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Integrated weed management practices under different drip irrigation methods in direct seeded rice

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Abstract
A field experiment was conducted on medium black soil during *kharif* 2016 & 2017 at Agricultural Research Station, Gangavathi to study the effect on weed growth, yield and yield attributes of direct dry seeded rice. The results revealed that among the different drip irrigation systems the surface drip irrigation proved best over subsurface drip irrigation systemand among herbicidal treatments, pretilachlor @1.0 kg a.i/ha followed by one hand weeding @ 45 DAS significantly reduced the weed density (5.33/m^2), dry weight of weeds (5.51 g/m^2), weed index (20.17%) and the hand weeding thrice @ 20, 40 and 60 DAS recorded higher weed control efficiency (65.62%) than other treatments at harvest. This was followed by pretilachlor @1.0 kg a.i/ha followed by one hand weeding @ 45 DAS which recorded WCE of (51.05%). Among the treatments, hand weeding thrice at 20, 40 and 60 DAS recorded higher grain yield (5365.88 kg ha^{-1}) which was followed by pretilachlor @1.0 kg a.i/ha followed by one hand weeding @ 45 DAS with a grain yield of 4273.08 kg ha^{-1} which was significantly superior to other treatments

Keywords: Surface drip irrigation, subsurface drip irrigation, weed management

Introduction
Rice (*Oryza sativa* L.) is the world's most important crop and is a staple food for more than half of the world's population. Centre of origin of cultivated rice is the part of South East Asia, which is considered as the heartland of rice cultivation. Asia accounts for 60% of the global population, about 92% of the world's rice production and 90% of global rice consumption (FAO, 2016). In India, rice is grown on 43.44 million hectares, with annual production of about 112.40 million tons and productivity of about 2700 kg ha^{-1} (Anon., 2016) [2]. India is the second largest country for rice production and rice continues to hold the key to sustain food production by contributing 20-25 per cent of agriculture and assures food security for more than half of the total population (Anon, 2012) [1].
In Tunga Bhadra Project (TBP) of Karnataka rice, cotton, red gram, sunflower are commonly grown of which rice is the principal crop. Farmers grow direct seeded rice in areas of water shortage such as tail end regions of command areas. Dry direct seeded rice is an important method of growing rice which consumes less water than transplanted rice. Some of the parameters which influence the productivity of dry direct seeded rice. One among them is weed infestation because due to a cyclic process of aerobic and anaerobic conditions a variety of weed flora infest the fields and weeds emerge in flushes making weed control a difficult task. Therefore, weed management is important factor in increasing the rice productivity in direct dry seeded rice.
Weed management during the early period of rice is critical for successful cultivation of dry seeded rice as soil conditions favour simultaneous germination of weed seed along with paddy seeds (James Martin, 1998) [5]. Weeds grow faster than rice plants and absorb the available nutrients earlier and faster resulting in deprivation of nutrients for the rice. The presence of weeds causes a heavy investment on farm operation and ultimately on the cost of cultivation. Weeds also interfere with cultural practices, particularly at harvest when weed seeds are mixed with rice seeds decreasing the purity of seeds.
Presently the conventional method of manual weeding is widely practiced as effective method of weed control. But, it is costlier, time and labour consuming and tedious. Many times it is

difficult to differentiate rice seedlings and grassy weeds like *Echinochloa colonum* and *Echinochloa crusgalli* in the initial stages due to pheno-typical resemblance. Under such situations the use of herbicides offer an advantage due to their inhibitive action on germinating weeds.

Use of pre-emergent herbicides is vital tool for effective and cost efficient weed control in dry seeded rice, which encounters weed competition from the day of germination. When herbicides are used for weed control, selectivity is most important as even the most effective herbicide may be phytotoxic to the rice plants and depends upon the dosage, formulation, proper method and time of application.

Direct seeded rice with drip irrigation can address the multifacet problems of water scarcity, weed competition and environmental pollution. When the rice cultivation is shifted from TPR to DSR, weeds pose major threat to rice production. Under such scenario micro-irrigation /Drip irrigation plays important role in restricting weed flora apart from regular supply of required amount of moisture for rice growth.

