EFFICACY OF DIFFERENT PRE AND POST-EMERGENCE HERBICIDES TO CONTROL WEEDS IN DIRECT SEEDED RICE

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ABSTRACT

Weed infestation is a major problem in direct seeded rice because weeds reduce yield as well as quality of rice. Manual weeding in direct seeded rice is very tedious, time consuming and mostly weather dependent operation. A field experiment was conducted in summer season 2018 to study the comparative efficacy of different pre and post-emergence herbicides in direct seeded rice to control weeds. The experiment was comprised of ten treatments with eight herbicides application viz. pendimethalin at 1137.5 g a.i. ha^{-1}, oxadiargyl 80 g a.i. ha^{-1}, triafaman+ ethoxy sulfuran ethyl 56.25 g a.i. ha^{-1}, pyriftalid+ bensulfuron ethyl 220.32 ml a.i. ha^{-1}, bispyribac sodium+bensulfuran 75 g a.i. ha^{-1}, phenoxaprop 431.25 ml a.i. ha^{-1}, pendimethalin 1137.5 g FB ethoxy sulfuran ethyl 7.5 g a.i. ha^{-1}, oxadiargyl 80 g a.i. ha^{-1} FB ethoxy sulfuran ethyl 7.5 g a.i. ha^{-1} and there were two control treatments viz. hand weeding and weedy check. The experiment was laid out in randomized complete block design (RCBD) with three replications. The data related to weed growth, weed dominance analyses and yield parameters were recorded and calculated by following the standard procedures. The results showed that triafaman+ ethoxy sulfuran ethyl gave effective weed control for about 50 days after sowing as compared to other herbicides. Also all the yield related parameters rice were recorded maximum in hand weeding and triafaman+ ethoxy sulfuran ethyl applied treatment. As hand weeding is a very tough operation, application of triafaman+ ethoxy sulfuran ethyl 56.25 g a.i ha^{-1} as pre-emergence herbicide is recommended to get effective control of weeds and higher paddy yield in direct seeded rice.

Keywords: Herbicide efficacy, herbicides, weed dominance analyses, hand weeding, direct seeded rice.

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INTRODUCTION

More than half of the world's human population depends upon rice (*Oryza sativa* L.) to fulfill their nutritional requirement making it a major grain crop among all the cereals (Kumar and Ladha, 2011). According to a report of FAO (2017), rice is grown on an area of 165 mha producing estimated yield of 758.8 million tons in the world. The largest continent in the world with respect to rice production ranking is Asia. The Asian countries contribute more than 90% share of rice production in the world and 30-75% demand of rice is provided by these countries (FAO, 2017).

In Asia, rice is mainly cultivated in puddled soils with continuous standing water conditions which is a conventional method of paddy cultivation in this area (Singh *et al*., 2006). Although flooded field conditions provide an effective control of weed growth, thus this method has a high requirement of labor which makes it difficult, costly and more tedious (Rajkumara *et al*., 2003). Transplanting is done manually by hand which require more time, thus transplanting of nursery is delayed and whole of the field cannot be transferred at once that results in over aging of the seedlings which enhances transplanting shock and production of tillers is reduced per plant of rice (Farooq *et al*., 2011). The management practices done to prepare a seedbed for rice cultivation has negative effects on the environment of soil which affects the growth and development of next crop i.e. wheat due to poor distribution of soil particles and formation of hard pan which makes tillage operations more difficult and more energy is required to prepare a good seedbed for wheat crop (Kumar and Ladha, 2011; Timsina and Connor, 2001). Production of puddled rice in a sustainable way has been threatened due to future water shortage (Tuong *et al*., 2005).

By keeping in mind the troubles associated with transplanted rice, the only alternative and feasible option to rescue the rice cultivating farmers is direct seeding of rice (Farooq *et al*., 2011). Khaliq *et al.* (2012) reported that, through direct seeding higher water use efficiency can be achieved as well as the conflict regarding the disturbance of soil physical properties can also be eliminated in Punjab where, the rice-wheat cropping system is practiced. As compared to transplanted rice, direct seeded rice requires 44% less amount of water for its production (Bouman *et al*., 2005). In DSR there is minimum need of labor and it is an easiest, cheap, less time consuming method of rice cultivation (Kumar and Ladha, 2011).

