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STUDIES IN WEED MANAGEMENT PRACTICES IN DRY DIRECT SEEDED RICE ESTABLISHMENT METHODS UNDER CAUVERY COMMAND AREA OF KARNATAKA INDIA

G.N. Kalyan[1], G.R. Denesh[2], H.R. Savitha[2], Hanumantappa Meti[3*] and K.V. Shivakumar[3]
[1]Department of Agronomy, CoA, UAS, Mandya, Karnataka, India
[2]AICRP on Rice, ZARS, V. C. Farm, UAS, Mandya, Karnataka, India
[3]Department of Crop physiology, CoA, Mandya, UAS, GKVK, Bangalore, Karnataka, India
*Corresponding author E-mail: hmeti784@gmail.com
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ABSTRACT

The field experiment was conducted during 2022 *Kharif* at Zonal Agricultural Research Station, Vishwesharaiah Canal Farm, Mandya to study the Effect weed management practices in dry direct seeded rice establishment methods under Cauvery Command area of Karnataka. The experiment laid out in a split plot design with three replications. The treatments comprised of three rice establishment methods *viz*., seed drill sowing, semidry system & aerobic rice and four weed management practices comprising of manual weeding, application of pre- and post- emergence herbicides, pre emergence herbicide with manual weeding and mulching with post emergence herbicide were evaluated with three replications in subplot for different rice establishment methods in main plot. Sequential applications of pendimethalin (1.0 kg/ha) as pre-emergence followed by penoxsulam + cyhalofop-butyl (0.276 kg/ha) as post emergence herbicide significantly recorded lower total weed count (5.77 and 18.90 No. m^{-2}) and weed dry weight (4.39 and 12.39 g m^{-2}) at 40 DAS and at harvest. The same was superior to other treatments with increased grain yield (4870 kg ha^{-1}) by 14.93 % over manual weeding, straw yield (6677 kg ha^{-1}), net returns (Rs. 59037 ha^{-1}) and gave higher benefit: cost ratio (2.10).
***Keywords* :** Dry Direct seeded rice, Herbicide, sequential and Weed dry weight.

Introduction

The rice (*Oryza sativa* L.) is one of the world's most significant cereal crops and it contribute to the production of about 40% of total food grains. Weed management is a critical aspect of modern agriculture and it becomes even more challenging when rice is established through dry direct seeding. Dry direct seeded rice (DSR) an innovative and water-efficient method of cultivation with different ways have gained popularity in the recent days as due to limited water resources. However, unlike transplanted rice, dry DSR is established in unpuddled soil by directly from seed and hence, weed seeds germinate along with crop to pose critical competition. Effective weed management practices are essential to ensure timely ease of weed competition in dry DSR (Sanjay *et al*., 2006). The combination of different post emergence herbicides, combi products, traditional method of hand weeding and mulching are very much essential to lower the menace of complex weed flora timely in dry DSR as indicated by Awan *et al*. (2015). Furthermore, an over-reliance on a single type of herbicide may result in weed resistance and a shift in weed populations. Limited research has shed light on the enhanced effectiveness of employing a sequential approach involving both pre- and post-emergence herbicides in weed control (Awan *et al*., 2015 and Chauhan *et al*., 2015).

In this context the experiment entitled “Studies in weed management practices in dry direct seeded rice establishment methods under Cauvery Command area of Karnataka” was taken for effective management of weeds to lower crop weed competition in dry DSR for higher yield.

Material and Methods

The field experiment was conducted during 2022 *Kharif* at Zonal Agricultural Research Station, Vishwesharaiah Canal Farm, Mandya to study the effect of different establishment methods and nutrient management on growth and yield of rice (*Oryza sativa* L.). Its geographical location situated at coordinates, 12° 57' N Latitude and 76° 82' E Longitude, with an Altitude of 757.10 m above mean sea level. The experimental soil was red sandy loam in texture with an average particle content of 57.36 per cent coarse sand, 14.78 per cent fine sand, 16.58 per cent silt and 15.19 per cent clay. The soil was neutral in reaction (pH 7.15), organic carbon content was medium (0.59%) with the electrical conductivity of 0.25 dSm^{-1}. The soil was low in available nitrogen (245.79 kg ha^{-1}) and high in available phosphorus (79.58kg ha^{-1}) and medium in available potassium (256.68 kg ha^{-1}).

