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RESEARCH ARTICLE

Weed management efficacy of herbicides and their mixtures in transplanted rice

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ABSTRACT

An experiment was conducted at Research Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main campus at Chatha, Jammu, India during *Kharif* 2023 and 2024. The objective of this study was to evaluate the efficacy of a few herbicides and their mixtures in managing weeds and improve transplanted rice (*Oryza sativa* L.) productivity and economics. The higher number of rice effective tillers, dry matter accumulation, grain yield and straw yield were recorded with pre-emergence application (PE) of pyrazosulfuron-ethyl 15 g/ha followed by (*fb*) post-emergence application (PoE) of triafamone + ethoxysulfuron 66.5 g/ha which was statistically equivalent to pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE. Pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE and pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE have also recorded the lower weed density (48.68-77.36%), weed biomass (75.78-86.65%), weed index (85.61%), weed persistence index and higher weed control efficiency (75.78-86.66%); crop resistance index, higher net returns and benefit-cost ratio.

Keywords: Bispyribac-sodium, Herbicide, Pyrazosulfuron-ethyl, Transplanted rice, Triafamone + ethoxysulfuron, Weed management

INTRODUCTION

Rice is one of the most important staple foods in India and feeds nearly half of the world's population. India contributes approximately 26% of the total global rice production, with second rank amongst the leading producers in the world (USDA 2024). In India, rice is cultivated over an area of about 51.4 million hectares, with total production of 149.07 million tonnes and an average productivity of 2.93 t/ha during 2024-25 (Ministry of Agriculture and Farmers Welfare 2025). In rice cultivation, transplanting is one of the most common methods due to its better crop establishment and higher yield potential (Rao *et al.* 2017). Although transplanted rice generally experiences lower weed infestation as compared to direct-seeded rice but uncontrolled weeds can still cause the significant yield losses ranging from 25-47% in grain and 13-38% in straw yield (Salam 2022). In rice fields, 85% are grassy weeds, 7% were sedges and 8% were broad-leaved weeds. The critical period of crop-weed competition in transplanted rice was reported to be 35-40 days after transplanting (Ghandor *et al.* 2024). To control, different weed management methods are used in rice fields (Rao and Chandrasena 2024). The manual weeding is effective but not practical due to labor-intensive operations, unavailability of labor in time and high labor cost. The mechanical weeding is also less effective in puddled soil and for controlling intra-row weeds. To overcome these limitations, herbicides usage is widely adopted as they provide effective, timely and efficient diverse weed flora management with less labor (Rao *et al.* 2020). For effective weed control, factors such as herbicide selectivity, dose, timing and method of application are very important. The pre-emergence application (PE) of herbicides is generally done at 0-3 days after transplanting (DAS) and the post-emergence application (PoE) at 20-30 DAT. The response of both weeds and crop largely depend on the herbicide applied and the dose of herbicide. The application of lower dose of herbicides results in poor weed control, leading to higher weed competition, whereas higher dose may cause the phytotoxicity in rice crop and increase cost of cultivation (Jena *et al.* 2002). Therefore, it is important to evaluate the effect of herbicides on weed

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dynamics, crop growth and relative economics of rice to identify an optimum, effective and economically viable weed management option. Thus, this study was conducted to evaluate the efficacy of herbicides and their mixtures in managing weeds and improve transplanted rice (*Oryza sativa* L.) productivity and economics.

MATERIAL AND METHODS

The experiment was conducted at AICRP-Weed Management Research Farm, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main campus at Chatha, Jammu, India (320 - 40´ N, 740 -58´ E; with 332 m above mean sea level) during *Kharif* season of 2023 and 2024. The soil was sandy clay loam with pH 7.5 with low organic carbon (4.34 g/kg), available nitrogen (236.62 kg/ha), medium available phosphorus (14.35 kg/ha) and potassium (163.74 kg/ha). The rice variety *Basmati-370* was transplanted at spacing of 20 × 10 cm. The seed rate was 20 kg/ha with fertilizer application of NPK 30:20:10 kg/ha as per package and practices. The gross plot size was 28 m^2 (4m x 7m) and net plot size 19.2 m^2 (3.2m x 6m). The pre-emergence herbicide application was done at 2 DAT whereas post-emergence herbicide application was done at 25 DAT. The treatments consist of the 100% and 75% of recommended dose of herbicides (RDH). The experiment was laid in Randomized Block Design (RBD) with three replications and nine treatments: pyrazosulfuron-ethyl 15 g/ha PE, pyrazosulfuron-ethyl 11.25 g/ha PE, pyrazosulfuron-ethyl 15 g/ha PE followed by (*fb*) triafamone + ethoxysulfuron 66.5 g/ha PoE, pyrazosulfuron-ethyl 11.25 g/ha PE *fb* triafamone + ethoxysulfuron 49.87 g/ha PoE, pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE, pyrazosulfuron-ethyl 11.25 g/ha PE *fb* bispyribac-sodium 18.75 g/ha PoE, bispyribac-sodium 25 g/ha PoE, weed free, unweeded check.