In direct seeding of rice weed infestation could cause a reduction of 60% in yield or it may be upto 100% where there is overload and over growth of weeds occur in the rice field (Kim and Ha, 2005). There is higher pressure of weed plants in DSR (Chauhan, 2012; Ali *et al*., 2018). Yield reduction in rice is caused by several weed species included *Cyperus rotundus* (Chauhan and Opena, 2012), *Echinochloa crus-galli* (Ntanos and koutroubas, 2000), *Leptochloa mucronata* (Chauhan and Johnson, 2011), *Echinochloa colona* (Rabbani *et al*., 2011) and *Scirpus dichotomus* (Begum *et al*., 2009).

Management of weeds at proper time by using a proper method is also big challenge because weed plants and rice germinate at the same time in the field (Khaliq and Matloob, 2011). There are several methods including cultural and chemical control which are mainly adopted to avoid weed infestation in DSR. There is a huge opportunity to examine the persistence of different weeds in response to chemical herbicides applied in direct seeded rice. That is why, the current research was planned to study the comparative efficacy of different pre and post-emergence herbicides to control weeds in DSR.

MATERIALS AND METHODS

Experimental Location, Design and Treatments:

The field experiment to evaluate efficacy of different pre and post emergence herbicides was conducted at Agronomic Research Area, University of Agriculture, Faisalabad during summer

season 2018. A Randomized complete block design (RCBD) was used to layout the experiment. It included three replications having net plot size of 6.30 m × 1.80 m. Each plot contained eight rows maintaining row to row distance of 22.5 cm. The experiment was comprised of following treatments.

Factor: Herbicides (H)

H_c: Control/Weedy check

H_w: Hand weeding/ Weed free (3 times hand weeding was done after 20 day's interval)

H_1: Pendimethalin at 1137.5 g a.i. ha^{-1} (pre-emergence)

H_2: Oxadiargyl at 80 g a.i. ha^{-1} (pre-emergence)

H_3: Triafaman+ Ethoxy Sulfuran ethyl at 56.25 g a.i. ha^{-1} (pre-emergence)

H_4: Pyriftalid+ bensulfuron ethyl at 220.32 ml a.i. ha^{-1} (pre-emergence)

H_5: Bispyribac sodium+bensulfuran 75 g a.i. ha^{-1} (post-emergence)

H_6: Phenoxaprop at 431.25 ml a.i. ha^{-1} (post emergence)

H_7: Pendimethalin at 1137.5 g a.i. ha^{-1} (pre-emergence) FB Ethoxy Sulfuran ethyl at 7.5 g a.i. ha^{-1} (post-emergence)

H_8: Oxadiargyl at 80 g a.i. ha^{-1} (pre-emergence) FB Ethoxy Sulfuran ethyl at 7.5 g a.i. ha^{-1} (post-emergence).

Rice Plantation

Preparation of seedbed was done by using the cultivator followed by planking to make soil in well pulverized form. Initially mixed seed of rice and sesbania were broadcasted. After 30-35 days of seed broadcast sesbania and rice was rotavated as a purpose of stale bed technique. For seedbed preparation for rice, soil was ploughed two times followed by planking after incorporation of preceding crop plants. Seed at the rate 30 kg ha^{-1} was sown by using a hand drill during last week of June, 2018 maintaining row to row distance of 22.5 cm. Topsin M was used as a fungicide at 25g/10kg for seed treatment before sowing. Urea, di-ammonium phosphate and murat of potash were used as sources for the application of NPK @ 100, 80, 60 kg ha^{-1} respectively. Full dose of phosphorus, potassium and half dose of nitrogen was incorporated at the preparation of seedbed, while remaining nitrogen was applied at panicle initiation. General recommendations of rice production were followed in respect to all other agronomic operations except the treatment under study.

Procedure for Recording Data

At maturity total number of tillers, productive tillers and number of panicles m^{-2} were recorded from each experimental unit. After that 10 plants were randomly selected to measure the panicle length by using a scale (meter rod) and number of branches and number of grains per panicle were also counted and averaged. Rice plant samples from each plot were weighed after threshing to record the straw yield and paddy yield by weighing of grains. Random sampling of 1000 grains was done and weighed.

