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Weed shift and grain yield as influenced by tillage and weed management methods in rice-wheat cropping system in Chattisgarh

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ABSTRACT

A field experiment was conducted in rainy season of 2005, 2006 and 2007 with direct seeded line sown rice as first crop and wheat as subsequent crop in winter season at the University farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India to understand the effect of tillage systems and weed control methods on weed flora and grain yield of rice-wheat cropping system. The weeds found in initial two year consisted of *Echinochloa colona, Ischaemum rugosum, Fimbristylis miliacea, Cyperus iria, Alternanthera triandra, Cynotis axillaris* and *Croton bonplandianum.* In third Year, *Setaria glauca* emerged as new weed and *Fimbristylis miliacea* got disappeared, whereas in wheat, broad leaf weeds like *Melilotus indica* and *Chenopodium album* dominated the weed flora. In the initial two years, the grain yield of rice was not influenced significantly due to tillage methods, but during 2007, the grain yield was significantly higher by 10.24% under zero tillage than conventional tillage. Among the different weed control practices, farmer's practice produced maximum grain yield which was significantly superior over recommended herbicide and unweeded check and the increase in yield was to the tune of 48.09 and 96.64%, respectively, in order. During dry season, significantly higher grain yield of wheat by 5.55% was recorded under conventional tillage than zero tillage. Significant variation in grain yield and yield attributes was also registered due to various weed control treatments. Grain yield of wheat was significantly higher under herbicidal treatment i.e. pendimethalin 1.0 kg/ha as pre-emergence followed by metsulfuron 2.0 g/ha as post-emergence by 10.0 and 31.3%, respectively, as compared to farmer's practice i.e. two hand weeding and weedy check.

Key words : Rice-wheat cropping system, Zero tillage, Conventional tillage, Weed control,Herbicide

Rice grain production in India suffers a yearly loss of 15 million tones due to weed competition (Kathiresan 2002).The main benefits derived from intensive/ conventional tillage is suppression of weed growth, control of volunteer plants, good tilth for crop growth, thus, minimizing crop-weed competition in the initial crop growth stage. But in this system of tillage, on an average, around 30% of total expenditure of crop production is incurred on tillage operations. The primary objective of tillage is to control weeds and about 50% of the energy required for tillage is spent for weed control only (Yaduraju 2004). Increased energy costs, concerns about soil erosion losses and environment and rising cost of crop production and protection have led agricultural producers and scientists to adopt conservation tillage practices. Weed problem begins with weed seed in the soil. Tillage influences the vertical distribution of weed seeds in soil layer and their diversity. For many buried seeds, it is the exposure to light during soil cultivation that stimulates germination. Cussans *et al*. (1996) showed that weed species varied in their emergence to clod size. More importantly, emergence through compact soil (no-tilled) is more difficult than loose soil. Morton and Buchele (1960) found that seedlings needed more energy to emerge from compacted soil, especially when the soil had dried to form a surface crust. The dramatic improvement being made in the field of herbicide technology, the necessity of soil manipulation for weed control has decreased. Rice and wheat as in individual crop or in the system are the highest consumers of total herbicides used in India. Due to availability of effective herbicides, zero tillage technology is gaining popularity in rice-wheat system in India. In the recent past, many workers have also reported that there is no difference in weed dynamics and grain yield due to zero/conservation or conventional tillage in rice-wheat cropping system. Therefore, keeping above in view, the current study was undertaken with the objective to quantify the weed flora under various tillage system and subsequent crop and to evaluate the effect of cropping system on weed growth and grain yield of cropping system

