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Bio-efficacy of herbicide for weed control in direct-seeded rice (*Oryza sativa* L.) varieties in Chhattisgarh plain

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ABSTRACT

The experiment was conducted at Research cum Instructional Farm, IGKV, Raipur (Chhattisgarh) during Kharif season 2015-2016 to study the bio-efficacy of herbicide for weed control in direct seeded rice (Oryza sativa L.) varieties. The soil of experimental field was sandy loam in texture (Inceptisols) known as Matasi. The Experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. The treatment consisted of three varieties viz. MTU-1010 (V_1), Indira barani dhan (V_2) and IR-64 (V_3) and four weed management practices viz. H_1 - Rinskor @ 37.5 ml a.i. ha^{-1} at 20 DAS, H_2 - Rinskor @ 75 ml a.i. ha^{-1} at 20 DAS, H_3 - Mechanical weeding at 20 and 40 DAS and H_4 - Control. The results of experiment indicated that variety MTU-1010 (V_1) registered significantly highest values of rice yield of rice like grain yield, straw yield and harvest index. It was at par to variety IR-64 for above parameters. Among weed management practices, Mechanical weeding at 20 and 40 DAS (H_3) registered significantly highest values of rice yield rice like grain yield, straw yield and harvest index, but it was comparable to Rinskor @ 37.5 ml a.i. ha^{-1} at 20 DAS (H_1). Among the varieties, higher grain yield and B:C ratio was recorded under MTU-1010 (V_1) as regards to weed management practices maximum grain yield and B:C ratio were obtained under Mechanical weeding at 20 and 40 DAS (H_3).

Key word: *Herbicide, Bio-efficacy, Direct-seeded rice, Economics, Grain yield, Straw yield, Harvest index, Weed control efficiency, Chhattisgarh plain.*

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INTRODUCTION

Rice is the most consumed cereal grain in the world, constituting the dietary staple food for more than half of the planets human population. In world, rice is the second most widely consumed cereal next to wheat and it has occupied an area of 163.20 million hectares, with a total production of 719.70 million tonnes [1]. Rice provides about two-third of the calorie intake for more than two billion people in Asia and a third of the calorie intake of nearly one billion people in Africa and Latin America [25]. Hence there is a need to increase the productivity of rice.

Direct seeding of rice has been receiving increased attention recently in view of increased labour costs, scarcity of water and increased availability of herbicides for weed management and is an economical alternative to transplanted rice. The average productivity of rice is very low due to several constraints. Among these, in direct seeded rice, weeds are one of the major constraints for low productivity of rice because both rice and weed germinate almost simultaneously. Weed problem persists because of their ability to cope with their great reproductive capacity and massive recycling. Aerobic soil conditions and dry-tillage practices, besides alternate wetting and drying conditions are conducive for germination and growth of highly competitive weeds, which makes that weeds becoming a serious problem in direct seeded drilled rice ecosystems.

Based on research findings it was estimated that extent of yield reduction in rice due to weeds alone is about 15-20 per cent for transplanted rice, 30-35 per cent for direct seeded puddled rice and 50-95 per cent or even more in direct seeded rice under severe weed infestation [5]. However, if the weed population could effectively be controlled, direct seeded rice cultivation may offer a unique advantage of raising yields at par with transplanted rice.

MATERIAL AND METHODS

Field experiment was conducted during *kharif* season of 2015 at the Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, geographically, Raipur situated in mid – eastern part of Chhattisgarh state and lies at 21^0 16′ North Latitude and 81^0 36' East Longitude with an altitude of 314.15 m above the mean sea level. Climatologically, Raipur comes under the Chhattisgarh plains agro climatic sub zone which having sub humid climatic condition. The region receives an average of 1104 mm annual rainfall, out of which about 87 per cent received during the rainy season (June to September) and the rest of 13 per cent during the winter season (October to February). The soil was neutral (pH 7.3) in reaction with medium in fertility having 0.67% soil organic carbon, low nitrogen (211.4 kg ha^{-1}), medium phosphorus (18.4 kg ha^{-1}) and high potassium (325 kg ha^{-1}) content. The experiment was laid out in Factorial Randomized Block Design with three replication. The treatments comprised of twelve treatments. Three varieties MTU-1010 (V_1), Indira Barani Dhan (V_2) and IR-64 (V_3) and four herbicide doses were consisting in experiment Rinskor 2.5% EC @ 37.5 ml *a.i.* ha^{-1} at 20 DAS (H_1), Rinskor 2.5% EC @ 75 ml *a.i.* ha^{-1} at 20 DAS (H_2), Mechanical weeding at 20 and 40 DAS (H_3) and Control (H_4). Rice varieties was sown in rows 20 cm apart during the fourth week of June.

RESULTS AND DISCUSSION

Floristic composition of weeds:

The major weeds species observed in the experimental field have been given in Table 1. The weed flora composition (%) according to different categories of weed species at different time interval of direct seeded rice. have been given in Table 1 and Fig 1 to 5.