Materials & Methods

A field experiments on "Integrated weed management practices under different drip irrigation methods in direct seeded rice'' was conducted at Agricultural Research Station (ARS), Gangavathi during *kharif* 2016 & 2017. The soil of experimental site was medium black clay in texture. The soil was normal with an electrical conductivity of 0.52 dS/m, neutral in reaction (pH 8.22) and medium in organic carbon content (0.55%). The soil was low in available N (176.20 kg ha^{-1}) high in available P_2O_5 (154.31 kg ha^{-1}) and high in exchangeable K_2O (365.57 kg ha^{-1}). The experiment was laid out with split plot design with two main treatments and six sub treatments which were replicated thrice. The fertilizer dose of 150-60-50 kg N-P2O5-K2O ha^{-1} was applied. Recommended N was applied in three splits as basal, active tillering and panicle initiation stage and rest of the fertilizers (P & K) were applied as basal dose. Pendimethalin (PE) 38.7 CS, Pretilachlor (PE) and Pyrozosulfuron ethyl (PE) was applied as pre-emergence and Bispyribac sodium 10% SL was applied as post-emergence using hand knapsack sprayer fitted with flat fan nozzle with spray volume of 500 litres ha^{-1}. Density and biomass of weeds were recorded at 30, 60, 90 DAS and at harvest with 0.5 m quadrant at four places in each plot. The weed density and weed dry matter data was subjected to square root transformation before statistical analysis. Weed control efficiency denotes the magnitude of reduction in weed dry weight due to weed control treatments. It was calculated by using the formula given by Patel *et al*. (1987) and expressed in percentage. Economics of the treatments was computed based on the prevalent market prices.

$$\text{WCE (\%)} = \frac{\text{DMC}-\text{DMT}}{\text{DMC}} \text{ X } 100$$

Weed index is the reduction in crop yield due to the presence of weeds in comparison with weed free check plot. Weed index was calculated by using the formula and expressed in percentage.

$$\text{Weed index (\%)} = \frac{x-y}{x} \text{ X } 100$$

Where,

x = Grain yield of weed free plot

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

Results and Discussion

The predominant weed flora observed in the experimental field in association with the direct seeded rice under different drip irrigation systems includes grassy weeds *viz., Dinebra retroflexa, Echinochloa colona, Panicum repens, Chloris barbata*. Among the sedges *Cyperus difformis, Cyperus iria* and *Fimbristylis miliaceae* and among broad leaf weeds *Ammania baccifera, Cyanotis axillaris, Eclipta alba, Phyllanthus niruri* and *Amaranthus viridis* were present. All the weed control practices recorded significantly lower weed density and weed dry weight as compared to unweeded check at different stages of crop growth.

Unweeded check recorded the highest weed density and weed dry weight as compared to other treatments. Among different drip irrigation systems the pooled data revealed that surface drip irrigation system recorded significantly lowest population of grasses, sedges, broad leaf weeds and total weeds as compared to subsurface drip irrigation system (Table 1). This was because surface drip system favoured the growth of rice by reducing the weed density which increased the grain yield. Among various weed management practices that hand weeding thrice @ 20, 40 and 60 DAS recorded significantly lowest population of total weeds as compared to other treatments at all growth stages. Among herbicidal treatments pretilachlor @1.0 kg a.i/ha followed by one hand weeding @ 45 DAS recorded significantly lower total weed population indicating that it is effective against all type of weeds. This was followed by recommended pendimethalin 38.7 CS @1.0 kg a.i/ha followed by bispyribac sodium 10% SL @250 ml/ha in controlling all type of weeds at all stages. Payman *et al.* (2008) [8] reported that pretilachlor and bispyribac sodium effectively reduced the weed density at different stages and at harvest in direct dry seeded rice. Similar results were obtained in case of total dry weight of weeds at all the stages of crop (Table 2).

The performance of crops as measured in terms of growth and yield is directly related to the weed control efficiency and inversely related to the weed index. The weed control efficiency determined from weed dry weight was significant at all growth stages (30,60,90 DAS and harvest). The pooled data on hand weeding thrice @ 20, 40 and 60 DAS recorded higher weed control efficiency (69.14, 67.21, 60.49 and 65.62 at 30, 60, 90 DAS and harvest respectively) than other treatments at all growth stages (Fig. 1 & Table 3). This was followed by pretilachlor @1.0 kg a.i/ha followed by one hand weeding @ 45 DAS which recorded WCE of (53.24, 50.29, 48.75 and 51.05% respectively at 30,60, 90 DAS and harvest) indicating over all effective control of weeds. Minimum weed control efficiency was recorded in weedy check at all growth stages (Table 3).

