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Lalit Kumar Rolaniya
Department of Agronomy
Punjab Agricultural University, Ludhiana, India

Vivek
Department of Agronomy
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, India

Robin Kumar
Department of Soil Science
Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, India

Love Kumar Singh
Borlaug Institute for South Asia
Ludhiana, India

KM Choudhary
Borlaug Institute for South Asia
Ludhiana, India

Arun Kumar
Department of Agronomy
Punjab Agricultural University, Ludhiana, India

Correspondence
Lalit Kumar Rolaniya
Department of Agronomy
Punjab Agricultural University, Ludhiana, India

Influence of irrigation scheduling and weed management practices on weed density and performance of dry direct seeded rice

Lalit Kumar Rolaniya, Vivek, Robin Kumar, Love Kumar Singh, KM Choudhary and Arun Kumar

Abstract
A field experiment was carried out at Chirrori farm of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) in spilt plot design. The main plots in the study included four irrigation scheduling namely, continuous shallow flooding irrigation at 10 kPa (I_1), alternate wetting drying irrigation at 20 kPa (I_2), alternate wetting drying irrigation at 20 kPa with irrigation after herbicide application (I_3) and alternate wetting drying irrigation at 20 kPa with mid-season drying (45 to 80 DAS irrigation at 40 kPa) (I_4) and sub-plot with weed management treatments i.e. weedy treatment (W_1), weed free (W_2), pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} fb post-emergence Bispyribac-Na @ 25 g a.i. ha^{-1} (W_3) and Propanil @ 4 kg a.i. ha^{-1} + Pendimethalin 1 kg a.i. ha^{-1} (W_4). Continuous shallow flooding irrigation at 10 kPa (I_1) reduces the weed density significantly. The applications of Pendimethalin 1 kg a.i. ha^{-1} at 3 DAS followed by Bispyribac 25 g a.i. ha^{-1} at 25 DAS (W_3) controlled weed very effectively and produce similar yield (6.32 t ha^{-1}) as weed free (W_2) (6.67 t ha^{-1}). However, the study also suggested that detail study should be carried out to understand interaction of irrigation scheduling and weed management practices.

Keywords: Direct seeded rice, bispyribac, irrigation scheduling and weed density

1. Introduction

The world entered in the 21^{st} century facing many challenges, often in an agricultural context. Prominent still is the concern for feeding an ever growing population with safe and healthy food. However, a sustainable living environment is a major issue as well. This is strongly related to management of natural resources such as land, water, nutrients and energy etc. This is posing a serious problem to even maintain the food grain production and leaving only the option of increasing the productivity of grain crops particularly rice (*Oryza sativa* L.). In the major rice-growing Asian countries, per capita water availability decreased by 34–76% between 1950 and 2005 and is likely to decline by 18–88% by 2050. Conventional rice production systems (puddled transplanting) require large quantities of water. On an average, 2500 l of water are applied, ranging from 800 to more than 5000 l, to produce 1 kg of rough rice (Bouman, 2009) [3]. Since rice is primarily grown by transplanting seedlings in puddled fields it requires a large amount of water (~150 cm), of which 20-25 cm is used for puddling (intensive cultivation in wet conditions) only. An alarming rate of ground water depletion and increasing labour scarcity are major threats to future rice production in north-west India. Management strategies that reduce the irrigation amount and labour requirement while maintaining or increasing yield are urgently needed. Dry seeded rice (DSR) has been proposed as one means of achieving these objectives, but little is known about optimal water management for DSR. However, weeds are a serious problem because dry tillage practices and aerobic soil conditions are conducive for germination and growth of weeds, which can cause grain yield losses from 50 to 90% (Rao *et al.*, 2007) [15, 16]. The development and adoption of DSR may enable good crop growth but the lack of sustained flooding will greatly increase potential losses from weeds. These systems may integrate direct seeding and herbicide use, yet, to be sustainable, effective weed management strategies are required. A multitude of prerequisites, including level land, effective weed control, efficient water management, and timely water supply in relation to crop water demand, need to be met to ensure a successful

