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Weed control in direct seeded hybrid rice (*Oryza sativa* L.) under different mulches

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Abstract

A field experiment was conducted to evaluate the effect of different mulching practices on growth, yield, and weed dynamics of direct-seeded hybrid rice. The treatments included synthetic mulches (silver, black, and transparent polythene of 7 and 25 micron thickness), organic mulches (paddy straw and *Glyricidia* leaves @ 5 t ha⁻¹ with one hand weeding at 40 DAS), weed-free check, and unweeded control. Results revealed that 25 micron silver polythene mulch (M9) significantly enhanced plant height, number of tillers hill⁻¹, and dry matter accumulation hill⁻¹, and produced the highest grain (60.13 q ha⁻¹) and straw yield (77.63 q ha⁻¹), remaining statistically at par with 25 micron black and 7 micron silver and black polythene mulches. Weed-free treatment recorded the lowest weed density and highest weed control efficiency; however, among mulches, 25 micron silver polythene mulch was most effective in reducing weed density, weed dry matter accumulation, and improving weed control efficiency at harvest. Transparent polythene mulches were comparatively less effective. The study concludes that silver and black polythene mulches, particularly 25 micron silver polythene mulch, significantly improve crop growth, yield, and weed suppression in direct-seeded hybrid rice and can be recommended for higher productivity.

Keywords: Direct seeding, growth, hybrid rice, mulching, weed density, yield

Introduction

Rice (*Oryza sativa* L.) remains a principal food crop globally, but traditional puddled transplanting is increasingly challenged by labour scarcity, rising production costs and water resource constraints. Direct seeded rice (DSR) offers a resource-saving alternative that reduces labour and water requirements while enhancing timely crop establishment; however, weed infestation is a major limitation in DSR systems often causing substantial reductions in crop growth and yield if not managed effectively. Efficient weed control strategies are therefore indispensable for the successful adoption of DSR technology. Recent research emphasizes integrated weed management that combines cultural, mechanical and ecological practices to sustainably suppress weed populations and support crop productivity in DSR systems (Nagargade *et al.*, 2024) ^[10].

Mulching has emerged as a promising cultural tool for weed management and soil moisture conservation. Plastic mulches modify soil microclimate by conserving moisture, increasing soil temperature and creating an unfavorable environment for weed germination resulting in reduced weed density and biomass in several crops including rice (Zhao *et al.*, 2024) ^[13]. Both organic and synthetic mulches have been reported to influence crop performance and weed dynamics but the effectiveness varies with mulch type, thickness and colour. While organic mulches improve soil physical properties and provide some degree of weed suppression, synthetic mulches such as coloured polythene films have shown greater potential to suppress weed emergence and improve crop growth and yield due to enhanced light exclusion and microclimate modification. Yet, comparative studies on different polythene mulch colours and thicknesses under direct-seeded hybrid rice are limited.

In view of these challenges and research gaps, the present study was undertaken to evaluate the effects of different mulch materials including various colours and thicknesses of polythene mulches, organic mulches and control treatments on growth, yield, weed density, weed dry matter accumulation and weed control efficiency in direct-seeded hybrid rice.

Materials and Methods

The experiment was conducted during *kharif* season of the year 2017-18 at Agronomy Farm, Department of Agronomy, College of Agriculture, Dapoli to study the effect of different mulches on growth, yield, weed density, weed dry matter production and weed control efficiency in direct seeded hybrid rice. The experimental field was levelled and well drained. The soil of the experimental plot was sandy clay loam in texture, acidic in pH and medium in organic carbon content. It was low in available nitrogen, medium in available phosphorus and available potassium. The mean rainfall during crop growing season was 3582.4 mm, which was received in 106 rainy days. The mean relative humidity during crop period ranged from 86 to 98% in morning and 68 to 91% in evening, respectively. The minimum temperature during crop growth period was in the range of 21.9 °C to 25.2 °C and maximum temperature was 27.4 °C to 32.5 °C. In general, the climatic conditions were congenial and favorable for growth of hybrid rice during the experimentation period.

