Original Research Article

Effect of Herbicides Combination on Weed Management and Yield ofDirect Wet Seeded Rice (*Oryza sativa* L.)

ABSTRACT

Rice is the most stable food crop in the world, especially in Southeast Asia. Different types of methods are used in rice cultivation *viz.*, conventional method and the no-till (direct seeding) method. Now a days, the direct seeding method of rice cultivation is gaining popularity among farmers due to its lowerlabour and energy requirements. In direct seeding rice weeds are the major hindrance, which compete with crops for important factors suchas light, space, nutrient and moisture. To manage the weeds population in direct-seeded rice, a study was conducted in the *summer*,2022 to find out the best herbicide combination. The design adopted for this experiment was Randomized Block Design (RBD) with 12 treatments and 3 replications. The results of the study revealed that a weed free plot (T_{11}) followed by the application of Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS and 40 DAS (T_9) recorded higher weed control efficiency, lesser weed density and weed dry weight compared to all other treatments. Asimilar trend was observed in yield attributes like number of tillers m^{-2}, number of productive tillers m^2, panicle length, number of grains $panicle^{-1}$, test weight, higher grain and straw yield of direct wet seeded rice.

Key words: Herbicide mixtures, direct wet seeded rice, weeds, yield attributes

INTRODUCTION

Rice is the most significant stable food crop nourishing two third of the Southeast Asianpopulation. In India, rice is extensively grown in an area of 47.70 million ha, with a production of 136 million metric tonnes and productivity of 4.28 metric tonnes per ha [1]. For emergence, rice needs anoptimal temperature of 16°C – 27°C and rainfall of 100 cm to 200 cm during its growth period. Though rice canbe grown in all kinds of soil right, from light to heavy, clay will be the most appropriate for realising maximum productivity[2]. When compared to other grains like maize, wheat and potatoes, rice is a boundless source of carbs, as well as other minerals like calcium, iron, and thiamine as well as pantothenic acids, folate, and vitamin E.It covers 5.8 g -7.7 g of protein, 0.5 g -2.3 g of fat, 0.01 g -0.78 g of crude

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Comment [IA2]: carbohydrates

fiber, 0.12 g -1.22 g of crude ash and 76.80 g -86.56 g of carbohydrates [3]. In India, rice has been cultivatedusing various methods like transplanting and direct seeding. In transplanting, demands for continuous water stagnation has been maintained throughout the season.

The wet-seeded method of ricecutting down the labour requirement by 97% compared to traditional methods owing to the absence of nursery preparation [4]. In India, pest damage accounts for 33% of total rice yield losses, whereas weeds account for 12.5%. *Kharif* rice showed more weed flora than summer transplanted rice [5]. In the case of direct seeded rice, the emergence of weeds occurs simultaneously with the crop's emergence, which has a substantial impact on the overall quality of the crop and acts as a vector for the main insects and pests. Weeds play a negative role in the emergence of crops at early stages of growth, and they compete with other crops. To reduce the weed flora in direct seeded rice hand weeding is the best one.However, due to a lack of labour and high labour wages, this method is no longer feasible. When compared to manual weeding, chemical weed control is the most effective way to suppress the weeds in direct-sown rice.

Nevertheless, a single weed control technique may not be sufficient to reduce weeds to the economic threshold level and may lead to a change in weed flora, the development of resistance and environmental threats. Therefore, it is imperative to adopt a variety of technologies for weed management, as weed communities are highly adaptable to management strategies [6].Hence, an experiment was carried out to study the effect of different herbicide combinations on wet direct seeded rice.

MATERIALS AND METHODS

Comment [IA3]: A method for the application of herbicide should be provided, such as spraying? or spreading, Time of the application relative to sowing, etc.
Weed free treatment should be clearly described, how to prepare this weed free plot.

