Plant Archives Volume 20 No. 2, 2020 pp. 4462-4466 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF WEED MANAGEMENT TECHNIQUES ON DRIP IRRIGATED AEROBIC RICE

T. Ramesh* and S. Rathika

Tamil Nadu Rice Research Institute, Tamil Nadu Agricultural University, Aduthurai–612 001 (Tamil Nadu), India.

Abstract

Direct-seeded aerobic rice under drip irrigation is subject to more severe weed infestation than transplanted lowland rice, because in aerobic rice systems weeds germinate simultaneously with rice. A field experiment was conducted at Tamil Nadu Rice Research Institute (TRRI), Tamil Nadu Agricultural University, Aduthurai to study the effect of weed management practices on weed control efficiency, yield and economics of drip irrigated aerobic rice. Treatments consisted of pre emergence (PE) soil application of pendimethalin 1.0 kg/ha, herbigation of pendimethalin 1.0 kg/ha, post emergence (POE) spray of bispyribac sodium 25 g/ha 20 DAS, herbigation of pre emergence pendimethalin 1.0 kg/ha + post emergence spray of bispyribac sodium 25g/ha 20 DAS, black plastic mulch, weeding twice on 20 and 40 DAS and control. Results revealed that use of plastic mulch showed significantly lesser weed density, dry matter (28.4 g/m^2) and higher weed control efficiency of 83.9% and than other treatments. It was on par with hand weeding twice at 20 and 40 DAS and PE herbigation of pendimethalin 1.0 kg/ha + POE spray of bispyribac sodium 25g/ha on 20 DAS which registered higher WCE of 80.3% and 79.1% respectively on 60 DAS. Herbigation of PE pendimethalin at 1.0 kg/ha followed by POE bispyribac sodium 25 g/ha 20 DAS recorded significantly more number of panicles (446/ m^2), filled grains (130.4 /panicle), grain yield (4583 kg/ha), net returns (Rs. 32362 /ha) and BCR (2.02) than all other treatments. However, it was comparable with black plastic sheet mulching which produced 422 panicles /m^2, 123.3 filled grains per panicle and grain yield of 4333 kg/ha. But it was gave lesser net returns (Rs. 26724 /ha) and BCR (1.79) due to higher cost of mulching. Thus, from the field study, it could be concluded that herbigation of pre emergence pendimethalin at 1.0 kg/ha followed by spray of post emergence herbicide bispyribac sodium 25 g/ha 20 DAS found to control the weeds effectively and increased the yield and net returns of drip irrigated aerobic rice.

Key words: Aerobic rice, Drip irrigation, Herbigation, Plastic mulch, Weed management, Pendimethalin, Bispyribac sodium

Introduction

Rice (*Oryza sativa* L.) is grown annually an areas of about 163 million ha in 118 countries across the world, about 11% of the world's cultivated land. More than 90% of rice is grown (146 million ha) and produced (680.1 million tonnes) in Asia (FAO, 2017), which uses more than 45% of the total irrigated fresh water resources (Kush, 2005). India produces more than 111 million tonnes of milled rice (14.6% of global rice production) from 44 million ha in 2017-18 (FAO, 2017). In major rice growing areas, farmers are already facing a challenge to produce more rice with limited water in order to meet the food demand of the growing population. This is crucial for food security in many Asian countries including India where large and dense populations depend on subsistence agriculture (Thakur *et al*., 2014). Water shortage is becoming severe in many rice growing areas of the world, the introduction of aerobic rice which means growing of high yielding rice in nonpuddled and non-flooded aerobic soil with the support of external inputs like supplementary irrigation, manures and fertilizers can reduce water use in rice production by as much as 50% (Bouman, 2001). Recently, drip irrigation can be recommended for aerobic rice to increase the productivity besides saving water. Drip irrigated rice is a new innovative production system in which seeds are directly sown in well-drained and non-puddled soil using mechanized multi-crop seed drills and the crop is grown in unsaturated soil moisture conditions for the entire crop duration (Sharda *et al.*, 2017). It involves using high yielding varieties well-adapted to aerobic conditions and responsive to irrigation and fertigation, attaining high yields (Sharma *et. al.,* 2018).

