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Research Article

ORGANIC WEED MANAGEMENT IN TRANSPLANTED RICE

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Abstract: A field trial was conducted during *kharif* season of 2017-18 and 2018-19 in red sandy clay loam soils of Agricultural Research Station, Ragolu. The trial was taken up with ten organic weed management treatments in randomized block design in three replications. From the data analysed for two years it was concluded that weeds can be managed in organic rice by Summer ploughing followed by Green manuring followed by 3 weeks puddling interval + One conoweeding at 15 DAT +Need based hand weeding at 40 DAT as it has recorded the highest mean grain yield (6542 kg/ha), WCE (77.77%) and B:C ratio(1.50) as compared to other treatments and hence can be recommended for organic rice production.

Keywords: *Kharif season, Weed Management, WCE, Yield and Economics*

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Introduction

Weed competition is one of the prime yield limiting factor in organic rice production system and the yield loss ranges usually up to 40 percent and even more in some cases. It has also been found that in some cases herbicides use can cause some weed species to dominate fields because the weeds develop resistance to herbicides besides reduced bio diversity. Application of rice bran suppresses weeds effectively besides adding nutrients on decomposition in rice fields. Dual cropping of Azolla with rice showed weed detectable suppression in rice. Application of rice bran@ 2t ha^{-1} at 3DAT followed by hand weeding at 35 DAT recorded reduced weed biomass (3.38 gm^{-2}) and increased grain yields in organic rice [1]. There were evidences for growing of green manuring, puddling and efficient water management reduce the occurrence of weeds under transplanted condition. Since chemical weed controls are prohibited in organic production, research into alternative methods of weed control is needed. Hence, a study was conducted to find out the effective weed management option for organic rice and to work out the economics of such weed management practices for organic rice.

Material and methods

A field trial was taken up Agricultural Research Station farm, Ragolu, Srikakulam district of Andhra Pradesh during two consecutive *kharif* seasons of 2017 and 2018. The soil is red sandy clay loam. The soil is having a pH of 7.75 (slightly alkaline), EC 0.225 dSm^{-1}, organic carbon was low (0.38%,), low in available nitrogen (96 kg/ac), medium in available P_2O_5 (12.4 kg/ac) and medium in available K_2O (104 kg/ac). The crop received a rainfall of 420.7 mm in 24 rainy days in 2017 and 661 mm in 20 rainy days during 2018. The weather was congenial for growth of rice and it was free from major pest and disease attack. The trial was conducted with ten treatments in three replications in randomized block design. The ten treatments consisted of T1- Summer ploughing T2- Summer ploughing followed by (fb) Greenmanuring, T3- Summer ploughing fb Greenmanuring fb 3 weeks puddling interval, T4- Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + mulching with crop residue, T5- Summer ploughing fb Greenmanuring fb 3 weeks puddling interval +Conoweeding twice,T6- Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + Azolla dual cropping,T7- Summer ploughing fb Greenmanuring with fb 3 weeks puddling interval + Need based hand weeding,T8-Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + One conoweeding at 15 DAT +Need based hand weeding at 40 DAT,T9- Two hand weedings at 20 & 40 DAT,T10- Weedy Check. Data was collected on weed parameters and weed control efficiency (WCE), growth, yield attributes, yield and economics of the treatments. The data are subjected to square root transformation for weed count and weed dry weight and are analyzed. The data was statistically analysed following the analysis of variance for randomized block design as suggested by Panse and Sukhatme (1978) [2] and pooled data using SPSS software.

Results and discussion

During *kharif* 2017,the results of the trial revealed that weed count at active tillering stage [Table-1 & 2] was significantly lowest with summer ploughing followed by green manuring followed by three weeks puddling interval(T3) which was at par with T9 and at PI stage was the lowest with hand weeding at 20 and 40 DAS (T9) which was on par with T8.Weed dry weight at both stages of observation followed similar trend as that of weed count. Weed control efficiency (WCE) was highest with T3 which was on par with T9,T7,T4 and T2. At PI stage, WCE was highest with T9 which was on par with T8, T7,T4 and T3.

With respect to growth parameters [Table-3 & 4], plant height was not influenced by different treatments. Productive tillers per sq.m were the highest with T9which was on par with all the treatments except T1 and T10.All the other yield attributing parameters (filled grains per panicle, thousand grain weight) were found to be non-significant. Grain yield was the highest with T9 which was on par with all the treatments except T1 and T10. Net returns and benefit cost ratio were the highest with T8 (Rs. 62851 and 1.50) followed by T7.

