Journal of Crop and Weed 7(1): 33-36 (2011)

A study on wheat cultivation under zero tillage and conventional tillage practices

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Received: 05.01.2011, Revised: 23.05.2011, Accepted: 30.05.2011

ABSTRACT

Zero tillage saves tillage and irrigation costs, results in yield gains through a possible improvement in sowing time and enhanced fertilizer and water use efficiencies. The present study was conducted to explore the possibilities of saving critical inputs and to enhance the profit margin of the rural farmers of Uttar Dinajpur, Dakshin Dinajpur, Malda and Murshidabad districts of West Bengal through National Agricultural Innovation Project. Mean grain yield of 10 villages showed that zero tillage practices produced 8.004 % more grain yield than conventional tillage method. On an average zero tillage method save total cost of Rs. 4449.67 ha^{-1} and increase profit margin of Rs. 7056.25 ha^{-1}. Zero till field also recoded higher B: C ratio of 0.923 as compared to conventional tillage method (0.432).

Key words: Conventional tillage, economics, yield, zero tillage

Wheat (*Triticum aestivum* L.) is the second most important cereal crop in West Bengal. Wheat is usually planted either by drilling closely spaced rows apart on the flat bed or by broadcasting the seed on a leveled soil surface and then incorporating it by means of a shallow tillage operations. This involves a high cost of seedbed preparation and also needs 7-12 days for preparation of land which results in delay in sowing of wheat. Late sowing is a major factor responsible for low wheat yields obtained by the farmers. Introduction of the new zero-tillage seed drill in the project area during early 2008-09 made it possible to sow wheat in freshly harvested untilled paddy fields utilizing residual moister. Zero-tillage wheat allows for a drastic reduction in tillage intensity, resulting in significant cost savings as well as potential gains in wheat yield through earlier planting of wheat. The cost-saving effect alone makes zero tillage profitable and is the main driver behind its spread. Sowing of wheat in residual moisture through zero tillage not only facilitate the germination but also improve the soil fertility, soil physical properties and saves time hence increases net return on sustained basis (Malhi *et al.*, 2006; Franchini *et al.*, 2007). Halvorson *et al.* (2000) reported that no tillage yield of wheat is greater than minimum tillage and conventional tillage. Zero tillage also reduces the cost of production and saves time for sowing of wheat by 10-15 days as compared to conventional tillage (Erenstein and Laxmi, 2008). Continuously, need is being felt to explore the possibilities of saving critical inputs by adopting alternative resource conservative technologies as zero tillage. The main objective of the present experiment was to enhance the profit margin of the rural farmers.

MATERIALS AND METHODS

The study was conducted during *rabi* season in the districts of Uttar Dinajpur, Dakshin Dinajpur, Malda and Murshidabad of West Bengal. The physical stretch of project area spreads over three distinct agro–climatic zones *viz.* terai, old and new alluvial, which itself adds further complexity. Four block were selected namely Itahar of Uttar Dinajpur, Tapan of Dakshin Dinajpur, Manichalk of Malda and Suti-1 of Murshidabad districts. Among the 4 selected blocks 10 villages were chosen on the basis economic backwardness.

The West Bengal Human Development Report (Anon, 2004) has clearly indicated of prevalence of very poor health index, gender development index, and high degree of female IMR and low HDI values across all those districts.

The number of total beneficiaries in the selected villages was 1314, out of which 180 farmers shown interest on zero tillage cultivation. Among the interested beneficiaries 60 farmers was selected randomly falling in two categories namely, those who adopted zero tillage technology, and those who adopted conventional tillage. In order to kill the existing weeds glyphosate was applied @ 75-80 ml L^{-1} of water at 10 days before sowing the seed. Seed was treated with vitavax @ 2.5 g kg^{-1} seed. The Wheat variety PBW-343 was sown during 3rd November, 2009 with the help of zero tillage drill maintaining row to row spacing 20 cm after rice harvesting field with no land preparation, while in the conventional method the crop was sown during 16th November, 2009 by broadcasting method maintaining row to row spacing 20 cm after 3 ploughing (one deep ploughing followed by two harrowing) followed by planking. The recommended seed rate of 125kg ha^{-1} was maintained. Borax was applied @ 15 kg ha^{-1} at 35 and 55 days after sowing.