The field experiment was laid out in a randomized block design. There were ten treatments which were replicated thrice. The treatments mainly comprised No mulch and no weed management (Un weeded control) (M₁), No mulch with weed management (Weed free) (M₂), Paddy straw mulch @ 5 t ha⁻¹ at 20 DAS + One hand weeding at 40 DAS (M₃), *Glyricidia maculata* leaves mulch @ 5 t ha⁻¹ at 20 DAS + One hand weeding at 40 DAS (M₄), Black Polythene mulch (7 micron) (M₅), Silver polythene mulch (7 micron) (M₆), Transparent Polythene mulch (7micron) (M₇), Black Polythene mulch (25 micron) (M₈), Silver polythene mulch (25 micron) (M₉) and Transparent Polythene mulch (25 micron) (M₁₀). Thus, the gross plot size was 5.10 m × 3.90 m and net plot size was 4.50m × 3.38m, respectively. The seeds of hybrid rice variety Sahyadri-3 were dibbled at a spacing of 20 cm X 15 cm. The recommended dose of fertilizer (RDF) was 150:50:50 NPK kg ha⁻¹. The recommended cultural practices and plant protection measures were undertaken as per recommendation given during experiment. Five plants were randomly selected and tagged for recording observations. The data recorded for various parameters were analyzed further for statistical analysis. The weed count was done species wise *i.e.* grasses, sedges and broad leaf weeds by counting the weeds individually within a 0.25 m² quadrat and then it was converted on square meter basis. The weed count was taken at 30 days interval from the date of sowing. After recording weed density, the roots of uprooted weeds were separated by cutting at collar region and only aerial parts were kept in oven for drying at 60 °C temperature till constant weight was obtained. The dry matter accumulation of

weeds was observed at 60 DAS and at the time of harvest of crop from 0.25 m² area and then it was converted on square meter basis. Weed control efficiency (WCE) was worked out by using the formula suggested by Mani *et al.* (1973) [8] and expressed in percentage. It was calculated at 60 DAS and at harvest.

$$WCE (\%) = \frac{x - y}{x} \times 100$$

Where,

x = Dry weight of weeds in unweeded control,

y = Dry weight of weeds in treatment plot.

Results and Discussion

Effect on growth and yield

Data presented in Table 1 clearly indicated that the maximum plant height, number of tillers hill⁻¹ and dry matter accumulation hill⁻¹ was observed in the treatment of 25 micron silver polythene mulch (M₉) followed by 25 micron black polythene mulch (M₈), 7 micron silver polythene mulch (M₆) and 7 micron black polythene mulch (M₅). The lowest values of growth attributes were observed in no mulch and no weed management treatment (M₁). Use of 25 micron silver polythene mulch (M₉) recorded significantly taller plants and maximum number of tillers hill⁻¹ at all the stages of crop growth over rest of the treatments under study except treatments M₈ and M₆ at harvest. Dry matter accumulation in the plant gradually increased with crop age. The hybrid rice grown under 25 micron silver polythene mulch (M₉) recorded significantly more dry matter accumulation hill⁻¹ than the rest of treatments under investigation except treatments M₈, M₆ and M₅ at harvest. In general, it was observed that there was improvement in all the growth attributes at all the stages of crop growth under silver and black polythene mulch. This increase in values of growth attributes might be due to effective weed control under silver and black polythene mulch which had reduced the competition of weeds with rice crop for space, water, light and nutrients. Thus more space, water, light and nutrients were available for the better growth and development of crop which resulted in higher values of growth attributes. Similarly, increase in minimum soil temperature and soil moisture content in the upper portion of the soil, provided an ideal environment for vigorous growth of the plant. Similar findings were also reported by Ehsanullah *et al.* (2014) [4] and Iqbal and Ali (2014) [5] in rice.