DSR crop. In most places, insufficient attention is given to the importance of weeding. In DSR fields, it is not uncommon to see fields full of weeds, mainly grasses. Water management is an important component of any weed control program, whether any herbicide is used or not. Herbicides which give excellent control when applied into water may perform poorly in the absence of standing water (Kumar *et al*., 2009) [9]. There should be enough moisture in the field during the application of pre-emergence herbicides in DSR. In case of post-emergence application of herbicide, fields should be drained at the time of herbicide application and should not be irrigated immediately after its application. Good water management together with chemical weed control offers an unusual opportunity for conserving moisture and lowering the cost of rice production (Rao *et al*., 2007 and Singh *et al*., 2009) [15, 16, 18, 19]. Keeping these points in view the current study was therefore, undertaken to evaluate the influence of irrigation scheduling and weed management practices on weed density and performance of dry direct seeded rice

2. Materials and Methods

The experiment was conducted at Chirrori farm (29^0 13' 96" N latitude, 77^0 68' 43" E longitudes) of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) situated in Indo-Gangetic plains of India during Kharif 2013. The climate in the area is semi-arid subtropical, with an average annual rainfall of 850 mm (75–80% of which is typically received from June to September). The site was under a continuous RWS for the last > 30 years before the establishment of the experiment. At the start of the experiment, soil samples at 0–15 cm depth were collected using an auger of 5-cm internal diameter. The soil samples were mixed thoroughly, air-dried, crushed to pass through a 2-mm sieved and stored in sealed plastic jars before analysis. Soil bulk density was measured to a depth of 15-cm using the protocol of (Black 1964) [2]. Particle size distribution was determined by particle size analysis (Bouyoucos, 1962). Soil chemical parameters were measured using the standard methods (Table 2.1). The soil of the experimental field is loam with organic carbon content 0.33 g kg^{-1} and pH 8.8 (Table 2.1).

2.1 Experimental design and treatments

This experiment was laid out in a split plot design consisting four irrigation scheduling practices in main plot and four weed management practices in sub plot with three replications. Details of experimental treatments presented in table 2.2.

2.2 Seeding, seed rate and seed treatment

In this experiment a DSR hybrid Arize 6129 was sown by direct seeded rice zero till drill machine on 8th June 2013. The seed rate used was 25 kg ha^{-1}. The row to row spacing was kept at 20 cm special care was taken to ensure that seed was not placed deeper than 2.5 cm to maximize uniform crop establishment. Prior to sowing seeds were treated with fungicides, imidachloropid and tabuconazole at 5 ml kg^{-1} and 1 g kg^{-1} seed, respectively.

2.3 Irrigation scheduling

Uniform irrigation was applied to ensure proper crop establishment up to 20 DAS except I_3. After that irrigation was applied as per treatments based on tensiometer reading. (a) Continuous shallow flooding: To maintain continuous submergence in plot applied irrigation at 10 kPa with the help of tensiometer based reading. (b) Alternate wetting and drying (AWD): To maintain the alternate wetting and drying we impose the treatment at 20 DAS and apply irrigation 5 cm depth at 20 kPa at 15 cm soil depth with tensiometer based reading. (c) AWD with irrigation after application of herbicide: We apply irrigation 5 cm depth at 20 kPa at 15 cm soil depth with tensiometer based reading. In this treatment we also applied irrigation after the application of herbicide to ensure the better efficacy of herbicide. (d) AWD with mid-season: Shallow flooding initially during crop establishment and then mid-season AWD (from tillering to a week before the onset of flowering) irrigation at 40 kPa); subsequent irrigation at 20 kPa at 15 cm soil depth).

