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Efficacy and Selectivity of Different Herbicides on the Transplanted Late *Boro* Rice under the Lateritic Soil of West Bengal

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ABSTRACT

A field experiment was conducted during the late *boro* seasons (January–May) of 2018 and 2019 to assess the impact of herbicides on rice growth, yield and weed control in transplanted rice in the Agricultural Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati University, Sriniketan, West Bengal, India. There were eight different treatments consisting of pretilachlor 50 EC @ 500 g ha^{-1} at 3 DAT, pyrazosulfuron ethyl 10 WP @ 30 g ha^{-1} at 3 DAT, ethoxysulfuron 15 WDG @ 15 g ha^{-1} at 10 DAT, penoxsulam 21.7 SC @ 22.5 g ha^{-1} at 12 DAT, bispyribac-sodium 10 SC @ 25 g ha^{-1} at 15 DAT, hand weeding at 20 and 40 DAT, weed-free check and weedy check. Results from the pooled analysis of both the years revealed that pyrazosulfuron ethyl 30 g ha^{-1} and pretilachlor at 500 g ha^{-1} resulted in lower weed population and dry weight; higher plant height, number of tillers m^{-2}, dry matter accumulation, leaf area index; grain and straw yield (5.98 and 7.81 t ha^{-1} and 5.81 and 7.62 t ha^{-1} respectively). The lowest weed index was registered by pyrazosulfuron ethyl 30 g ha^{-1} and pretilachlor at 500 g ha^{-1} and was superior to all other herbicidal treatments. Yield loss due to weeds infestation throughout the crop season was to the extent of 54.33%. Thus, pyrazosulfuron ethyl 30 g ha^{-1} and pretilachlor at 500 g ha^{-1} as pre-emergence may be recommended for effective weed control in transplanted late *boro* rice.

KEYWORDS: Late *boro* rice, pretilachlor, pyrazosulfuron ethyl, weed management

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1. INTRODUCTION

More over half of the human race relies on rice as their primary source of food, making it the leading cereal in the world. Millions of rural households depend on it for their livelihood, and it is essential to our country's food security. With a high biological value of protein, it is a high-energy food. It provides over two-thirds of the food needs for one-third of the world's population. The agriculture sector in India, the second-largest rice producer in the world, is of the utmost significance. In terms of acreage, production, and economic significance, food grains come in first, followed by oilseeds. With a contribution of around 10.24% to the global grain pool, India ranks third in the world behind China and the United States (Anonymous, 2018). India is second to China in the overall global output of rice, making it one of the major producers. The total production of rice in India in the year 2021–2022 is 129.47 mt and in the third advance estimation for the year 2022–2023, 135.54 mt of rice are expected to be produced overall, with 9.61 mt of that amount produced during the growing season (Anonymous, 2022). More than 60% of the population in India is still dependent on rice, however due to low productivity; rice cannot ensure food and nutritional security for that population (Ram et al., 2014). In addition to poor crop management, various abiotic and biotic factors, and weeds, poor weed control is a major cause of decreased rice output (Jabran et al., 2019). One of the major factors in the loss of desired yield in rice production is problems caused by troublesome weed species (Ganie et al., 2015). In India, weed-related losses are thought to be about 4420 million USD annually, according to Gharde et al. (2018). In large portions of eastern India's rice-growing regions, weeds pose a serious threat to rice production. Without carefully thought-out weed management measures, it is nearly difficult to produce rice profitably. According to Arthanarie et al. (2017), transplanted rice is plagued with a wide variety of weed species, including grasses, sedges, and broad-leaved weeds. Weeds are a good rival for rice in terms of all the key variables that affect potential yield, including moisture, nutrients, light, temperature, and space. Uncontrolled weeds have been shown to reduce rice output by 28 to 45% when transplanted (Manhas et al., 2012). In the region of tropical Asia, yield losses owing to weeds in lowland rice ranges from 10% to 20% (Savary et al., 2012). According to Sharma et al. (2016), the losses in yield caused by weeds in key field crops ranged between 28.2 and 83.5% over weedy check and between 12.8 and 42.7% over farmer's practice. In the opinion of Veeraputhiran and Balasubramanian (2013), uncontrolled weed development in rice transplants can reduce production by 45–51%. In the rice fields, weeds proliferate in large numbers and significantly lower crop production (Sureshkumar et al., 2016). Pre-emergence herbicide, post-emergence herbicide, a combination of both, or hand weeding are all effective weed control methods. One of these techniques for controlling weeds in rice transplants is hand weeding. However, the rising expense of labourers and a lack of workers during the busiest time of agricultural production prompted the search for substitute techniques. This limitation compels the farming community to seek out a new, workable solution. Chemical weed control was the most practical and cost-efficient strategy among the alternatives (Sureshkumar and Durairaj, 2016; Wang et al., 2018; Pinjari et al., 2019). Many scientists have stated in their research that application of new, highly effective herbicides that offer broad-spectrum weed control would be desired for weed control in rice (Arthanari et al., 2017). In the studies conducted by Rani et al. (2021), findings on weed dry matter studies in plots treated with herbicides, the low revival frequency and growth of weeds may be the cause of the greater representation of yield attributes by crop. Effective weed management techniques boost grain production. Therefore, an experiment was carried out to evaluate the efficacy of various herbicides on weed parameters, plant growth and yield of late *boro* rice.