The weed index is a measure of yield reduction due to weed competition. Among different drip irrigation systems surface drip irrigation system recorded lower weed index (29.36%). The pooled data on weedy check (73.44%) recorded the highest weed index as a result of severe weed competition. The competition offered by weeds for nutrients, moisture, space and light was higher in weedy check as indicated through lower growth and yield components. This ultimately reduced the grain yield significantly. Lower weed index was recorded with hand weeding thrice @ 20, 40 and 60 DAS (0.0%) (Fig.1 & Table 4). Among herbicidal treatments lower weed index was recorded in pretilachlor @1.0 kg a.i/ha

followed by one hand weeding @ 45 DAS (20.17%) indicating higher growth and yield as a result of better control of weeds. These results are in conformity with the findings of Bhanu Rekha *et al.* (2003) [3] and Satyanarayana *et al.* (1997) [9].

Among different drip irrigation systems higher grain yield kg ha^{-1} in surface drip irrigation system as compared to subsurface drip irrigation system (Fig. 2 & Table 5), where 11.6% of higher grain yield was noticed this was due to better control of weeds as this weed free condition resulted in availability of more amount of space, nutrients, moisture and light to the crop which in turn put forth better growth in terms of higher functional leaf area, higher number of tillers m^{-2}, higher plant dry matter, more number of panicles m^{-2}, higher number of grains per panicle and higher test weight and contributed for higher grain yield in surface drip irrigation these results are in conformity with the findings of Among different weed control treatments, hand weeding thrice at 20, 40 and 60 DAS recorded higher grain yield as compared to other treatments. Where 73.4% of higher grain yield was noticed when compared to weedy check but 20.3% lesser grain yield was noticed in next best treatment compared to hand weeding thrice. This was due to better control of all types of weeds during most part of the crop growth. It was followed by pretilachlor @1.0 kg a.i/ha followed by one hand weeding @ 45 DAS which was significantly superior to weedy check but on par with the other treatments. The increase in grain yield might be attributed to the effective control of all types of weeds such as grasses, sedges, broad leaf weeds and also total weeds. This weed free condition resulted in availability of more amount of space, nutrients, moisture and light to the crop which in turn put forth better growth in terms of higher functional leaf area, higher number of tillers m^{-2}, higher plant dry matter, more number of panicles m^{-2}, higher number of grains per panicle and higher test weight and contributed for higher grain yield in this treatment. These results are in conformity with the findings of Wells (2006) [10] in rice. Lowest grain yield was recorded in weedy check. This was due to severe weed competition that reduced the plant growth and resulted in lower yield components reflected in lower grain yield. Similar was noticed in straw yield also.

Table 1: Density of total weeds (no. m^{-2}) as influenced by weed management practices and drip irrigation methods at various stages in direct seeded rice

