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RESEARCH ARTICLE :

Bispyribac sodium – Early post-emergence herbicide for weed control in aerobic rice (*Oryza sativa* L.)

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SUMMARY : An experiment was conducted to evaluate the effect of bispyribac sodium for weed control in aerobic rice (*Oryza sativa* L.), consisting of 11 treatments comprising two components, dose (20 g a.i/ha, 25 g a.i/ha and 30 g a.i/ha) and time of application of herbicide (10 DAS, 15 DAS and 20 DAS). Along with this, hand hoeing at 20 and 40 DAS and unweeded control plots were also maintained for comparison.Among various doses, bispyribac sodium 25g/ha and among different time of application, bispyribac sodium at 10 DAS was found to be effective against weeds by registering the lowest weed density, dry weight, nutrient removal and recorded highest weed control efficiency throughout the crop growing season. As the weeds were checked effectively application of bispyribac sodium 25 g/ha at 10 DAS recorded higher growth and yield attributes, substantially increased the yield of aerobic rice by 0.9 times than unweeded control. Due to higher yield and lower cost of weed control application of bispyribac sodium 25 g/ha at 10 DAS registered highest net returns and B:C ratio (2.63) and hence, will be a suitable weed management option in aerobic rice for higher profit.

KEY WORDS :
Aerobic rice, Bispyribac sodium, Weed control, Dose, Time of application

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BACKGROUND AND OBJECTIVES

Aerobic rice system has been evolved as the most promising water saving technology in rice culture wherein the crop is established via direct seeding in non-puddled and non-flooded fields (Mahajan *et al*., 2009 and Anwar *et al*., 2010). Its adoption has been impeded by serious weed problems, since both weed and crop seeds emerge at the same time and compete with each other resulting in less grain yield.Uncontrolled weeds reduce the yield by 96 per cent in dry direct-seeded rice (Johnson and Mortimer, 2006).Over the years, chemical weed control has emerged as promising solution of weed problem. Application of pre-emergence herbicides mainly control weeds during the earlier stages of crop growth.The second flush of weeds at 25 to 30 days after sowing becomes a problem. A weed-free period for the first 30-45 days after sowing (DAS) is required to avoid any loss in yield because the dry weight of weeds increases greatly from 30 DAS in dry direct-seeded rice (Maity and Mukherjee, 2008).

Heavy infestation of weeds at later stages of rice growth are not controlled effectively by the pre-emergence herbicides. This situation warrants for initiating research efforts to identify and evaluate suitable early post-emergence herbicides for successful cultivation of aerobic rice.

Among the early post emergence herbicides bispyribac sodium is found to be effective in controlling many annual and perennial grasses, sedges and broad-leaved weeds in rice fields (Schmidt *et al*., 1999 and Yun *et al*., 2005).

Keeping these in views the present study was undertaken to evaluate the effect and to standardize the dose and time of application of bispyribac sodium for weed control in aerobic rice system of cultivation.

RESOURCES AND METHODS

A field experiment was conducted during *Rabi* 2013 in the farm lands of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry. The experimental site is situated 10° 25' North latitude and 79° 49' East longitude at an altitude of 4 meters above the mean sea level. The college farm is located 12 km away from the sea coast of Bay of Bengal.

A total rainfall of 597 mm was received during the cropping period against the normal rainfall of 1022 mm, which was less and unevenly distributed. The soil texture was loamy sand with alkaline pH (8.2). The soil was low in available nitrogen (60.6 kg/ha) and phosphorus (10.5 kg/ha) and medium in available potassium (184.4 kg/ha). A medium duration (135 days) rice cv.'ADT(R) 46'was sown on 5 September, 2013 and the recommended package of practices for aerobic rice was followed.

The experiment involved 11 treatments, replicated thrice was laid out in Randomized Block Design (RBD).