The number of tillers and dry matter accumulation were recorded at different growth stages of crop, whereas the number of panicles, number of grains per panicle, grain yield, straw yield and harvest index were recorded at harvest. The data of weeds was recorded at 30 and 60 DAT. Weed density was recorded randomly from the four spots by placing the quadrat of 1m x 1m in each plot whereas the weed dry matter (weed biomass) was determined by uprooting the weeds with roots and cleaning the soil from the roots. Collected weeds were oven-dried at 60°C for 1.5-2 days. After complete oven drying, the weed biomass was recorded. The different weed indices were estimated *viz.* weed control efficiency (WCE) **(**Mishra and Mishra 1997), weed index (WI) (Raju 1998**),** relative weed density (RWD) **(**Mishra and Mishra 1997), Weed Persistence Index (WPI) and Crop Resistance Index (CRI).

$$\text{WCE (\%)} = \frac{\text{Weed biomass in control plot - Weed biomass in treated plot}}{\text{Weed biomass in control plot}} \times 100$$

$$\text{WI (\%)} = \frac{\text{Yield of weed free treatment - Yield of treatment plot}}{\text{Yield of weed free treatment}} \times 100$$

$$\text{RWD} = \frac{\text{Absolute density for individual weed species}}{\text{Total number of weed species}} \times 100$$

$$\text{WPI (\%)} = \frac{\text{Weed biomass in treated plot}}{\text{Weed biomass in control plot}} \times \frac{\text{Weed density in control plot}}{\text{Weed density in treated plot}}$$

$$\text{CRI (\%)} = \frac{\text{Dry weight of crop in treated plot}}{\text{Dry weight of crop in control plot}} \times \frac{\text{Dry weight of weeds in control plot}}{\text{Dry weight of weeds in treated plot}}$$

The statistical analysis of the data collected from the field was conducted as per the methodology of Gomez and Gomez (1984). The data recorded for two consecutive years was statistically analyzed and since the treatments effect were consistent across the years, the data were pooled and analyzed. In this a Least significant difference (LSD) of 5% level has been calculated for the various parameters for minimising the treatment and row effects. The results were then tested for measuring the treatments mean by applying the F-test on the basis of null hypothesis. Further, the square root transformation *ie.* $(\sqrt{x+1})$ was applied on weed density and weed biomass for statistical analysis.

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was infested with a mixed flora comprises of grasses, sedges and broad-leaved weeds. *Echinochloa colona, Dactlyloctenium aegyptium* and *Cyanodon dactylon* were the dominant grassy weeds, while *Cyperus rotundus* was the major sedge and *Caesulia axillaris* was the pre-dominant broad-leaved weed. The other weeds associated were

Eleusine indica, Physalis minima, Digitaria sanguinalis, Eclipta prostrata and Phyllanthus niruri etc. The relative weed density represents the proportion of individual weed species in the total weed population indicates the dominance and composition of weeds in the field. Among the different weed flora, the most dominant weed was *Cyperus rotundus* with relative density (33, 23%) among sedges followed by *Echinochloa colona* with relative density (18, 19%) among grasses at 30 and 60 DAT **(Figure 1)**. The main reason for the dominance of sedges was due to short life cycle, high production of seeds, dissemination to far areas, low water requirement, high light compensation points and easily adaptable to new climate.

The total weed density and weed biomass at 30 and 60 DAT were significantly lower with pyrazosulfuron-ethyl 15g/ha PE *fb* triafamone + ethoxysulfuron 66.5g/ha PoE which was statistically at par with pyrazosulfuron-ethyl 15g/ha PE *fb* bispyribac-sodium 25g/ha PoE and pyrazosulfuron-ethyl 15g/ha PE **(Table 1** and **2)**. The highest weed density and weed biomass was observed in weedy check plot. This was mainly due to the pre-emergence application of pyrazosulfuron-ethyl which was used to control grasses, sedges and broad-leaved weeds at early stages of weeds whereas triafamone + ethoxysulfuron and bispyribac-sodium managed weeds that emerged at the later stages of weeds due to its broad-spectrum activity of inhibiting weed germination and cell division (Menon *et al.* 2016).