A) Weed growth

1) Weed density and dry weight

Weed density was counted separately for each weed specie after 25, 50 and 75 days after sowing. Weeds were uprooted manually and their fresh weight was recorded immediately. After recording fresh weight weeds were kept for oven drying at 70 ºC for 72 hours until the constant weight was achieved and after that dry weight of individual weed specie was recoded. Two quadrates of 0.5 m × 0.5 m placed randomly in each plot to record the density of weed plants. Density and dry weight of weeds was expressed as number m^{-2} and g m^{-2} respectively.

B) Weed dominance analyses

Relative weed density and relative weed dry weight was calculated by using the following formulas;

1) Relative density:

$$\mathrm{RD} = \frac{\text{Density of a given species}}{\text{Total density}} \times 100$$

2) Relative dry weight:

$$\mathrm{RDW} = \frac{\text{Dry weight of a given species}}{\text{Total dry weight}} \times 100$$

Agronomic and yield parameters:

Data regarding agronomic and yield parameters including number of productive tillers, number of grains per

panicle, 1000- grain weight were recorded.

Statistical analysis

The collected data were analyzed by using the Fisher's analysis of variance technique with the help of Statistix 8.1 statistical software and the treatment's means were compared by using least significance difference test (LSD) at 5% level of probability (Montogomery, 2013).

RESULTS

Weed Density

Data pertaining to the weed density m^{-2} after 25, 50 and 75 days of sowing as affected by different herbicides are presented in Table-1.

Weed Density 25 DAS

After 25 days of sowing, highest density (35.67) of broadleaf weeds was recorded in the control treatment where no weeding was done, followed by the phenoxayprop treatment where broadleaf density was found 25.33. Highest density (18.67) of grasses was found in bispyribac sodium+bensulfuran followed by density (16.67) of grasses in control treatment where no weeding was done. Highest density (12.0) of sedges was found in the control treatment where no weeding was done. While no sedges were found in triafaman+ ethoxy sulfuran ethyl, phenoxaprop and hand weeding treatments. The highest total weed density (56.33) was found in the control treatment where no weeding was done, followed by the bispyribac sodium+bensulfuran treatment where total density (48.33) was recorded. While there was no weed found in triafaman+ ethoxy sulfuran ethyl and hand weeding treatments 25 DAS.

Weed Density 50 DAS

After 50 days of sowing, highest density of broadleaf weeds 16.0 was found in the control and phenoxyprop treatments. While no broadleaf weed was found in hand weeding treatment followed by broadleaf weed density (0.33) and (1.33) in Oxadiargyl and triafaman+ ethoxy sulfuran ethyl applied treatments respectively. Highest density (15.67) of grasses was found control treatment where no weeding was done followed by Bispyribac Sodium+Bensulfuran where density (15.0) of grasses was found. While lowest grass weed density (0.33) was found in hand weeding treatment followed by triafaman+ ethoxy sulfuran ethyl treatment where density of grasses was 2.33. The highest density (5.0) of sedges was found each in the control treatment where no weeding was done and in Bispyribac Sodium+Bensulfuran treated plots. While no sedges were found in Triafaman+ ethoxy sulfuran ethyl, phenoxyprop and hand weeding treatments. The highest total density (33.0) was found in the control treatment where no weeding was done, followed by the bispyribac sodium+bensulfuran treatment where total density (26.0) was found. While lowest total weed density (0.33) was found in hand weeding treatment, followed by total weed density (3.66) in Triafaman+ ethoxy sulfuran ethyl applied treatment.

Weed Density 75 DAS

After 75 days of sowing, highest density (9.0) of broadleaf weeds was found in Phenoxyprop treated plot. While lowest broadleaf weed density (0.33) was found in Pendimethalin FB ethoxy sulfuran ethyl treatment, followed by broadleaf weed density (0.67) in Triafaman+ ethoxy sulfuran ethyl applied treatment. The highest density (9.0) of grasses was found control treatment where no weeding was done followed by bispyribac sodium+bensulfuran where density (8.0) of grasses was found. While lowest grass weed density (1.67) was found in phenoxyprop treatment followed by Triafaman+ Ethoxy Sulfuran ethyl and hand weeding where density (2.33) of grasses was found in each treatment. The highest density (3.33) of sedges was found each in the control treatment where no weeding was done and in bispyribac sodium+bensulfuran treated plot each. While no sedges were found in phenoxaprop applied treatment, followed by density (0.67) of sedges in hand weeding, Triafaman+ ethoxy sulfuran ethyl and Pyriftalid+ Bensulfuron ethyl

applied treatments each. The highest total density (20.33) was found in the control treatment where no weeding was done, followed by the Bispyribac Sodium+Bensulfuran treatment where total density (16.67) was found. While lowest total weed density (3.67) was found in Triafaman+ ethoxy sulfuran ethyl treatment, followed by total weed density (6.33) in Pendimethalin FB ethoxy sulfuran ethyl applied treatment.

