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Weed management practices in direct seeded rice ecosystem in north western zone of Tamil Nadu

Sivakumar C. [1]✉, Krishnaveni A.[2] and Pandiyan M. [3]

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Abstract

Field experiments were conducted to study the cost effective weed management practices in direct seeded rice at Regional Research Station, Tamil Nadu Agricultural University, Paiyur 635 112, Tamil Nadu, India in wet and dry seasons of 2015 and 2016 respectively in randomized block design with four replications. The treatments are pre- emergence application of Pendimethalin @ 1.0 kg ai ha^{-1} at 8 DAS followed by hand weeding at 25 DAS (T_1), pre- emergence application of Pendimethalin @ 1.0 kg ai ha^{-1} at 8 DAS followed by post emergence application of Bispyribac sodium 25 g ha^{-1} at 25 DAS+ hand weeding at 45 DAS (T_2) and Cono weeder weeding at 10 and 25 DAS (T_3), Hand weeding on 15 and 30 DAS (T_4) and Control - Weedy check (T_5). The results revealed that, among the different weed control treatments, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded higher grain yield of 6438 kg ha^{-1} with the B:C ratio of 2.77. With respect to weed control efficiency, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded higher weed control efficiency of 81.0 % as compared with Cono weeder weeding at 10 and 25 DAS. Hence, it was concluded that considering the weed control efficiency, yield and economics, pre-emergence application of pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS is recommended for weed management in direct seeded puddled rice to meet the challenges against labour scarcity and weed infestation in the field of small and marginal farmers.

Key Words: ***Bispyribac sodium, ConoWeeder, Direct seeded rice, Grain yield, Pendimethalin, Weed control efficiency, Weed management***

Introduction

Rice is a golden crop of paramount importance to Indian economy. The future of Indian food security and foreign exchange earnings through food grains would also largely depends on desired rice production and productivity. The need for greater food production at prices affordable by consumers and profitable to farmers has been a concern for all. Industrializations leads to diversification in employment and in turn many labourers switch over from farming which caused labour shortage and increasing labour cost for agricultural operation. The major operations like nursery preparation and its management, pulling out seedlings, transporting and distribution of seedlings to main field and transplanting consumes 30-40 per cent of total cost of cultivation in transplanted rice.

Author's Address
Agricultural College and Research Tamil Nadu Agricultural University Vazhavachanur - 606 753 Thiruvannamalai Dt,
E-mail.: *sivachi15@yahoo.co.in*

The yield loss due to weeds has been reported to reduce the yield by 50-60 % in direct seeded rice. To manage the wasteful loss, control of weeds in time is most important. Though weeding by using labours, control weeds effectively, it is costly and time consuming. Labours are not available many times and right time to weeding thus causing severe yield loss. The competition is more severe in direct seeded rice, crop as well as weeds emerge simultaneously starting from early period of growth of crop and in turn cause reduction in the rice yield. Rice crop sown through drum seeding technique by using sprouted seeds on puddled soil is associated with the problem of profuse growth of weeds and infestation of heterogeneous weed flora becomes the biggest biological constraint and the success of wet seeding entirely depends on efficient weed management practices because uncontrolled weeds in direct wet seeded rice can reduce yields to the tune of 53 percent (Nyarko and Datta, 1991) and

losses were reported even up to 90 per cent (Bhat et. al., 2011). Budhar and Tamil selvan (2002) recommended that wherever labour is scarce, costlier and for easy intercultural operations, direct seeding through drum seeder may be advantageous for increasing the productivity and profitability of direct seeded rice under puddled condition for northwestern zone of Tamil Nadu. Therefore, the present investigation was undertaken with a view to study the effect of cost effective weed management practices in direct seeded rice under lowland irrigated condition.

Materials and Method

Field experiments were conducted to study the cost effective weed management practices in direct seeded rice at Regional Research Station, Tamil Nadu Agricultural University, Paiyur 635 112, Tamil Nadu, India during wet and dry seasons of 2015 and 2016 respectively in randomized block design with four replications. The treatments are pre- emergence application pendimethalin @ 1.0 kg ai ha^{-1} at 8 DAS followed by hand weeding at 25 DAS (T_1), pre- emergence application of pendimethalin @ 1.0 kg ai ha^{-1} at 8 DAS followed by post emergence application of bispyribac sodium 25 g ha^{-1} at 25 DAS+ hand weeding at 45 DAS (T_2) and Cono weeder weeding at 10 and 25 DAS (T_3), hand weeding on 15 and 30 DAS (T_4) and Control - Weedy check (T_5). The paddy variety-Paiyur 1 was used for study. Pre emergence herbicide pendimethalin 1.0 kg ai ha^{-1} was applied on 8 DAS. The herbicide injury was observed on earlier stage and it was recovered after 15 DAS. Hand weeding, cono weeding and post emergence application of bispyribac sodium @ 25 g ai ha^{-1} were done on 25 DAS as per the treatment schedule. All other package practices were followed as indicated in direct seeded crop. The soil was sandy loam in texture with pH 8.1. The available NPK were 175, 25 and 235 kg/ha with organic carbon of 0.5%. The recommended fertilizer @ 150: 50: 50 kg NPK/ha was applied as urea (46%N), single super phosphate (16%) and muriate of potash (60%K). The full dose of Phosphorus was applied as basal at the time of sowing. Nitrogen and Potassium was applied in four equal splits viz., basal, active tillering, panicle initiation and flowering stages. The cono weeder operation was done on 10 and 25 DAS.

