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Effect of Tillage and Weed Control Methods on Weeds and Yield of Rice-Wheat and Soybean-Wheat Cropping Systems

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Wheat is the major winter season cereal crop grown in an area of about 27 million hectares in India under diverse agro-ecological conditions. It is rotated with rice (about 10.5 m ha) in the Indo-Gangetic Plains (IGP) and with soybean (about 2.0 m ha) mostly in Madhya Pradesh. However, rice-wheat cropping system has become more fragile and system productivity is showing the sign of fatigue (Hobbs and Morris, 1996). In recent years, major emphasis in this system has been on crop diversification with greater inclusion of legumes and use of resource conservation technologies to alleviate declining factor productivity, input use efficiency and increasing cost of cultivation for realizing sustainable use of natural resources. Zero tillage and bed planting have been widely adopted by the farmers in more than one million hectares area of Indo-Gangetic Plains. Altering tillage practice changes weed population dynamics, including weed seed distribution and abundance in the soil seed bank and affects the efficacy of control practices. Different tillage implements move the soil in different ways and, therefore, have substantially different effect on weed seed distribution in the soil profile. Keeping these points in view, the present investigation was conducted.

Field experiments were carried out at National Research Centre for Weed Science, Jabalpur (23° 90' N, 79°58' E, 412 m above mean sea level) during **kharif** 2002 and **rabi** 2002-03. The soil was clay loam (Typic Chromusterts) in nature, medium in organic carbon (0.66%), low in available nitrogen 239 kg ha^{-1}), medium in available phosphorus (17 kg ha^{-1}) and potassium (298 kg ha^{-1}) with neutral in reaction (pH 7.2). Treatments comprised combinations of two cropping systems (direct seeded rice-wheat and soybean-wheat), three tillage practices (zero tillage–ZT, conventional tillage–CT and furrow irrigated raised bed-planting system–FIRBS) and three weed control measures (weedy check, recommended herbicide as per the crop and herbicide+one hand weeding) were replicated thrice in a split-plot design. ZT comprised sowing directly with zero-till seed drill, CT consisted of disc ploughing once+cultivator twice+rotavator and sowing and FIRBS consisted of sowing directly in well prepared land on beds with bed planter. Rice (cv. Kranti) and soybean (cv. JS 335) were sown in rows using ZT seed drill, conventional seed drill and bed-planter as per the treatment on June 28, 2002. After the harvest of these **kharif** crops, wheat (cv. WH 147) was sown on November 18, 2002 with the same tillage treatments. The crops were raised under irrigated condition with recommended package of practices, except weed control. Metribuzin at 0.50 kg ha^{-1} in soybean and butachlor at 1.5 kg ha^{-1} in rice were applied as pre-emergence and isoproturon at 1.0 kg ha^{-1} in wheat as post-emergence using flat-fan nozzle. Hand weeding was done at 25 days after sowing (DAS) during rainy season and 30 DAS during winter season. Weed population was recorded by placing a quadrate of 0.50 m x 0.50 m (0.25 m^2) size randomly at four places in a plot. The data on number and dry weight of weeds were subjected to square-root transformation using ($\sqrt{X+0.5}$).

Density of *Phyllanthus* spp., *Physalis minima* and *Corchorus* spp. was significantly less in soybean as compared to rice (Table 1). However, the population of *Echinochloa colona, Commelina* spp. and *Cyperus iria* as well as total weed dryweight was not affected due to cropping system. The population of *E. colona* increased, whereas that of *P. minima* decreased significantly due to ZT. FIRBS significantly reduced the population of *Corchorus* spp. as well as total weed dry matter. Butachlor in rice and metribuzin in soybean significantly reduced

Table 1. Effect of treatments on weeds and grain yield of rice and soybean

Treatment	Weed population (No. m^{-2})* at 30 DAS							Weed dry weight at harvest* ($g\ m^{-2}$)	Grain yield ($kg\ ha^{-1}$)	
	Echinochloa colona	*Commelina* spp.	*Phyllanthus* spp.	*Physalis minima*	*Corchorus* spp.	*Cyperus iria*	Total		Rice	Soybean
Cropping system										
Rice-wheat	3.74	2.05	4.26	6.65	2.92	2.66	7.58	15.36	-	-
	(13)	(4)	(18)	(44)	(8)	(7)	(57)	(236)		
Soybean-wheat	3.32	1.88	3.40	1.61	1.70	2.38	6.11	15.34	-	-
	(11)	(3)	(11)	(2)	(2)	(5)	(37)	(235)		
LSD (P=0.05)	NS	NS	0.74	1.85	0.54	NS	1.13	NS	-	-
Tillage										
ZT	5.20	2.35	4.45	1.72	2.90	3.12	8.61	15.58	1103	258
	(27)	(5)	(19)	(2)	(8)	(9)	(74)	(242)		
CT	2.52	1.78	4.70	5.23	3.04	2.55	7.52	16.06	1164	329
	(6)	(3)	(22)	(27)	(9)	(6)	(56)	(257)		
FIRBS	4.10	2.52	4.51	7.50	1.95	2.99	8.09	14.18	527	131
	(16)	(6)	(20)	(56)	(3)	(8)	(65)	(201)		
LSD (P=0.05)	1.26	NS	NS	1.24	0.59	NS	0.94	1.52	297	65
Weed control										
Weedy	5.00	2.57	4.52	4.15	2.69	3.22	9.12	20.35	80	186
	(25)	(6)	(20)	(17)	(7)	(10)	(83)	(414)		
Herbicide (H)	3.18	1.86	4.09	5.49	2.58	2.55	7.03	13.73	1282	248
	(10)	(3)	(16)	(30)	(6)	(6)	(49)	(188)		
H+1 HW	0.71	0.71	0.71	0.71	0.71	0.71	0.71	12.21	1445	284
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(149)		
LSD (P=0.05)	1.44	0.73	0.65	0.49	0.46	0.89	1.41	1.32	197	33