Table-1 *Weed Count (No/m²)as influenced by different organic weed management treatments*

Treatments	AT stage		PI Stage	
	2017	2018	2017	2018
T1	152(12.22)	27.00(5.20)	209(14.22)	36.00(5.95)
T2	200(14.13)	17.00(4.14)	332(18.10)	40.00(6.17)
T3	32(5.25)	13.33(3.75)	351(18.72)	18.67(4.36)
T4	164(12.57)	23.67(4.92)	199(13.94)	58.67(7.62)
T5	208(14.40)	21.00(4.62)	255(15.69)	42.67(6.26)
T6	292(17.08)	31.33(5.64)	279(16.19)	58.67(7.33)
T7	140(11.76)	17.00(4.17)	173(12.82)	46.67(6.67)
T8	244(15.33)	11.00(3.05)	87(8.51)	25.33(5.03)
T9	56(7.49)	3.00(1.97)	40(6.35)	24.00(3.70)
T10	400(19.97)	29.00(5.46)	661(25.55)	76.00(8.74)
S Em +/-	1.220	0.629	1.955	1.29
CD (5%)	3.65	1.88	5.85	3.86
CV(%)	16.23	25.39	22.56	25.80

The data in the parenthesis were square root transformed

During *kharif* 2018,the results of the trial revealed that weed count [Table-1 &2] at active tillering stage was significantly lowest with hand weeding at 20 and 40 DAS (T9) followed by Summer ploughing fb Green manuring fb 3 weeks puddling interval + One conoweeding at 15 DAT +Need based hand weeding at 40 DAT (T8) and summer ploughing followed by greenmanuring followed by three weeks puddling interval(T3) and at PI stage was the lowest with T9which was on par with all other treatments except Weedy check (T10). Weed dry weight at both stages of observation followed almost similar trend as that of weed count. Weed control efficiency (WCE) was highest with T9followed by T8 at both stages of observation. With respect to growth parameters [Table-3 & 4], plant height, panicle length and 1000 grain weight were not influenced by different treatments. Productive tillers per sq.m and filled grains per panicle were the highest with T9which was on par with all the treatments except T1,T2 and T10. Grain yield was the highest with T9 which was on par with all the treatments except T1,T2,T3 and T10.Net returns and benefit cost ratio were the highest with T7 (Rs.64480 and 1.56) followed by T5.

Table-3 *Growth parameters and yield attributes as influenced by different organic weed management treatments*

Treatment	Pl.ht (cm)		Panicle length (cm)		Productive tillers (No.m^{-2})	
	2017	2018	2017	2018	2017	2018
T1	106.70	94.60	23.87	22.50	351	302
T2	107.40	93.80	24.13	22.50	417	318
T3	109.83	95.20	25.27	22.73	383	326
T4	111.30	97.53	24.60	23.50	428	362
T5	109.50	95.07	24.33	23.60	396	366
T6	106.63	95.40	24.10	22.80	388	344
T7	106.97	93.53	25.00	24.20	415	375
T8	107.80	92.93	24.80	22.80	402	379
T9	107.03	92.53	25.27	23.10	448	389
T10	109.33	95.13	24.33	23.40	257	264
SEm+/-	4.78	1.57	0.36	0.50	26.06	21
CD(5%)	NS	NS	NS	NS	78	64
CV(%)	8.59	2.88	2.57	3.78	11.65	11

Table-4 *Growth parameters and yield attributes as influenced by different organic weed management treatments*

Treatment	Filled grains/panicle		Seed Yield (kg/ha)		1000 grain wt (g)	
	2017	2018	2017	2018	2017	2018
T1	135	92	5787	5069	23.10	22.20
T2	133	100	6335	5139	23.23	21.80
T3	140	102	6274	5722	23.80	21.93
T4	137	108	6579	5875	23.83	21.07
T5	146	107	6396	5903	23.30	23.20
T6	141	105	6335	5833	23.40	21.20
T7	138	112	6823	6042	24.20	22.27
T8	141	117	6944	6139	23.40	22.13
T9	149	121	7127	6528	23.43	22.27
T10	102	82	5117	4306	23.33	22.07
SEm+/-	9	7	356.95	253	0.31	0.66
CD (5%)	NS	20	1069	757	NS	NS
CV(%)	11	11	9.7	8	2.28	5.17