The details of the treatments (T) imposed in the experiment are given below :

T_1 : Bispyribac sodium 20 g/ha at 10 DAS
T_2 : Bispyribac sodium 25 g/ha at 10 DAS
T_3 : Bispyribac sodium 30 g/ha at 10 DAS
T_4 : Bispyribac sodium 20 g/ha at 15 DAS
T_5 : Bispyribac sodium 25 g/ha at 15 DAS
T_6 : Bispyribac sodium 30 g/ha at 15 DAS
T_7 : Bispyribac sodium 20 g/ha at 20 DAS
T_8 : Bispyribac sodium 25 g/ha at 20 DAS
T_9 : Bispyribac sodium 30 g/ha at 20 DAS
T_{10} : Hand hoeing at 20 and 40 DAS
T_{11}: Unweeded control

Bispyribac sodium, a pyrimidinylcarboxy herbicide, is systemic in action that works by interfering with the synthesis of acetolactate synthase (ALS), an enzyme necessary for plant growth. The herbicide were sprayed as per-treatment using a spray volume of 625 l/ha with the help of a knapsack sprayer, fitted with a flat fan nozzle. Hand hoeing was taken twice at 20 and 40 DAS in the treatment T_{10}.

The data on weed density, weed biomass, weed control efficiency and yield of rice were recorded. Observations on weeds were recorded with the help of a 0.25 m^2 quadrate placed randomly in the sampling area of each plot. Weeds falling within the frames of quadrat were counted, recorded and mean values are expressed in number/m^2. After observing weed density, the weeds were removed, oven dried at 70°C for 72 hours and the dry weight was recorded and expressed in g/m^2. The data on weed density and dry weight were recorded at 30, 60 and 90 days after seeding (DAS). The growth and yield attributes of rice were recorded by following the standard procedures. The crop from the net plot area was harvestedon 20 January, 2014, threshed and sundried. The grain and straw yields were recorded and expressed in kg/ha.

The data were analyzed statistically by adopting the technique of analysis of variance and the significance was tested by F test (Gomez and Gomez, 1984). The data on weed count and dry weight showed considerable variation and hence, were subjected to square root transformation before statistical scrutiny using the formula $\sqrt{x+0.5}$. Wherever the treatments were significant, critical differences (C.D.) were calculated and inferences were drawn at 5 per cent level of significance.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Weed flora of the experimental field :

Diverse weed flora was observed in aerobic rice. Totally, 29 species of weeds from 22 genera belonging to 17 families were noticed in the experimental field during the ontogeny of aerobic rice, of which four were grasses, six were sedges and nineteen were broad leaved.

Out of these 29 species, four were perennials and the rest were annuals (Table 1).

Weed density:

Application of various doses of bispyribac sodium did not significantly influence the weed density. Irrespective of the dose, application of bispyribac sodium at 10 DAS significantly decreased the population of weeds as compared to application at 15 or 20 DAS at all the stages (Table 2). This implies that bispyribac sodium is effective against complex weed flora.Chauhan and Abugho (2012) also reported that application of bispyribac sodium at four-leaf stage provided greater than 97 per cent control but the efficacy of herbicide was reduced when applied at the eight-leaf stage of the weeds.

Weed dry weight :

Application of bispyribac sodium at 25 g/ha recorded the lower weed dry weight (26.9 to 115.8 g/m^2) at all stages when compared to 20 or 30 g/ha (36.1 to 183.2 g/m^2). Similarly, application of bispyribac sodium at 10 DAS resulted inthe lower weed dry weight (6.0 to 85.4 g/m^2)