2. MATERIALS AND METHODS

The experiment was carried out during late *boro* seasons (January–May) 2018 and 2019 at the Agricultural Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal, India (20°39′N, and 87°42′E, 58.9 m above mean sea level). The experimental station lies within typical semi-arid tropical climate. . The total rainfall received during the experimental period was 19.2 and 42.27 mm respectively in both the years. The textural soil class of the experimental site was sandy loam having good internal drainage. The experimental soil contains 0.36% organic carbon (Walkley and Black, 1934), 291.44 kg ha^{-1} alkaline permanganate oxidizable nitrogen (N) (Subbiah and Asija, 1956), 22.3 kg ha^{-1} available phosphorus (P) (Bray and Kurtz, 1945) and 141.34 kg ha^{-1} 1 N ammonium acetate exchangeable potassium (K) (Hanway and Heidel, 1952). The pH of the soil was 5.79 (1:2.5 soil: water ratio) (Prasad et al., 2006). The treatments were replicated thrice in randomized complete block design keeping individual net plot size of 5×4 m^2 indiscriminately on the same unit of cultivation. 'MTU 1010' rice variety was used as a test crop. The crop was transplanted on 17th February, 2018 during first year and 14th February, 2019 during the second year. The crop was planted at row-to-row spacing of 20 cm and plant-to-plant spacing of 10 cm. The crop was subjected to 120:60:60 kg N, P_2O_5 and K_2O per ha, P_2O_5 was supplied at basal and N was applied with three splits (25% basal, 50% at tillering, and 25% at panicle initiation). Three fourth dose of K_2O were applied as basal dose before transplanting and one fourth of K_2O were applied as top dressing at panicle initiation stage. Total eight treatments comprised of pretilachlor 50 EC (500 g ha^{-1}), pyrazosulfuron ethyl 10 WP (30 g ha^{-1}), ethoxysulfuron 15 WDG (15 g ha^{-1}), penoxsulam 21.7 SC (22.7 g ha^{-1}), bispyribac-sodium 10 SC (25 g ha^{-1}), hand weeding at 20 and 40 DAT, weed-free check and weedy check. Herbicides applied to the experimental plot as per treatment with battery operated knap-sack sprayer fitted with flat-fan nozzle and using spray volume of 500 l ha^{-1}. Data on density and dry matter of weeds were recorded at with the help of 0.25 m^2 quadrate selected randomly in each plot and pooled data of both years was computed. After identifying, the weed species were grouped into grassy, broadleaved and sedge separately and individual species of weed was counted. All weed samples were oven dried at a temperature of 70°C until constant weight. The different weed indices were calculated using the standard procedure.

2.1. Weed index (WI)

According to Gill and Kumar (1969), Weed index measures the percentage of yield from crops lost because of weeds in a given treatment as compared to weed-free plots. This is done in order to evaluate how effective an herbicide is. The effectiveness of an herbicide is assessed by a lower weed index. It is determined with the following formula and expressed in percentage:

WI (%)={(Crop yield from weed free plot-Crop yield from treated plot)/Crop yield from weed free plot}×100

Where, WI=Weed index. Crop was harvested at physiological maturity and data on yield attributes and yield were recorded.

2.2. Statistical analysis

Prior to statistical analysis, the combined data from both years on the dry weight of the data and the density of weeds were transformed using the square root (√x+0.5) to increase the homogeneity of the variance (ANOVA) independently for each year. The F-test was conducted following the instructions provided by Gomez and Gomez (1984). To assess the significance of differences between treatment means, LSD values at p=0.05 were utilized. SPSS software was used for the data analysis. The 'F' test at the 5% level of significance was used to determine whether a treatment effect was significant.