Pooled analysis

Weed flora observed

The major weed flora observed in the trial during the study period of two years are *Echinochloa colona, Cynodon dactylon, Leptochloa chinensis, Eclipta alba, Cyanotis cuccullata, Ammania baccifera, Sphenocloa zeylanica, Cyperus rotundus* and *Cyperus iria.*

Weed count

The lowest Weed count at active tillering stage [Table-5] was observed with Summer ploughing fb Greenmanuring fb 3 weeks puddling interval (T3) and was comparable with Two hand weedings at 20 and 40 DAT (T9). It was however significantly superior to all the other organic weed management treatments. At panicle initiation (PI) stage the lowest weed density was recorded with Two hand weedings at 20 and 40 DAT (T9) and was comparable with Summer ploughing fb Greenmanuring with fb 3 weeks puddling interval + Need based hand weeding (T7), Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + One conoweeding at 15 DAT +Need based hand weeding at 40 DAT (T8) and Summer ploughing (T1).

Table-5 *Weed count and weed dry weight of rice due to various treatments in both years*

	Weed count (No.m^{-2})		Weed dry weight (g.m^{-2})	
Year	AT	PI	AT	PI
Year 1	13.0^{b}	15.0^{b}	7.5^{b}	13.1^{b}
Year 2	4.2^{a}	6.2^{a}	5.8^{a}	5.9^{a}
Treatment				
T_1	8.7^{cd}	10.1^{ab}	6.8^{bc}	11.4^{cd}
T_2	9.1^{cd}	12.1^{bc}	6.8^{bc}	10.3^{bc}
T_3	4.4^{a}	11.5^{b}	4.1^{ab}	9.5^{abc}
T_4	8.7^{cd}	10.8^{b}	6.6^{abc}	10.0^{bc}
T_5	9.5^{cde}	11.0^{b}	6.2^{abc}	8.9^{abc}
T_6	11.3^{de}	11.8^{bc}	8.3^{cd}	10.9^{bcd}
T_7	7.9^{bc}	9.7^{ab}	5.8^{abc}	8.0^{abc}
T_8	9.1^{cd}	6.8^{ab}	7.5^{cd}	6.0^{ab}
T_9	4.6^{ab}	5.0^{a}	3.9^{a}	4.3^{a}
T_{10}	12.7^{e}	17.2^{c}	10.3^{d}	16.1^{d}
Source	F value and significance			
Year	401.75***	146.75***	21.20***	111.05***
Treatment	13.64***	7.94***	10.02***	8.61***
Year × Treatment	7.22***	3.89**	7.44***	3.15**

*Mean value followed by different letters within each column denote significance at P< 0.05, Tukey's test. * and ***indicate the significance levels at P< 0.05 and 0.001, respectively. ns denotes to non-significant at P > 0.05.*

Table-6 *Weed control efficiency of rice due to various treatments pooled over two seasons*

Weed control efficiency (%)		
Year	30 DAS	50 DAS
Year 1	61.4^{a}	54.7^{b}
Year 2	34.9^{b}	65.9^{a}
Treatment		
T_1	42.1^{abc}	55.4^{ab}
T_2	47.9^{ab}	59.1^{ab}
T_3	73.1^{a}	52.1^{ab}
T_4	43.0^{ab}	53.9^{ab}
T_5	62.1^{ab}	65.5^{ab}
T_6	28.5^{bc}	66.7^{ab}
T_7	59.4^{ab}	61.7^{ab}
T_8	46.4^{ab}	81.3^{a}
T_9	78.8^{a}	57.5^{ab}
T_{10}	0.0^{c}	50.0^{b}
Source	F value and significance	
Year	22.01***	8.06**
Treatment	6.47***	2.15*
Year × Treatment	3.70**	11.34***

*Mean value followed by different letters within each column denote significance at P< 0.05, Tukey's test. *, ** and ***indicate the significance levels at P< 0.05, 0.01 and 0.001, respectively.*

Weed dry weight

The lowest weed dry weight at active tillering stage [Table-5] was recorded with Two hand weedings at 20 and 40 DAT (T9) and was comparable with all the treatments except T1, T2, T6 and T10 (Weedy check).