Relative Weed Density

Data pertaining to the relative weed density m^{-2} after 25, 50 and 75 days of sowing as affected by different herbicides are presented in Table 2.

Relative Weed Density 25 DAS

After 25 days of sowing, highest relative weed density (77.31) of *T. portulacastrum* was found in phenoxyprop treated plot, while lowest relative weed density (0.0) of *T. portulacastrum* was found in Triafaman+ ethoxy sulfuran ethyl and hand weeding treatments. The highest relative weed density (11.20) of *D. aegyptium* was found in Oxadiargyl FB ethoxy sulfuran ethyl treatment, while lowest relative weed density (0.0) of *D. aegyptium* was found in Triafaman+ ethoxy sulfuran ethyl, pyriftalid+ bensulfuron ethyl and hand weeding treatments each. The highest relative weed density (21.64) of *E. colona* was found in pyriftalid+ bensulfuron ethyl treatment, while lowest relative weed density (0.0) of *E. colona* was found in Triafaman+ ethoxy sulfuran ethyl and hand weeding treatments. The highest relative weed density (20.13) of *C. rotundus* was found in pendimethalin treatment, while lowest relative weed density (0.0) of *C. rotundus* was found in Triafaman+ ethoxy sulfuran ethyl, phenoxyprop and hand weeding treatments.

Relative Weed Density 50 DAS

After 50 days of sowing, highest relative weed density (63.79) of *T. portulacastrum* was found in Phenoxyprop treatment, while lowest relative weed density (0.0) of *T. portulacastrum* was found in hand weeding. The highest relative weed density (28.89) of *D. aegyptium* was found in Triafaman+ ethoxy sulfuran ethyl treatment, while lowest relative weed density (0.0) of *D. aegyptium* was found in hand weeding. The highest relative weed density (36.1) of *E. colona* was found in oxadiargyl treatment, while lowest relative weed density (4.76) of *E. colona* was found in hand weeding. The highest relative weed density (27.78) of *C. rotundus* was found in oxadiargyl treatment, while lowest relative weed density (0.0) of *C. rotundus* was found in Triafaman+ ethoxy sulfuran ethyl, phenoxyprop and hand weeding treatments.

Relative Weed Density 75 DAS

After 75 days of sowing, highest relative weed density (65.76) of *T. portulacastrum* was found in phenoxyprop, while lowest relative weed density (6.67) of *T. portulacastrum* was found in pendimethalin FB ethoxy sulfuran ethyl. The highest relative weed density (27.77) of *D. Aegyptium* was found in Triafaman+ ethoxy sulfuran ethyl, while lowest relative weed density (3.03) of *D. aegyptium* was found in phenoxyprop applied treatment. The highest relative weed density (35.83) of *E. colona* was found in pendimethalin FB ethoxy sulfuran ethyl, while lowest relative weed density (9.4) of *E. Colona* was found in phenoxyprop treatment. The highest relative weed density (20.1) of *C. Rotundus* was found in bispyribac sodium+bensulfuran, while lowest relative weed density (0.0) of *C. rotundus* was found in phenoxyprop treatment.

Relative Weed Dry Biomass

Data pertaining to the relative weed dry biomass after 25, 50 and 75 days of sowing as affected by different herbicides are presented in Table-3.

Relative Weed Dry Biomass 25 DAS

After 25 days of sowing, highest relative weed dry biomass (77.86) of *T. portulacastrum* was found in Phenoxyprop treated plot, while lowest relative weed dry biomass (0.0) of *T. portulacastrum* was found in Triafaman+ ethoxy sulfuran ethyl and hand weeding. The highest relative weed dry biomass (13.05) of *D.*

aegyptium was found in oxadiargyl fb ethoxy sulfuran ethyl treated plot, while lowest relative weed dry biomass (0.0) of *D. aegyptium* was found in Triafaman+ ethoxy sulfuran ethyl, pyriftalid+ bensulfuron ethyl and hand weeding treatments. The highest relative weed dry biomass (20.31) of *E. colona* was found in Bispyribac Sodium+Bensulfuran treatment, while lowest relative weed dry biomass (0.0) of *E. colona* was found in Triafaman+ Ethoxy Sulfuran ethyl and hand weeding treatments. The highest relative weed dry biomass (20.78) of *C. rotundus* was found in oxadiargyl, while lowest relative weed dry biomass (0.0) of *C. rotundus* was found in Triafaman+ ethoxy sulfuran ethyl, phenoxyprop and hand weeding treatments.

