Original Research Article

Effect of different method of rice establishment and weed management options on yield and economics of paddy

Abstract

A field experiment was conducted during *rabi* 2022 at Zonal Agricultural and Horticultural Research Station, Brahmavara, Udupi, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, on sandy loam soil to study the Effect of different method of rice establishment and weed management options on yield and economics of paddy. The experiment was laid out in Factorial RCBD (Randomized Complete Block Design) with broadcasting and drum seeder method of establishment and five treatment combinations, replicated thrice. The study revealed that, the weed free treatment maintain by hand weeding recorded highest growth parameters and rice grain yield(). The sequential application of pre-emergence herbicide pendimethalin 38.7 % CS @ 750 g a.i. ha^{-1} at 0-3 DAS (*fb*) early post-emergence application of bispyribac sodium 10 % SC @ 25 g a.i ha^{-1} at 13-15 DAS, recorded lowest total weed density (36.92, 31.73 and 40.45 No. m^{-2}) at 15, 30 and 45 DAS, respectively and lower weed index () under drum seeder method of establishment . The yield and yield attributing parameters like number of tillers (291.33 m^{-2}), panicle length (19 cm), filled grains (89.33 $panicle^{-1}$), grain yield (4221 kg ha^{-1}) and straw yield (5387 kg ha^{-1}) were observed in **s**equential application of pre-emergence herbicide pendimethalin 38.7 % CS @ 750 g a.i. ha^{-1} at 0-3 DAS (*fb*) early post-emergence application of bispyribac sodium 10 % SC @ 25 g a.i ha^{-1} at 13-15 DAS under the drum seeder method of establishment. The highest net return (₹ 82586 ha^{-1}) and B:C ratio (2.81) was also recorded in the same treatment.

Keyword: direct seeded rice, drum seeder, broadcasting, pre and post-emergent herbicides

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops in the world and serves as the primary staple food source for more than half of the global population (Kennedy, 2009). On a global scale, rice provides 21 per cent of per capita energy and 5 per cent of per capita protein for humans (Maclean *et al*., 2002). India occupies a prime position in rice production among the food crops cultivated worldwide. In India, it is grown in an area

of 45.07 million hectares with a production and productivity of 122.27 million tonnes and 2713 kg ha^{-1}, respectively (Anon., 2021). In Karnataka, rice is grown in an area of 9.93 lakh hectares with a production of 29.07 lakh tonnes with a productivity of 2927 kg ha^{-1} (Anon., 2020). In the Udupi district of Coastal Karnataka, rice is grown in 37729 ha with a productivity of 3729 kg ha^{-1} (Anon., 2021).

In recent years, rice cultivation in the coastal zone is declining because of the scarcity, costly and timely non availability of labour for carrying various crop management practices. Among them management of weed flora under low land situation is a tedious task to the farmers. Weeding is the important operation in rice cultivation which consumes major labour force. There is a need to reduce the dependence of labour on weed management by adopting appropriate technology especially in this area where labour is very costly and scarce. Weed infestation is the major problem in direct seeded wet land rice as pre germinated seeds and already existing weed seed in soil weed bank grow simultaneously thereby creating competition for resources like moisture, nutrient and light.

Chemical methods of weed control offer an excellent alternative to control weeds. In some instances, herbicides alone offer the most practical, effective and economical means of reducing weed competition (Balasubramanian *et al*., 1996). However, the choice of the best specific herbicide varies with agronomic, ecological and economic factors. Herbicides not only control the weeds timely and effectively but also offer great scope for minimizing the cost of weed control irrespective of the situation. Hence, the present investigation was carried out to study the suitable method of establishment and weed management practices for direct seeded rice under puddled condition in Coastal zone of Karnataka.

Material and Methods

Site Description

A field experiment was conducted during *rabi* 2022 at Seed Farm, Zonal Agricultural and Horticultural Research Station, Brahmavara, Udupi, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga. The experimental **si**te is situated at 12^{o} 54′ N latitude and 74^{o} 54′ E longitude at an altitude of 10 m above mean sea level. The soil was sandy loam in texture with 1.20% organic carbon and a pH of 5.3. With respect to initial available nutrients, N (286 kg ha^{-1}) was medium, high P_2O_5 (62.10 kg ha^{-1}) and low K_2O (115.80 kg K_2O ha^{-1}) was noticed in the soil.

