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Bioefficacy of pyrazosulfuron and bensulfuron methyl in combination with pretilachlor against weeds in transplanted rice (*Oryza sativa* l.) under temperate conditions of Kashmir

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ABSTRACT

Field experiment entitled "bioefficacy of pyrazosulfuron and bensulfuron methyl in combination with pretilachlor against weeds in transplanted rice under Kashmir conditions" was conducted at Mountain Research Centre for Field Crops, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir during kharif 2014 and 2015. The experiment comprised of six treatments (W_1:Pretilachlor+Bensulfuron methyl, W_2:Pretilachlor+ pyrazosulfuron, W_3:Butachlor, W_4:Hand weeding twice (15 and 30 DAT), W_5 :Weed free and W_6:Weedy check) replicated four times in a randomized block design. The results revealed that application of Pretilachlor+Bensulfuron methyl, on an average caused a reduction of 7.44 and 79 per cent in weed population as compared to butachlor and weedy check, respectively. Pretilachlor+pyrazosulfuron application also proved effective in controlling the weeds and reduced their density by 10.25 per cent compared to commonly used butachlor. Among the tested herbicides, lowest weed dry matter of 9.45 (3.22) g m^{-2} was recorded with Pretilachlor+pyrazosulfuron application. Application of Pretilachlor+Bensulfuron methyl exhibited a superiority of 11.09 per cent in reducing the dry weight of weeds as compared to Butachlor and the corresponding figure for Pretilachlor+pyrazosulfuron was 17.06 per cent. Combination application of Pretilachlor+pyrazosulfuron recorded considerably higher grain yield (7.27 t ha^{-1}) than butachlor (6.74 t ha^{-1}) and weedy check (4.17 t ha^{-1}). The superiority exhibited by Pretilachlor+pyrazosulfuron over butachlor was 7.35 and 7.76 per cent during 2014 and 2015, respectively.

Keywords : Bensulfuron-methyl, pyrazosulfuron-ethyl, butachlor, pretilachlor, grain yield, weed control efficiency

Rice is the staple food for more than half of the world's population and life for millions of people especially in Asia, where 90 percent of the world's rice is produced and consumed. In India rice is grown in about 45 million hectares with a production of about 92 million tonnes. In Jammu and Kahmir, State the rice crop occupies an area of 2.65 lakh hactares with a production of around 454.8 thousand tones out of which Kashmir valley alone accounts for 62 per cent of the production (Economic Survey, 2015). The very low annual growth rate of rice yield observed for the last two decades is a cause for concern with regard to food security. Due to abundant sunshine with nearly pest free environment Kashmir region is suitable for very good rice yields. In spite of this fact the average productivity (around 2.2 t ha^{-1}) is far below the potential yields (6-7 t ha^{-1}). This lower productivity is due to inappropriate management related to nutrients, weeds and water including low and imbalanced use of manures and fertilizers, faulty irrigation and cultural practices and poor weed control practices. With strategic management of all these factors, the yield gap can be narrowed to improve the rice productivity, food security and the socio-economic well-being of rice growers throughout Kashmir valley. Due to the increasing cost and availability of inputs and labour, rice farming is becoming unprofitable in the valley, as more than 80 per cent of the farmers in Kashmir are either small or marginal.

Weed competition is going to be the major constraint in achieving higher productivity. Experiments showed that yields were comparable across all establishment methods of rice when competition from weeds was removed. Thus, weed control is major prerequisite for improved rice productivity and production in all of the rice establishment methods. Weed infestation in rice has been established as one of the important factors responsible for lower productivity as the weed flora under transplanted conditions cause a yield reduction upto 45 per cent (Manhas *et al.*, 2012). Out of the losses due to various biotic stresses, weeds are known to account for 45 per cent of the losses. The effective control measures at initial stage of crop growth can help in improving the productivity of rice. Although a number of pre-emergence herbicides provide good control of grassy weeds but due to continuous use of such herbicides a shift in weed flora and evolution of herbicide resistant weeds has been observed (Rajkhowa *et al*, 2006). Hence the evaluation of new herbicide molecules for the control of wide spectrum of weed flora is imperative. Recent trend of herbicide use is to find out the effective weed control measures using low dose high efficiency herbicides which not only reduce the total

volume of herbicide but also the application becomes easier and economical. In this context, two herbicides pyrazosulfuron and bensulfuron methyl in combination with pretilachlor were evaluated.