Relative Weed Dry Biomass 50 DAS

After 50 days of sowing, highest relative weed dry biomass (70.31) of *T. portulacastrum* was found in phenoxyprop treated plot, while lowest relative weed dry biomass (0.0) of *T. portulacastrum* was found in hand weeding. The highest relative weed dry biomass (35.12) of *D. aegyptium* was found in Oxadiargyl, while lowest relative weed dry biomass (0.0) of *D. aegyptium* was found in hand weeding. The highest relative weed dry biomass (25.68) of *E. colona* was found in oxadiargyl treatment, while lowest relative weed dry biomass (0.0) of *E. colona* was found in hand weeding. The highest relative weed dry biomass (24.30) of *C. rotundus* was found in Oxadiargyl, while lowest relative weed dry biomass (0.0) of *C. rotundus* was found in Triafaman+ ethoxy sulfuran ethyl, phenoxyprop and hand weeding treatments.

Relative Weed Dry Biomass 75 DAS

After 75 days of sowing, highest relative weed dry biomass (51.53) of *T. portulacastrum* was found in Phenoxyprop, while lowest relative weed dry biomass (11.08) of *T. portulacastrum* was found in pendimethalin fb ethoxy sulfuran ethyl treatment. The highest relative weed dry biomass (47.95) of *D. aegyptium* was found in Pendimethalin FB Ethoxy Sulfuran ethyl, while lowest relative weed dry biomass (16.56) of *D. aegyptium* was found in Phenoxaprop treatment. The highest relative weed dry biomass (26.73) of *E. colona* was found in Pendimethalin FB Ethoxy Sulfuran ethyl treatment, while lowest relative weed dry biomass (12.36) of *E. colona* was found in control. The highest relative weed dry biomass (17.03) of *C. rotundus* was found in oxadiargyl fb ethoxy sulfuran ethyl treatment, while lowest relative weed dry biomass (0.0) of *C. rotundus* was found in phenoxyprop.

Agronomic and Yield Attributes

Data pertaining to the agronomic and yield parameters as affected by different herbicides are presented in Table-5.

Productive Tillers (m^{-2})

Maximum number of productive tillers (m^{-2}) were recorded 280.63 and 267.50 in hand weeding and Triafaman+ Ethoxy Sulfuran ethyl treatments respectively followed by 194.17 in Pendimethalin FB Ethoxy Sulfuran ethyl applied treatment. While minimum number of productive tillers (53.0) were recorded in control treatment where no weeding was done followed by number of productive tillers 138.50 and 150.90 in pyriftalid+ bensulfuron ethyl and oxadiargyl applied treatments respectively.

Number of Grains Per Panicle

Maximum number of grains per panicle were recorded 102.67 in hand weeding treatment, followed by number of grains per panicle 89.37, 86.60 and 86.13 were recorded Triafaman+ ethoxy sulfuran ethyl, pendimethalin FB ethoxy sulfuran ethyl and Pendimethalin in applied treatments respectively. While minimum number of grains per panicle (51.53) were recorded in control treatment where no weeding was done.

1000 grain weight (g)

Maximum 1000- grain weight was recorded 23.80 and 23.70 in Triafaman+ ethoxy sulfuran ethyl and hand weeding treatments respectively, in all other treatments except control treatment means were non-significant. While in control treatment where no weeding was

done minimum 1000- grain weight (19.80 g) was recoded.

Paddy Yield (t ha^{-1})

Maximum paddy yield was recorded 4.63 and 4.14 t ha^{-1} in hand weeding and Triafaman+ ethoxy sulfuran ethyl treatments respectively followed by 3.5 t ha^{-1} in bispyribac sodium+bensulfuran applied treatment. While minimum paddy yield (1.31) was recorded in control treatment where no weeding was done, followed by paddy yield of 2.14 and 2.19 in Oxadiargyl and Pendimethalin applied treatments respectively.