Table 1: Weed flora composition in control plots at different time interval

No.	Categories of weed species	Weed flora composition (%)				
		20 DAS	40 DAS	60 DAS	80 DAS	At harvest
1.	Narrow leaved weed	21.43	30.66	39.23	36.10	34.85
2.	Broad leaved weed	52.99	48.58	41.79	45.44	54.78
3.	Sedges	25.58	20.76	18.98	18.47	10.37

At 20, 40, 60, 80 DAS and at harvest, the percentage composition of broad leaved weeds were 52.99, 48.58, 41.79, 45.44, 54.78 % respectively which were comparatively higher to narrow leaved weeds (21.43, 30.66, 39.23, 36.10 and 34.85 % at 20, 40, 60, 80 DAS and at harvest, respectively) and sedges (25.58, 20.76, 18.98, 18.47 and 10.37 % at 20, 40, 60, 80 DAS and at harvest, respectively). Similar trends for weed flora were identified by Dwivedi *et al*. [7] reported that the following species of weeds *viz*., *Echinochloa colona, Cyperus difformis*, *Eclipta alba*, *Fimbristylis miliacea*, *Commelina benghalensis* and *Cynodon dactylon* were observed in direct seeded rice. Also reported by Kolhe [14], Singh *et al*. [26] and Singh *et al*. [27], Urkurkar and Chandrakar [31], Jaya Suria *et al.* [11], Singh and Namdeo [27], Mann *et al.* [15] and Khaliq *et al.* [13].

Weed density (No. m^{-2}) according to categories of weed species

The weed density according to categories of weed species (Broad leaved, narrow leaved and sedges) at 20, 40, 60, 80 DAS and at harvest as influenced by varieties and weed management practices in Table 2.

Different varieties failed to give significant impact on weed density of broad leaved, narrow leaved and sedges in different crop growth periods in direct seeded rice.

Similarly, different weed management practices gave non-significant influence on weed density for narrow leaved, broad leaved and sedges at 20 DAS and 80 DAS for narrow leaved weeds and at harvest for sedges.

At 40 DAS, the density of narrow leaved, broad leaved and sedges were minimum under H_1- Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS, whereas these were maximum under H_4 - Control plot. At 60 DAS, the same trend as noted above for different treatments have been observed.

At 80 DAS, the maximum density of broad leaved weeds was observed under H_1- Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS, whereas the minimum density of sedges was noted with H_2 - Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS. However, the maximum density of broad leaved weeds and sedges were observed under H_4 - Control plot.

At harvest, the minimum density of narrow leaved weeds was noted under H_3-Mechanical weeding at 20 and 40 DAS. Whereas, the maximum density of broad leaved weeds was observed under H_1- Rinskor @

37.5 ml *a.i.* ha^{-1} at 20 DAS. The maximum density of narrow leaved and broad leaved weeds were observed under H_4- Control plot.

