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Effect of new herbicide pyrazosulfuron-ethyl on transplanted rice based cropping system in Cauvery Delta Zone of Tamil Nadu

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Abstract
Rice (*Oryza sativa* L.) is an important food crop extensively grown in India. The average production and productivity are low in both India and Tamil Nadu. Several factors are responsible for reducing the yield of transplant rice. Among them, weed infestation is one of the major threats for low productivity of transplanted rice and subsequently on pulses yield. Therefore, field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during 2017-2018 in both kharif and rabi seasons with different doses of pyrazosulfuron-ethyl (20,30 and 42.85g ha^{-1}) which compared with Pretilachlor dichloride 50% EC, Butachlor 50% EC, Hand weeding twice and untreated check. The results of the experiments revealed that application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence controlled the weed menace in all stages of transplanted rice and also succeeding crop of blackgram in Cauvery Delta regions. Higher yield could be obtained under Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence applied plot.

Keywords: Transplanted rice, weed menace, herbicides, yield, nutrient uptake, succeeding crop blackgram

Introduction
Rice (*Oryza sativa* L.) is a major staple food for more than 60 per cent of the world population, providing energy for about 40% of the world population where every third person on earth consumes rice every day in one form or other (Ramesha, *et al.* 2017) [9]. It is extensively grown in tropical and subtropical regions of the world. It is cultivated in area of 44.0 million hectares with an annual production of 104.3 million tons in India. Its production has been found to be distributed as 91.5 million tons in kharif and 12.8 million tons in rabi season. The productivity in India is very low (2.37t ha^{-1}) as compared to other rice growing countries like Japan (6.35t ha^{-1}), Australia (6.22t ha^{-1}), Spain (6.16t ha^{-1}), Egypt (5.0 t ha^{-1}) and China (5.2t ha^{-1}). In Tamil Nadu, rice is grown in an area of 2.04 million hectare with total production of 9.98 million tonnes. In Cauvery Delta Zone (CDZ), major crop is rice which is grown in an area of 14.47 lakh ha which contributes 11 per cent of the total area of Tamil Nadu with average productivity of 2.8 tonnes ha^{-1}. The Cauvery Delta Zone includes Thanjavur, Nagapattinam, Tiruvarur, Trichy and parts of Karur, Ariyalur, Pudukkottai and Cuddalore districts of Tamil Nadu. The practice of double cropping of rice in *kuruvai* (June - September) and *thaladi* (October - February) is on the increase because of the development of short and medium duration high yielding rice varieties (Subrahmaniyan *et al.*, 2016) [13].

Weeds are the major cause of yield reduction in rice. Hand weeding is the traditional weed control measure and still being the most popular in rice. However, due to high labour cost, non-availability of labour and huge time requirement for manual weeding, farmers are inevitable to go for other alternative measures like chemical weed control. Many herbicides are being used successfully for weed control in transplanted rice as pre-emergence spray. New herbicides are available in the market and use of herbicides of different composition is desirable to reduce the problem of residue buildup, shift in weed problem (Rajkhowa., *et al.* 2006) [10] and development of herbicide resistance in weeds (Rao, 1999, Saha., *et al.* 2006) [11, 12]. The recent trend of herbicide use is to find out an effective weed control measure by using low dose high efficiency herbicides which will not only reduce the total volume of herbicide use but also the application become easier and economical (Pal and Banerjee, 2007) [7].

The herbicide pyrazosulfuron ethyl 10% WP has both foliar and soil activity (Rajkhowa., *et al*. 2006) [10]. It is generally recommended as a pre-emergence herbicide in transplanted rice (Angiras and Kumar, 2005) [1]. Studies on bio-efficacy and phytotoxicity of pyrazosulfuron ethyl 10% WP for pre-emergence weed control in transplanted rice are scanty. The present experiment was therefore undertaken to study the bio-efficacy and phytotoxicity of pyrazosulfuron ethyl in pre-emergence control of major weeds in transplanted rice based cropping system (succeeding crop of blackgram) and to determine an optimum dosage of application that can be recommended to rice growing farmers.