MATERIALS AND METHODS

A field experiment was conducted to study the bioefficacy of pyrazosulfuron and bensulfuron methyl in combination with pretilachlor on weeds in transplanted rice (*Oryza sativa* L.) under Kashmir conditions, at Mountain Research Centre for Field Crops, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Khudwani, Anantnag, Jammu and Kashmir during *kharif* 2014 and 2015. Khudwani is situated in temperate zone between 34^{o} N latitude and 74^{o} E longitude at an altitude of 1560 metres above mean sea level. The experimental site is characterized by hot summers and very cold winters with an average annual precipitation of 812 mm (average of past 20 years) most of which is received from December to April in the form of snow and rains. during *kharif* 2014 and 2015. The soil of experimental field was silty clay loam in texture, neutral in reaction (pH 7.3), low in available nitrogen, medium in available phosphorous and potassium. The treatments consisted of six weed control practice (W_1: Bensulfuron methyl 0.6 per cent + Pretilachlor 6 per cent G (Erase Strong 10 kg ha^{-1}) 3-5 DAT (PE), W_2 : Pyrazosulfuron 0.75 per cent + Pretilachlor 30 per cent DF (Eros 10 kg ha^{-1}) 3-5 DAT (PE), W_3 : Butachlor 1.5 kg *a i* ha^{-1} 3 DAT, W_4 : Hand weeding twice (15 & 30 DAT), W_5 : Weed free, W_6 : Weedy check). The treatments were replicated four times in a randomized block design. Twenty five days old seedlings of rice variety Jhelum were transplanted in second week of June at a spacing of 15 cm x 15 cm during both the seasons of experimentation. The size of each experimental plot was

Table 1 : Weed control efficiency, population and dry weight of weeds as affected by different herbicides (pooled over two years).

Treatment	Weed density at 55 DAT (No. m^{-2})			Dry weight of weeds (gm^{-2})	Weed control efficiency(%)
	Grasses	Sedges	Broad leaved		
Pretilachlor+Bensulfuron methyl(BSM)	5.50(2.529)	5.50(2.529)	12.50(3.650)	11.85(3.58)	79.01
Pretilachlor+Pyrazosulfuron ethyl (PSE)	4.50(2.314)	5.50(2.529)	9.50(3.230)	9.45(3.22)	83.26
Butachlor	7.00(2.799)	12.00(3.600)	22.00(4.789)	16.30(4.13)	71.12
Two hand weeding	6.5(2.720)	6.00(2.554)	13.50(3.788)	9.02(3.15)	84.61
Weed free	0.00(1.000)	0.00(1.000)	0.00(1.000)	0.00(1.000)	100.0
Weedy check	19.00(4.465)	22.00(4.789)	40.00(6.393)	56.45(7.54)	-
LSD (0.05)	**0.571**	**0.638**	**0.516**	**0.673**	-
CV (%)	**14.38**	**14.96**	**8.98**	**11.85**	-

Figures in parenthesis are transformed values, data subjected to square root (√x+1) transformation

Table 2 : Yield and yield attributes of rice as influenced by different weed control practices.