Experimental Details

The experiment was laid out in RCBD with factorial concept replicated thrice, involving two methods of establishment *i.e.,* broadcasting (M_1) and drum seeder (M_2) with five weed management treatment consisting of pre-post emergent herbicides *viz.*,weed free (W_1), bensulfuron methyl 0.6 % + pretilachlor 6 % GR (a.i 660 g/ha) at 0-3 DAS *fb* Metsulfuron methyl 10 % + Chlorimuron ethyl 10 % WP (8g/ac i.e 0.066g/l) at 13 to 15 DAS (W_2), pendimethalin 38.7% CS (a.i- 580.0 - 750.25 g/ha) at 0-3 DAS *fb* bispyribac Sodium 10% SC (a.i. 20-25 g/ha) 13 to 15 DAS(W_3), pendimethalin 38.7% CS (a.i-580.0-750.25 gm) at 0-3 DAS *fb* penoxsulum 1.02% + cyhalofop-butyl 5.1% OD (a.i 120-135) 27- 30 DAS (W_4) and weedy check (W_5).

. The paddy variety used was MO-21 (Prathaysa). It is non-lodging, photoinsensitive, semi-tall variety with duration of 100 to 110 days. It can produce a grain yield of 3750 to 4500 kg ha^{-1}. It is a red rice variety and is moderately resistant to gall midge, brown plant hopper, sheath blight and blast.

Sowing of pre-germinated seeds done through eight row drum seeder spaced at 30 cm row spacing was used. Seeds are filled in the drums and the drum seeder was manually dragged on the field after draining the water to saturation. A seed rate of 45 kg ha^{-1} was used in this method. In case of broadcasting method seeds are broadcasted into 2-5 cm depth of standing water. Seeding rate 60 kg ha^{-1} was used. The crop was fertilized with 60:30:75 kg N, P_2O_5, and K_2O ha^{-1} and 50% nitrogen, potassium and entire dose of phosphorus was applied as basal and remaining 50% nitrogen and potassium was top dressed at two equal splits at 30 and 55 DAS.

The gross plot size was 4.2 x 3.0 m. Granular formulated herbicides were mixed with sand 100kg/ha and applied uniformly in the field at one day after sowing. The remaining herbicides were sprayed by using knap-sack sprayer fitted with flat-fan nozzle with water 250 liter/ha. Hand weeding was performed as per treatment by pulling out weeds manually. In case of weed free treatment (W_1) the weeds were uprooted at 15, 30, 45, and 60 DAS. All other agronomic and plant protection measures were adopted as per the recommended package for the Coastal Zone of Karnataka.

Collection of Experimental data

The efficacy of herbicides was tested by taking the observation on category wise weeds viz. grasses, sedges and broad-leaved weeds, weed density, biomass and weed control

efficacy at 15, 30 and 45 days after treatment of the crop by using a quadrate (1 x 1 m) randomly in each plot and their subsequent effect on growth and yield of drum seeded and broadcasted rice. The weeds were uprooted from one m^2 area selected at random and were oven dried to a constant weight at 65°C and dry weight of weeds in each treatment was recorded and expressed as g per square meter. Data on growth parameters like plant height (cm) and number of tillers at harvest and yield parameters like grain weight per panicle (g), 100-seed weight (g), per cent choppiness and yield (kg/plot) of direct seeded rice was recorded at harvest. The weed index was worked out by using the formula given by Gill and Vijay Kumar (1969).

$$\text{Weed index (\%)} = \frac{X - Y}{X}$$

Where, X = Grain yield of weed free plot (hand weeding twice)

Y = Grain yield from the treatment plot for which the weed index is to be worked out.

Statistical analysis

The data collected from the experiment at different growth stages were subjected to analysis of variance (ANOVA) appropriate to the experimental design as described by Gomez and Gomez (1984). The normality of distribution was not seen in case of observation on weeds hence, the values were subjected to square root transformation ($\sqrt{x + 0.5}$) prior to statistical analysis to normalize their distribution. Statistical analysis was carried out based on mean values obtained. The level of significance used in 'F' and't' test was P= 0.05.

Results and discussion

Weed flora

The predominant weed flora were observed in the experimental field in association with the direct seeded rice includes, grassy weeds like *Digitaria sanguinalis, Panicum repens, Echinochloa colonum, Eleusine indica* sedges like *Cyperus difformis, Cyperus procerus*, broad leaved weeds like *Monochoria vaginalis, Ammania baccifera, Eclipta alba, Ludwigia parviflora, Commelina benghalensis, Eclipta alba* and *Marsilea quadrifolia.* The extent of growth and yield loss caused by weeds depends on weed species and their density in a crop community. Broad leaved weeds were the most dominated weed species fallowed by grass and sedges. These result sane finding with Mohapatra *et al.* (2021).