To evaluate the effect of different combination of herbicides on weed control and yield of direct seeded puddled lowland rice, an experiment was conducted at Wetland farms, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, during *summer*,2022. The trial site is located at 11°N latitude and 77°E longitude with an elevation of 426.7 m above mean sea level which is classified under the western agricultural climate zone of Tamil Nadu. The edaphic characteristics of the trial site include clay loam soil type, alkaline pH of 8.10 with an EC of 0.50 (dSm^{-1}), high organic content (1.42%), low available nitrogen (125.60 kg ha^{-1}), high available phosphorus (36.75 kg ha^{-1}) and high available potassium (282.00 kg ha^{-1}).

The field experiment was designed in a Randomized Block Design (RBD) with three

replications and twelve treatments. The treatment details are, T_1 -Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS, T_2 - Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1}on 15 DAS, T_3- Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1}on 15 DAS, T_4 - Pretilachlor 50% EC @ 625 g a.i.ha^{-1}on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} on 15 DAS,T_5 - Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} on 15 DAS, T_6 - Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS, T_7 - Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS, T_8 - Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS & 40 DAS, T_9 - Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i.ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i.ha^{-1} (Tank Mix) on 15 DAS & 40 DAS, T_{10} - Recommended practice (Pretilachlor 50% EC @ 750 g a.i. ha^{-1} on 3 DAS *fb* one hand weeding on 40 DAS), T_{11} - Weed free, T_{12} - Weedy check. The rice variety chosen for the experiment was CO 55 and adopted a spacing of 20 cm × 10 cm. Other management practices were adopted as per the recommendation.Weed control efficiency (WCE) was calculated by using the formula,

$$\text{Weed Control Efficiency} = \frac{\text{Wpc - Wpt}}{\text{Wpc}} \times 100$$

Where,

Wpc = Weed population in the control plot

Wpt =Weed population in the treated plot

Observation on weed flora, density and dry weight was recorded at 20, 40 and 60 DAS and yield attributes of direct wet seeded rice was recorded at the time of harvest and the data was statistically analysed by following the analysis of variance for Randomized Block Design (RBD) as suggested by Gomez and Gomez [7]. Statistical significance was tested with the F test at a 5 per cent level of probability and compensed with treatmentmeans with the critical difference.

RESULT AND DISCUSSION

A. Weed flora

Major weeds observed in the experimental field were *Echinochloa crus-galli*, *Echinochloacolona* and *Leptochloa chinensis* among grassy weeds; *Cyperus iria* and *Cyperus difformis* among sedges and *Ecliptaprostrata*among broadleaved weeds(Table 1).These findings were in confirmitywith Guru [8].

B. Weed Density

Weed density represented the degree of competition from weeds on the crop(Table 2). The treatment showing the lowest weed density was considered the best. Weed control practices had a major impact on weed populations. The total weed population was significantly reduced by various weed control measures. Lower weed density was observed in weed-free plots (T_{11}) with 0.71 m^{-2} at 20,40 and 60DAS followed by treatment with Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank mix) on 15 DAS and 40 DAS(T_9) with 5.92 m^{-2}, 7.40 m^{-2} and 8.87 m^{-2} at 20,40 and 60DAS respectively. This might be due to reduced weed infestation, as evident from lower weed density and bio-mass which facilitated better utilization of grown resources and reproductive potential of the crop.These findings were in confirmitywithTeja [9].

C. Weed Dry Weight Accumulation

Higher weed dry weight was recorded(Table 3) in weedy check (T_{12}) with 9.69 g m^{-2},11.33 g m^{-2}, 13.11 g m^{-2} at 20,40 and 60 DAS and lower weed dry weight was recorded in weed free (T_{11}) with 0.71 g m^{-2} at 20,40 and 60DAS followed byPretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS and 40 DAS (T_9) with 3.44 g m^{-2}, 4.11 g $m^{-2}$and 6.41 g m^{-2}at 20,40 and 60 DAS, respectively.Similar findings were also recorded Kumar [10].

