ECONOMICS OF WET SEEDED RICE AS INFLUENCED BY ALTERNATE WETTING AND DRYING IRRIGATION REGIMES AND WEED MANAGEMENT

ABSTRACT

An experiment was conducted at College Farm, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad during *rabi* 2020-21 and 2021-22.The experiment was laid out in split plot design with two factors i.e., irrigation regimes (I_1 : Farmers practice (Continuous flooding of 2-5 cm from 3-4 days after sowing), I_2: AWDI at 5 cm depletion of ponded water, I_3: AWDI at 10 cm depletion of ponded water and I_4: AWDI at 15 cm depletion of ponded water) and weed management practices (W_1: Control (Unweeded check), W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* Penoxsulam (1.02%) + Cyhalofop butyl (5.1%) 120 g ha^{-1} PoE, W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* Penoxsulam (1.02%) + Cyhalofop butyl (5.1%) 120 g ha^{-1} PoE + Mechanical weeding at 45 DAS and W_4: Weed free (Mechanical weeding at 15, 35 and 55 DAS with line weeding). Among the irrigation regimes, cost of cultivation and gross returns were highest in farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing) and lowest in AWDI at 15 cm depletion of ponded water. Net returns and B:C ratio was highest in AWDI at 5 cm depletion of ponded water and lowest net returns and B:C ratio was recorded in AWDI at 15 cm depletion of ponded water. Among weed management practices highest cost of cultivation, gross returns were achieved in weed free (mechanical weeding at 15, 35 and 55 DAS with line weeding) and lowest cost of cultivation and gross returns was achieved in Control (unweeded control). With respective to herbicide application highest gross returns, net returns and B:C ratio were achieved in pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE + mechanical weeding at 45 DAS.

KEY WORDS: Wet seeded rice, Irrigation regimes, weed management, economics

INTORDUCTION :

The most popular method for establishing rice in South East Asian nations, including India, is transplanting. In India, rice is traditionally grown in flooded conditions, however this method requires a lot of water. Water-saving technologies are required in order to continue production even with decreased water use in order to fulfil the increasing demand for food from the population growth. Alternate wetting and drying approach, reduce water input by 30% without lowering yield (Bouman *et al.*, 2007). Compared to continuous flooding, the AWD greatly reduced the number of irrigations and the amount of irrigation water used.

Heavy weed infestation puts direct seeded rice's viability in jeopardy (Mahajan *et al.*, 2013). In fields that were direct sown, weed growth is typical. Due to the same age and physical characteristics of grass weeds and rice seedlings, rice seedlings in wet seeded conditions experience higher weed growth than transplanted rice. Weed growth decreases the grain yield of wet-sown rice by up to 53% (Ramzan, 2003). Direct seeded rice's productivity may be increased by good weed management practices throughout the first 40 days of crop growth (Maity and Mukherjee, 2008). Herbicides are currently the most crucial weed management tool since they provide fast, efficient, cost-effective, and useful methods of weed control. However, diverse weeds in direct seeded rice could not be adequately controlled by pre or post-emergence herbicide sprays alone (Awan *et al.*, 2015). Although manual, mechanical, and chemical weed control methods were effective, lack of labour during peak season and rising labour costs are causing weed control procedures to be delayed and expensive. Therefore, timely weed control is achieved by combining herbicide applications such as pre and postemergence with mechanical and manual weeding techniques. With these considerations in mind, the current study was conducted to investigate the effects of alternating wetting and drying irrigation regimes, as well as weed management practices, on the economics of wet seeded rice during the *rabi* season.

MATERIAL AND METHODS

An experiment was carried out at College Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana State Agricultural University, Rajendranagar,Hyderabad at an altitude of 527 m above mean sea level (MSL), 17^{o} 31’ N latitude, 78^{o} 40’ E longitude in Southern Telangana zone. The soil of the experimental site was sandy loam in texture with pH 7.9, available nitrogen (251.0 kg ha^{-1}), available phosphorus (42.5 kg ha^{-1} P_2O_5) and available potassium (364.0 kg ha^{-1} K_2O).