Materials and Methods

Field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during *2017-2018* in both kharif and rabi seasons. The experimental area located at latitude of 11^0 N, longitude of 79^0 E and an altitude of 19.5 m above MSL. The region is characterized by a sub-tropical climate with a hot dry summer (March -June) and extended wet period from September to February. The mean annual rainfall is about 1176 mm majority of which was received during North East Monsoon. The mean annual maximum and minimum temperatures were 33.3 ºC and 23.5 ºC. The mean annual relative humidity was 89 per cent. The mean wind velocity and bright sunshine hours were 5.2 kmph and 6.7 hours day^{-1}. The sown rice variety was ADT 43 of 120 days duration. The crop was transplanted during 1st week of August at a spacing of 20 × 15 cm and harvested during 2nd week of October in both the years. Full doses of phosphorus through single super phosphate (SSP) and potash through muriate of potash (MOP) each 30 kg/ha along with 25% recommended doses of nitrogen (60 kg/ ha) through urea were applied at basal during the final land preparation. Remaining 75% nitrogen was applied through urea in three equal splits at 25, 45 and 65 DAT. The different weed management treatments were imposed as the technical programme as furnished below.

The different weed management treatments were imposed as the technical programme as furnished below.

Treatments		Dosage		Water for Dilution (in litres)
		a.i/ha (gm)	Formulation/ha (gm)	
T_1	Pyrazosulfuron Ethyl 70% WDG	14	20	500
T_2	Pyrazosulfuron Ethyl 70% WDG	21	30	500
T_3	Pyrazosulfuron Ethyl 70% WDG	30	42.85	500
T_4	Pyrazosulfuron Ethyl 70% WDG (UPL)	21	30	500
T_5	Pretilachlor dichloride 50% EC	500	1000	500
T_6	Butachlor 50% EC	1250	2500	250
T_7	Hand Weeding (20 DAS & 40 DAS)	-	-	500
T_8	Untreated Control (Weedy Check)	-	-	500
T_9	*Pyrazosulfuron Ethyl 70% WDG	42	60	500
T_{10}	*Pyrazosulfuron Ethyl 70% WDG	84	120	500

An area of 0.25 m^2 was selected randomly at two spots by throwing a quadrat of 0.5 × 0.5 m, weed species were counted from that area and density was expressed in number per m2. The collected weeds were first sun-dried and then kept in an electric oven at 700C till the weight became constant and weed biomass was expressed as g/ m2. Comparison of treatment means for significance at 5% level was done using the critical differences as suggested by Gomez and Gomez (1984) [5]. Data on grain yield were recorded from the net plot. Weed control efficiency (WCE) was worked out using the formula as suggested by (Mani *et al*. 1973, Gill and Vijayakumar, 1969).

Weather and climate during the cropping period

During *kharif* 2017, the amount of rainfall received during cropping season was 474.6 mm in 27 rainy days. The maximum temperature ranged from 32.1 to 37 ºC, while minimum temperature ranged from 23.8 to 26.3 ºC, during *kharif* 2017. In *kharif* 2017, the relative humidity ranges from 75 to 94 per cent and 46 to 76 per cent during forenoon and afternoon respectively. The mean sunshine hours was 5.7 hours day^{-1}. During *rabi* 2017, the amount of rainfall received during cropping season was 770.8 mm in 29 rainy days. Similar trend was also observed during 2018.