Table 1 : Weed flora observed in aerobic rice

Sr. No.	Botanical Name	Common Name	Tamil Name	Family	Life forms
Grasses					
1.	*Echinochloacolona* L.	Jungle grass	*Kudiraivali*	Poaceae	Annual
2.	*Echinochloacruss-galli* B.	Barnyard grass	*Koravampul*	Poaceae	Annual
3.	*Leptochloachinensis* (L.) Nees.	Chinese sprangle top	*Vakkapul*	Poaceae	Annual
4.	*Panicumrepens* L.	Ginger grass	*Ingipul*	Poaceae	Perennial
Sedges					
1.	*Cyperusdifformis* L.	Variable flat sedge	*Vottakorai*	Cyperaceae	Annual
2.	*Cyperushaspan* L.	Haspan flat sedge	-	Cyperaceae	Perennial
3.	*Cyperusiria* L.	Rice field flat sedge	*Pookorai*	Cyperaceae	Annual
4.	*Cyperusrotundus* L.	Purple nut sedge	*Koraikilangu*	Cyperaceae	Perennial
5.	*Fimbristylismiliacea* L.	Grass-like fimbry	-	Cyperaceae	Annual
6.	*Scirpusarticulatus*	-	-	Cyperaceae	Annual
Broad leaved weeds					
1.	*Aeschynomeneindica* L.	Indian jointvetch	*Netti*	Fabaceae	Annual
2.	*Aponogetonmonostachyon* L.	-	*Kottikizhangu*	Aponogetonaceae	Annual
3.	*Bergiacapensis* L.	Cape ash	*Nandukalkeerai*	Elatinaceae	Annual
4.	*Cleome viscosa* L.	Tick weed	*Naikkaduku*	Capparidaceae	Annual
5.	*Corchorustridens* L.	Jew's mallow	*Perumpunnakkupoondu*	Tiliaceae	Annual
6.	*Eclipta alba* (L.) Hassk.	False daisy	*Karisilanganni*	Asteraceae	Annual
7.	*Glinusoppositifolius* L.	Bitter cumin	*Pampantra, Thurapoondu*	Molluginaceae	Annual
8.	*Hydroleazeylanica* (L.) Vahl.	Ceylon hydrolea	*Vellel*	Hydrophyllaceae	Perennial
9.	*Linderniacrustacea*	Malaysian false pimpernel	*Pitt papadi*	Scrophulariaceae	Annual
10.	*Linderniaoppositifolia*	-	-	Scrophulariaceae	Annual
11.	*Linderniaprocumbens* (Krock.)	Prostrate false pimpernel	-	Scrophulariaceae	Annual
12.	*Ludwigiaabyssinica*	-	-	Onagraceae	Annual
13.	*Ludwigiaparviflora* L.	Water prime rose	*Neerkerambu*	Onagraceae	Annual
14.	*Marsileaquadrifolia* L.	European water clover	*Allakodi*	Marsileceae	Perennial
15.	*Melochiacorcorifolia* L.	Chocolate weed	*Punnakkukirai*	Sterculiaceae	Annual
16.	*Oldenlandiacorymbosa* L.	Diamond flower	*Kattucayaver*	Rubiaceae	Annual
17.	*Phyllanthusniruri* L.	Stonebreaker	*Keezhanelli*	Euphorbiaceae	Annual
18.	*Sphaeranthusindicus* L.	East Indian globe thistle	*Kottakaranthai*	Asteraceae	Annual
19.	*Trianthemaportulacastrum* L.	Horse purslane	*Saranai*	Aizoaceae	Annual

when compared to application at 15 or20 DAS (20.5 to 194.5 g/m^2) at all stages. Irrespective of the dose application of bispyribac sodium at early stage (30 DAS) registered the lowest dry weight of weeds owing to effective suppression of all groups of weeds. With delay in time of application, the dry weight of weeds increased (Sipaseuth *et al.*, 2000). Hand Hoeing at 20 and 40 DAS (T_{10}) recorded lowest weed dry weight next to bispyribac sodium applied plots. In contrary, unweeded control registered the highest dry weight of weeds throughout the crop growth period, since the weeds fully enjoyed the available resources like water, nutrients and sunlight.

Weed control efficiency :

The weed control efficiency at 30 DAS ranged from 37.5 per cent in application of bispyribac sodium 20 g/ha at 20 DAS (T_7) to 96.3 per cent in bispyribac sodium 25 g/ha at 10 DAS (T_2) indicating the superiority of early application of bispyribac sodium (Fig. 1) (Table 2). In general, the weed control efficiency increased upto 60 DAS and then declined. Application of bispyribac sodium 25 g/ha at 10 DAS (T_2) was the best method in controlling the weed growth. It was observed that irrespective of the dose delay in times of bispyribac sodium application, decreased the weed control efficiency significantly (Fig. 2). This indicates that the efficacy of bispyribac sodium decreased as the weeds grow older. Williams (1999) and Chauhan and Abugho (2012) also reported that the weed control efficiency decreased due to late application of bispyribac sodium.