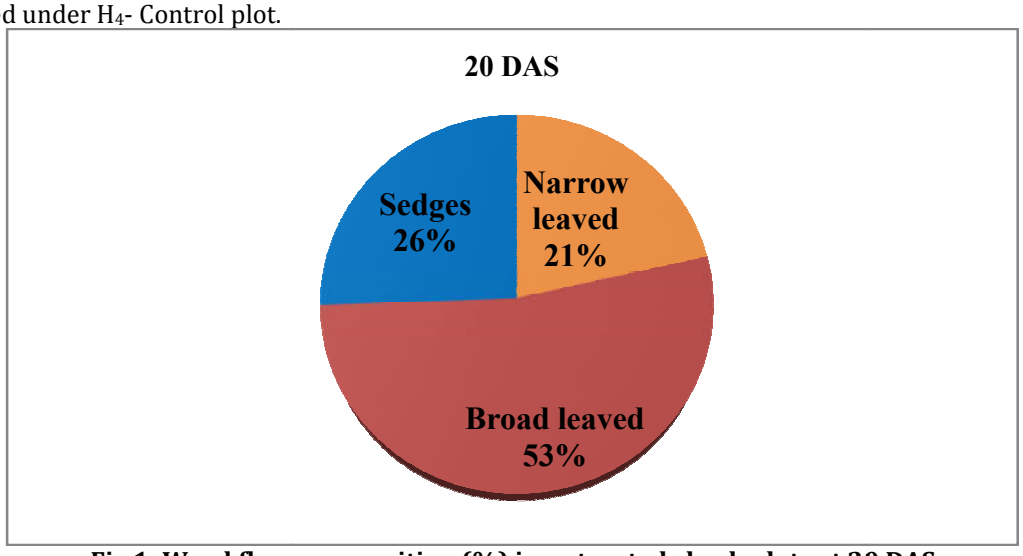

Fig 1: Weed flora composition (%) in untreated check plots at 20 DAS

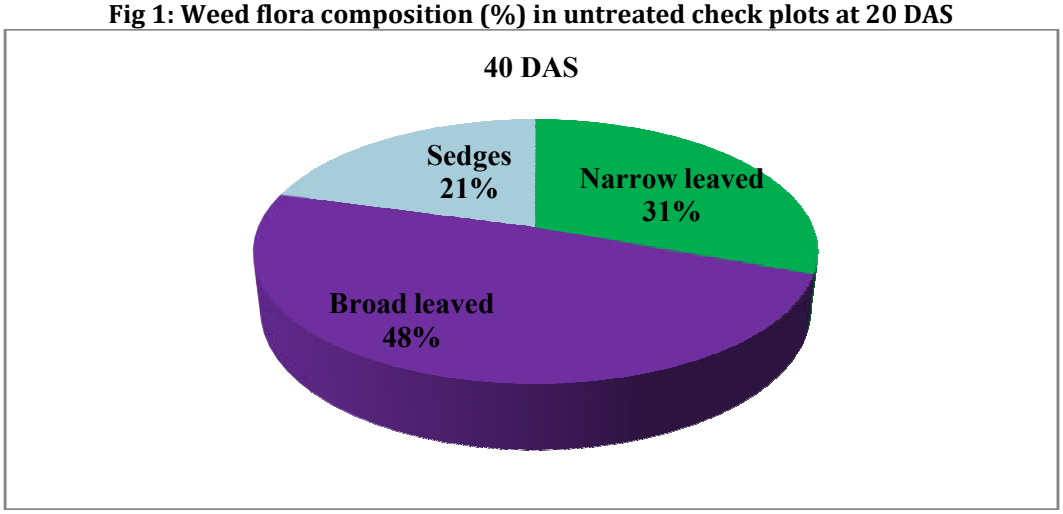

Fig 2: Weed flora composition (%) in untreated check plots at 40 DAS

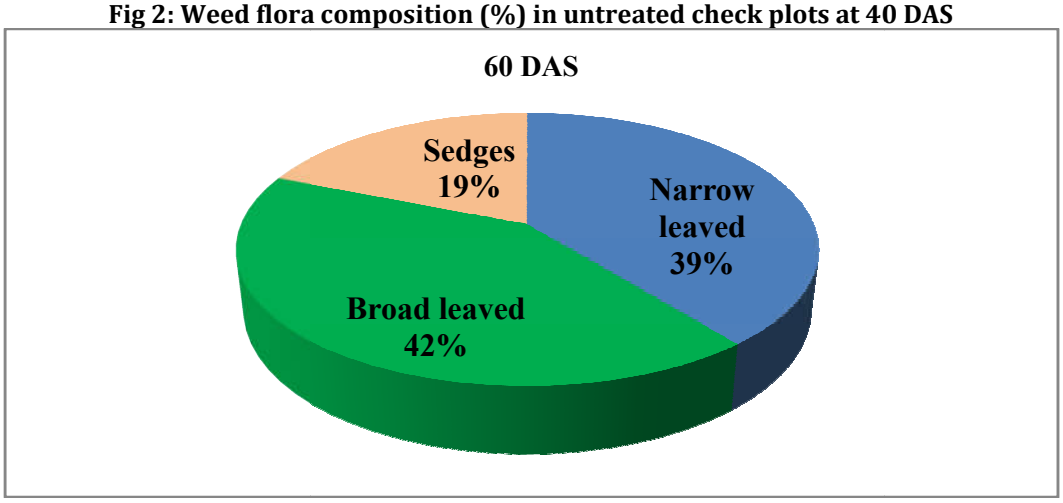

Fig 3: Weed flora composition (%) in untreated check plots at 60 DAS

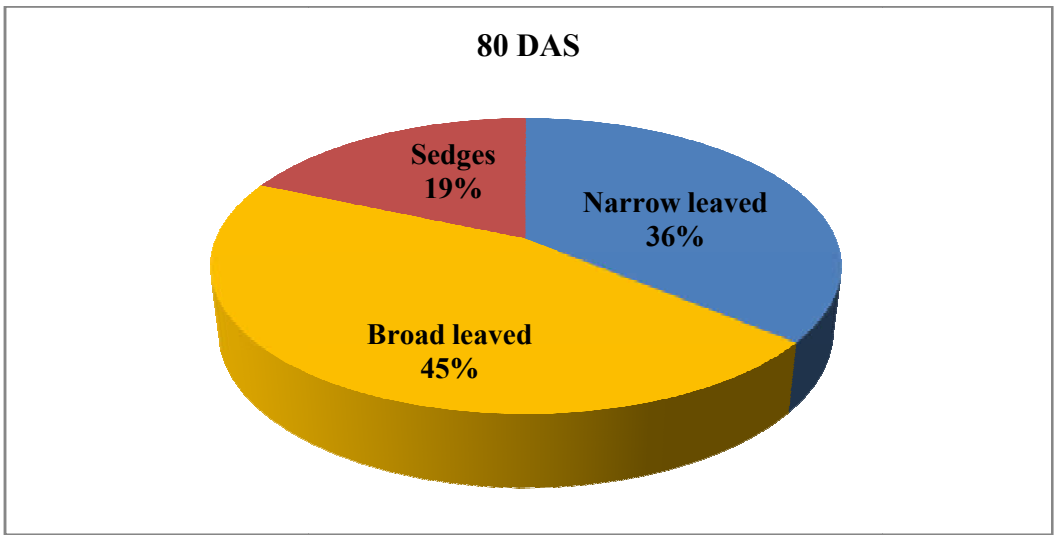

Fig 4: Weed flora composition (%) in untreated check plots at 80 DAS

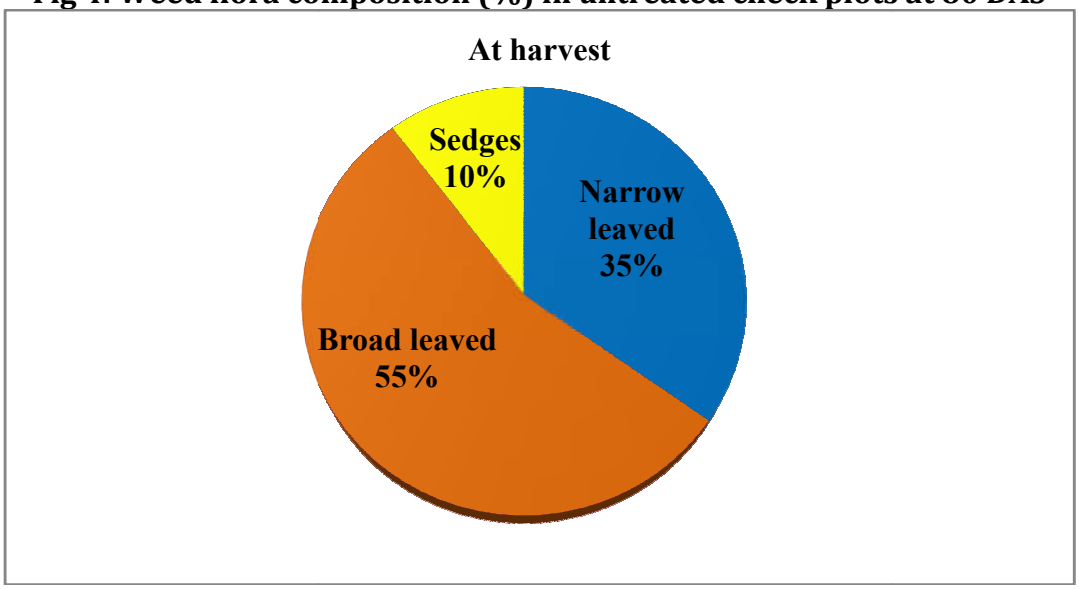

Fig 5: Weed flora composition (%) in untreated check plots at harvest

During the cropping period, there is a particular duration, the critical period of competition, the presence of weeds above a certain density, critical threshold level, will cause a significant reduction in yield. Weed species differ in their ability to compete with rice. The degree of rice-weed competition depends on rainfall, rice variety, soil factors, weed density, duration of rice, weed growth and crop age when weeds started to compete, and nutrient resources, among other variables. Similar result was also reported by Rathore *et al.* [23] reported that combined application of tank mixed fenoxaprop-p-ethyl 60 g ha^{-1} and chlorimuron+ metsulfuron 4 g ha^{-1} + one hand weeding, control weeds effectively in direct seeder rice. In addition to effective control of weeds, it enhanced 26% seed yield of rice compared to inter-culture *biasi* operation, Khaliq *et al.* [13] shows that pendimethalin followed by post emergence application of bispyribac sodium and penoxsulam gave more than 80% reduction in weed density and also observed by Jaya Suria *et al.* [11].

Weed dry matter (g m^{-2}) according to categories of weed species

Dry matter production according to categories of weed species at 20, 40, 60, 80 DAS and at harvest as influenced by varieties and weed management practices are presented in Table 2.

The findings revealed that different varieties could not show significant influence on weed dry matter at different crop growth period in direct seeded rice. In case of weed management, non significant difference was observed for dry matter production of weeds at 20 DAS for narrow, broad leaved and sedges and at harvest for sedges.

At 40, 60, 80 DAS and at harvest, weed management through H_1 - Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS registered significantly lowest values of narrow leaved, broad leaved and sedges, however, it was at par