Comment [IA4]: Interpretation of data found in this present study should be made first before the finding by other study. For example "this data indicate that more herbicides is required to reduce the weed dry weight in the rice field.

D. Weed Control Efficiency

The weed control efficiency was maximum underthe weed free plot (T_{11}) with 100% at 20,40 and 60 DAS respectively(Fig 1).followed by treatment with Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i.ha^{-1} (Tank Mix) on 15 DAS and 40 DAS with 87.52%,87.12% and 75.49% at 20,40 and 60 DAS, respectively . The lowest weed control efficiency was recorded in the weedy check(T_{12}).Similar results were also observed Chauhan and Johnson [11].

Comment [IA5]: Interpretation of data found in this present study should be made first by the author of this manuscript before the finding by other study.

E. Yield attributes

Comment [IA6]: Rice yield attributes

Results show that yield attributes(Table 4) like number of tillers m^{-2} (649) at harvest,number of productive tillers m^{-2}(366), panicle length(21.29 cm), number of filled grains $panicle^{-1}$ (176)and test weight (18.23 g) were found to be higher in the weed free plot (T_{11}) followed byPretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS and 40 DAS (T_9). Which recorded more number of tillers m^{-2} (632) at harvest, number of productive tillers m^{-2}(350), panicle length(21.18cm), number of filled grains $panicle^{-1}$(164)and test weight (18.19g). Lower yield attributes like a number of tillers m^{-2}(536) at harvest, number of productive tillersm^{-2}(150), panicle length (17.09 cm), number of grains $panicle^{-1}$(81) and test weight(17.34 g). The lowest yield attributes were recorded in weedy check(T_{12}). Similar results were also reported by Ramana [12]. This was clearly related to weed competition for grown resources immediately from seedling emergence, resulting in poor crop growth and inefficient transfer of photosynthates from source to sink, resulting in decreased yield attributes of riceUmamahesh, Rao[13],[14].

F. Grain and Straw Yield

Among the treatments weed free check (T_{11}) registered higher grain (5,897 kg ha^{-1}) and straw yield (9,100 kg ha^{-1}) (Fig. 2) followed bytreatment Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS and 40 DAS (T_9) (5,560 kg $ha^{-1}$and 8,970 kg ha^{-1}) of grain and straw yield, respectively.Similarly, higher grain and straw yield were observed by Pusdekar[15].

Comment [IA7]: Interpretation should also be made, for example, this data indicate that application of more herbicide does not reduce the yield. However, the impact on environment may be higher, etc.

Table 1. Weed flora in the direct seeded rice during*Summer* season

S.No.	Common Name	Scientific Name	Family	Morphological type
1.	Barnyard grass	*Echinochloa crus-galli*	Poaceae	Grass
2.	Jungle rice	*Echinochloacolona*	Poaceae	Grass
3.	Chinese sprangletop	*Leptochloa chinensis*	Poaceae	Grass
4.	Rice flatsedge	*Cyperus iria*	Cyperaceae	Sedge
5.	Umbrella plant	*Cyperus difformis*	Cyperaceae	Sedge
6.	False daisy	*Ecliptaprostrata*	Asteraceae	Broad leaved

Table 2. Effect of weed management practices on total weed density of different weed species at 20, 40 and 60 DAS in direct wet seeded rice