Table 1: Effect of different treatments on growth and yield of direct seeded hybrid rice

Treatments		Plant height (cm)	No. of tillers hill ⁻¹	Dry matter production hill ⁻¹ (g)	Grain yield (q ha ⁻¹)	Straw yield (q ha ⁻¹)
M ₁ :	No mulch and no weed management (Unweeded control)	55.47	7.77	24.17	18.23	28.11
M ₂ :	No mulch with weed management (Weed free)	68.80	13.70	36.00	53.51	74.35
M ₃ :	Paddy straw mulch @ 5 t ha ⁻¹ at 20 DAS + One hand weeding at 40 DAS	67.20	11.93	31.67	54.64	71.24
M ₄ :	<i>Glyricidia maculata</i> leaves mulch @ 5 t ha ⁻¹ at 20 DAS + One hand weeding at 40 DAS	68.53	12.67	31.83	54.02	72.52
M ₅ :	Black Polythene mulch (7 micron)	69.20	14.67	36.83	58.70	76.41
M ₆ :	Silver polythene mulch (7 micron)	72.47	15.70	37.00	59.10	76.86
M ₇ :	Transparent Polythene mulch (7 micron)	59.33	10.87	24.33	49.42	67.92
M ₈ :	Black Polythene mulch (25 micron)	72.93	16.03	37.50	59.60	77.43
M ₉ :	Silver polythene mulch (25 micron)	73.20	16.60	37.67	60.13	77.63
M ₁₀ :	Transparent Polythene mulch (25 micron)	66.00	11.37	29.00	50.28	69.84
	S.E.m ±	0.42	0.43	0.34	0.52	0.46
	CD at 5%	1.15	1.19	0.93	1.45	1.26
	General mean	67.31	13.13	32.60	51.77	69.23

Significantly higher grain and straw yield was recorded by silver and black polythene mulch of both the 25 and 7 micron thickness *i.e.* treatments M₉, M₈, M₆ and M₅ over rest of the treatments under study (Table 1). However, the effects of these treatments were statistically equal. A critical look of data further indicated that among synthetic mulch, silver and black polythene mulch were significantly superior over transparent polythene mulch while both the organic mulch *i.e.* paddy straw mulch @ 5 t ha⁻¹ at 20 DAS + one hand weeding at 40 DAS (M₃) and *Glyricidia maculata* leaves mulch @ 5 t ha⁻¹ at 20 DAS + one hand weeding at 40 DAS (M₄) remained statistically identical with each other in respect of yield of rice. The higher grain and

straw yield of direct seeded hybrid rice obtained under silver and black polythene mulch may be due to significant increase in growth and yield attributes in polythene mulch (Table 1). It depends upon the dry matter production per unit area therefore; high production of total dry matter is the first prerequisite for higher yield, which showed the progressive increase in total dry matter accumulation as the crop attained maturity. A unit increase in growth attributes increased the grain and straw yield of rice. The beneficial effect of silver and black polythene mulch on growth and yield attributes of rice finally enhanced the yield of rice. These results corroborate the findings of Liu *et al.*, Ehsanullah *et al.* (2014)^[4] and Ali *et al.* (2016)^[11] in rice.

Table 2: Effect of different treatments on total weed density m⁻² at 30, 60, 90 DAS and at harvest in direct seeded hybrid rice

Treatments	Total weed density m ⁻²			
	30 DAS	60 DAS	90 DAS	At harvest
M ₁ : No mulch and no weed management (Unweeded control)	204.67 (14.30)	276.67 (16.62)	290.67 (17.04)	298.67 (17.27)
M ₂ : No mulch with weed management (Weed free)	10.67 (3.28)	21.33 (4.61)	25.33 (5.03)	30.67 (5.53)
M ₃ : Paddy straw mulch @ 5 t ha ⁻¹ at 20 DAS + One hand weeding at 40 DAS	51.33 (7.16)	36.00 (5.99)	72.00 (8.48)	77.33 (8.79)
M ₄ : <i>Glyricidia maculata</i> leaves mulch @ 5 t ha ⁻¹ at 20 DAS + One hand weeding at 40 DAS	52.00 (7.20)	40.00 (6.32)	77.33 (8.79)	84.00 (9.16)
M ₅ : Black Polythene mulch (7 micron)	40.00 (6.32)	61.33 (7.83)	66.63 (8.16)	69.33 (8.30)
M ₆ : Silver polythene mulch (7 micron)	26.00 (5.99)	57.33 (7.57)	62.67 (7.91)	65.33 (8.07)
M ₇ : Transparent Polythene mulch (7 micron)	64.00 (8.00)	80.67 (8.98)	96.00 (9.80)	102.67 (10.13)
M ₈ : Black Polythene mulch (25 micron)	30.67 (5.52)	50.00 (7.00)	56.00 (7.47)	58.67 (7.66)
M ₉ : Silver polythene mulch (25 micron)	24.00 (4.89)	45.33 (6.67)	52.00 (7.18)	56.00 (7.45)
M ₁₀ : Transparent Polythene mulch (25 micron)	60.00 (7.74)	76.00 (8.72)	83.33 (9.13)	92.00 (9.59)
S.E.m ±	(0.17)	(0.23)	(0.15)	(0.18)
CD at 5%	(0.47)	(0.62)	(0.41)	(0.49)
General mean	57.33 (7.04)	74.47 (8.03)	88.20 (8.90)	93.47 (9.20)