DISCUSSION

All the parameters recorded during the experiment were significantly affected by the application of different pre and post emergence herbicides and two other control treatments. In triafaman+ ethoxy sulfuran ethyl applied treatment there was not a single weed emerged 50 days after sowing, so it gave an effective control of weeds for a longer period as compared to other applied herbicides. In control treatment where no weeding was done, a large population of weeds infested in that treatment. In weed free and and triafaman+ ethoxy sulfuran ethyl applied treatments yield related parameters like number of productive tillers, number of grains per panicle, 1000-grain weight and paddy yield were recorded maximum, as there was less infestation of weeds in these treatments in comparison with other herbicides applied or control treatment. In control treatment where no weeding was done all the yield contributing attributes were affected by large infestation of weeds.

Triafaman+ ethoxy sulfuran ethyl inhibited aceto lactate synthase (ALS) an enzyme involved in the production and activity of many branched chain amino acids which are integral part of protein molecules. The inhibition of ALS resulted in no emergence of any kind of weeds in Triafaman+ ethoxy sulfuran ethyl applied treatment. While in control treatment where no weeding was done weeds continued to infest and affected the crop growth. Similar results were demonstrated by (Naik *et al*., 2018; Menon *et al*., 2016; Deivasigamani, 2016; Singh *et al*., 2012).

Applied inputs during the growing period to the crop and their uptake in optimum amount by the plant have major role in the vegetative growth and plant height is major sign of optimum growth of plant and has direct relation with competition to weeds (Saito *et al*., 2010; Mennan *et al*., 2012). Weed plants strived with main crop for different growth elements like sunlight, moister contents, nutrition and space which affected plant growth and development. Variation in plant height was observed under different weed populations. The ability of rice to compete with weeds depends fundamentally on capturing of sunlight and plants with taller height are more efficient in intercepting the sunlight (Rao *et al*., 2007).

As the period of weed competition increased number of productive tillers were reduced. Large weed infestation for a long period in the field reduced the availability of resources to plant specially nitrogen which forms different kind of amino acids which are integral protein part to rice plants due to which abortive tillers were increased (Morshed *et* al., 2015; Adhikari *et al*., 2018). After the end of competition there was another competition between rice plants themselves for carbohydrates which decreased the number of productive tillers. Formation of tillers is a genetic character but it is also largely dependent upon the availability of resources for plant growth as well as on the competition of rice plants with weeds and competition between themselves (Fageria, 2007). High population of weeds and less number of productive tillers resulted in reduction of paddy yield in these treatments. Similar results were described by (Veeraputhiran and Balasubramanian, 2013; Deepthi *et al*., 2010).

CONCLUSION

On the basis of recoded results, Triafaman+ ethoxy sulfuran ethyl and hand weeding provide effective control of weeds and recorded higher paddy yield as compared to all other herbicidal and control treatment. As hand weeding is cumbersome and time consuming operation, application of triafaman+ ethoxy sulfuran ethyl 56.25 g a.i ha^{-1} as pre-emergence herbicide is recommended to get effective control of weeds and higher yield in direct seeded rice.

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Table-1. Effect of Different Pre and Post Emergence Herbicides on Weed Density (Broad Leaf, Grasses, Sedges and Total) 25 DAS, 50 DAS and 75 DAS.