The experiment laid out in a split plot design with three replications. The treatments comprised of three establishment methods *viz.*, Seed drill sowing (**M$_1$**), Semidry system (**M$_2$**) & Aerobic rice (**M$_3$**) and four weed management practices *viz.*, manual weeding at 20, 35 and 50 DAS (**S$_1$**), Pendimethalin 30 EC @ 1.0 kg a.i. /ha at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i.ha^{-1} at 20 DAS (**S$_2$**), Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} 1 DAS fb manual weeding at 35 and 50 DAS (**S$_3$**) and mulching with paddy straw @ 5 t ha^{-1} at the time of sowing fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS (**S$_4$**). Different establishment methods were placed in main plots while weed management practices were allocated to the subplots.

The variety used was KMP 175 with spacing for seed drill sowing was 30 X 10 cm, semidry system was 30 X 10 cm, whereas for aerobic rice was 30 X 20 cm. Weed samples were collected from the experimental area and categorized into sedges, grasses and broad-leaved weeds. Collected weed samples were first air-dried for 2 days and then oven-dried at 65±5°C until constant dry weight (48 hrs), which is more reliable estimate for bio-efficacy evaluation of weed control treatments (Das 2001). Weed control index (WCI), that portrays per cent reduction in weed dry weight per unit area was determined as per Das (2008). Rice crop was harvested at physiological maturity and grain yield was recorded at 14% moisture content. Minimum support price (MSP) was used to calculate the economics. Analysis of data was performed through analysis of variance (ANOVA) using the F-test. Weed data with coefficient of variation (CV) >20% were transformed through log (x+2) method prior to ANOVA to improve the homogeneity of variance (Das 1999). Multiple comparisons of treatment means were made using least significant difference at p=0.05 (Fisher 1960). The relationships between rice grain yield and weed density and dry weight were evaluated using correlation.

Results and Discussion

Composition of weed flora in experimental field

Being sown in upland condition and receiving alternate wetting and drying method of irrigation, in the absence of standing water in aerobic rice and seed drill sowing and impounding of water after 35 DAS in semidry system rice establishment recorded several species of weeds, that included sedges, grasses and broad leaved weeds (Table 1). It was clearly showed periodicity of weed seed germination, as several weeds were seen after a month of sowing and few weeds made their presence even at flowering stage of crop and during entire period of crop growth (Munnoli *et al.*, 2018).

Table 1: Composition of weed flora in experimental field

Sl. No.	Botanical name	Family
I	**Sedges**	
1	*Cyperus procerus*	Cyperaceae
2	*Cyperus difformis*	Cyperaceae
3	*Cyperus iria*	Cyperaceae
4	*Fimbristylis miliacea*	Cyperaceae
II	**Grasses**	
1	*Echinochloa colonum*	Poaceae
2	*Panicum tripheron*	Poaceae
3	*Dactyloctenium aegyptium*	Poaceae
4	*Dinebra retroflexa*	Poaceae
III	**Broad leaved weeds**	
1	*Dopatrium junceum*	Plantaginaceae
2	*Ludwizia parviflora*	Onagraceae
3	*Physalis minima*	Solanaceae
4	*Ageratum conyzoides*	Asteraceae

Weed density

Among different rice establishment methods, the sedge, broad leaved and total weeds density was significantly lower in semidry system (4.33, 5.33 and 16.33 m^{-2}, respectively) at 40 DAS and (8.67, 9.83 and 27.67 m^{-2}, respectively) at harvest (Table 2), as compared to rest of the establishment methods, except for on par sedge density with seed drill sowing (5.17 m^{-2}). While, grassy weed population being statistical on par among rice establishment methods (6.63 to 6.67

m^{-2}) at 40 DAS. The lower sedge, broad leaved and total density of weeds in semidry system could be attributed to preventing of succeeding germination of weeds with the allowing standing water from 35 DAS.

Among the weed management practices, application of Pendimethalin 30 EC @ 1.0 kg a.i./ha at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i./ha at 20 DAS recorded significantly lower sedge, grass and broad leaved and total weeds (1.33, 2.22, 2.22 and 5.77 m^{-2}, respectively) at 40 DAS and at harvest (5.56, 6.67, 6.67 and 18.90 m^{-2}, respectively) (Table 3). This might be assigned to sequential application of Pendimethalin 30 EC @ 1.0 kg a.i./ha at 1 DAS followed by combi product herbicides at 20 DAS which is having a distinct mode of action such as acetolactate synthase inhibition of penoxsulam and acetyl CoA carboxylase fatty acid synthesis inhibition of Cyhalofop butyl herbicide in grassy weed could contain the emerged weeds effectively in the treatment combination. The results are in line with Hemalatha *et al.* (2017).