Treatments	Total density of weeds (No. m^{-2})		
	20 DAS	**40 DAS**	**60 DAS**
T_1– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS	10.30 (105.67)	12.40 (153.33)	14.91 (222.33)
T_2–Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} on 15 DAS	7.47 (55.33)	9.26 (85.33)	11.49 (131.67)
T_3– Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} on 15 DAS	7.36 (53.67)	8.99 (80.33)	11.07 (122.00)
T_4– Pretilachlor 50% EC @ 625 g a.i.ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} on 15 DAS	7.12 (50.33)	8.70 (75.33)	11.19 (125.00)
T_5– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} on 15 DAS	7.01 (48.67)	8.57 (73.00)	11.09 (122.67)
T_6–Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS	7.21 (51.67)	8.37 (69.67)	11.19 (125.00)
T_7– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS	6.59 (43.00)	8.09 (65.00)	10.68 (113.67)
T_8–Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS & 40 DAS	6.91 (47.33)	8.36 (69.67)	10.04 (101.00)
T_9– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS & 40 DAS	5.92 (34.67)	7.40 (54.33)	8.87 (78.33)
T_{10}– Recommended practice (Pretilachlor 50% EC @ 750 g a.i. ha^{-1} on 3 DAS *fb* one hand weeding on 40 DAS)	8.87 (78.33)	10.89 (118.00)	9.53 (90.33)
T_{11}– Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_{12}– Weedy check	10.9	15.08	18.04

	(118.67)	(227.33)	(325.00)
S. Ed	0.30	0.34	0.44
CD (P=0.05%)	0.62	0.70	0.91

Figures in parenthesis are original values; Data subjected to square root transformation.

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Table 3. Effect of weed management practices on total weed dry weight accumulation (g m^{-2}) of different weed species at 20, 40 and 60 DAS in direct wet seeded rice

Treatments	Total weed dry weight accumulation (g m^{-2})		
	20 DAS	**40 DAS**	**60 DAS**
T_1– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS	7.72 (59.07)	9.81 (95.73)	10.59 (111.89)
T_2–Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} on 15 DAS	4.03 (15.72)	7.10 (49.97)	8.24 (67.67)
T_3– Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} on 15 DAS	3.96 (15.17)	6.58 (43.47)	8.34 (69.07)
T_4– Pretilachlor 50% EC @ 625 g a.i.ha^{-1}on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} on 15 DAS	3.90 (14.75)	6.73 (44.87)	7.92 (62.33)
T_5– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} on 15 DAS	3.94 (15.01)	6.62 (43.4)	7.86 (61.32)
T_6–Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS	3.86 (14.42)	6.37 (40.07)	7.58 (56.97)
T_7– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS	3.71 (13.32)	6.43 (40.87)	7.73 (59.27)
T_8–Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS & 40 DAS	3.66 (12.89)	6.83 (46.13)	7.58 (56.95)
T_9– Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i.ha^{-1} (Tank Mix) on 15 DAS & 40 DAS	3.44 (11.36)	4.11 (16.4)	6.41 (40.67)
T_{10}– Recommended practice (Pretilachlor 50% EC @ 750 g a.i. ha^{-1} on 3 DAS *fb* one hand weeding on 40 DAS)	7.29 (52.66)	7.94 (62.57)	7.25 (52.09)
T_{11}– Weed free	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
T_{12}– Weedy check	9.69 (94.3)	11.33 (128.13)	13.11 (171.33)
S. Ed	0.29	0.28	0.25
CD (P=0.05%)	0.60	0.59	0.53

Figures in parenthesis are original values; Data subjected to square root transformation.

Table. 4. Effect of weed management practices on Numbers of tillers (m^{-2}) at harvestNo. of productive tillers (m^{-2}), No. of filled grains panicle^{-1}, Panicle length (cm), Panicle weight (g), Test weight (g), Grain conversion efficiency (%) in direct wet seeded rice

Treatments	Yield components				
	Numbers of tillers (m^{-2}) at harvest	**No. of productive tillers (m^{-2})**	**No. of filled grains panicle^{-1}**	**Panicle length (cm)**	**Test weight (g)**
T_1 - Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS	560.00	166.00	95.00	17.89	17.35
T_2 - Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} on 15 DAS	571.00	191.00	110.00	18.17	17.39
T_3 - Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} on 15 DAS	584.00	250.00	127.00	18.9	17.58
T_4 - Pretilachlor 50% EC @ 625 g a.i.ha^{-1}on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} on 15 DAS	579.00	200.00	119.00	18.62	17.44
T_5 - Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} on 15 DAS	597.00	258.00	129.00	19.78	17.62
T_6 - Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS	601.00	275.00	135.00	19.92	17.75
T_7 - Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS	609.00	325.00	140.00	20.34	17.87
T_8 - Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i. ha^{-1} (Tank Mix) on 15 DAS & 40 DAS	614.00	325.00	143.00	20.79	17.98
T_9 - Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g a.i.ha^{-1} (Tank Mix) on 15 DAS & 40 DAS	632.00	350.00	164.00	21.18	18.19
T_{10} - Recommended practice	627.00	338.00	155.00	21.09	18.05