Treatment	Panicles (No. m^{-2})		Grains panicle^{-1} (No.)		Grain yield (q ha^{-1})		Straw yield (q ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015
Pretilachlor+Bensulfuron methyl	368	374	84.7	91.9	62.71	71.73	80.92	93.97
Pretilachlor+Pyrazosulfu-ron ethyl	375	380	88.3	93.7	64.25	72.73	82.88	95.28
Butachlor	339	345	80.6	86.7	59.84	67.49	77.19	88.41
Two hand weedings	354	365	82.8	92.6	61.76	71.11	79.67	93.15
Weed free	378	395	91.4	98.0	66.82	80.39	86.20	101.31
Weedy check	254	266	61.5	64.8	38.97	41.17	52.27	52.68
LCD (0.05)	**14.74**	**12.08**	**9.25**	**6.52**	**7.12**	**6.70**	**8.67**	**9.43**
C.V. (%)	**6.13**	**4.27**	**7.35**	**4.92**	**7.21**	**6.68**	**9.14**	**6.75**

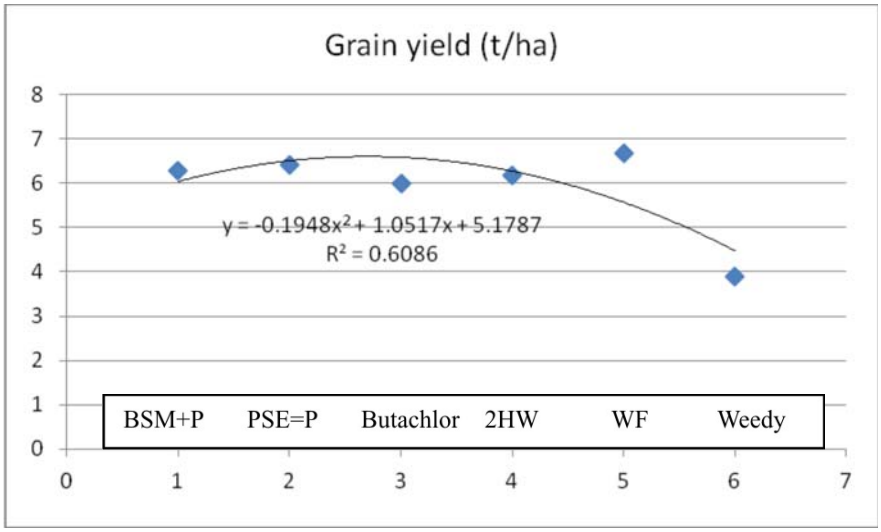

Fig 1 : Correlation between grain yield and weed control practices (2014)

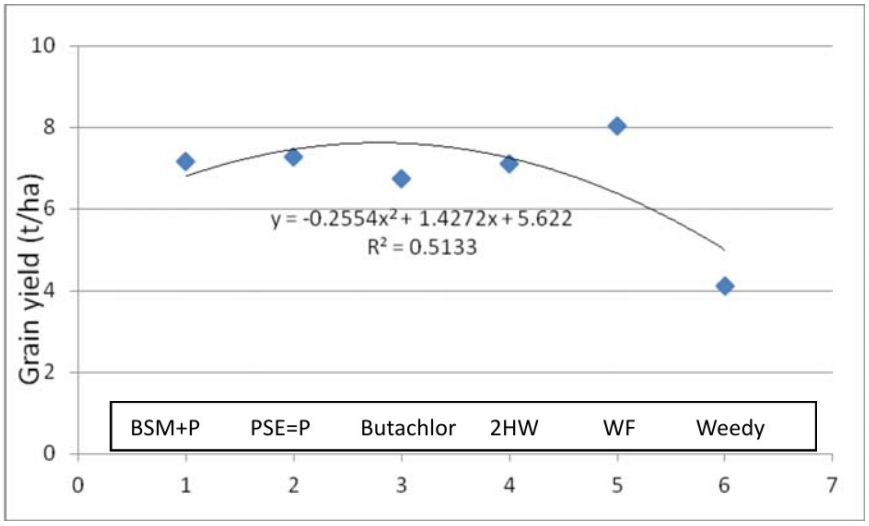

Fig 2 : Correlation between grain yield and weed control practices (2015)