The experiment was laid out in split plot design with two factors i.e., irrigation regimes (I_1 : Farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing), I_2: AWDI at 5 cm depletion of ponded water, I_3: AWDI at 10 cm depletion of ponded water and I_4: AWDI at 15 cm depletion of ponded water) and other weed management practices (W_1: Control (Unweeded check), W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* Penoxsulam (1.02%) + Cyhalofop butyl (5.1%) 120 g ha^{-1} PoE, W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* Penoxsulam (1.02%) + Cyhalofop butyl (5.1%) 120 g ha^{-1} PoE + Mechanical weeding at 45 DAS and W_4: Weed free (Mechanical weeding at 15, 35 and 55 DAS with line weeding). The test variety used for the study was Jagtial Rice-1 (JGL-24423). Sowing was done by drum seeder by maintaining spacing of 25 cm x 8 cm. The data were analyzed statistically applying analysis of variance technique for split plot design. The significance was tested by 'F' test (Gomez and Gomez, 1984)

Cost of cultivation (Rs. ha^{-1})

Cost of cultivation was calculated by adding the cost of all the inputs viz., seed, fertilizer, herbicides, irrigation water, labour, pesticides etc.

Gross returns (Rs. ha^{-1})

Gross returns were calculated by using the cost of grain and straw in the market at the time of harvesting of the crop and by multiplying them with respective grain and straw yields and expressed as Rs. ha^{-1}

Net returns (Rs. ha^{-1})

Net returns were calculated by subtracting the cost of cultivation from the gross returns and expressed as Rs. ha^{-1}

Benefit cost ratio

Benefit cost ratio was calculated using the formula

$$\text{B-C Ratio} = \frac{\text{Gross returns (Rs. ha}^{-1})}{\text{Cost of cultivation (Rs. ha}^{-1})}$$

RESULTS AND DISCUSSION :

Cost of cultivation

Cost of cultivation as influenced by irrigation regimes and weed management practices were presented in table 1.

The highest cost of cultivation was found with I_1: Farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing) (74370 and 72470.0 Rs ha^{-1}) followed by I_2: AWDI at 5 cm depletion of ponded water and I_3 : AWDI at 10 cm depletion of ponded water. The lowest cost of cultivation resulted in I_4: AWDI at 15 cm depletion of ponded water (56170 and 55450 Rs ha^{-1}). This might be due to more number of irrigations are applied in farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing) when compared with other alternate wetting and drying irrigation regimes.

Cost of cultivation varied with different weed management practices. The highest cost of cultivation was achieved in W_4: Weed free (mechanical weeding at 15, 35, and 55 DAS with line weeding) (Rs. 70845 and 70292 Rs ha^{-1}) followed by W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE + mechanical weeding at 45 DAS) and W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE when compared with W_1:Control (unweeded check) which resulted in the lowest cost of cultivation (55695 and 55142 Rs ha^{-1}). Weed free condition recorded the highest cost of cultivation due to the high requirement of labour for mechanical weeding and line weeding. The lowest cost of cultivation was recorded in unweeded control as there was no usage of labour or herbicide. Similar findings were reported by Mounisha *et al.* (2021)

Gross returns (Rs ha^{-1})

Gross returns as influenced by irrigation regimes and weed management practices were presented in table 1.

The highest gross returns in both years of study were found in with I_1: Farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing) (149154 and 156709 Rs ha^{-1}) might be due to higher biological yield in farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing) and it was on par with by I_2: AWDI at 5 cm depletion of ponded water.The lowest gross returns resulted in I_4: AWDI at 15 cm depletion of ponded water. (104576 and 110845 Rs ha^{-1})

Gross returns varied with different weed management practices during both years of study. The highest gross returns were achieved in W_4: Weed free (mechanical weeding at 15, 35 and 55

DAS with line weeding) (153021 and 155503 Rs ha^{-1}) and it was on par with W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE + mechanical weeding at 45 DAS). Application of herbicide alone i.e W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE resulted in higher gross returns when compared with with W_1:Control (unweeded check) which resulted in the lowest gross returns. (78974 and 83875 Rs ha^{-1}). Higher gross returns were achieved in weed free condition followed by W_3 and W_2 due to the higher grain and straw yield in these treatments when compared to unweeded control which resulted in lower gross returns due to lower grain and straw yield. Similar findings were reported by Mohanta *et al*. (2020)

Net returns (Rs ha^{-1})

Net returns as influenced by irrigation regimes and weed management practices were presented in table 2.

