

Effect of Wet Tillage Techniques on Weed and Yield of Transplanted Rice

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ABSTRACT

The need to reduce application of weedicide or herbicide and reverse the decline of soil fertility in rice cultivation, an attempt has been made to conduct an experiment to see the effect of wet tillage techniques i.e. puddling operation on weed dynamics and yield of transplanted rice under animal farming system. Five different types of animal drawn puddling equipments were used for wet field preparation with two level of intensity. Results obtained from the study showed that the rotary blade puddler with three passes gave better performance to reduce weed population in transplanted rice. It also revealed that the increase in level of puddling decreased the regrowth of weeds and exhibited poor weed population up to 25 days after transplanting. The minimum density of weeds was recorded under rotary blade puddler with three passes after 25 days of transplanting. Similar results were obtained at 40 and 60 DAT in next flush of weed emergence. Increased values of yield attributing characters were observed under three passes of puddling operation. Significant differences in yield of rice grain were found due to different puddling treatments. The highest grain yield of 48.79 q/ha was recorded under rotary blade puddler with puddler with three passes.

Keywords: Draught animals, Animal drawn puddler, Weed density, Puddling equipment.

INTRODUCTION

Among cereals, rice is the most important crop and major source of calories for about 40 per cent of the world population and every third person on the earth consumes rice every day in any form (Mukherjee, 2002). In India rice has an area of 44 million hectare with an annual production of 141.13 million tonnes (FAO, 2008). The rice productivity in India is very

low as compared to other rice growing countries and among the causes of low productivity weed is one of the most important factor. The yield loss due to the weed in rice varies from 12 to 81 per cent from low land to upland (Chopra & Chopra, 2003). In transplanting method of rice cultivation, weed problem is slightly lower compared to direct dry sown rice.

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However, failed to maintain continuous standing water in the field for first 45 days weed infestation is high as direct sown rice. Also prior to transplanting rice field has to be puddled. Puddling refers to wet land preparation for transplanting of rice seedlings. This puddling process has been repeatedly reported as a method for reducing weeds (Moody, 1977 & Mabbayad et al., 1983). Puddling buries the weeds in the lower layers of the mud, where they decomposed by anaerobic action (Moody, 1992). Weed control practices by using weedicide may play an important role in boosting the crop yield. However, indiscriminate use of these inputs resulted into increase in soil environmental pollution and cost of production. Similarly, this has been global concern regarding the persistence of herbicide residues in soil system. Also as now day's people are more aware about their health issues, organic farming is promoted. But as the use of weedicide or herbicide is remain an important component in rice cultivation, the efforts to be made for low consumption of these herbicides in the soil. Optimum tillage operation and hand weeding is very effective if followed in time to reduce the excessive use of herbicides. Therefore, keeping in view the above present study was undertaken to see the effect of different wet tillage techniques by using different animal drawn puddling equipments with two levels of intensity on weed dynamics and yield of transplanted rice.

MATERIALS AND METHODS

Field study was conducted at research field of Indira Gandhi Krishi Vishwavidyalaya, Raipur (CG). The soil of the experimental plots was silty clay loam in texture with pH 6.80, organic carbon 0.47%, available N (218.76 kg/ha), P (13.30 kg/ha) and K (246.63 kg/ha). To maintain the uniformity in field condition, initially one dry cross ploughing by animal drawn MB plough and flooding the field to saturation was done. For wet field preparation (puddle bed) five types of animal drawn puddlers viz. lugged wheel puddler, zigzag puddler, rotary blade puddler, disc harrow cum puddler and indigenous plough (farmers

practice) with two level of intensity (two and three passes) in total ten puddling treatments were tested as presented in Table 1. The mat type seedlings of rice (CV - Danteshwari) were grown by following the standard procedure (CIAE, 2002). Rice seedlings were used for transplanting at 2-3 leaf stage and 21 days old. Transplanting operation was performed immediately after 24 hours of settlement period of puddled field. Recommended dose of fertilizer was applied. Full dose of phosphorus and potash with one third dose of nitrogen was applied at the time of field preparation (puddling). The remaining nitrogen was applied at tillering and panicle initiation stage in equal split. Experiment was laid out in a randomized block design with three replications. Weed samples were taken at 25, 40 and 60 days after transplanting for recording of weed population and weed dry matter with the help of quadrat (1 m²) from each plot. Observations were also recorded for field capacity in ha/h of different animal drawn puddlers, field efficiency in percentage, yield attributing characters, yields. Cost of operation was determined. Operational energy was also calculated as suggested by Mittal and Dhawan (1988).