Results and Discussion

Weed flora of the experimental field

The dominant weed flora of the experimental fields are *Echinochola colona(L.)* among the grasses, *Cyperus difformis(L.)* among the sedges and *Ammannia baccifera(L.), Bergia capensis(L.)*, *Marsilia quadrifolia(L.)*, *Eclipta alba (L.) Hassk.* among the broad leaved weeds

Weed density and dry weight (m^{-2}) (Table 1)

The weed density was recorded on 20 and 45 DAS as grasses, sedges, broad leaved weeds .With respect to weed dry weight, samples were dried and dry weight was recorded for individual treatments at 20 and 45 DAS.

Among the treatments, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded the lowest weed density of 236.3 m^{-2} and 231.0 m^{-2} at 20 & 45 DAS respectively. This was followed by PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with hand weeding (HW) 25 DAS (T_1), it recorded the total weed density of 242.7 m^{-2} and 277.7 m^{-2} at 20 & 45 DAS respectively. The higher weed density of 900.5 m^{-2} and 1054.5 m^{-2} at 20 & 45 DAS were recorded in control (weedy check). Regarding weed dry weight, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded the lowest dry weight of 6.9 g m^{-2} and 29.49 g m^{-2} at 20 & 45 DAS respectively. The higher dry weight of 53.2 g m^{-2} and 158.2 g m^{-2} at 20 & 45 DAS were recorded in control (weedy check). These findings are in agreement with Yadav *et al*. (2009) and Nalini *et al*. (2012). With respect to weed control efficiency, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded higher weed control efficiency of 81.0%. This treat treatment was followed by PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb Hand weeding (HW) 25 DAS. The broad spectrum weed control was received due to application pre emergence followed by Cono weeding operation. Pal et al. (2012) observed that pyrazosulfuron ethyl can safely be used for controlling all three categories of weeds in transplanted rice.

Table 1. Effect of weed control treatments on weed density (Nos) and weed dry weight (WDW)(g) of wet seeded rice.

Treatments	Weed density at 20 DAS (No.m^{-2})				WDW at 20 DAS (g m^{-2})	Weed density at 45 DAS (No.m^{-2})				WDW at 45 DAS (g m^{-2}	Weed control efficiency (WCE) (%)
	Grasses	BLW	Sedges	Total		Grasses	BLW	Sedges	Total		
T_1 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS Fb Hand weeding (HW) 25DAS	4.5 (20.0)	7.2 (51.0)	13.1 (171.7)	15.6 (242.7)	2.86 (7.7)	4.8 (22.7)	7.7 (59.3)	14.0 (195.7)	16.8 (277.7)	6.81 (35.94)	77.0
T_2 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb POE Bispyribac sodium 25g ha^{-1} at 25 DAS fb HW on 45 DAS	4.3 (18.3)	7.4 (54.0)	12.8 (164.0)	15.4 (236.3)	2.72 (6.9)	4.0 (16.0)	5.7 (32.0)	13.5 (183.0)	15.2 (231.0)	5.48 (29.49)	81.0
T_3 - Cono weeder weeding at 10 and 25 DAS	6.01 (35.7)	7.8 (60.0)	14.4 (205.7)	17.4 (301.4)	3.66 (12.9)	5.2 (26.7)	9.8 (95.3)	16.2 (263.0)	19.6 (385.0)	7.31 (52.88)	66.0
T_4- Hand weeding on 15 and 30 DAS	5.10 (25.6)	7.27 (52.4)	13.14 (172.2)	15.8 (250.2)	3.0 (8.5)	6.49 (41.6)	7.9 (62.4)	12.8 (164.2)	16.39 (268.2)	7.0 (48.5)	69.0
T_5 -Control - Weedy check	10.0 (100.5)	13.42 (179.8)	24.91 (620.2)	30.02 (900.5)	7.33 (53.2)	9.20 (84.1)	15.19 (230.2)	27.22 (740.2)	32.48 (1054.5)	12.60 (158.2)	-
SEd	0.72	0.85	0.96	1.34	0.29	0.68	0.65	0.86	1.26	0.75	-
CD(P=0.05)	1.45	1.71	1.92	2.69	0.59	1.37	1.31	1.62	2.52	1.43	-

*Figures in parenthesis are original values (Analysis by $\sqrt{x+0.5}$ transformations)

Angiras and Kumar (2005) recorded pyrazosulfuron ethyl in rice nursery.

