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RESEARCH PAPER

Effect of weed management practices on yield attributes, yield and economics of rice var. MTU-1010 under system of rice intensification

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Abstract : The present experiment was conducted at Research cum-Instructional Farm, Department of Agronomy, Indira Gandhi Krishi Vishwa Vidyalaya, Raipur (C.G.) during *Kharif* season of 2009 to find out the effect of weed management practices on plant height, no. of tillers, SPAD value, dry matter accumulation, grain yield and net return of rice var. MTU-1010 under system of rice intensification. The twelve different weed management practices were laid out in Randomized Block Design (RBD) with three replications. Rice variety "MTU-1010" was grown as a test crop. Rice was transplanted on 27th July, 2009 with a spacing of 20 x 20 cm. The crop was fertilized with 90, 60 and 40 kg N, P_2O_5 and K_2O ha^{-1}, respectively.The results of experiment indicated that growth character like plant height, number of total tillers, chlorophyll content, CGR, dry matter of rice, at initial period of crop growth responded significantly better under two ways mechanical weeding performed at 12, 25 and 35 DAT and this was followed by one way mechanical weeding. At later period of growth, significant higher number of effective tillers, total tillers, number of grains $panicle^{-1}$, panicle length, weed index, straw yield and grain yield were produced under fenoxaprop-p-ethyl 60 g ha^{-1} + ethoxysulfuron 15 g ha^{-1} at 20 and 35 DAT, which was at par with hand weeding, fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} at 20 DAT + MW performed on two ways at 35 DAT. It was also observed that all the herbicides treatments were effective and significantly enhanced the grain yield over control. In the experimental field was dominated by mainly *Echinocloa colona, Alternanthera triendra, Cyperus iria, Fimbristylis miliacea* throughout the crop season.

Key Words : SRI, Yield, Weed management, SPAD value, Rice

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INTRODUCTION

Rice (*Oryza sativa* L.) is 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. The static and low productivity of rice in India suggests the yield maximization as the most promising route for achieving growth. In order to meet the requirement of growing population there is need to boost its productivity by generating the location specific effective agro techniques. Increase in productivity mainly depends upon the proper method of rice establishment and effective weed management strategies.

The system of rice intensification (SRI) is one such alternative, integrated and agroecologically sound approach and system that claims to boost yield with fewer plants and fewer inputs resulting lower cost to farmers (Thiyagarajan *et al*., 2002). In Chhattisgarh state, farmers generally control weed manually. The physical methods are costly, labour consuming and the advantage of manual weeding could only be achieved when it is performed timely. Now a day's timely unavailability of labourers make weed management more difficult and costlier but with the application of mechanical weeding and new post emergence herbicides either alone or in combination, give effective alternative to labourers dependent of weed management. Thus, an effective and economic weed

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management is required for control of mixed weed flora in field and their effect on growth and yield of rice under SRI.

MATERIALS AND METHODS

The present investigation was conducted at the Research cum-Instructional Farm, IGKV, Raipur, Chhattisgarh. The experimental site is situated in the centre of Chhattisgarh and lies between 21°16'N latitude and 81°26'E longitude with an altitude of 289.56 meters above the mean sea level. A semi dwarf variety MTU-1010 was grown as tested variety. There were three replications and twelve treatments of various combinations of different herbicides (*viz.*, post-emergence application of fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} + chlorimuron-ethyl + metsulfuron-methyl 20 WP @ 4 g ha^{-1} at 20 DAT, post-emergence application of fenoxaprop-p-ethyl 9 EC @ 60 g ha^{-1} + ethoxysulfuron 15 WG @ 15 g ha^{-1} at 20 DAT, post-emergence application of fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} + chlorimuron-ethyl + metsulfuron-methyl 20 WP @ 4 g ha^{-1} at 20 DAT + mechanical weeding (one way) at 35 DAT, post-emergence application of fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} + ethoxysulfuron 15 WG @ 15 g ha^{-1} at 20 DAT + mechanical weeding (one way) at 35 DAT, post-emergence application of fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} + ethoxysulfuron 15 WG @ 15 g ha^{-1} at 20 DAT + mechanical weeding (two way) at 35 DAT, post-emergence application of fenoxaprop-p-ethyl 9.3 EC @ 60 g ha^{-1} + chlorimuron -ethyl + metsulfuron-methyl 20 WP @ 4 g ha^{-1} at 20 DAT + mechanical weeding (two way) at 35 DAT, two purely of mechanical type (mechanical weeding performed one way and two ways), one hand weeding at 20 and 40 DAT and one unweeded control with three replications.