RESULTS AND DISCUSSION

Effect of puddling on weed density and weed dry matter

The effect of different puddling treatments on weed density and weed dry matter production at 25, 40 and 60 days after transplanting were studied and observed. One hand weeding was done at 26 DAT to keep the field weed free and to observe the effect of puddling on next flush of the weed emergence. The common weed species observed were are *Borreria hispida* L., *Ludwigia prvirflora* L., *Physalis minima* L., *Commelina communis* L., *Celosia argentea* L., *Aaschynomene indica* L., *Phyllanthus niruri* L., *Cyperus iria* L. and *Echinochloa colona* L.

The mean values of recorded data on weed density and their corresponding dry matter presented in Table 2 shows that they were influenced significantly due to different puddling treatments. At 25 days after

transplanting the intensity of the above mentioned weed flora in tested treatments were quite low as compared to the observation recorded in non puddled field, which shows that puddling affected the weed growth. The minimum (37.66) density of weeds was recorded under rotary blade puddler with three passes (T_6) as compared to the rest of the treatments which was at par with T_4 , T_8 and T_5 . The highest (57.33) weed density was recorded under puddling by indigenous plough (T_9) followed by T_1 and T_{10} which were differed significantly from rest of the treatments. Results also shows that weed density reduced as the level of puddling increased (two to three passes) and in rotary action of puddling. Weed dry matter production was found significantly maximum (13.42 g/m^2) in treatment T_9 which was statistically at par to T_{10} , T_1 and T_7 . Minimum weed dry matter (4.66 g/m^2) was produced by treatment T_6 which was statistically similar to those of T_4 , T_5 and T_8 . However, no significant variation was observed in treatments T_3 , T_2 , T_8 and T_5 . The reduction in weed density and corresponding dry matter after 25 days of transplanting due to puddling was also compared to unpuddled saturated condition and presented in Fig. 1. It shows that maximum percentage decrease of weed density and dry matter production was in T_6 as compared to rest of the puddling treatments.

At 40 DAT, the lowest weed density was observed in T_6 which was statistically at par with T_4 , T_8 and T_5 . The significantly highest weed density (33.33) was recorded in T_9 . Similar trend was observed in case of weed dry matter production at 40 days after transplanting of rice seedlings.

At 60 DAT, treatment T_9 gave maximum number of weeds which was significantly higher over rest of the puddling treatments but similar to T_1 and T_{10} . Lowest population of weeds was recorded in T_6 followed by T_4 and T_8 . The dry matter of weeds was lowest (3.71 g/m^2) in T_6 followed by T_4 , T_8 and T_5 . No significant variation was observed in between treatments T_4 , T_8 and T_5 ; T_5 , T_3 and T_2 ; T_{10} , T_7 and T_1 . The significantly highest weed dry matter production of 7.41

g/m^2 was found in T_9 . Results show that two passes of rotary blade puddler for puddling operation is enough than three passes of zigzag puddler, disc harrow cum puddler and lugged wheel puddler in reduction of weed density and dry matter production.

Results revealed that due to puddling weed seeds and weeds were buried under the stratified layer and exhibited poor weed dynamics up to 25 days after transplanting. The weed competition up to 40 days of transplanting remained low and by that time crops are of 60 days old remained almost unaffected from the weeds. Singh and Bhan, (1986) also reported that maximum emergence of weeds were appeared between 15 and 45 days after transplanting and recommended a weed free situation in this period to obtain maximum productivity.