Treatments	30 DAS			60 DAS			90 DAS			At harvest		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Main plots: Drip Methods												
M_1	5.71 (33.33)	5.96 (36.06)	5.83 (34.69)	6.31 (40.39)	6.76 (46.22)	6.54 (43.31)	6.85 (47.39)	7.20 (52.11)	7.03 (49.75)	5.93 (35.89)	6.00 (36.61)	5.97 (36.25)
M_2	6.48 (42.72)	6.71 (45.61)	6.60 (44.17)	7.01 (49.78)	7.40 (55.28)	7.21 (52.53)	7.52 (57.11)	7.78 (60.83)	7.65 (58.97)	6.69 (45.50)	6.73 (45.94)	6.71 (45.72)
S.Em±	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.04	0.01	0.04	0.03	0.04
CD at 0.05	0.08	0.05	0.05	0.08	0.05	0.03	0.08	0.11	0.04	0.10	0.10	0.11
Sub plots : Weed Management Practices												
S_1	5.80 (33.34)	6.04 (36.17)	5.93 (34.75)	6.35 (40.00)	6.81 (46.00)	6.59 (43.00)	6.88 (47.00)	7.18 (51.17)	7.03 (49.08)	5.94 (35.00)	6.03 (36.00)	5.98 (35.50)
S_2	5.10 (25.67)	5.37 (28.50)	5.24 (27.08)	5.69 (32.00)	6.18 (37.83)	5.94 (34.92)	6.28 (39.00)	6.73 (44.83)	6.51 (41.92)	5.31 (27.83)	5.35 (28.33)	5.33 (28.08)
S_3	6.34 (40.00)	6.56 (42.83)	6.45 (41.42)	6.82 (46.33)	7.24 (52.17)	7.04 (49.25)	7.32 (53.33)	7.66 (58.33)	7.49 (55.83)	6.52 (42.17)	6.57 (42.83)	6.54 (42.50)
S_4	4.58 (20.67)	4.91 (23.83)	4.75 (22.25)	5.23 (27.00)	5.79 (33.17)	5.52 (30.08)	5.92 (34.67)	6.29 (39.17)	6.11 (36.92)	4.86 (23.33)	5.02 (24.83)	4.94 (24.08)
S_5	7.71 (59.17)	7.88 (61.83)	7.80 (60.50)	8.35 (69.50)	8.67 (74.83)	8.51 (72.17)	8.77 (76.67)	8.92 (79.17)	8.85 (77.92)	8.09 (65.17)	8.04 (64.33)	8.06 (64.75)
S_6	7.05 (49.33)	7.23 (51.83)	7.14 (50.58)	7.49 (55.67)	7.81 (60.50)	7.65 (58.08)	7.95 (62.83)	8.16 (66.17)	8.06 (64.50)	7.15 (50.67)	7.19 (51.33)	7.17 (51.00)
S.Em±	0.08	0.09	0.09	0.08	0.09	0.08	0.08	0.09	0.07	0.10	0.08	0.08
CD at 0.05	0.25	0.26	0.25	0.25	0.25	0.25	0.23	0.25	0.22	0.28	0.24	0.25
Interaction (M x S)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Data in ($\sqrt{x}$ + 0.5) transformation Data in parenthesis indicate original values NS – Non significant Main plots: Drip Methods: M_1: Surface drip irrigationM_2 Sub surface drip irrigation

Sub plots: Weed Management Practices:

S_1: Pendimethalin (PE) 38.7 CS @ 1.0 kg a.i./ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.

S_2: Pretilachlor (PE) @ 1.0 kg a.i / ha followed by one hand weeding @ 45 DAS

S_3: Pretilachlor (PE) @ 1.0 kg a.i/ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.

S_4: Three hand weeding @ 20, 40 & 60 DAS

S_5: Weedy Check

S_6: Pyrozosulfuron ethyl (PE) 10% WP @ 20 g a.i / ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha

Table 2: Total dry weight of weeds (g m^{-2}) as influenced by weed management practices and drip irrigation methods at various stages in direct seeded rice

Treatments	30 DAS			60 DAS			90 DAS			At harvest		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Main plots: Drip Methods												
M_1	2.70 (7.10)	2.95 (8.41)	2.83 (7.75)	5.87 (35.11)	6.19 (38.97)	6.03 (37.04)	7.21 (52.96)	7.62 (58.85)	7.41 (55.91)	6.07 (37.63)	6.40 (41.64)	6.23 (39.64)
M_2	2.78 (7.51)	3.02 (8.88)	2.91 (8.19)	6.22 (39.39)	6.55 (43.51)	6.38 (41.45)	7.55 (57.91)	7.94 (63.81)	7.75 (60.86)	6.47 (42.56)	6.76 (46.38)	6.62 (44.47)
S.Em±	0.01	0.01	0.01	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02
CD at 0.05	0.03	0.02	0.02	0.08	0.08	0.10	0.09	0.07	0.06	0.07	0.07	0.06
Sub plots : Weed Management Practices												
S_1	2.67 (6.64)	2.91 (7.96)	2.79 (7.30)	5.88 (34.17)	6.23 (38.33)	6.06 (36.25)	7.21 (51.52)	7.61 (57.50)	7.41 (54.51)	6.18 (37.80)	6.47 (41.43)	6.33 (39.62)
S_2	2.34 (4.98)	2.61 (6.30)	2.48 (5.64)	5.25 (27.15)	5.64 (31.37)	5.45 (29.26)	6.32 (39.55)	6.78 (45.58)	6.56 (42.57)	5.35 (28.18)	5.68 (31.80)	5.51 (29.99)
S_3	2.95 (8.19)	3.17 (9.54)	3.06 (8.87)	6.30 (39.33)	6.59 (43.00)	6.45 (41.17)	7.78 (60.13)	8.15 (65.97)	7.97 (63.05)	6.64 (43.68)	6.91 (47.33)	6.78 (45.51)
S_4	1.88 (3.04)	2.21 (4.41)	2.05 (3.73)	4.24 (17.52)	4.64 (21.03)	4.44 (19.28)	5.51 (29.88)	6.00 (35.50)	5.76 (32.69)	4.43 (19.20)	4.83 (22.85)	4.63 (21.03)
S_5	3.44 (11.35)	3.64 (12.77)	3.54 (12.06)	7.55 (56.63)	7.84 (60.97)	7.70 (58.80)	8.96 (79.85)	9.29 (85.92)	9.13 (82.88)	7.69 (58.72)	8.00 (63.55)	7.85 (61.13)
S_6	3.18 (9.62)	3.37 (10.88)	3.28 (10.25)	7.01 (48.72)	7.29 (52.73)	7.15 (50.73)	8.49 (71.67)	8.83 (77.50)	8.66 (74.58)	7.31 (52.98)	7.59 (57.10)	7.45 (55.04)
S.Em±	0.03	0.03	0.03	0.08	0.07	0.07	0.09	0.09	0.09	0.07	0.07	0.07
CD at 0.05	0.08	0.07	0.08	0.23	0.21	0.22	0.26	0.26	0.26	0.22	0.22	0.22
Interaction (M x S)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Data in ($\sqrt{x + 0.5}$) transformation Data in parenthesis indicate original values NS – Non significant

