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Weed management in rice – soybean intercropping system under rainfed condition of Marathwada region of Maharshtra

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ABSTRACT

A field experiment was conducted in medium black soil with slightly alkaline in reaction in 2011, 2012 and 2013 at Upland Paddy Research Scheme, Research farm, VNMKV, Parbhani (Maharashtra). Rice variety 'Parag' was sown with 30 cm row spacing and 60 kg seed rate ha^{-1}. Soybean variety 'MAUS-71' was sown as intercrop with the seed rate of 75 kg ha^{-1} as per the treatments. Experiment was laid out in split plot design with three replications. In main plot four weed control methods and in sub-plots five intercropping treatments were followed. Soil was low in nitrogen, ferrous and zinc; medium in phosphorous and rich in potash. Rainfall during experimental period was 636 mm, 678 mm, 1134 mm in cropping season during 2011, 2012 and 2013, respectively. Significantly highest rice grain equivalent yield, gross monitory return, net monitory return was observed with pendimethalin @ 0.75 kgha^{-1} followed by one hand weeding at 25 days after sowing over rest of the weed management practices, however, it was at par with two hand weedings at 20 and 45 days after sowing for rice grain equivalent yield and gross monitory return in all the three years. Moreover, pendimethalin @ 0.75 kgha^{-1} followed by one hand weeding at 25 days after sowing recorded lowest weed dry matter and highest weed control efficiency in 2011-12, 12-13 and 13-14. In pooled analysis, pendimethalin @ 0.75 kgha^{-1} followed by hand weeding at 25 DAS recorded highest rice grain equivalent yield. Significantly highest rice grain equivalent yield, gross monitory return, net monitory return was observed with rice + soybean intercropping at the ratio of 3:2 over rest of the intercrop treatments in all the three years. Significantly highest rice grain equivalent yield was obtained with rice + soybean intercropping with the ratio of 3:2 in pooled results.Amongst various interactions, highest rice grain equivalent yield was obtained with pendimethalin @ 0.75 kg ha^{-1} followed by one hand weeding at 25 days after sowing for rice + soybean intercropping at the ratio of 3:2 over rest of the interactions of weed management and intercropping of rice + soybean in all three years and pooled analysis.

***Keywords*:** Rainfed drilled rice, rice + soybean intercropping and weed management

Rice is the main staple food in Asia and particularly in Indian subcontinent. India ranks first in area (42.4 mill. ha.) and second in rice production with a share of 21 percent (104 mill. tones) of world rice production in 2012. Moreover, rice is major agriculture commodity of India for earning foreign currency and contributes about 338090 million rupees in agricultural exports (20%) in 2012-13 (Anonymous, 2013). Further it provides employment to millions of people in rice cultivation and rice based industry. This indicates the importance of rice crop in national food security and economy of India. However, in view of shrinking resources like arable land, irrigation water and energy there is shifting of rice crop by more remunerative crops like soybean which require less labour and water (Tomar *et al*., 2012). Short fall in rice production leads to economical, social and nutritional insecurity in India and this has been witnessed in recent past and will be acute in future. Moreover, uncertainties of rainfall, limitation for increasing irrigation facilities towards traditional rice cultivation method, fertilizer and pesticide availability are major challenges for attaining desired rice production at state and national level. This necessitates to find out appropriate alternative and more efficient production systems such as multiple cropping which can ensure proper utilization of resources to obtain increased production per unit area and time on a sustainable basis (Trenbath, 1986; Jabbar *et al*., 2010), particularly for upland rainfed rice growing region like Marathwada (Maharashtra), wherein rice productivity is very low (520 kg ha^{-1}) (Anon., 2013b). Legumes in association with major staple food crops like rice could be successfully introduced to enhance the productivity of the system (Saeed *et al*., 1999). Similarly, weed management is big challenge in upland rice. The extent of yield reduction due to weed infestation was 15-20 per cent under transplanted system, 30-35 per cent under direct seeded low land system and more than 50 per cent under upland situation (Pillai and Rao, 1974). Whereas, Singh *et al*. (2005) reported reduction in grain yield by 75.8, 70.6 and 62.6% under dry seeded rice, wet seeded rice and transplanted rice, respectively due to uncontrolled weeds. Dwivedi and