(Note: Figures in parenthesis denotes values of square root transformation)

Effect on total weed density m⁻²

Data pertaining to the mean number of total weeds m⁻² area in the rice as affected by different treatments at 30, 60, 90 DAS and at harvest are presented in Table 2. Treatment weed free check without mulch (M₂) recorded significantly lower number of weed flora m⁻² than rest of the treatments at all growth stages of rice. This was due to complete removal of weeds manually by performing hand weeding. These results corroborate the findings of Bhurer *et al.* (2013)^[2] in rice and Mohitsham *et al.* (2013)^[9] in aerobic rice. Un-weeded control without mulch (M₁) recorded significantly higher number of weed flora as compared to other treatments at 30, 60, 90 DAS and at harvest. This was due to the unrestricted weed growth under the above referred treatment. Same results observed by Bhurer *et al.* (2013)^[2] in rice, Chauhan and Abugho (2013)^[3] in rice, Liu *et al.* in rice, Mohitsham *et al.* (2013)^[9] in aerobic rice and Shah *et al.* (2014)^[12] in maize. Among different mulches, 25 micron silver polythene mulch (M₉) significantly reduced the density of weed than rest of the mulch treatments at 30 DAS and remained

statistically similar with treatment M₈ at 90 DAS of rice. The reduction in weed density under silver and black polythene mulch was observed. This is because of most of the weed seed are light sensitive, so did not germinate under the plastic mulch so ultimately caused a reduction in population. Similar findings were also reported by Mohitsham *et al.* (2013)^[9] in aerobic rice, Shah *et al.* (2014)^[12] in maize and Ocharo *et al.* (2017)^[11] in green pepper. Among different mulches, paddy straw mulch @ 5 t ha⁻¹ at 20 DAS + one hand weeding at 40 DAS significantly reduced the density of weeds than rest of the mulch treatments at 60 DAS of rice. This is because of one hand weeding carried out in treatments M₃ and M₄ at 40 DAS. A critical examination of data further indicated that among different types of mulches, treatment M₈ and M₉ significantly reduced the density of grasses than rest of the mulch treatments under investigation. Treatment M₉ was found superior in reducing the density of weeds than rest of the mulch treatments followed by treatment M₈ for total weed flora.

Table 3: Effect of different treatments on total weed dry matter production m⁻² (g) and weed control efficiency (%) at 60 DAS and at harvest in direct seeded hybrid rice