Treatments	Weed Density 25 DAS				Weed Density 50 DAS				Weed Density 75 DAS			
	Broadleaf	**Grass**	**Sedges**	**Total**	**Broadleaf**	**Grass**	**Sedges**	**Total**	**Broadleaf**	**Grass**	**Sedges**	**Total**
H_1	9.0 d	9.33 b	8.33 b	24.33cd	6.33 c	11.00 b	3.00 b	20.33 c	8.67 ab	4.0 bc	1.33 bc	14.0 c
H_2	8.0 d	6.33 b	5.0 cd	19.33 d	0.33 d	3.33 de	2.33 bc	6.0 e	2.33 de	5.0 b	1.67 b	9.0 de
H_3	0.0 e	0.0 c	0.0 f	0.0 e	1.33 d	2.33def	0.0 d	3.66 ef	0.67 e	2.33 cd	0.67 bc	3.67 g
H_4	18.67 c	1.0 c	0.67 f	20.33 d	12.33 b	5.67 c	2.0 bc	20.0 c	6.33 bc	3.0 cd	0.67 bc	10.0 d
H_5	21.33 c	18.67 a	8.33 b	48.33 b	6.0 c	15.00 a	5.0 a	26.0 b	5.33 c	8.0 a	3.33 a	16.67 b
H_6	25.33 b	1.67 c	0.0 f	27.0 c	16.0 a	1.67 ef	0.0 d	17.67 c	9.0 a	1.67 d	0.0 c	10.67 d
H_7	10.0 d	7.0 b	3.6 de	20.66 d	6.0 c	4.00 cd	1.33 cd	11.33 d	0.33 e	5.0 b	1.0 bc	6.33 f
H_8	10.33 d	7.3 b	2.6 e	20.33 d	5.67 c	4.00 cd	1.33 cd	11.0 d	2.67 de	3.67 bc	1.0 bc	7.33 ef
H_c	35.67 a	16.67 a	12.0 a	56.33 a	16.00 a	15.67 a	5.0 a	33.0 a	8.0 ab	9.0 a	3.33 a	20.33 a
H_w	0.0 e	0.0	0.0 f	0.0 e	0.0 d	0.33 f	0.0 d	0.33 f	4.0 cd	2.33 cd	0.67 bc	7.0 e
LSD $_{0.05}$	**4.14**	**3.62**	**1.74**	**6.52**	**2.37**	**2.26**	**1.43**	**3.64**	**2.36**	**1.91**	**1.50**	**2.48**

Table-2. Effect of Different Pre and Post Emergence Herbicides on Relative Weed Density (*Trianthema portulacastrum, Dactyloctenium aegyptium, Echinochloa colona and Cyprus rotundus*) 25 DAS, 50 DAS and 75 DAS.

Treatments	Relative Weed Density 25 DAS				Relative Weed Density 50 DAS				Relative Weed Density 75 DAS			
	T. portulacastrum	***D. aegyptium***	***E. colona***	***C. rotundus***	***T. portulacastrum***	***D. aegyptium***	***E. colona***	***C. rotundus***	***T. portulacastrum***	***D. aegyptium***	***E. colona***	***C. rotundus***
H_1	26.47 cd	10.90 ab	18.18 ab	20.13 a	21.53 ef	13.18 b	29.24 ab	11.85 b	38.77 b	11.71 c	16.71 cde	9.33 ab
H_2	29.03 cd	6.80 c	15.65 abc	18.82 a	4.17 g	9.72 bc	36.11 a	27.78 a	21.94 bc	22.41 ab	29.91 ab	18.70 a
H_3	0.0 e	0.0 d	0.0 c	0.0 e	28.89 de	28.89 a	35.55 a	0.0 c	25.0 bc	27.77 a	27.78 abc	19.44 a
H_4	67.48 a	0.0 d	21.64 a	3.12 de	45.0 b	10.0 bc	13.33 def	13.33 b	46.26 ab	10.07 cd	17.10 bcde	7.41 ab
H_5	32.54 cd	10.89 ab	18.39 ab	13.45 b	16.73 f	15.28 b	31.04 ab	15.2 b	24.14 bc	15.93 bc	23.9 abcd	20.1 a
H_6	77.31 a	2.34 d	3.73 bc	0.0 e	63.79 a	3.81 cd	5.77 ef	0.0 c	65.76 a	3.03 d	9.4 e	0.0 b
H_7	33.87 c	9.75 abc	14.30 abc	12.85 bc	37.97 bc	8.93 bc	17.39 cd	8.93 b	6.67 c	26.11 a	35.83 a	15.0 ab
H_8	21.08 d	11.20 a	13.04 abc	8.09 cd	33.23 cd	11.92 b	15.25 cde	9.14 b	27.98 bc	22.62 ab	22.02 bcde	13.1 ab
H_c	48.24 b	7.72 bc	11.93 abc	15.05 ab	28.23 de	14.24 b	25.13 bc	12.21 b	38.1 b	14.28 c	22.84 bcd	9.52 ab
H_w	0.0 e	0.0 d	0.0 c	0.0 e	0.0 g	0.0 d	4.76 f	0.0 c	29.8 bc	16.48 bc	14.28 de	13.0 ab
LSD $_{0.05}$	**11.75**	**3.26**	**16.36**	**5.34**	**8.75**	**7.06**	**10.13**	**7.44**	**26.45**	**7.51**	**12.87**	**16.46**

Table-3. Effect of different pre and post emergence herbicides on relative weed dry biomass (*Trianthema portulacastrum, Dactyloctenium aegyptium, Echinochloa colona and Cyprus rotundus*) 25 DAS, 50 DAS and 75 DAS.