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Srivastava (2011) found reduction in weed population under cereal + legume intercropping. Moreover, Intercropping also offers opportunity to incorporate the crops of commercial importance and furnishing the requirement of family (Arya *et al*., 2012). Patra (2005) also confirmed that intercropping of rice with greengram was beneficial over sole crop of direct seeded rice. In view of this, there is an urgent need to design and develop new methods and techniques of crop production to meet the increasing demand for food, feed and forage through effective utilization of available resources in rainfed upland rice. Accordingly a trial was conducted to test the performance of soybean as an intercrop in different row ratios with rice and weed management practices.

MATERIALS AND METHODS

A field experiment was conducted on medium black soil with slightly alkaline in reaction in 2011, 2012 and 2013 at Upland Paddy Research Scheme, research farm, VNMKV, Parbhani (Maharashtra). Rice variety 'Parag' was sown with 30 cm row spacing and seed rate of 60 $kgha^{-1}$. Recommended dose of N-P-K @ 80-50-50 $kgha^{-1}$ was used. Sources of fertilizers were Urea, Single Super Phosphate and Murate of Potash. The seed was treated with carbofuron @ 2 $gmkg^{-1}$ seed and azorpirillium @ 10 $gmkg^{-1}$ seed. Soybean variety 'MAUS-71' was sown as intercrop with the seed rate of 75 kg ha^{-1} as per the treatments. Experiment was laid out in split plot design with three replications. In main plot four weed control methods viz. Pendimethalin @ 0.75 kg a.i. ha^{-1}, Pendimethalin @ 0.75 kg a.i. ha^{-1} followed by one hand weeding at 25 days after sowing (DAS); two mechanical weeding at 20 and 45 DAS and unweeded control and in sub-plots five intercropping treatments were followed viz. rice (30 cm row spacing); inter cropping rice + soybean (2:1); rice + soybean (3:2); rice + soybean (4:2) and rice + soybean (5:1). Soil was low in available nitrogen, ferrous and zinc; medium in available phosphorous and rich in potash. Rainfall during experimental period was 636 mm, 678 mm, 1134 mm in cropping season during 2011, 2012 and 2013, respectively.

RESULTS AND DISCUSSION

Rice grain yield was significantly influenced due to weed management practices and intercropping treatments under study in 2011-12, 12-13, 13-14 and in pooled analysis (Table 1). Amongst weed management practices, pre emergence (PE) application of pendimethalin @ 0.75 kg/ha followed by one hand weeding at 25 DAS produced significantly highest grain yield over rest of the weed management practices except two hand weeding at 20 and 40 DAS in 2011-12, 2012-13 and 2013-14. In pooled data, pre-emergence application of pendimethalin @ 0.75 $kgha^{-1}$ followed by hand weeding at 25 DAS showed higher rice seed yield, however, it was at par with rest of the treatments, except unweeded control. Significantly the lowest seed yield was observed with unweeded control in 2011-12, 12-13, 13-14 and pooled data over the seasons. Sinha *et al.,* (2006) reported higher rice grain yield with pre emergence application of pendimethalin coupled with one hand weeding at 25 DAS under dry seeded sole rice crop. Amongst various intercropping treatments sole rice crop gave significantly highest rice grain yield than rest of the various rice + soybean intercropping systems during three years of investigation. rice + soybean (4:2) showed significantly highest grain yield over rest of the rice inter cropping systems except rice + soybean at 2:1 ratio during first two years of experimentation (2011-12 and 2012-13). However, in 2013-14, rice + soybean at 2:1 ratio found significantly superior over lowest introduction of soybean with rice i.e. rice + soybean at 5:1 ratio and was at par with other rice + soybean combinations. Significantly lowest rice grain yield was observed with rice + soybean (5:1) in all the three seasons. Pooled data was non-significant for intercropping treatments under study. Reduction in grain yield of rice due to intercropping was also reported by Chandra *et al*., (1992). This might be attributed to lowered population of rice in intercropping system due to introduction of soybean crop. Amongst weed management practices application of pendimethalin @ 0.75 kg ha^{-1} followed by one hand weeding at 25 DAS produced significantly more soybean grain yield over rest of the treatments except hand weeding on 25 and 40 DAS in the entire period of investigation and pooled analysis. Jadhav *et al.,* (2003) found superiority of hand weeding twice in soybean over pendimethalin followed by hand weeding in sole soybean crop. Unweeded control gave significantly lowest soybean grain yield over rest of the treatments in all the seasons and pooled results.