to H_2 - Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS. The maximum dry matter production of narrow leaved, broad leaved and sedges at 40, 60, 80 DAS and at harvest were noted under H_4 - Control plot similar result observed by Chandra *et al*. [4] found that in direct seeded rice, total dry matter production of weed was achieved by manual weeding at 25 and 40 DAS. Manual weeding was found best method of weed control, and also reported that Kolhe [14], Choubey [6], Puniya *et al.* [22] and Singh *et al.* [29].

Table 2: Weed dry matter (g m^{-2}) according to categories of weed species at different crop growth period in direct seeded rice as influenced by varieties and weed management practices

Treatment			Varieties					Weed management
			MTU 1010	Indira barani dhan	IR64	**SEm±**	**CD(P=0.05)**	Rinskor @ 37.5 ml *a.i.*
			V_1	V_2	V_3			H_1
Weed dry matter (g m^{-2})	**20 DAS**	**Narrow leaved**	**1.30** (1.20)	**1.68** (2.33)	**1.40** (1.45)	**0.26**	**NS**	**1.30** (1.20)
		Broad leaved	**3.39** (11.01)	**3.77** (13.75)	**3.63** (12.70)	**0.16**	**NS**	**3.47** (11.55)
		Sedges	**1.29** (1.17)	**1.56** (1.92)	**1.43** (1.54)	**0.19**	**NS**	**1.20** (0.94)
	40 DAS	**Narrow leaved**	**3.48** (11.63)	**3.91** (14.76)	**3.88** (14.54)	**0.70**	**NS**	**2.06** (3.74)
		Broad leaved	**3.22** (9.89)	**4.07** (16.05)	**3.83** (14.20)	**0.25**	**NS**	**0.71** (0.00)
		Sedges	**1.51** (1.77)	**2.52** (5.86)	**2.08** (3.83)	**0.34**	**NS**	**0.71** (0.00)
	60 DAS	**Narrow leaved**	**4.51** (19.82)	**5.49** (29.64)	**4.58** (20.51)	**0.74**	**NS**	**3.85** (14.35)
		Broad leaved	**4.76** (22.16)	**5.49** (29.68)	**4.98** (24.35)	**0.54**	**NS**	**0.71** (0.00)
		Sedges	**1.86** (2.96)	**3.25** (10.06)	**2.32** (4.89)	**0.52**	**NS**	**0.71** (0.00)
	80 DAS	**Narrow leaved**	**5.09** (25.39)	**5.86** (33.81)	**5.09** (25.43)	**0.59**	**NS**	**3.67** (12.99)
		Broad leaved	**5.78** (32.86)	**6.48** (41.50)	**5.03** (24.81)	**0.95**	**NS**	**1.53** (1.86)
		Sedges	**1.83** (2.84)	**3.62** (12.57)	**2.18** (4.25)	**0.53**	**NS**	**1.01** (0.52)
	At harvest	**Narrow leaved**	**14.24** (202.31)	**16.53** (272.58)	**15.65** (244.48)	**1.24**	**NS**	**9.02** (80.79)
		Broad leaved	**9.32** (86.34)	**9.41** (88.07)	**9.03** (80.97)	**0.70**	**NS**	**1.03** (0.56)
		Sedges	**1.15** (0.83)	**1.11** (0.72)	**1.16** (0.86)	**0.33**	**NS**	**0.71** (0.00)