Main plots: Drip Methods: M_1: Surface drip irrigation M_2: Sub surface drip irrigation

Sub plots: Weed Management Practices:

S_1: Pendimethalin (PE) 38.7 CS @ 1.0 kg a.i./ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.

S_2: Pretilachlor (PE) @ 1.0 kg a.i / ha followed by one hand weeding @ 45 DAS

S_3: Pretilachlor (PE) @ 1.0 kg a.i/ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.

S_4: Three hand weeding @ 20, 40 & 60 DAS

S_5: Weedy Check

S_6: Pyrozosulfuron ethyl (PE) 10% WP @ 20 g a.i / ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.

Table 3: Weed control efficiency (%) as influenced by weed management practices and drip irrigation methods at various stages in direct seeded rice

Treatments	30 DAS			60 DAS			90 DAS			At harvest		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Main plots: Drip Methods												
M_1	35.79	32.22	33.91	34.57	32.61	33.55	31.93	29.78	30.82	33.99	32.83	33.39
M_2	35.39	32.34	33.77	33.79	32.01	32.87	29.24	27.47	28.32	29.55	28.71	29.11
S.Em±	0.77	0.62	0.68	2.03	1.97	1.98	0.35	0.25	0.29	0.59	0.22	0.39
CD at 0.05	NS	NS	NS	NS	NS	NS	1.70	0.75	0.85	1.69	0.64	1.16
Sub plots : Weed Management Practices												
S_1	41.43	37.64	39.42	39.60	37.06	38.29	35.59	33.16	34.33	35.74	34.87	35.29
S_2	56.11	50.69	53.24	52.12	48.59	50.29	50.59	47.04	48.75	52.13	50.06	51.05
S_3	27.85	25.33	26.51	30.42	29.29	29.83	24.78	23.32	24.02	25.71	25.59	25.65
S_4	73.23	65.51	69.14	69.07	65.49	67.21	62.52	58.60	60.49	67.35	64.03	65.62
S_5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S_6	14.94	14.50	14.71	13.86	13.42	13.63	10.04	9.63	9.83	9.68	10.06	9.88
S.Em±	1.53	1.37	1.44	1.71	1.47	1.58	1.70	1.61	1.65	1.69	1.54	1.60
CD at 0.05	4.51	4.03	4.25	5.06	4.34	4.65	5.02	4.76	4.86	4.97	4.55	4.72
Interaction (M x S)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS – Non significant Main plots: Drip Methods: M_1 : Surface drip irrigation M_2 : Sub surface drip irrigationSub plots:

Weed Management Practices:

S_1: Pendimethalin (PE) 38.7 CS @ 1.0 kg a.i./ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.