Pooled data rice + soybean (3:2) gave significantly more seed yield over rest of the intercropping systems. rice + soybean (4:2) was observed statistically at par with rice + soybean (2:1) in all the years of investigation and both were significantly better than rice + soybean (5:1). Amongst weed management

practices, application of pendimethalin (PE) @ 0.75 kg/ha followed by one hand weeding at 25 DAS produced significantly highest grain yield over rest of the weed management practices except two mechanical weedings at 20 and 40 DAS in 2011-12, 2012-13, 2013-14 and in pooled analysis. Significantly lowest rice grain equivalent yield was observed with unweeded control in 2011-12,2012-13, 2013-14 and pooled data, rice + soybean (3:2) gave significantly more rice grain equivalent yield over rest of the intercropping systems except rice + soybean (4:2) in first year of investigation. Significantly lowest rice grain equivalent yield was observed under rice + soybean (5:1). Munda *et al.,* (2002) reported higher rice grain equivalent yield under rice + soybean (4:2) intercropping system in comparison to sole crop of rice under rainfed mid-hill dry terraces of Meghalaya.

Rice grain yield significantly influenced due to interaction effects of weed management practices and intercropping treatments (Table 3). Significantly highest rice grain yield was obtained with pendimethalin @ 0.75 kg/ha followed by one hand weeding at 25 DAS in sole crop of rice and it was at par with two hand weeding at 25 DAS and 40 DAS with sole crop of rice in 2011-12 and similar trend was observed in 2012-13 and pooled data. Rice seed yield was not influenced significantly in 2013-14 due to various interactions. In 2011-12, rice + soybean (4:2) with pendimethalin @ 0.75 $kgha^{-1}$ followed by one hand weeding at 25 DAS gave more rice seed yield, however, it was at par with rice + soybean (2:1) with pendimethalin @ 0.75 $kgha^{-1}$ followed by one hand weeding at 25 DAS and rice + soybean (4:2) with two hand weeding at 25 DAS and 40 DAS. Similar results were observed in 2012-13.

Soybean yield was significantly influenced by interaction of weed management practices and intercropping treatments under study (Table 3). Significantly highest soybean yield was obtained with pendimethalin @ 0.75 kg ha^{-1} followed by one hand weeding at 25 DAS with rice + soybean (3:2) over rest of the treatment combinations except the treatment of hand weeding at 25 DAS and 40 DAS with rice + soybean (3:2) in 2011-12. Similar trend was noted in rest of the period of experimentation (2012-13, 13-14) and in pooled data. The significantly lowest soybean grain yield was obtained with unweeded control with least introduction of soybean intercrop with a ratio of rice + soybean at 5:1during three years of experimentation and pooled analysis.

