in most of the Indian states and plays a major role in Indian economy by contributing 45 per cent of the total food grain production. In India, rice is grown in an area of 43.13 m.ha with a production of 100.45 m.t and an average productivity of 2.3 t/ha (Anonymous, 2013).

Intensive soil tillage is the main cause of reduced soil organic matter and hence of soil degradation. Tillage accelerates the mineralization of organic matter and destroys the habitat of the soil life. Tillage and current agricultural practices result in the decline of soil organic matter due to increased oxidation over time, leading to soil degradation, loss of soil biological fertility and resilience (Lal, 1989). This is particularly significant in the

tropics where organic matter reduction is processed more quickly, with low soil carbon levels resulting only after one or two decades of intensive soil tillage. Tractors consume large quantities of fossil fuels that add to costs while also emitting greenhouse gases (mostly CO₂) and contributing to global warming when used for ploughing (Grace *et al.*, 2003).

On the contrary, when soil tillage is reduced or eliminated, soil life returns and the mineralization of soil organic matter slows down, resulting in better soil structure. Under zero tillage the mineralization of soil organic matter can be reduced to levels inferior to the input, converting the soil into a carbon sink (Reicosky, 2001). Zero-tillage, on the other hand, combined with permanent soil cover, has been shown to result in a build-up of organic carbon in the surface layers (Lal 2005). In this context, Conservation tillage (CT) has been gaining in popularity throughout the world during the last decade. It defined as minimal soil disturbance (no-till, NT) and permanent soil cover (mulch) combined it aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production.

Irrigated rice has for a long time been considered a stable and sustainable cropping system, although it is far from being conservation agriculture (the puddling results in the destruction of the soil structure). However, irrigated rice is increasingly subject to pressures *viz.*, high fuel costs of puddling and the reduced availability of labour mean that there is pressure to change from transplanted to direct-seeded rice. Rice cultivation has therefore been adapted to conservation agriculture in several countries. Rice can be cultivated without puddling by

adopting resource-conserving technologies. Hence, the present investigation has been carried out to study the effect of conservation tillage practices and cultivars on growth, yield and economics of rice.

Materials and Methods

A field experiment was conducted at Tamil Nadu Rice Research Institute, Aduthurai during Kuruvai, 2013 to study the impact of conservation agriculture on rice. The soil of the experimental field was alluvial clay with pH of 7.8 and EC of 0.3 dS/m. The experimental soil was low, high and medium in available nitrogen, phosphorus and potassium contents, respectively. The experiments were laid out in strip plot design with three replications. The main plot treatments comprised of three levels of tillage treatments (conventional tillage, zero tillage and minimum tillage) and two rice cultivars [Hybrid (CORH - 3) and high yielding variety (ADT - 43)] were assigned to sub plots. Conventional tillage practice includes mould board ploughing twice followed by cultivator and planking followed by sowing. Zero tillage involves spraying of glyphosate for killing existing vegetation followed by sowing. Minimum tillage involves single pass of rotavator followed by sowing. Glyphosate herbicide was applied at 15 days prior to sowing to control the weed menace.

Observations on growth characters *viz.*, plant height and dry matter production were recorded at tillering, flowering and at harvest stages. Tillers count was taken at maximum tillering stage. The yield parameters *viz.*, productive tillers/m², number of grains/panicle and test weight and yield of rice were recorded at harvest stage. Economics of weed management was worked out by using the current market price of inputs and rice grain. All the recorded data were analyzed statistically as per the method suggested by Gomez and Gomez (1984).

Results and Discussion

Effect on growth parameters

The growth parameters *viz.*, plant height, dry matter production and numbers of tillers/m² were significantly influenced by conservation tillage practices. The rice cultivated with conventional tillage recorded the tallest plant (53.8, 92.9 and 98.6 cm at tillering, flowering and at harvest stages, respectively), higher dry matter production (3245, 7132 and 12933 kg/ha at tillering, flowering and at harvest stages, respectively) and numbers of tillers/m² (459/m² at maximum tillering stage) and it was followed by minimum tillage and zero tillage practices. This might be due to reducing tillage often leads to surface sealing, which reduces water infiltration and affects seedling root development and growth (Vanlauwe *et al.*, 2014). The studies by Prasad *et al.*, (2016) in semi-arid tropical regions of India showed that rice growth decreased with reduction of tillage. This is in conformity with the findings of Ke Song *et al.*, (2019).

Between rice cultivars, CORH-3 produced tallest plant (54.2, 92.2 and 99.3 cm at tillering, flowering and at harvest stages, respectively), higher dry matter production (3052, 7015 and 12492 kg/ha at tillering, flowering and at harvest stages, respectively) and numbers of tillers/m² (472/m² at maximum tillering stage) than ADT - 43. The probable reason for this may be the genetical potential of the cultivars that has helped in producing tallest plant and higher DMP and tillers count.