2.4 Weed management

Before the sowing of the crop weed seed of *Echinochloa crus-galli* and *Leptichola chinensis* were broadcasted to ensure uniform weed population in all the plots. (a) Weedy Plot (W_1) : After crop establishment of the rice crop there was no weed management practices adopted to control the weeds, all the weeds were allow to growing till harvest of the crop. (b) Weed free (W_2) :In this plots we followed both chemical and mechanical weed control practices as per the recommendations to keep plot weed free. After 3 day of rice seeding at optimum moisture level we applied Pendimethalin @ 1 kg a.i. ha^{-1} as pre-emergence followed by Bispyribac-Na @ 25 g a.i. ha^{-1} at 25 day after seeding followed by two hand weeding to keep plot weed free. At 10 and 20 DAS recorded the weeds before the application of herbicides to just know the efficiency of pre-emergence and their persistence. (c) Pre emergence fb post-emergence (W_3) : After 3 day of rice seeding at optimum moisture level we applied Pendimethalin @ 1 kg a.i. ha^{-1} as pre-emergence followed by Bispyribac-Na @ 25 g a.i. ha^{-1} at 25 DAS. (d) Early post-emergence (W_4) : After 12 DAS we applied tank mixed of early post emergence (Propanil @ 4 kg a.i ha^{-1} + Pendimethalin 1 kg a.i. ha^{-1}).

2.5 Application of fertilizer

Recommended dose of Nitrogen (150 kg ha^{-1}), Phosphorus (75 kg ha^{-1}), Potash (75 kg ha^{-1}) and Zinc (5 kg ha^{-1}) were applied through urea, diammonium phosphate, muriate of potash and Zinc Sulphate, respectively to all the plots. A 30 kg ha^{-1} of the total nitrogen along with total quantity of P_2O_5, K_2O and Zinc was applied as basal application. Remaining nitrogen was applied as top dressing in three equal splits at 20, 40 and 55 DAS.

2.6 Statistical analysis

The data recorded for different parameters (weed dry matter, crop yields) were subjected to analysis of variance (ANOVA) for split plot design using Statistical Analysis System software (SAS, 2001) by using LSD procedure was used where ANOVA was significant and the treatment differences were compared at 5% level of significance.

3. Results and discussion

3.1 Weed flora

The crop infested with *Echnochloa crus-galli, Echnochloa colonum, Eclipta alba, Phyllanthus niruri, Cyperus difformis, Cyperus iria, Cyperus rotundus, Ammania baccifera* and *Ludwigia parviflora* etc. The most dominant weed spicies found in the experiment field were *Echnochloa crus-galli, Echnochloa colonum, Eclipta alba, Cyperus iria, Cyperus rotundus.*

3.1.1 Grassy weed density
The data presented in Table 3.1 showed that interaction between irrigation scheduling and weed management was observed non-significant. However, the effect of different irrigation scheduling on grassy weed was found significant only at 40 and 60 DAS. At 40 DAS the minimum weed density was recorded with I_1, which was 17 and 13.68 per cent significantly lower than I_2 and I_4, respectively. It was statistically *at par* with I_3. However, I_3 was also found similar to I_3 and I_4. Further at 60 DAS, similar results were obtained. I_1 significantly reduced grassy weed density as compare to remaining treatments. However, I_3 was also statistically lower weed density than I_2 and I_4, respectively. Further, I_2 and I_4 were statistically *at par* with each other. Minimum weed density in I_1 might be due to continuous submergence inhibit the emergence of weed. Similar results reported by Hill *et al*. (2001) [6] who reported that continuous submergence reduced grassy weed density in rice. Kim *et al*. (2001) [8] found that flood water increased the effectiveness of herbicide. Among the weed treatments W_2 followed by W_3 were observed significant lesser grassy weed density in comparison to all the treatments irrespective different growth intervals. Except at only 20 DAS, where W_4 was recorded significantly lower grassy weed density in comparison to others. However, highest grassy weed density was recorded with W_1 in all the growth stages. Lower grassy weed density in W_2 might be due to better efficacy of pre and post emergence herbicide followed by two time spot hand weeding while in W_3 only pre fb post emergence showed better control of weed. While in W_4 pre along with post emergence herbicides i.e. Pendimethalin @ 1 kg a.i. ha^{-1} with Proponil 4 @ kg a.i. ha^{-1} worked only upto 20 DAS. After that new flush of grassy weed emerged out. Results are in agreement of (Bhurer *et al*., 2013; Mahajan *et al*., 2013 and Mishra and Singh 2012) [1, 10, 11] who reported that application of pre emergence Pendimethalin better controlled of grassy weed which caused better crop establishment in DSR. After that, new flush of grassy weed controlled by post emergence application i.e. Bispyribac-Na.