Among different treatments, the higher weed control efficiency at 30 days and 60 DAT was recorded with pyrazosulfuron-ethyl 15g/ha PE *fb* triafamone + ethoxysulfuron 66.5g/ha PoE **(Table 2)**. This was mainly due to the fact that the herbicidal

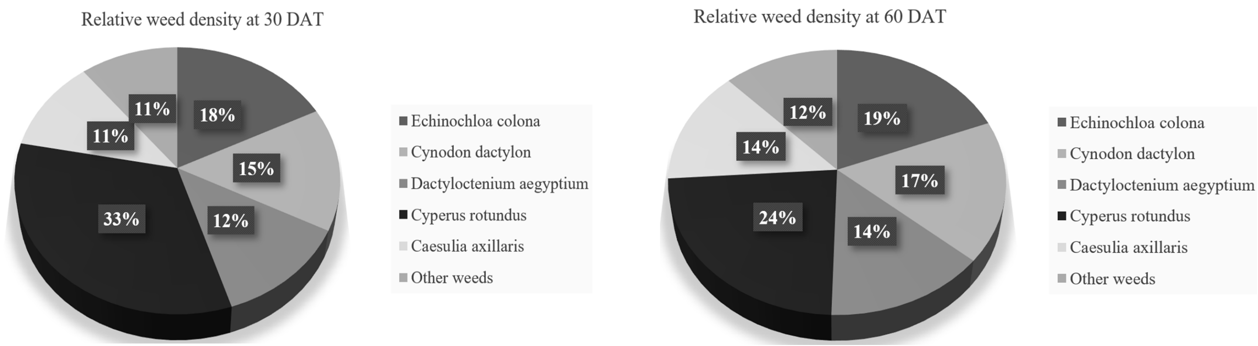

Figure 1. The relative density of weeds occurring in transplanted rice at 30 and 60 days after transplanting (pooled values for two years)

Table 1. Effect of different herbicides on density of individual weed species in transplanted rice (pooled values for two years)

Treatment	*Echinochloa colona*		*Cynodon dactylon*		*Dactyloctenium aegyptium*		*Cyperus rotundus*		*Caesulia axillaris*		Other weeds	
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT
Pyrazosulfuron-ethyl 15 g/ha PE	2.71 (6.33)	3.79 (13.33)	2.71 (6.33)	3.79 (13.33)	2.31 (4.33)	3.11 (8.66)	3.79 (13.33)	4.16 (16.33)	2.31 (4.33)	3.26 (9.66)	2.38 (4.66)	2.89 (7.33)
Pyrazosulfuron-ethyl 11.25 g/ha PE	3.51 (11.33)	4.12 (16.00)	3.05 (8.33)	4.28 (17.33)	2.83 (7.00)	3.65 (12.33)	4.36 (18.00)	4.58 (20.00)	2.89 (7.33)	3.78 (13.33)	2.64 (6.00)	3.37 (10.33)
Pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE	2.64 (6.00)	2.38 (4.66)	2.51 (5.33)	2.31 (4.33)	2.38 (4.66)	2.23 (4.00)	3.83 (13.66)	2.64 (6.00)	2.23 (4.00)	2.08 (3.33)	2.31 (4.33)	2.16 (3.66)
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* triafamone + ethoxysulfuron 49.87 g/ha PoE	3.46 (11.00)	3.41 (10.66)	3.11 (8.66)	2.89 (7.33)	3.05 (8.33)	2.71 (6.33)	4.43 (18.66)	3.51 (11.33)	2.83 (7.00)	2.71 (6.33)	2.71 (6.33)	2.64 (6.00)
Pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE	2.77 (6.66)	2.64 (6.00)	2.64 (6.00)	2.38 (4.66)	2.45 (5.00)	2.31 (4.33)	3.87 (14.00)	2.77 (6.66)	2.31 (4.33)	2.23 (4.00)	2.45 (5.00)	2.31 (4.33)
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* bispyribac-sodium 18.75 g/ha PoE	3.51 (11.33)	3.46 (11.00)	3.21 (9.33)	2.94 (7.66)	3.05 (8.33)	2.77 (6.66)	4.47 (19.00)	3.51 (11.33)	2.89 (7.33)	2.77 (6.66)	2.77 (6.66)	2.71 (6.33)
Bispyribac-sodium 25 g/ha PoE	3.65 (12.33)	3.32 (10.00)	3.41 (10.66)	2.77 (6.66)	3.11 (8.66)	2.64 (6.00)	5.03 (24.33)	3.46 (11.00)	2.94 (7.66)	2.89 (7.33)	2.83 (7.00)	2.64 (6.00)
Weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
Unweeded check	3.74 (13.00)	4.40 (18.33)	3.51 (11.33)	4.62 (20.33)	3.21 (9.33)	4.47 (19.00)	5.10 (25.00)	5.42 (28.33)	3.00 (8.00)	4.04 (15.33)	2.89 (7.33)	3.79 (13.33)
LSD (p= 0.05)	0.44	0.47	0.40	0.46	0.38	0.31	0.47	0.54	0.42	0.45	0.20	0.36

