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EFFECT OF HERBIGATION BASED WEED MANAGEMENT PRACTICES ON WEED DYNAMICS AND YIELD IN DIRECT SOWN AEROBIC RICE (*Oryza sativa* L.)

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A Field experiment was conducted at Annamalai University experimental farm during the season *Summer*, 2020. to find out the effect of herbigation based weed management practices in direct sown aerobic rice on weed and yield parameters. The experiment was laid out in randomized block design with eight treatments and replicated thrice. The results showed that among the different herbigation treatments, PE herbigation of pretilachlor 6% + bensulfuron methyl 0.6% GR @ 10 kg ha^{-1} on 3 DAS + PoE herbigation of bispyribac sodium 10% SC @ 200 mL ha^{-1} on 20 DAS recorded lower weed density Table 1., Fig.1. (23.70 m^{-2} and 33.52 m^{-2}) less dry weight of weeds (39.3 kg ha^{-1} and 65.10 kg ha^{-1}) which exhibited highest WCE (87.65 and 89 %), than other treatments at 20 and 40 DAS whereas, weed free check stood superior in all the aspects of crop and weed parameters except in monetary returns. Suppression of weeds among the treatments resulted in weed free plot to record higher grain yield. PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 ml ha^{-1} on 20 DAS recoded highest grain yield of (6156 kg ha^{-1}) and lowest weed index of (2.56 %) and it was on par with PE application of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* HW on 30 DAS (6107 kg ha^{-1}) which was significantly superior to other treatments. Weedy check had accounted for lower yield of (3500 kg ha^{-1}) and highest weed index (44.60 %) due to heavy weed infestation.

Key words: Drip Irrigation-Weed Management-Herbigation-Direct Sowing-Aerobic Rice

Introduction

Globally, rice (*Oryza sativa* L.) is being widely cultivated in tropical regions and it is cultivated in an area of 164 million hectares and a production of 756.74 million tonnes with a productivity of 4.6 tonnes ha^{-1} (FAO STAT, 2022). India has the largest area among rice growing countries and ranks second in production. It produces 100 million tonnes of rice in an area of 43.97 million hectares with the productivity of 2.27 tonnes per hectare. Rice occupies about 26 per cent of total cropped area of the country and contributes 44 per cent of total food grain production and 45 per cent of total cereal production. As one of the prime food crop, rice is consumed by more than half of the world population providing around 20 per cent of the world's dietary energy supply. In Tamil Nadu, rice is grown in an area of 1.85 million hectare with a production of 6.95 million tonnes and productivity of 3.7 t ha^{-1} (Anonymous., 2019) This is crucial for food security

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in many Asian countries including India where large and dense populations depend on subsistence agriculture (Thakur *et al*., 2014). In major rice growing areas, farmers are already facing a challenge to produce more rice with limited water in order to meet the food demand of the growing population. Recently, drip irrigation can be recommended for aerobic rice to increase the productivity besides saving water. Drip irrigated rice is a new innovative production system in which seeds are directly sown in well-drained and non puddled soil using mechanized multi-crop seed drills and the crop is grown in unsaturated soil moisture conditions for the entire crop duration (Sharda *et al*., 2017). It involves using high yielding varieties well-adapted to aerobic conditions and responsive to irrigation and fertigation, attaining high yields (Sharma *et. al*., 2018). Direct-seeded aerobic rice is subject to more severe weed infestation than transplanted lowland rice, because in aerobic rice systems weeds germinate simultaneously with rice, and there is no water layer to suppress weed growth. In aerobic rice, weeds cause yield loss to an extent of 56.4 to 90.70 percent (Paradkar *et al*., 1997). There is an equal competition between the crop and weeds in absorption of nutrients and moisture, to avoid this weed management is an important agro-technique for successful cultivation of aerobic rice. Weed free condition during the critical period of competition is absolutely essential for obtaining maximum yield. This can be achieved by either application of pre emergence or post emergence or combination of both or manual weeding. Manual weeding although effective and most common practice of weed control in rice, increasing labour wages and scarcity of labour during peak period of agricultural operation lead to the search for alternative methods. Herbicides offer the most effective, economical and practical way of weed management. Herbigation is another technique, where herbicides are applied through ventury along with the irrigation water and applied through the irrigation system to crop, weed or field. However, it requires detailed investigation. In drip irrigated aerobic rice, there is possibility to adopt herbigation through drip irrigation system along with other weed control methods, whose efficiency needs to be worked out. Hence, the present investigation was undertaken to study the effect of different herbicide combinations through herbigation along with manual weeding on weed dynamics and yield of aerobic rice under drip irrigation.

