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Integrated weed management with new low rate herbicide and non-chemical methods for rice-rice-green gram cropping system

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Abstract : Experiments were carried out to study the integrated methods of weed management using acetochlor the new low rate herbicide, incorporation of biomass of weed *Lantana camara* L. and azolla with two different land preparation methods in 'rice-rice-greengram' cropping system. Land preparation methods of paraquat at 1.0 kg ha^{-1} + tractor ploughing with cage wheel by one pass and tractor ploughing with cage wheel by two passes are comparable in weed control. Acetochlor 50 g ha^{-1} was selective and efficient in checking the weeds than the higher dose (75 g ha^{-1}) in both the rice crops. Acetochlor application of 8 DAT + HW controlled the weeds efficiently than applied at transplanting. Among the non-chemical weed management methods, lantana incorporation + HW showed effective weed control (especially the sedges) due to the release of allelo chemicals and addition of nitrogen through lantana incorporation also complemented for the increased grain and straw yield, resulting in higher net income. The lantana biomass incorporation is ecologically safe, because it is not causing any residue problem.
(Key words : Acetochlor, Butachlor, Paraquat, Lantana camara L., rice, cropping system, integrated weed management)

Weed infestation was the primary constraint in rice production. Yield reduction caused by uncontrolled weed growth through a crop season has been estimated to be from 16 to 86 per cent Cropping systems play a vital role in weed management. Rotation of low land rice with upland crop will reduce infestation of weeds in rice (Srinivasan *et al.*, 1992). Land preparation especially pudding and harrowing provided weed free conditions at planting and helped in better crop establishment. In intensive cropping, use of herbicides form an integral part of crop production technology. The over dependence and over use of herbicides for weed management resulted in greater pressure on farmers to reduce herbicide use and the need to reorient our efforts towards non-chemical and non-hazardous means of weed management. Hence an integrated weed management strategy was formulated to reduce the technological gap in weed management of rice based cropping system integrating the tillage methods, herbicide (new low rate herbicides "acetochlor", butachlor and paraquat) and non chemical methods of using *Lantana camara* biomass and azolla for effective alternative for weed control in 'rice-rice-greengram' cropping system.

Materials and Methods

Field experiments were carried out at Tamil Nadu Agricultural University, Coimbatore from June, 1996 to April 1998 to evaluate the efficacy of land preparation methods and integrated methods of weed managment using the low rate new herbicide acetochlor and incorporation of a weed *Lantana camara* L. biomass and azolla in the "rice (CORH1)-rice (Co 45) - greengram (KM-2)" cropping system. Experiments were laid out in split plot design, replicated thrice. The main plot treatment includes two land preparation methods viz., tractor ploughing with cage wheel by two passes (M1) and spraying paraquat at 1.0 kg ha^{-1} (7 days before tractor ploughing) + tractor ploughing with cage wheel by one pass (M2). The sub-plot treatment include ten weed management methods viz., acetochlor at 50 g ha^{-1} at transplanting + HW (40 DAT) (S_1), acetochlor at 50 g ha^{-1} at 8 DAT + HW (40 DAT) (S_2), acetochlor at 75 g ha^{-1} at transplanting (S_3), acetochlor at 75 g ha^{-1} at 8 DAT (S_4), *Lantana camara* L. biomass incorporation at 5 t ha^{-1} + acetochlor at 50 g ha^{-1} at 8 DAT (S_5), *Lantana camara* L. biomass incorporation at 5 t ha^{-1} + HW (40 DAT) (S_6), acetochlor at 50 g ha^{-1} at 8 DAT + azolla inoculation as dual culture at 2.5 t ha^{-1} (S_7), butachlor at 1.25 kg ha^{-1} as pre emergence + HW (40 DAT) (S_8), hand weeding twice (20 and 40 DAT) (S_9) and control (S_{10}). The experiment was carried out for two years. (ie.) kharif, rabi and summer of 1996-97 (I year) and kharif, rabi and summer of 1997-98 (II year). The other practices (fertilizer, irrigation and plant protection) given were same to all treatment as per the recommendation.

Results and Discussion

Weed spectrum

The weed spectrum observed consisted of

eleven species, of which three were grasses, three sedges, and five broad leaved and aquatic weeds. The predominant weeds were *Echinochloa crus-galli* L. in grass, *Cyperus iria* L. in sedges, *Eclipta alba* L. in broad leaved weeds and *Marsilea quadrifolia* L. in aquatic weeds. The other weeds recorded in the experimental fields were, *Echinochloa colona* L. *Paspalum distichum* L. *Cyperus difformis* L. *Fimbristylis miliacea* L. *Ammania baccifera* L. *Ludwigia parviflora, Monochoria vaginalis* L.