Growth characters (Table 2)

With respect to herbicide application, pre emergence application of pendimethalin 1.0 kg ai ha^{-1} at 8 DAS exhibits less injury for the rice crop however it will recover after 15 DAS. Regarding biometric observation, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded the higher plant height of 64.3, 99.5,138.7 cm at 30, 60 and 90 DAS respectively. This was followed by PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with hand weeding (HW) 25 DAS (T_1), it recorded the plant height of 62.1, 98.7 and 136.4 cm at 30, 60 and 90 DAS respectively. The lower plant height of 62.1, 91.5 and 129.3 cm at 30,60, 90 DAS were recorded in control (weedy check).Chopra and Chopra (2003) observed similar results with regard to growth characters in rice. The herbicide injury was exhibited by the treatments involving application of pre emergence herbicide pendimethalin later it was recovered. However, the yield was not affected.

Regarding growth characters, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded the higher tiller number of 366.7 m^{-2} and panicle length of 25 cm. The lower tiller number of 313.2 m^{-2} and panicle length of 21.0 cm were recorded in control (weedy check). The results are in consonance with the findings of Porpavai et al. (2006).

Yield and yield attributes (Table 3)

Regarding yield parameters, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded the higher no. of panicle m^{-2} (291.3), no. of grains $panicle^{-1}$(265.3) and 1000 grain weight (17.8 g). This was followed by PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with hand weeding (HW) 25 DAS (T_1), it recorded the no. of panicle m^{-2} (274.3), no. of grains $panicle^{-1}$ (257.3) and 1000 grain weight (17.3 g). The lower no. of panicle m^{-2} (241.3), no. of grains $panicle^{-1}$(205.0) and 1000 grain weight (16.9 g) were recorded in control (weedy check). The similar results also obtained by Yadav *et al.* (2009). The lower infilled grains are recorded in treatment having better weed management. application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded lower infilled grains of 26.7 as compared with other treatments (Fig-1).

Table 2.Effect of weed control treatments on growth characters of wet seeded rice

Treatments	Herbicide injury	Plant height (cm)			No.of tillers (m^{-2}) on 90 DAS	Panicle length (cm)
		30 DAS	60 DAS	90 DAS		
T_1 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb Hand weeding (HW) 25 DAS	1	62.1	98.7	136.4	366.7	23.1
T_2 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb POE Bispyribac sodium 25 g ha^{-1} at 25 DAS fb HW on 45 DAS	1	64.3	99.5	138.7	371.8	25.0
T_3 - Cono weeder weeding at 10 and 25 DAS	0	61.1	92.9	136.0	363.5	22.2
T_4- Hand weeding on 15 and 30 DAS	0	60.0	95.6	135.2	364.5	23.3
T_5 -Control - Weedy check	0	56.0	91.5	129.3	313.2	21.0
SEd	-	1.6	2.38	2.51	29.8	1.00
CD(P=0.05)	-	3.2	4.72	4.90	58.6	1.98

0	No injury
1-3	Less injury
4-6	Moderate injury
7-9	Severe injury
10	All plants killed

Application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded the higher grain and straw yield of 6438 kg ha^{-1} and 7110 kg ha^{-1} respectively. This treatment was recorded 4.9 % higher grain yield over PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with hand weeding (HW) 25 DAS (T_1) and 6.4 % higher yield over cono weeder weeding at 10 and 25 DAS (T_3). The lower grain and straw yield of 4889 kg ha^{-1} and 6131 kg ha^{-1} were recorded in control (weedy check).The higher yield was recorded as the weed free environment created by the application of pre emergence herbicide followed by cono weeding and left weeds out are removed by the hand pulling. Due to operation of cono weeder, it incorporates the weeds and after decomposition it will release the nutrients, also gives the aeration to the root zone of the rice for better growth. Similar results were also reported by Veeraputhiran and Balasubramanian (2013), Narendra (2011), and Kumaran (2012).

Table 3.Effect of weed control treatments on yield and yield attributes of direct seeded rice.