3.1.2 Sedges weed density
The data on weed density of sedges at different days of interval as influenced by various treatments are presented in Table 3.2. The effect of different irrigation scheduling on density of sedges was found non-significant at 10 and 20 DAS. It was significant at 40 and 60 DAS, respectively. At 40 and 60 DAS, I_1 and I_3 were declined significantly sedge density as compared to I_2 I_4, respectively. However, both were statistically similar. Similar results reported by Seal *et al.* (2004) [17] reported that continuous submergence reduced weed density in rice and irrigation after herbicide application improved efficacy of herbicide. The weed management practices had significant effect on total sedges density at different days of interval of crop growth. Sedges density increased with the time in W_1 only. However, it declined in W_2 and W_3 with advancement of crop growth. The treatment W_2 i.e. pre fb by post and two spot hand weeding resulted minimum sedges density in all the growth intervals followed by W_3 as compared to W_1 and W_2, respectively. Initially sedges density was higher in W_4 but as application of early post emergence application of Propanil @ 4 kg a.i. ha^{-1} + Pendimethalin 1 kg a.i. ha^{-1} at 12 DAS declined significantly sedge density at 20 DAS as compared to other treatments. However, as advancement of growth new flush of sedge increased weed density in W_4. Similar results were obtained by Moon *et al.* (1999) [12] who reported that tank mixture application of pre and post emergence herbicide (Pendimethalin + Propanil) application shows better control of sedges. Results are in agreement of (Bhurer *et al*., 2013; Mahajan *et al*., 2013 and Mishra and Singh 2012) [1, 10, 11] who reported that application of pre emergence pendimethalin followed by post emergence Bispyribac-Na controlled weed effectively.

3.1.2 Broad leaves weed density
Effect of irrigation scheduling and weed management on broad leaf density at different intervals is summarized in Table 3.2. The effect of different irrigation scheduling on density of broad leaf was found non-significant at 10 and 20 DAS. I_3 was numerically lower number of broad leaf density than other treatments. Whereas, irrigation scheduling effect on broad leaf was significant at 40 and 60 DAS, respectively. At 40 and 60 DAS, I_1 and I_3 were declined significantly broad leaf density as compared to I_2 and I_4, respectively. I_1 was 16.36 and 43.40 per cent at 40 DAS and 26.61 and 46.81 per cent at 60 DAS lower broad leaf density than I_2 and I_4, respectively. However, I_1 and I_3 were statistically similar with each other at both intervals. I_2 and I_4 were also observed statistically *at par* with each other at 40 and 60 DAS. Similar results reported by Seal *et al.* (2004) [17] and Kim *et al.* (2001) [8] who reported that continuous submergence reduced broad leaves weed density in rice and irrigation after herbicide application enhanced efficacy of herbicide application. The weed management practices had significant effect on total broad leaves weed density at different days of interval of crop growth. Broad leaves weed density increased with the time in W_1 only. However, it declined in W_2 and W_3 with advancement of crop growth. The treatment W_2 resulted minimum broad leaves weed density in all the growth intervals followed by W_3. Initially broad leaves weed density was higher in W_4 but after the tank mix application of Propanil @ 4 kg a.i. ha^{-1} + Pendimethalin 1 kg a.i. ha^{-1} at 12 DAS its density declined significantly at 20 DAS as compared to other treatments. However, as advancement of growth new flush of broad leaves weed increased broad leaves weed density in W_4. Moon *et al.* (1999) [12] who reported that tank mixture application of pre and post emergence (Pendimethalin + Propanil) herbicide application shows better control of weeds. Results are in agreement of (Bhurer *et al.*, 2013, Mahajan *et al*., 2013 and Mishra and Singh 2012) [1, 10, 11] who reported that application of pre emergence pendimethalin followed by post emergence bispyribac-Na controlled weed effectively.