MATERIALS AND METHODS

A field experiment was conducted in wet season of 2005, 2006 and 2007 with direct seeded line sown rice as first crop and wheat as subsequent crop in winter season at the University farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India. The soil of experimental field was Inceptisol, nearly neutral in reaction with low organic carbon and available Nitrogen, medium in available Phosphorus and high in available potash. The experiment was laid out in split plot design replicated thrice. Two tillage practices , zero tillage and conventional/intensive tillage were kept as main plots and three treatments of weed control in rice namely farmer's practice i.e. hand weeding twice at 20 and 35 days after sowing, recommended herbicides i.e. butachlor 1.5 kg/ha as pre-emergence applied at 3 DAS followed by phenoxaprop-p-ethyl 56.25 g/ha + ethoxysulfuron 15 g/ha as post-emergence applied at 21 DAS and a weedy check were kept in sub-plots. Similarly in wheat, three weed control treatments namely farmer's practice i.e. hand weeding twice at 20 and 35 days after sowing, recommended herbicides i.e. application of pendimethalin 1.0 kg/ha as pre-emergence applied at 3 DAS followed by metsulfuron 2 g/ha as post-emergence applied at 25 DAS and a weedy check were in sub-plots. Main plots were similar to rice. Medium duration (115-125 days) varieties of rice variety(*MTU-1010*) and wheat *(GW-273)* were under test. Recommended dose of N:P:K was applied. Full dose of N:P and a half dose of N was applied as basal and remaining quantity of N was applied in two equal splits after 20 and 40 DAS of both crops individually. Rice was sown in the 1st week of July and harvested in the 1st week of November whereas, wheat was sown in the last week of November or 1st week of December and was harvested in last week of March or 1st week of April during all the three years of experimentation.

RESULTS AND DISCUSSION

Weed shift in rice

In rice, weed flora of the experimental field in the initial two years (2005 and 2006) consisted of *Echinochloa colona, Ischaemum rugosum, Fimbristylis milicea, Cyperus iria, Alternanthera triandra, Cynotis axillaries* and *Croton bonplandianum,* but in 2007*, Setaria glauca* emerged as new weed and *Fimbristylis miliacea* got disappeared. Further, it was observed that overall weed population under zero and conventional tillage was almost similar; however, remarkable increase in population of *Cyperus iria* under zero tillage was recorded (Table 1 and 2) as compared to conventional tillage during 3rd year of experimentation.

Also, it was interesting to notice the changes in weed flora during 3rd year such as emergence of new weed *Setaria glauca,* disappearance of *Fimbristyllis miliacea* and remarkable increase in the population of *Cyperus iria*. This might be due to the effect of either tillage or rice-wheat cropping system

In the initial two years, weed population recorded at 60 DAS revealed that tillage methods did not influence the population of weeds significantly, but in 2007, tillage methods influenced the weed population significantly. However, weed control measures showed variation in weed population. Maximum weed population was recorded under unweeded control. The lowest weed population was seen under farmer's practice i.e. hand weeding twice at 20 and 35 DAS during all the three years (Table 1 and 2).

Dry matter of weeds

In rice, dry matter of weeds at 60 DAS and at harvest was not influenced significantly due to tillage during 2005 and 06, but in 2007, a significant variation in dry matter production due to tillage was recorded. Zero tillage produced significantly higher dry matter of weeds as compared to conventional tillage. Weed control treatments showed significant variation in the dry matter production of weeds during all the three years. Farmer's practice reduced the dry matter of weeds significantly and was superior over herbicidal treatment and unweeded check (Table 3).

Yield attributes and grain yield

Yield attributes like plant height and test weight did not differ significantly due to tillage but effective tillers were significantly superior under zero tillage than conventional tillage. In the initial two years, the grain yield of rice was not influenced significantly due to tillage methods, but during 2007, the grain yield was significantly higher by 10.24 % under zero tillage than conventional tillage, might be due to higher number of effective tillers under zero tillage. Among the different weed control practices, Farmer's practice produced maximum grain yield which was significantly superior over recommended herbicide and unweeded check and the increase in yield was to the tune of 48.09 and 96.64%, respectively (Table 4). Higher grain yield under hand weeding and herbicidal treatments is also attributed to better utilization of applied nutrients by crop as compared to weedy-crop. The results are similar to that of the experiment of Amarjeet *et.al* (2006)