Direct-seeded aerobic rice is subject to more severe weed infestation than transplanted lowland rice, because in aerobic rice systems weeds germinate simultaneously

***Author for correspondence :** E-mail : agronramesh@gmail.com

with rice, and there is no water layer to suppress weed growth. In aerobic rice, weeds cause yield loss to an extent of 56.4 to 90.70 percent (Paradkar *et al.,* 1997). Weeds grow faster than rice plants and absorb the available nutrients earlier and faster resulting in deprivation of nutrients for the rice. Weed management is an important agro-technique for successful cultivation of aerobic rice. Weed free condition during the critical period of competition is absolutely essential for obtaining maximum yield. This can be achieved by either application of pre emergence or post emergence or combination of both or manual weeding. Manual weeding although effective and most common practice of weed control in rice, increasing labour wages and scarcity of labour during peak period of agricultural operation lead to the search for alternative methods. Herbicides offer the most effective, economical and practical way of weed management. Herbigation is another technique, where herbicides are injected into irrigation water and applying through the irrigation system to crop, weed or field (Jagadish *et al.,* 2016). When drip irrigation couples with plastic mulch, weeds can be effectively controlled within rows, leaving only between plants areas to be managed. However, it requires detailed investigation. In drip irrigated aerobic rice, there is possibility to adopt herbigation through drip irrigation system along with other weed control methods, whose efficiency needs to be worked out. Hence, the present investigation was undertaken to study the effect of weed management practices on weed control efficiency, yield and economics of aerobic rice under drip irrigation.

Materials and Methods

A field experiment was conducted at Tamil Nadu Rice Research Institute (TRRI), Tamil Nadu Agricultural University, Aduthurai to study the effect of weed management practices on weed control efficiency, yield and economics of drip irrigated aerobic rice. The experimental site TRRI, Aduthurai is present in the middle of the Cauvery Delta Zone, Tamil Nadu, India, geographically located at 11° N latitude 79.3° E longitude with an altitude of 19.4 m above MSL. The soil of the experimental field was alluvial clay with pH of 7.5 and EC of 0.3 dS/m and low, high and medium in available nitrogen, phosphorus and potassium contents respectively. The experiment was conducted in Randomized Block design with replicated thrice. Treatments consisted of pre emergence soil application of pendimethalin 1.0 kg/ha, herbigation of pendimethalin 1.0 kg/ha, post emergence spray of bispyribac sodium 25 g/ha 20 DAS, herbigation of pre emergence pendimethalin 1.0 kg/ha + post emergence spray of bispyribac sodium 25g/ha 20 DAS, black plastic mulch, hand weeding twice on 20 and 40 DAS and control. Short duration hybrid CORH 3 was used. Manual sowing of seeds was done in the finely prepared dry soil. Drip system was installed with the lateral spacing of 80 cm and emitter/dripper spacing of 30 cm. Discharge rate of drippers was 1.0 litre per hour. Irrigation was given at 150% Pan Evaporation during throughout the cropping period in every alternate day. Recommended dose of fertilizer (150: 50:50 kg NPK/ha) was adopted. The entire P as SSP was applied as basal during land preparation. The N as urea and K were given in 15 splits starting from 14 DAS to heading stage at 5 days interval along with irrigation water. Herbigation was preceded by trickle irrigation for 30 minutes and the irrigation was done for 30 minutes after herbigation as well to apply the chemicals completely. 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 on 20 DAS. Black plastic sheet with 200 gauge thickness was spread after germination of seeds (7 DAS) in between rows of plants. Observations on weeds density, yield attributing characters and grain yield were recorded. Weed count was recorded by using 0.25 m^2 quadrate at four places in each plot and expressed as number m^{-2}. Weed dry weight in each treatment was worked out taking the weeds from net plot area, sundried followed by drying at 60°C till it attained constant weight. Square root transformation (x+0.5) was used to analyze the data on weeds. Weed control efficiency was worked out on 60 DAS and expressed as the percentage reduction in weed density due to weed management practices over control. The cost of cultivation was computed by considering the prevailed prices of input market price for rice and straw. The cost of cultivation was deducted from gross returns to arrive at net returns. Benefit cost ratio was worked out by taking the ratio of grass returns to total cost of cultivation. Data on various characters studied during the course of investigation was statistically analysed with the confidence level set at 5% was used to compare the differences among treatment means (Gomez and Gomez, 1984).