Total weed density and weed index

At 15, 30 and 45 DAS, among the different weed management treatments, the **s**equential application of PE herbicide pendimethalin 38.7% CS @ 750g a.i. ha^{-1} at 3 DAS *fb* EPoE application of bispyribac sodium 10% SC @ 25 g a.i ha^{-1} at 12 DAS (W_3) under drum seeded method of establishment was found to be more effective in controlling all types of weeds *viz*., grasses, sedges and broad leaved weeds (39.53, 34.02, and 43.44 m^{-2} respectively) as evidenced from lower weed population when compared to other herbicidal treatments and next to weed free (W_1). This may be due to the fact that these herbicides having a broad-spectrum action and more persistence resulted in effective control of all group of weeds leading to vigorous growth of rice plants and suppressed the complex weed flora with those treatments. These results are in conformity with the findings of Yogananda *et al.* (2021).

Sequential application of PE herbicide pendimethalin 38.7% CS @ 750g a.i. ha^{-1} at 3 DAS *fb* EPoE application of bispyribac sodium 10% SC @ 25 g a.i ha^{-1} at 15 DAS (W_3) recorded lower weed index (7.23%). Further, weedy check recorded significantly higher weed index weeds compared to other weed management treatments (65.05 %) (Table 1). These results were in conformity with findings of Reddy and Ameena (2021).

Growth, yield and yield attributes

Among the rice establishment methods, drum seeded with herbicidal treatment *i.e.*, PE application of pendimethalin 38.7 CS @ 750 g a.i. ha^{-1} at 3 DAS *fb* EPoE application of bispyribac sodium 10 SC @ 25 g a.i. ha^{-1} at 15 DAS (M_2W_3) recorded highest leaf area, dry matter production, next to the weed free (M_2W_1) (Table.2). This may be due to attributed to uniformity in population of rice plant there by providing equal space to each and every plant in a row on the other hand broadcast sowing may have different plant population at different sites. Where ever the rice plants are sparse, there may be more weeds and their better growth rates at such places. On the other hand where ever more seeds fall per unit area, there may be severe competition for nutrient, moisture, space and radiant energy (Evans, 1979). Where ever there might be denser plant population, the weeds may be less, but due to severe competition for nutrients amongst the rice plants themselves, there may be restricted growth.

Yield attributes

Among the different weed management treatments, the highest number of panicles m^{-2} at harvest (272.33), total number of grains $panicle^{-1}$ (97.67) and lower chaffiness per cent

(8.54) was recorded under application of pendimethalin 38.7 CS @ 750 g a.i. ha^{-1} at 3 DAS *fb* EPoE application of bispyribac sodium 10 SC @ 25 g a.i. ha^{-1} at 15 DAS (M_2W_3) in drum seeder method of establishment. Highest yield attributes recorded in this treatment might due to the less competition, and comparatively better availability of inputs involved in manufacture of building blocks for plant bodies. These results were in conformity with findings of Reddy *et al.* (2021).

Grain and straw yields

Among the method of establishment and weed management treatment influenced the grain and straw yield (Table.3). The higher grain yield (3810 kg ha^{-1}) was observed in pendimethalin 38.7 CS @ 750 g a.i. ha^{-1} at 3 DAS *fb* EPoE application of bispyribac sodium 10 SC @ 25 g a.i. ha^{-1} at 15 DAS (W_3) may be due to the better weed control efficiency, better plant growth and dry matter accumulation supported for higher yield attributes, observed with those treatments increased yield. Similar report of increased yield components and yield was made by Sarvanane (2020) and Reddy *et al.* (2021). The treatment weedy check (W_5) recorded lowest grain yield (1457 kg ha^{-1}). Contrarily, the poor growth of plants as well as development of yield attributing characters in weedy check might be due to higher crop-weed computation for nutrient, space and light available at the time of flowering and grain development adversely influenced the lower grain yield. The lower grain yield under weedy check (W_5) may be due to the high weed interference and less number of effective tillers.