Weed shift in wheat

In wheat**,** weed flora of the experimental field consisted of *Echinochloa colona, Cynodon dactylon, Alternathera triandra, Melilotus indica, Chenopodium*

Table 1. Effect of tillage and weed control on weed population /m^2 at 60 DAS, during wet season of 2006

Treatment	Grasses		Broad leaf				Sedges		Total
	EC	*Ir*	*Ca*	*AT*	*Cb*	Other	*Ci*	*Fm*	
Zero tillage									
W_1	1.0	-	6.0	-	15.0	-	1	-	23.0
W_2	-	-	22	3	-	-	1	-	26.0
W_3	6.0	1	27	17	2	-	10	6	69.0
Zero tillage									
W_1	-	3	7	3	5	-	4	-	22.0
W_2	-	-	19	6	-	-	-	-	25.0
W_3	10.0	1	40	5	5	-	3	2	67.0
Conventional tillage									
W_1	-	-	-	-	30	-	7	-	37.0
W_2	-	-	17	3	-	-	1	-	21.0
W_3	4	7	22	-	5	-	-	30	68.0
Conventional tillage									
W_1	5	-	2	3	4	-	3	-	17.0
W_2	-	-	20	4	4	-	-	-	28.0
W_3	2	1	50	1	5	-	10	2	71.0

W_1- Hand weeding twice (farmer's practice), W_2- Recommended herbicide, W_3- Weedy check, DAS - Days after sowing,
E. colona- Echinochloa colona , Ir - Ischaemum rugosum, Ca - Cynotis axillaris, AT - Alternathera triandra, Cb -Croton bonplandianum Ci - Cyperus iria, Fm - Fimbristylis miliacea

Table 2. Effect of tillage and weed control on weed population/m^2 at 60 DAS, wet season 2007

Treatment	Grasses		Broad leaf					Sedges	Total
	Ec	*Ir*	*At*	*Ca*	*Cb*	*Sg*	Other	*Ci*	
Zero tillage									
W_1	-	-	1.3	1.0	-	-	-	2.3	4.7
W_2	-	0.7	3.0	4.0	3.0	0.7	0.7	2.3	14.3
W_3	1.3	5.3	14.7	6.3	6.0	3.0	1.3	41.0	79.0
Zero tillage									
W_1	-	0.7	0.7	1.7	1.7	-	1.0	13.7	19.3
W_2	-	0.3	3.3	3.7	1.7	0.7	1.3	6.7	18.6
W_3	2.3	2.7	6.0	10.3	8.3	1.0	3.0	64.3	98.0
Conventional tillage									
W_1	-	-	2.0	2.7	2.0	-	1.0	2.3	10.0
W_2	1.3	-	6.7	2.0	1.0	-	2.0	11.7	24.7
W_3	1.7	1.7	14.7	25.7	3.3	1.0	5.7	29.0	82.6
Conventional tillage									
W_1	-	-	0.7	1.0	1.0	0.7	0.7	3.3	7.3
W_2	-	-	6.3	3.7	1.3	0.7	1.3	3.3	16.6
W_3	1.3	4.0	16.3	19.7	3.7	2.7	3.0	34.7	85.3

E. colona- Echinochloa colona, *Ir- Ischaemum rugosum*, *Ca- Cynotis axillaris*, *At- Alternathera triandra*, *Cb - Croton banplandianum Setaria glanca*, Ci - *Cyperus iria*, W_1- Hand weeding twice (farmer's practice); W_2-Recommended herbicide, W_3- weedy check and DAS-Days after sowing

album, Melilotus alba, *Anagalis arvensis*, *etc*. Broad leaf weeds completely dominated the flora as compared to grasses. Broad leaf weeds like *Melilotus indica* and *Chenopoduium album* dominated the weed flora in wheat. Weed population recorded at 60 DAS revealed that tillage methods did not influenced the weed population much during all the three years. The weed control measures showed significant variation in weed population. Highest weed population was recorded under un-weeded control. The lowest weed population was seen under farmer's practice i.e. hand weeding twice (Table 5).