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Plant height (cm) :

The data presented in Table 1 revealed that different weed management practices significantly affected the plant height at different growth stages except at 15 DAT. In general, plant height increased with the advancement in age of the crop but the maximum increase was recorded between 60 DAT to at harvest. From the table it was concluded that the height of the plant goes on increasing as the age of the plant increased. At 30 DAT, maximum plant height was observed under the treatment of T_8 where mechanical weeding was performed on two ways. Moreover, all other treatments of weed management practices were also significantly superior over control but were comparable to mechanical weeding performed on two ways (T_8). At 45 DAT, treatment comprised of mechanical weeding performed two ways, hand weeding (T_{11}), fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5), fenoxaprop-p-ethyl 60 g ha^{-1}+ CME+MSM + MW (two ways) (T_6) and PoE followed by PoE (fenoxaprop-p-ethyl + ethoxysulfuron 15 g ha^{-1}) (T_{10}) produced comparable plant height, which were significantly superior than unweeded control. At 60 DAT, and at harvest, PoE

Table 1: Plant height of rice at different intervals as influenced by integrated weed management practices under SRI

Treatments		Plant height (cm)				
		15 DAT	30 DAT	45 DAT	60 DAT	At harvest
T_1 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+CME+MSM @ 4 g ha^{-1} at 20 DAT	24.52	65.12	69.29	79.15	87.63
T_2 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1} + Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT.	24.44	69.99	72.00	81.18	92.13
T_3 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+ CME+MSM 4 g ha^{-1} at 20 DAT + MW (one way) at 35 DAT	25.80	65.00	73.14	83.38	93.55
T_4 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+ Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT + MW (one way) at 35 DAT	25.98	67.86	76.44	86.13	97.73
T_5 :	Fenoxaprop-p-ethyl 60 g ha^{-1} + Ethoxysulfuron 15 g ha^{-1} at 20 DAT + MW (two way) at 35 DAT	26.89	67.53	80.00	96.25	103.76
T_6 :	Fenoxaprop-p-ethyl 60 g ha^{-1}+ CME+MSM 4 g ha^{-1} at 20 DAT + MW (two way) at 35 DAT	24.49	64.89	79.38	90.28	100.90
T_7 :	Mechanical weeding (one way) -12, 25, 35 DAT.	27.61	70.70	74.68	75.85	87.30
T_8 :	Mechanical weeding (two way) -12, 25, 35 DAT	27.38	71.19	80.59	90.68	101.8
T_9 :	PoE followed by PoE Fenoxaprop-p-ethyl + CME+MSM @ 4 g ha^{-1} at 20 and 35 DAT	26.54	64.80	74.62	90.28	99.53
T_{10} :	PoE followed by PoE Fenoxaprop-p-ethyl + Ethoxysulfuron 15g ha^{-1} at 20 and 35 DAT	26.49	65.34	79.15	97.97	107.93
T_{11} :	Hand weeding – 20, 40 DAT	24.44	70.40	80.56	96.55	107.20
T_{12} :	Unweeded control.	25.37	52.92	58.10	64.25	79.01
S.E. ±		NS	2.23	0.91	2.12	2.04
C.D. at 5%		NS	6.55	2.66	6.21	5.99

CME + MSM = Chlorimuron ethyl +Metsulfuron methyl: DAT =Days after transplanting: PoE =Post emergence: MW = Mechanical weeding

followed by PoE fenoxaprop-p-ethyl + ethoxysulfuron 15 g ha^{-1} (T_{10}), narrowly followed by hand weeding (T_{11}) and fenoxaprop-p-ethyl 60 g ha^{-1} + ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5) were found to be equally effective in enhancing the plant height of rice. This point revealed that the chemical treatment with fenoxaprop-p-ethyl + ethoxysulfuron which was used as post emergence followed by post emergence herbicide produced the plant height similar to hand weeding (T_{11}) or fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5). These three treatments were significantly superior over rest of the treatments including unweeded control. Other treatments of weed management also favoured significant increase in plant height as compared to unweeded control. The possible reason of the maximum plant height in these treatments might be due to congenial and longer weed free environment during crop growth period provided better opportunity for over all growth and development of rice plants lead to maximum plant height. Sharma *et al.* (2003) noted that application of ethoxysulfuron was as effective as weed free treatment, hand weeding to produce plant height. This is in accordance with finding of Narwal *et al.* (2002).