S_2: Pretilachlor (PE) @ 1.0 kg a.i / ha followed by one hand weeding @ 45 DAS

S_3: Pretilachlor (PE) @ 1.0 kg a.i/ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.

S_4: Three hand weeding @ 20, 40 & 60 DAS

S_5: Weedy Check

S_6: Pyrozosulfuron ethyl (PE) 10% WP @ 20 g a.i / ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha

Table 4: Weed index (%) as influenced by weed management practices and drip irrigation methods at different stages in direct seeded rice

Treatments	Weed index (%)		
	2016	2017	Pooled
Main plots: Drip Methods			
M_1	30.36	27.81	29.36
M_2	37.64	30.88	34.11
S.Em±	1.02	5.34	3.12
CD at 0.05	3.44	15.75	NS
Sub plots : Weed Management Practices			
S_1	28.71	27.96	28.83
S_2	27.32	13.37	20.17
S_3	36.62	28.73	32.61
S_4	0.00	0.00	0.00
S_5	72.12	74.62	73.44
S_6	39.24	31.37	35.36
S.Em±	3.44	4.57	3.41
CD at 0.05	10.14	13.48	10.05
Interaction (M x S)	NS	NS	NS

NS – Non significant Main plots: Drip Methods: M_1 : Surface drip irrigation M_2: Sub surface drip irrigation
Sub plots: Weed Management Practices:
S_1: Pendimethalin (PE) 38.7 CS @ 1.0 kg a.i./ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.
S_2: Pretilachlor (PE) @ 1.0 kg a.i / ha followed by one hand weeding @ 45 DAS
S_3: Pretilachlor (PE) @ 1.0 kg a.i/ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.
S_4: Three hand weeding @ 20, 40 & 60 DAS
S_5: Weedy Check
S_6: Pyrozosulfuron ethyl (PE) 10% WP @ 20 g a.i / ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml

Table 5: Grain and straw yield and harvest index as influenced by weed management practices and drip irrigation methods in direct seeded rice

Treatments	Grain yield (kg ha^{-1})			Straw yield (kg ha^{-1})			Harvest index		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Main plots: Drip Methods									
M_1	3564.01	4201.29	3882.65	4452.69	5051.10	4751.89	0.44	0.45	0.44
M_2	3099.44	3757.40	3428.42	3890.50	4557.92	4224.21	0.44	0.45	0.44
S.Em±	31.34	101.74	59.02	64.03	126.00	93.52	0.01	0.01	0.01
CD at 0.05	174.72	300.12	174.12	188.89	371.69	275.89	NS	NS	NS
Sub plots : Weed Management Practices									
S_1	3596.14	4036.50	3816.32	4484.36	5164.19	4824.28	0.44	0.44	0.44
S_2	3671.92	4874.25	4273.08	4571.56	5236.32	4903.94	0.45	0.48	0.46
S_3	3201.43	3966.69	3584.06	3851.00	5120.17	4485.58	0.45	0.43	0.44
S_4	5045.04	5686.72	5365.88	6017.50	6517.50	6267.50	0.46	0.47	0.46
S_5	1407.00	1443.74	1425.37	2324.00	2031.64	2177.82	0.38	0.42	0.40
S_6	3068.83	3868.18	3468.51	3781.14	4757.25	4269.19	0.45	0.45	0.45
S.Em±	174.72	266.89	187.47	127.38	163.83	90.34	0.01	0.02	0.02
CD at 0.05	515.43	787.32	553.04	375.78	483.30	266.50	0.04	NS	NS
Interaction (M x S)	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS – Non significant Main plots: Drip Methods: M_1: Surface drip irrigation M_2: Sub surface drip irrigation Sub plots:
Weed Management Practices:
S_1: Pendimethalin (PE) 38.7 CS @ 1.0 kg a.i./ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.
S_2: Pretilachlor (PE) @ 1.0 kg a.i / ha followed by one hand weeding @ 45 DAS
S_3: Pretilachlor (PE) @ 1.0 kg a.i/ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha.
S_4: Three hand weeding @ 20, 40 & 60 DAS
S_5: Weedy Check
S_6: Pyrozosulfuron ethyl (PE) 10% WP @ 20 g a.i / ha followed by Bispyribac sodium (POE) 10% SL @ 25.0 ml a.i/ha