Effect on yield parameters

The yield parameters of rice were significantly varied due to different conservation tillage practices.

The rice cultivated with conventional tillage recorded higher number of productive tillers/m² (313) and number of grains/panicle (184) than minimum and zero tillage practices. This might be due to the reason that tillage is minimally or not carried out in paddy fields under minimum and zero tillage, so it will be difficult to incorporate the fertilizers in soil. This may cause substantial loss of nutrients via runoff or evaporation in the topsoil at the early growth stage of rice. This results in lower levels of soil-available nutrients at the mature stage of rice, which in turn causes a shortage of fertilizers at the middle to late stage of rice ultimately results in lower yield production. This is in line with the findings of Ke Song *et al.*, (2016). The test weight was not significantly influenced by different conservation tillage practices.

Between rice cultivars tested, CORH-3 produced more number of productive tillers/m² (308), number of grains/panicle (175) and test weight (20.3) than ADT-43. This might be due to genetic makeup of the cultivars that has helped in improving the photosynthetic activity due to increased source capacity and efficient translocation of photosynthates to the sink

Effect on yield

Adoption of different conservation tillage practices significantly influenced the grain and straw yields. The highest grain and straw yields (4648 kg/ha and 7530 kg/ha) were recorded in conventional tillage practices. This was followed by minimum and zero tillage practices. This might be due to cumulative effect of increased levels of yield attributes and reducing the intensity of tillage had a significant negative impact on crop yield. This corroborates with the findings of Das *et al.*, (2014) and Seema *et al.*, (2019).

Table.1 Effect of conservation tillage practices and cultivars on the growth parameters of rice

Treatments	Plant height (cm)			Dry matter production (kg/ha)			No. of Tillers/ m ² at maximum tillering stage
	Tillering	Flowering	At harvest	Tillering	Flowering	At harvest	
Conservation Tillage Practices							
T₁ - Conventional tillage	53.8	92.9	98.6	3245	7132	12933	459
T₂ - Zero tillage	47.0	81.2	84.3	2773	5054	11007	362
T₃ -Minimum tillage	50.3	87.2	91.4	2935	6853	11796	414
SEd	1.6	2.6	3.6	76.3	114.1	313.9	10.9
CD (P=0.05)	3.2	5.2	6.2	152.6	228.2	627.8	21.8
Rice cultivars							
S₁ - Hybrid (CORH-3)	54.2	92.2	99.3	3052	7015	12492	472
S₂ - High yielding variety (ADT 43)	49.5	86.4	90.6	2917	6833	11469	444
SEd	1.3	2.4	2.7	74.8	86.3	299.6	8.2
CD (P=0.05)	2.6	4.8	5.4	149.5	172.6	599.2	16.4

Table.2 Effect of conservation tillage practices and cultivars on the yield parameters, yield and economics of rice

Treatments	Yield parameters			Grain yield (Kg/ha)	Straw yield (Kg/ha)	Net return (Rs./ha)	BC ratio
	No. of productive tillers/m ²	No. of grains/panicle	Test weight (g)				
Conservation tillage practices							
T₁ - Conventional tillage	313	184	19.7	4648	7530	37463	1.98
T₂ - Zero tillage	287	154	18.6	4055	6266	27671	1.75
T₃ - Minimum tillage	303	170	19.4	4302	6668	32472	1.88
SEd	7.7	3.6	0.8	121	177	-	-
CD (P=0.05)	15.6	7.6	NS	242	354	-	-
Rice cultivars							
S₁ - Hybrid (CORH-3)	308	175	20.3	4439	7280	33380	1.90
S₂ - High yielding variety (ADT 43)	293	163	18.1	4230	6599	31690	1/85
SEd	6.9	4.3	0.4	101	154	-	-
CD (P=0.05)	.14.2	8.9	1.0	203	308	-	-

Between rice cultivars tested, CORH-3 produced higher grain and straw yields (4439 kg/ha and 7280 kg/ha) than ADT - 43 (4230 kg/ha and 6599 kg/ha). The highest yield of CORH-3 might be due to the higher yield parameters *viz.*, number of productive tillers/m², number of grains/panicle and test weight than ADT-43.

Effect on economics

Among different conservation tillage practices, the highest net return (Rs.37463/ha) and BC ratio (1.98) were registered under conventional tillage practices. This was followed by minimum and zero tillage practices. This was due to higher grain and straw yields were recorded in conventional tillage practices.

Between rice cultivars tested, CORH-3 recorded higher net return (Rs.33380/ha) and BC ratio (1.90) than ADT - 43. This might be due to higher grain and straw yields were recorded by cultivating CORH-3 rice cultivars than ADT-43.

From the study it was concluded that rice cultivar CORH-3 cultivated under conventional tillage recorded higher growth, yield, net return and BC ratio.

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