(Pretilachlor 50% EC @ 750 g a.i. ha^{-1} on 3 DAS *fb* one hand weeding on 40 DAS)					
T_{11} - Weed free	649.00	366.00	176.00	21.29	18.23
T_{12} - Weedy check	536.00	150.00	81.00	17.30	17.34
S. Ed	29.48	12.99	6.44	0.97	0.88
CD (P=0.05%)	61.14	26.93	13.36	2.01	NS

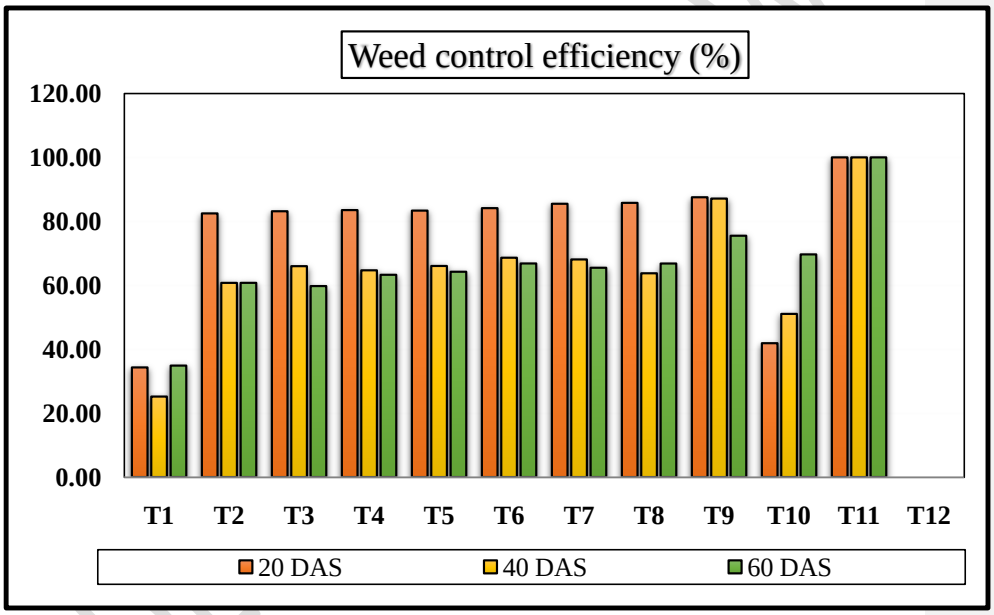

Fig. 1. Effect of weed management practices on Weed Control Efficiency (WCE) 20, 40 and 60 DAS in direct wet seeded rice