H_2	H_3	H_4		
Rinskor @ 75 ml *a.i.* ha^{-1} at	Mechanical weeding at	Control	SEm±	CD (P=0.05)
1.60 (2.06)	**1.28** (1.14)	**1.66** (2.25)	**0.30**	**NS**
3.74 (13.52)	**3.24** (10.02)	**3.94** (15.05)	**0.19**	**NS**
1.29 (1.16)	**1.22** (0.99)	**1.99** (3.47)	**0.22**	**NS**
3.57 (12.23)	**3.50** (11.78)	**5.89** (34.22)	**0.81**	**2.37**
0.71 (0.00)	**5.51** (29.81)	**7.92** (62.15)	**0.29**	**0.86**
0.71 (0.00)	**1.21** (0.97)	**5.52** (30.00)	**0.39**	**1.16**
3.97 (15.29)	**4.21** (17.21)	**7.41** (54.34)	**0.86**	**2.51**
0.71 (0.00)	**6.38** (40.20)	**12.52** (156.37)	**0.62**	**1.83**
0.71 (0.00)	**2.24** (4.53)	**6.25** (38.58)	**0.61**	**1.78**
6.06 (36.22)	**5.18** (26.35)	**6.47** (41.35)	**0.69**	**2.01**
2.55 (5.99)	**8.20** (66.75)	**10.77** (115.44)	**1.10**	**3.23**
1.63 (2.17)	**2.96** (8.26)	**4.56** (20.32)	**0.61**	**1.79**
17.87 (318.71)	**14.50** (209.84)	**20.51** (419.96)	**1.43**	**4.21**
1.90 (3.12)	**11.46** (130.75)	**22.62** (511.22)	**0.81**	**2.37**
0.71 (0.00)	**1.20** (0.94)	**1.95** (3.30)	**0.38**	**NS**

Relative weed density (%)

The relative weed density of narrow leaved, broad leaved and sedges at 20, 40, 60, 80 DAS and at harvest as influenced by varieties and weed management practices are given in Table 3.

It is clear from the data that relative weed density remained unaffected due to varieties at all the crop growth periods. Similarly, weed management practices failed to affect relative weed density of narrow leaved, broad leaved and sedges at 20 DAS, narrow leaved weeds at 40 DAS, sedges at 80 DAS as well as at harvest.

The relative weed density of broad leaved weeds and sedges at 40 and 60 DAS were recorded minimum having similar values in treatments H_1 - Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS and H_2 - Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS. At 60 DAS, the minimum relative weed density of narrow leaved weeds was noted under H_4 -Control plot, which was at par to H_3- Mechanical weeding at 20 & 40 DAS.

At 80 DAS, relative weed density of narrow leaved weeds was significantly lowest under H_3 - Mechanical weeding at 20 & 40 DAS which was at par to H_4 - Control plot. However, relative weed density of broad leaved weeds was significantly lowest under H_1 - Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS and it was at par to H_2 - Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS. At harvest, relative weed density under different weed management practices followed the same trend as noted for 80 DAS. Similar result found that Chandra *et al*. [4] in direct seeded rice the lowest weed density of some species was achieved by manual weeding at 25 and 40 DAS.

Table 3: Relative weed density (%) according to categories of weed species at different crop growth period in direct seeded rice as influenced by varieties and weed management practices

Treatment	**Relative weed density (%)**														
	20 DAS			**40 DAS**			**60 DAS**			**80 DAS**			**At harvest**		
	Narrow leaved	**Broad leaved**	**Sedges**	**Narrow leaved**	**Broad leaved**	**Sedges**	**Narrow leaved**	**Broad leaved**	**Sedges**	**Narrow leaved**	**Broad leaved**	**Sedges**	**Narrow leaved**	**Broad leaved**	**Sedges**
Varieties															