3.2 Yield and yield attribute characteristics
3.2.1 Length of panicle
Effect of irrigation scheduling and weed management on panicle length is summarized in Table 3.4. The data showed that only irrigation schedule and weed management practices were statistically differed. However, its interaction was non-significant. The higher panicle length was recorded with I_1 (24.89 cm) treatment which was numerical comparable I_3 (24.52 cm) treatment and statistically superior over I_2 and I4 treatments, respectively. However, W_2 (25.91cm) and W_3 (25.43 cm) was performed better than W_1 (21.50 cm) and W4 (23.93 cm). W_4 are also recorded higher panicle length than W_1.

3.2.2 Test weight (1000 grain weight)

On the perusal of data indicated that test weight was statistically higher in I_1 and I_3 in comparison to I_2 and I_4, respectively. I_1 was 7.21 and 10.72 percent higher test weight than I_2 and I_4, respectively. However, I_1 and I_3 were statistically *at par* with each other. Similarly, test weight was recorded with I_2 and I_4. Weed management practices significantly influence test weight of rice. W_2 (weed free) recorded higher test weight as compared to W_1 and W_4, respectively. However, it was similar to W_3. W_3 was statistically similar with W_4 but significantly higher than W_1. W_3 was increased 11.43 percent test weight than W_1. W_4 was also higher test weight in comparison to W_1.

3.2.3 Tiller density

Tillers are an important component of rice yield because they have the potential to develop grain-bearing heads. The total number of tillers eventually developed does not produce grain-bearing heads. Under recommended plant populations, usually two or three tillers, in addition to the main shoot, produce grain and are called as effective tillers. On the perusal of the data irrigation scheduling and weed management practices had marked impact on tiller density irrespective of days after sowing. But its interaction was found statistically non-significant. At 60 DAS, maximum tiller density (323) was recorded with I_1 followed by I_3, both the treatments had increased significantly in comparison to I_2 and I_4, respectively. The I_1 produced 8.44 and 11.65 per cent more tiller density than I_2 and I_4, respectively. The maximum panicle was recorded with I_1 followed by I_3 as compare to I_2 and I_4, respectively. While at 60 DAS, the tiller density was drastically decreased in W_1 treatment. The significantly higher tiller density was recorded with W_2 and W_3 treatments than W_1 and W_4, respectively. W_4 was also statistically more tiller density than W_1. Overall, performance of irrigation scheduling (I_1) and weed management practices (W_2 and W_3) were found better tiller density and panicle number than rest of the treatments. The improvement of tiller density by I_1 at different growth stages might be due to adequate water supply by I_1. However, I_2 and I_3 i.e. alternate wetting and drying irrigation at 20 kPa also supplied optimum quantity of irrigation water to maintain tiller density. Mid-season drying stress condition negatively affected tiller density. Several studies suggested that continuous flooding improves tiller density of rice but AWD was statistically similar tiller density of rice plant (Parihar 2004 and Gil and singh 2008) [14, 4].

Better tiller density in W_2 and W_3 might be due to weed population suppressed by herbicide therefore lesser competition between plant and weed for light, water and nutrient. However, weed density was more in weedy plot (W_1) and combination of pre-post emergence herbicide (W_4) that adversely affected proper tillering and panicle density. Similar result reported that application of pre-emergence herbicide i.e. pendimethalin reduced significantly weed population that improved tiller and panicle density (Rao and Nagmani 2007 and singh *et al*., 2009) [15, 16, 18, 19].

3.2.4 Grain yield

The grain yield, the overall resultant of the crop in rice basically depends on the different critical components of yield attributing parameters, soil quality and environmental factors during the crop growth. The interaction between these components and yield attributing parameters is important to understand for the final grain yield in the rice crop. Effect of irrigation scheduling and weed management on grain yield is summarized in Table 3.4. I_1 treatment was recorded significantly higher grain yield (5.60 t ha^{-1}) followed by I_3 (5.28 t ha^{-1}) as compare to I_2 and I_4, respectively. I_1 was increased 14.05 and 22.80 percent grain yield over I_2 and I_4 However, I_2 was statistically *at par* with I_3 but significantly superior over I_4. Among the weed management practices highest grain yield (6.68 t ha^{-1}) was recorded with W_2 which statistically *at par* with W_3 but both the treatments were significantly superior over W_1 and W_4. Overall irrigation scheduling I_1 and I_3 and weed management practices W_2 and W_3 were performed higher grain yield than rest of the treatments.