Treatments	No. of panicle (m^{-2})	No.of grains panicle $^{-1}$	No. of unfilled grains $panicle^{-1}$	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb Hand weeding (HW) 25 DAS	274.3	257.3	28.7	17.3	6139	6839
T_2 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb POE Bispyribac sodium 25 g ha^{-1} at 25 DAS fb HW on 45 DAS	291.3	265.3	26.7	17.8	6438	7110
T_3 - Cono weeder weeding at 10 and 25 DAS	267.3	248.3	31.3	17.7	6048	6768
T_4- Hand weeding on 15 and 30 DAS	272.0	255.5	29.4	17.2	6089	6612
T_5 -Control - Weedy check	241.3	205.0	34.4	16.9	4889	6131
SEd	22.95	9.5	2.8	0.35	152	164
CD(P=0.05)	45.54	19.2	5.6	0.70	312	327

Table 4.Effect of different weed control treatments on economics of drum seeded rice

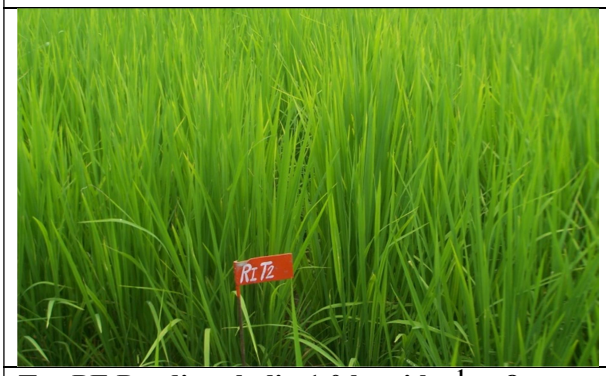
Treatments	Cost of cultivation (Rs)	Gross income (Rs) ha^{-1}	Net income (Rs) ha^{-1}	B:C ratio
T_1 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb Hand weeding (HW) 25 DAS	35418	96209	60791	2.71
T_2 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb POE Bispyribac sodium 25 g ha^{-1} at 25 DAS fb HW on 45 DAS	36398	100802	64403	2.77
T_3 - Cono weeder weeding at 10 and 25 DAS	38032	94827	56795	2.49
T_4- Hand weeding on 15 and 30 DAS	40678	91335	50657	2.24
T_5 -Control - Weedy check	35825	79335	43510	2.21
SEd	-	-	-	-
CD(P=0.05)	-	NA	NA	NA

Economics of weed management (table 4)

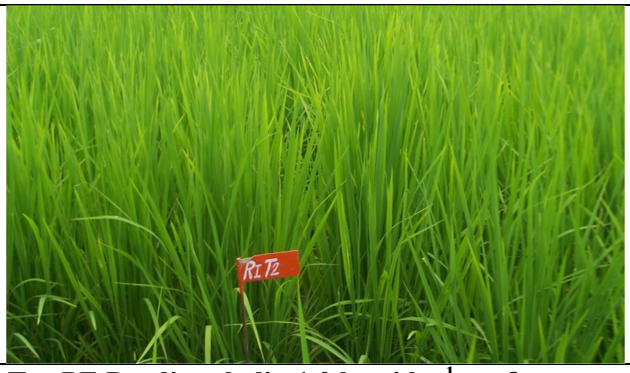
With regard to economics, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded the higher gross income of Rs. 100802/- ,net income of Rs. 64403/- with the B:C ratio of 2.77. This was followed by PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with hand weeding (HW) 25 DAS (T_1), it recorded the gross income of Rs. 96209/-, net income of Rs. 60791/- with the B:C ratio of 2.71.The lower gross income of Rs. 79335/-, net income of Rs. 43510/- with the B:C ratio of 2.21 were recorded in control (weedy check).

Drum seeding

T_3 - Cono weeder weeding at 10 and 25 DAS



T_2 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb POE Bispyribac sodium 25 g ha^{-1} at 25 DAS fb HW on 45 DAS



T_1 - PE Pendimethalin 1.0 kg ai ha^{-1} at 8 DAS fb Hand weeding (HW) 25 DAS

T_5-Control (Weedy check)

Fig -1. Effect of weed control treatments on yield and yield attributes of direct seeded rice

The higher income was received in herbicide treatment followed by cono weeding; it is due to lower cost involving in the cono weeder operation and hand weeding. The findings agreed with the earlier reports of Raghavendra *et al*. (2015).

Conclusion

The results revealed that, among the different weed control treatments, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded higher grain yield of 6438 kg ha^{-1} with the B:C ratio of 2.77. With respect to weed control efficiency, application of pre-emergence herbicide pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS (T_2) recorded higher weed control efficiency of 81.0% as compared with Cono weeder weeding at 10 and 25 DAS. Hence, it is concluded that considering the weed control efficiency, yield and economics, pre-emergence application of pendimethalin 1.0 kg ai ha^{-1} at 8 DAS with POE Bispyribac sodium 25g ha^{-1} at 25 DAS and HW on 45 DAS is recommended for weed management in direct seeded puddled rice to meet the challenges against labour scarcity and weed infestation in the field of small and marginal farmers.

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