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Sudharani JS
Scientist (CP) District Agricultural Advisory and Transfer of Technology Centre Rangareddy, Telangana, India

Madhukar Rao P
Scientist (Agro) Regional Agricultural Research Station Jagtiyal, Telangana, India

Sreedhar C
Senior Scientist (Agro) Agriculture Research Station Adilabad, Telangana, India

Thirumala Rao V
Senior Scientist (Pl.Br.) Regional Agricultural Research Station, Warangal, Telangana, India

Correspondence
Sudharani JS
Scientist (CP) District Agricultural Advisory and Transfer of Technology Centre Rangareddy, Telangana, India

Evaluation of pre and post emergence herbicides in aerobic rice

Sudharani JS, Madhukar Rao P, Sreedhar C and Thirumala Rao V

Abstract
Aerobic rice is one of the contingent production systems (Sreedevi *et al*., 2014). The major constraint in the success of aerobic rice is high weed infestation, yield loss from 50 to 100% has been reported in aerobic rice (Mishra and Singh 2007), A wide increase in grain yield (15–30%) by implementing different weed control practices elaborates the scope of weed management in aerobic rice. A study was conducted at Regional Agricultural Research Station, Jagtial, Karimnagar district of Telangana state in India, during kharif season of 2012 to investigate the most effective and economical weed management practice in aerobic rice cultivation. The study treatments were seven laid out in RBD viz. Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb hand weeding at 30 & 45 DAS, Bispyribac sodium (25 g a.i/ha at 20DAS), 2,4-D sodium salt (1.5kg a.i/ha at 35 DAS), Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS)f b Bispyribac sodium (25 g a.i/ha at 20 DAS), Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS), f b 2,4-D sodium salt(1.5kg a.i/ha at 40 DAS), Un weeded control and Weed free check (3HW at 20, 35 & 50 DAS). Results of the experiment depicted that highest grain yield (3456kg/ha) could be obtained with hand weeding thrice at 20, 35& 50 DAS, however most economical weed management practice was integrated weed management with pre emergence herbicide Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS) fb hand weeding at 30 & 45 DAS which recorded higher net returns and BC ratio of 2.2. Chemical or integrated weed management practice with post emergence herbicides Bispyribac sodium (25 g a.i/ha at 20DAS), or 2,4-D sodium salt (1.5kg a.i/ha at 40 DAS) were not economical which recorded negative BC ratio. And a reduction in yield to the tune of 85.5% was noted under un weeded control.

Keywords: Aerobic rice, integrated weed management, chemical weed management

Introduction
Rice (*Oryza sativa* L.) is one of the most important staple food crop in the world. Globally rice is grown over an area of 157 million ha with an annual production of 746.6 million tonnes (FAO, 2016). In Asia more than two billion people are getting 60-70% of the energy requirements from rice. In India, rice occupies an area of 43.39 million ha with an average production of 104.32 million tonnes with productivity of 2404 kg ha^{-1} (DES, 2016). Demand for rice is increasing every year and estimates by 2025 AD, would be around 140 million tonnes. To sustain the present food self sufficiency and to meet future food requirements, India has to increase the productivity. Rice cultivation requires large quantity of water and for producing one kg of rice, about 3000-5000 liters of water is required under irrigated conditions (Bouman and Tuong, 2001) [1]. In the present scenario of increasing water scarcity, aerobic rice is one of the contingent production systems (Sreedevi *et al.*, 2014). Aerobic rice is novel method of growing rice by direct seeding in non puddled conditions without standing water. The major constraint in the success of aerobic rice is high weed infestation, yield loss from 50 to 100% has been reported in aerobic rice (Mishra and Singh 2007), oflate, the use of herbicides is gaining popularity in rice fields due to their rapid effects and the lower costs compared with the traditional methods. A wide increase in grain yield (15–30%) by implementing different weed control practices elaborates the scope of weed management in aerobic rice. The present study was initiated to identify the suitable post emergence herbicides with proper dose for effective weed control in aerobic rice.