					Weed management						
0.98 (0.46)	**0.91** (0.32)	**1.02** (0.53)	**0.20**	**NS**		**0.71** (0.00)	**0.71** (0.00)	**1.03** (0.57)	**1.42** (1.51)	**0.23**	**NS**
5.93 (34.66)	**6.18** (37.73)	**5.01** (24.60)	**0.63**	**NS**		**1.42** (1.51)	**2.80** (7.31)	**9.30** (86.07)	**9.31** (86.21)	**0.72**	**2.12**
6.06 (36.19)	**6.07** (36.37)	**6.55** (42.40)	**0.57**	**NS**		**9.70** (93.60)	**8.62** (73.86)	**3.19** (9.68)	**3.39** (11.00)	**0.66**	**1.92**
2.22 (4.42)	**2.81** (7.41)	**2.17** (4.21)	**0.59**	**NS**		**1.91** (3.14)	**2.53** (5.89)	**2.37** (5.09)	**2.80** (7.33)	**0.68**	**NS**
5.36 (28.26)	**5.67** (31.64)	**4.74** (21.95)	**0.70**	**NS**		**1.60** (2.05)	**2.59** (6.19)	**8.51** (71.92)	**8.34** (68.98)	**0.81**	**2.38**
6.26 (38.73)	**6.29** (39.01)	**6.27** (38.80)	**0.62**	**NS**		**8.79** (76.69)	**7.96** (62.87)	**3.87** (14.48)	**4.47** (19.53)	**0.71**	**2.09**
1.86 (2.94)	**1.60** (2.06)	**1.96** (3.32)	**0.26**	**NS**		**0.71** (0.00)	**0.71** (0.00)	**1.66** (2.26)	**4.14** (16.63)	**0.30**	**0.87**
4.21 (17.26)	**4.35** (18.40)	**4.41** (18.91)	**0.22**	**NS**		**0.71** (0.00)	**0.71** (0.00)	**8.24** (67.35)	**7.64** (57.85)	**0.26**	**0.75**
7.43 (54.73)	**7.64** (57.82)	**6.98** (48.17)	**0.46**	**NS**		**10.02** (100.00)	**10.02** (100.00)	**4.81** (22.68)	**4.53** (20.01)	**0.53**	**1.56**
2.04 (3.67)	**1.71** (2.43)	**1.71** (2.44)	**0.25**	**NS**		**0.71** (0.00)	**0.71** (0.00)	**1.29** (1.17)	**4.58** (20.51)	**0.29**	**0.85**
4.35 (18.41)	**4.51** (19.80)	**4.51** (19.83)	**0.18**	**NS**		**0.71** (0.00)	**0.71** (0.00)	**8.40** (70.02)	**8.00** (63.51)	**0.20**	**0.60**
4.22 (17.28)	**4.07** (16.10)	**4.81** (22.67)	**0.90**	**NS**		**3.81** (14.05)	**4.85** (23.02)	**5.13** (25.83)	**3.68** (13.02)	**1.04**	**NS**
4.00 (15.51)	**3.51** (11.80)	**3.92** (14.85)	**0.62**	**NS**		**3.65** (12.82)	**3.90** (14.72)	**3.45** (11.38)	**4.23** (17.43)	**0.71**	**NS**
8.24 (67.48)	**8.32** (68.76)	**8.19** (66.55)	**0.23**	**NS**		**8.47** (71.16)	**8.17** (66.33)	**8.31** (68.56)	**8.06** (64.41)	**0.26**	**NS**
3.27 (10.21)	**2.95** (8.23)	**3.50** (11.78)	**0.65**	**NS**		**3.09** (9.02)	**3.10** (9.11)	**3.43** (11.24)	**3.36** (10.81)	**0.75**	**NS**
MTU 1010	Indira barani	IR64	**SEm±**	**CD(P=0.05**		Rinskor @	Rinskor @	Mechanical	Control	**SEm±**	**CD (P=0.05)**
V_1	**V_2**	**V_3**				**H_1**	**H_2**	**H_3**	**H_4**		

Weed growth rate (g^{-1} day^{-1} m^{-2}) according to categories of weed species

The weed growth rate (g^{-1} day^{-1} m^{-2}) of weed according to categories of weed species at 0-20, 20-40, 40-60, 60-80 DAS and 80-at harvest as influence by varieties and weed management practices are present in Fig 6.

The finding revealed that different varieties could not show significant influence on weed growth at different crop growth period in direct seeded rice.

At 0-20, 20-40, 40-60, 60-80 DAS and 80-at harvest, weed management practices through H_1 -Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS registered minimum weed growth rate followed by H_2-Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS. The maximum weed growth rate at 0-20, 20-40, 40-60, 60-80 DAS and 80-at harvest noted under H_4- Control plot. Chandra *et al*. (1998) similar result noticed that in direct seeded rice, growth rate of weed was achieved by manual weeding at 25 and 40 DAS. Manual weeding was found best method of weed control.

