International Journal of Agriculture, Environment and Biotechnology
Citation: IJAEB: 8(2): 323-329 June 2015
DOI Number: 10.5958/2230-732X.2015.00040.6

AGRONOMY

Effect of Bensulfuron-Methyl+Pretilachlor and Other Herbicides on Mixed Weed Flora of Wet Season Transplanted Rice

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Paper No. 324 Received: 12 September 2014 Accepted: 16 May 2015 Published: 29 June 2015

Abstract

Field experiments were conducted during the wet season of 2012 and 2013 at farmer's field of village Binuria, Sriniketan, Birbhum, West Bengal, India with rice variety '*Swarna*' (MTU 7029) to study the effect of bensulfuron-methyl + pretilachlor and other herbicides on growth of different weed species and productivity of transplanted rice. Twelve treatments in the experiment were assigned in a randomized block design with three replications. Results revealed that rice was infested with three categories of weeds *viz*. grasses, broadleaved and sedges. *Cynodon dactylon* and *Paspalum distichum* among the grasses; *Fimbristylis miliacea,* among the sedges and *Ludwigia parviflora* and *Commelina nudiflora* among the broadleaved weeds were predominant throughout the cropping period. Bensulfuron-methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1}applied at 3 DAT completely controlled the grasses, broadleaved and sedges at 30 and 60 DAT except *Cynodon dactylon* and *Paspalum distichum*. However, the density, as well as dry weight of both the species were significantly reduced. Metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} at 15 DAT was also quite effective in controlling broad spectrum weeds. Lower values of weed density, total weed dry weight and higher values of herbicide efficiency index and yield of rice were registered with application of bensulfuron-methyl 0.6%+ pretilachlor 6% at 60 + 600 g ha^{-1} at 3 DAT followed by metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} at 15 DAT. Weed infestation resulted in grain yield reduction of rice to the tune of 40% Application of bensulfuron-methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} at 3 DAT or metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4 + 35 g ha^{-1} at 15 DAT appeared to be the most promising for managing mixed weed flora and obtaining higher yield of transplanted rice in the lateritic belt of West Bengal, India.

Highlights

- Bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} and metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} effectively managed the weeds and produced higher grain yield in transplanted rice.

Keywords: Azimsulfuron, bensulfuron-methyl+pretilachlor, metsulfuron-methyl+chlorimuron-ethyl, transplanted rice, weed management

Rice is one of the three most important food crops in the world and major staple food for over 3 billion people (Gill *et al*. 2013 and Thirunavukkarasu and Vinoth, 2013). In India, rice is grown over 42.4 million ha area with the production of 104.4 million tons and a productivity of 2.46 tons ha^{-1}. Low productivity of rice in India is a

major concern for food and nutritional security of more than 60% population that is dependent on rice (Ram *et al*. 2014). Weeds pose a major threat for increasing productivity (Shilpa Sree *et al.* 2014). Uncontrolled weed growth caused 33-45% reduction in grain yield of rice (Manhas *et al.* 2012). Bensulfuron methyl + pretilachlor is a new herbicide combination reported to provide effective control of broad-leaved weeds, sedges and grasses in rice when applied at 3 DAT. It has been found effective for complex weed flora in rice without any phytotoxic symptoms in the crop (Sunil *et al*. 2010). Several new herbicide molecules including azimsulfuron and bispyribac-sodium have also been launched for effective weed management in transplanted rice (Chandra Prakash *et al*. 2013 and Singh *et al.* 2010). But the information on their efficacy in transplanted wet season rice is not adequate particularly in the sub-humid lateritic belt of West Bengal. Therefore, the present study was aimed to study the efficacy of these comparatively new herbicides on complex weed flora either alone or in combination with other as pre-emergence and early post-emergence in wet season transplanted rice.