Table 2.1: Physico-chemical properties of the experimental field.'

SNo	Soil Properties	Values	Methods of determination
1.	Soil Texture	Loam	Hydrometer Method (Bouyoucos,1962)
	Sand (%)	43.3	
	Silt (%)	33.4	
	Clay (%)	23.4	
2.	Bulk Density (Mg/m^3)	1.64	Core Method, Black, 1965
3.	pH(1:2 Soil: Water)	8.8	Glass Electrode. Jackson, 1973)
4.	EC	0.71	Glass Electrode. Jackson, 1973)
5.	Total Carbon (%)	0.33	TOC N Analyzer (Combustion Method)
6.	Available N (kg ha^{-1})	175	Alkaline permagnate method (Subbiah and Asija, 1956)
7.	Available P_2O_5 (kg ha^{-1})	41.5	0.5 M $NaHCO_3$ (Olsen *et al*., 1954)
8.	Available K_2O (kg ha^{-1})	316.6	1 N NH_4OAC (Hanway and Heidel, 1952)

Table 2.2: Details of experimental treatments

A. Irrigation scheduling (Main plot)		
i.	Continuous shallow flooding	I_1
ii.	AWD	I_2
iii.	AWD with irrigation after application of herbicide	I_3
iv.	AWD with mid-season drying	I_4
B. Weed management practices (Sub plot)		
i.	Weedy check	W_1
ii.	Weed free	W_2
iii.	Pre-emergence Pendimethalin @ 1 kg a.i. ha^{-1} fb post-emergence Bispyribac-Na @ 25 g a.i. ha^{-1}	W_3
iv.	Early post emergence (Propanil @ 4 kg a.i. ha^{-1} + Pendimethalin 1 kg a.i. ha^{-1})	W_4

Table 3.1: Grassy weed density (m^{-2}) at different stages of crop growth as influenced by irrigation scheduling and weeds management practices

Treatment	Grassy weed density (m^{-2})			
	10 DAS	20 DAS	40 DAS	60 DAS
Irrigation scheduling				
I_1	7.02	8.14	6.03	6.45
	(61.96)	(73.92)	(58.17)	(63.08)
I_2	7.34	7.71	6.80	7.18
	(62.67)	(68.00)	(68.08)	(75.00)
I_3	6.44	6.96	6.36	6.83
	(55.81)	(59.00)	(60.67)	(68.75)
I_4	7.13	7.70	6.69	7.29
	(58.96)	(68.58)	(66.13)	(77)
S.Em±	0.28	0.39	0.14	0.08
LSD at 5%	NS	NS	0.48	0.28
Weed management				
W_1	10.32	12.86	13.11	13.63
	(106.21)	(164.67)	(171.96)	(185)
W_2	3.18	6.06	1.00	1.00
	(9.89)	(36.88)	(0.00)	(0.00)
W_3	4.12	6.43	3.38	3.97
	(17.13)	(41.33)	(10.92)	(15.08)
W_4	10.31	5.16	8.39	9.16
	(106.17)	(26.63)	(70.17)	(83.75)
S.Em±	0.22	0.26	0.23	0.15
LSD at 5%	0.63	0.75	0.68	0.45

*Data subjected to square root transformation; Value in parentheses are original

Table 3.2: Sedges weed density (m^{-2}) at different stages of crop growth as influenced by irrigation scheduling and weeds management practices