The data were subjected to $(\sqrt{x+1})$ transformation; Figures in the parenthesis are original values; PE- pre-emergence application; PoE- post-emergence application; *fb*- followed by; DAT- days after transplanting treatment helped in better suppression of weeds, reducing the crop weed competition allowing better crop growth.

The weed index is an essential parameter for indicating percentage of yield loss due to crop weed competition. Among all treatments, the lowest yield loss was recorded with pyrazosulfuron-ethyl 15g/ha PE *fb* triafamone + ethoxysulfuron 66.5g/ha PoE with weed index (4.55 %) **(Table 2)**. This was due to the better effectiveness of herbicides in weed management which leads to efficient resource use by crops and attain maximum production (Bandyopadhyay *et al.* 2024). The weed persistence index (WPI) indicates the tolerance of weeds against the different herbicidal treatments. The lower value of WPI indicates better weed control and less tolerance against herbicides. Among different treatments, the lower value of WPI at 30 and 60 DAT (0.47, 0.59%) was recorded with pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE which was statistically at par with pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE **(Table 2)**. The lower value of WPI indicates the better efficacy and effectiveness of herbicides which result in lower weed density and reduce crop weed competition (Bandyopadhyay *et al.* 2024).

The crop resistance index (CRI) represents the resistance shown by the crop against a particular dose of herbicides. The higher value of CRI shows the better resistance shown by the crop and remain unaffected by application of herbicides. In different treatments, the higher CRI value at 30 and 60 DAT (4.57, 11.31%) recorded with pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE which was statistically at par with pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE **(Table 2)**. The higher value of CRI resulted in direct development of resistance against a particular dose of herbicides. Also, it reduces the weed growth and boosts the crop production (Prasath and Ramesh 2015).

Effect on rice

Different herbicides did not show any significant effect on crop growth at 30 DAT. However, at 60 and 90 DAT, the higher number of tillers and dry matter accumulation was recorded with pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE which was statistically at par with pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE **(Table 3)**. The application of high dose of herbicide caused mild leaf scorching which were disappeared after irrigation. This was mainly due to the reduced crop-weed competition by which there was decrease weed counts and weed dry matter by which help in better uptake of light, nutrients and water which ultimately improve the growth of crop (Choudhary and Dixit 2024).

A negative linear relationship was observed between weed persistence index (WPI) and crop dry matter with coefficient of determination R^2= 0.70.

Table 2. Effect of different herbicides on weed dynamics in transplanted rice (pooled values for two years)