Number of tillers (m^{-2}) :

The data on number of tillers m^{-2} are presented in Table 2. It is obvious from the data that at all the growth stages *i.e.* 30, 60 DAT and at harvest, the treatment of weed management practices produced significantly higher number of tillers m^{-2} than unweeded control. At 30 DAT, maximum tiller m^{-2} (359.45) was produced under the treatment of T_8 where mechanical weeding was performed on two ways. However, comparable tillers were also obtained from mechanical weeding performed on one way (T_7). Both the treatments were significant superior to rest of the treatments. Unweeded control yielded the minimum number of tillers m^{-2} (197.55). Mechanical weeding by cono weeder not only helped in reducing weed competition, but also improving root growth by increasing soil aeration and root pruning, therefore, increased the tiller density (Shad, 1986). Thiyagarajan *et al.* (2002) found that profuse tillering achieved through cono weeder operation and this favoured increase in grain yield.

At 60 DAT, all the weed management practices of herbicide, mechanical and hand weeding proved significantly superior to unweeded control in producing number of tillers m^{-2}. The highest number of tillers (469.91) was produced under PoE followed by PoE (fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) (T_{10}), however, it was comparable to hand weeding (T_{11}), and both were significantly superior to rest of the treatments. Other treatment of weed management practices also proved to be significantly superior over unweeded control. The minimum number of tillers m^{-2} was observed in unweeded control (352.55). At harvest, PoE followed by PoE fenoxaprop-p–ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} (T_{10}) gave maximum number of tillers m^{-2} (535.00), comparable tillers were also obtained from hand weeding (T_{11}), fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5), mechanical weeding performed two ways (T_8). Unweeded control yielded the minimum number of tillers m^{-2} (406.55).

Higher number of tiller under these treatments were because of the fact that there was more space to crop to show their potential due to the lower weed competition in term of

Table 2: Total no. of tillers m^{-2} and effective tillers m^{-2} of rice as influenced by integrated weed management under SRI

Treatments		Total no. of tillers m^{-2} 30 DAT	60 DAT	At harvest	Effective tillers
T_1 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+CME+MSM @ 4 g ha^{-1} at 20 DAT	320.00	375.50	438.66	384.68
T_2 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1} + Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT.	324.10	394.00	451.88	397.53
T_3 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+ CME+MSM 4 g ha^{-1} at 20 DAT + MW (one way) at 35 DAT	319.66	405.40	463.24	399.78
T_4 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+ Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT + MW (one way) at 35 DAT	323.00	423.55	478.14	406.77
T_5 :	Fenoxaprop-p-ethyl 60 g ha^{-1} + Ethoxysulfuron 15 g ha^{-1} + MW (two way) at 20 and 35 DAT	322.50	442.41	514.00	446.50
T_6 :	Fenoxaprop-p-ethyl 60 g ha^{-1}+ CME+MSM 4 g ha^{-1} at 20 DAT + MW (two way) at 35 DAT	319.33	427.15	490.33	424.38
T_7 :	Mechanical weeding (one way) -12, 25, 35 DAT.	349.25	374.81	438.33	375.66
T_8 :	Mechanical weeding (two way) -12, 25, 35 DAT	359.45	437.16	505.83	433.66
T_9 :	PoE followed by PoE Fenoxaprop-p-ethyl + CME+MSM @ 4 g ha^{-1} at 20 and 35 DAT	318.00	425.25	478.33	422.91
T_{10} :	PoE followed by PoE Fenoxaprop-p-ethyl + Ethoxysulfuron 15g ha^{-1} at 20 and 35 DAT	321.30	469.91	535.00	460.70
T_{11} :	Hand weeding – 20, 40 DAT	325.33	461.65	524.00	458.95
T_{12} :	Unweeded control.	197.55	352.55	406.55	355.66
S.E. ±		5.69	5.10	10.11	6.21
C.D. at 5%		16.68	14.97	29.67	18.21

CME + MSM = Chlorimuron ethyl +Metsulfuron methyl: DAT =Days after transplanting: PoE =Post emergence: MW = Mechanical weeding

dry matter of weeds, which allow crop to absorb required amount of nutrient, water and sunlight for their growth and tillering behaviour. Narwal *et al.* (2002) and Rekha *et al.* (2003) also reported similar results.