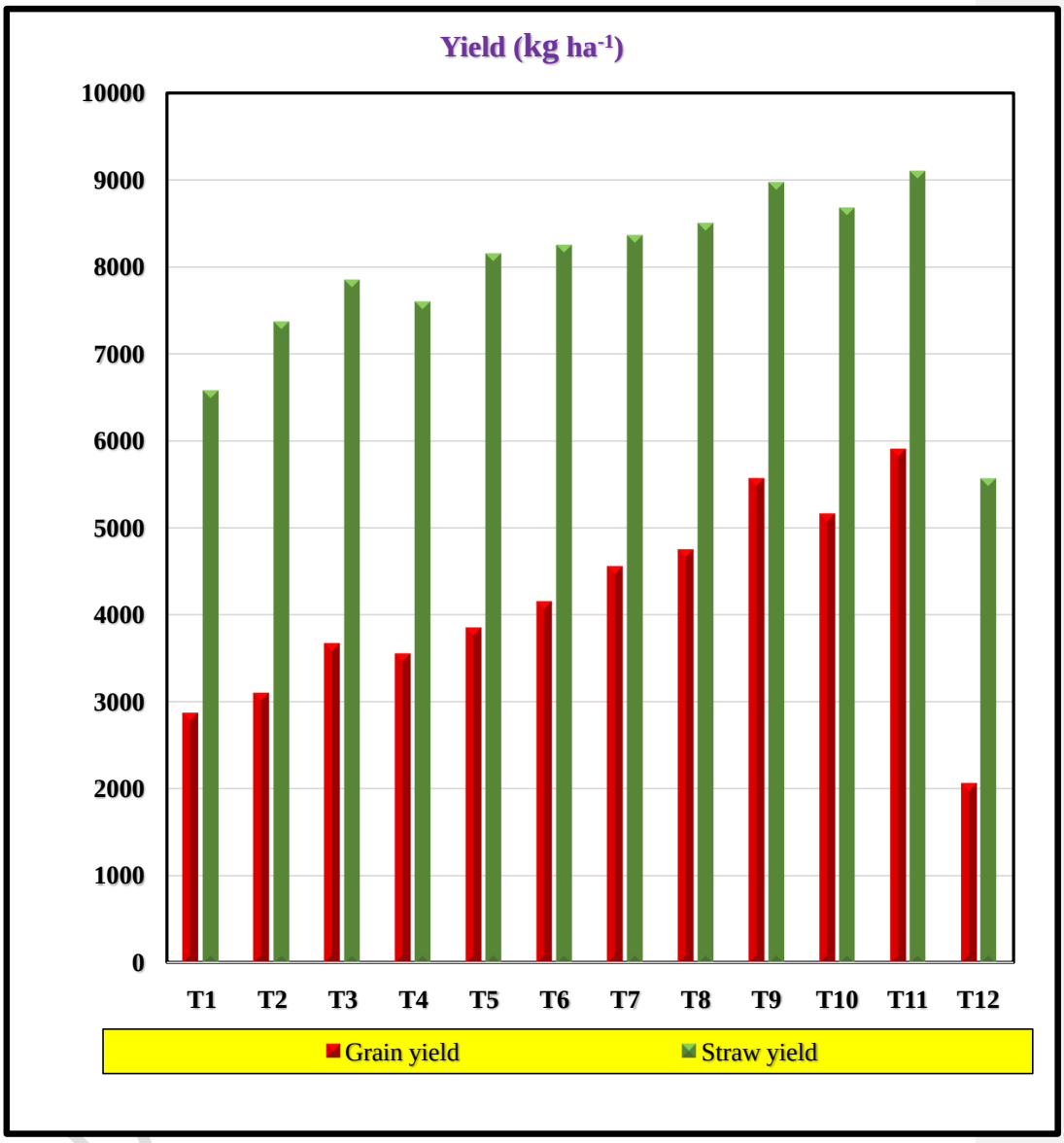

Fig. 2. Effect of weed management practices on Grain yield (kg ha^{-1}) and Straw yield (kg ha^{-1}) in direct wet seeded rice

F. Conclusion

Based on the results obtained from the study, it could be concluded that the lowest weed density and weed dry matter accumulation, maximum weed control efficiency and with higher grain and straw yield were observed in weed free treatment followed by Pretilachlor 50% EC @ 625 g a.i. ha^{-1} on 3 DAS + Bispyribac-sodium 10% SC @ 20 g a.i. ha^{-1} + Ethoxysulfuron 15% WDG @ 15 g $a.iha^{-1}$ (Tank Mix) on 15 DAS & 40 DAS. Which recorded lower weed density, higher weed control efficiency, grain and straw yield of direct wet seeded rice.

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