Results and Discussion

Weed species like *Eclipta alba* (18.3%), *Euphorbia prostrata* (12.1%), *Trianthema portulacastrum* (6.3%), *Corchorus olitorius* (4.5%), *Amaranthus viridis* (3.5%), *Cliome viscose* (3.2%), and *Acalifa indica* (1.8%) in broad leaved weeds, *Echinochloa colona* (24.3%), *Leptochloa chinensis* (12.7%) *Cynodon doctylon* (3.3%) and *Panicum repens* (2.8%) in grasses and *Cyperus rotuntus*(4.8%) *Cyperus difformis (2.4%)* in sedges were the predominant weed species found in the

experimental field.

Effect on weeds

Weed density on 60 DAS was significantly influenced weed management treatments table 1. Use of plastic mulch registered significantly lesser number of grasses (20/m^2) and broad leaved weeds (BLW) (12/m^2) than hand weeding twice, PE herbigation of pendimethalin 1.0 kg/ha and control treatments. However, it was on par with POE spray of bispyribac sodium 25g/ha on 20 DAS (T_5) and PE herbigation of pendimethalin 1.0 kg/ha + POE spray of bispyribac sodium 25g/ha on 20 DAS (T_6). Plastic mulch reduced the weed emergence and also arresting the growth of weeds by preventing sunlight needed for photosynthesis. Earlier report by Egley (1983) who found that plastic mulch reduced the weed emergence by 64 to 98% during growing season. The reduction of weed density and dry weight under PE herbigation of pendimethalin 1.0 kg/ha + POE spray of bispyribac sodium 25g/ha on 20 DAS may be attributed to broad spectrum and season long weed control properties exhibited by sequential application of pendimethalin 1 kg/ ha at 3-4 DAS as herbigation followed by bispyribac sodium 25 g/ha. Inhibition of germination by pendimethalin during initial stage and later the emerged weeds were killed by bispyribac sodium which inhibits the enzyme acetohydroxy acid synthase, also known as acetolactate synthase (ALS), in susceptible plants. This ultimately reduces transport of photosynthate from source leaves to roots, resulting in root growth inhibition. Sequential application of pendimethalin at 1 kg a.i./ha at 3-4 DAS fb bispyribac sodium 35 g a.i./ ha at 2-4 leaf stage of weeds found superior in controlling weeds of aerobic rice (Sreedevi *et al.,* 2016). Hand weeding twice at 20 and 40 DAS and soil application of pendimethalin 1.0 kg/ha were comparable with each other in terms of grasses and broad leaved weeds. Herbigation of pendimethalin 1.0 kg/ha recorded more number of broad leaved weeds (49 /m^2) than all other treatments except control. More number of grasses (223/m^2) and BLW (185 /m^2) were noticed with control plot. No sedge was found in PE herbigation of pendimethalin 1.0 kg/ha + POE spray of bispyribac sodium 25g/ha on 20 DAS (T_6). Plastic mulch registered lesser sedges density whereas herbigation of pendimethalin 1.0 kg/ha(T_3) and control plots higher density of sedges. Significantly lesser total weed density was obtained with plastic mulch (34 /m^2) than soil application or herbigation of pendimethalin 1.0 kg/ha and control. It was comparable with PE herbigation of pendimethalin 1.0 kg/ha + POE spray of bispyribac sodium 25g/ha on 20 DAS (44 /m^2) (T_6) and POE spray of bispyribac sodium 25g/ha on 20 DAS (46 /m^2) (T_5). Control plot recorded significantly higher total weed density of 436 /m^2.