Number of effective tillers :

At harvest, all the weed management practices of herbicide, mechanical weeding (one/two ways) either alone or with post emergence herbicides and hand weeding proved significant superior to unweeded control (Table 2). Though, PoE followed by PoE (fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) (T_{10}) produced significantly highest number of ear bearing tillers (460.70 m^{-2}), but was statistically at par to hand weeding (T_{11}) and fenoxaprop- p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5). This is quite possible because these combinations of herbicides might have been very effective to reduce the mixed weeds density and their growth resulting better and congenial environment favoured the rice plant to utilize nutrients, light, space luxuriantly and grew well to produce more number of fertile tillers. Rest of the treatments of weed management also proved to be significantly effective in producing higher number of effective tillers as compared to unweeded control under which the minimum tiller m^{-2} (355.66) was recorded. Similar results were noted by Bhowmick and Ghosh (2006). Behera and Jena (1997), Rekha *et al.* (2003) and Sharma *et al.* (2003) also confirmed the same.

Dry matter accumulation (g plant^{-1}) :

It is clearly evident from the data (Table 3) that dry matter plant^{-1} was significantly influenced by the different weed management practices throughout the crop growth period. The dry matter of rice was increased with the advancement of crop age.

At 30 DAT, significantly highest dry matter of rice (11.73) was noted under the treatment of T_8 where mechanical weeding was performed on two ways followed by mechanical weeding performed on one way (T_7). This might be due to favourable effects of mechanical weeding. Treatment comprised of hand weeding(T_{11}), fenoxaprop-p-ethyl 60 g ha^{-1} + ethoxysulfuron 15 g ha^{-1} (T_2), fenoxaprop-p-ethyl 60 g ha^{-1} +ethoxysulfuron 15 g ha^{-1} + MW (one way) (T_4), fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5), PoE followed by PoE (fenoxaprop-p-ethyl + ethoxysulfuron 15 g ha^{-1}) (T_{10}), fenoxaprop-p-ethyl 60 g ha^{-1}+CME+ MSM 4 g ha^{-1} (T_1), fenoxaprop-p-ethyl 60 g ha^{-1} + CME + MSM + MW (one way) (T_3), fenoxaprop-p-ethyl 60 g ha^{-1}+ CME+MSM + MW (two ways) (T_6) also produced significantly higher dry matter than unweeded control but were at par to each other. At 60 DAT and at harvest, significantly higher dry matter of rice was noted under PoE followed by PoE (fenoxaprop-p-ethyl+ ethoxysulfuron 15 g ha^{-1}) (T_{10}), followed by hand weeding (T_{11}), fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5) and mechanical weeding performed two ways (T_8). Unweeded control proved to be significantly inferior to rest of treatments and produced lowest dry matter.

In general, all the plots where herbicides, cultural and mechanical (alone or with herbicide) method applied to control weeds accumulated the higher dry matter of rice than unweeded control. The possible reason of higher accumulation

Table 3: Dry matter accumulation, grain yield and benefit cost ratio of rice as influenced by integrated weed management under SRI