Treatment	Sedges weed density (m^{-2})			
	10 DAS	20 DAS	40 DAS	60 DAS
Irrigation scheduling				
I_1	8.49	7.43	6.63	7.06
	(94.88)	(71.58)	(72.33)	(78.08)
I_2	8.58	7.32	7.26	7.70
	(95.88)	(70.75)	(86.08)	(91.83)
I_3	8.31	6.43	6.67	7.37
	(93.67)	(61.42)	(74.58)	(85.5)
I_4	8.83	7.29	7.33	7.77
	(96.17)	(69.71)	(85.75)	(94.58)
S.Em±	0.18	0.26	0.09	0.12
LSD at 5%	NS	NS	0.30	0.43
Weed management				
W_1	13.34	14.46	15.55	15.82
	(177.42)	(208.42)	(241.42)	(249.75)
W_2	3.43	4.58	1.00	1.00
	(11.17)	(20.30)	(0.00)	(0.00)
W_3	4.17	5.30	3.05	3.71
	(16.75)	(27.75)	(8.58)	(13.00)
W_4	13.26	4.13	8.31	9.38
	(175.25)	(17.00)	(68.75)	(87.25)
S.Em±	0.17	0.19	0.16	0.11
LSD at 5%	0.51	0.57	0.48	0.33

*Data subjected to square root transformation; Value in parentheses are original

Table 3.3: Broad leaves weed density (m^{-2}) at different stages of crop growth as influenced by irrigation scheduling and weeds management practices

Treatment	Broad leaves weed density (m^{-2})			
	10 DAS	20 DAS	40 DAS	60 DAS
Irrigation scheduling				
I_1	5.53	5.58	4.22	4.53
	(31.21)	(32.17)	(23.13)	(26.79)
I_2	5.48	5.49	4.56	5.11
	(30.38)	(31.75)	(26.92)	(33.92)
I_3	5.18	4.98	4.59	4.90
	(28.13)	(27.38)	(28.67)	(32.33)
I_4	5.72	5.61	4.95	5.46
	(32.88)	(32.92)	(33.17)	(39.33)
S.Em±	0.37	0.24	0.12	0.12
LSD at 5%	NS	NS	0.44	0.41
Weed management				
W_1	6.52	7.40	8.32	8.71
	(42.29)	(54.29)	(68.92)	(75.75)
W_2	4.45	5.34	1.00	1.00
	(19.29)	(27.75)	(0.00)	(0.00)
W_3	4.70	5.83	3.11	3.53
	(21.71)	(33.25)	(8.83)	(11.67)
W_4	6.25	3.09	5.89	6.77
	(39.29)	(8.92)	(34.13)	(45.46)
S.Em±	0.26	0.15	0.15	0.15
LSD at 5%	0.78	0.44	0.44	0.43

*Data subjected to square root transformation; Value in parentheses are original

Table 3.4: Yield attributes and grain yield influenced by irrigation scheduling and weeds management practices

Treatment	Grain yield, straw yield, biological yield and harvest index			
	Panicle length (cm)	Test weight (g)	Tiller density (60 DAS)	(Grain yield t ha^{-1})
Irrigation scheduling				
I_1	24.89	24.68	323.00	5.60
I_2	23.97	23.02	297.87	4.91
I_3	24.52	24.18	314.60	5.28
I_4	23.39	22.29	289.29	4.56
S.Em±	0.18	0.32	2.97	0.12
LSD at 5%	0.65	1.11	10.47	0.44
Weed management				
W_1	21.50	21.61	189.67	2.43
W_2	25.91	24.78	369.71	6.67
W_3	25.43	24.08	363.14	6.32
W_4	23.93	23.75	302.24	4.93
S.Em±	0.20	0.25	3.55	0.12
LSD at 5%	0.58	0.75	10.43	0.37

4. Conclusion
Continuous shallow flooding irrigation at 10 kPa (I_1) reduces the weed density significantly. The applications of Pendimethalin 1 kg a.i. ha^{-1} at 3 DAS followed by Bispyribac 25 g a.i. ha^{-1} at 25 DAS (W_3) controlled weed very effectively and produce similar yield (6.32 t ha^{-1}) as weed free (W_2) (6.67 t ha^{-1}). However, the study also suggested that detail study should be carried out to understand interaction of irrigation scheduling and weed management practices.

5. References

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