Use of plastic mulch (T_4) showed significantly lesser weed dry matter (28.4 g/m^2) than other treatments. It was on par with hand weeding twice at 20 and 40 DAS (34.6 g/m^2) (T_1) and PE herbigation of pendimethalin 1.0 kg/ha + POE spray of bispyribac sodium 25g/ha on 20 DAS (36.8 g/m^2) (T_6). Higher weed dry weight was noticed with herbigation of pendimethalin 1.0 kg/ha (T_3) and control plot. Higher weed control efficiency of 83.9% was obtained with plastic mulch, followed by hand weeding twice at 20 and 40 DAS (80.3%). Significant reduction in weed density and dry weight under plastic mulch was the reason for higher WCE. Similar effect of black plastic mulch on weed control in onion was reported at Nigeria (Chhangani 2000). Combination of PE herbigation of pendimethalin 1.0 kg/ha + POE spray of bispyribac sodium 25g/ha on 20 DAS (T_6) registered weed control efficiency of 79.1%. The reduced grasses, sedges, broad leaved weeds and their total dry weight in this treatment was the reason for higher WCE. Soil application of pendimethalin 1.0 kg/ha (T_2) recorded weed control efficiency of 75.3% whereas herbigation of same herbicide showed lesser WCE of 66.7%. Limited weed control was noticed under hebigation of pendimethalin mainly due to its poor movement in the soil. The lower weed control efficiency was noticed under control plot due to poor control of weeds as a result of higher weed population and dry weight.

Effect on crop

Yield attributes and yield of aerobic rice under drip irrigation varied significantly due to weed management practices table 2. Herbigation of pre emergence pendimethalin at 1.0 kg/ha followed by POE spray of bispyribac sodium 25 g/ha 20 DAS recorded significantly more number of panicles (446/ m^2), filled grains (130.4 / panicle) and grain yield (4583 kg/ha) than all other treatments except plastic mulch. However, it was comparable with black plastic sheet mulching treatment which produced 422 panicles /m^2, 123.3 filled grains per panicle and grain yield of 4333 kg/ha. The combination of two herbicides controlled the weeds both first flush as well as later emerged weeds. Application of bispyribac sodium 25g ha^{-1} interfered with production of a plant enzyme necessary for growth and development named acetolactate synthase (ALS) led to effectively controlled the emerged weeds during critical stages and maintain the crop free from crop weed competition resulted in lesser competition by weeds for nutrients, space and light ultimately increased plant growth and yield parameters and finally rain yield. These findings are in corroboration

with the findings of Abhishek *et al.,* (2017) who reported that pre emergent herbigation of pretilachlor + bensulfuron methyl 6.6% GR @ 10 kg ha^{-1} + post emergent herbigation of bispyribac sodium 10% SC at 200 ml ha^{-1} + one hand weeding have resulted higher grain and straw yield of drip irrigated aerobic rice. Manisankar *et al.,* (2019) who also reported that POE bispyribac sodium at 25 g ha^{-1} at 15 DAT followed by one hand weeding at 45 DAS recorded significantly higher grain yield in transplanted rice. In plastic mulch, better weed control during growing season favoured less competition by weeds and increased the yield of paddy. Similar effect of black polythene mulch on onion bulb yield due to best weed control was reported by Waiganjo *et al*., (2009). Post emergence spray of bispyribac sodium 25g/ha on 20 DAS produced 410 panicles per m^2, 199.7 filled grains per panicle and grain yield of 4208 kg/ha, which was comparable with hand weeding twice at 20 and 40 DAS (4070 kg/ha). Application of pendimethalin at 1.0 kg/ha as herbigation showed significantly lesser yield attributes and grain yield (3658 kg/ha) than soil application of same herbicide (3962 kg/ha) as well as POE of bispyribac sodium 25g/ha on 20 DAS (4208 kg/ha) indicates poor effect of herbigation on weed control resulted in more weed competition which led to lesser yield attributes. Distribution of pendimethalin to entire field was not found under herbigation and confined to first row alone in the drip irrigation. But, when herbigation of pendimethalin at 1.0 kg/ha combined with post emergence spray of bispyribac sodium 25g/ha on 20 DAS registered significantly higher yield attributes mainly because of better weed control by POE of bispyribac sodium 25g/ha on 20 DAS. Minimum number of panicles per unit area and filled grains per panicle and grain yield (1654 kg/ha) were recorded with control plot. This was due to severe weed competition with crop plants for water, nutrients, light, space / atmosphere (CO_2) that reduced the plant growth and resulted in lower yield components and grain yield.

