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Impact of integrated weed management on weed flora distribution and weed dynamics in rice (*Oryza sativa* L.) under system of rice intensification (SRI)

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Abstract
A field experiment conducted at Research cum-Instructional Farm, Department of Agronomy, IGKV, Raipur (C.G.) during Kharif season of 2009 in Randomized Block Design (RBD) with three replications. The dominated weed flora of the rice field comprised *Alternanthera triandra, Echinocloacolona, Fimbristylis miliacea* and *Cyperus iria* throughout the crop season. Other weeds were *Ischaemum rugosum, Boreriasirida, Commelina benghalensis, Cyanotis axillaris, Aeschynomene indica* etc. observed in the experiment field. Results revealed that post-emergence combined application of Fenoxaprop-p-ethyl 60 g ha^{-1}+ Ethoxysulfuron 15 g ha^{-1} at 20 and 35 DAT was statistically at par with hand weeding (twice) at 20 and 40 DAT for controlling weeds effectively in system of rice intensification method of rice.

Keywords: Rice, weed flora, weed dynamics, integrated weed management

Introduction
Rice (*Oryza sativa* L.) is one of the most important and extensively grown premium food crop of the world and important staple food of more than 60 per cent of the world's population. Chhattisgarh is known as rice bowl of central India. The area and productivity of rice in Chhattisgarh is 3.61 million ha and 1.5 t ha^{-1} (Anonymous, 2008-09) [1], which is quite low as compared to many states as well as country. Weeds are the major constraints in production of rice which often pose serious problem. Weeds compete with crop plants for moisture, light, nutrients and space. The extent of yield reduction of rice due to weeds is estimated from 15-95 per cent (Gogoi *et al*., 1996) [5]. Weed competition depends upon method of rice cultivation, weed species and their time of emergence etc. Weed problems are generally of lower magnitude in traditional method because of puddling, transplanting and continuous submergence of water but in SRI fields, weeds infestation is higher as compared to traditional transplanting system due to wetting and drying of field. The untimely and poor weed management adversely affects proper growth and yield of rice. Herbicide used in isolation, however, unable to obtain complete weed control because of their selective killing. Their use can be made more effective if apply in combination and/or supplemented with other weed management practices such as hand weeding or mechanical weeding etc which are available for weed control in rice. Keeping these points in view, integrated approach of weed management was evaluated for more feasible and practicable control of mixed weed flora in SRI.

Materials and methods
The experiment was carried out at research cum-instructional-Farm, IGKV, Raipur (C.G.) during *kharif* season (July to November) of 2009. The experiment was conducted in randomized block design (RBD). There were three replication and twelve treatments of various combinations of different herbicides. Rice variety *"MTU-1010"* was grown as a test crop. Rice seedlings of 14 days old were transplanted with a spacing of 20 x 20 cm. The crop was fertilized with 90, 60 and 40 kg N, P and K ha^{-1} applied through urea, single super phosphate and muriate of potash, respectively. The whole amount of P and K was applied as basal dressing, while nitrogen was applied in three splits *viz.*, 30 kg N/ha as basal and remaining 60 kg/N in two equal splits at maximum tillering and panicle initiation stage. Organic manures as green manuring crop was grown and incorporated in soil at flowering stage. Rice was harvested in the second week of November, 2009.

Results and discussion

Weed flora

The experiment field was infested throughout the crop season with different weeds. The dominant weed species were *Alternanthera triandra, Echinocloacolona, Fimbristylis miliacea and Cyperus iria* throughout the crop season. Other weeds were *Ischaemum rugosum, Boreriasirida, Commelina benghalensis, Cyanotis axillaris, Aeschynomene indica* etc.

Total and Species wise dry matter accumulation

Resulted revalidated that different weed management practices showed significant effect on total dry matter accumulation of weeds. In general, the increased density of weeds enhanced dry matter accumulation of weeds per unit area. At harvest, the total dry matter accumulation by weed was observed lowest() in treatment PoE followed by PoE (Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) followed by hand weeding twice and Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} + MW (two ways). Similar results were also noted by Pal *et al.* (2002). Unweeded control treatment allowed significantly higher dry biomass accumulation at 30 and 60 DAT.

At 30 DAT, the lowest dry matter accumulation of all the weed species viz. *Echinochloa colona, Alternanthera triandra, Cyperus iria, Fimbristylis miliacea* and other weeds were observed under two ways mechanical weeding followed by one way mechanical weeding. Both the treatments were significantly lower than the rest of the treatments including the unweeded control. However, it was comparable to each other. Hand weeding twice, Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} at 20 DAT + MW (two ways) were next in order. These results are in accordance with Nair (2002) [8].

Whereas, at 60 DAT, the lower dry matter accumulation of *Echinochloa colona, Alternanthera triandra, Cyperus iria, Fimbristylis miliacea* and other weeds were observed in treatment PoE followed by PoE (Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) followed by hand weeding twice and Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} at 20 DAT + MW (two ways). Treatment unweeded control produced maximum dry matter of all the weed species at 60 DAT. The minimum dry matter accumulation under these treatments might be due to better efficacy of Fenoxaprop-p-ethyl against grassy weeds like *Echinochloa colona* etc. and Ethoxysulfuron against broad leaved weeds like *Alternanthera triandra* etc. Singh *et al.* (2003) [13] found that the dry weight of weed deceased by the application of Fenoxaprop-p-ethyl. Singh *et al.* (2004) [14] also found that of Fenoxaprop-p-ethyl reduced growth and dry matter of narrow leaves of weeds. These results also confirmed with the findings of Saini and Angiras (2002) [10]. The lowest dry matter accumulation of *Alternanthera triandra* found under the treatments of ethoxysulfuron was might have been due to the better killing capacity of ethoxysulfuron as compared to CME + MSM against broad leaf weed. They also observed ethoxysulfuron resulted in significantly lower density of broad-leaved weeds and sedges and hence lower total weed dry weight. Sharifi (2003) [11] found application of Ethoxysulfuron has good effect on broadleaves and sedges (*Cyperus* spp.) of paddy fields. Unweeded control yielded the highest dry matter accumulation till harvest.