Table 3. Effect of tillage and weed management practices on dry matter of weeds of direct seeded rice, during wet season 2005 to 2007

Treatment	Dry matter of weeds (g/m^2)							
	60 DAS				At harvest			
	2005	2006	2007	Mean	2005	2006	2007	Mean
Tillage								
Zero tillage	84.4	89.3	41.3	71.7	161.5	197.0	127.3	161.9
Zero tillage	77.9	92.0	58.5	52.8	150.2	171.2	116.3	146.4
Conventional tillage	78.6	84.5	44.2	69.1	135.5	170.7	109.0	138.4
Conventional tillage	78.7	91.4	41.4	70.5	141.3	197.0	111.1	149.8
LSD(P=0.05)	NS	NS	2.0	-	NS	NS	4.6	-
Weed Management								
Hand weeding twice (Farmers practice)	45.9	42.9	16.0	34.9	51.8	112.3	34.7	66.3
Recommended herbicide	76.2	91.0	37.1	68.1	156.5	160.0	98.4	138.3
Weedy check	116.6	134.2	87.2	79.3	232.7	269.5	214.7	239.0
LSD (P=0.05)	10.5	13.8	2.1	-	15.5	24.2	2.9	-

Dry matter of weeds

At 60 DAS, dry matter of weeds was not influenced significantly due to tillage. Zero and conventional tillage produced almost similar dry matter of weeds. However, weed control measures showed significant variation in dry matter production of weeds. Farmer's practice i.e. hand weeding twice reduced the dry matter of weeds significantly and was superior over herbicidal treatment i.e. pendimethalin 1.0 kg/ha as pre-emergence *fb* metsulfuron 2.0 g/ha as post-emergence and un-weeded check. Whereas, maximum dry matter of weeds was observed under un-weeded check at 60 DAS (Table 6).

Yield attributes and grain yield in wheat

Grain yield of wheat in 2006-07 was influenced significantly due to tillage methods. Significantly higher grain yield by 5.55% was recorded under conventional tillage than zero tillage. Similar trend was also noted for yield attributes except test weight. Significant variation in grain yield and yield attributes was also registered due to various weed control treatments. Grain yield of wheat was

Table 4. Effect of tillage and weed management practices on yield attributes and grain yield of direct seeded rice, during wet season 2005 to 2007

Treatment	Yield attributes			Grain yield (kg/ha)			
	Plant height (cm) at harvest	Effective tillers/m^2	Test weight (g)	2005	2006	2007	Mean
Tillage							
Zero tillage	84.9	176.3	27.52	2930	3640	2380	2980
Zero tillage	86.8	176.5	27.90	3090	3430	2500	3030
Conventional tillage	84.0	150.8	27.45	3140	3350	2150	2880
Conventional tillage	84.6	150.5	26.71	3130	3670	2230	3010
LSD(P=0.05)	NS	3.1	NS	NS	NS	0160	-
Weed Management							
Hand weeding twice (Farmers practice)	99.1	278.5	27.86	5470	5540	4470	5160
Recommended herbicide	94.5	189.1	27.97	3350	4450	2320	3370
Weedy check	61.6	74.1	26.36	0620	0590	150	450
LSD (P=0.05)	2.2	5.1	NS	180	250	120	-

Table 5. Effect of tillage and weed control on weed population/m^2 at 60 DAS in wheat, during dry season, 2006-07