Crop Performance

The data on yield attributing characters and yield are presented in Table 3. The effect of different puddling treatments resulted in significant variations on plant hill population. The mean values of puddling treatments showed that maximum number of hill (37.96) was recorded in rotary blade puddler with three passes (T_6) which was statistically at par with T_4 . However, treatments T_1 and T_9 show significantly low number of plant hill population. Significant variations were observed in total number of tiller per hill due to various puddling treatments. The highest (22.56) number of tillers per hill were observed in T_4 followed by T_8 and T_6 . Treatment T_9 was significantly poor than other treatments with lowest (16.24) number of tillers per hill for all the transplanting methods. The data pertaining to number of effective tillers per hill in Table 3 revealed that the effective tillers per hill were influenced by different puddling methods. In puddling treatments, maximum (13.27) number of effective tillers was obtained in treatments T_6 followed by T_4 and T_8 which were statistically at par to each other but have significant differences from treatments T_3 , T_1 , T_{10} and T_9 . Among the puddling treatments maximum (109.63) number of sound grains were observed under the treatment T_6 . Puddling

with indigenous plough gave significantly poor number of sound grains 69.47 and 77.73 in two and three passes respectively. It was also revealed from the Table 3 that increased level of puddling (three passes) increased the grain yield significantly as compared to two passes of puddling in each of the puddling equipment. The significant highest grain yield (48.79 q/ha) was obtained in T₆ where three passes of rotary blade puddler for puddling operation was performed and it was at par with T₈ followed by rest of the treatments. This may be due to the better churning of soil with more passes of puddling equipment facilitate better crop growth and weed free environment.

Cost Economics

Cost of operation of any implement is depends upon its initial cost of the machine, annual use and actual field capacity. Cost of operation of different puddlers for two and three passes have been determined on the basis of hourly use per year and given Fig. 2. The cost of puddling operation was observed as highest in indigenous plough due to its lower effective field capacity as compared to other puddling equipment. It was noticed that in three passes of different puddlers, cost of puddling increased by 42.59, 45.45, 33.33, 42.10 and 22.22 per cent under lugged wheel puddler, zigzag puddler, rotary blade puddler, disc harrow cum puddler and indigenous plough as compared to two passes of puddling operation. The study revealed that the minimum cost of puddling operation (Rs. 937.85 per ha) was estimated under puddling by rotary blade puddler with three passes followed by zigzag puddler (Rs. 1079.44 per ha) and the both were

gave a monetary benefit of Rs. 1630 and 1488.41 per ha over puddling by indigenous plough with three passes. The highest cost of puddling operation was obtained in puddling by indigenous plough as Rs. 1997.22 and 2567.85 per ha with two and three passes respectively, this might be due to the lower actual field capacity of the equipment used for puddling operation as compared to other puddling equipments.

Production economics of transplanted rice, while studying the effect of different puddling methods are given in Table 4. No significant variation was found on cost of production due to different puddling and transplanting methods. The highest cost of production (Rs. 14489.76 per ha) was found in T₁₀. The cost of production was lowest in case of treatment T₃ as Rs. 12261.11 per ha, this may be due to that effective field capacity of the zigzag puddler was low in two passes of puddling operation and the initial cost of the machine was also lowest as compared to other bullock drawn puddlers except indigenous plough. The net profit was differed significantly due to different puddling treatments. The puddling operation performed by rotary blade puddler with three passes (T₆) recorded significantly higher net profit (Rs. 38134.56 per ha) as compared to the rest of the puddling treatments followed by T₄, while the lowest was observed in T₉. Benefit cost ratio of production of rice in respect to different methods of puddling was significantly high (3.04) in T₆, which was statistically similar to T₄ and T₅.

Table 1: Treatments (Puddling equipments & their level of intensity)

Treatments	Puddling equipment and number of passes	
	Type of puddler	Passes
T ₁	Animal drawn lugged wheel puddler	2 pass
T ₂	Animal drawn lugged wheel puddler	3 pass
T ₃	Animal drawn zigzag puddler	2 pass
T ₄	Animal drawn zigzag puddler	3 pass
T ₅	Animal drawn rotary blade puddler	2 pass
T ₆	Animal drawn rotary blade puddler	3 pass
T ₇	Animal drawn disc harrow cum puddler	2 pass
T ₈	Animal drawn disc harrow cum puddler	3 pass
T ₉	Animal drawn indigenous plough	2 pass
T ₁₀	Animal drawn indigenous plough	3 pass

Table 2: Weed density and weed dry matter as influenced by different puddling methods