Economics

The net returns and benefit cost ratio were positively influenced by weed management practices table 2. Higher net returns (Rs. 32362 /ha) and BCR (2.02) were obtained with pre emergence pendimethalin at 1.0 kg/ha as herbigation followed by POE bispyribac sodium 25 g/ha 20 DAS. This was followed by POE spray of bispyribac sodium 25 g/ha 20 DAS which registered net returns of Rs. 28762 /ha and BCR of 1.95. Higher net returns under this treatment was due to higher grain and straw yield as a result of better control of weeds throughout crop growth

Table 1: Effect of weed management practices on weed density, dry weight and WCE at 60 DAS in drip irrigated aerobic rice.

Treatments	Grasses (Nos. /m^2)	Sedges (Nos. /m^2)	BLW (Nos. /m^2)	Total density (Nos. /m^2)	Weed dry weight (g/m^2)	WCE %
T_1: Hand weeding 20 and 40 DAS	30 (5.52)	8 (2.92)	24 (4.95)	62 (7.91)	34.6	80.3
T_2: PE spray pendimethalin 1.0 kg/ha	32(5.70)	4 (2.12)	20(4.53)	56(7.52)	43.4	75.3
T_3: PE herbigation pendimethalin 1.0 kg/ha	38(6.20)	10 (3.24)	49(7.04)	97(9.87)	58.6	66.7
T_4: Plastic mulch	20(4.53)	2(1.58)	12(3.54)	34(5.87)	28.4	83.9
T_5: POE bispyribac sodium 25g/ha on 20 DAS T_6: PE pendimethalin at 1.0 kg/ha herbigation	24(4.95)	6(2.55)	16(4.06)	46(6.82)	38.6	78.1
+ POE bispyribac sodium 25 g/ha 20 DAS	26(5.15)	0(0.71)	18(4.30)	44(6.67)	36.8	79.1
T_7: Control	223(14.85)	28(5.34)	185(13.62)	436(20.89)	176	-
CD(P=0.05)	0.95	0.45	1.00	1.40	9.14	

*Figures in parenthesis are SQRT (x+0.5) transformed values; BLW-Broad leaved weeds; WCE-Weed control efficiency.

Table 2: Effect of weed management practices on yield parameters, grain yield and economics of drip irrigated aerobic rice.

Treatments	Panicles /m^2	Filled grains /paicle	Grain yield (Kg/ha)	Net profit (Rs./ha)	BCR
T_1: Hand weeding 20 and 40 DAS	396	115.8	4070	19230	1.51
T_2: PE spray pendimethalin 1.0 kg/ha	385	112.7	3962	23040	1.71
T_3: PE herbigation pendimethalin 1.0 kg/ha	356	104.1	3658	16712	1.48
T_4: Plastic mulch	422	123.3	4333	26724	1.79
T_5: POE bispyribac sodium 25g/ha on 20 DAS T_6: PE pendimethalin at 1.0 kg/ha herbigation	410	119.7	4208	28762	1.95
+ POE bispyribac sodium 25 g/ha 20 DAS	446	130.4	4583	32362	2.02
T_7: Control	161	87.0	1654	-4844	0.83
CD(P=0.05)	28	9.1	302	-	-

period. Similar findings were reported by Munnoli *et al*., (2018) who found the net return was higher in PE application of pendimethalin (1.0 kg/ha) on 3 DAS+ EPOE application of bispyribac sodium (25 g /ha) on 20 DAS in aerobic rice. Even though, plastic mulch treatment recorded higher weed control efficiency and grain yield than POE spray of bispyribac sodium 25 g/ha 20 DAS, produced lesser net returns (Rs. 26724 /ha) and BCR (1.79). This is mainly because of higher cost of plastic sheet when compared to herbicide application cost. Soil application of pendimethalin at 1.0 kg/ha found to give more net returns (Rs. 23040 /ha) and BCR (1.71) than herbigation of same herbicide because of poor weed control and lesser grain yield under this treatment. Hand weeding twice at 20 and 40 DAS gave lesser net returns (Rs. 19230 /ha) and BCR (1.51) than soil application of PE pendimethalin at 1.0 kg/ha or POE spray of bispyribac sodium 25 g/ha 20 DAS mainly due to higher cost of weeding increased the cost cultivation. Negative net returns (Rs. -4844 /ha) were obtained with weedy check due to lower grain and straw yield upon severe weed competition.