Treatment	Grasses		Broad leaf				Total
	Echinochloa colona	*Cynodon dactylon*	*Alternathera triandra*	*Melilotus indica*	*Chenopodium album*	Other	
Zero tillage							
W_1	-	-	3.0	2.7	2.7	1.0	9.3
W_2	-	1.0	6.0	2.3	0.7	1.0	11.0
W_3	0.3	1.0	21.7	24.7	3.7	9.0	60.3
Zero tillage							
W_1	-	-	-	2.3	0.4	2.3	5.1
W_2	0.3	-	3.0	3.7	0.3	2.7	10.0
W_3	0.7	2.0	9.7	34.0	6.0	10.7	63.0
Conventional tillage							
W_1	1.0	-	1.3	2.7	6.3	3.7	14.9
W_2	-	-	4.3	3.0	5.7	1.0	14.0
W_3	1.7	1.3	7.3	31.7	12.3	9.6	63.9
Conventional tillage							
W_1	-	-	1.7	3.3	5.0	2.0	12.0
W_2	-	-	4.0	6.0	3.3	-	13.3
W_3	-	-	9.3	34.7	7.0	6.0	57.0

W_1 - Hand weeding twice (farmers practice), W_2 - Recommended herbicide, W_3 - Weedy check

significantly higher under herbicidal treatment i.e. pendimethalin 1.0 kg/ha as pre-emergence followed by metsulfuron 2.0 g/ha as post-emergence by 10.0 and 31.3%, respectively, as compared to farmer's practice i.e. two hand weeding and weedy check. The yield under herbicidal treatments was higher because of lower dry weight of weeds due to significant control of weeds, which might have shifted the competition for moisture, nutrients, space and light in favor of the crop rather than of weeds. These results are in close conformity with those reported by Singh *et al*. (2003) and Azad *et al*. (2003). The grain yield was significantly lower under weedy check. Except test weight, other yield attributes followed the similar trend as that of grain yield (Table 6).

Table 6. Effect of tillage and weed management practices on dry matter of weeds, yield attributes and grain yield of wheat, during dry season 2006-07

Treatment	Dry matter of weeds g/m^2 at 60 DAS	Plant height (cm) at harvest	Effective tillers/m^2	Test weight (g)	Grain yield (kg/ha)
Tillage					
Zero tillage	50.2	69.9	187.5	42.1	2460
Conventional tillage	54.9	71.1	200.7	43.0	2550
Zero tillage	50.2	70.5	183.3	42.0	2300
Conventional tillage	52	73.4	192.0	42.8	2490
LSD(P=0.05)	NS	1.3	4.7	NS	170
Weed Management					
Hand weeding twice (Farmer's practice)	32.3	73.4	201.1	42.7	2560
Recommended herbicide	38.4	71.7	217.9	43.1	2840
Weedy check	65.3	68.6	153.7	41.8	1950
LSD (P=0.05)	1.9	1.9	5.0	NS	150

In the initial two years in 2005 and 2006, dry matter of weed g/m^2 as well as the grain yield of direct seeded rice were not influenced significantly due to tillage methods and produced similar dry matter of weeds and grain yield. However, during 2007, the variation in dry matter production of weeds and grain yield was significant due to tillage methods. Also, shift in weed flora in terms of disappearance of *Fimbristylis miliacea* and emergence of *Setaria glauca* was observed. Grain yield obtained from zero tillage was significantly higher than conventional tillage. Among the weed control measures, farmer's practice i.e. hand weeding twice performed at 20 and 35 days after sowing reduced the dry matter of weeds and increased the grain yield of rice over recommended herbicide and weedy check by 48.09 and 96.64%, respectively.

Broad leaf weeds like *Melilotus indica* and *Chenopoduium album* dominated the weed flora in wheat. Tillage methods did not influenced the dry matter production of weeds significantly at 60 DAS, but weed control measures showed significant variation in dry matter production. Significantly low dry matter was recorded under farmer's practice i.e. hand weeding twice followed by herbicidal treatment.

Grain yield was significantly higher under conventional tillage than zero tillage. Grain yield of wheat was significantly higher by 10.0 and 31.3 %, respectively under herbicidal treatment of pendimethalin 1.0 kg/ha as pre emergency fb by metsulfuron 2.0 g/ha as post-emergence than hand weeding and weedy check.

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