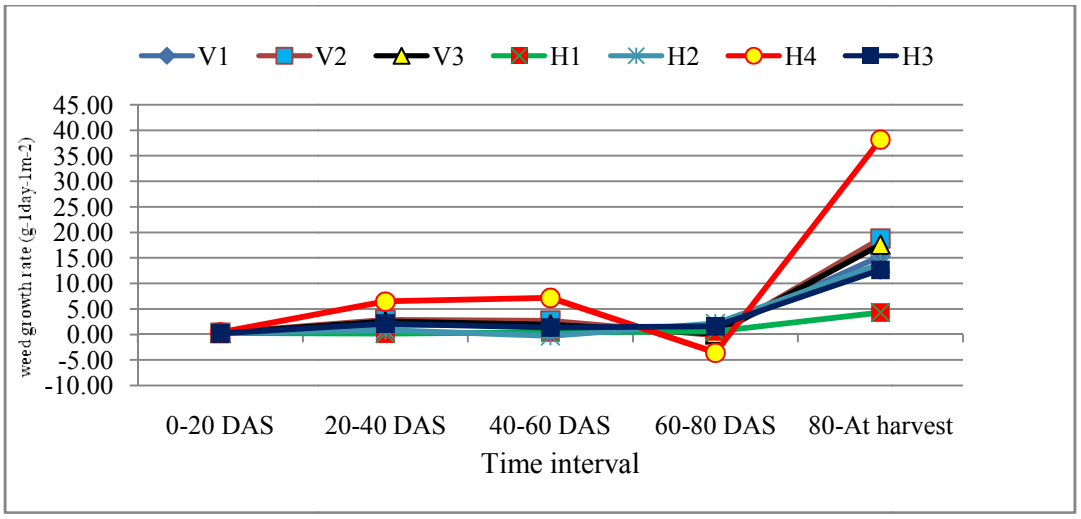

Fig 6: Weed growth rate (g^{-1} day^{-1} m^{-2}) of direct seeded rice as influenced by varieties and weed management practices

Weed control efficiency (%)

The weed control efficiency (%) of different weed species at 20, 40, 60, 80 DAS and at harvest are presented in Table 4.

It is clear from the data that among varieties, non-significant difference with regards to weed control efficiency was observed at 20, 40, 60, 80 DAS and at harvest.

As regards to weed management practices, weed control efficiency at 40, 60, 80 DAS and at harvest was significantly highest under H_1- Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS but it was at par to H_2 - Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS. Similar result was observed by Nevse *et al.* (2010) reported that under the various weed management practices; the treatment hand weeding twice (20 and 40 DAS) exhibited 95% and 89% weed control efficiency during the year followed by use of pyrazosulfuron (85%) and conoweeder (70%), and Jaya Suria *et al.* (2011) stated that the weed control efficiency of different herbicide treatments at 30, 60 and 75 DAS in both off and main season varied significantly. The highest (95.62%) weed control efficiency was found with propanil/benthiocarb fb. manual weeding followed by propanil/benthiocarb fb. bentazon/MCPA 1.2/2.4 kg ha^{-1} fb 0.6/0.1 kg ha^{-1} (86.59%), cyhalofop-butyl + bensulfuron fb. bentazon/MCPA 0.1 kg ha^{-1} + 0.06 kg ha^{-1} fb.0.6/0.1 kg ha^{-1} (79.78%), pendimethalin fb. manual weeding 1.0 kg ha^{-1} (79.27%) and pendimethalin fb. bentazon/MCPA 1.0 kg ha^{-1} fb. 0.6/0.1 kg ha^{-1} (79.02%) respectively also reported by Saha and Rao [24],

Weed index (%)

Weed index as influenced by varieties and weed management practices are given in Table 4. Among varieties, the highest weed index (28.88%) was noted with cv. Indira barani dhan (V_2) and the lowest was found under cv. MTU-1010 (V_1). In case of weed management practices, the weed index was recorded maximum under Control plot (H_4) and minimum was observed under Mechanical weeding at 20 and 40 DAS (H_3). Similar findings were also noted by Nayak *et al.* [19] and Prameela *et al.* [21].

Table 4: Weed control efficiency (%) at different growth period of rice and weed index as influenced by varieties and weed management practices

Treatment		Weed control efficiency (%)					Weed index (%)
		20 DAS	40 DAS	60 DAS	80 DAS	At harvest	
	Varieties						
V_1	MTU 1010	26.60	64.87	59.08	55.35	57.35	14.88
V_3	Indira barani dhan	10.59	64.52	64.21	39.57	60.53	28.88
V_3	IR64	23.43	62.24	56.12	52.73	55.99	23.20
	SEm±	**5.36**	**3.59**	**2.24**	**4.66**	**2.82**	---
	CD(P=0.05)	**NS**	**NS**	**NS**	**NS**	**8.26**	---
	Weed management						
H_1	Rinskor @ 37.5 g *a.i.* ha^{-1} at 20 DAS	34.47	97.33	89.87	77.63	90.06	6.96
H_2	Rinskor @ 75 g *a.i.* ha^{-1}at 20 DAS	28.51	94.51	89.37	77.59	86.95	13.01
H_3	Mechanical weeding 20 & 40 DAS	17.85	55.27	59.97	41.66	42.82	00.00
H_4	Control	00.00	00.00	00.00	00.00	00.00	69.30
	SEm±	**6.19**	**4.15**	**2.58**	**5.38**	**3.25**	---
	CD(P=0.05)	**NS**	**12.17**	**7.57**	**15.77**	**9.54**	---

Grain yield (q ha^{-1})

Data regarding grain yield (q ha^{-1}) as influenced by varieties and weed management practices are given in Table 5.

The grain yield influenced significantly due to different varieties. The maximum grain yield (30.00 q ha^{-1}) was recorded under cv. MTU-1010(V_1) which was significantly superior over cv. Indira barani dhan (V_2), but at par to cv. IR-64 (V_3). Jadhav [10] and Behera *et al* [3] Similar reported the grain yield (4.69 t ha^{-1}) were highest with manual management.