The highest net returns during both years of study were found in I_2 : AWDI at 5 cm depletion of ponded water (76972 and 84855 Rs ha^{-1}) and it was on par with I_1: Farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing) and I_3:AWDI at 10 cm depletion of ponded water. This might be due to the lesser cost of cultivation in alternate wetting and drying irrigation at 5 cm depletion of ponded water because of lesser amount of irrigation water and fewer number of irrigations when compared to farmer practice (continuous flooding of 2-5 cm from 3-4 days after sowing). Similar findings were reported by Rahaman and Sinha 2013 The lowest net returns resulted in I_4: AWDI at 15 cm depletion of ponded water (48406 and 55395 Rs ha^{-1})

Net returns varied with different weed management practices. Highest net returns was achieved W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl(5.1%) 120 g ha^{-1} PoE + mechanical weeding at 45 DAS) (83380 and 92409 Rs ha^{-1}) and it was on par with W_4: Weed free (Mehcanical weeding at 15, 35, and 55 DAS with line weeding) and W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE during 2020-21 and during 2021-22, highest net returns was achieved W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl(5.1%) 120 g ha^{-1} PoE + mechanical weeding at 45 DAS) (92409 Rs ha^{-1}) and it was on par with W_4: Weed free (Mehcanical weeding at 15, 35, and 55 DAS with line weeding).

The lowest net returns were resulted in W_1:Control (Unweeded check) (23279 and 31233 Rs ha^{-1}). The highest net returns were achieved in W_3 when compared to the weed free condition due to less cost of cultivation incurred in W_3 where herbicide combination + mechanical weeding was carried out. Similar findings were reported by Mohanta *et al.* (2020) and Mounisha *et al*. (2021)

B:C ratio

B:C ratio as influenced by irrigation regimes and weed management practices were presented in table 2.

The highest B : C ratio during both years of study was found in I_2 : AWDI at 5 cm depletion of ponded water (2.24 and 2.36) and this was on par with I_3:AWDI at 10 cm depletion of ponded water and I_1: Farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing). This might be due to lesser cost of cultivation and more net returns in alternate wetting and drying irrigation at 5 cm depletion of ponded water and alternate wetting and drying irrigation at 10 cm depletion of ponded water because of lesser amount of irrigation water and fewer number of irrigations when compared to Farmer practice (continuous flooding of 2-5 cm from 3-4 days after sowing). Similar findings were reported by Nayak *et al.* (2016) and Shabana *et al.* (2019) and.The lowest B:C ratio was resulted in I_4: AWDI at 15 cm depletion of ponded water (1.84 and 1.98)

B:C ratio varied with different weed management practices. Highest B:C ratio during both years of study was achieved in W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE + mechanical weeding at 45 DAS) (2.32 and 2.47) and this was on par with with W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE (2.30 and 2.40) followed by W_4: Weed free (Mechanical weeding at 15, 35 and 55 DAS with line weeding) (2.16 and 2.30) which might be due to reduced cost of weeding with higher grain and straw yield. W_1: Control (Unweeded check) resulted in the lowest B:C ratio (1.42 and 1.57) which might be due to lower grain and straw yield in unweeded control. Similar findings were reported by Nagarjun *et al*. (2019)

CONCLUSION :

Economics of wet seeded rice was significantly influenced by different irrigation regimes and weed management practices. Among irrigation regimes highest gross returns were achieved in farmers practice and it was on par with AWDI at 5 cm depletion of ponded water, highest net returns and B:C ratio was achieved under AWDI at 5 cm depletion of ponded water. Among the weed management practices highest gross returns were noticed under Weed free (mechanical weeding at 15, 35 and 55 DAS with line weeding). Highest net returns and B:C ratio was noticed in W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE + mechanical weeding at 45 DAS