Table-2 *Weed dry weight (g/m²) and WCE (%) as influenced by different organic weed management treatments*

Treatments	AT stage		WCE(%)		PI Stage		WCE%	
	2017	2018	2017	2018	2017	2018	2017	2018
T1	43.92(6.58)	50.70(7.07)	75.03(60.30)	9.24(22.73)	265.89 (15.96)	45.60(4.78)	55.22(48.07)	67.54(55.59)
T2	53.14(7.32)	39.50(6.28)	68.753(56.173)	27.01(30.16)	207.87(14.22)	40.93(6.32)	64.574(53.53)	69.14(56.65)
T3	10.32 (3.06)	26.27(5.17)	93.95(77.25)	52.30(46.30)	190.52(13.46)	34.53(5.52)	68.64(56.08)	74.13(60.83)
T4	41.24 (6.38)	50.10(6.92)	77.15(61.62)	8.88(32.95)	181.28(13.23)	45.33(6.72)	69.57(56.63)	65.80(54.36)
T5	65.41 (8.08)	20.23(4.43)	60.18(51.09)	63.95(53.44)	156.39(12.28)	36.13(5.56)	68.319(56.67)	72.45(60.15)
T6	90.97 (9.59)	48.83(6.98)	46.85(43.16)	10.21(23.32)	238.18(15.45)	43.73(6.41)	56.64(48.84)	67.23(55.82)
T7	39.51(6.23)	31.30(5.51)	75.20(61.02)	43.50(39.88)	126.45 (10.71)	30.40(5.28)	74.41(61.37)	77.19(62.50)
T8	136.92 (11.57)	17.47(3.53)	23.73(28.09)	68.99(61.52)	64.57(7.40)	22.67(4.63)	90.21(72.66)	82.88(66.42)
T9	11.34 (3.49)	19.17(4.41)	93.06(74.98)	64.58(53.64)	26.10 (5.13)	22.53(3.59)	94.81(77.34)	83.18(72.27)
T10	174.49(13.20)	55.10(7.45)	0.00(0.00)	0.00(0.00)	575.48(23.84)	69.07(11.54)	0.00(0.00)	0.00(0.00)
S Em +/-	0.826	0.85	4.576	9.82	1.767	1.33	5.314	7.59
CD (5%)	2.47	2.55	13.70	29.42	5.29	3.97	15.91	22.71
CV(%)	18.95	25.50	15.25	46.75	23.24	28.02	17.33	24.13

The data in the parenthesis were square root transformed and WCE data in the parenthesis are arc sine transformed

Table-7 *Growth, yield attributes and yield of rice due to various treatments in both years*

	Plant height (cm)	Productive tillers (No/m²)	Filled grains panicle^{-1}	Panicle length (cm)	1000-grain weight (g)	Seed yield (kg ha^{-1})
Year 1	108.25^{a}	387.4^{a}	136.2^{a}	24.6^{a}	23.5^{a}	6371.8^{a}
Year 2	93.91^{b}	342.6^{b}	104.8^{b}	23.1^{b}	22.0^{b}	5655.6^{b}
Treatment						
T_1	100.7^{ab}	326.8^{bc}	113.4^{ab}	23.2^{a}	22.7^{a}	5428.3^{cd}
T_2	100.6^{ab}	367.6^{ab}	116.57^{ab}	23.3^{a}	22.5^{a}	5737.1^{bcd}
T_3	102.5^{ab}	354.2^{ab}	121.2^{a}	24.0^{a}	22.9^{a}	5998.3^{abc}
T_4	104.4^{a}	395.0^{ab}	122.5^{a}	24.1^{a}	22.5^{a}	6227.0^{abc}
T_5	102.3^{ab}	376.0^{ab}	126.7^{a}	24.0^{a}	23.3^{a}	6149.5^{abc}
T_6	101.0^{ab}	365.7^{ab}	123.0^{a}	23.5^{a}	22.3^{a}	6084.3^{abc}
T_7	100.3^{ab}	394.9^{ab}	125.4^{a}	24.6^{a}	23.2^{a}	6432.2^{abc}
T_8	100.4^{ab}	390.7^{ab}	128.7^{a}	23.8^{a}	22.8^{a}	6541.7^{ab}
T_9	99.8^{ab}	418.3^{a}	135.2^{a}	24.2^{a}	22.9^{a}	6827.5^{a}
T_{10}	98.9^{b}	260.8^{c}	92.3^{b}	23.9^{a}	22.7^{a}	4711.3^{d}
Year	442.27***	17.81***	82.19***	54.74***	42.09***	26.81***
Treatment	2.17*	7.02***	4.48**	1.89^{ns}	0.73^{ns}	7.67***
Year × Treatment	1.42^{ns}	0.74^{ns}	0.44^{ns}	0.97^{ns}	1.05^{ns}	0.23^{ns}