Results and Discussions

Weed flora of the experimental area

The predominant grassy weeds associated with transplanted rice are *Echinochloa colona* (L.), *Echinochloa crusgalli* (L.), *Cynodon dactylon* Pers *and Panicum repens* (L.). *Cyperus iria* (L.), *Cyperus difformis* (L.), *Cyperus rotundus* (L.) and *Fimbristylis miliacea* (L.) among sedges and *Eclipta alba* (L.), *Marsilea quadrifolia*, *Ludwigia parviflora* and *Commelina benghalensis* among broad leaved and aquatic weeds. However, the effect of Pyrazosulfuron Ethyl was assessed on the weeds such as *Echnochloa spp, Cyperus rotundus, Cyperus iria, Cyperus difformis, Ludwigia parviflora, Fimbristylis miliacea* during 20, 40 and 60 DAT during 2017 and 2018 seasons. The number of dominant broad-leaved, grass and sedge weeds was gradually decreased with the increase of doses of tested herbicide pyrazosulfuron-ethyl in all the three dates of observation. Better weed control was observed with application of maximum dose of the tested herbicide. Pyrazosulfuron-ethyl is highly selective to rice crop so also called as rice herbicide. It control grasses, sedges and broad leaf weed in rice. Grasses includes *Echinochloa colona, Panicum spp.*, sedges includes *Fimbristylis millacea*, *Cyperus spp.*, and broad leaf weeds includes *Ludwigia parviflora*, *Marsilea quadrifolium, Alternanthera sesselis* etc. Pyrazosulfuron is absorbed by roots or leaves and translocated to meristem which inhibits ALS/AHAS enzyme catalyzing the biosynthesis of three essential branched-chain amino acid, namely leucine, valine and isoleucine they stops cell division of roots and check the plant growth (Priyanka Kabdal *et al*. 2018) [8].

Effect of weed management practices on weed characters

Weed density

The weed density (Nos./m^2) was recorded for different weed species during 20,40 and 60 Days After Transplanting during Kharif 2017 and 2018. The different weed management practices were significantly on weed density under various

stages of the crop growth of transplanted rice. In kharif 2017, among different weed species, higher weed density was observed under *Echnochloa spp in grasses, Cyperus rotundus in sedges and Ludwigia parviflora in broadleaved weeds* (Table. 2 and 3). Similar trend was also recorded in Kharif 2018 (Fig.1). In both seasons, higher weed density was noticed under untreated check. Application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence reduced the weed density of weed species in all stages of crop (20,40 and 60 DAT) which was followed Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} compared to other treatments. Hand weeding twice controlled weed from initial stage to harvest. Similarly, application of Pyrazosulfuron-ethyl at 20 and 25 g/ha significantly reduced weed density and total weed biomass of *Cyperus iria, Echinochloa colona etc.* when applied at 3 to 10 days after transplanting were reported by Chopra and Chopra 2003 [2].

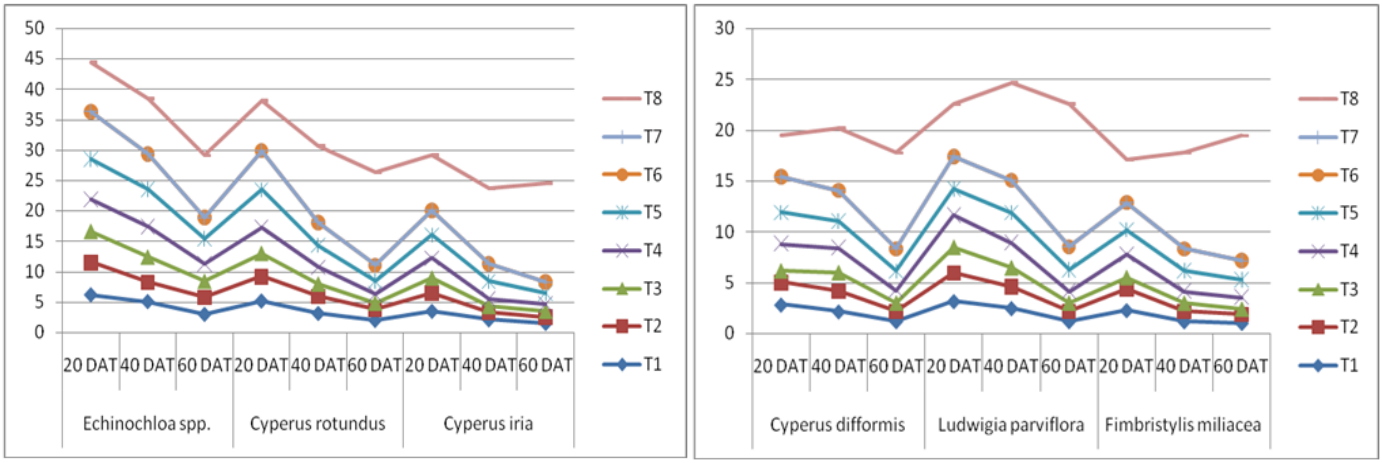

Fig 1: Weed density of different weed species wise during *kharif* 2018

Weed dry weight (g/m^2)