Further, mechanical weeding produced the minimum weed dry matter accumulation at early growth stages but increased in later growth stages (at 60 DAT and after) might be due to increased occurrence of weeds in the inter plant spaces where weeder could not reach. Hiromi *et al.* (2001) [6] noted that mechanical weeding become difficult due to increased occurrence of weeds at interhilll spaces in later stages of rice. Similar difficulty with cono-weeder was also reported by Rajendran *et al.* (2007) [9].

Effect on grain yield

The highest grain yield (51.85) was observed underPoE followed by PoE (Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) narrowly followed by hand weeding. However, both the treatments were comparable to each other. This was owing to low crop-weed competition and longer weed free period under these treatments which leads to high growth and yield of rice. This was in accordance with Fischer *et al.* (1993) [4] and Kolhe (1999) [7].

Weed control efficiency (WCE)

The maximum weed control efficiency was observed with PoE followed by PoE (Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) closely followed by hand weeding and Fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} at 20 DAT + MW (two ways). It was also noted that application of herbicides enhanced weed control efficiency due to restricted weed growth, resulted lower production of dry matter of weeds lead to high weed control efficiency. This is in accordance with the finding of Kolhe (1999) [7].

Table 1: Total and species wise weed dry matter accumulation, grain yield and WCE as influenced by weed management practices at 30 and 60 DAT in SRI.

Treatments	30 DAT					60 DAT					Total weed dry matter accumulation (m^{-2})	Grain yield (q ha^{-1})	WCE
	Echinochloa colona	*Alternanthera triandra*	*Cyperus iria*	*Fimbristylis miliacea*	Other weeds	*Echinochloa colona*	*Alternanthera triandra*	*Cyperus iria*	*Fimbristylis miliacea*	Other weeds			
T_1	0.75	0.54	0.68	19.30	132.85	52.05	4.45	3.45	2.45	3.61	132.85	41.16	52.05
T_2	0.77	0.64	0.6	15.65	116.05	58.11	3.82	2.35	2.11	3.08	116.05	43.30	58.11
T_3	0.70	0.65	0.57	14.95	113.35	59.09	3.76	2.20	1.98	2.76	113.35	45.32	59.09
T_4	0.63	0.52	0.55	13.39	111.36	59.81	3.5	2.16	1.81	2.16	111.36	45.73	59.81
T_5:	0.78	0.59	0.59	8.67	80.07	70.93	2.05	1.29	1.20	1.40	80.07	48.30	70.93
T_6	0.64	0.61	0.64	11.08	99.83	63.97	2.92	1.85	1.47	1.98	99.83	46.90	63.97
T_7	0.21	0.43	0.28	22.84	148.59	46.37	5.66	3.58	2.53	3.85	148.59	40.93	46.37
T_8	0.17	0.39	0.26	9.15	92.20	66.72	2.4	1.75	1.39	1.89	92.20	48.11	66.72
T_9	0.65	0.64	0.66	12.23	105.48	61.93	3.22	1.98	1.53	2.15	105.48	45.77	61.93
T_{10}	0.66	0.55	0.67	6.87	69.91	74.77	1.83	1.05	0.91	1.05	69.91	51.85	74.77
T_{11}	0.40	0.46	0.35	7.91	77.39	72.07	1.91	1.22	1.06	1.35	77.39	50.50	72.07
T_{12}	1.22	3.12	1.37	33.1	277.05	-	10.63	8.25	6.39	9.72	277.05	21.12	-
SEm ±	0.06	0.02	0.05	0.86	4.17	-	0.18	0.13	0.10	0.13	4.17	0.83	-
CD at 5%	0.18	0.07	0.14	2.52	12.24	-	0.54	0.39	0.30	0.37	12.24	2.02	-

T_1:Fenoxaprop-p-ethyl @ 60 g ha^{-1}+CME+MSM @ 4 g ha^{-1} at 20 DAT, T_2:Fenoxaprop-p-ethyl @ 60 g ha^{-1} + Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT,T_3:Fenoxaprop-p-ethyl @ 60 g ha^{-1}+ CME+MSM 4 g ha^{-1} at 20 DAT + MW (one way) at 35 DAT,T_4:Fenoxaprop-p-ethyl @ 60 g ha^{-1}+

Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT + MW (one way) at 35 DAT,T_5:Fenoxaprop-p-ethyl 60 g ha^{-1} + Ethoxysulfuron 15 g ha^{-1} + MW (two way) at 20 and 35 DAT, T_6:Fenoxaprop-p-ethyl 60 g ha^{-1}+ CME+MSM 4 g ha^{-1} at 20 DAT + MW (two way) at 35 DAT,T_7:Mechanical weeding (one way) -12, 25, 35 DAT, T_8: Mechanical weeding (two way) -12, 25, 35 DAT, T_9:PoE followed by PoE Fenoxaprop-p-ethyl + CME+MSM @ 4 g ha^{-1} at 20 and 35 DAT, T_{10}:PoE followed by PoE Fenoxaprop-p-ethyl + Ethoxysulfuron 15g ha^{-1} at 20 and 35 DAT,T_{11}:Hand weeding–20, 40 DAT,T_{12}:Unweeded control

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