Weed population

In both the years (1996-97 & 1997-98) there was not significant differences observed between the land preparation methods on grass weed population (Except Ist crop, 1996-97) at 20 DAT (Table 1). In crop I (1996-97) paraquat + tractor ploughing with cage wheel by one pass exerted a marked influence on the control of grass weeds ($12.44m^{-2}$) compared to tractor ploughing with cage wheel by two passes ($14.12 m^{-2}$). The similar trend was observed in the control of broad leaved weeds also. However, the sedges population was effectively controlled by the land preparation methods of paraquat + tractor ploughing with cage wheel by one pass compared to tractor ploughing with cage wheel by two passes in Ist and IInd crops of both the years. The similar trend was observed by Choudhury (1995) and Kandasamy and Krishna Kumar (1997).

Among the weed management methods, acetochlor 50 g ha^{-1} at 8 DAT + HW recorded lower grasses and broad leaved weeds population in I & II crops of both the years. The sedges were effectively controlled by lantana incorporation + HW treatment. Both these treatments were on poor and significantly superior than the control and the recommended practice of butachlor 1.25 kg ha^{-1} +HW.

Weed Control Efficiency (WCE) and Weed Index (WI)

Among the land preparation methods, paraquat application + tractor ploughing with cage wheel by one pass recorded higher WCE and lower WI per cent in all the crops in both the years, in controlling the grasses, sedges and broad leaved weeds than the tractor ploughing with cage wheel by two passes (Table 2).

Among the weed management methods, acetochlor 50 g ha^{-1} at 8 DAT + HW recorded higher WCE in controlling grasses. Where as the sedges were effectively controlled by lantana biomass-incorporation + HW than any other treatment. It was higher WCE and lower WI than the recommended practice of butachlor 1.25 kg ha^{-1} + HW and the control in both the years of study.

Grain yield and Economics

In both the years in rice-rice system the land preparation methods did not show any significant influence on the grain and straw yield of rice and net income and B:C ratio. However, the values are numerically higher in paraquat + tractor ploughing with cage wheel by one pass than the tractor ploughing with cage wheel by two passes (Table 3).

Among the weed management methods acetochlor 50 g ha^{-1} at 8 DAT + HW recorded higher grain and straw yield, net income and B:C ratio of rice in both the years of rice crops and it was on par with lantana incorporation +HW. It was superior to all other weed management treatments. The lowest grain yield, straw yield, net income and B:C ratio recorded in unweeded control plot.

Studies on Lantana

The fresh biomass of lantana was analysed for its nutrient potential. The results showed that nitrogen, phosphorus and potassium content of fresh foliage was 0.85 per cent, 0.15 per cent and 0.92 per cent, respectively. Sharma *et al.* (1988) also reported similar findings regarding the nutrient content of lantana plant.

The total phenol content in the fresh biomass were estimated as per the procedure given by Bray and Thorpe (1954). The result showed that the total phenol content was 265 µg/g in fresh leaves. Many reports indicated that allelopathy plays an important role in weed-weed interaction (Newman and Rovira, 1975). Arora and Kohli (1993) observed that lantana incorporation reduced both the radicle and plumule growth of weed seeds.

Herbicide residue

Research on herbicides applied to rice crop were rarely a problem in the succeeding crops. The residue of the new herbicide acetochlor in soil and grain samples were estimated by adopting the procedure given by (Anonymous, 1995). The result showed that, there was no residue in soil and grain sample after the harvest of crops. In all the samples, the residue was below detectable limit (BDL). It was below 0.01 mg g^{-1} of sample tested. Similar observations were also made in maize crop by Bhagat *et al.* (1996). The growth and yield of succeeding green gram crop was not affected by the acetochlor, (or) but achlor herbicides. But the weed management methods adopted in the rice

Table 1. Effect of integrated weed management treatments on weed parameters (At 20 DAT) in rice-rice system