Fig. 1 : Excellent control of weeds by Bispyribac sodium compared with unweeded control

Growth and yield of rice :

Growth parameters :

Application of bispyribac sodium 25 g/ha at 10 DAS (T_2) recorded the tallest plants (32.0 to 108.5 cm) throughout the crop growth period (Table 3). This may be attributed to the increased availability of nutrients and other resources to the crop which in turn was due to reduced competition from the weeds for the available resources. Several workers (Jana, 2012; Singh *et al.*, 2008; Bouman *et al.*, 2002 and Thiyagarajan and Selvaraju, 2001) reported that plant height was affected if weeds were allowed to compete with rice. Due to effective control of weeds, bispyribac sodium 25 g/ha at 10 DAS (T_2) recorded higher LAI (6.90), number of

Table 2 : Observations on weeds at active tillering stage (60 DAS) of aerobic rice using bispyribac sodium

Tr. No.	Treatments	Weed density (Nos.)	Weed dry weight (g/plant)	Weed control * efficiency (%)
T_1	Bispyribac sodium 20 g ha^{-1}at 10 DAS	13.9	10.7	79.7
T_2	Bispyribac sodium 25 g ha^{-1}at 10 DAS	12.5	8.0	89.2
T_3	Bispyribac sodium 30 g ha^{-1}at 10 DAS	12.9	8.6	87.2
T_4	Bispyribac sodium 20 g ha^{-1}at 15 DAS	21.5	14.0	65.8
T_5	Bispyribac sodium 25 g ha^{-1}at 15 DAS	19.8	11.4	77.7
T_6	Bispyribac sodium 30 g ha^{-1}at 15 DAS	20.4	12.8	71.6
T_7	Bispyribac sodium 20 g ha^{-1}at 20 DAS	23.7	14.8	60.2
T_8	Bispyribac sodium 25 g ha^{-1}at 20 DAS	23.0	12.3	73.6
T_9	Bispyribac sodium 30 g ha^{-1}at 20 DAS	23.0	14.0	66.1
T_{10}	Hand hoeing at 20 and 40 DAS	10.5	5.2	92.4
T_{11}	Unweeded control	35.9	24.0	-
	S.E.±	2.2	1.8	
	C.D. (P=0.05)	4.5	3.7	

***** Data statistically not analyzed

tillers/m^2 (486.7) led to higher dry matter production (6.70 g/plant) of rice. Similarly, Hand weeding at 20 and 40 DAS (T_{10}) recorded relatively higher LAI (6.16), number of tillers/m^2 (441.3) and dry matter production (6.04 g/plant). Daniel, 2012 and Singh *et al.* (2005) also reported that control of weeds by herbicides during the early stages of rice resulted in lesser competition to the crop for moisture, nutrients and sunlight that influenced the crop to grow better as evidenced in increased plant growth attributes. On contrary, the unweeded control registered the lowest LAI throughout the crop growth period due to shorter plants, lesser number of leaves, leaves length and width, lesser number of tillers/m^2 (157.3) and dry matter production (1.98 g/plant).

Fig. 2 : Control of weeds by bispyribac sodium 25g/ha at 10 DAS

Yield parameters :

Application of bispyribac sodium 25 g/ha at 10 DAS (T_2) significantly enhanced the number of productive tillers m^{-2}, number of spiklets/panicle and test weight when compared to application of bispyribac sodium 20 or 30 g/ha at 15 or 20 DAS (Table 3). Thimmegowda *et al.* (2010) and Baloch *et al.* (2005) also found that rice

