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Performance of zero-till wheat (*Triticum aestvium* L.) with residue and weed management techniques under rice-wheat cropping system

Rakesh Kumar[1]* and U.P. Singh[2]

Department of Agronomy & Soil Science,
CSIR- CIMAP Research Centre, Pantnagar-263 149 Uttara Khand, India.
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ABSTRACT

An experiment was conducted during at Varanasi to find out the effect of residue management with *Trichoderma* application and weed management practices (W_{1-} - Control, W_2 -Hand weeding at 30 & 45 DAS, W_3 - Isoproturon + 2,4-D (1.0 + 0.5 kg ha^{-1}) at 30 DAS, W_4 - Fenoxaprop 120 g ha^{-1} *fb* Metsulfuron 4 g ha^{-1}) on growth, yield attributes and yield of wheat (*Triticum aestvium* L.) with weed density, WCE and net returns. The residue retention with *Trichoderma* application produced significantly higher crop growth, yield attributes, grain and straw yield as compared to residue retention alone and residue removal. Among the weedicide option fenoxaprop *fb* metsulfuron treatment was found most effective in controlling weed population and produced significantly higher grain (3355.06 and 3722.27 kg^{-1} ha) and straw yields (5050.23 and 5332.77 kg^{-1} ha) and higher weed control efficiency (74.19 & 75.07 %). Out of herbicides, Isoproturon + 2, 4-D gave the highest net return as compared to fenoxaprop *fb* metsulfuron followed by hand weeding twice.

Key words: Economics, Residue management, Rice-wheat cropping system, Weeds management, Zero tillage.

INTRODUCTION

Development of high input responsive and photo in sensitive varieties of rice and wheat has led to adoption of rice – wheat cropping system covering 10.4 million ha in India, mainly confined to Indo-Gangetic belt (Singh, 2000). Extensive area under intensive cropping system coupled with better irrigation and fertilizer application has provided congenial growing condition for weeds particularly in rice-wheat cropping system where weeds causing yield reduction to the level of 30-80% (Walia and Brar, 2001). Dependent on only one herbicide for very long period for the control of weeds in wheat has resulted in problem of resistance to herbicides (Walia *et al*; 1997). New herbicides (Fenoxaprop -P-ethyl, Clodinafop-proparyl and Sulfosulfuron) recommended in 1998 to control Isoproturon resistant weeds, were more effective against grasses and their incessant use shifted the weed flora towards broad leaf weed dominance particularly Clodinafop and Fenoxaprop were used. Efforts have been made to develop integrated approach to reduce weed population pressure through placement of rice residues or with application of herbicides in order to sustain the productivity of wheat crop. Also the uptake of nutrients by the crop is governed by the nutrient supply system of soil through leaching and removal by weeds. The weeds emerging with the crop compete with it for nutrients (especially nitrogen), grow faster and utilize it in large amount than the crop resulting in poor crop yields (Singh and Reddy, 1998). In this regard, placement of rice residue and herbicide could be a better solution in preventing weeds from removing nutrients from soil through restricting their growth and enhancing the time of nutrients availability S by increasing it's splitting over one time placement for the better nutrient uptake by the crop. The reason for promotion of ZT was on the grounds to reduce cost of production and to avoid delay in planting (Ali *et al.*, 2010; Grover *et al.*, 2011). Keeping these points in view, an experiment was conducted to study the effect of rice residue and weed management techniques on growth and development in zero-till wheat (*Triticum aestvium* L.) under rice-wheat cropping system.

MATERIALS AND METHODS

The study was conducted at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi during the year 2005-06 and 2006-07. The experimental site is situated in Eastern Uttar Pradesh at an altitude of 128.93 m above mean sea level. It lies on latitude $25^0$18'N and longitude $83^0$03'E. The soil was sandy clay loam (Black,1967) having pH 7.8 (Jackson, 1973), organic carbon 0.44 % (Walkley and Black, 1934), available N 200 kg ha^{-1} (Subbiah and Asija, 1956), available P 16.2 kg ha^{-1} (Olsen *et.al.*, 1954) and available K 240 kg ha^{-1} (Jackson, 1973). The experiment was laid out in the fixed plot size (4 × 5 m^2) during both the year in split plot design keeping three residue management techniques R_1 (Residue Removal), R_2 (Residue Retention), R_3 (Residue Retention with *Trichoderma*) in the main plot and four weed management techniques W_1 (control), W_2(Hand weeding at 30 and 45 DAS), W_3 (Isoproturon +2,4-D (1.0 + 0.5 kg ha^{-1}) at 30DAS, W_4(Fenoxaprop 120 g ha^{-1} *fb* Metsulfuron 4 g ha^{-1})