3. RESULTS AND DISCUSSION

3.1. Weed flora

The major weed flora infesting the experimental field were grasses like *Echinochloa crusgalli*, *Panicum repens* and *Digitaria sanguinalis* (L.); *Cyperus iria*, and *Cyperus difformis* (L.) among the sedges and broad-leaved weeds like *Ludwigia parviflora* Roxb., *Marsilea quadrifolia* and *Alternanthera philoxeroides* at the initial stages before application of the herbicide during both the years of experiment. Nazir et al. (2020) also concluded *Echinochloa crusgalli, Echinochloa colona*, and *Cynodon dactylon* were the most prevalent grassland weeds, whereas *Cyperus iria, Cyperus difformis* and *Fimbristylis miliacea* were notable sedges in the experimentation. According to Patra et al. (2011), 27.2% grasses, 36.8% sedges, and 36% broad leaf weeds infested rice.

3.2. Effect on density and dry weight of weeds

Results exhibited significant differences among the herbicidal treatments for the weed density of grass, sedge and broad-leaf species at periodical observation (Table 1). The weedy plot recorded highest density of all the weeds and consequently dry weight and it was significantly higher than other treatments. Based on pooed data, it was observed that weed-free treatment recorded significantly lower weed density of grasses, sedges and broad-leaved weeds over other herbicidal treatments at 45 and 60 DAT. Similarly, all herbicides considerably reduced the dry weight of grassy weeds, sedges and broad-leaf weeds at both 45 and 60 DAT in comparison to the weedy check (Table 1). Over other herbicidal treatments, hand weeding and weed-free treatments reported much lower weed dry matter accumulation. All of the aforementioned weeds recorded the maximum dry matter in the untreated weedy plot, which was also significantly greater than the treatments. Among the herbicidal treatments, whereas pretilachlor 50 EC at 500 g ha^{-1} as pre-emergence reduced grass density and dry weight *fb* Pyrazosulfuron ethyl 10 WP at 30 g ha^{-1} as pre-emergence. Mohapatra et al. (2017) in a study undertaken at Regional Research and Technology Transfer Station, Orissa University of Agriculture and Technology, Chiplima, Sambalpur, also concluded the sole application of pretilachlor was the best in controlling grasses. Bhat et al. (2017) also recorded lower grass density with application of pretilachlor and pyrazosulfuron. Among the herbicidal treatments, pyrazosulfuron ethyl 10 WP at 30 g ha^{-1} as pre-emergence recorded lower sedges density and dry weight at 45 DAT significantly followed by ethoxysulfuron 15 WDG at 15 g ha^{-1} whereas pretilachlor 50 EC at 500 g ha^{-1} as pre-emergence and penoxsulam 21.7 SC at 22.5 g ha^{-1} as post emergence recorded lowest density of sedges and dry weight at 60 DAT and was also significantly followed by ethoxysulfuron 15 WDG at 15 g ha^{-1}. Suryakala et al. (2019) concluded that pretilachlor inhibited the growth of grassy weeds, while pyrazosulfuron ethyl controlled sedges and weeds with broad leaves. Ethoxysulfuron 15 WDG at 15 g ha^{-1} as early post emergence recorded lowest density and dry weight of broad- leaved fb Pyrazosulfuron ethyl 10 WP at 30 g ha^{-1} as pre-emergence at 45 and at 60 DAT Pyrazosulfuron ethyl 10 WP at 30 g ha^{-1} as pre-emergence recorded lowest

Table 1: Effect of weed management treatments on density and dry weight of grasses, sedges and broad-leaved weeds at 45 and 60 DAT in transplanted rice