Table 3 : Growth and yield as influenced by weed control treatments

Tr. No.	Treatments	Plant height (cm)	LAI	DMP	No. of productive tillers/m^2	No. of spikelets/ panicle	No. of grains/p anicle	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1	Bispyribac sodium 20 g ha^{-1} at 10 DAS	68.8	4.17	4.91	394.7	92.9	80.6	26.3	3022	6393
T_2	Bispyribac sodium 25 g ha^{-1} at 10 DAS	71.6	6.90	6.70	477.3	100.3	90.9	27.0	4678	8550
T_3	Bispyribac sodium 30 g ha^{-1}at 10 DAS	65.0	3.95	4.53	393.3	91.3	79.1	26.3	2985	6611
T_4	Bispyribac sodium 20 g ha^{-1} at 15 DAS	64.4	3.66	4.08	362.7	86.5	74.2	26.4	2582	6216
T_5	Bispyribac sodium 25 g ha^{-1}at 15 DAS	69.0	4.71	5.34	394.7	98.2	86.4	26.2	3563	7258
T_6	Bispyribac sodium 30 g ha^{-1}at 15 DAS	64.7	3.52	4.54	305.3	88.0	76.0	26.0	2633	6139
T_7	Bispyribac sodium 20 g ha^{-1}at 20 DAS	62.4	2.88	4.05	284.0	78.8	67.1	26.4	2363	6212
T_8	Bispyribac sodium 25 g ha^{-1}at 20 DAS	68.9	4.51	5.35	397.3	96.7	85.4	25.7	3448	7227
T_9	Bispyribac sodium 30 g ha^{-1} at 20 DAS	62.7	3.17	4.00	306.7	85.3	72.4	26.4	2441	5866
T_{10}	Hand hoeing at 20 and 40 DAS	70.3	6.16	6.04	434.7	100.7	90.6	26.5	4674	8801
T_{11}	Unweeded control	52.2	1.47	1.98	113.3	50.0	37.3	25.3	333	1903
	S.E.±	4.1	0.62	0.55	40.5	4.2	2.7	0.4	280	711
	C.D. (P=0.05)	8.3	1.27	1.12	82.6	8.5	5.6	0.9	572	1451

plots without weed competition recorded higher number of productive tillers over control because of the greater space capture by rice. The canopy closure occurred earlier due to better competitive ability and nutrient use efficiency, which resulted in higher yield attributes of aerobic rice (Mandal *et al.*, 2011 and Micheal *et al.*, 2013).

Yield of aerobic rice :

When the weeds were left unchecked, they competed with rice for all resources which resulted in lower growth and yield attributes. Since the yield attributes were lower, the grain (333 kg ha^{-1}) and straw yields (1903 kg ha^{-1}) were also lower (Table 3). This is evident from the regression analysis which indicated that for every g m^{-2} of dry matter produced by weeds, the grain yield decreased by 7.28 kg ha^{-1} and the straw yield decreased by 10.96 kg ha^{-1}. Among the various weed control treatments, bispyribac sodium 25 g/ha at 10 DAS (T_2) followed by H.H at 20 and 40 DAS (T_{11}) recorded higher grain and straw yields. Though H.H at 20 and 40 DAS (T_{15}) resulted stastically similar grain and straw yield it was not as profitable which is evident from partial budget analysis of 10.7 MRR whereas bispyribac sodium 25 g/ha at 10 DAS (T_2) 25.8 MRR was more economical.

From the foregoing discussion, it is clear that rice-weed competition is moresevere under aerobic rice cultivation when the weeds are not controlled at right time and agreater yield loss may occur. Bispyribac sodium 25 g/ha at 10 DAS is the suitable weed management option in aerobic rice for higher yield and profit.

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REFERENCES

Anwar, M.P. Juraimi, A.S. Man, A. Puteh, A. Selamat, A. and Begum, M. (2010). Weed suppressive ability of rice (*Oryza sativa* L.) germplasm under aerobic soil conditions. *Australian J. Crop Sci.*, **4** (9): 706-717.

Baloch, M.S. Hassan, G. and Morimoto, T. (2005). Weeding techniques in transplanted and wet-seeded rice. *Weed Biol. & Mgmt.*, **5**: 190-196.

Bouman, B.A.M. Wang, H. Yang, X. Zhao, J. and Wang, C. (2002). Aerobic rice (Han Dao): A new way of growing rice in water-short areas. In: *Proceedings of 12th International Soil Conservation Organization Conference*. Beijing, China. Tsinghua University Press. pp. 175-181.

Chauhan, B.S. and Abugho, S.B. (2012). Effect of growth stage on the efficacy of postemergence herbicides on four weed species of direct-seeded rice. *Scientific World J. ID 123071*, p. 7.