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Table. 1. Cost of cultivation and Gross returns of wet seeded rice as influenced by alternate wetting and drying irrigation regimes and weed management practices in *rabi* season 2020-21 and 2021-22

Treatments	Cost of cultivation (Rs ha^{-1})			Gross returns (Rs ha^{-1})		
	20-21	21-22	Mean	20-21	21-22	Mean
Irrigation Regimes (I)						
I_1:Farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing)	74370	72470	73420	149154	156709	152932
I_2:AWDI at 5 cm depletion of ponded water	60820	61500	61160	137792	146355	142074
I_3: AWDI at 10 cm depletion of ponded water	57820	57550	57685	123615	130864	127239
I_4:AWDI at 15 cm depletion of ponded water	56170	55450	55810	104576	110845	107710
S.Em.±	-	-	-	4590	4649	-
CD (p=0.05)	-	-	-	15885	16088	-
Weed Management Practices (W)						
W_1:Control (Unweeded check)	55695	55142	55419	78974	83875	82675
W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120 g ha^{-1} PoE	59395	58842	59119	136517	139944	140109
W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl (5.1%) 120g ha^{-1} PoE + mechanical weeding at 45 DAS	63245	62692	62969	146625	151079	150863
W_4:Weed free (mechanical Weeding at 15, 35 and 55 DAS with line weeding)	70845	70292	70569	153021	155503	156308
S.Em.±	-	-	-	2264	2506	-
CD (p=0.05)	-	-	-	6609	7315	-
Interaction						
Weed management practices at same level of irrigation regimes						
S.Em.±	-	-	-	4528.8	5012.7	-
CD (p=0.05)	-	-	-	NS	NS	-
Irrigation regimes at same or different level of weed management						
S.Em.±	-	-	-	6037.7	6360.8	-
CD (p=0.05)	-	-	-	NS	NS	-
General Mean	62295	61742	62018	128784	136193	132488

Table. 2. Net returns and B:C ratio of wet seeded rice as influenced by alternate wetting and drying irrigation regimes and weed management practices in *rabi* season 2020-21 and 2021-22

Treatments	Net returns (Rs ha^{-1})			B:C ratio		
	20-21	21-22	Mean	20-21	21-22	Mean
Irrigation Regimes (I)						
I_1:Farmers practice (continuous flooding of 2-5 cm from 3-4 days after sowing)	74784	84239	79512	1.99	2.15	2.07
I_2:AWDI at 5 cm depletion of ponded water	76972	84855	80914	2.24	2.36	2.30
I_3: AWDI at 10 cm depletion of ponded water	65795	73314	69554	2.12	2.26	2.19
I_4:AWDI at 15 cm depletion of ponded water	48406	55395	51900	1.84	1.98	1.91
S.Em.±	4590	4649	-	0.08	0.07	-
CD (p=0.05)	15885	16088	-	0.27	0.25	-
Weed Management Practices (W)						
W_1:Control (Unweeded check)	23279	31233	27256	1.42	1.57	1.49
W_2: Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl(5.1%) 120 g ha^{-1} PoE	77122	84858	80990	2.30	2.44	2.37
W_3:Pyrazosulfuron ethyl (10% WP) 20 g ha^{-1} PE *fb* penoxsulam (1.02%) + cyhalofop butyl(5.1%) 120g ha^{-1} PoE + mechanical weeding at 45 DAS	83380	92409	87894	2.32	2.47	2.39
W_4:Weed free (mechanical weeding at 15, 35 and 55 DAS with line weeding)	82176	89303	85739	2.16	2.27	2.21
S.Em.±	2264	2506	-	0.04	0.04	-
CD (p=0.05)	6609	7315	-	0.11	0.12	-
Interaction						
Weed management practices at same level of irrigation regimes						
S.Em.±	4529	5013	-	0.08	0.08	-
CD (p=0.05)	NS	NS	-	NS	NS	-
Irrigation regimes at same or different level of weed management						
S.Em.±	6038	63601	-	0.10	0.10	-
CD (p=0.05)	NS	NS	-	NS	NS	-
General Mean	66489	74451	70470	2.05	2.19	2.12