Treatments	Grasses				Sedges			
	45 DAT		60 DAT		45 DAT		60 DAT	
	Density (No. m^{-2})	Dry weight (g m^{-2})	Density (No. m^{-2})	Dry weight (g m^{-2})	Density (No. m^{-2})	Dry weight (g m^{-2})	Density (No. m^{-2})	Dry weight (g m^{-2})
Pretilachlor 50 EC (500 g ha^{-1}) at 3 DAT	4.82 (22.75)	5.11 (25.63)	6.68 (44.17)	6.47 (41.31)	2.14 (4.08)	1.23 (1.02)	0.71 (0.00)	0.71 (0.00)
Pyrazosulfuron ethyl 10 WP (30 g ha^{-1}) at 3 DAT	6.15 (37.32)	6.67 (44)	10.52 (110.15)	12.15 (147.02)	0.71 (0.00)	0.71 (0.00)	2.59 (6.22)	1.27 (1.1)
Ethoxysulfuron 15 WDG (15 g ha^{-1}) at 10 DAT	8.64 (74.15)	11.94 (142.12)	15.02 (225.15)	22.33 (498.12)	0.97 (0.43)	0.79 (0.13)	1.17 (0.88)	0.77 (0.1)
Penoxsulam 21.7 SC (22.5 g ha^{-1}) at 12 DAT	8.37 (69.61)	8.08 (64.76)	10.31 (105.75)	10.51 (109.99)	1.03 (0.55)	0.89 (0.30)	0.71 (0.00)	0.71 (0.00)
Bispyribac-sodium 10 SC (25 g ha^{-1}) at 15 DAT	9.04 (81.28)	11.13 (123.32)	16.46 (270.57)	23.51 (551.99)	16.94 (286.63)	9.24 (84.87)	13.77 (189.22)	7.82 (60.65)
HW at 20 and 40 DAT	6.37 (40.04)	3.63 (12.67)	8.61 (73.58)	9.08 (81.86)	6.46 (41.29)	2.4 (5.27)	1.24 (1.04)	0.84 (0.2)
Weed-free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Weedy check	15.14 (228.59)	18.61 (345.71)	20.67 (426.64)	28.89 (834.17)	43.78 (1916.41)	22.07 (486.53)	29.4 (863.97)	15.57 (241.85)
SEm±	0.73	0.85	0.62	0.91	0.49	0.38	0.64	0.32
LSD (p=0.05)	2.12	2.47	1.81	2.63	1.41	1.11	1.86	0.93

Table 1: Continue...

Treatments	Broad-leaved weeds			
	45 DAT		60 DAT	
	Density (No. m^{-2})	Dry weight (g m^{-2})	Density (No. m^{-2})	Dry weight (g m^{-2})
Pretilachlor 50 EC (500 g ha^{-1}) at 3 DAT	10.51 (109.91)	4.47 (19.51)	10.63 (112.44)	4.97 (24.19)
Pyrazosulfuron ethyl 10 WP (30 g ha^{-1}) at 3 DAT	4.95 (23.99)	1.63 (2.15)	0.9 (0.31)	0.9 (0.31)
Ethoxysulfuron 15 WDG (15 g ha^{-1}) at 10 DAT	4.05 (15.9)	1.45 (1.6)	1.05 (0.6)	0.99 (0.47)
Penoxsulam 21.7 SC (22.5 g ha^{-1}) at 12 DAT	5.9 (34.27)	2.87 (7.71)	5.8 (33.13)	2.89 (7.87)
Bispyribac-sodium 10 SC (25 g ha^{-1}) at 15 DAT	7.67 (58.27)	3.48 (11.6)	7.45 (55.04)	3.03 (8.7)
HW at 20 and 40 DAT	5.59 (30.77)	2.31 (4.85)	5.69 (31.91)	2.77 (7.18)
Weed-free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
Weedy check	13.67 (186.33)	9.12 (82.59)	13.11 (171.3)	9.92 (97.85)
SEm±	0.54	0.33	0.58	0.29
LSD (p=0.05)	1.56	0.94	1.69	0.84

*LSD- least significant difference at the 5% level of significance; DAT: Days after transplanting; HW: Hand weeding; Values in parentheses are original. Data were transformed to square root transformation ($\sqrt{(x+0.5)}$) for analysis

broad- leaved density and dry weight. Pre-emergence herbicide was better positioned on the supplied inter-row space, and was more effective in suppressing emerging weeds, which led to the early suppression of weeds. Because pretilachlor has a half-life of 15.06 days and pyrazosulfuron ethyl had a half-life of 24.75 days, the persistence of pretilachlor and pyrazosulfuron ethyl herbicides might have a substantial role in the control of weeds (Nagwanshi et al., 2016). This might have also a long-lasting weed-controlling effect on weed seeds that were germinating, exhausting weed seed stores in the soil (Reddy et al., 2000). In case of broadleaved weeds, the treatment Ethoxysulfuron at 15 g ha^{-1} showed lower population of which might occur owing to the greater efficacy of ethoxysulfuron against broadleaved weeds reported by Saha et al. (2003). The use of sulfonylurea herbicides in dry-seeded rice was found to significantly reduce weed dry weight by Chauhan et al. (2015) as reported from the Philippines.