Treatments		DM accumulation, g m^{-2} 30 DAT	60 DAT	At harvest	Grain yield (q ha^{-1})	Benefit : cost ratio
T_1 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+CME+MSM @ 4 g ha^{-1} at 20 DAT	3.22	18.26	132.85	41.16	1.34
T_2 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1} + Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT.	3.14	14.68	116.05	43.30	1.42
T_3 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+ CME+MSM 4gha^{-1} at 20 DAT + MW (one way) at 35 DAT	2.94	14.00	113.35	45.32	1.43
T_4 :	Fenoxaprop-p-ethyl @ 60 g ha^{-1}+ Ethoxysulfuron @ 15 g ha^{-1} at 20 DAT + MW (one way) at 35 DAT	2.66	12.73	111.36	45.73	1.43
T_5 :	Fenoxaprop-p-ethyl 60 g ha^{-1} + Ethoxysulfuron 15 g ha^{-1} + MW (two way) at 20 and 35 DAT	2.96	8.14	80.07	48.30	1.52
T_6 :	Fenoxaprop-p-ethyl 60 g ha^{-1}+ CME+MSM 4 g ha^{-1} at 20 DAT + MW (two way) at 35 DAT	2.86	10.82	99.83	46.90	1.47
T_7 :	Mechanical weeding (one way) -12, 25, 35 DAT.	1.50	20.07	148.59	40.93	1.08
T_8 :	Mechanical weeding (two way) -12, 25, 35 DAT	1.36	9.78	92.20	48.11	1.34
T_9 :	PoE followed by PoE Fenoxaprop-p-ethyl + CME+MSM @ 4 g ha^{-1} at 20 and 35 DAT	3.02	11.77	105.48	45.77	1.45
T_{10} :	PoE followed by PoE Fenoxaprop-p-ethyl + Ethoxysulfuron 15g ha^{-1} at 20 and 35 DAT	2.93	6.49	69.91	51.85	1.72
T_{11} :	Hand weeding – 20, 40 DAT	1.88	7.54	77.39	50.50	1.58
T_{12} :	Unweeded control.	8.12	46.79	277.05	21.12	0.33
S.E. ±		0.14	0.66	4.17	0.83	-
C.D. at 5%		0.40	1.94	12.24	2.02	-

CME + MSM = Chlorimuron ethyl +Metsulfuron methyl: DAT =Days after transplanting: PoE =Post emergence: MW = Mechanical weeding

of dry matter of rice was the effect of herbicides on weeds so rice plant received more space, moisture, light and nutrient for their proper growth and this favoured the higher dry matter accumulation of rice per unit area. The higher dry matter accumulation also associated with the higher height and number of tillers (Table 3). The increasing foliage might have enhanced the photosynthesis due to which plant dry matter accumulation was higher under these treatments. This is in accordance with the findings of Kolhe (1999).

Crop growth rate (g day^{-1} plant^{-1}) :

The data on crop growth rate are given in Fig. 1. It is evident from the data that crop growth rate increased sharply up to 60 DAT and at later growth stage it decreased. During 0-30 DAT, the maximum crop growth rate was observed in mechanical weeding performed on two ways (T_8) followed by mechanical weeding performed on one way (T_7). It is quite clear from the data that during 60 DAT to at harvest, the treatment of PoE followed by PoE fenoxaprop-p-ethyl + ethoxysulfuron 15 g ha^{-1} (T_{10}), followed by fenoxaprop-p-ethyl 60 g ha^{-1} + ethoxysulfuron 15 g ha^{-1} + MW (two ways) (T_5) and hand weeding (T_{11}) registered higher CGR than rest of treatments whereas, the lowest CGR was recorded under unweeded control (T_{12}).

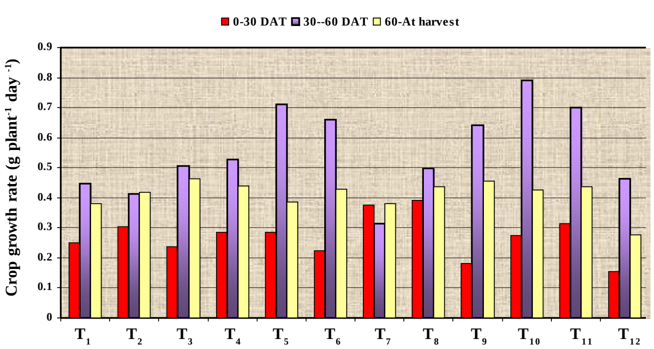

Fig. 1: Crop growth rate of rice as influenced by integrated weed management under SRI

Chlorophyll content (SPAD value) :

Effect of different treatments on chlorophyll content in rice plants are presented in Fig. 2. As weed management practices provide appropriate environment to plants to grow more vigorously. The chlorophyll contents of rice were significantly influenced due to different weed management practices. At 30 DAT, the treatment of T_8 where two ways mechanical weeding was performed showed highest chlorophyll content followed by PoE followed by PoE (fenoxaprop-p-ethyl+ ethoxysulfuron 15 g ha^{-1}) (T_{10}), mechanical weeding performed on one way (T_7). At 60 and 90 DAT, the treatment with the application of PoE followed by PoE (fenoxaprop-p-ethyl+ ethoxysulfuron 15 g ha^{-1}) (T_{10}), showed highest chlorophyll content followed by hand weeding (T_{11}) and mechanical weeding performed on one way (T_7). Unweeded control (T_{12}) showed the lowest value of chlorophyll content in all the growth stages.