Treatment	Total weed density (no. /m^2)		Weed biomass (g/m^2)		Weed control efficiency (%)		Weed persistence index (%)		Crop resistance index (%)		Weed index (%)
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	At harvest
Pyrazosulfuron-ethyl 15 g/ha PE	6.35 (39.31)	8.35 (68.64)	3.25 (9.55)	8.21 (66.37)	74.24	48.22	0.48	0.86	4.25	2.20	21.80
Pyrazosulfuron-ethyl 11.25 g/ha PE	7.68 (57.96)	9.50 (89.29)	3.96 (14.67)	9.55 (90.29)	60.44	29.55	0.50	0.90	2.71	1.60	24.64
Pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE	6.24 (37.95)	5.19 (25.95)	3.16 (8.98)	4.25 (17.10)	75.78	86.66	0.47	0.59	4.57	11.31	4.55
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* triafamone + ethoxysulfuron 49.87 g/ha PoE	7.81 (59.96)	7.00 (47.97)	4.05 (15.42)	6.22 (37.72)	58.41	70.57	0.51	0.70	2.58	4.16	18.41
Pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE	6.48 (40.95)	5.56 (29.96)	3.32 (10.01)	4.61 (20.24)	73.00	84.21	0.49	0.60	4.06	9.24	7.13
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* bispyribac-sodium 18.75 g/ha PoE	7.94 (61.97)	7.12 (49.63)	4.08 (15.63)	6.42 (40.20)	57.85	68.64	0.50	0.72	2.52	3.86	18.09
Bispyribac-sodium 25 g/ha PoE	8.46 (70.63)	6.92 (46.95)	5.85 (33.19)	6.17 (37.09)	10.49	71.06	0.94	0.71	1.14	4.42	17.12
Weed free	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	100.00	100.00	0.00	0.00	-	-	-
Unweeded check	8.66 (73.96)	10.75 (114.64)	6.17 (37.08)	11.37 (128.17)	0.00	0.00	1.00	1.00	1.00	1.00	31.63
LSD (p= 0.05)	1.01	1.20	0.43	0.55	-	-	0.49	0.93	2.92	1.61	-

The data were subjected to $(\sqrt{x+1})$ transformation; Figures in the parenthesis are original values; PE- pre-emergence application; PoE- post-emergence application; *fb*- followed by; DAT- days after transplanting

This indicates that with the increase in crop dry matter resulted in decrease in WPI. The higher value of R^2 indicates the higher variation in WPI by changes in crop dry matter **(Figure 2a)**. This shows the different treatments were performed better in crop growth, decrease persistence of weeds and improving crop-weed competition.

Similarly, the crop dry matter also has shown a negative linear relationship with weed biomass (R^2 = 0.83). The negative trend indicates the increase in weed biomass reduces the crop dry matter due to competition for growth resources. The high R^2 value indicates a strong association between these two variables, showing that weed biomass significantly influenced by the crop dry matter production **(Figure 2b)**. This result clearly showed that the effective weed management that lowers weed biomass is essential for enhancing crop growth and production.

The rice yield parameters were significantly affected by herbicidal treatments. The highest number of panicles, grains per panicle, grain yield and straw yield were recorded with pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE which was statistically at par with pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE **(Table 4)**. This was mainly achieved by the effective weed suppression with herbicidal treatments which leads to better sunlight, water and nutrient uptake by the crop (Prasath and Ramesh 2015).

Economics

The first stage of adopting any technology, method and suggestion is mostly determined by its input cost and profit. In this aspect, the net returns and benefit-cost ratio were the main parameters in economic viability. Among different treatments, pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE recorded highest net returns and benefit-cost ratio (1.97) **(Table 5)**. This was due to better weed control which led to higher production of grain and straw yield with lesser cost (Singh *et al.* 2021)

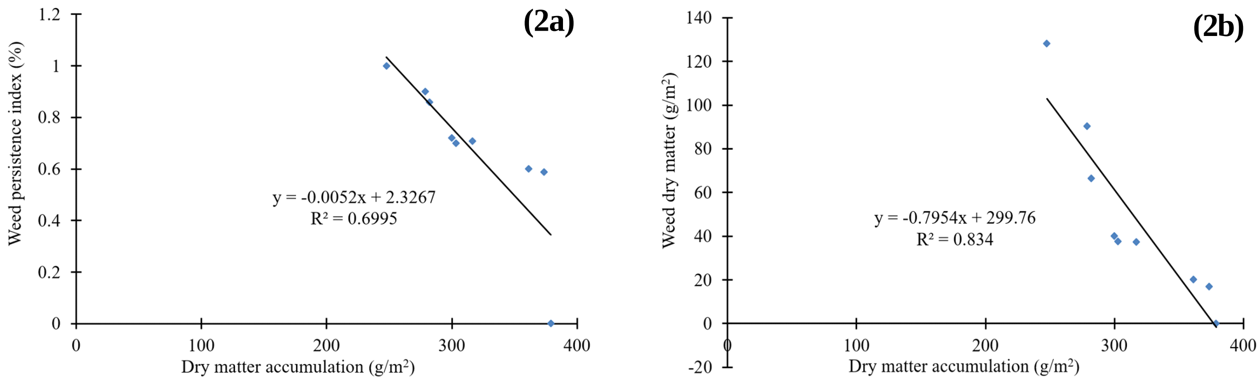

Figure 2. The relationship between crop dry matter and weed persistence index (a), crop dry matter and weed dry matter at 60 DAT(b)