Materials and Methods

A field experiment was conducted during wet season of 2012 and 2013 in the farmer's field of village Binuria, Sriniketan, Birbhum, West Bengal. The field is situated at about $23^0$39.823' N latitude and $87^0$37.972' E longitude with an altitude of 60 m above the mean sea level. The soil of the experimental field was sandy loam in texture, slightly acidic in reaction (pH 6.8), low in organic C (0.46%) and available N (149.6 kg ha^{-1}), high in available P (28.42 kg ha^{-1}) and medium in available K (129.5 kg ha^{-1}). The experiment consisted of twelve treatments was laid out in randomized block design with three replications. The treatments were as follows: Bensulfuron methyl 0.6% + pretilachlor 6% at 30+300 g ha^{-1} at 3 DAT, bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} at 3 DAT, bensulfuron methyl 0.6%+ pretilachlor 6% at 90+900 g ha^{-1} at 3 DAT, bensulfuron methyl 0.6%+ pretilachlor 6% at 120+1200 g ha^{-1} at 3 DAT, pretilachlor at 0.50 kg ha^{-1} at 3 DAT, pretilachlor at 0.75 kg ha^{-1} at 3 DAT, metsulfuron-methyl + chlorimuron-ethyl (Almix) at 4 g ha^{-1} at 10 DAT, azimsulfuron at 35 g ha^{-1} at 20 DAT, metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} at 15 DAT, bispyribac-Na at 25 g ha^{-1} at 20 DAT, hand weeding twice at 20 and 40 DAT and unweeded control. Recommended agronomic practices were followed for raising the rice crop. The rice variety '*Swarna*' (MTU-7029) was used in the study. The herbicide bensulfuron methyl 0.6%+ pretilachlor 6% was broadcasted at 3 DAT and other herbicides were applied using knapsack sprayer with a spray volume of 500 l ha^{-1}. Hand weeding was done manually with the hoe. Recommended dose of 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1} was applied through urea, single super phosphate and muriate of potash. One-third quantity of nitrogen and full amount of phosphorus and potassium was applied at the time of transplanting. Rest two-third quantity of N was applied in two equal splits as top dressing *i.e.* one third of nitrogen was top dressed at active tillering stage and rest one-third of nitrogen was top dressed at panicle-initiation. The data on weed density and dry weight of different weed flora m^{-2} were recorded at different growth stages of rice crop. These were subjected to square root transformation to normalize their distribution. The herbicide efficiency index (HEI) was calculated by using the formula described by Sharma and Gangaiah (2009). Grain yield of rice along with yield components like effective panicles m^{-2} were recorded at harvest and statistically analyzed at 5% level of significance.

Results and Discussion

Weed flora

Weeds of three categories under eight families infested the experimental field. The total number of weed species was 10 out of which *Cynodon dactylon, Paspalum distichum,* among the grasses*; Fimbristylis miliacea* among the sedges; and *Ludwigia parviflora, Commelina nudiflora,* among the broadleaved weeds were present as major weeds throughout the cropping period.

Effect on weeds

Unweeded control significantly recorded the highest density and dry weight of all the weed species both

Table 1. Effect of treatments on density of different weeds (no. m^{-2}) in transplanted rice at 30 and 60 DAT (Pooled data)