Materials and Methods

A Field experiment was conducted at Annamalai University Experimental Farm. during the seasons of kharif 2020, to find out the effect of herbigation based weed management practices on weed dynamics and yield in direct sown aerobic rice. The field trial was conducted in the experimental field plot of Q8 Block at Annamalai University experimental farm. The experimental farm is situated at 11°24'N latitude, 79°41'E longitude at an altitude of 5.79 m above mean sea level, the maximum temperature ranged from 38.4 ^{0}C to 30.6 ^{0}C with a mean of 34.3 ^{0}C and minimum temperature ranged from 27.2 ^{0}C to 20.9 ^{0}C with a mean of 24.8^{0}C. The relative humidity ranged from 92 to 75 per cent with a mean of 82.26 per cent. The bright sunshine hours and wind velocity ranged from 9.7 h d $^{-1}$ to 4.6 h d $^{-1}$ and from 6.9 km h^{-1} to 1.3 km h^{-1} with a mean of 7.7 h d $^{-1}$ and 3.55 km h^{-1} respectively. The soil of the experimental field was clay loamy soil

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with pH of 7.2 and EC of 0.32 dS m^{-1} and low in medium in available nitrogen, low in phosphorus, and high in potassium, contents respectively. The experiment was conducted in Randomized Block design with 8 treatments which are replicated thrice. T_1-PE herbigation of pendimethalin 1.0 kg ha^{-1}on 3 DAS *fb* HW on 30 DAS, T_2-PE herbigation of pyrazosulfuron ethyl 10 % WP @ 500 g ha^{-1} on 3 DAS *fb* HW on 30 DAS, T_3-PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* HW on 30 DAS , T_4-PE herbigation of pendimethalin 1.0 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribacsodium 10 % SC @ 200 mL ha^{-1} on 20 DAS, T_5- PE herbigation of pyrazosulfuron ethyl 10 % WP @ 500 g ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL ha^{-1} on 20 DAS, T_6 - PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mLha^{-1} on 20 DAS, T_7- Weed free check, T_8-Weedy check. A medium duration variety AU 1 GSR was used in the trial. Manual line sowing of seeds has done in the finely prepared dry soil. Drip system was installed with the lateral spacing of 100 cm and emitter/dripper spacing of 60 cm. Discharge rate of drippers was 4.0 litre per hour. Irrigation was given at every three days based on Pan Evaporation from open pan evaporometer (USWB class A) situated at Agro meteorology observatory, Annamalai university, Chidambaram throughout the cropping period. Recommended dose of fertilizer (150: 50:50 kg N P K ha^{-1}) was adopted as fertigation. Control valves were fixed in all the plots to facilitate controlling the water flow and application of herbicides as per treatments. Herbigation was preceded by drip irrigation for 30 minutes and the irrigation was done for 30 minutes after herbigation to get spread the chemicals completely and uniformly.

Biometric observations on weed flora, total weed count, weed dry matter production and weed control efficiency, grain yield and weed index were recorded. Weed count was recorded by using 0.25 m^{-2} quadrate at four places in each plot and expressed as number m^{-2}. Weed dry weight in each treatment was worked out taking the weeds from net plot area, sundried followed by drying at 60 ^{0}C till it attained constant weight. Square root transformation (x+0.5) was used to analyse the data on weeds.

