



Influence of Weed Management Practices on Growth and Yield of Aerobic Rice

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present field experiment was conducted to evaluate the effects of different chemical and non-chemical weed management practices on aerobic rice. The experiment was carried out at the Wetlands Farm of the Department of Farm Management, Tamil Nadu Agricultural University, India. Pre emergence (PE) application of pendimethalin (1.0 kg ha⁻¹), EPOE of bispyribac sodium (25 g ha⁻¹) and EPOE of chlorimuron ethyl + metsulfuron methyl (4 g ha⁻¹) were the chemical weed management practices. *Daincha* intercropping (1:1) *fb* spreading on 30DAS, Cowpea intercropping (1:1) *fb* spreading on 30DAS, Coir pith mulching (5 tons ha⁻¹) on 3 DAS, Shredded coconut waste mulching (5 tons ha⁻¹) on 3 DAS along with the combination of mechanical and hand weeding were the non chemical weed management practices. Pre emergence (PE) application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* Early post emergence (EPOE) application of bispyribac sodium (25 g ha⁻¹) on 20 DAS recorded significantly higher growth and yield attributes. Sequential application of pendimethalin and bispyribac sodium recorded 4128 kg ha⁻¹ grain yield which was nearly 60 per cent increased over the weedy check. Coir pith mulching @ 5 tons ha⁻¹ on 3 DAS recorded significantly lower grain yield (1840 kg ha⁻¹) over the rest of the treatments.

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1. INTRODUCTION

“The world produces a lot of rice, a staple food. It is essential for India to meet the country's dietary needs. With an annual yield of 132 MT of rice and an average productivity of 2.96 t ha⁻¹, it is grown all throughout the nation in a variety of ecologies throughout 44.6 M ha. Although rice is not just a wetland plant (hydrophyte), cultivating it in swampy circumstances (5–10 cm of water layer) is a long-standing custom. The main agronomic advantages associated with this practice are the suppression of weeds, ease of ploughing and storage of water from heavy rainfall particularly during monsoon season” [1].

“Aerobic rice concept capitalizes on the advantages of the characteristics of rice varieties adopted in upland with less water requirement and irrigated varieties with high response to inputs. The fact that this crop is heavily impacted by weed infestations is one of the main factors limiting the productivity of aerobic rice” [2]. In a wetland setting, rice has a two to three week “head start” on weeds that compete with it but have not yet emerged at transplanting. “After transplanting, the ongoing inundation of water successfully prevents the establishment and growth of the majority of weed flora. The aerobic rice system experiences the highest levels of weed pressure and competition, whilst the transplanted situation experiences the lowest levels. When compared to a conventional transplanted condition, an aerobic rice field had almost twice the weed density and biomass” [3]. “In aerobic rice, weeds are managed using a variety of techniques. In aerobic rice farming, herbicides have been used more frequently and extensively. In aerobic rice fields, herbicides can be administered either pre-emergence (before crop emergence) or post-emergence (after crop emergence), and both are effective if used correctly. In recent trends integrated weed management concept gives us wide and effective control of weeds” [4].

2. MATERIALS AND METHODS

During the 2017 Kharif season, the field experiment was carried out at the 'B1' field of the Wetland Farms of the Department of Farm Management, Tamil Nadu Agricultural University, Coimbatore. The farm is situated at an elevation of 426.7 m above mean sea level, at 11°N

latitude and 77°E longitude. “Coimbatore is located in Tamil Nadu's Western Agricultural Climate Zone. The soil in the test field had a pH of 7.1, was reactively neutral, had low accessible N (215.1 kg ha⁻¹), and had high levels of both P (13.5 kg ha⁻¹) and K (487.0 kg ha⁻¹). The research plot was laid out in RCBD with 12 treatments replicated thrice. Treatment details are T₁ - PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* HW on 40 DAS, T₂ - EPOE of bispyribac sodium (25 g ha⁻¹) on 20 DAS *fb* HW on 40 DAS, T₃ - EPOE of chlorimuron ethyl + metsulfuron methyl (4 g ha⁻¹), T₄ - PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* EPOE of bispyribac sodium (25 g ha⁻¹) on 20 DAS, T₅ - Daincha intercropping (1:1) *fb* spreading on 30DAS, T₆ - Cowpea intercropping (1:1) *fb* spreading on 30DAS, T₇ - Coir pith mulching (5 tons ha⁻¹) on 3 DAS, T₈ - Shredded coconut waste mulching (5 tons ha⁻¹) on 3 DAS, T₉ - Mechanical weeding on 20 and 40 DAS, T₁₀ - Hand weeding on 20 and 40 DAS, T₁₁ - Mechanical weeding on 20 DAS *fb* hand weeding on 40 DAS and T₁₂ - Weedy check. (HW - Hand weeding: MW - Mechanical weeding: DAS - Days after sowing: PE – Pre emergent: EPOE – Early post emergent)” [5].