Treatments	Weed density (no./m ²) and weed dry matter (g/m ²)		
	25 DAT	40 DAT	60 DAT
T ₁	54.00 (12.79)	30.26 (7.09)	27.73 (7.19)
T ₂	43.73 (11.32)	27.53 (6.53)	16.46 (5.86)
T ₃	47.33 (11.56)	31.06 (6.01)	16.66 (5.61)
T ₄	38.06 (10.38)	22.60 (5.48)	13.33 (4.06)
T ₅	42.26 (11.05)	24.86 (5.87)	15.06 (5.05)
T ₆	37.66 (9.66)	18.66 (4.73)	10.53 (3.71)
T ₇	47.46 (12.01)	28.73 (6.62)	19.06 (6.24)
T ₈	40.53 (11.21)	24.40 (5.84)	14.86 (4.52)
T ₉	57.33 (13.42)	33.33 (7.74)	30.46 (7.41)
T ₁₀	48.86 (12.82)	29.26 (6.89)	23.86 (6.08)
CD (0.05)	5.30 (1.48)	6.41 (1.26)	6.88 (1.32)
Non puddled (check) : 87 (24.44) at 25 DAT			

Table 3: Effect of puddling on yield and yield attributing characters

Treatments	Plant hills population/sq.m	No. of tillers/plant hill	No. of effective tillers/plant hill	Panicle length (cm)	No. of grains/panicle	Yield (q/ha)	Straw yield (q/ha)	Harvest index (%)
T ₁	33.78	18.89	10.29	21.00	83.27	38.33	48.58	44.12
T ₂	35.29	19.33	10.82	21.47	91.40	41.72	52.11	44.48
T ₃	35.89	18.42	11.16	21.82	94.20	42.92	53.28	44.62
T ₄	37.29	22.56	12.71	22.87	106.50	46.28	56.23	45.14
T ₅	36.00	18.71	11.13	22.15	99.73	43.93	53.99	44.87
T ₆	37.96	21.80	13.27	23.27	109.63	48.79	58.62	45.42
T ₇	34.71	18.00	10.69	21.32	85.07	40.73	51.13	44.35
T ₈	36.62	22.11	12.42	22.48	103.20	44.68	54.62	44.99
T ₉	33.67	16.24	9.78	19.32	69.47	32.07	41.84	43.39
T ₁₀	34.11	17.24	10.02	20.37	77.73	34.98	44.99	43.74
CD (0.05)	0.80	2.59						

Table 4: Cost economics of different puddling operations

Particulars	Puddling methods										CD (0.05)
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀	
Cost of production, Rs/ha	25914	13071	12261	12762	12298	12614	12387	12915	13720	14489	NS
Gross Income, (Rs./ha)	39995	43494	44729	48169	45754	50748	42468	46517	33520	36529	4016.23
Net Profit, (Rs./ha)	27504	30423	32468	35407	33456	38134	30081	33602	19800	22040	4051.76
Benefit Cost Ratio	2.22	2.35	2.67	2.80	2.74	3.04	2.45	2.62	1.45	1.55	0.35