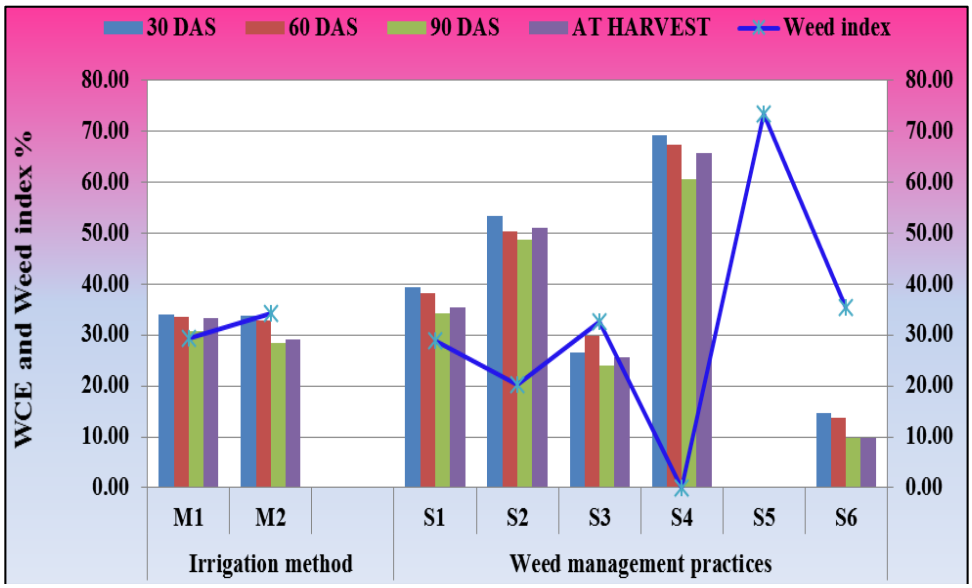

Fig 1: Weed control efficiency and Weed index as influenced by drip irrigation methods and weed management practices at various stages in direct seeded rice

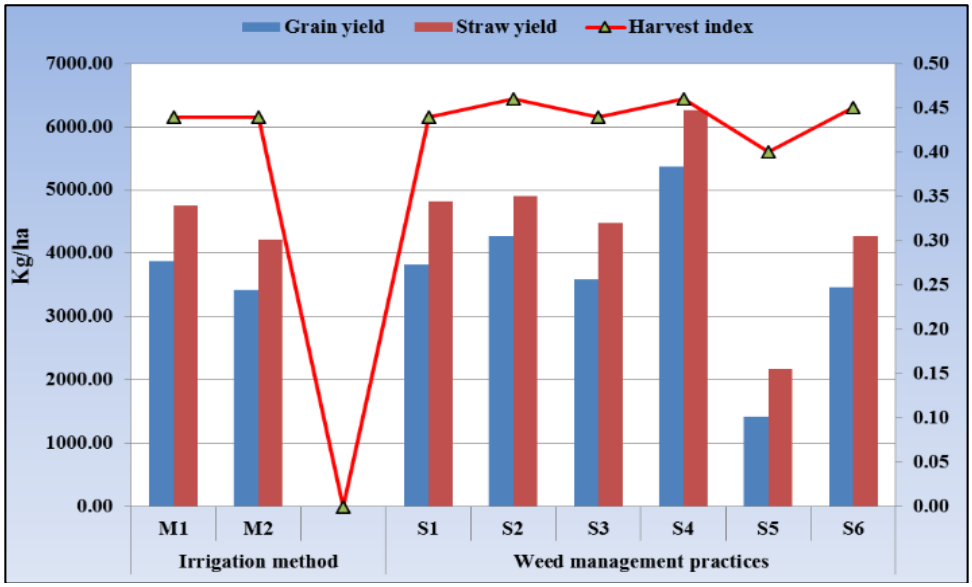

Fig 2: Grain yield, Straw yield and Harvest index as influenced by drip irrigation methods and weed management practices in direct seeded rice

Conclusion

The present investigation revealed that surface drip irrigation system was best method for direct seeded rice as compared to subsurface drip irrigation system as it increased grain yield to a tune of 11.6%. Among herbicides pretilachlor @1.0 kg a.i/ha followed by one hand weeding @ 45 DAS was best in controlling the weeds in direct seeded rice which was the next best treatment compared to hand weeding thrice @ 20, 40 & 60 DAS.

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