Table 3. Effect of different herbicides on transplanted rice growth parameters (pooled values for two years)

Treatment*	Effective tillers (no. /m^2)				Dry matter accumulation (g/m^2)			
	30 DAT	60 DAT	90 DAT	At harvest	30 DAT	60 DAT	90 DAT	At harvest
Pyrazosulfuron-ethyl 15 g/ha PE	135.0	208.3	205.3	203.7	164.6	282.4	497.3	635.3
Pyrazosulfuron-ethyl 11.25 g/ha PE	132.0	206.3	202.7	198.0	161.6	278.7	487.9	610.2
Pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE	135.3	252.7	250.3	248.3	166.7	373.5	643.9	775.4
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* triafamone + ethoxysulfuron 49.87 g/ha PoE	132.7	220.0	217.3	215.0	161.3	303.0	524.3	676.0
Pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE	134.3	250.3	248.6	245.3	164.9	361.2	625.0	763.8
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* bispyribac-sodium 18.75 g/ha PoE	131.0	217.3	215.3	212.7	159.7	300.0	505.2	656.4
Bispyribac-sodium 25 g/ha PoE	126.0	224.0	225.7	220.3	153.5	316.7	570.9	693.3
Weed free	136.3	255.7	253.7	250.3	168.6	378.9	682.7	795.1
Unweeded check	123.3	185.0	183.7	181.7	150.5	247.5	397.0	563.9
LSD (p= 0.05)	NS	24.81	22.3	21.7	NS	34.15	48.6	63.4

*PE- pre-emergence application; PoE- post-emergence application; *fb*- followed by; DAT- days after transplanting

Table 4. Effect of different herbicides on transplanted rice yield attributes and yield (pooled values for two years)

Treatment	Panicles/ m^2	Grains /panicle	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Pyrazosulfuron-ethyl 15 g/ha PE	200.67	64.00	2.42	4.30	36.05
Pyrazosulfuron-ethyl 11.25 g/ha PE	198.00	61.67	2.34	4.13	36.13
Pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE	246.00	73.00	2.96	5.57	34.70
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* triafamone + ethoxysulfuron 49.87 g/ha PoE	213.67	65.00	2.53	4.65	35.26
Pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE	243.67	71.67	2.88	5.38	34.89
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* bispyribac-sodium 18.75 g/ha PoE	209.33	64.67	2.54	4.64	35.38
Bispyribac-sodium 25 g/ha PoE	216.67	65.33	2.57	4.88	34.52
Weed free	246.34	74.00	3.10	5.71	35.21
Unweeded check	179.67	59.67	2.12	3.83	35.61
LSD (p= 0.05)	24.71	6.13	0.303	0.496	NS

*PE- pre-emergence application; PoE- post-emergence application; *fb*- followed by

Table 5. Effect of different herbicides on relative economics in transplanted rice (pooled values for two years)

Treatment	Cost of cultivation ($x10^3$ ₹/ha)	Gross returns ($x10^3$ ₹/ha)	Net returns ($x10^3$ ₹/ha)	B:C ratio
Pyrazosulfuron-ethyl 15 g/ha PE	50.43	125.12	74.69	1.48
Pyrazosulfuron-ethyl 11.25 g/ha PE	49.37	120.56	71.18	1.44
Pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE	51.62	153.37	101.75	1.97
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* triafamone + ethoxysulfuron 49.87 g/ha PoE	51.25	130.86	79.61	1.55
Pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE	51.46	149.13	97.68	1.90
Pyrazosulfuron-ethyl 11.25 g/ha PE *fb* bispyribac-sodium 18.75 g/ha PoE	51.02	131.33	80.31	1.57
Bispyribac-sodium 25 g/ha PoE	49.93	133.24	83.31	1.67
Weed free	65.88	160.41	94.54	1.44
Unweeded check	48.23	109.53	61.31	1.27

PE- pre-emergence application; PoE- post-emergence application; *fb*- followed by

It can be concluded that higher weed control efficiency with highest rice grain yield, net returns and benefit-cost ratio can be obtained with pyrazosulfuron-ethyl 15 g/ha PE *fb* triafamone + ethoxysulfuron 66.5 g/ha PoE and pyrazosulfuron-ethyl 15 g/ha PE *fb* bispyribac-sodium 25 g/ha PoE.

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