Weed dry weight

Among different rice establishment methods, the dry weight of grass, broad leaved weeds and total weeds recorded lower in semidry system (3.82, 11.86 and 11.86 g/m^2, respectively) being on par with seed drill sowing (4.33, 12.31 and 12.31 g/m^2, respectively) and were being superior over the aerobic rice (6.08, 16.59 and 16.59 g m/2, respectively). While, the dry weight of sedges found to be on par among rice establishment methods (3.41 to 4.38 g m/2) at 40 DAS. The lower dry weight of weeds in semidry system was owing to closer intra row spacing and submergence of field at 35 DAS, (Table 4). while in seed drill sowing on account of closer intra row spacing only for suppressing of weeds physically.

Among the weed management practices application of Pendimethalin 30 EC @ 1.0 kg a.i./ha at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i./ha at 20 DAS recorded significantly lower sedge, grass, broad leaved and total dry weight of weeds (1.17, 1.78, 1.44 and 4.39 g/m^2, respectively) at 40 DAS and (3.17, 4.78, 4.44 and 12.39 g/m^2, respectively) at harvest (Table 5). This reduced dry weight as a result of broad spectrum activity along with lengthier period of applied herbicides activity by combination of herbicides for effective control of major weed flora in dry DSR. The results were in conformity with the results obtained by Kumaran *et al.* (2015) and Suman *et al.* (2020). The reduction in dry weight of weeds in the former treatments at harvest owing to pre emergence application of pendimethalin followed by post emergence application of penoxsulam + cyhalofop butyl at 20 DAS or followed by manual weeding at 35 and 50 DAS helps to control growth of all category of weeds effectively during critical crop growth period as seen by its lower density recorded in this experiment. Furthermore, weed free conditions leading to better growth of rice with elevated tillers and LAI, which smothered the weeds at later stages especially at harvest in these treatments. Similar reduction in the dry matter production by weeds by application of cyhalofop was reported by Bahar and Singh (2004) and Singh *et al.* (2009).

Grain and straw yield

Grain yield differed significantly due to variable weed control treatments at 40 DAS (Table 6) mainly because of relatively lower weed interference. Among different rice establishment methods, semidry system recorded higher grain and straw yield (4.88 & 6.32 t/ha) which was statistically on par with seed drill sowing (4.64 & 6.22 t/ha), but was being significantly superior over aerobic rice (4.05 & 6.12 t/ha). Between weed management practices, the application of pendimethalin 30 EC @ 1.0 kg a.i./ha at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i./ha at 20 DAS and recorded higher grain yield (4.87 t/ha), straw yield (6.67 t/ha) and harvest index (42.00%) with 14.92 % increase in grain yield over manual weeding. This could have responsible for uptake of more nutrients from deeper layer for production of optimum photosynthesis for growth and development.Further, allowing of standing water in semidry rice could lower the weed emergence at later stages apart from suppressing the non productive tillers which produced in the plant after panicle intiation. All these effects were visible in a positive mode on tillers, LAI, panicles, panicle weight etc., in this experiment and thus leading to superior grain and straw yield. This comparable yields in rice through alternate methods of establishment was also reported by Sandhya et al. (2014).

Weed index

Lower weed index (-17.50%) is recorded in the application of pendimethalin 30 EC @ 1.0 kg a.i./ha 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i./ha at 20 DAS as compared to rest of the weed management practices (-9.00 to -10.20 %) shows that no yield loss due to weeds as compared to hand weeding (Table 6). This explains the greater efficacy of pre and post emergence. These results are in conformity with Saha *et al.* (2005) and Ramesh *et al.* (2009). Higher crop growth in this treatment might have led to greater accumulation of photosynthates in sources that translocated to sink at later growth stages, resulting in significant yield improvement.

Economics of weed management practices in dry direct seeded rice

The weed free condition (WFC) fetched highest gross returns owing to highest grain and straw yields, by the application of pendimethalin 30 EC @ 1.0 kg a.i./ha 1 DA fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i./ha at 20 DAS as pre and post emergence herbicide (Table 6) and gave 38.28% higher net return, respectively over manual weeding with B: C (2.10). This could be attributed to lower cost with efficient weed control by only herbicide alone which was cheaper than other methods/combination along with higher grain and straw yield. The results obtained are in line with the Nawaz *et al.* (2017), Paliwal *et al*. (2017) and Suman *et al.* (2020).

