Indian Journal of Agronomy 47 (3) : 305–310 (September 2002)

Effect of tillage and mechanization on production potential of rice (*Oryza sativa*)–wheat (*Triticum aestivum*) cropping system

S.N. SHARMA[1], J.S. BOHRA, P.K. SINGH AND R.K. SRIVASTAVA

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005

Received : December 2001

ABSTRACT

A field trial was conducted during 1998–99 and 1999–2000 at Varanasi, to compare the performance of the conventional tillage, reduced tillage (Chinese rotavator), zero tillage in wheat (*Triticum aestivum* L. emend. Fiori & Paol.] under varying sowing/transplanting methods of rice (*Oryza sativa* L.), viz. direct dry sowing, direct wet sowing, manual transplanting and mechanical transplanting by self-propelled transplanter. The manual and mechanical transplanting of rice ('HUR 36') being at par produced significantly higher grain yield than direct seedings. However, the use of self-propelled transplanter gave the maximum output : input ratio (2.53), followed by direct wet sowing with anaerobic seeder (2.10). Labour utilization was very poor under manual transplanting. As regards the wheat ('HUW 234'), Chinese rotavator proved most effective and recorded markedly higher values of yield-attributing characters, grain yield and output : input ratio. Conventional tillage though resulted in higher grain yield than zero tillage, the latter proved more remunerative.

Key words : Zero tillage, Rotavator, Wheat, Rice, Sowing/transplanting methods

Rice–wheat is a predominant cropping system in India and it contributes 74% of the total foodgrains production of the country. In this system, rice is mostly taken as a manually transplanted crop in puddled soil. Rice transplanting on puddled soil is complicated and highly labour intensive. The timely availability of labour for transplanting is a big problem in most areas. Moreover, under puddled condition though the yield is high, it has its own limitations and ill-effects on soil health. Besides other things, wheat sowing is also delayed which results in linear decline in wheat productivity equivalent to 1–1.5% loss/ha/day when sowing occurs after

Present address : [1]Department of Agronomy, Institute of Agricultural Sciences, B.H.U., Varanasi, Uttar Pradesh 221 005

November (Hobbs *et al.*, 1997).

Use of long-duration rice varieties and delayed transplanting of rice for want of sufficient monsoon rain for puddling are the major causes of late wheat sowing. The conventional method of wheat sowing by giving repeated tillage further delays sowing and adversely affects the yield. With these facts in view, field experiment was conducted to find out the suitable sowing/transplanting methods of rice and wheat under different tillage practices in rice–wheat system.

MATERIALS AND METHODS

A field experiment was conducted during 1998–99 and 1999–2000 at Varanasi. The experimental soil was deep sandy loam, having pH 7.3 and organic carbon 0.32%. The design of experiment was split plot. The main plot (35 m x 20.5 m) treatment involved 4 sowing/transplanting methods of rice ('HUR 36'), viz. direct-dry manual line sowing, direct-wet sowing by anaerobic seeder, manual transplanting, and mechanical transplanting by self-propelled rice transplanter. After the rice harvest in post-rainy season, each main plot was divided into 3 subplots (19.5 m x 108 m) to facilitate wheat ('HUW 234') sowing under 3 tillage practices, viz. conventional tillage (direct manual line sowing), reduced tillage (Chinese rotavator) and zero tillage giving 2 discings and 2 ploughings with double row cultivator attached to a 35 HP tractor followed by planking. Twenty-four days old rice seedlings were used for manual transplanting and a spacing of 23 cm x 10 cm was adopted. However, for mechanical transplanting by self-propelled transplanter 18 days old seedlings were raised on mat-type nursery. Yield assessment of rice and wheat was done by drawing 5 and 3 replicate samples (1 m^2) from respective plots. Data were statistically analysed by using randomized block design and split-plot design for rice and wheat respectively.

Recommended fertilizer doses (120 kg N + 60 kg P_2O_5 + 60 kg K_2O/ha) were applied to both the crops. Need-based intercultural and plant protection were adopted. Rainfall during rainy season was good and being recorded as 1,234.25 mm (mean over 2 experimental years). Therefore, no post-sowing/transplanting irrigation was given to rice. However, in following season, wheat crop received only 26.8 mm precipitation and hence 4 irrigations were given to meet the water requirement of crop.

RESULTS AND DISCUSSION

Effect of sowing/transplanting methods on rice

Yield attributes and yield : Transplanting by self-propelled transplanter though statistically at par with the manual transplanting, produced significantly higher number of effective tillers/m^2 than direct sowing both under dry and wet conditions (Table 1). This can be attributed to the higher number of seedlings/hill planted through mechanical transplanter (Garg *et al.*, 1997). Manual transplanting and direct wet sowing by anaerobic seeder also proved superior to direct dry sowing.