Rice equivalent grain yield was significantly influenced by interaction of weed management practices and intercropping treatments under study. Significantly highest REY was obtained with pendimethalin @ 0.75 kg ha^{-1} followed by one hand weeding at 25 DAS with rice + soybean (3:2) over rest of the treatment combinations except in 2011-12. Similar trend was noted in rest of the period of experimentation (2012-13, 13-14) and in pooled data (Table 4). The lowest soybean seed yield was significantly obtained under unweeded control with least introduction of soybean intercrop with a ratio of rice + soybean at 5:1 in first two years; however, in last year and in pooled analysis sole crop of rice gave lowest rice grain equivalent yield, however, both the treatments were at par with each other in all the years and pooled analysis.

Significantly highest weed dry weight was recorded with weedy check. Amongst weed control treatments pendimethalin @ 0.75 kg a.i. ha^{-1} followed by one hand weeding at 25 DAS recorded significantly lowest weed dry weight in three years of study and pooled analysis at all stages of observation (30 DAS, 60 DAS and at harvest); however, this was at par with two hand weeding at 20 and 45 DAS at 30 DAS in 2011-12, at 60 DAS in 2012-13 and at harvest in 2011-12 and 2012-13 (Table 5). Reduction in weed dry matter due to pre emergence application of pendimethalin in integration with one hand weeding was reported by Walia *et al*., (2009) in dry seeded rice and Jadhav *et al*., (2003) in soybean indicating suitability of pendimethalin and integration hand weeding with herbicide in intercropping system of rice + soybean. Weed dry weight was not influenced significantly due to intercropping treatments alone or their interaction effects with weed management practices. Major associated weeds in the present investigation were

Broad-leaved weeds: *Commelina benghalensis, Amaranthus sp, Merrimia emarginata, Euphorbia sp., Convolvulus arvensis, Parthenium sp., Xanthium strumarium, Digera arvensis, Abtulion indicum, Alternanthera philoxeroides*

Grasses: *Echinochloa colonum, Echinochloa crusgali, Dactyloctenium aegyptium, Brachiaria eruciformis, Digitaria sanguinalis, Cynadon dactylon, Setaria tomentosa, Dinebra retroflexa.*

Sedges: *Cyprus rotundus*

Table 1: Effect of weed management and intercropping on rice, soybean and rice grain equivalent yield during 2011-14

Grain yield	Rice yield (kg ha^{-1})				Soybean yield(kg ha^{-1})				Rice equivalent yield(kg ha^{-1})			
	11-12	12-13	13-14	pooled	11-12	12-13	13-14	pooled	11-12	12-13	13-14	Pooled*
Weed management												
W_1 - Pendimethalin @ 0.75 kgha^{-1}	2338	2602	2074	2446	497	546	494	512	3115	3481	3605	3738
W_2 - W_1 fb.one HW at 25 DAS	2636	2895	2268	2714	629	691	624	648	3620	4006	4199	4357
W_3 – Two weeding at 20&45DAS	2553	2831	2250	2671	603	662	599	621	3497	3897	4116	4245
W_4 - Un weeded	813	897	7044	8238	223	254	223	233	1173	1306	1359	1413
SEm(±)	**62.7**	**71.6**	**2.6**	**2.26**	**13.9**	**15.4**	**11.62**	**20.29**	**81.6**	**82**	**91.42**	**54.27**
LSD (0.05)	**173.6**	**197.6**	**118.5**	**553.42**	**38.5**	**42.9**	**32.2**	**135**	**217**	**230.5**	**69.6**	**167.94**
Intercroping												
C_1 - Rice (20 cm row spacing)	2294	2523	1981	2329	—	—	—	—	2294	2523	2261	2359
C_2 -Rice + Soybean (2:1)	2131	2341	1880	2179	629	769	696	698	3130	3471	3914	3991
C_3 - Rice + intercrop 3:2	2022	2292	1824	2094	861	946	856	888	3370	3815	4266	4399
C_4 - Rice + intercrop 4:2	2171	2382	1861	2190	700	702	626	676	3266	3620	3708	3924
C_5 - Rice + intercrop 5:1	1807	1998	1583	1838	249	275	247	257	2196	2438	2449	2519
SEm(±)	**16.5**	**19.7**	**26.85**	**15.60**	**24.0**	**27.0**	**24.6**	**30.98**	**43.2**	**61.25**	**53.47**	**62.42**
LSD (0.05)	**45.6**	**54.5**	**74.1**	**NS**	**48.0**	**74.7**	**68.0**	**117**	**113.5**	**171.6**	**156.26**	**81.71**
Interaction (W x C)												
SEm(±)	**32.96**	**39.5**	**53.7**	**25.64**	**48.0**	**53.9**	**49.1**	**30.98**	**72.3**	**87.45**	**49.23**	**62.42**
LSD (0.05)	**91.23**	**108.9**	**NS**	**73.72**	**133**	**149**	**136**	**90.81**	**193**	**247.8**	**154.38**	**46.49**