The different weed management practices significantly influenced on the weed dry weight in all stages crop during both kharif seasons. Application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence reduced the weed dry weight of 17.82, 17.14 and 20.19 g m^{-2} during 20,40 and 60 DAT respectively which was followed Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} compared to other treatments. Higher weed dry weight was recorded in untreated plots in all stages. Similar trend was observed in kharif 2018 (Fig.2).

Weed control efficiency

The different weed management practices significantly influenced on the weed control efficiency in all stages crop during both kharif seasons. Application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence recorded higher weed control efficiency of 57.32, 76.74 and 88.34 per cent during 20,40 and 60 DAT respectively which was followed Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} compared to other treatments. Higher weed control efficiency was recorded in all stages under hand weed twice on 20 and 40 DAS. Similar trend was observed in kharif 2018 (Fig.2).

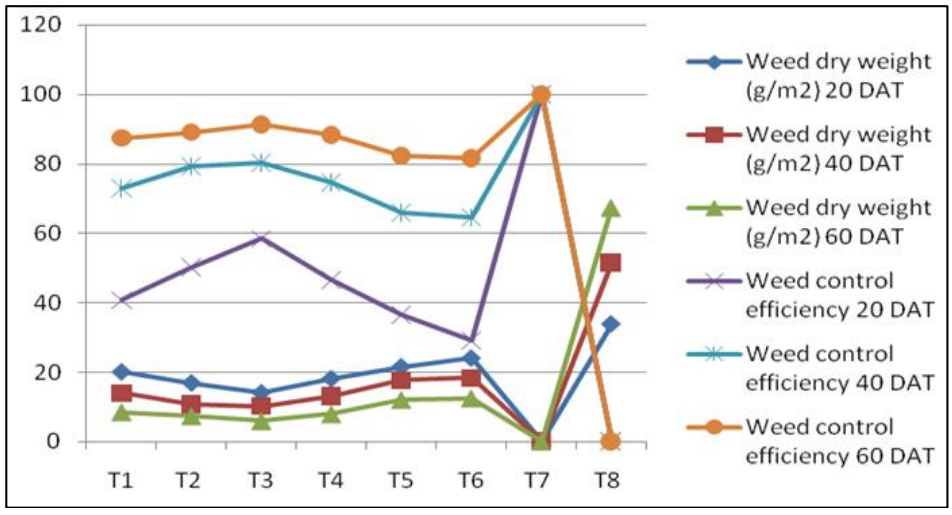

Fig 2: Weed dry weight and weed control efficiency in transplanted rice during *kharif* 2018

Effect of weed management practices on growth & yield attributes of transplanted rice

All growth and yield attributes of transplanted rice were significantly influenced by different weed management practices in both kharif seasons. The highest rice grain yield (6266 kg/ha) was recorded in application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence which was followed Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} compared to other treatments (5683 kg/ha). The increase in grain yield under this treatment was due to less weed density and weed biomass as compared to all other treatments tried in this study and also mainly due to higher trend in plant height, No. of tillers and No. of productive tillers. Lowest grain yield of rice was observed in untreated check (4240 kg/ha) which

was due to high weed density and biomass (Table 4, 4a). Similar trend was observed in kharif 2018. The increase in grain yield under this treatment was due to less weed density and weed biomass as compared to all other treatments. Das (2008) found that the application of Pyrazosulfuron in general increase vigor of rice plants in terms of more number of tillers and better grain filling resulting in higher yield.

Effect of weed management practices on growth and yield attributes of succeeding blackgram (Table 5)

All growth and yield attributes of succeeding blackgram were significantly influenced by different weed management practices in both kharif seasons.