Treatments	Weed density (no. m^{-2})													
	C. dactylon		*P. distichum*		*l. parviflora*		*C. nudiflora*		*F. mileaceae*		Other weeds		Total weed	
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT
T_1	2.08 (4)	2.73 (7)	1.56 (2)	1.68 (2.33)	0.71 (0)	1.86 (3)	1.34 (1.33)	1.34 (1.33)	0.71 (0)	0.71 (0)	1.95 (3.33)	1.58 (2)	3.34 (10.67)	4.01 (15.67)
T_2	2.03 (3.67)	2.54 (6)	1.17 (1)	1.46 (1.67)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	1.05 (0.67)	2.24 (4.67)	2.97 (8.33)
T_3	1.94 (3.33)	2.55 (6)	1.05 (0.67)	1.46 (1.67)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	1.05 (0.67)	2.11 (4)	2.97 (8.33)
T_4	2.04 (3.67)	2.54 (6)	1.22 (1)	1.46 (1.67)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	2.27 (4.67)	2.85 (7.67)
T_5	2.03 (3.67)	2.73 (7)	1.56 (2)	1.56 (2)	1.68 (2.33)	2.12 (4)	1.05 (0.66)	1.58 (2)	1.34 (1.33)	1.34 (1.33)	2.33 (5)	2.80 (7.33)	3.94 (15)	4.91 (23.67)
T_6	2.26 (4.67)	2.60 (6.33)	1.34 (1.33)	1.56 (2)	1.22 (1)	1.46 (1.67)	1.34 (1.33)	1.05 (0.67)	1.05 (0.67)	0.71 (0)	1.68 (2.33)	2.02 (3.67)	3.43 (11.33)	3.85 (14.33)
T_7	2.32 (5)	2.78 (7.33)	1.68 (2.33)	1.46 (1.67)	0.71 (0)	1.22 (1)	1.46 (1.67)	1.56 (2)	1.46 (1.67)	0.88 (0.33)	1.34 (1.33)	1.46 (1.67)	3.53 (12)	3.81 (14)
T_8	2.26 (4.67)	2.54 (6)	1.34 (1.33)	1.34 (1.33)	0.71 (0)	0.71 (0)	1.34 (1.33)	0.88 (0.33)	0.71 (0)	0.71 (0)	1.34 (1.33)	2.02 (3.67)	3.02 (8.67)	3.44 (11.33)
T_9	2.10 (4)	2.34 (5)	1.17 (1)	1.34 (1.33)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	1.34 (1.33)	0.71 (0)	0.71 (0)	1.34 (1.33)	2.59 (6.33)	2.86 (7.67)
T_{10}	2.08 (4)	2.46 (5.67)	1.34 (1.33)	1.34 (1.33)	0.71 (0)	1.05 (0.67)	0.71 (0)	1.05 (0.67)	1.34 (1.33)	0.71 (0)	1.68 (2.33)	1.22 (1)	3.06 (9)	3.12 (9.33)
T_{11}	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)
T_{12}	2.79 (7.33)	3.62 (12.67)	1.77 (2.67)	2.26 (4.67)	1.68 (2.33)	2.67 (6.67)	1.58 (2)	2.48 (5.67)	2.20 (4.33)	3.13 (9.33)	3.76 (13.67)	5.15 (26)	5.73 (32.33)	8.09 (65)
LSD (P=0.5)	0.54	0.40	0.42	0.40	0.11	0.26	0.21	0.28	0.26	0.18	0.28	0.34	0.46	0.37

Figures in parentheses are the original values. The data was transformed to SQRT (x + 0.5) before analysis.

T_1: bensulfuron methyl 0.6%+ pretilachlor 6% at 30+300 g ha^{-1} at 3 DAT, T_2: bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} at 3 DAT, T_3: bensulfuron methyl 0.6%+ pretilachlor 6% at 90+900 g ha^{-1} at 3 DAT, T_4: bensulfuron methyl 0.6%+ pretilachlor 6% at 120+1200 g ha^{-1} at 3 DAT , T_5: pretilachlor at 0.50 kg ha^{-1} at 3 DAT,T_6: pretilachlor at 0.75 kg ha^{-1} at 3 DAT, T_7: metsulfuron-methyl + chlorimuron-ethyl (Almix) at 4 g ha^{-1} at 10 DAT, T_8: azimsulfuron at 35 g ha^{-1} at 20 DAT, T_9: metsulfuron-methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} at 15 DAT, T_{10}: bispyribac-Na at 25 g ha^{-1} at 20 DAT, T_{11}: hand weeding twice at 20 and 40 DAT and T_{12}: unweeded control

Table 2. Effect of treatments on dry weight of different weeds (g. m^{-2}) in transplanted rice at 30 and 60 DAT (Pooled data)