Treatments	Total weed dry matter production m ⁻² (g)		Weed control efficiency (%)	
	60 DAS	At harvest	60 DAS	At harvest
M ₁ : No mulch and no weed management (Unweeded control)	728.32 (26.96)	892.03 (29.85)	---	---
M ₂ : No mulch with weed management (Weed free)	15.61 (3.95)	42.45 (6.51)	97.86	95.23
M ₃ : Paddy straw mulch @ 5 t ha ⁻¹ at 20 DAS + One hand weeding at 40 DAS	27.40 (5.23)	133.01 (11.53)	96.17	85.03
M ₄ : <i>Glyricidia maculata</i> leaves mulch @ 5 t ha ⁻¹ at 20 DAS + One hand weeding at 40 DAS	34.11 (5.83)	144.14 (12.01)	95.31	83.79
M ₅ : Black Polythene mulch (7 micron)	115.80 (10.75)	109.32 (10.44)	83.86	87.61
M ₆ : Silver polythene mulch (7 micron)	110.57 (10.51)	102.03 (10.10)	84.68	88.54
M ₇ : Transparent Polythene mulch (7 micron)	249.79 (15.79)	299.65 (17.30)	65.67	66.36
M ₈ : Black Polythene mulch (25 micron)	91.81 (9.55)	99.13 (9.94)	87.21	88.77
M ₉ : Silver polythene mulch (25 micron)	82.62 (9.05)	88.07 (9.37)	88.44	90.05
M ₁₀ : Transparent Polythene mulch (25 micron)	233.39 (15.25)	269.83 (16.42)	69.76	69.63
S.E.m ±	(0.24)	(0.17)	-	-
CD at 5%	(0.66)	(0.48)	-	-
General mean	168.94 (11.29)	217.97 (13.35)	-	-

(Note: Figures in parenthesis denotes values of square root transformation)

Effect on weed dry matter accumulation $m^{-2}(g)$

Data pertaining to the mean dry matter accumulation of weeds $m^{-2}(g)$ at 60 DAS and at harvest in rice as affected by different mulch treatments are presented in Table 3. Weed free treatment without mulch (M_2) recorded significantly lower dry matter accumulation of weeds than rest of the treatments. Significantly higher weed dry matter accumulation of weeds was recorded in treatment of unweeded control without mulch. Among different types of mulches, paddy straw mulch @ $5 t ha^{-1}$ at 20 DAS + one hand weeding at 40 DAS (M_3) and *Glyricidia maculata* leaves mulch @ $5 t ha^{-1}$ at 20 DAS + one hand weeding at 40 DAS (M_4) remained statistically at par with each other and found significantly superior over rest of the mulch treatments for dry matter weight of total weed flora at 60 DAS. At harvest, treatment M_9 recorded significantly less dry weight of weeds than rest of the mulch treatments. The less number of weeds under mulches resulted in lower dry matter production of weeds. Similarly the dry matter production of weeds in plastic mulched treatment was less due to increase in minimum temperature and vigorous growth of the rice crop as reflected in plant height, which caused an early canopy of crop and ultimately helped in smothering the weed flora. The same results were reported by Jeon *et al.* (2011)^[6] in transplanted rice and Ocharo *et al.* (2017)^[11] in green pepper.

Effect on weed control efficiency (WCE%)

Data computed for weed control efficiency (%) at 60 DAS and at harvest is presented in Table 3 and indicates that the weed control efficiency at 60 DAS and at harvest in direct seeded rice was higher under weed free check without mulch (M_2). Among mulch treatments, paddy straw mulch @ $5 t ha^{-1}$ at 20 DAS + one hand weeding at 40 DAS (M_3) recorded higher WCE followed by *glyricidia* leaves mulch @ $5 t ha^{-1}$ at 20 DAS + one hand weeding at 40 DAS (M_4), 25 micron silver (M_9) and black polythene mulch (M_8) at 60 DAS. At harvest, use of 25 micron silver polythene mulch (M_9) resulted in higher weed control efficiency followed by 25 micron black (M_8), 7 micron silver (M_6) and black (M_5) polythene mulch. Transparent polythene mulch of 7 and 25 micron thickness recorded lower WCE at 60 DAS and at harvest. This might be due to lower dry matter accumulation in weed free check and polythene mulch treatment. Similar findings were reported by Liu *et al.* in rice.

Conclusion

It can be concluded that 25 micron silver polythene mulch (M_9) recorded the highest plant height, number of tillers, dry matter accumulation, grain and straw yield remaining statistically at par with 25 micron black and 7 micron silver and black polythene mulches. Silver and black polythene mulches were superior to transparent and organic mulches in enhancing crop performance. These treatments effectively reduced weed density, weed dry matter accumulation and increased weed control efficiency. Therefore, 25 micron silver polythene mulch can be recommended for achieving higher productivity and better weed suppression in direct-seeded hybrid rice.

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