*Corresponding author's e-mail: rakes27@gmail.com [1]Department of Agronomy & Soil Science, CSIR- CIMAP Research Centre, Pantnagar-263 149 Uttara Khand, India. [2]Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi-221 005, U.P., India.

Table 1: Effect of residue and weed management on plant height (cm), number of tillers (m^{-2}), ear head (m^{-2}), test weight (g) and grain yield (kg ha^{-1}).

Treatment	Plant Height (cm)		Number of tillers m^{-2}		Ear head (m^{-2})		Test Weight(g)		Grain Yield(kg ha^{-1})	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Residue Management										
R_1 (Residue Removal)	84.25	85.31	334.35	348.75	289.56	301.58	39.87	40.05	3068.82	3385.66
R_2 (Residue Retention)	89.10	89.88	356.48	370.38	308.29	321.96	40.50	41.22	3264.00	3580.62
R_3 (Residue Retention with *Trichoderma*)	90.56	90.83	362.71	373.13	312.32	323.79	40.62	41.37	3320.73	3616.48
SEm±	1.39	1.37	5.78	5.77	4.81	5.00	0.64	0.65	51.90	55.79
CD (*P*=0.05)	4.39	4.32	18.23	18.19	15.16	15.77	NS	NS	163.54	175.78
Weed Management										
W_1 (Control)	83.57	83.84	335.56	343.81	275.61	290.61	38.23	39.33	2788.56	2958.35
W_2 (Hand weeding at 30 &45 DAS)	90.35	91.24	361.94	377.69	313.67	326.67	41.33	41.66	3414.67	3788.12
W_3 (Isoproturon +2,4-D (1.0+0.5 Kg/ha) at 30 DAS)	88.74	89.58	351.67	365.19	311.17	322.39	40.76	41.15	3313.11	3641.60
W_4 (Fenoxaprop 120 g/ha *fb* Metsulfuron 4g/ha)	89.24	90.02	355.56	369.64	313.11	323.44	41.00	41.39	3355.06	3722.27
SEm±	0.59	0.57	2.45	2.43	2.03	2.12	0.27	0.27	21.28	23.86
CD (*P*=0.05)	1.67	1.62	7.02	6.94	5.80	6.05	0.77	0.78	60.81	68.18
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of residue, nitrogen and weed management on straw yield (kg ha^{-1}), total weed density ($m^{-0.25}$) at 45 DAS, total weed density ($m^{-0.25}$) at 90 DAS, weed control efficiency (%) and net return (Rs. ha^{-1}).

Treatment	Straw Yield (kg/ha)		Total weed density ($m^{-0.25}$) at 45 DAS		Total weed density ($m^{-0.25}$) at 90 DAS		Weed control efficiency (%)		Net return(Rs. ha^{-1})	
	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07	2005-06	2006-07
Residue Management										
R_1 (Residue Removal)	4752.40	5020.93	5.61 *(40.99)	5.21 (35.07)	5.87 (38.26)	5.32 (31.66)	59.77	60.25	18794.86	28562.07
R_2 (Residue Retention)	5018.88	5295.76	5.38 (37.73)	4.99 (32.41)	5.61 (35.12)	5.21 (30.57)	60.60	61.40	20619.00	30854.00
R_3 (Residue Retention with *Trichoderma*)	5100.34	5332.27	5.29 (36.66)	4.96 (32.00)	5.55 (34.40)	5.16 (30.09)	61.08	61.68	20273.78	30286.78
SEm±	60.30	82.66	0.03	0.04	0.04	0.04	0.18	0.28	470.75	723.16
CD (*P*=0.05)	190.00	260.43	0.10	0.12	0.12	NS	0.56	0.89	1483.26	NS
Weed Management										
W_1 (Control)	4672.10	4813.83	9.91 (97.29)	9.28 (85.24)	9.29 (85.44)	8.72 (75.09)	0.00	0.00	17807.96	25541.66
W_2(Hand weeding at 30 &45 DAS)	5118.39	5426.33	1.00 (0.00)	1.00 (0.00)	3.58 (11.86)	3.19 (9.21)	100.00	100.00	19659.43	30017.44
W_3 (Isoproturon +2,4-D (1.0+0.5 Kg/ha) at 30 DAS)	4988.11	5292.34	5.69 (31.43)	5.20 (26.13)	5.18 (25.82)	4.77 (21.73)	67.72	69.44	21911.4	32679.78
W_4 (Fenoxaprop 120 g/ha *fb* Metsulfuron 4g/ha)	5050.23	5332.77	5.11 (25.12)	4.71 (21.25)	4.64 (20.58)	4.25 (17.07)	74.19	75.04	20204.72	31364.92
SEm±	34.89	34.91	0.02	0.03	0.02	0.02	0.15	0.18	140.03	187.77
CD (*P*=0.05)	99.71	99.77	0.06	0.08	0.05	0.06	0.42	0.53	400.23	536.67
Interaction	NS	NS	**	**	NS	NS	**	**	NS	NS