Application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence was recorded increased trend of growth attributes such as plant height (28.10 cm), No. of branches (7.3), No. of pods (36.78) and in turn increased higher pod yield (940.12 kg/ha) which was followed Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} compared to other treatments (835 kg/ha). The increased growth and yield attributes under this treatment is mainly due to lower weed menace in the proceeding crop of transplanted rice during kharif seasons. The same trend was also observed in second year (kharif 2018 and Rabi 2018) (Fig.3).

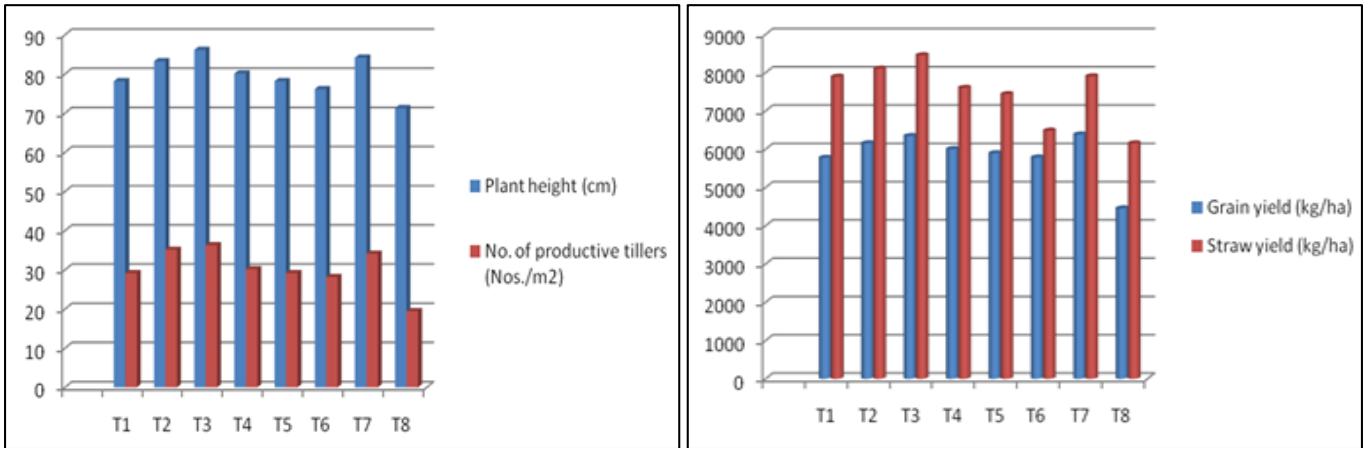

Fig 3: Growth and yield of transplanted rice during *kharif* 2018

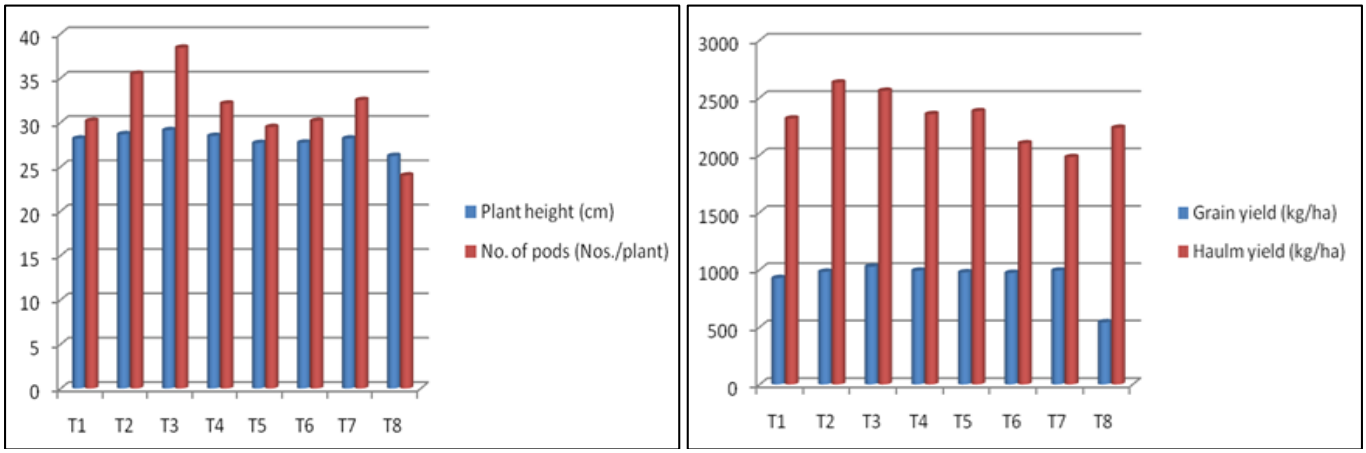

Fig 4: Growth and yield of succeeding blackgram during *Rabi* 2018

Table 2: Influence of pyrazosulfuran on species wise weeds density (Nos./ m^2) during *kharif 2017*

Treatment details	*Echinochloa spp.*			*Cyperus rotundus*			*Cyperus iria*		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	6.17(2.64)	5.40(2.31)	3.50(1.50)	6.45(2.76)	5.20(2.23)	4.10(1.75)	4.50(1.93)	3.60(1.54)	2.40(1.03)
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	5.10(2.18)	4.00(1.71)	3.10(1.33)	6.00(2.57)	4.80(2.05)	3.80(1.63)	3.80(1.63)	3.00(1.28)	1.80(0.77)
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	4.20(1.80)	3.90(1.67)	3.00(1.28)	5.40(2.31)	4.10(1.75)	3.40(1.45)	3.20(1.37)	2.80(1.20)	1.20(0.51)
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	5.16(2.21)	5.20(2.23)	4.10(1.75)	6.20(2.65)	4.90(2.10)	4.05(1.73)	4.00(1.71)	3.10(1.33)	2.10(0.90)
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	6.80(2.91)	6.20(2.65)	5.00(2.14)	7.10(3.04)	5.20(2.23)	4.30(1.84)	4.20(1.80)	3.25(1.39)	2.30(0.98)