Treatment	1996-97						1997-98					
	Grasses (No m^{-2})		Sedges (No m^{-2})		Broad leaved weeds (No m^{-2})		Grasses (No m^{-2})		Sedges (No m^{-2})		Broad leaved weeds (No m^{-2})	
	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop
M_1	14.12	12.44	10.55	6.24	8.28	10.43	6.41	6.50	14.78	6.50	10.06	2.26
	(2.78)	(2.67)	(2.53)	(2.11)	(2.33)	(2.52)	(2.33)	(2.14)	(2.82)	(2.14)	(2.49)	(1.45)
M_2	12.44	13.18	9.94	4.49	7.97	9.94	5.02	5.54	12.15	5.69	8.80	1.71
	(2.67)	(2.72)	(2.48)	(1.87)	(2.30)	(2.48)	(1.95)	(2.02)	(2.65)	(2.04)	(2.38)	(1.31)
SE_d	0.02	0.06	0.01	0.04	0.02	0.05	0.09	0.06	0.01	0.01	0.04	0.03
CD (P=0.05)	0.08	NS	0.05	0.18	Ns	NS	NS	NS	0.05	0.05	NS	0.13
S_1	9.70	10.94	7.68	7.21	9.13	10.93	6.41	6.25	14.95	6.34	7.77	2.76
	(2.46)	(2.56)	(2.27)	(2.22)	(2.41)	(2.56)	(2.13)	(2.11)	(2.83)	(2.19)	(2.28)	(1.56)
S_2	7.87	10.18	5.61	4.05	4.62	7.49	3.87	7.78	10.55	5.38	7.12	0.56
	(2.29)	(2.50)	(2.03)	(1.80)	(1.89)	(2.25)	(2.13)	(2.11)	(2.83)	(2.19)	(2.28)	(1.56)
S_3	17.89	17.10	13.80	7.30	8.80	15.99	6.94	9.82	19.93	9.13	11.87	4.62
	(2.99)	(2.95)	(2.76)	(2.23)	(2.38)	(2.89)	(2.19)	(2.47)	(3.09)	(2.41)	(2.63)	(1.89)
S_4	13.80	14.76	7.30	7.49	5.32	9.36	5.69	7.30	15.46	6.33	9.13	2.95
	(2.76)	(2.82)	(2.23)	(2.25)	(1.99)	(2.43)	(2.04)	(2.23)	(2.86)	(2.12)	(2.41)	(1.60)
S_5	12.44	11.74	8.70	5.32	6.58	8.59	6.16	3.10	11.87	4.42	7.39	0.94
	(2.67)	(2.62)	(2.37)	(1.99)	(2.15)	(2.36)	(2.10)	(1.63)	(2.63)	(1.86)	(2.24)	(1.08)
S_6	9.36	4.62	4.89	2.66	5.69	8.27	3.81	3.26	6.17	4.05	5.92	0.00
	(2.43)	(1.89)	(1.93)	(1.54)	(2.04)	(2.33)	(1.76)	(1.66)	(2.10)	(1.80)	(2.07)	(0.69)
S_7	13.33	15.11	11.07	3.87	8.28	14.78	5.69	12.88	13.49	5.69	12.15	0.16
	(2.37)	(2.84)	(2.57)	(1.77)	(2.33)	(2.82)	(2.04)	(2.70)	(2.71)	(2.04)	(2.65)	(0.77)
S_8	12.01	10.93	15.12	4.62	9.47	5.09	4.36	3.42	9.36	4.55	9.13	1.74
	(2.64)	(2.56)	(2.84)	(1.89)	(2.44)	(1.96)	(1.85)	(1.69)	(2.43)	(1.88)	(2.41)	(1.32)
S_9	15.46	12.15	15.29	4.30	9.94	7.97	6.94	4.36	13.33	5.85	9.13	2.09
	(2.50)	(2.65)	(2.85)	(1.84)	(2.48)	(2.30)	(2.19)	(1.85)	(2.73)	(2.06)	(2.41)	(1.41)
S_{10}	28.88	31.78	22.53	8.80	19.76	2.42	13.64	21.57	27.93	9.47	19.54	10.55
	(3.43)	(3.52)	(3.20)	(2.38)	(3.08)	(3.11)	(2.75)	(3.16)	(3.40)	(2.44)	(3.07)	(2.53)
SE_d	0.13	0.16	0.11	0.28	0.13	0.19	0.14	0.08	0.09	0.13	0.10	0.11
CD (P=0.05)	0.26	0.33	0.23	NS	0.26	0.38	0.29	0.16	0.18	0.26	0.19	0.23

Table 2. Effect of weed management methods on weed control efficiency (WCE) and weed index (WI) in rice-rice system

Treatment	1996-97								1997-98							
	Weed control efficiency (%)						Weed index %		Weed control efficiency (%)						Weed index %	
	Grasses		Sedges		Broad leaved weeds				Grasses		Sedges		Broad leaved weeds			
	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop
M_1	51	60	53	29	58	49	14.36	35.41	53	69	46	31	48	78	35.48	25.72
M_2	57	59	56	49	60	51	11.17	30.47	63	74	56	40	55	83	29.36	21.86
S_1	66	65	66	18	54	46	9.59	15.78	53	71	46	33	60	74	14.70	13.35
S_2	73	68	75	54	77	63	3.59	2.04	72	64	62	43	63	94	1.03	3.22
S_3	38	46	39	17	55	22	23.50	50.61	49	58	28	13	39	56	48.26	43.53
S_4	52	54	67	15	73	54	16.19	39.58	58	66	44	33	53	72	37.10	39.69
S_5	57	63	61	40	66	58	11.15	39.74	54	85	57	53	62	91	39.66	19.25
S_6	68	85	78	70	71	60	6.83	16.47	72	85	78	57	70	100	15.16	7.62
S_7	54	52	51	56	58	78	12.35	37.32	58	40	52	40	38	98	35.31	18.89
S_8	58	66	53	47	52	75	1043	21.68	68	84	66	52	53	83	19.20	15.25
S_9	46	62	32	51	50	61	12.12	46.82	49	80	52	38	53	80	45.49	32.11
S_{10}	-	-	-	-	-	-	21.94	59.26	-	-	-	-	-	-	58.62	41.95