*Data transformed to “×+1. Figure in parentheses indicate original values

in sub plot. The treatments were replicated thrice. The crop of wheat was sown with zero tillage maintaining the rice residue in respective plots as per treatments allocated during both the years. Rice cultivar 'Sarjoo-52' was grown from June to October and wheat cultivar 'HUW-234' was grown from November to March in each treatment with recommended package of practices. Isoproturon + 2, 4-D (1.0+ 0.5 Kg ha^{-1}) at 30 DAS and Fenoxaprop (120 g ha^{-1}) *fb* Metsulfuron (4 g ha^{-1}) were applied as post emergence with 500 liters ha^{-1} of water with the help of knap sack sprayer, fitted with flat-fan nozzle at 30 DAS. Weed density was recorded at 45 and 90DAS from 0.25 m^{-2} areas by placing a quadrate of 0.5 × 0.5 m randomly at three places in border rows of each plot. A total number of weeds enclosed in each quadrate were identified as well as counted species wise. The statistical analysis was done by "F" test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth, yield attributes and yield: Taller plants, with maximum tillers, ear head m^{-2}, 1000-grain weight Grain and straw yield were observed under residue retention with *Trichoderma* application was closely followed by residue retention alone (Table -1). Better soil moisture conducive for good germination brought good crop establishment and supported growth parameters which attributed to more dry matter production which lead to effective formation of structural components under residue retention with *Trichoderma* application and thus resulted in better development of yield attributes. Similar findings were also observed by Singh and Yadav (2005). Hand weeding employed twice at 30 DAS and 45 DAS accounted for higher growth and yield attributing characters. This might be attributed to poor weed competition during early crop growth period which enabled the crop to make maximum use of inputs for the growth and development of yield attributes Walia *et al*; (2000) and Thomas *et al*; (2000) were also of same opinion. Residue retention with *Trichoderma* application accounted for higher grain and straw yield, whereas, it was closely followed by residue retention alone which accounted for higher net returns Singh *et al*, (2005). Among the weed management practices, hand weeding twice at 30 and 45 DAS gave maximum grain and straw yield which was at par with Fenoxaprop *fb* metsulfuron and significantly over weed control. This was evident from the higher growth and yield attributes of the crop due to better reduced weed population and better weed control efficiency.

Weed density and WCE: Out of the weed species present in the experimental field during the investigation, six species were identified as major one. Among these species *Phalaris minor* was grasses, *Cyprus rotundous* was sedges and other four species were *viz. Chenapodium album, Rumex*

Table 2.1: Interaction effect of residue and weed management on total weed dry weight (g m^{-2}) at 45 days after sowing.