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	8.60(3.68)	6.80(2.91)	5.25(2.25)	7.89(3.38)	6.40(2.74)	4.85(2.08)	4.30(1.84)	3.40(1.45)	2.45(1.05)
T_7 - Hand weeding (20 and 40 DAS)	0.00(2.64)	0.00(2.64)	0.00(2.64)	0.00(2.64)	0.00(2.64)	0.00(2.64)	0.00(2.64)	0.00(2.64)	0.00(2.64)
T_8- Untreated control	9.25(3.96)	10.21(4.31)	12.35(5.28)	8.40(3.59)	9.10(3.89)	10.20(4.36)	7.20(3.08)	8.45(3.62)	13.20(5.65)
SEd	0.05	0.06	0.05	0.07	0.08	0.06	0.06	0.05	0.06
CD (p=0.05)	0.18	0.18	0.16	0.21	0.20	0.17	0.18	0.15	0.18

Treatment details	*Cyperus difformis*			*Ludwigia parviflora*			*Fimbristylis miliacea*		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	3.20 (1.38)	2.50(1.08)	1.50(0.65)	4.20(1.81)	3.00(1.29)	1.20(0.52)	2.50(1.08)	1.60(0.69)	1.00(0.43)
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	2.60(1.12)	2.20(0.95)	1.00(0.43)	3.00(1.29)	2.60(1.12)	0.98(0.42)	1.15(0.49)	1.10(0.47)	0.90(0.39)
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	1.80(0.77)	1.00(0.43)	1.00(0.43)	2.60(1.12)	2.20(0.95)	0.88(0.38)	0.98(0.42)	0.90(0.39)	0.00(0)
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	3.00(1.29)	2.60(1.12)	2.30(0.99)	3.20(1.38)	2.90(1.25)	1.20(0.52)	2.00(0.86)	1.30(0.56)	1.10(0.47)
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	4.10(1.76)	3.00(1.29)	2.00(0.86)	3.80(1.63)	3.10(1.33)	1.80(0.77)	1.8(0.77)	1.00(0.43)	0.98(0.42)
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	4.60(1.98)	3.20(1.38)	3.00(1.29)	3.00(1.29)	2.8(1.20)	2.00(0.86)	2.0(0.86)	1.40(0.60)	1.00(0.43)
T_7 - Hand weeding (20 and 40 DAS)	0(1.38)	0(1.38)	0(1.38)	0(1.38)	0(1.38)	0(1.38)	0(1.38)	0(1.38)	0(0)
T_8- Untreated control	5.6(2.41)	9.20(3.96)	13.10(5.63)	6.15(2.64)	13.10(5.63)	16.2(6.97)	6.00(2.58)	14.0(6.02)	16.25(6.99)
SEd	0.05	0.06	0.05	0.07	0.08	0.05	0.06	0.05	0.07
CD (p=0.05)	0.16	0.18	0.16	0.21	0.25	0.20	0.18	0.16	0.14