Treatments	Weed dry weight (g. m^{-2})													
	C. dactylon		*P. distichum*		*L. parviflora*		*C. nudiflora*		*F. miliacea*		Other weeds		Total	
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT
T_1	1.05 (0.59)	1.36 (1.34)	0.92 (0.35)	1.15 (0.81)	0.71 (0)	2.65 (6.51)	0.94 (0.39)	1.00 (0.51)	0.71 (0)	0.71 (0)	1.37 (1.44)	1.43 (1.60)	1.80 (2.77)	3.30 (10.58)
T_2	1.00 (0.51)	1.29 (1.16)	0.84 (0.21)	1.04 (0.58)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.78 (0.11)	1.10 (0.72)	1.49 (1.74)
T_3	1.00 (0.49)	1.29 (1.16)	0.85 (0.22)	1.04 (0.59)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.78 (0.10)	1.10 (0.71)	1.50 (1.75)
T_4	0.95 (0.41)	1.27 (1.11)	0.84 (0.21)	1.02 (0.55)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	1.06 (0.62)	1.47 (1.65)
T_5	1.06 (0.63)	1.35 (1.31)	0.95 (0.41)	1.13 (0.78)	2.02 (3.59)	3.06 (8.84)	0.93 (0.37)	1.07 (0.65)	1.05 (0.61)	1.11 (0.73)	1.78 (2.67)	1.59 (2.04)	2.95 (8.28)	3.82 (14.12)
T_6	1.04 (0.59)	1.28 (1.13)	0.92 (0.34)	1.08 (0.67)	1.32 (1.25)	1.98 (3.41)	0.90 (0.30)	0.85 (0.22)	0.94 (0.38)	0.71 (0)	1.21 (1.00)	1.01 (0.52)	2.08 (3.87)	2.48 (5.68)
T_7	1.10 (0.72)	1.37 (1.38)	0.97 (0.44)	1.04 (0.58)	0.71 (0)	1.52 (1.81)	0.97 (0.44)	1.09 (0.68)	1.05 (0.60)	0.82 (0.17)	1.00 (0.51)	0.86 (0.24)	1.79 (2.71)	2.26 (4.63)
T_8	1.07 (0.64)	1.35 (1.33)	0.96 (0.43)	1.09 (0.68)	0.71 (0)	0.71 (0)	0.93 (0.36)	0.78 (0.11)	0.71 (0)	0.71 (0)	1.00 (0.51)	0.95 (0.40)	1.56 (1.94)	1.67 (2.28)
T_9	1.00 (0.50)	1.29 (1.17)	0.95 (0.40)	1.06 (0.61)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.89 (0.28)	0.71 (0)	0.71 (0)	0.82 (0.17)	1.29 (1.18)	1.51 (1.78)
T_{10}	1.03 (0.55)	1.34 (1.29)	0.96 (0.42)	1.00 (0.50)	0.71 (0)	1.34 (1.29)	0.71 (0)	0.84 (0.21)	0.98 (0.45)	0.71 (0)	0.98 (0.46)	0.84 (0.21)	1.54 (1.89)	1.94 (3.30)
T_{11}	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)
T_{12}	1.30 (1.19)	1.79 (2.70)	0.98 (0.46)	1.39 (1.42)	2.18 (4.24)	4.26 (17.69)	1.04 (0.58)	1.56 (1.94)	1.76 (2.59)	2.76 (7.10)	2.16 (4.21)	2.92 (8.04)	3.70 (13.28)	6.17 (37.77)
LSD (P=0.5)	0.16	0.09	0.13	0.16	0.30	0.45	0.12	0.12	0.15	0.14	0.26	0.19	0.32	0.38

Figures in parentheses are the original values. The data was transformed to SQRT (x + 0.5) before analysis.

T_1: bensulfuron methyl 0.6%+ pretilachlor 6% at 30+300 g ha^{-1} at 3 DAT, T_2: bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} at 3 DAT, T_3: bensulfuron methyl 0.6%+ pretilachlor 6% at 90+900 g ha^{-1} at 3 DAT, T_4: bensulfuron methyl 0.6%+ pretilachlor 6% at 120+1200 g ha^{-1} at 3 DAT , T_5: pretilachlor at 0.50 kg ha^{-1} at 3 DAT,T_6: pretilachlor at 0.75 kg ha^{-1} at 3 DAT, T_7: metsulfuron-methyl + chlorimuron-ethyl (Almix) at 4 g ha^{-1} at 10 DAT, T_8: azimsulfuron at 35 g ha^{-1} at 20 DAT, T_9: metsulfuron-methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} at 15 DAT, T_{10}: bispyribac-Na at 25 g ha^{-1} at 20 DAT, T_{11}: hand weeding twice at 20 and 40 DAT and T_{12}: unweeded control

Table 3. Effect of treatments on growth attributes yield components, yield and herbicide efficiency index of transplanted rice

Treatments	Plant height (cm) at harvest	No. of tillers m^{-2} at 45 DAT	No. of panicles m^{-2}	No. of grains $panicle^{-1}$	Test weight (g)	Grain yield (kg ha^{-1})	Herbicide efficiency index (%)	
							30 DAT	60 DAT
T_1	82.1	239	237	139	18.1	3956	1.34	1.00
T_2	83.8	260	243	148	19.2	5151	12.31	14.52
T_3	79.0	247	241	147	19.0	4647	9.39	10.91
T_4	80.7	247	236	144	18.4	4733	11.34	12.16
T_5	78.7	203	202	140	18.3	4267	0.61	1.02
T_6	81.2	208	207	140	18.5	4502	1.57	3.04
T_7	79.2	209	207	140	17.2	4274	1.88	3.13
T_8	80.3	240	222	148	18.6	4865	3.94	9.51
T_9	79.6	249	236	149	19.1	4978	6.88	12.98
T_{10}	79.5	249	232	149	18.6	4659	3.58	5.81
T_{11}	84.8	264	252	150	19.4	5170	-	-
T_{12}	76.1	172	120	112	15.7	3089	0	0
LSD (P=0.5)	4.05	26.91	33.99	8.61	1.12	591	-	-