** Market prices for rice and soybean are from 2013-14 to calculate rice grain equivalent yield for pooled data.*

Table 2: No. of panicles and straw yield (kg ha^{-1}) as influenced by different weed management and intercropping treatments during 2011-14

	No of panicles (m^{-2})			Straw yield (kg ha^{-1})		
Weed management	**11-12**	**12-13**	**13-14**	**11-12**	**12-13**	**13-14**
W_1 - Pendimethalin @ 0.75 kg a.i. ha^{-1}	143	157	143	2843	3045	2407
W_2 - W_1 fb.one HW at 25 DAS	153	171	155	2980	3173	2592
W_3 - Two weeding at 20 &45 DAS	152	167	152	3004	3184	2491
W_4 - Un weeded	68	076	68	1089	1282	1028
SEm (±)	**5.06**	**6.2**	**5.4**	**48.9**	**53.41**	**55.55**
LSD (0.05)	**13.9**	**17.3**	**15.1**	**143.6**	**148.5**	**155**
Intercropping						
C_1 Rice (20 cm row spacing)	145	159	145	2771	2970	2324
C_2 Rice + Soybean (2:1)	131	147	133	2579	2756	2231
C_3 Rice + intercrop 3:2	123	135	123	2431	2639	2065
C_4 Rice + intercrop 4:2	132	145	131	2401	2607	2130
C_5 Rice + intercrop 5:1	113	128	116	2212	2414	1898
SEm(±)	**1.31**	**1.92**	**1.8**	**75.4**	**83.33**	**74.99**
LSD (0.05)	**3.62**	**5.33**	**4.9**	**201.7**	**229.7**	**204**
Interaction (W x C)						
SEm(±)	**2.61**	**3.85**	**3.54**	**158**	**166.66**	**149**
LSD (0.05)	**7.24**	**10.66**	**9.79**	**NS**	**NS**	**NS**

Table 3: Interaction effect between weed management treatments and rice + soybean intercropping on rice grain yield (kg ha^{-1}), soybean seed yield (kg ha^{-1}) and rice equivalent yield (kg ha^{-1})

Treatments	Sole rice crop (20 cm row spacing)			Rice + soybean (2:1)			Rice + soybean (3:2)			Rice + soybean (4:2)			Rice + soybean (5:1)		
	11-12	12-13	13-14	11-12	12-13	13-14	11-12	12-13	13-14	11-12	12-13	13-14	11-12	12-13	13-14
Rice grain yield (kg ha^{-1})															
W_1	2564	2820	—	2404	2650	—	2297	2660	—	2425	2660	—	1908	2211	—
W_2	2862	3152	—	2703	2949	—	2596	2825	—	2724	2991	—	2297	2521	—
W_3	2799	3077	—	2618	2874	—	2447	2831	—	2692	2959	—	2425	2436	—
W_4	951	1047	—	801	887	—	748	823	—	844	929	—	723	801	—
SEm (±)	**32.9**	**39.5**	**—**			**—**			**—**			**—**			**—**
LSD(0.05)	**91.2**	**108.9**	**NS**												
Soybean seed yield (kg ha^{-1})															
W_1	—	—	—	633	695	698	900	990	897	700	770	628	250	274	249
W_2	—	—	—	775	870	891	1120	1227	1107	925	990	798	323	354	321
W_3	—	—	—	825	890	895	1000	1094	992	875	991	795	315	347	313
W_4	—	—	—	318	351	298	425	474	428	300	327	284	107	117	107
SEm (±)	**48.2**	**53.99**	**49.12**												
LSD (0.05)	**133**	**149.4**	**135.9**												
Rice equivalent yield (kg ha^{-1})															
W_1	2564	2820	2560	3395	3769	4160	3705	4554	4730	3520	3900	3942	2389	2652	2645
W_2	2862	3152	2840	3916	4366	4960	4349	4801	5360	4172	4585	4674	2802	3091	3164
W_3	2799	3077	2780	3909	4291	4930	4012	4592	5150	4061	4554	4713	2705	2995	3003
W_4	951	1047	961	1299	1452	1600	1413	1586	1830	1313	1475	1514	890	989	998
SEm (±)	**72.3**	**87.45**	**69.12**												
LSD(0.05)	**193**	**217.8**	**187.0**												