Table 2: Density of sedge, grass, broad leaved and total weeds (No. m^{-2}) as influenced by establishment methods and weed management practices of dry direct seeded rice at 40 DAS.

Treatment		Weed density at 40 DAS			
		Sedges*	**Grasses***	**Broad leaved***	**Total***
Main plot: Rice establishment methods (M): 03					
M_1	Seed drill sowing	0.79(5.17)	0.88(6.50)	0.96(8.67)	1.27(20.34)
M_2	Semidry system	0.72(4.33)	0.86(6.67)	0.79(5.33)	1.16(16.33)
M_3	Aerobic rice	0.84(6.17)	0.88(6.63)	0.93(9.33)	1.31(22.13)
S.Em ±		0.02	0.01	0.02	0.03
CD (p=0.05)		0.09	NS	0.09	0.10
Sub plot: Weed management methods (S): 04					
S_1	Manual weeding at 20, 35 and 50 DAS	0.79(4.67)	0.93(6.89)	0.96(7.56)	1.31(19.12)
S_2	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	0.49(1.33)	0.62(2.22)	0.56(2.22)	0.88(5.77)
S_3	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb manual weeding at 35 and 50 DAS	0.75(4.00)	0.81(4.67)	0.84(5.33)	1.19(13.97)
S_4	Mulching with paddy straw @ 5 t ha^{-1} fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	1.09(10.89)	0.11(12.22)	1.20(16.00)	1.16(39.11)
S.Em ±		0.02	0.02	0.03	0.03
CD (p =0.05)		0.07	0.06	0.09	0.09
Interaction (MXS)					
S.Em ±		0.05	0.02	0.05	0.05
CD (p=0.05)		NS	NS	NS	NS

Note: * = log (x+2) transformed value; ( ) = Figures in parenthesis are original value

Table 3: Density of sedge, grass, broad leaved and total weeds (No. m^{-2}) as influenced by establishment methods and weed management practices of dry direct seeded rice at harvest

Treatment		Weed density at harvest			
		Sedges*	**Grasses***	**Broad leaved***	**Total***
Main plot: Rice establishment methods (M): 03					
M_1	Seed drill sowing	1.01(8.83)	1.06(9.83)	1.05(9.33)	1.47(27.99)
M_2	Semidry system	0.98(8.67)	0.99(9.17)	1.04(9.83)	1.42(27.67)
M_3	Aerobic rice	0.97(7.50)	1.10(11.00)	1.07(10.00)	1.48(28.50)
S.Em ±		0.02	0.02	0.03	0.03
CD (p=0.05)		NS	0.07	NS	NS
Sub plot: Weed management methods (S): 04					
S_1	Manual weeding at 20, 35 and 50 DAS	0.96(7.33)	1.09(10.89)	1.09(10.67)	1.48(28.89)
S_2	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	0.87(5.56)	0.92(6.67)	0.93(6.67)	1.31(18.90)
S_3	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb manual weeding at 35 and 50 DAS	0.95(7.11)	1.04(9.33)	1.05(9.33)	1.44(25.77)
S_4	Mulching with paddy straw @ 5 t ha^{-1} fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	1.16(13.33)	1.15(13.11)	1.12(12.22)	1.58(38.66)

S.Em ±	0.03	0.02	0.04	0.03
CD (p =0.05)	0.09	0.07	0.12	0.09
Interaction (MXS)				
S.Em ±	0.05	0.03	0.07	0.05
CD (p=0.05)	NS	NS	NS	NS

Table 4: Dry weight of sedge, grass, broad leaved and total weeds (g m^{-2}) as influenced byestablishment methods and weed management practices in dry direct seeded rice at 40 DAS