Thus, from the field study, it could be concluded that herbigation of pre emergence pendimethalin at 1.0 kg/ha followed by spray of post emergence herbicide bispyribac sodium 25 g/ha 20 DAS found to control the weeds effectively and increased the yield and profit of drip irrigated aerobic rice.

References

Abhishek, G.M., M.N. Thimmegowda, B.K. Ramachandrappa, Nagaraju and Murukannappa (2017). Efficiency of herbigation based weed management practices in aerobic rice. *International Journal of science and nature*, **8(3):** 447-452.

Bouman, B.A.M. (2001). Water-efficient management strategies in rice production. *Int. Rice Res. Notes,* **16:** 17–22.

Chhangani, S. (2000). Effects of mulches (synthetic and non-synthetic) on water conservation and bulb yield of irrigated onion cultivated in semiarid zone of Bomo State, Nigeria. *Journal of Eco-Physiology*, **3(1-2):** 5-9.

Egley, G.H. (1983). Weed seed and seedling reductions by soil solarization with transparent polythene sheets. *Weeds Sci*., **31:** 404-409.

FAO (Food and Agriculture Organization of United Nations). (2017). *FAO Rice market monitor,* **20(3):** October 2017, 33p.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. 2nd Edn., John Wiley and Sons, UK.

Jagadish, M.N. Thimmegowda, Rohini, N. Meti and G. Prakash (2016). Water use efficiency and economics of weed management practices under drip irrigated aerobic rice. *Advances in Life Sciences*, **5(8):** 3410-3415.

Khush, G.S. (2005). What it will take to feed 5.0 billion rice consumers in 2030. *Plant Mol. Biol*., **59:** 1–6.

Manisankar, G., T. Ramesh, S. Rathika, P. Janaki and P. Balasubramanian (2019). Evaluation of sequential herbicide application on transplanted paddy under sodic soil. *The Pharma Innovation Journal*, **8(5):** 633-638.

Munnoli, S., D. Rajakumar, C. Chinnusamy and N. Thavaprakaash (2018). Integrated Weed Management in Aerobic Rice. *Madras Agricultural Journal*, **105:** 161. 10.29321/MAJ.2018.000122.

Paradkar, N.R., S.P. Kurchania and J.P. Tiwari (1997). Chemical control of *Parthenium hysterophorus* L. and other associated weeds in upland drilled rice. *Indian J. Weed Sci.,* **29(3&4):** 151-154.

Sharda, R., G. Mahajan, M. Siag, A. Singh and B.S. Chauhan (2017). Performance of drip-irrigated dry-seeded rice (*Oryza sativa* L.) in South Asia. *Paddy and Water Environment,* **15:** 93–100.

Sharma, N., R. Bansal, S.N. Singh and B. Singh (2018). A pragmatical approach on the rice fields demonstrating increase in yield and water saving by using micro irrigation technology. *International Journal of Applied Engineering Research,* **13:** 5197–5200.

Sreedevi, B.A., D. Sandhyarani, B. Srinivas, A. Venkatanna, Vinaykartheek and R. Mahender Kumar (2016). Chemical Weed Control in Aerobic Rice. *Journal of Rice Research,* **9(2):** 28-31.

Thakur, A.K., R.K. Mohanty, D.U. Patil and A. Kumar (2014). Impact of water management on yield and water productivity with system of rice intensification (SRI) and conventional transplanting system in rice. *Paddy and Water Environment,* **12:** 413–424.

Waiganjo, M.M., J. Kiritu and B. Kuria (2009). Effects of weeds on growth of bulb onion and some cost-effective control options at THIKA, Kenya. *Afr. J. Hort. Sci*., **2:** 92-102.