*Mean value followed by different letters within each column denote significance at P< 0.05, Tukey's test. * and ***indicate the significance levels at P< 0.05 and 0.001, respectively. ns denotes to non-significant at P > 0.05.*

Table-8 *Economics of rice as influenced by different organic weed management treatments*

Treatments	Cost of cultivation (Rs/ha)			Gross returns (Rs/ha)			Net returns (Rs/ha)			B:C ratio		
	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean	2017	2018	Mean
T1	37040	37820	37430	87384	88716	88050	50344	50896	50620	1.36	1.35	1.35
T2	39360	40185	39773	95663	89931	92797	56303	49746	53025	1.43	1.24	1.33
T3	39360	40185	39773	94743	100140	97441	55383	59955	57669	1.41	1.49	1.45
T4	40110	41250	40680	99342	102813	101078	59232	61563	60398	1.48	1.49	1.48
T5	41110	41000	41055	96583	103299	99941	55473	62299	58886	1.35	1.52	1.43
T6	39560	41000	40280	95663	102084	98873	56103	61084	58593	1.42	1.49	1.45
T7	43110	41250	42180	103021	105730	104376	59911	64480	62196	1.39	1.56	1.48
T8	42010	43210	42610	104861	107431	106146	62851	64221	63536	1.50	1.49	1.49
T9	54290	55200	54745	107621	114237	110929	53331	59037	56184	0.98	1.07	1.03
T10	35540	38740	37140	77266	75348	76307	41726	36608	39167	1.17	0.94	1.06

At PI Stage, lowest weed dry weight was recorded with Two hand weedings at 20 and 40 DAT (T9) and was comparable with all the treatments except T1, T2, T4, T6 and T10 (Weedy check). Hence treatments that included Summer ploughing and green manuring with any of other interventions (three weeks puddling interval or Azolla dual cropping or Need based hand weeding or One conoweeding at 15 DAT +Need based hand weeding at 40 DAT or Two hand weedings at 20 and 40 DAT were effective suppression of weed dry weight in organic rice. These results are in conformity with the research findings on green manuring in rice-rice cropping system in which the least weed growth was recorded with ploughing the land twice, during off-season followed by twice hand weeding in the crop, raising green manure of Sesbania aculeata and incorporation of press mud at 10 t ha–1 +Azolla inoculation at 1 t ha–1 [3]. In rice/wheat cropping system, inclusion of greengram in summer or summer cowpea for fodder or Sesbania for green manuring resulted in lowest grasses and sedges [4].

Kristine Samoy-Pascual *et al* (2019) [5] recommended that 14 days as optimum period of wet land preparation due to less weed density compared with 7 days. Marsh *et al*. (2006) [6] also reported similar result on weed suppression due to repeated land cultivation. Timing and frequency of soil cultivation may influence the composition, density and long-term persistence of weed populations [7]. Soil disturbance with tillage will expose weed seeds to a flash of light that releases seeds from dormancy [8].

According to Biswas *et al*. (2005) [9], when the plot area coverage by Azolla pinnata reached 100% at 18 DAT in paddy field and peaked after 56 DAT with a biomass production of ≈2.5 and 4.2 kg m^{-2}, respectively, then it was able to inhibit more weeds. The result indicates that A. pinnata can be regarded as a biological control agent of paddy weeds. The dry weights of weeds also were significantly reduced by 7.26%, to 22.00%, over control. Azolla pinnata did not have any detrimental effect on the growth of rice plants.

Research done earlier by Thiyagarajan *et al*., 2002 [10] revealed that the impact of conoweeding in increasing the ammoniacal and nitrate nitrogen content of the rhizosphere soils was evident only at harvest (37.9 ppm) and grain filling stages (49.6 ppm) respectively while at the rest of the stages conoweeding had not set

any notable impact on the nitrogen fractions of the rhizosphere soil and also that problems are encountered in incorporation of weeds like Cynodon and sedges with underground stolons and rhizomes which result in faster regeneration under mechanical weeding [11]. Application of rice bran@ 2t ha^{-1} at 3DAT followed by hand weeding at 35 DAT recorded reduced weed bio mass (3.38 g m^{-2}) and increased grain yields in organic rice.