Treatment	Residue Management					
	2005-06			2006-07		
Weed Management	R_1 (Residue Removal)	R_2 (Residue Retention)	R_3(Residue Rention with *Trichoderma*)	R_1 (Residue Removal)	R_2 Residue Retention)	R_3(Residue Rention with *Trichoderma*)
Trichoderma)			with			
W_1 (control)	8.35*(68.71)	7.92(61.69)	7.83(60.38)	7.86(60.78)	7.42(54.13)	7.39(53.68)
W_2 (Hand weeding at 30 &45 DAS)	1.00(0.00)	1.00(0.00)	1.00(0.00)	1.00(0.00)	1.00(0.00)	1.00(0.00)
W_3 (Isoproturon +2,4-D(1.0+0.5 Kg/ha) at 30DAS)	3.94(14.53)	3.62(12.09)	3.50(11.27)	3.59(11.90)	3.36(10.30)	3.36(10.30)
W_4 (Fenoxaprop 120 g/ha *fb* Metsulfuron 4g/ha)	3.55(11.64)	3.36(10.31)	3.27(9.71)	3.21(9.33)	3.08(8.52)	3.08(8.48)
SEm± for weed management at the same level of residue management.		0.03			0.03	
CD (P=0.05)		0.10			0.09	
SEm± for residue management at the same or different levels of weed management.		0.03			0.03	
CD (P=0.05)		0.09			0.10	

*Data transformed to "×+1. Figure in parentheses indicate original values

Table 2.2: Interaction effect of residue and weed management on weed control efficiency (%) at 45 days after sowing.

Treatment	Residue Management					
	2005-06			2006-07		
Weed Management	R_1 (Residue Removal)	R_2 (Residue Retention)	R_3(Residue Retention with *Trichoderma*)	R_1 (Residue Removal)	R_2 (Residue Retention)	R_3(Residue Retention with *Trichoderma*)
W_1 (control)	1.00(0.00)	1.00(0.00)	1.00(0.00)	1.00(0.00)	1.00(0.00)	1.00(0.00)
W_2 (Hand weeding at 30 &45 DAS)	10.05(100.00)	10.05(100.00)	10.05(100.00)	10.05(100.00)	10.05(100.00)	10.05(100.00)
W_3 (Isoproturon +2,4-D(1.0+0.5 Kg/ha) at 30DAS)	8.20(66.21)	8.30(67.94)	8.37(69.02)	8.27(67.46)	8.43(70.08)	8.47(70.78)
W_4 (Fenoxaprop 120 g/ha *fb* Metsulfuron 4g/ha)	8.59(72.85)	8.69(74.44)	8.73(75.28)	8.64(73.66)	8.75(75.53)	8.77(75.93)
SEm± for weed management at the same level of residue management.		0.015			0.019	
CD (*P*=0.05)		0.043			0.054	
SEm± for residue management at the . same or different levels of weed management		0.014			0.019	
CD (*P*=0.05)		0.041			0.057	

*Data transformed to $\sqrt{x+1}$. Figure in parentheses indicate original values

denticulate, Anagalis arvensis and *Melilotus species*. Other minor species were *Lathyrus aphace* L., *Solenum nigrum* L., *Avena fatua* L. *Setaria gluca* L. Residue retention with *Trichoderma* application recorded minimum total population of weeds which was at par with residue retention alone and significantly lower than residue removal treatment. Among the weed management, hand weeding twice was recorded lesser number of total weed densities as compared to rest of the weed management options. Out of herbicidal options, total weed population was recorder significantly lowered by Fenoxaprop *fb* metsulphuron followed by isoproturon +2, 4-D application over weedy checkat 45th& 90thdays stage.

The data associated to weed control efficiency as influenced by residue and weed management are presented in Table 2. Data revealed that fenoxaprop *fb* metsulfuron under residue retention with *Trichoderma* application recorded minimum total weed population which was at par with residue retention alone and significantly superior in reducing total weed population as compared to residue removal treatments at 45th day stage during both the year of investigation.

Interaction effect: The interaction effect between residue and weed management was significant at 45th days stage of crop. It is evident from the Table 2.1 and 2.2 that under each residue retention treatment was recorded less total weed by hand weeding twice followed by fenoxaprop *fb* metsulfuron and isoproturon +2,4-D over weedy check. Among the herbicidal treatments fenoxaprop *fb* metsulfuron was noted minimum weeds resulted less dry weight of total weeds with residue retention with *Trichoderma* application which was at par with residue retention alone and significantly superior in reducing total weed dry weight than residue removal treatment at 45th day of stage during both the years. Amongst herbicides, the highest weed control efficiency was associated with fenoxaprop *fb* metsulfuron which may be attributed to its effective control of complex weed flora grassy as well as broad leaved weeds and to some extent to sedges. Isoproturon + 2, 4-D recorded lower weed control efficiency as compared to fenoxaprop fb metsulfuron due to poor efficacy on weed flora these finding established support from Sinha and Singh, (2005)

ECONOMICS

Weed management treatments showed significant advantage over weedy check in maximizing net return. All the herbicidal treatments gave more net returns than that of weedy check. Out of herbicides, Isoproturon + 2, 4-D gave the highest net return as compared to Fenoxaprop *fb* metsulphuron followed by hand weeding twice. The higher net return under this treatment was owing to more grain yield and comparatively low cost of herbicide used and less labour cost as involved in hand weeding twice.