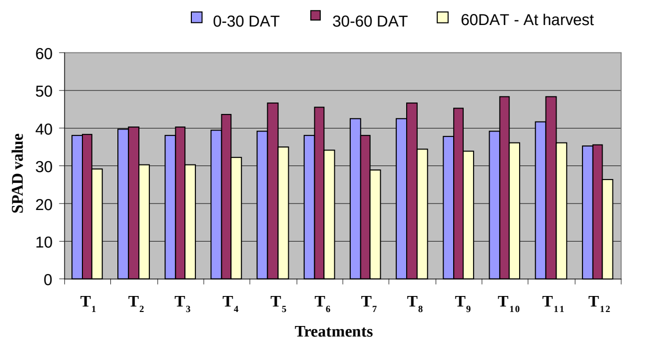

Fig. 2: Chlorophyll content (SPAD value) of rice as influenced by integrated weed management under SRI

Grain yield (q ha^{-1}) :

Data related to grain yield are presented in Table 3. It is clear from the data that weed management practices comprised of post emergence herbicides, mechanical weeding (one/two ways) either alone or with post emergence herbicides and hand weeding proved to be significantly superior over unweeded control in enhancing grain yield of rice. The highest grain yield (51.85) was observed under PoE followed by PoE (fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) narrowly followed by hand weeding. This was owing to high growth and yield attributes as well as low crop-weed competition and longer weed free period under these treatments. Kolhe (1999) observed that post emergence application of fenoxaprop-p-ethyl + ethoxysulfuron was as effective as hand weeding twice. He also reported that lower yield reduction (5.3 to 12.8%) was obtained with combined application of these chemicals. Rekha *et al.* (2003) also reported that application of ethoxysulfuron produced the highest grain yield due to effective control of weeds favouring increased yield attributes like crop dry matter, effective tillers and 1000-grain weight. Saba *et al*. (2003) too, reported that application of ethoxysulfuron controlled weeds effectively and increased grain yield of rice. Moorthy and Saha (2002) reported that application of ethoxysulfuron was as effective as hand weeding to produce grain yield.

It was observed that significantly higher grain yield was also recorded under fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1} +MW (two ways) (T_5), mechanical weeding performed two ways (T_8) and fenoxaprop-p-ethyl 60 g ha^{-1}+ CME+MSM + MW (two ways) (T_6) as compared to rest of the treatments including unweeded control. This was might be due to the higher crop growth of rice in terms of foliage, large amount of photosynthates, which act as source and helped in developing yield attributes due to low crop-weed competition and finally the higher grain yield. The cono weeder was found to increase the grain yield. This might be due to the fact that cono weeding incorporated the weeds in the soil and minimized the weeds besides increasing the soil aeration and root pruning (Uphoff, 1999). Rajendran *et al.* (2007) reported that mechanical weeding plus soil stirring by cono weeder significantly increased the grain yield. Similar increased grain yield with cono weeder was reported by Thiyagarajan *et al.* (2002). Sharma *et al.* (2003) found application of ethoxysulfuron increased the grain yield of transplanted rice. Application of post emergence herbicide Fenoxyprop-p-ethyl + ethoxysulfuron resulted in the highest grain yield (Bhowmick and Ghosh, 2006). The minimum grain yield was obtained from unweeded control (21.12 q ha^{-1}) due to no control measure was adopted in this plot. Finding of present investigation are in agreement with finding of Narwal (2002) .

Economics :

The maximum benefit cost ratio was found in PoE followed by PoE (fenoxaprop-p-ethyl 60 g ha^{-1}+ ethoxysulfuron 15 g ha^{-1}) narrowly followed by hand weeding, fenoxaprop-p-ethyl 60 g ha^{-1} + ethoxysulfuron 15 g ha^{-1} at 20 DAT + MW (two way) at 35 DAT, PoE followed by PoE fenoxaprop-p-ethyl + CME+MSM @ 4 g ha^{-1} at 20 and 35 DAT. The minimum B:C ratio was obtained in unweeded control.

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