Materials and Methods
Field experiment was conducted during *Kharif* (June to September) 2012 at Regional Agricultural Research Station, Jagtial, Karimnagar district of Telangana state in India. To evaluate the effect of pre and post emergence herbicides in aerobic rice. The farm is geographically situated at 78045'E to 7900'E Longitude and 18045' N to 1900' N Latitude. The climate of polasa, Jagtial was classified as subtropical. The southwest monsoon usually sets in during June second week giving 40-50 rainy days per year (IMD, 1978). Winter is generally milder at Jagtial and temperature begins to rise from January and reach it peak by

May. The soil of the experimental field was sandy clay loam in texture, neutral in reaction (pH: 7.21), low in available N (119 kg/ha) and medium in available P (12 kg/ha) and high in available K (368 kg/ha).The experiment was laid out in randomized block design with seven treatments in three replications. The treatments were viz. Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb hand weeding at 30 & 45 DAS, Bispyribac sodium (25 g a.i/ha at 20DAS), 2,4-D sodium salt(1.5kg a.i/ha at 35 DAS), Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS)f b Bispyribac sodium (25 g a.i/ha at 20 DAS), Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS), f b 2,4-D sodium salt(1.5kg a.i/ha at 40 DAS), Un weeded control and Weed free check (3HW at 20, 35 & 50 DAS). The rice cultivar 'Pradhyumna (JGL-17004)' was sown on 5th June, 2012 with 20 cm spacing between rows. Recommended dose of fertilizers and irrigations were given uniformly. Herbicides for concerned treatments were applied with knapsack sprayer with a spray volume of 500 l/ha. Rest of the management practices were in accordance with the recommended package of practice. Weed counts (monocots and dicots) were recorded at 30, 60 and 90 days after sowing, with the help of 50 x 50 cm quadrates at two random places in each plot. The data on weed density and weed dry matter accumulation was subjected to square root transformation to normalize their distribution before analysis.

Results and Discussion

The experimental plots were dominated with *Digitaria sanguinalis*, *Cynodon dactylon*, *Aegeratum conyzoids*, *Commelina benghalensis*, *Celosia argentia* and *Cyperus rotundus*

Weed density (No/m^2)

During the crop growing season a continuous increase in weed density was observed.

Highest weed density was recorded at 90 days after sowing. A significant lower weed density was observed with application of Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS) at 15 days after sowing. At 30 days after sowing chemical control with application of Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) followed by Bispyribac sodium (25 g a.i/ha at 20 DAS) or Bispyribac sodium (25 g a.i/ha at 20DAS) alone, recorded significant lower weed density, and they did not differ significantly with hand weeding (at 20 DAS) or IWM practice(Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS fb HW at 30 and 45 DAS) and were significantly superior over application of either Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS) fb 2,4-D sodium salt (1.5kg a.i/ha at 40 DAS) or un weeded control. At 60 and 90 DAS hand weeding (at 20, 35 & 50 DAS) recorded significantly lower weed density over the rest of treatments and un weeded control recorded highest weed density.

Weed dry matter (g/m^2)

Data pertaining to weed dry matter indicated that, weed management practices exerted significant influence on weed dry matter production at various stages of crop growth. At 30 days after sowing, hand weeding(thrice at 20, 30 and 45 DAS) recorded a significant lower weed dry matter and it in turn was on par with chemical control treatment of Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb Bispyribac sodium (25 g a.i/ha at 20 DAS) or Bispyribac sodium (25 g a.i/ha at 20DAS) alone and these treatments were significantly superior over application of 2,4-D sodium salt (1.5 kg a.i/ha at 40days) or un weeded control. At 60 and 90 days after sowing hand weeding (thrice at 20, 35 & 50 DAS) or the IWM (Pretilachlor + safener 0.4 kg a.i/ha at 3 DAS fb HW at 30 & 45 DAS) practices showed the lowest and at par dry matter/ m^2 with each other and were significantly superior over rest of treatments these were followed by chemical control either with, Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb Bispyribac sodium (25 g a.i/ha at 20 DAS) or Bispyribac sodium (25 g a.i/ha at 20 DAS) alone or Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS), fb 2,4-D sodium salt (1.5kg at 40 DAS) and unweeded control recorded highest weed dry matter at all the stages of crop.