T_1: bensulfuron methyl 0.6%+ pretilachlor 6% at 30+300 g ha^{-1} at 3 DAT, T_2: bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} at 3 DAT, T_3: bensulfuron methyl 0.6%+ pretilachlor 6% at 90+900 g ha^{-1} at 3 DAT, T_4: bensulfuron methyl 0.6%+ pretilachlor 6% at 120+1200 g ha^{-1} at 3 DAT , T_5: pretilachlor at 0.50 kg ha^{-1} at 3 DAT,T_6: pretilachlor at 0.75 kg ha^{-1} at 3 DAT, T_7: metsulfuron-methyl + chlorimuron-ethyl (Almix) at 4 g ha^{-1} at 10 DAT, T_8: azimsulfuron at 35 g ha^{-1} at 20 DAT, T_9: metsulfuron-methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} at 15 DAT, T_{10}: bispyribac-Na at 25 g ha^{-1} at 20 DAT, T_{11}: hand weeding twice at 20 and 40 DAT and T_{12}: unweeded control

at 30 and 60 DAT. Weed control treatments brought about significant variation in the density of *Cynodon dactylon* and *Paspalum distichum* at both 30 and 60 DAT (Table 1). The lowest count and dry weight of *C. dactylon* and *P. distichum* were registered in hand weeding twice at 20 and 40 DAT. Among the herbicidal treatments application of bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} registered the lower number as well as the lowest dry weight of *C. dactylon* and *P. distichum*. However, it was statistically at par with all the higher doses of bensulfuron methyl + pretilachlor, pretilachlor alone at 0.75 kg ha^{-1}, metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1}. Bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} as well as higher doses effectively controlled *Ludwigia parviflora* at 30 and 60 DAT. No *Commelina nudiflora* was recorded in the treatments bensulfuron methyl 0.6%+pretilachlor 6% at 60+600 g ha^{-1}, and its higher doses and metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1}. A similar trend was observed in the case of dry weight of *L. parviflora and C. nudiflora* (Table 2). All the treatments were significantly superior to unweeded control in reducing the count and dry weight of *Fimbristylis miliacea* at 30 and 60 DAT. There was significant variation in the count of other weeds *(Echinocloa colona, Marselia quadrifolia, Alternanthera sessilis,*