Treatments	Relative Weed Dry Biomass 25 DAS				Relative Weed Dry Biomass 50 DAS				Relative Weed Dry Biomass 75 DAS			
	T. portulacastrum	*D. aegyptium*	*E. colona*	*C. rotundus*	*T. portulacastrum*	*D. aegyptium*	*E. colona*	*C. rotundus*	*T. portulacastrum*	*D. aegyptium*	*E. colona*	*C. rotundus*
H_1	30.93 cd	10.90 a	17.66 ab	18.9 a	53.89 bcd	16.0 bc	14.47 c	9.67 c	42.11 ab	25.18 cd	17.7 ab	12.08 a
H_2	29.03 d	10.42 a	15.64 ab	20.78 a	8.09 e	35.12 a	25.68 a	24.30 a	36.61 ab	29.06 bcd	15.38 ab	13.18 a
H_3	0.0 e	0.0 c	0.0 c	0.0 c	43.01 d	25.72 ab	23.0 ab	0.0 d	19.49 bc	42.79 ab	20.76 ab	13.93 a
H_4	72.03 a	0.0 c	4.97 c	3.12 c	63.9 ab	12.65 c	12.82 c	9.03 c	40.84 ab	26.27 cd	12.91 b	6.59 ab
H_5	34.53 cd	10.9 a	20.31 a	14.06 b	46.96 cd	25.74 ab	15.99 bc	14.6 b	39.68 ab	32.49 abc	12.93 b	12.29 a
H_6	77.86 a	2.34 c	3.73 c	0.0 c	70.31 a	7.55 cd	9.21 c	0.0 d	51.53 a	16.56 d	19.27 ab	0.0 b
H_7	33.89 cd	11.45 a	15.79 ab	13.19 b	60.85 ab	11.43 cd	9.71 c	9.55 c	11.08 c	47.95 a	26.73 a	8.23 ab
H_8	37.65 c	13.05 a	16.39 ab	9.94 b	56.06 bcd	16.47 bc	14.78 c	10.76 bc	40.67 ab	24.44 cd	19.16 ab	17.03 a
H_c	48.23 b	6.72 b	12.88 b	13.54 b	56.91 bc	16.13 bc	12.95 c	10.78 bc	43.12 ab	28.09 bcd	12.36 b	8.82 ab
H_w	0.0 e	0.0 c	0.0 c	0.0 c	0.0 e	0.0 d	0.0 d	0.0 d	54.0 a	19.31 cd	16.82 ab	10.73 ab
LSD $_{0.05}$	**7.68**	**2.97**	**5.16**	**4.76**	**13.22**	**11.68**	**7.43**	**4.15**	**24.34**	**15.58**	**13.77**	**11.19**

Table-5. Effect of different pre and post emergence herbicides on productive tillers (m^{-2}), No. of grains per panicle, 1000- grain weight (g) and paddy yield (t ha^{-1}).

Treatments	Productive Tillers	No. of Grains per Panicle	1000- Grain Weight	Paddy Yield
Pendimethalin	168.90 cd	86.13 b	22.033 b	2.19 e
Oxadiargyl	150.90 de	75.67 c	21.73 b	2.14 e
Triafaman+ Ethoxy Sulfuran ethyl	267.50 a	89.37 b	23.80 a	4.14 ab
Pyriftalid+ Bensulfuron ethyl	138.50 e	72.37 cd	21.97 b	2.56 e
Bispyribac Sodium+Bensulfuran	168.60 cd	64.70 d	22.167 b	3.5 bc
Phenoxaprop	180.30 bc	70.60 cd	21.80 b	3.27 cd
Pendimethalin FB Ethoxy Sulfuran ethyl	194.17 b	86.60 b	21.367 b	3.34 cd
Oxadiargyl FB Ethoxy Sulfuran ethyl	177.50 bc	76.63 c	21.63 b	2.68 de
Control/Weedy check	53.00 f	51.53 e	19.80 c	1.31 f
Hand Weeding	280.63 a	102.67 a	23.70 a	4.63 a
$LSD_{0.05}$	**22.18**	**7.89**	**1.38**	**0.69**