Indices were calculated after reviewing the literatures. Formula of Mani *et al.* (1973) was adopted for computing the weed control efficiency, weed index by Gill and Vijaykumar (1969). Indices calculated are as follows:

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

$$\text{Weed index (WI)} = \frac{\text{Grain yield in weed free plot - Grain Yield in weed free plot}}{\text{Grain yield in weed free plot}}$$

Statistical analysis:

The data on weeds were statistically analysed (Gomez and Gomez, 1984). The data on weed density were subjected to square root transformation $\sqrt{(x+0.5)}$ before analysis. The critical difference was worked out at five percent probability level.

Results and Discussion

The predominant weeds observed in the field were weed species like *Echinocloa colona*, *Leptochloa chinensis*, *Panicum repens, Cynodan dactylon,* among grasses *Cyperus rotundus , Cyperus difformis* among sedges *Eclipta alba, Trianthema portulacastrum, Phyllanthus maderaspatensis, Phyllanthus niruri,* among Broad leaved weeds .whereas*, Chloris barbata Euphorbia prostrata, Commelena benghalensis, Portulaca olereceae* are less in number. Similar weed species under direct sown aerobic rice were also reported by Palani (2020), Kanimozhi (2019), Nambi (2017), Jagadish (2015).

Effect on weeds:

Application of pre emergence herbicides and post emergence herbicides had a significant effect on weed density, weed dry weight and weed control efficiency (Table 1, Fig.1.) Among the herbigation based weed management practices T_6- PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL ha^{-1} on 20 DAS registered significantly lower weed density (23.70 m^{-2} and 33.52 m^{-2}), dry weight (39.3 kg ha^{-1} and 65.10 kg ha^{-1}) and higher WCE (87.65 and 89 %) at 20 and 40 DAS. This is due to application of pretilachlor + bensulfuron methyl herbigation controlled the weeds effectively through inhibition of mitosis, cell division and acetolactate synthase (Sunil *et al*., 2010). which is on par with T_3-PE herbigation of pretilachlor 6% + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* HW on 30 DAS. Weed free check registered significantly lower weed density dry weight and higher WCE (97 %, 97.2 %) at 20 and 40 DAS. Reduced weed density, dry weight and higher weed control efficiency might be due to broad spectrum control of weeds by PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 25 g ha^{-1} on 20 DAS. Unweeded control recorded higher weed density (191.96 m^{-2}, 241.96 m^{-2}), increased dry weight (339.8 kg ha^{-1}, 499.4 kg ha^{-1}) at 20 and 40 DAS.

The weed index is a measure of yield reduction due to weed competition. Among different herbigation based weed management practices PE herbigation of pretilachlor 6% + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 10% SC @ 200 mL ha^{-1} on 20 DAS recorded lower weed index Table 2, Fig 2, (2.56 %). weedy check (44.60 %) Table 2, Fig 2, recorded the highest weed index as a result of severe weed competition. The competition offered by weeds for nutrients, moisture, space and light was higher in weedy check as indicated through lower growth and yield components. This ultimately reduced the grain yield significantly. Lower weed index was recorded with weed free. These results are in conformity with the findings of Bhanu Rekha *et al.,* (2003) and Abhishek *et al.,* (2017)

Effect on yield

Among different herbigation based weed management practices the higher grain yield of (5755 kg ha^{-1}) which is 55 % highest was observed in PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 10% SC @ 200 mL ha^{-1} on 20 DAS this was due to better control of weeds as this weed free condition resulted in availability of more amount of space, nutrients, moisture and light to the crop

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which in turn put forth better growth in terms of reducing of all types of weeds during most part of the crop growth resulted in higher grain yield and it was on par with PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* HW on 30 DAS which was significantly superior to weedy check and other treatments.

Conclusion:

The above study indicates that PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha^{-1} on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL ha^{-1} on 20 DAS has recorded less weed density, lower weed DMP, highest WCE which lead to obtain higher grain yield and straw yield and less weed index. Hence, it is recommended to farmers to practice the above herbicide combination through herbigation as to control the weeds in an efficient way.