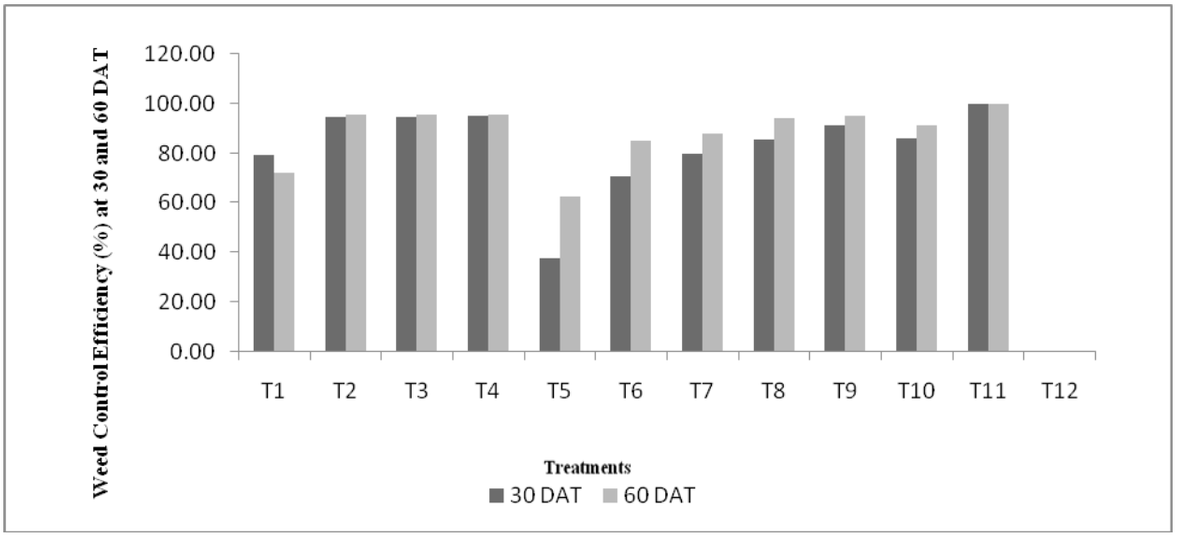

Figure 1. Effect of treatments on Weed Control Efficiency in transplanted rice at 30 and 60 DAT

Eclipta alba, *Aeschynomene aspera*). Bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} brought about a significant reduction in their count and dry weight at 30 and 60 DAT. Bensulfuron methyl + pretilachlor with higher doseregistered the lowest number and dry weight of total weeds. However, it was statistically at par with bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} and metsulfuron methyl + chlorimuron-ethyl (Almix)+azimsulfuron at 4+35 g ha^{-1}. Among the herbicidal treatments higher doses of bensulfuron methyl + pretilachlor registered the highest weed control efficiency at 30 and 60 DAT. But it was very close to bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} and metsulfuron methyl + chlorimuron-ethyl (Almix)+azimsulfuron at 4+35 g ha^{-1} (Figure 1). The results were in conformity with Partipan *et al.* 2013 and Sunil *et al.* 2010.

Effect on Crop

The plant height of rice varied significantly among the treatments. The highest plant height was recorded under the treatment with hand weeding at 20 and 40 DAT which was statistically at par with bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} and all other doses of bensulfuron methyl 0.6%+ pretilachlor 6% , azimsulfuron at 35 g $ha^{-1}$and metsulfuron methyl + chlorimuron-ethyl (Almix)+ azimsulfuron at 4+35 g ha^{-1} at 45 DAT. The number of tillers m^{-2} also varied significantly among the treatments at 45 DAT. Highest tiller number m^{-2} was recorded in the treatment with hand weeding at 20 and 40 DAT which was statistically at par with bensulfuron-methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1}, metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} and bispyribac-Na at 25 g ha^{-1}. The highest number of panicles $m^{-2}$and number of grains $panicle^{-1}$ were recorded in the treatment with hand weeding at 20 and 40 DAT which was statistically at par with bensulfuron-methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1}, metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} and bispyribac-Na at 25 g ha^{-1}. Effective and timely management of weeds facilitated the crop plants to have sufficient space, light, nutrient and moisture and thus the yield componenets like tillers m^{-2}, number of panicles m^{-2} and number of filled grains per panicle increased. There was about 40% yield reduction due to weed

competition in transplanted *kharif* rice. Similar result of reduction in yield of wet season rice in the lateritic belt of West Bengal was also reported by Duary *et al.* (2009), Mandal *et al*. (2013) and Hossain *et al.* (2010). Hand weeding twice at 20 and 40 DAT recorded the highest grain yield and it was statistically at par with bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1}, metsulfuron methyl + chlorimuron-ethyl (Almix)+ azimsulfuron at 4+35 g ha^{-1}, bispyribac-Na at 25 g ha^{-1} and azimsulfuron at 35 g ha^{-1} (Table 3). Higher grain yield in herbicide treated plots may be the resultant of efficient weed management by herbicide in those plots. Herbicide efficiency index, which expresses efficiency to eradicate the weeds, was the highest with the pre-emergence application of bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} followed by metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1}.

Conclusion

From the above findings, it can be stated that the bensulfuron methyl + pretilachlor can effectively manage different categories of weeds, especially of sedge and broad leaved weeds in transplanted rice field. Bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1} suppressed all the predominant weeds throughout crop growing season and recorded higher weed control efficiency, higher grain yield and high herbicide efficiency index. Thus, combined application of bensulfuron methyl 0.6%+ pretilachlor 6% at 60+600 g ha^{-1}at 3 DAT or metsulfuron methyl + chlorimuron-ethyl (Almix) + azimsulfuron at 4+35 g ha^{-1} at 15 DAT may be recommended for broad spectrum weed management and higher paddy yield of wet season rice in the lateritic belt of West Bengal.

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