For conventional tillage N: P: K was applied @ 120:40:40 kg ha^{-1}. Half of the nitrogen and full dose of phosphorus and potassium was applied at the

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time of sowing. The remaining half of the nitrogen was applied in the form of urea in two equal split as top dressing. First top dressing was done with first irrigation at 21 DAS and second top dressing was done with second irrigation at 45 DAS. In zero tillage field 154 kg 10:26:26 kg ha^{-1} was applied at the time of sowing. Remaining nitrogen was applied in two splits in the form of urea. First and second top dressing of urea @ 113.40 kg ha^{-1} was given at 21 and 45 DAS respectively.

Three irrigations were given in the field where wheat grown through conventional tillage. First, second and third irrigation was given at CRI, flowering and milk stage respectively, where as in case of zero tillage, 2 irrigations were given first at CRI stage and second at flowering stage.

The proper weed control practices were adopted to control the weeds. Harvesting was done manually on its physiological maturity. The yield attributes namely spike length, number of spike m^{-2}, number of grains $spike^{-1}$ and 1000 grain weight were recorded at the time of harvesting from five randomly selected plants leaving border areas of experimental plot. The figure shown in the table is the mean value of the randomly collected data. Grain yield was recorded from each plots and converted to t ha^{-1} and economics was based on prevailing market price. Co-relation analysis was done by using INDOSTAT Version 7.

RESULTS AND DISCUSSION

Yield attributes and grain yield

The data for different yield attributes viz., spike length, number of spike m^{-2}, number of grains $spike^{-1}$ and 1000 grain weight were presented in table 1. All these yield attributes were found to be highest in Sripur village (9.16, 374.98, 38.44 and 41.15 and 9.60, 382.10, 39.50 and 42.25, respectively) which was followed by Dahina and Mahukuri under both conventional tillage and zero tillage practices. The lowest yield attributes were found in Bansthupi village (8.78, 337.17, 33.83 and 40.18 and 9.21, 344.29, 34.42 and 41.13 respectively) under both conventional tillage and zero tillage practices.

Grain yield is a function of inter various yield components such as number of productive tillers m^{-2}, number of grains $spike^{-1}$ and 1000 grain weight. Grain yield was differing marginally among the tillage methods. Data presented in table 1 showed that zero tillage fields recorded comparatively higher grain yield in all the 10 villages than conventionally tilled field. Sripur village perform best in terms of grain yield and recorded highest grain yield (3.667 and 3.704 t ha^{-1}) both in conventional and zero tillage practice. Among the villages Bansthupi (2.450 and 3.120 t ha-^{1}) and Pulintola (2.845 and 3.015 t ha^{-1}) recorded lower grain yield in both conventional and zero tillage method. Mean grain yield of 10 villages showed that zero tillage practices produced 8.004 % more grain yield than conventional tillage method. The probable reason might be due to delayed sowing, which leads to less time available for the physiological growth and development and high temperature trigger the grain filling stage (Bear *et al.*, 1994) under conventional tillage. Yield of wheat in zero tillage was more than the conventional tillage because of better utilization of soil moisture, water use efficiency, nutrients uptake and less fluctuation of soil temperature (Cham *et al.*, 2002; Bauer *et al.*, 2002).

Simple correlation analysis revealed that high, significant and positive correlation existed between wheat yield and its yield attributes. The highest correlation coefficient was between grain yield and number of spike m^{-2} (0.971 and 0.957), followed by number of grains $spike^{-1}$ (0.945 and 0.931) and spike length (0.904 and 0.873) under both zero and conventional tillage practices (Table 3).These results are due to during grain filling, spikes play an important role in photosynthesis, especially late in the growing season (McMaster, 1997).

Economics

Total cost in wheat cultivation was varied among the villages due to varied cost of lobour and hiring machineries. Mean data showed that zero tillage field recorded higher gross and net return to the tune of ₹35265.13 and ₹16936.43ha^{-1} than conventional tillage where gross and net return was ₹32658.55 and ₹9880.18ha^{-1}. The probable reason is due comparatively higher grain yield and lower cost of cultivation. From the mean data of 10 villages it was observed that zero tillage method save total cost of ₹4449.67 $ha^{-1}$and increase profit margin of ₹7056.25 ha^{-1}.

Zero till field also fetched higher B: C ratio than conventional tillage irrespective of villages. Mean data of table 1 and 2 exhibited that zero till field recoded higher B: C ratio of 0.923 as compared to conventional tillage method (0.432). This was simply due to higher net return and lower cost of cultivation.