Table 1: Effect of weed management techniques on weed density in rice under aerobic condition:

Weed management	Weed desity (no./m2)			
	15 DAS	30 DAS	60 DAS	90 DAS
Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb HW at 30 & 45 DAS	3.1	6.6	5.1	8.1
	(9.1)	(43.3)	(25.3)	(64.7)
Bispyribac sodium (25 g a.i/ha at 20DAS)	4.9	4.4	7.3	13.6
	(23.0)	(18.3)	(53.3)	(183.0)
2,4-D sodium salt@1.5kg a.i/ha at 35 DAS.	4.6	7.9	9.1	12.8
	(19.9)	(62.3)	(82.0)	(164.3)
Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS)f b Bispyribac sodium (20 DAS @25 g a.i/ha)	3.1	3.9	6.9	10.9
	(9.0)	(14.3)	(47.3)	(118.0)
Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS), f b 2,4-D sodium salt@1.5kg a.i/ha at 40days after seeding.	3.1	7.2	6.5	11.6
	(8.9)	(51.0)	(67.3)	(134.3)
Un weeded control	5.4	7.3	11.3	17.9
	(28.3)	(53.3)	(126.3)	(321.3)
Weed free check (3HW at 20, 35 & 50 DAS)	5.1	4.1	4.4	6.5
	(25.0)	(16.3)	(18.3)	(41.3)
CD(P=0.05)	0.9	0.8	2.6	1.4
CV%	12.9%	8.1%	20.5%	6.8%

(figures in the parenthesis are original values subjected to transformation √(x+1)

Table 2: Effect of weed management techniques on weed dry matter in rice under aerobic condition:

Weed management	Weed dry matter (g/m^2)		
	30 DAS	60 DAS	90 DAS
Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb HW at 30 & 45 DAS	3.1	4.1	7.3
	(8.8)	(16.0)	(52.3)
Bispyribac sodium (25 g a.i/ha at 20DAS)	4.3	6.3	11.7
	(17.2)	(38.3)	(137.0)
2,4-D sodium salt@1.5kg a.i/ha at 35 DAS.	5.4	7.5	11.5
	(27.8)	(55.0)	(131.3)
Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS)f b Bispyribac sodium (20 DAS @25 g a.i/ha)	3.0	5.8	9.9
	(7.8)	(33.3)	(97.3)
Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS), f b 2,4-D sodium salt@1.5kg a.i/ha at 40days after seeding.	4.9	6.9	10.9
	(23.4)	(46.7)	(118.3)
Un weeded control	5.0	10.1	13.3
	(24.3)	(101.0)	(177.3)
Weed free check (3HW at 20, 35 & 50 DAS).	3.0	3.7	6.3
	(8.1)	(12.8)	(41.4)
CD(P=0.05)	0.5	0.9	2.6
CV%	7.4%	7.9%	6.5%

(figures in the parenthesis are original values subjected to transformation √(x+1)

Growth, growth attributes and yield attributes of aerobic rice

During crop growing season, weed management practice had significant influence on Growth and yield attributes. Maintaining weed free condition has given significantly superior plant height (114cm), effective tillers (160/m^2), panicle length (24 cm) and filled grains per panicle (162 no. / panicle). However test weight of aerobic rice was not influenced by the treatments.