Filled grains/panicle and 1,000-grain weight were maximum in the manual transplanting, followed closely by mechanical transplanting and both recorded

significantly higher test weight than direct sowings. Similar trend was observed for grain and straw yields. Direct dry sowing resulted in lowest grain and straw yields. The overall performance of rice in direct dry sowing was not good probably because ideal condition for rice germination and growth did not prevail in this method. Moreover, in spite of herbicidal use, weed infestation was particularly more pronounced than other methods (data not given).

Output : input ratio : Use of the self-propelled transplanter gave the maximum output:input ratio (2.53) and proved more remunerative than the other methods of transplanting/sowing (Table 1). The next best was direct wet sowing by anaerobic seeder (2.10). However, sowing by conventional method resulted in lowest output : input ratio. The higher profits from self-propelled transplanter and anaerobic seeder can be ascribed to their low cost of transplanting/sowing. These results are in agreement with those of Megahed and Hamied (1998).

Comparison of field operations: Direct wet sowing by anaerobic seeder covered maximum area (156 m^2)/labour hr, followed by self-propelled transplanter (Table 2). However, the labour utilization was very poor under manual transplanting. In comparison to manual transplanting, mechanical transplanting saved 93% time and 65.87% cost of transplanting. Garg *et al.* (1997) obtained similar results. Likewise, anaerobic seeder saved 73% time and 24.5% cost than manual direct dry line sowing.

Effect of sowing/transplanting methods on wheat adopted in rice

Yield attributes and yield : Manual direct dry line sowing produced significantly higher effective tillers/m^2 and number of grains/ear than direct wet sowing (Table 3). It also recorded significantly higher number of grains/ear than manual transplanting. However, different sowing/transplanting methods remained statistically at par for other yield-attributing characters and grain as well as straw yields. Notwithstanding, direct dry sowing of rice resulted in the maximum grain and straw yields of wheat. The better performance of wheat on plots following direct-seeded rice can be attributed to its effect on providing ideal seedbed for wheat sowing, which resulted in better growth and yield.

Table 1. Yield attributes, yield and output : input ratio of rice as influenced by various sowing/transplanting methods (average data of 2 years)

Treatment	Effective tillers/m^2	Filled grains/ panicle	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Output : input ratio*
Direct-dry sowing	182.4	114.4	15.4	33.83	51.10	1.90
Direct-wet sowing	201.2	122.4	15.6	35.18	55.73	2.10
Manual transplanting	212.5	136.1	17.8	39.97	61.36	2.05
Transplanting by SPT	217.2	129.7	17.2	38.55	62.15	2.53
CD (P=0.05)	12.45	13.09	0.99	3.20	4.32	

SPT, Self-propelled transplanter; *Output : input ratio = gross return/cost of cultivation

Table 2. Comparison of different sowing/transplanting methods of rice for various field operations

Particulars	Sowing/transplanting			
	Direct-dry line sowing	Direct-wet sowing by anaerobic seeder	Manual transplanting	Transplanting by SPT
Labour for nursery raising (h/ha)			80	64
Labour for sowing/transplanting (h/ha)	240	64	640	48
Capacity (m^2/hr)	42	156	14	89
Saving (%) in time by use of anaerobic seeder compare to manual sowing		73		
Saving (%) in time by use of SPT* compared to manual transplanting				93
Cost of sowing/transplanting including the cost of nursery raising (Rs/ha)*	1,572	1,186	3,850	1,314
Saving (%) in cost of sowing by anaerobic seeder compared to manual sowing		24.5		
Saving (%) in cost of transplanting by SPT* compared to manual transplanting			–	65.87

SPT, Self-propelled transplanter; *based on fuel consumption

Table 3. Effect of various treatments on yield attributes, output : input ratio and yield of wheat (average data of 2 years)

Treatment	Effective tillers/m^2	Grains/ panicle	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Output : input (ratio)
Sowing/transplanting (rice)						
Direct-dry sowing	218.25	34.89	41.74	32.21	46.12	2.74
Direct-wet sowing	211.00	30.22	40.44	30.43	44.77	2.60
Manual transplanting	213.83	29.34	40.11	29.80	43.84	2.55
Transplanting by SPT	214.22	32.78	41.49	31.24	45.81	2.67
CD (P=0.05)	5.79	3.57	NS	NS	NS	
Sowing of wheat						
Manual line sowing	206.17	31.16	40.96	29.42	43.07	2.25
Chinese rotavator	238.92	35.42	41.55	35.27	51.61	3.14
Zero till drill	198.00	28.83	40.03	28.15	40.73	2.57
CD (P=0.05)	12.15	3.03	NS	2.31	4.32	