ACKNOELEDGEMENT

The authors are thankful to the Indian Council of Agricultural Research (ICAR), New Delhi for the financial support provided under National Agricultural Innovation Project, Component-3.

Table 1: Yield attributes and yield of wheat under conventional and zero tillage practices

Name of the villages	Conventional tillage practice					Zero tillage practice				
	Spike length (cm)	No. of spike m^{-2}	No. of grains $spike^{-1}$	1000 grain weight (g)	Grain yield t ha^{-1}	Spike length (cm)	No. of spike m^{-2}	No. of grains $spike^{-1}$	1000 grain weight (g)	Grain yield t ha^{-1}
Sripur	9.16	374.98	38.44	41.15	3.667	9.60	382.10	39.50	42.25	3.704
Gotlu	8.94	362.74	36.63	40.55	3.250	9.36	368.86	37.33	41.54	3.512
Bansthupi	8.78	337.17	33.83	40.18	2.450	9.21	344.29	34.42	41.13	3.120
Mahukuri	9.06	367.19	37.24	40.71	3.350	9.48	373.31	37.50	41.68	3.650
Kashitara	8.87	354.24	35.39	40.33	3.152	9.29	359.33	36.28	41.34	3.375
Shibpur	8.89	357.76	36.32	40.45	3.289	9.33	364.50	37.21	41.39	3.510
Pulintola	8.80	341.25	34.33	40.21	2.845	9.24	348.00	34.91	41.20	3.015
Sankartola	8.81	348.85	34.6	40.3	3.054	9.25	355.67	35.25	41.31	3.279
Dahina	9.10	371.49	38.03	40.99	3.475	9.53	377.49	38.60	42.00	3.694
Gambhira	9.02	364.07	37.17	40.69	3.330	9.45	370.34	37.82	41.63	3.546
Mean	**8.94**	**357.97**	**36.20**	**40.56**	**3.186**	**9.37**	**364.39**	**36.88**	**41.55**	**3.441**

Table 2: Economics of wheat cultivation under conventional and zero tillage practice

Name of the villages	Conventional tillage practice				Zero tillage practice			
	Total cost (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net Return (₹ ha^{-1})	B:C ratio	Total cost (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Sripur	24965.92	37586.75	12620.83	0.506	19692.49	37966.00	18273.51	0.928
Gotlu	23458.50	33312.50	9854.00	0.420	18845.25	35998.00	17152.75	0.910
Bansthupi	18879.75	25112.50	6232.75	0.330	16890.00	31980.00	15090.00	0.893
Mahukuri	24175.25	34337.50	10162.25	0.420	18660.75	37412.50	18751.75	1.005
Kashitara	22157.80	32308.00	10150.20	0.458	17987.90	34593.75	16605.85	0.923
Shibpur	24101.75	33712.25	9610.50	0.399	19123.50	35977.50	16854.00	0.881
Pulintola	20895.50	29161.25	8265.75	0.396	16575.33	30903.75	14328.42	0.864
Sankartola	21000.00	31303.50	10303.50	0.491	17660.25	33609.75	15949.50	0.903
Dahina	24158.25	35618.75	11460.50	0.474	18980.50	37863.50	18883.00	0.995
Gambhira	23991.00	34132.50	10141.50	0.423	18871.00	36346.50	17475.50	0.926
Mean	**22778.37**	**32658.55**	**9880.18**	**0.432**	**18328.70**	**35265.13**	**16936.43**	**0.923**

Table 3: Co-relation between the yield attributes and grain yield of wheat under conventional and zero tillage practices

Conventional tillage	X1	X2	X3	X4	Y
Spike length (X1)	1.000				
No. of spike m^{-2} (X2)	0.956**	1.000			
No. of grains $spike^{-1}$ (X3)	0.973**	0.988**	1.000		
1000 grain weight (X4)	0.982**	0.940**	0.960**	1.000	
Grain yield (Y)	0.873**	0.957**	0.931**	0.870**	1.000
Zero tillage					
Spike length (X1)	1.000				
No. of spike m^{-2} (X2)	0.957**	1.000			
No. of grains $spike^{-1}$ (X3)	0.955**	0.983**	1.000		
1000 grain weight (X4)	0.974**	0.932**	0.938**	1.000	
Grain yield (Y)	0.904**	0.971**	0.945**	0.860**	1.000

*** are significant at 1% level of significance*

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