Table 3: Influence of pyrazosulfuran on weeds dry weight (g/m^2) and weed control efficiency during *kharif 2017*

Treatment details	Weed dry weight (g/m^2)			Weed control efficiency		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	26.48	24.50	29.18	36.57	66.75	83.14
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	21.22	20.36	24.67	49.17	72.37	85.75
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	17.82	17.14	20.19	57.32	76.74	88.34
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	23.09	23.00	31.63	44.69	68.77	81.73
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	27.24	25.01	34.89	34.74	66.04	79.85
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	29.78	27.60	39.51	28.66	62.53	77.18
T_7 - Hand weeding (20 and 40 DAS)	0.00	0.00	0.00	100.00	100.00	100.00
T_8- Untreated control	41.75	73.67	173.17	0.000	0.000	0.000
SEd	1.02	2.10	1.18	-	-	-
CD (p=0.05)	2.86	5.11	3.20	-	-	-

Table 4: Influence of pyrazosulfuran on growth and yield attributes of transplanted rice during *kharif 2017*

Treatment details	Plant height (cm)	No. of tillers (Nos./m^2)	No. of productive tillers (Nos./m^2)	No. of grains (Nos./panicle)	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	75.15	26.30	25.10	263.10	15.60	5420	7140
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	81.10	30.15	29.10	270.00	15.80	5683	7455
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	84.40	33.20	31.20	275.20	15.85	6266	7680
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	78.60	29.30	27.60	269.00	15.70	5668	6835
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	76.00	29.00	26.40	260.30	15.60	5540	6705
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	73.20	28.20	24.20	258.50	15.63	5500	6620
T_7 - Hand weeding (20 and 40 DAS)	85.30	35.10	32.00	260.00	15.80	6420	7828
T_8- Untreated control	70.15	19.25	17.10	220.30	15.25	4240	5829
SEd	2.01	1.10	0.75	5.20	1.16	154	163
CD (p=0.05)	5.47	3.40	2.36	13.80	3.40	508	499

Table 5: Growth and yield attributes of succeeding blackgram influenced by pyrazosulfuran during *kharif 2017*

Treatment details	Plant height (cm)	No. of branches (Nos./plant)	No. of pods (Nos./plant)	Test weight (g)	DMP (kg/ha)	Grain yield (kg/ha)	Haulm yield (kg/ha)
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	26.95	6.6	31.12	32.14	3970	780.00	2146
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	27.30	7.1	35.40	33.18	3927	835.45	2315
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	28.10	7.3	36.78	34.23	3687	940.12	2470
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	27.00	6.5	31.10	33.20	4031	820.50	2390
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	26.60	6.8	30.42	32.15	3683	785.45	2190
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	26.45	6.9	31.12	32.00	3129	770.30	2090
T_7 - Hand weeding (20 and 40 DAS)	26.90	6.5	33.47	32.08	3289	810.00	2130
T_8- Untreated control	24.75	6.4	24.97	30.05	2795	580.10	2070
SEd	1.17	0.09	2.00	1.40	147	65	101
CD (p=0.05)	3.45	1.13	3.88	3.60	456	134	222