Table 4: Pooled Interaction effect between weed management treatments and rice + soybean intercropping on rice grain yield (kg ha^{-1}), soybean seed yield (kg ha^{-1}) and rice equivalent yield (REY) (kg ha^{-1})

Treatments	sole rice crop (20 cm row spacing)			Rice + soybean (2:1)			Rice + soybean (3:2)			Rice + soybean (4:2)			Rice + soybean (5:1)		
	Rice	Soybean	REY	Rice	Soybean	REY	Rice	Soybean	REY	Rice	Soybean	REY	Rice	Soybean	REY
W_1	2650	—	2650	2511	675	4284	2468	929	4821	2511	699	4223	2073	258	2732
W_2	2949	—	2949	2799	845	5060	2671	1151	5583	2778	904	4954	2393	335	3245
W_3	2885	—	2885	2746	870	5014	2682	1029	5285	2767	887	4945	2286	325	3113
W_4	951	—	951	844	322	1615	791	442	1914	801	304	1595	726	110	1004
S Em (±)	**25.6**	**30.98**	**75**												
LSD(0.05)	**73.7**	**90.81**	**209**												

Table 5: Weed dry weight, weed control efficiency (WCE) and weed index (WI) as influenced by weed management and intercropping

Treatment	Weed dry weight (g m^{-2})									WCE (%)			WI			
Main plot	30 DAS			60 DAS			At Harvest									
	11-12	12-13	13-14	11-12	12-13	13-14	11-12	12-13	13-14	11-12	12-13	13-14	11-12	12-13	13-14	P
W_1	38	33	42	94	104	99	167	156	174	45	52	43	14	13	14	14.2
W_2	13	16	15	39	48	41	116	127	120	62	61	60.5	—	—	—	—
W_3	20	24	24	49	59	59	128	132	126	58	60	59	4	3	2	2.6
W_4	96	89	101	214	235	217	305	328	307	—	—	—	67	69	66	67.6
SEm(±)	**2.3**	**2.3**	**0.59**	**2.96**	**3.45**	**1.52**	**4.7**	**5.4**	**1.89**							
LSD(0.05)	**7.4**	**7.4**	**1.64**	**8.94**	**11.49**	**4.2**	**14.8**	**16.3**	**5.25**							
Sub Plot																
C_1	48	47	59	108	120	110	191	198	191	—	—	—	31.9	33.3	47	46.4
C_2	41	40	45	98	109	103	175	184	183	8.4	7	4.2	7.1	9	8.2	9.3
C_3	38	37	43	95	108	101	169	172	178	11.5	13.1	6.8	—	—-	—	—
C_4	36	33	41	93	105	99	172	179	174	10	9.6	8.9	3	5.1	10.8	13.1
C_5	47	46	48	102	114	106	188	197	185	1.6	0.05	3.1	34.8	36.1	42.7	42.6
SEm(±)	**1.78**	**1.64**	**0.93**	**3.5**	**3.7**	**2.28**	**6.4**	**7.2**	**3.13**							
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**							
Interaction																
SEm(±)	**3.2**	**3.5**	**1.85**	**4.8**	**5.6**	**4.55**	**9.4**	**11.2**	**6.25**							
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**							

P- pooled data.