Table 1. Effect of herbigation based weed management practices on weed density and weed dry matter production and weed control Index on 20 and 40 DAS in direct sown aerobic rice

Treatments	Total weed count at 60 DAS (no. m^{-2})				Total weed count at 40 DAS (no. m^{-2})				Weed DMP (kg ha^{-1})		WCE (%)	
	Grasses	Sedges	BLW	Total weed density	Grasses	Sedges	BLW	Total weed density	20 DAS	40 DAS	20 DAS	40 DAS
T_1	4.28 (17.79)	2.81 (7.37)	4.84 (22.93)	6.97 (48.09)	4.72 (21.79)	3.14 (9.37)	5.24 (26.93)	7.65 (58.09)	80.05	113.3	74.95	76.8
T_2	4.93 (23.77)	3.33 (10.56)	5.52 (29.96)	8.05 (64.29)	5.32 (27.77)	3.61 (12.56)	5.87 (33.96)	8.65 (74.29)	106.97	144.4	66.51	91.5
T_3	3.08 (8.97)	1.95 (3.30)	3.59 (12.36)	5.01 (24.63)	3.67 (12.97)	2.41 (5.30)	4.11 (16.36)	5.93 (34.63)	40.36	67.44	87.17	73.3
T_4	4.02 (15.67)	2.64 (6.46)	4.58 (20.51)	6.57 (42.64)	4.49 (19.67)	2.99 (8.46)	5.00 (24.51)	7.29 (52.64)	86.18	102.2	77.79	66.1
T_5	4.79 (22.44)	3.14 (9.38)	5.53 (30.12)	7.90 (61.94)	5.19 (26.44)	3.45 (11.38)	5.88 (34.12)	8.51 (71.94)	100.92	137.4	67.73	60.8
T_6	3.00 (8.52)	1.89 (3.08)	3.55 (12.10)	4.92 (23.70)	3.61 (12.52)	2.36 (5.08)	4.07 (16.10)	5.85 (33.52)	39.3	65.10	87.65	89.0

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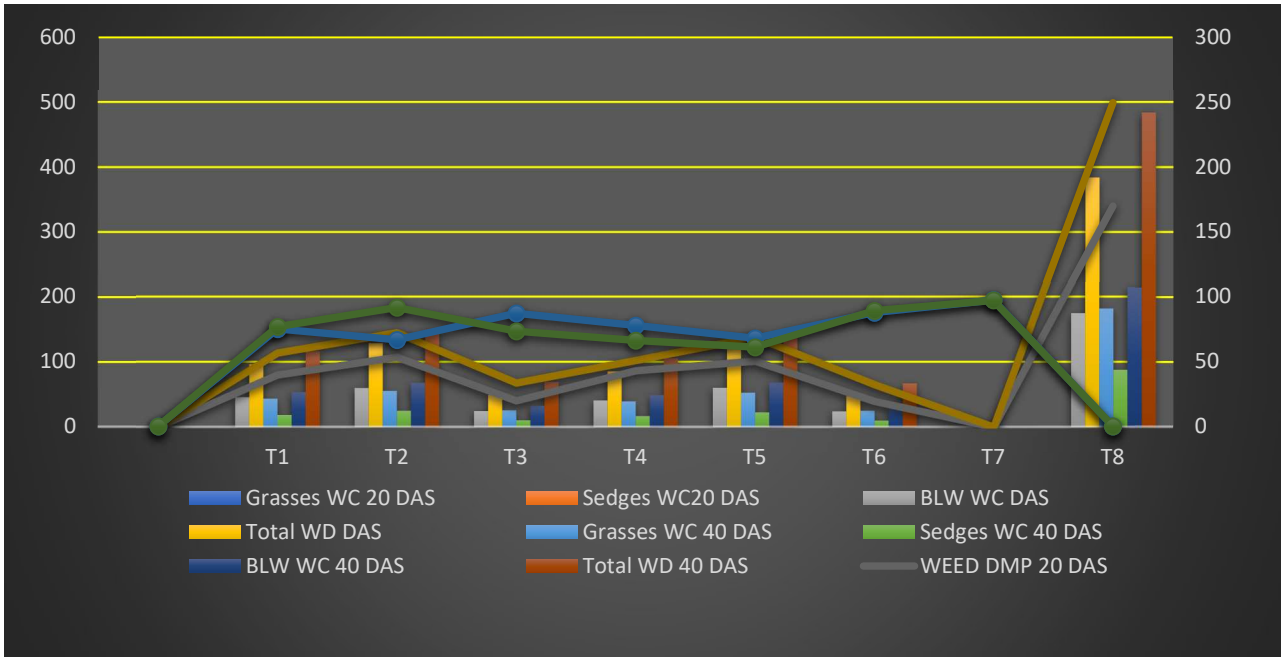
T_7	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.0	0	97.40	97.2
T_8	8.44 (70.80)	5.87 (33.92)	9.37 (87.24)	13.87 (191.96)	9.56 (90.80)	6.66 (43.92)	10.38 (107.24)	15.57 (241.96)	339.8	499.4	0.00	0.00
S.Ed	0.09	0.06	0.12	0.15	0.11	0.07	0.12	0.17	2.12	3.02	NA	NA
CD(p=0.5)	0.21	0.14	0.25	0.33	0.23	0.16	0.25	0.37	4.50	6.40	NA	NA