20.65 m^2 (5.10 x 4. 05 m) having 27 rows with 34 hills per row. Well decomposed farm yard manure @ 10 t ha^{-1} was incorporated in the field uniformly during land preparation. The crop was fertilized as per the recommended package of practices (120:60:30; kg N: P_2O_5: K_2O ha^{-1}). The entire quantity of phosphorus and potassium and half of nitrogen was applied as basal at the time of transplanting while remaining N was applied in two equal splits at active tillering and panicle initiation stages. Liquid herbicides (butachlor 50 EC @1.5kg *a.i.* ha^{-1}) as per treatments were applied with knapsack sprayer fitted with flat fan nozzle using 300 litres of water ha^{-1} whereas the granular herbicides were mixed with sand and applied uniformly accross the plot. Weed density (number of weeds m^{-2}) was recorded at 45 days after transplanting (DAT) using a quadrat (50 x 50 cm) 0.25 m^2. The weeds falling in the quadrat randomly at two points from each plot in all replications were identified, grouped and separately counted as grasses, sedges and broad leaf weeds and then doubled for conversion into per square metre. The samples collected for the weed density from two quadrats of 0.25 m^2 each (=0.5m^2) were sun dried first and then dried in oven to determine the dry weight of weeds. Weed control efficiency of different treatments was determined by using the following formula :

$$WCE\ (\%) = \frac{W_c - W_t}{W_c} \times 100$$

Where, W_c is weed dry weight (g) in weedy (control) plot and W_t is weed dry weight (g) in herbicide treated plot.

The yield and yield attributes were recorded at maturity. The crop was harvested during last week of September in both the years.

RESULTS AND DISCUSSION

Effect on weeds

Major weed species infesting the field were; *Echinocloa crusgali* L., *Echinocloa colona* L., *Cyperus iria* L., *Cyperus difformis* L., *Marsilia quadrifolia* L., *Potamogeton distinctus.*, *Ammania baccifera* L. and *Monochoria vaginalis*. On an average of two years, weed density of 81.0 m^{-2} was observed in weedy plots among which 23.45 per cent were grasses, 27.16 per cent were sedges and 49.39 per cent were broad leaved weeds (Table 1). All the weed control (herbicidal treatment) plots recorded significant reduction in weed population compared to weedy check. Application of Pretilachlor + Bensulfuron methyl combination (Erase strong formulation @10 kg ha^{-1}), on an average, caused a reduction of 7.44 and 79 per cent in weed population as compared to butachlor and weedy check, respectively. Teja *et al*. (2015) from West Bengal recorded significant decrease in weed population in wet season transplanted rice with the application of Bensulfuron methyl+pretilachlor. Likewise, Pretilachlor + pyrazosulfuron ethyl (Eros 10 kg ha^{-1}) application also proved more effective in controlling the weeds and reduced their density by 10.25 per cent and 83 per cent compared to commonly used butachlor and weedy check, respectively. Significant reduction in weed density in low land rice with pyrazosulfuron application was also reported by Acharya and Batacharya (2013). Total dry weight of weeds was also significantly affected by the herbicidal treatments. Among the tested herbicides, lowest weed dry matter of 9.45 (3.22) g m^{-2} was recorded with Pretilachlor + pyrazosulfuron application. Plots treated with Pretilachlor + Bensulfuron methyl (Erase strong) exhibited a superiority of 11.09 per cent in reducing the dry weight of weeds as compared to Butachlor and the corresponding figure for Pretilachlor + pyrazosulfuron was 17.06 per cent. Chauhan *et. al.* (2015) from Philippines also reported significant reduction in weed dry weight by the use of sulfonyl urea herbicides in dry seeded rice. Highest weed control efficiency of 83.26 per cent was recorded with the application of Pretilachlor + pyrazosulfuron followed by 79.01 per cent in case of Pretilachlor + Bensulfuron methyl. Halder *et al.* (2005) also reported highest weed control efficiency of 78 per cent with the application of pyrazosulfuron in boro rice. Butachlor treated plots recorded a weed control efficiency of 71.12 per cent.