ECONOMICS

Among the different weed management practice, Highest net returns of (Rs. 77559 ha^{-1}) and B:C ratio (2.30) was noticed with(M_2W_3) drum seeded with PE application of pendimethalin 38.7 CS @ 750 g a.i. ha^{-1} at 3 DAS *fb* EPoE application of bispyribac sodium 10 SC @ 25 g a.i. ha^{-1} at 15 DAS and lower net returns (Rs.1183 ha^{-1}) and B:C ratio (1.03) recorded broadcasting with weedy check (M_1W_5)(Table. 3). Due to the reduced the requirement of labour for hand weeding, leading to high net returns, thus the results revealed that pre and post-emergence herbicides studied for control of weeds in direct seeded rice are more profitable. Though weed free (W_1) recorded with higher grain yield and gross returns, the net returns (Rs. 66104 ha^{-1}) observed was less which was due to the high cost of labour. Net return was lower in weedy check (Rs.4463 ha^{-1}) due to low grain and straw yield caused by

reduced crop growth and yield components as a consequence of more weed competition. The results of this study are confirmed by the earlier studies of Kashid *et al.* (2019).

Conclusion

drum seeded with pre-emergence application of pendimethalin 38.7 CS @ 750 g a.i. ha^{-1} at 3 DAS *fb* EPoE application of bispyribac sodium 10 SC @ 25 g a.i. ha^{-1} at 15 DAS, recorded higher growth and yield attributes with least cost of cultivation and gross return and highest net return and B:C ratio and this treatment is fisiable for manage weeds in field condition at Coastal Karnataka in during *rabi* season.

Table1: Total weed density (No. m^{-2}) as influenced by methods of establishment and weed management option in direct seeded rice

Treatment	15 DAS	30 DAS	45 DAS	Weed index (%)
Factor 1 : Methods of Establishment (M)				
M_1	6.99 (65.33)	8.26 (98.26)	8.51 (109.59)	22.15
M_2	6.60 (58.25)	7.82 (88.90)	8.14 (99.96)	21.48
S.Em (±)	0.09	0.10	0.07	0.21
C.D (P = 0.05)	0.27	0.29	0.21	0.62
Factor 2: Weed Management Option (W)				
W_1	0.71(0.00)	0.71 (0.00)	0.71(0.00)	0.00
W_2	7.10 (50.06)	6.48 (41.83)	8.68 (75.27)	24.29
W_3	6.32 (39.53)	5.87 (34.02)	6.62 (43.44)	7.23
W_4	6.55 (42.75)	10.12(102.09)	6.06 (36.38)	12.51
W_5	13.30 (176.60)	17.04(289.96)	19.55 (368.79)	65.05
S.Em (±)	0.15	0.16	0.11	0.33
C.D (P = 0.05)	0.45	0.46	0.31	0.98
Interactions (M X W)	NS	NS	NS	NS

Note: Original values are given in parenthesis, data subjected to square root transformation.

Table 2: Different growth and yield attributes as influenced by methods of establishment and weed management options in direct seeded rice

Treatment	Leaf area at 90 DAS	Dry matter production at 90 DAS	No. Panicles (m^{-2})at harvest	Panicle length(cm)	Numbers of grains $panicle^{-1}$	Filled grains $panicle^{-1}$	Chaffiness (%)
Factor 1 : Methods of Establishment(M)							
M_1	35.98	747.39	169.63	15.97	81.17	68.39	16.89
M_2	41.86	808.94	232.33	17.15	88.33	77.42	13.04
S.Em (±)	0.49	8.42	5.24	0.25	0.41	0.30	0.32
C.D (P = 0.05)	1.45	25.02	15.57	0.74	1.21	0.90	0.95
Factor 2: Weed Management Option (W)							
W1	46.01	913.86	250.50	19.69	99.67	90.43	9.27
W2	34.83	737.42	194.84	15.30	73.98	62.93	14.92
W3	43.99	872.98	231.83	18.26	95.50	85.78	10.24
W4	42.06	801.25	184.25	16.95	90.67	78.54	13.38
W5	27.71	565.33	143.50	12.61	63.93	46.84	27.01
S.Em (±)	0.83	13.32	8.29	0.40	0.65	0.48	0.51
C.D (P = 0.05)	2.50	39.56	24.62	1.17	1.92	1.42	1.50
Interactions (M X W)							
M1W1	43.33	846.72	203.00	18.25	96.67	86.20	10.82
M1W2	29.33	729.75	192.00	15.77	69.32	57.89	16.46
M1W3	41.65	837.58	191.33	17.52	93.33	82.23	11.93
M1W4	39.83	772.33	149.17	16.49	87.33	74.63	14.51
M1W5	25.75	550.58	112.67	11.83	59.18	41.00	30.72
M2W1	48.68	981.02	298.00	21.12	102.67	94.67	7.72
M2W2	40.33	745.08	197.67	14.83	78.63	67.97	13.38
M2W3	46.34	908.38	272.33	19.00	97.67	89.33	8.54
M2W4	44.29	830.17	219.33	17.41	94.00	82.45	12.24
M2W5	29.67	580.08	174.33	13.39	68.67	52.67	23.30
S.Em (±)	1.09	18.83	11.72	0.56	0.91	0.67	0.72
C.D (P = 0.05)	3.25	55.95	34.81	1.66	2.71	2.00	2.13