According to Devasinghe *et al* (2011) [12] the application of rice straw mulch at the time of crop establishment in DWS, results in suppressing growth and development of a wide range of weeds. The allelopathy effect could be due to the release of certain phytotoxic compounds by rice straw which in aid of the other agroecosystem factors, have the ability to accumulate in the soil in sufficient amounts and probably with sufficient persistence to cause a remarkable reduction in weed growth. Research found that several rice cultivars strongly inhibited (30 - 90%) the growth and development of *E. crus-galli* and *C. difformis* under field conditions, suggesting that allelopathic effect of rice cultivars could play a key role in weed control under field conditions as they can actively release certain phytotoxins.

Subramanyam *et al*. (2007) [13] emphasized that intensive puddling with continuous submergence recorded the lowest weed dry weight of 6.63 g m^{-2}.

Pooled data on Weed Control efficiency (WCE) in [Table-6] revealed that at 30 DAS, highest WCE was recorded with two hand weedings at 20 & 40 DAT (T9) and was on par with all the treatments except Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + Azolla dual cropping (T6), and Weedy Check (T10). However, at 50 DAS, highest WCE was recorded with Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + One conoweeding at 15 DAT +Need based hand weeding at 40 DAT (T8) which was comparable with all the treatments and was significantly superior than weedy check.

During both the years, among the growth parameters, plant height was not influenced by different treatments [Table-7]. Productive tillers per sq.m were the highest with T9 which was on par with all the treatments except T1 and T10. All the other yield attributing parameters (filled grains per panicle, thousand grain weight) were found to be non-significant. Grain yield was the highest with T9 which was on par with all the treatments except T1 and T10in first year and T1,T2,T3 and T10during second year. Net returns and benefit cost ratio were the highest with T8 (Rs. 62851 and 1.50) followed by T7 in first year and in the second year Net returns and benefit cost ratio were the highest with T7 (Rs.64480 and 1.56)followed by T5.

Pooled analysis of the data showed that all the parameters differed between the two years. The analysis indicated that plant height was recorded highest with T4-Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + mulching with crop residue and was on par with all the other treatments except Weedy check (T10). Productive tillers m^{-2} of organic rice were the highest with the treatment Two hand weedings at 20 and 40 DAT (T9) and was comparable with all the other treatments except Summer ploughing (T1) and Weedy Check (T10) with which it was significantly superior. Filled grains per panicle of organic rice were the highest with the treatment Two hand weedings at 20 and 40 DAT (T9) and was comparable with all the other treatments except Weedy Check (T10) with which it was significantly superior. The parameters panicle length and thousand grain weight did not differ among the treatments.

Grain yield was the highest with the treatment Two hand weedings at 20 and 40 DAT (T9) and was comparable with all the other treatments except Summer ploughing (T1) Summer ploughing followed by (fb) Greenmanuring (T2) and Weedy Check (T10) with which it was significantly superior which clearly indicated that treatments that combination of Summer ploughing and green manuring with any of other interventions (three weeks puddling interval or mulching with crop residue or conoweeding twice or Azolla dual cropping or One conoweeding at 15 DAT +Need based hand weeding at 40 DAT or Two hand weedings at 20 and 40 DAT can be recommended for effective suppression of weed population in organic rice. Pal *et al*. (2009) [14] opined that hand weeding on 20 and 40 DAT recorded highest grain yield of 5.08 t ha^{-1} in Gangetic alluvial soil because it gave little scope to weeds to flourish and to compete with the crop preferably at the critical stage of crop weed competition. Khare and Jain (1995) [15] reported that rotary weeder attained the highest net profit because of less cost of cultivation and thus resulted in the highest value of B: C ratio of 1.90 in sandy loam soil during wet season at Jabalpur. According to Kristine Samoy-Pascual *et al* (2019) shortening the conventional wet land preparation period (*i.e*., 21 days) did not affect the grain yield of rice. Research done by Thiyagarajan *et al*., 2002 revealed that the use of conoweeder resulted in 10 percent grain yield increase during wet season while the yield increase was only three percent higher in dry season than conventional method of weeding.

Conclusion

In view of the result, the economics was worked out [Table-8] to arrive at the most economical weed management practice. On computation it was observed that Summer ploughing fb Greenmanuring fb 3 weeks puddling interval + One conoweeding at 15 DAT +Need based hand weeding at 40 DAT (T8) is the most economical and can be recommended for weed management for organic rice.

Application of research: This research is highly useful to organic farmers as it would help them in controlling the weeds without the use of chemicals besides being environmentally friendly and a sustainable method of weed management.

Research Category: Organic Weed Management

Abbreviations: WCE- Weed Control efficiency

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