Grain and straw yield of aerobic rice

Significantly more grain yield (3456 kg/ha) and straw yield (4089 kg/ha) was obtained with hand weeding (at 20, 35& 50 DAS) and was on par with IWM practice (Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS fb HW at 30 &45 DAS) which recorded 3206 kg/ha grain yield of and 3953 kg/ha straw yield and in turn these were significantly superior over rest of the treatments and un weeded control recorded lowest grain yield (155 kg/ha) and straw yield (607 kg/ha). The reduction in yield to the tune of 85.5% was noted under un weeded control.

Table 3: Effective tillers, Plant height, Filled grains per panicle, Test weight & Grain yield of rice under aerobic condition as influenced by the treatments

Weed management	Effective Tillers (No.m^2)	Plant height at harvest (cm)	Panicle length (cm)	Filled grains per panicle (no.)	Test weight (gm)	Grain yield (kg/ha)	Straw yield (kg/ha)
T1 -Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb HW at 30 &45 DAS	157	115	22	146	20	3206	3953
T2-Bispyribac sodium (20 DAS @25 g a.i/ha)	86	82	18	93	20	994	1320
T3-2,4-D sodium salt (1.5kg a.i/ha) at 35 DAS.	86	75	17	88	18	650	1000
T4- Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) - Bispyribac sodium (20 DAS @25 g a.i/ha)	122	104	22	126	20	1407	2422
T5-Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS), f b 2,4-D sodium salt (1.5kg a.i/ha) at 35 DAS.	113	98	20	118	19	825	1124
T6-Un weeded control	85	77	15	75	18	155	607
T7-Weed free check (3HW at 20,35& 50 DAS).	160	114	24	162	20	3456	4089
CD(P=0.05)	24	17	2.7	24	NS	503	672
CV%	11.7	10..4	7.8	12		10.5	18

Table 4: Influence of weed management practices on productivity and economics of aerobic rice

	Weed management	Grain yield (kg/ha)	Straw yield (kg/ha)	REY of Straw	Total yield of rice (kg/ha)	Gross returns Rs.	COC Rs.	Net returns Rs.	BC ratio Rs.
T1	Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) fb HW at 30 &45 DAS	3206	3953	296	3502	70050	32450	37600	2.2
T2	Bispyribac sodium (20 DAS @25 g a.i/ha)	994	1320	99	1093	21860	27500	-5640	-
T3	2,4-D sodium salt (1.5kg a.i/ha) at 35 DAS.	650	1000	75	725	14500	25650	-11150	-
T4	Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS) - Bispyribac sodium (20 DAS @25 g a.i/ha)	1407	2422	182	1589	31773	30500	1273	1.0
T5	Pretilachlor + safener(0.4 kg a.i/ha at 3 DAS), f b 2,4-D sodium salt (1.5kg a.i/ha) at 35 DAS.	825	1124	84	909	18186	26500	-8314	-
T6	Un weeded control	155	607	46	201	4011		4011	-
T7	Weed free check (3HW at 20,35& 50 DAS).	3456	4089	307	3763	75254	40150	35104	1.9
	CD(P=0.05)	503	672						
	CV%	10.5	18						

Economics

Significantly more net returns (Rs. 37600/-) and BC (2.2) ratio was obtained with IWM practice (Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS) fb HW at 30 &45 DAS). In Hand weeding (3HW at 20, 35& 50 DAS) practice, reduced BC (1.9) ratio was obtained due to increased cost of cultivation (Rs. 40150/-) due to hand weeding.

Conclusions

Results of the experiment depicted that highest grain yield (3456kg/ha) could be obtained with hand weeding thrice at 20, 35& 50 DAS, however most economical weed management practice was integrated weed management with pre emergence herbicide Pretilachlor + safener (0.4 kg a.i/ha at 3 DAS) fb hand weeding at 30 & 45 DAS which recorded higher net returns and BC ratio of 2.2. Chemical or integrated weed management practice with post emergence herbicides Bispyribac sodium (25 g a.i/ha at 20DAS), or 2,4-D sodium salt(1.5kg a.i/ha at 40 DAS) were not economical which recorded negative BC ratio. And a reduction in yield to the tune of 85.5% was noted under un weeded control

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