3.3. Effect on crop growth parameters

The pooled data observations on plant biometric parameters such as plant height at harvest, tillers m^{-2} at 60 DAT; total dry matter accumulation (g m^{-2}) and leaf area index at 90 DAT were significantly ($p<0.05$) influenced by weed control treatments (Table 2). Significantly higher plant height, tillers m^{-2}, total dry matter accumulation (g m^{-2}) and leaf area index over the unweeded weedy plot was recorded by herbicidal treatments. The weed-free check recorded highest plant growth parameters over all other treatments. This may be attributable to less weed crop competition throughout the crop growth period, which would in turn maintain soil fertility by preventing weeds from removing as many plant nutrients, and ultimately have a positive impact on growth parameters and yield attributes as in conformity with Patra et al. (2011). Among the herbicidal treatments, the highest plant height was recorded by pretilachlor 50 EC at 500 g ha^{-1} closely followed by ethoxysulfuron 15 WDG at 15 g ha^{-1} and pyrazosulfuron ethyl 10 WP at 30 g ha^{-1}. Among all the treatments, weedy check recorded the lowest plant height. In weedy check, continuous weed growth led to the highest crop-weed competition for growth resources from the start, resulting in the shortest rice plants possible. In contrast, the plant height was at its maximum in the weed-free plot because there was no crop-weed competition throughout the crop's growth. In addition, frequent weeding promoted soil aeration and the release of toxic gases, which aided in the growth of the rice crop. The better effect of pretilachlor and pyrazosulfuron ethyl might be due to the better efficacy of both the herbicides against rice weeds that minimized the competition between weeds and rice plants for growth resources as reported by Akabar and Ali (2011). The highest tillers m^{-2} at 60 DAT was obtained in weed-free check closely followed by two-hand weeding at 20 and 40 DAT, pyrazosulfuron ethyl 10 WP at 30 g ha^{-1}, pretilachlor 50 EC at 500 g ha^{-1} and ethoxysulfuron 15 WDG at 15 g ha^{-1}. Two-hand weedings resulted in the lowest weed population and greater dry matter and ultimately yield at 30 and 60 DAS, according to Bera et al. (2016) observation, which was statistically similar with mechanical weeding using Japanese paddy weeders. Although application of

Table 2: Effect of weed management treatments on plant growth parameters, grain yield, straw yield and weed index of transplanted rice

Treatments	Plant height (cm) (At harvest)	Tillers (No. m^{-2}) (60 DAT)	Dry matter accumulation (g m^{-2}) (90 DAT)	Leaf Area index (90 DAT)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Weed index (%)
Pretilachlor 50 EC (500 g ha^{-1}) at 3 DAT	101.25	265.88	1052.55	4.02	5.81	7.62	8.03
Pyrazosulfuron ethyl 10 WP (30 g ha^{-1}) at 3 DAT	98.97	270.05	1089.37	3.78	5.98	7.81	5.34
Ethoxysulfuron 15 WDG (15 g ha^{-1}) at 10 DAT	99.32	252.12	823.05	2.36	4.38	7.07	29.63
Penoxsulam 21.7 SC (22.5 g ha^{-1}) at 12 DAT	94.17	242.82	832.91	2.99	4.55	6.96	27.95
Bispyribac-sodium 10 SC (25 g ha^{-1}) at 15 DAT	97.88	239.27	737.82	2.72	3.52	5.20	44.23
HW at 20 and 40 DAT	100.03	264.85	1029.97	3.90	6.06	7.46	3.79
Weed-free check	101.63	275.93	1151.48	4.22	6.35	7.47	0.00
Weedy check	88.82	155.87	585.51	2.25	2.90	4.90	54.12
SEm±	1.70	8.24	71.30	0.27	0.44	0.44	-
LSD (p=0.05)	4.91	23.85	206.46	0.80	1.28	1.26	-