SPT, Self-propelled transplanter

Output : input ratio : Different sowing and transplanting methods of rice also influenced the output : input ratio of succeeding wheat crop (Table 3). Manual direct line sowing produced maximum output : input ratio (2.74) and so proved most remunerative. It was closely followed by self-propelled transplanter (2.67). Manual transplanting proved the most uneconomical.

Effect of sowing methods/tillage practices in wheat

Yield attributes and yield : Sowing methods of wheat under different tillage practices revealed that sowing by Chinese rotavator (reduced tillage) resulted in significantly higher number of effective tillers/m^2, grains/ear as well as grain and straw yields than zero till drill (zero tillage) and direct sowing in line (conventional tillage). Zero-till drill recorded the lowest grain and straw yields. However, it remained statistically at par with direct sowing in line. The poor performance of wheat under conventional tillage by manual line sowing can be attributed to its delayed sowing (Table 4). The beneficial effects of reduced tillage over conventional tillage have also been reported by other workers (Arshad *et al.*, 1991; Ahmad *et al.*, 1992; Hobbs *et al.*, 1996)

Output : input ratio : Chinese rotavator resulted in the maximum output : input ratio (3.14) as given in Table 3. Zero till drill was next best, which recorded output : input ratio of 2.57. However, direct line sowing by manual was found to be the most uneconomical.

Table 4. Comparison of sowing operations in wheat under different tillage practices

Particulars	Sowing		
	Line sowing	Chinese drill	Zero till drill
Labour for sowing	280	20	6
Capacity (m^2/hr/ha)	36	500	1,667
Date of sowing			
Y_1	20 December 1998	8 December 1998	8 December 1998
Y_2	18 December 1999	6 December 1999	6 December 1999
Earlyness in sowing (days) by Chinese and zero till drill compared to line sowing (conventional)			
Y_1		12	12
Y_2		12	12
Saving (%) in time by Chinese and zero till drill compared to line sowing (conventional)		92.8	97.8
Cost of sowing (Rs/ha)	1,050	794	596
Saving (%) in cost of sowing by Chinese and zero till drill compared to line sowing (conventional)			

Y_1, 1998–99; Y_2, 1999–2000

Comparison of different field operations : Zero tillage covered the maximum area (1,667/m^2/labour hr, followed by reduced tillage (500 m^2/labour hr) (Table 4). However, the labour utilization was found to be most inefficient in conventional tillage. In comparison to line sowing by manual, Chinese rotavator and zero till drill saved about 92.8% and 97.8% time as well as 24.4% and 43.2% cost of sowing respectively. Conventional tillage, as it involves repeated ploughings, also resulted in delayed sowing by 12 days compared to reduced and zero tillage during both years.

Based on these results, self-propelled transplanter and anaerobic seeder can be recommended for transplanting and direct wet sowing of rice respectively. Similarly, Chinese rotavator and zero till drill should be given preference over conventional tillage for wheat sowing.

REFERENCES

Ahmad, S., Chattha, A.A., Khan, R.H. and Rafique, M. 1992. Soil and fertilizer management for wheat in rice–wheat-cropping system. *Journal of Agricultural Research, Lahore* **30** : 75–82.

Arshad, M., Ahmad, S. and Kausar, A.G. 1991. Wheat productivity through zero tillage adoptation in rice–wheat system in Farming System Research Project area, Shahkot. *Journal of Agricultural Research, Lahore* **29** : 265–269.

Garg, I.K., Mahal, J.S. and Sharma, V.K. 1997. Development of field evaluation of manually operated, six-row paddy transplanter. *Agricultural Mechanization in Asia, Africa and Latin America* **28** : 21–24.

Hobbs, R.R., Giri, G.S. and McNab, A. 1997. Reduced and zero tillage options for establishment of wheat after rice in South Asia. *(In) Proceedings of 5th International Wheat Conference,* Braun, H.J. *et al.,* (Eds), held at Ankara, Turkey, during 10–14 June 1996, pp. 455–465.

Megahed, M.M. and El Hamied, U.A.A. 1998. A comparative economical study on rice transplanting systems. *Bulletion of Faculty of Agriculture University of Cairo* **49** : 481–500.