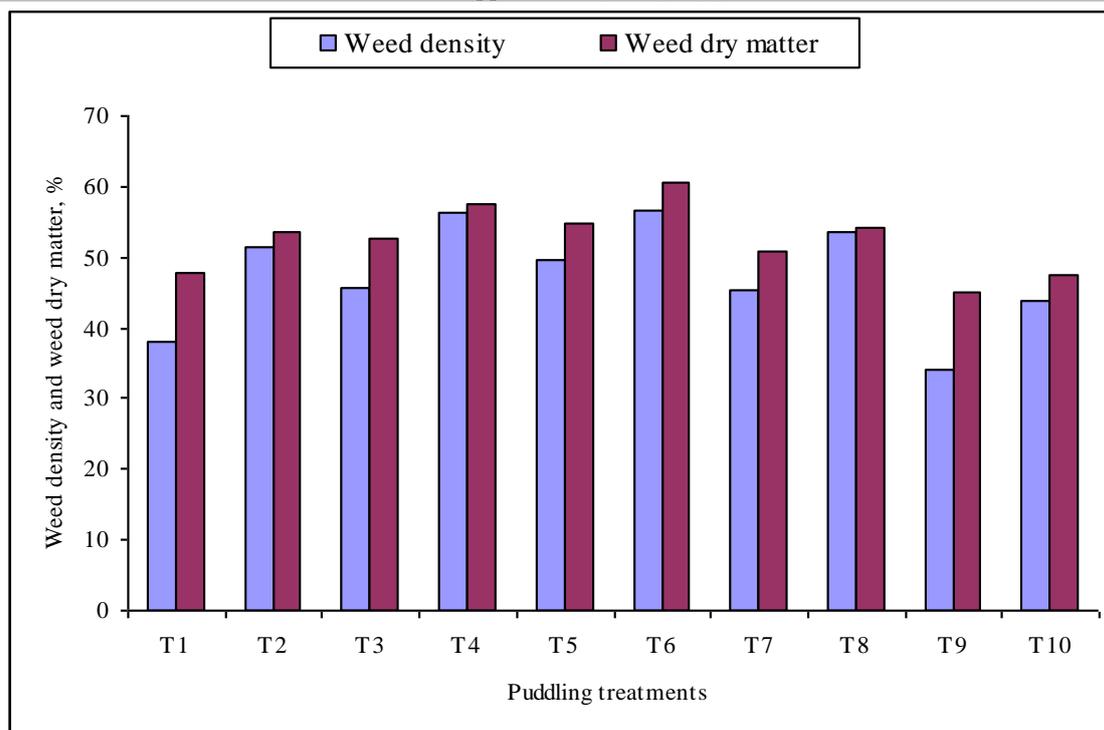


Fig. 1: Percentage reduction in weed density and their corresponding dry matter (25 DAT)

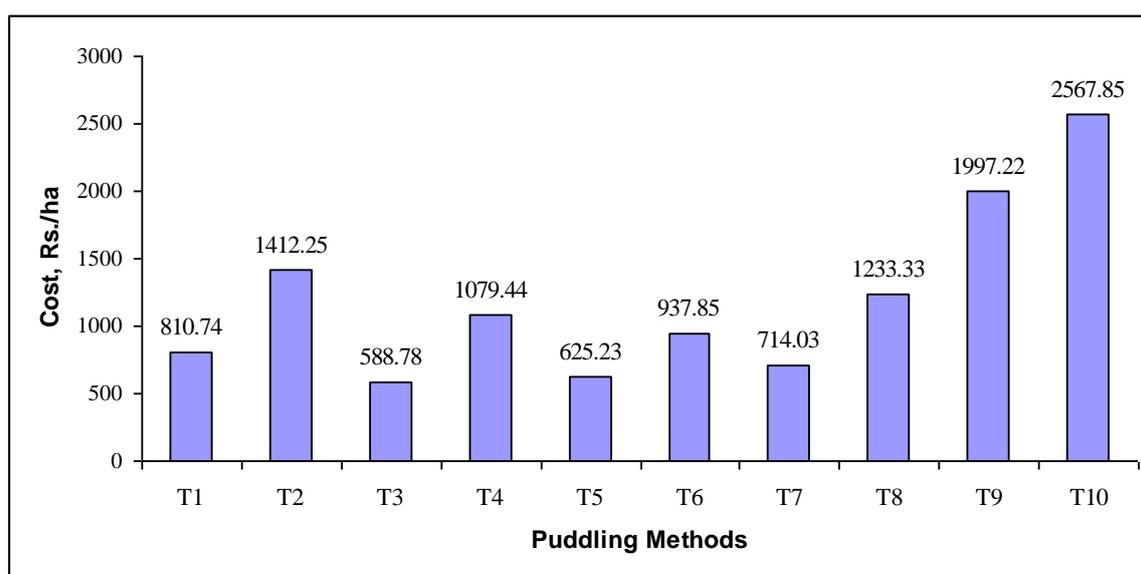


Fig. 2: Cost of operation different puddling methods

CONCLUSIONS

Three passes of puddling reduced the weed population and their biomass at 25, 40 and 60 days after transplanting and increased the yield and yield attributing characters compared to two pass of puddling. Grain and straw yield was obtained higher in puddling by rotary blade puddler (three passes). The cost of puddling operation (Rs./ha) was increased by 42.59, 45.45, 33.33, 42.10 and 22.22 per cent for lugged wheel puddler, zigzag puddler, rotary blade puddler, disc harrow cum puddler and indigenous plough respectively in three pass puddling operations compared to two pass. Overall, rotary blade puddler with three passes was found suitable for puddling operation to reduce weeds during first 45 days after transplanting to obtain higher grain yield.

rotary blade puddler, disc harrow cum puddler and indigenous plough respectively in three pass puddling operations compared to two pass. Overall, rotary blade puddler with three passes was found suitable for puddling operation to reduce weeds during first 45 days after transplanting to obtain higher grain yield.

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