*LSD: Least significant difference at the 5% level of significance; DAT: Days after transplanting; HW: Hand weeding different herbicides at all the doses improved the crop growth parameters, yet their effect was less pertinent in comparison to two-hand weeding at 20 and 40 DAT except pretilachlor 50 EC at 500 g ha^{-1}. Das (2008) had similar type of findings by application of pyrazosulfuron ethyl. The pooled data on total dry matter accumulation (g m^{-2}) at 90 DAT reveals highest is recorded by weed-free check closely followed by pyrazosulfuron ethyl 10 WP at 30 g ha^{-1}, pretilachlor 50 EC at 500 g ha^{-1} and two-hand weeding at 20 and 40 DAT (Table 2). The weed-free check attained maximum leaf area index at 90 DAT and was followed by pretilachlor 50 EC at 500 g ha^{-1}, two-hand weeding at 20 and 40 DAT and by pyrazosulfuron ethyl 10 WP at 30 g ha^{-1}. Weedy plots in both the years registered least plant height, number of tillers, dry matter accumulation and leaf area index as compared to other treatments. It can be concluded that not only reduction of weed density and dry weight but also some additive effect on the crops is gained by appropriate usage of herbicides. Stevan and Adewale (2020) reported that by using pretilachlor and pyrazosulfuron-ethyl as pre-emergence, early crop-weed competition could be overcomed owing to the variable herbicide regimes having variation in mode of action and thus maximizing plant growth parameters leading to higher plant height, leaf area and dry matter accumulation $hills^{-1}$. Yadav et al. (2018) observed that the increment in plant height, more number of effective tillers m^{-2}, increased leaf area and more dry matter accumulation was noted under the application of pretilachlor and pyrazosulfuron-ethyl. Singh et al. (2016) ultimately reached the conclusion that pyrazosulfuron and pretilachlor-treated plots had taller plants, more tillers $hills^{-1}$, higher total dry matter accumulation $hills^{-1}$, longer and wider leaves, and more leaf area index, which might have inhibited the growth and development of weeds in the future. Duary et al. (2015a), Kumar and Punia (2014) had all previously demonstrated effective weed management that resulted in higher plant height, tillers, and dry matter accumulation $hills^{-1}$ in transplanted rice due to the combined application of herbicides.

3.4. Effect on crop yield and weed index

The highest values of the grain and straw yield per hectare were obtained with weed-free check followed by HW at 20 and 40 DAT. Weedy check recorded lowest yield of grain and straw. The herbicidal treatments recorded significantly higher grain and straw yield over the weedy plot (Table 2). Among the herbicidal treatment, pyrazosulfuron ethyl 10 WP at 30 g ha^{-1} registered maximum grain and straw yield significantly followed by pretilachlor 50 EC at 500 g ha^{-1}. Weed-free check followed by HW at 20 and 40 DAT registered lowest weed index. The effectiveness of an herbicide is assessed by a lower weed index and it was obtained among herbicidal treatments by pyrazosulfuron ethyl 10 WP at 30 g ha^{-1} followed by pretilachlor 50 EC at 500 g ha^{-1}. Thus, based on pooled data of two years, the lowest yield reduction was recorded under the optimum dose of pyrazosulfuron ethyl 10 WP at 30 g ha^{-1}. Pretilachlor and pyrazosulfuron ethyl might have produced higher yields due to improved photosynthetic production and translocation, appropriate growth resource availability, and reduced weed competition during the crop's critical growing period. These findings were consistent with those reported Duary et al. (2015b) and Teja et al. (2016). Pretilachlor and pyrazosulfuron-ethyl pre-emergence herbicide applications followed by post-emergence herbicide applications resulted in a greater number of yield characteristics and yield than unweeded control, according to Suryakala et al. (2019). The absence of crop weed competition and sustained nutrient availability, which resulted in better uptake of NPK by the crop, might have contributed to synchronous tillering and spikelet formation, which led to a higher number of panicles m^{-2} and higher post-flowering photosynthesis, as well as a higher number of filled grains $panicle^{-1}$. Rapid growth of seedlings was supposed to take place in the early stages. Acharya and Bhattacharya (2013) found that the application of pyrazosulfuron ethyl @ 20 g a.i. ha^{-1} to *boro* rice produced the highest yield parameters, yield, gross returns, and net returns when compared to other weed control methods. Therefore, using herbicides enabled economical and effective weed control resulting greater crop establishment and competitiveness. Weeds and rice competed for the same resources, including air, light, moisture, and nutrients (Mandal et al., 2011).

4. CONCLUSION

Pyrazosulfuron ethyl 10 WP at 30 g ha^{-1} and pretilachlor 50 EC at 500 g ha^{-1} as pre-emergence proved most efficient for the control of weed flora in transplanted late *boro* rice.

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