Table 3: yield and economics as influenced by methods of establishment and weed management options in direct seeded rice

Treatment	Grain Yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Gross returns	Net returns	B:C ratio
Factor 1 : Methods of Establishment (M)					
M_1	2917	4277	91384	43694	1.90
M_2	3514	4656	107624	60810	2.28
S.Em (±)	46	44	-	-	-
C.D (P = 0.05)	135	130	-	-	-
W_1	4103	5520	126074	66104	2.10
W_2	3118	4506	97358	54626	2.28
W_3	3810	5145	117176	71071	2.54
W_4	3589	4971	110982	64993	2.42
W_5	1457	2192	45930	4463	1.11
S.Em (±)	72	69	-	-	-
C.D (P = 0.05)	214	205	-	-	-
Interactions (M					
M_1W_1	3715	5181	115075	54650	1.90
M_1W_2	2852	4452	90714	47527	2.10
M_1W_3	3400	4903	106117	59557	2.28
M_1W_4	3255	4755	101905	55552	2.20
M_1W_5	1360	2094	43108	1183	1.03
M_2W_1	4491	5858	137073	77559	2.30
M_2W_2	3383	4560	104001	61725	2.46
M_2W_3	4221	5387	128235	82586	2.81
M_2W_4	3922	5186	120059	74435	2.63
M_2W_5	1554	2290	48752	7742	1.19
S.Em (±)	102	98	-	-	-
C.D (P = 0.05)	306.34	290	-	-	-

References

1. Anonymous, 2020, https://www.fao.org/faostat/en/#data/QCL.
2. Anonymous. 2021. *www. indiastat.com*
3. Balasubramanian R, Veerabadran V, Devasagayam M, Krishnasamy S and Jayapaul P. 1996. Influence of herbicides on weed management in lowland rice. Pestology., 24(12): 18-20
4. Evans, LT., 1979, An agriculturist in the botanical gardens. *Search*, 10341-10346.
5. Gill, G.S. and Vijaya kumaR, 1969. Weed index a new method for reporting weed control trials. Indian J. Agron., 19 (3):96-98.
6. Gomez, KA. and Gomez, AA., 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons, New York, USA.
7. Kashid, NV. Jadhav, VT. and Patil, YJ. 2019, Herbicides for weed management in dry direct-seeded rice. *Indian, J. Weed Sci*.,51(1): 72-74.
8. Kennedy D. 2009. The importance of rice. Science, 296(5): 13-18.
9. Maclean JL, Dawe DC and Hettel GP. 2002. Rice almanac: Source book for the most important economic activity on earth. International Rice Research institute 7: 56-61.
10. Mohapatra S, Tripathy SK and Mohanty AK. 2021. Sequential application of pre- and post-emergence herbicides for the control of weeds in transplanted rice at Hirakud command areas of Odisha. Indian J. Weed Sci., 53(4): 358-362.
11. Reddy TV, Meera V, Menon PV, Sindhu PV and Pujari SR. 2021.Weed management efficacy of tank mix herbicides in wet-seeded rice. Indian J. Weed Sci.,53(2): 123-128.
12. Reddy,MSS and Ameena M.2021.Efficacy of pre-and-post-emergence ready-mix herbicides in rainfed lowland wet-seeded rice. Indian J. Weed Sci.53(1):88-91.
13. Saravanane P. 2020. Effect of different weed management options on the diverse weed flora, rice grain yield and economics in dry-DSR. Indian J. Weed Sci., 52(2): 102-106.
14. Yogananda SB, Thimmegowda P and Shruthi GK. 2021. Weed management in wet (drum)-seeded rice under Southern dry zone of Karnataka. Indian J. Weed Sci., 52(2): 117-122.