Effect on crop

Minimum number of panicles m^{-2} was recorded in weedy check (control plots) as compared to other weed control treatments due to severe weed competition (Table-2). During 2015, application of Pretilachlor + bensulfuron methyl (Erase strong) recorded 374 panicles m^{-2} while butachlor and weedy plots recorded 345 and 266 panicles m^{-2} respectively. The magnitude of superiority of Pretilachlor + bensulfuron methyl over butachlor and control was 8.4 and 40.6 per cent, respectively. Use of Pretilachlor + pyrazosulfuron (Eros) also significantly enhanced the number of panicles by 9.8 and 42.4 per cent over butachlor and control, respectively, though the highest number of panicles (395) was observed in weed free treatment.

Among the weed control treatments, both the herbicides (Erase strong and Eros) recorded higher number of grains/panicle in comparison to butachlor and control (Table 1). Application of Pretilachlor + bensulfuron methyl during 2014 recorded 84.7 grains $panicle^{-1}$ as compared to 80.6 and 61.5 grains $panicle^{-1}$ by butachlor and control, respectively while the corresponding figures for 2015 were 91.9 as compared to 86.7 and 64.8 grains $panicle^{-1}$ by butachlor and control, respectively. Therefore in respect of number of grains, the advantage of using Pretilachlor + bensulfuron methyl combination was 5.08 and 5.99 per cent over butachlor during 2014 and 2015, respectively, while the corresponding figures against weedy check were 37.72 and 41.82 per cent, respectively. Pretilachlor + pyrazosulfuron application also enhanced the number of grains $panicle^{-1}$ significantly over control and butachlor. Plots treated with this herbicide combination (Eros) recorded 93.7 grains $panicle^{-1}$ which was 44.5 and 8.0 per cent higher than weedy check and butachlor, respectively. The yield data (Table 1) indicated that all the weed control treatments markedly increased the grain yield of rice over control during both the years of evaluation. Maximum grain yield of rice (8.03 t ha^{-1}) was recorded in weed free plots followed by Eros and Erase treated plots. During 2014, application of Pretilachlor + bensulfuron methyl produced higher grain yield (6.27 t ha^{-1}) than butachlor and weedy check but was comparable to two hand weedings and weed free treatments. Managing weeds by the application of Pretilachlor + bensulfuron methyl provided a yield advantage of 4.84 (*i.e.* 2.90 q ha^{-1}) and 6.3 per cent (4.24 q ha^{-1}) over commonly used butachlor during 2014 and 2015, respectively. Pretilachlor + pyrazosulfuron application recorded considerably higher grain yield of 7.27 t ha^{-1} than butachlor (6.74 t ha^{-1}) and control (4.17

t ha^{-1}). The superiority exhibited by Pretilachlor + pyrazosulfuron over butachlor was 7.35 and 7.76 per cent during 2014 and 2015, respectively. The higher grain yield obtained under Pretilachlor + bensulfuron and Pretilachlor + pyrazosulfuron applied plots might be due to their significant control over a broad spectrum of weeds, offering minimum crop-weed competition leading to better growth and development of the crop. Increase in rice yields with the use of herbicides like pyrazosulfuron ethyl and bensulfuron methyl has also been reported by Ramesha *et. al.* 2015 and Teja *et. al.* 2015. All the weed control treatments and grain yield indicated a positive correlation with R^2 value of 0.608 and 0.5 during 2014 and 2015, respectively (Fig 1 and Fig 2).

Based on two years study it can be concluded that weeds in transplanted rice can be effectively managed by the application of Pretilachlor + pyrazosulfuron (Eros) and Pretilachlor + Bensulfuron methyl (Erase strong @ 10 kg ha^{-1}). Both the herbicidal products being superior to commonly used butachlor may be recommended for use by the farmers to boost productivity of rice in Kashmir valley.

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