* *Figures in parenthesis indicates original values, DAS-Days after sowing, BLW- Broad leaved weeds ,
NA- statistically not analyzed



* *Figures in parenthesis indicates original values, DAS-Days after sowing, BLW- Broad leaved weeds ,
DMP-dry matter production, WUE-weed control efficiency.

Fig 1: Weed density and weed dry matter production on 60 DAS as influenced by various herbigation based weed management practices in direct sown aerobic rice

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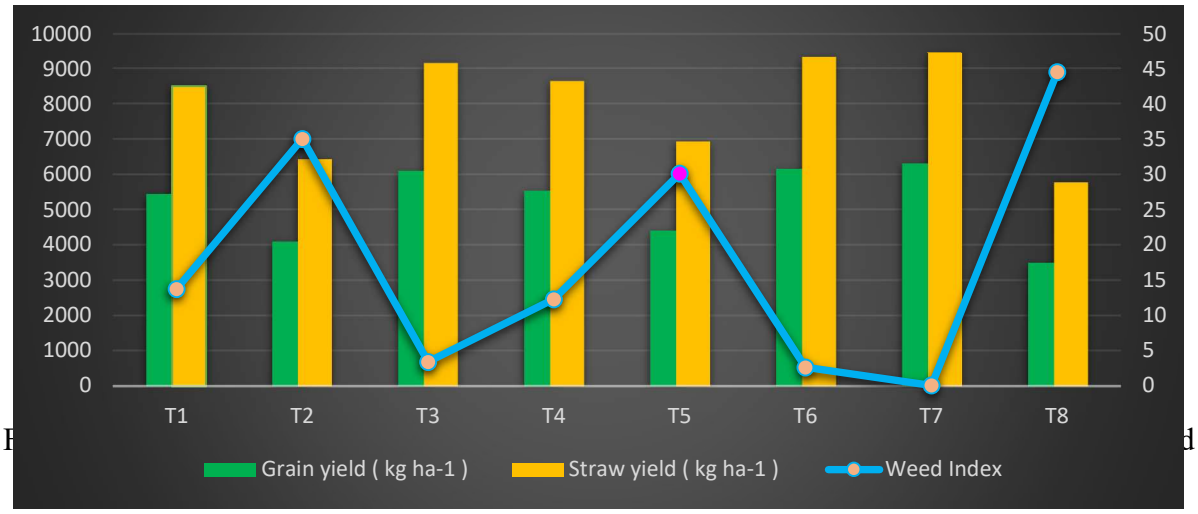
Table 2. Effect of herbigation based weed management practices on grain yield , straw yield and weed index in direct sown aerobic rice

Treatment	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Weed Index
T_1	5451.8	8504.7	13.72
T_2	4100.5	6437.8	35.10
T_3	6107.1	9160.6	03.34
T_4	5544.9	8650.0	12.24
T_5	4415.5	6932.3	30.12
T_6	6156.6	9334.9	02.56
T_7	6318.7	9478.1	00.00
T_8	3500.2	5775.3	44.60
S.Ed	150.4	243.0	NA
CD(p=0.5)	314.6	494.0	NA



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