Data were not statistically analysed

Table 3. Yield and economics of weed management methods in rice-rice system

Treatment	1996-97								1997-98							
	Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Net income (kg ha^{-1})		B:C ratio		Grain yield (kg ha^{-1})		Straw yield (kg ha^{-1})		Net income (kg ha^{-1})		B:C ratio	
	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop	I crop	II crop
M_1	5952	4390	9173	6936	16070	13185	2.99	2.45	4472	4216	6698	6473	10068	8062	2.24	1.88
M_2	6173	4595	9498	7938	17075	15042	3.28	2.77	4813	4435	7290	6790	12032	95096	2.66	2.10
SE_d	60	51	143	54	NA	NA	NA	NA	154	280	245	415	NA	NA	NA	NA
CD (P=005)	NS	NS	NS	232	NA	NA	NA	NA	NS	NS	NS	NS	NA	NA	NA	NS
S_1	6283	4320	10275	7214	16938	13297	3.26	2.57	5830	4918	8718	7567	16104	11452	3.16	2.35
S_2	6700	5469	11150	8655	20589	18915	3.76	3.25	6782	5493	10082	8416	19950	13786	3.67	2.63
S_3	5525	3569	7966	6357	13558	10180	2.86	2.24	3420	3205	5206	4920	6600	4726	1.92	1.57
S_4	5616	3738	8825	7475	15199	10990	3.09	2.33	4184	3423	6369	5256	9696	5616	2.22	1.68
S_5	6313	4796	9225	8455	16577	14948	2.95	2.57	4172	4583	6192	7057	8362	9072	1.98	1.95
S_6	6316	5254	10025	9497	19874	17918	3.37	2.91	5782	5243	8750	7876	15037	11833	2.79	2.26
S_7	6091	4764	9541	7583	16855	15218	3.14	2.71	4339	4604	6630	7189	9691	9797	2.23	2.10
S_8	6225	4749	9266	7554	17333	15421	3.22	2.75	5421	4510	8151	7334	14085	106621	2.79	2.20
S_9	6108	4610	9083	6541	16067	13992	2.96	2.52	3673	3683	5636	5562	6688	5715	1.82	1.62
S_{10}	5425	3661	8000	5039	12738	10259	2.78	22.26	2820	3295	4207	5138	4289	5238	1.60	1.64
SE_d	119	420	360	1054	NA	NA	NA	NA	466	378	700	547	NA	NA	NA	NA
CD (P=005)	404	851	731	2139	NA	NA	NA	NA	944	767	1421	1109	NA	NA	NA	NA

NA - Not analysed

significantly increased the yield of following green gram crop. But the weed management methods adopted in the rice significantly increased the yield of succeeding green gram.

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Genetic evaluation for resistance to rice white backed planthopper *Sogatella furcifera* (Horvath) in brown planthopper resistant rice varieties

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Abstract : Of 15 planthopper resistant varieties evaluated for resistance to *Sogatella furcifera*, nine had high levels of resistance. Among the IR varieties, IR 36 and IR 56 had field resistance to *S.furcifera* as indicated by their susceptibility in the standard seedbox test and resistance as older plants in the modified seedbox test. Insect growth and development, food intake, longevity and egg hatchability differed significantly among varieties of the same age and at different plant ages within the same variety. Population increase on resistant varieties was low at the two plant ages tested. *(Key words : Whitebacked planthopper, Sogatella furcifera; Mechanisms of resistance, Plant resistance to insects)*

The whitebacked planthopper, *Sogatella furcifera* (Horvath) has emerged as a serious pest of rice in many Asian countries. Serious outbreaks of the pest have been reported in Bangladesh, China, Nepal, Pakistan, Taiwan, Vietnam and India (Alam and Alam, 1988; Mochida *et. al.*, 1982; Gyawali, 1983; Khush, 1984). In India, serious outbreaks of *S.furcifera* and subsequent yield reduction have been reported from Madhya Pradesh, Haryana, Punjab, Uttar Pradesh, Orissa, West Bengal, Andhra Pradesh and Tamil Nadu (Kuswaha and Kapoor, 1986). The increased incidence of *S.furcifera* is attributed to