*Data transformed to square root transformation. Values in parentheses are original.
NS–Not Significant.

the population of *E. colona* and *Commelina* spp. Other weeds were not affected due to herbicides. However, the total weed population and dry matter were significantly reduced due to herbicides compared to weedy check. Conventional tillage (1164 and 329 kg ha^{-1}) being at par with zero tillage (1103 and 258 kg ha^{-1}) produced significantly higher grain yield of both rice and soybean as compared to FIRBS (527 and 131 kg ha^{-1}). The lowest grain yield in FIRBS might be due to poor raised-bed formation and collapse of beds during rainy season due to heavy soil. Chauhan *et al.* (1999) also reported that FIRB system was not suitable for black cotton soils.

During subsequent **rabi** season (Table 2), population of *Medicago hispida* was significantly reduced in rice-wheat (2) as compared to soybean-wheat (4). Other weed species, total weed population and dry matter were not affected due to preceding crops. ZT significantly reduced the population of *Chenopodium album* but increased the population of *Medicago hispida* as compared to CT. O'donovan and McAndrew (2000) also reported the lowest population of *C. album* in barley under zero tillage suggesting that the requirement for herbicides for controlling these weeds in the crop may be least under zero tillage. The highest population of *C. album* was obtained in FIRBS. The population of *Vicia sativa* was not affected due to tillage practices. Isoproturon at 1.0 kg ha^{-1} significantly reduced the population of *C. album*, *M. hispida*, total weeds and weed dry matter as compared to weedy check. However, *Vicia sativa* was not controlled by isoproturon. The higher grain yield of wheat (5748 kg ha^{-1}) in soybean-wheat system as compared to rice-wheat system (4428 kg ha^{-1}) was due to legume effect of preceding soybean crop. CT (5281 kg ha^{-1}) yielded significantly higher than ZT (4951 kg ha^{-1}) but was at par with FIRBS

Table 2. Effect of cropping system, tillage and weed control methods on weeds and grain yield of wheat

Treatment	Weed population* (No. m^{-2}) at 90 DAS					Weed dry weight* (g m^{-2})	Grain yield (kg ha^{-1})
	Chenopodium album	*Medicago hispida*	*Vicia sativa*	Others	Total		
Cropping system							
Rice-wheat	4.53	2.38	1.23	1.42	5.89	4.97	4428
	(20)	(5)	(1)	(2)	(34)	(24)	
Soybean-wheat	5.04	3.89	1.27	1.35	7.15	6.07	5748
	(25)	(15)	(1)	(1)	(51)	(36)	
LSD (P=0.05)	NS	0.71	NS	NS	NS	NS	444
Tillage							
ZT	2.80	3.71	1.34	1.41	5.26	5.26	4951
	(7)	(13)	(1)	(1)	(27)	(27)	
CT	5.34	1.88	1.26	1.12	6.24	5.17	5281
	(28)	(3)	(1)	(1)	(38)	(26)	
FIRBS	6.22	3.82	1.14	1.63	8.06	6.02	5031
	(38)	(14)	(1)	(2)	(64)	(36)	
LSD (P=0.05)	1.28	0.76	NS	0.38	1.22	NS	277
Weed control							
Weedy	8.90	4.75	1.46	1.49	10.79	8.30	4569
	(79)	(22)	(2)	(2)	(116)	(68)	
Herbicide	4.46	3.15	1.14	1.38	3.71	4.29	5073
	(19)	(9)	(1)	(1)	(13)	(18)	
Herbicide+1 HW	1.00	1.51	1.15	1.30	5.07	4.08	5622
	(1)	(2)	(1)	(1)	(25)	(16)	
LSD (P=0.05)	1.42	0.67	NS	NS	1.42	1.11	281

*Data transformed to square root transformation. Values in parentheses are original.
NS–Not Significant.

(5031 kg ha^{-1}). Isoproturon+1 HW resulted in the highest grain yield (5622 kg ha^{-1}) which was significantly higher than isoproturon alone (5073 kg ha^{-1}) and weedy check (4569 kg ha^{-1}). The interaction effects between tillage and weed control methods were non-significant.

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