CONCLUSION

On the basis of above findings, it is concluded that wheat should be sown under residue retention (30-40 cm) with *Trichoderma* application along with application of fenoxaprop 120 g a.i. ha^{-1} *fb* metsulfuron 4 g a.i. ha^{-1} post emergence (30DAS) for obtaining higher grain yield, maximum weed control efficiency and minimum weed index under rice-wheat cropping system.

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REFERENCES

Ali, M.A., Ali, M. and Sattar, M. (2010). Sowing date effect on yield of different wheat varieties. *Journal of Agriculture Research*, **48**:157-162.

Black, C.A. (1967) Soil-Plant Relationship. 2nd edn. John. Willey & Sons. Pub. New York, U.S.A. pp. 515-516.

Grover, D.K. and Sharma, Tarun. (2011) Alternative resources conservative technologies in agriculture: impact analysis of zero – tillage technology in Punjab. *Indian J. Agric. Res..,* **45**: 283-290.

Gomez, K.A. and Gomez, A.A. (1984) Statistical Procedures for Agricultural Research (Second Eds.). *An International Rice Research Institute Book*. John Wiley and Sons.

Jackson, M.L. (1973) Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, India, pp. 183-204.

Olsen, S.R.; Cole, C.W.; Watanabe, F.S. and Dean, L. A. (1954) Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular No. 939. pp. 19-23.

Singh, Y. (2000) Development of efficient complementary practices for zero and reduced tillage systems for establishing wheat after rice. P.I. Report presented in Annual workshop of NATP project held at RAU, Patna. 4-6 Sept.: 7-11.

Singh, R.P. and Reddy, B.G. (1998) Weed growth of wheat response to N levels and weed control Methods. *Indian Journal of Weed Science* **29**(4):1-6.

Singh, Y., Singh, B. and Timsina, J. (2005) Crop residue management for nutrient cycling and improving soil productivity in rice-based cropping systems in the tropics. *Advances in Agronomy* **85**: 269-407.

Sinha, A.K. and Singh, R.P. (2005) Studies on the effect of herbicides under different tillage practices in wheat. *Indian Journal of weed science* **37** (3&4):159-162.

Subbiah, B.V. and Asija,G.L. (1956) A rapid procedure for estimation of available nitrogen in soils. *Current Science* **28**(8): 259-260.

Thomas, C.G., Yaduraju, N.T. and Kumar, J. S. (2000) Estimation of yield losses of wheat caused by wild oats (Avena sterilis spp. ludoviciana) competition. *Indian J. Weed Sci.* **32:** 44-50.

Walia, U.S. and Brar, L.S. (2001). Competitive ability of wild oats (*Avena ludoviciana* Dur). and broad leaf weeds with wheat in relation to crop density and nitrogen level. *Indian J. Weed Sci.***33**: 120-123.

Walia, S.S., Brar,S.S and Kler,D.S.(1997) Uptake of nutrient by wheat and *Phalaris minor* as influenced by crop residue management systems and weed control methods in rice-wheat system. *Environment and Ecology***15**: 617-620.

Walia, U.S., Kaur, R. and Kumar, N. (2000) Nitrogen uptake by wheat and *Phalaris minor* as influenced by irrigation and weed control treatments. *Environment and Ecology***18:**134-137.

Walkley, A. and Black, I.A. (1934) An examination of the Digtijareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science* **37**:29-33.

Yadav, D.S., Shukla, R.P., Sushant and Kumar, B. (2005) Effect of zero tillage and nitrogen level on wheat (*Triticum aestivum*) after rice (*Oryza sativa*). *Indian Journal of Agronomy*, **50**(1): 52-53.