Table 6: Nutrient uptake (kg/ha) by transplanted rice during kharif season

Treatment details	Nitrogen		Phosphorus		Potassium	
	2017	2018	2017	2018	2017	2018
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	49.8	51.0	14.8	15.3	76.9	77.1
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	53.4	53.2	16.7	15.9	78.1	79.2
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	56.8	55.1	18.4	16.4	79.6	81.0
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	52.8	52.3	15.3	15.8	76.7	74.3
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	51.3	52.0	15.1	15.3	74.4	73.8
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	51.9	52.3	15.3	15.6	74.0	72.3
T_7 - Hand weeding (20 and 40 DAS)	53.4	54.1	14.9	15.0	75.0	75.2
T_8- Untreated control	48.1	47.3	14.0	13.8	66.0	64.0
SEd	2.45	3.22	1.50	1.81	2.06	4.12
CD (p=0.05)	5.62	8.30	3.20	4.05	5.23	9.14

Table 6a: Nutrient uptake (kg/ha) by succeeding blackgram during Rabi season

Treatment details	Nitrogen		Phosphorus		Potassium	
	2017	2018	2017	2018	2017	2018
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	49.9	45.6	6.36	5.50	50.6	45.4
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	40.4	37.0	5.45	4.70	43.8	39.0
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	56.3	52.3	7.37	7.16	54.8	51.9
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	42.8	48.1	6.03	6.70	46.3	50.1
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	41.9	45.3	6.00	6.20	44.1	48.3
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	36.4	36.0	4.97	4.57	39.1	37.7
T_7 - Hand weeding (20 and 40 DAS)	60.4	59.8	7.65	7.90	57.6	58.3
T_8- Untreated control	34.7	34.8	4.62	4.54	36.1	36.0
SEd	6.41	5.12	0.98	1.21	1.63	2.01
CD (p=0.05)	19.08	16.23	2.15	3.65	3.86	4.35

Table 7: Soil available nutrient (kg/ha) after harvest of crops

Treatment details	Nitrogen		Phosphorus		Potassium	
	2017	2018	2017	2018	2017	2018
T_1- PE Pyrazosulfuron ethyl 70% WDG @ 14 g ha^{-1}	182.1	187.4	53.8	56.7	129.4	121.0
T_2 - PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}	188.4	191.7	56.9	57.3	132.1	128.7
T_3 - PE Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1}	189.5	193.8	57.6	58.1	134.0	130.8
T_4- PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} (UPL)	192.2	196.6	64.1	59.4	137.3	132.4
T_5- Pretilachlor dichloride 50% EC @ 500g ha^{-1}	186.0	188.3	55.0	55.8	133.0	126.0
T_6- Butachlor 50% EC @ 1250 g ha^{-1}	185.0	186.8	54.6	55.9	132.4	124.0
T_7 - Hand weeding (20 and 40 DAS)	192.8	196.1	54.0	54.4	131.5	124.6
T_8- Untreated control	176.0	178.2	46.1	48.6	125.0	118.0
SEd	8.01	7.15	8.23	6.12	0.98	2.13
CD (p=0.05)	19.12	21.04	22.10	19.18	2.10	6.10

Nutrient availability and uptake by crops (Transplanted rice and blackgram)

The available nitrogen, phosphorus and potassium ranged from 176 to 192.8 kg/ha, from 46.1 to 64.1 kg/ha and from 125 to 137.3 kg/ha respectively were recorded after harvest of the crops during kharif 2017. In case of second year, availability of nitrogen and phosphorus were higher than potassium. Application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence was recorded increased trend of nutrients uptake by both proceeding and succeeding crops of transplanted rice and blackgram respectively (Table.6, 6a & 7).

Phyto-toxicity

Visual observations viz., leaf injury, yellowing, stunting, necrosis, vein clearing, wilting, epinasty and hyponasty at 1,3,7 and 10 days after application of treatments were not noticed in both proceeding and succeeding crops of transplanted rice and blackgram respectively.

Conclusion

The results of two years experiments revealed that application of Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence controlled the weed menace in all stages of transplanted rice and also succeeding crop of blackgram in Cauvery Delta regions which inturn resulted in higher yield in both transplanted rice and succeeding blackgram could be obtained under Pyrazosulfuron ethyl 70% WDG @ 30 g ha^{-1} as post emergence applied plot.

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