Table 6: Monitory returns obtained in 2011-12, 12-13 and 13-14 with weed management practices and intercropping in rice

Treatments	Gross monitory returns (Rs ha^{-1})			Net monitory returns (Rs ha^{-1})		
	Year of experiment					
	11-12	**12-13**	**13-14**	**11-12**	**12-13**	**13-14**
W_1	36485	48785	51074	17311	27891	29060
W_2	42076	55811	59278	20602	32348	34428
W_3	40772	54391	58057	16998	28557	30947
W_4	13757	18443	20103	-4397	-2817	-790
SEm (±)	**881.3**	**1078**	**1233**	**451**	**356**	**634**
LSD(0.05)	**2344**	**3028**	**3631**	**1254**	**958**	**1856**
C_1	27546	36122	32847	7836	13582	10560
C_2	36383	48365	55070	15368	25490	30955
C_3	38827	52768	59656	17612	29693	35229
C_4	36674	50174	52188	15659	27299	27961
C_5	25929	34449	35904	5664	13829	12377
Sem (±)	**467**	**805**	**722**	**254**	**394**	**329**
LSD(0.05)	**1220**	**2247**	**2106**	**634**	**1096**	**1142**

Highest weed control efficiency was recorded with pendimethalin @ 0.75 kg a.i. ha^{-1} followed by one hand weeding at 25 DAS and lowest weed index i.e. per cent seed yield loss was observed with two hand weeding at 20 and 45 DAS amongst weed management practices.

Gross monitory return (GMR) and net monitory return (NMR)

Weed Management Practices: Significantly highest GMR was obtained with pendimethalin @ 0.75 kg a.i. ha^{-1} followed by one hand weeding at 25 DAS over rest of the practices; however, it was on par with two hand weeding at 20 and 45 DAS amongst weed management practices in all the three years of experimentation (Table 6). However, significantly highest NMR was obtained with pendimethalin @ 0.75 kg a.i. ha^{-1} followed by one hand weeding at 25 DAS than rest of the weed management practices in all the three years of experimentation followed by two hand weeding at 20 and 45 DAS . Significantly highest GMR and NMR was noted with rice + soybean intercropping (3:2) in 2011-12, 2012-13 and 2013-14 and was closely followed by rice + soybean (2:1) and rice + soybean (4:2) and were at par with each other in all the years of study.

Significantly maximum rice equivalent yield (REY) and net returns were observed with pendimethalin @ 0.75 kg ha^{-1} followed by one hand weeding at 25 DAS over rest of the weed management practices.. Moreover, pendimethalin @ 0.75 kg ha^{-1} followed by hand weeding at 25 DAS recorded lowest weed dry matter and highest weed control efficiency in 2011-12,12-13 and 13-14. This confirmed advantage of integration of pendimethalin and mechanical weeding in controlling weeds and improving yield of rice + soybean intercropping.

Significantly highest rice equivalent yield, GMR, NMR was observed with rice + soybean intercropping at the ratio of 3:2 over rest of the intercrop treatments in all the three years. Significantly highest REY was obtained with rice + soybean intercropping with the ratio of 3:2 in pooled results. Amongst various interactions, the highest rice grain equivalent yield was obtained with the treatment of pendimethalin @ 0.75 kg ha^{-1} followed by hand weeding at 25 DAS for rice + soybean intercropping at the ratio of 3:2 over rest of the interactions of weed management and intercropping of rice + soybean in all three years and pooled analysis. It proved beneficial over rest of the combinations of row proportions of rice+ soybean or sole rice crop, respectively during all the years of study and pooled analysis.

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