Daniel, P.S.J. Poonghzhalan, R. Mohan, R. and Suburayalu, E. (2012). Weed management for enhanced production of aerobic rice. *Indian J. Weed Sci.*, **44** (4): 270-273.

Gomez, K.A. and Gomez, A.A. (1984). *Statistical procedure for agricultural research*, IInd Edn, John Wiley and Sons, New York, U.S.A. p. 680.

Jana, K. (2012). Effect of nitrogen levels and weed management practices on grain yield of aerobic rice cultivation system. *Green Farm.*, **3** (6): 687-689.

Johnson, D.E. and Mortimer, A.M. (2005). Issues for weed management in direct seeded rice and the development of decision-support frameworks. In: Workshop on direct seeded rice in the rice-wheat system of the indo-gangetic plains. 1-2 February 2005. G. B. Pant University of Agriculture and Technology, Pantanagar, Uttarakhand. India, p.8.

Mahajan, G., Chauhan, B.S. and Johnson, D.E. (2009). Weed management in aerobic rice in Northwestern Indo-Gangetic Plains. *J. Crop Improvem.*, **23**: 366-382.

Maity, S.K. and Mukherjee, P.K. (2008). Integrated weed management in dry direct-seeded rainyseason rice (*Oryza sativa*). *Indian J. Agron.*, **53**(2): 116-120.

Mandal, D., Singh, D., Kumar, R., Kumari, A. and Kumar, V. (2011). Effects on productionpotential and economics of direct seeded rice sowing dates and weed managementtechniques. *Indian J. Weed Sci.*, **43** (3&4): 139-144.

Micheal, J.S.A.S., Juraimi, A.S., Selamat, A., Man, A., Anwar, M.P. and Uddin, M.K. (2013). Critical period of weed control in aerobic system. *Australian J. Crop Sci.*, **7** (5): 665-673.

Schmidt, L.A., Scherder, E.F., Wheeler, C.C., Rutledge, J.S., Talbert, R.E. and Baldwin, F.L. (1999). Performance of V-10029 (bispyribac-sodium) in rice weed control programmes. In: *Pro. Southern Weed Sci. Soc.*, **52** : 49-50.

Singh, S. Ladha, J.K. Gupta, R.K. Bhushan, L. and Rao, A.N. (2008). Weed management inaerobic rice systems under varying establishment methods. *Crop Protec.*, **27**: 660-671.

Singh, V.P., Singh, G., Singh, R.K., Singh, S.P., Kumar, A., Dhyani,

V.C., Kumar, M. and Sharma, G. (2005). Effect of herbicides alone and in combination on direct seeded rice. *Indian J. Weed Sci.*, **37** (3&4): 197-201.

Sipaseuth, I.P., Siyavong, P., Sihathep, V., Chanphengsay, M., Schiller, J.M., Linquist, B., Fukai, S. and Basnayake, J. (2000). Agronomic practices for improving yields of rainfed lowland rice in Laos. In: *Proceeding of International Workshop Increased Lowland Rice Production in the Mekong Region*, 30 October-2 Novermber, Vientiane (Laos). pp. 31-40.

Williams, B.J. (1999). Barnyard grass (*Echinochloa crus-galli*) control in dry seeded rice with V 10029. *Proc. Southern Weed Sci. Soc.*, **52**: 50.

Thimmegowda, P., Murthy, K.N.K., Fathima, P.S. and Vidya, A. (2010). Studies in chemicalweed control in aerobic rice (*Oryza sativa* L.). *Crop Res.*, **40** (1): 20-24.

Thiyagarajan, T. M. and Selvaraju, R. (2001). Water-saving in rice cultivation in India. In: *Proceedings of International Workshop on Water Saving Rice Production Systems*, Nanjing University. pp. 15-45.

Yun, M.S., Yogo, Y., Miura, R., Yamasue, Y. and Fischer, A.J. (2005). Cytochrome P-450monooxygenase activity in herbicide-resistant and susceptible late watergrass (*Echinochloa phyllopogon*). *Pesticide Biochem.Physiol.*, **83**: 107-114.