Treatment		Weed dry weight at 40 DAS			
		Sedges*	Grasses*	Broad leaved*	Total*
Main plot: Rice establishment methods (M): 03					
M_1	Seed drill Sowing	0.70(3.41)	0.76(4.33)	0.77(12.31)	1.03(12.31)
M_2	Semidry system	0.71(3.46)	0.74(3.82)	0.77(11.86)	1.01(11.86)
M_3	Aerobic rice	0.76(4.38)	0.86(6.08)	0.86(16.59)	1.14(16.59)
S.Em ±		0.02	0.02	0.02	0.02
CD (p=0.05)		NS	0.08	0.08	0.07
Sub plot: Weed Management methods (S): 04					
S_1	Manual weeding at 20, 35 and 50 DAS	0.82(4.77)	0.89(5.98)	0.94(6.96)	1.26(17.70)
S_2	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	0.48(1.17)	0.54(1.78)	0.51(1.44)	0.60(4.39)
S_3	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb manual weeding at 35 and 50 DAS	0.69(2.97)	0.73(3.56)	0.75(3.63)	1.03(10.16)
S_4	Mulching with paddy straw @ 5 t ha^{-1} fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	0.90(6.09)	0.97(7.67)	1.01(8.33)	1.35(22.09)
S.Em ±		0.03	0.03	0.03	0.03
CD (p =0.05)		0.08	0.08	0.09	0.10
Interaction (MXS)					
S.Em ±		0.05	0.05	0.05	0.06
CD (p=0.05)		NS	NS	NS	NS

Note: * = log (x+2) transformed value; ( ) = Figures in parenthesis are original value

Table 5: Dry weight of sedge, grass, broad leaved and total weeds (g m^{-2}) as influenced byestablishment methods and weed management practices in dry direct seeded rice at harvest

Treatment		Weed density at harvest			
		Sedges*	Grasses*	Broad leaved*	Total*
Main plot: Rice establishment methods (M): 03					
M_1	Seed drill sowing	0.87(5.67)	0.98(7.88)	0.98(8.08)	1.36(21.63)
M_2	Semidry system	0.78(4.71)	0.99(9.33)	0.90(7.13)	1.29(21.17)
M_3	Aerobic rice	0.85(5.38)	1.04(9.21)	0.99(8.04)	1.38(22.63)
S.Em ±		0.02	0.03	0.02	0.03
CD (p=0.05)		0.07	NS	NS	NS
Sub plot: Weed management methods (S): 04					
S_1	Manual weeding at 20, 35 and 50 DAS	0.92(6.56)	1.00(8.28)	0.98(7.72)	1.38(22.56)
S_2	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	0.71(3.17)	0.83(4.78)	0.80(4.44)	1.15(12.39)
S_3	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1}at 1 DAS fb manual weeding at 35 and 50 DAS	0.76(3.89)	1.03(8.89)	0.92(6.50)	1.33(19.28)
S_4	Mulching with paddy straw @ 5 t ha^{-1} fb Penoxsulam 1.02 WP + Cyhalofop butyl10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	0.95(7.39)	1.15(13.28)	1.12(12.33)	1.51(33.00)
S.Em ±		0.03	0.04	0.02	0.04
CD (p =0.05)		0.09	0.11	0.06	0.11
Interaction (MXS)					
S.Em ±		0.05	0.07	0.04	0.07
CD (p=0.05)		NS	NS	NS	NS

Table 6: Grain yield, straw yield, weed index and economics as influenced by establishment methods and weed management practices in dry direct seeded rice.

Treatment		Grain yield (t /ha)	Straw yield (t /ha)	WI (%) at harvest	Net Returns (Rs. ha^{-1})	B:C ratio
Main plot: Rice establishment methods (M): 03						
M_1	Seed drill sowing	4.64	6.22	-12.20	48595	1.84
M_2	Semidry system	4.88	6.32	-17.50	53783	1.93
M_3	Aerobic rice	4.05	6.12	2.0	36746	1.64
S.Em ±		76.06	76.06	-	-	-
CD (p=0.05)		298.66	298.66	-	-	-
Sub plot: Weed Management methods (S): 04						
S_1	Manual weeding at 20, 35 and 50 DAS	4.14	5.76	0.00	36437	1.61
S_2	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	4.87	6.67	-17.50	59037	2.10
S_3	Pendimethalin 30 EC @ 1.0 kg a.i. ha^{-1} at 1 DAS fb manual weeding at 35 and 50 DAS	4.56	6.36	-10.20	49426	1.88
S_4	Mulching with paddy straw @ 5 t ha^{-1} fb Penoxsulam 1.02 WP + Cyhalofop butyl 10 EC @ 0.276 kg a.i. ha^{-1} at 20 DAS	4.53	6.07	-9.00	40599	1.63
S.Em ±		97.47	161.11	-	-	-
CD (p=0.05)		289.61	478.70	-	-	-
Interaction (MXS)						
S.Em ±		168.83		-	-	-
CD (p=0.05)		NS	NS	-	-	-

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