The grain yield influenced significantly due to different weed management practices. The maximum grain yield (37.87q ha^{-1}) was recorded with Mechanical weeding at 20 and 40 DAS (H_3). It was significantly superior over other treatments but at par to Rinskor @ 37.5 ml *a.i.* ha^{-1}at 20 DAS (H_1). Timely and effective control of weeds with integrated use of post-emergence herbicides and mechanical weeding resulted in increased yield components, which ultimately reflect on grain yield. Gogai and Kalita [8] similar result noticed that the highest grain yield (1.47 t ha^{-1}) was associated with hand weeding at 15, 30 and 45 DAE.

Table 5: Grain yield, straw yield and harvest index of direct seeded rice as influenced by varieties and weed management practices

Treatment		Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
	Varieties			
V_1	MTU 1010	30.00	47.17	49.48
V_2	Indira barani dhan	26.51	37.30	42.18
V_3	IR64	28.81	42.82	39.93
	SEm±	**1.11**	**1.80**	**1.53**
	CD(P=0.05)	**3.26**	**5.28**	**NS**
	Weed management			
H_1	Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20DAS	34.19	49.69	40.83
H_2	Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS	32.67	45.43	41.50
H_3	Mechanical weeding at 20 & 40 DAS	37.87	53.67	41.45
H_4	Control	11.69	20.94	38.35
	SEm±	**1.28**	**2.08**	**1.76**
	CD(P=0.05)	**3.76**	**6.10**	**NS**

Straw yield (q ha^{-1})

Data regarding straw yield as influenced by varieties and weed management practices (Table 5).The straw yield influenced significantly due to different varieties. The maximum straw yield (47.17 q ha^{-1}) was recorded with cv. MTU-1010 (V_1) which was significantly superior over cv. Indira barani dhan (V_2), however, it was at par to cv. IR-64 (V_3). Similar finding was also reported by Mutnal *et al.* [18].The maximum straw yield (53.67 q ha^{-1}) was recorded with Mechanical weeding at 20 and 40 DAS (H_3). It was significantly superior over others, but at par to Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS (H_1). The minimum straw yield (20.94 q ha^{-1}) was recorded with Control plot (H_4). Similar finding was reported by Choubey *et al.* [5] observed that the different weed control treatments produced significantly higher straw yield over unweeded check. The highest being obtained in hand weeding, followed by chemical weed control/chemical + chemical weed control and mechanical weeding treatments.

Harvest index (%)

Data regarding harvest index as influenced by varieties and weed management practices are given in Table 5.

The harvest index remained unaffected due to different varieties as well as due to weed management practices. Similar findings were also noted by Tiwari [30] revealed that significantly highest straw yield over unweeded check. The highest being obtained in hand weeding, followed by chemical and mechanical weeding treatments.

Economics

The data on economics of direct seeded rice as influenced by varieties and weed management practices are given in Table 6.

Among the varieties, maximum gross return (Rs 59792 ha^{-1}), net return (Rs. 37054 ha^{-1}) and B:C ratio (2.63) were recorded under cv. IR 64 (V_3). The next performing variety was cv. MTU1010 (V_1) with gross return of Rs. 58421 ha^{-1}, net return of Rs. 35682 ha^{-1} and B:C ratio of 2.57. Similar finding was also reported by Mukhrjee and Maity [17] and Jacob *et al.* [9]**.**

As regards to weed management practices, the maximum gross return (Rs. 84603 ha^{-1}), net return (Rs. 60177 ha^{-1}) and B:C ratio (3.46) were obtained under mechanical weeding at 20 and 40 DAS (H_3). The next performing weed management practices was application of Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS (H_1) with gross return of Rs. 62653 ha^{-1}, net return of Rs. 40477ha^{-1} and B:C ratio of 2.83. Similar finding was also noted by Khaliq *et al.* [12] and Mishra and Das [16].

Table 6: Economics of direct seeded rice as influenced by varieties and weed management practices

Treatment		Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio (Rs. ha^{-1})
	Varieties				
V_1	MTU 1010	22738	58421	35682	2.57
V_2	Indira barani dhan	22738	54953	32215	2.42
V_3	IR64	22738	59792	37054	2.63
	SEm±	---	---	---	---
	CD(P=0.05)	---	---	---	---
	Weed management				
H_1	Rinskor @ 37.5 ml *a.i.*ha^{-1} at 20 DAS	22176	62653	40477	2.83
H_2	Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS	24426	58958	34532	2.41
H_3	Mechanical weeding at 20 & 40 DAS	24426	84603	60177	3.46
H_4	Control	19926	24675	4749	1.24
	SEm±	---	---	---	---
	CD(P=0.05)	---	---	---	---

CONCLUSION

The findings of direct seeded rice under *Inseptisols* of Chhattisgarh plains, clearly visualized that variety MTU-1010 recorded significantly highest growth parameters, yield attributes, grain and straw yield. However, gross return, Net return and B:C ratio were maximum under IR-64 followed by MTU-1010.

Among weed management practices, H_3 - Mechanical weeding at 20 and 40 DAS registered significantly highest values of grain and straw yield, and economic returns but it was comparable to H_1 - Rinskor @ 37.5 *a.i.* ml ha^{-1} at 20 DAS. These treatments also recorded lower weed density, weed dry matter, relative weed density and higher weed index. The weed control efficiency was highest under H_1 - Rinskor @ 37.5 ml *a.i.* ha^{-1} at 20 DAS followed by H_2 - Rinskor @ 75 ml *a.i.* ha^{-1} at 20 DAS.

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