The plant height of the tagged plants was measured from the ground level to the tip of the top most fully opened leaf or flag leaf at active tillering (AT) stage and panicle initiation (PI) up to the tip of the panicle at flowering and harvest stages and mean values were expressed in cm. Root volume per plant was measured after washing by volume displacement method and expressed in cc plant⁻¹. Root length was determined by measuring the length of root from the base of the culm to the tip of the lengthiest root and expressed in cm plant⁻¹.

“The ear bearing tillers per quadrat (0.25 m²) were counted randomly at four places in each net plot, pooled and expressed as number m⁻². The length of panicle was taken from ten panicles selected randomly from the tagged plant. It was measured from the neck-node to the tip of the apical grains. After this, the average length of panicle was determined and expressed in cm. The panicles selected for measuring length were weighed on an electrical weighing balance and then mean was worked out and expressed in g” [5]. “The total numbers of filled grains and ill filled grains in the panicles were counted from the

tagged plants and the mean was expressed as number panicle. From each net plot, one thousand well filled grains were collected at harvest. The grains were weighed in an electronic balance corrected to 14 per cent moisture level and expressed in g. The grain yield from each net plot area was recorded after threshing, cleaning, drying and winnowing. From that weight, the final grain yield was computed at 14 per cent moisture content and expressed in kg ha^{-1} . The dry weight of straw per net plot was recorded after sun drying for three days and expressed in kg ha^{-1} [5].

3. RESULTS AND DISCUSSION

3.1 Effect of Weed Management Practices on Plant Height

“At PI stage, hand weeding on 20 and 40 DAS (T_{10}) recorded taller plants (89.2 cm) followed by PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS (T_4) (86.2 cm), PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* HW on 40 DAS (T_1) (85.6 cm) and EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS *fb* HW on 40 DAS (T_2) (83.2 cm). Favourable environment created by weed free situation enhanced the plant height in these treatments. Coir pith mulching @ 5 tons ha^{-1} on 3 DAS (T_7) (71.3 cm), EPOE application of chlorimuron ethyl *fb* metsulfuron methyl (4 g ha^{-1}) (T_3) (80.1 cm) and other non-chemical weed management practices were on par with each other” [5].

At flowering and maturity stages, though there was statistical difference among the treatments, they were only numerical. Hand weeding on 20 and 40 DAS (T_{10}) recorded taller plants (93.5 and 99.7 cm) followed by PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS (T_4) (91.1 and 96.1 cm). Coir pith mulching @ 5 tons ha^{-1} on 3 DAS (T_7) and weed check T_{12} (73.2 and 79.3 cm; 71.6 and 75.6 cm at flowering and maturity stages, respectively) registered lower plant height than other treatments.

3.2 Effect of Weed Management Practices on Root Length

At AT, PI and flowering stages, hand weeding on 20 and 40 DAS (T_{10}) recorded higher root

length (12.2, 18.9 and 22.9 cm) which was on par with the treatments,

“PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS (T_4) (11.9, 18.7 and 22.7 cm, respectively), PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* HW on 40 DAS (T_1) (11.7, 18.3 and 22.3 cm, respectively) and EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS *fb* HW on 40 DAS (T_2) (11.5, 17.9 and 21.8 cm on AT, PI and flowering stages, respectively). Coir pith mulching @ 5 tons ha^{-1} on 3 DAS (T_7) (7.2, 11.9 and 16.4 cm) and weedy check (T_{12}) (7.0, 11.7 and 16.2 cm on AT, PI and flowering stages, respectively) recorded significantly lower root length” [5].

3.3 Effect of Weed Management Practices on Root Volume

Hand weeding on 20 and 40 DAS (T_{10}) recorded higher root volume at all the crop growth stages (14.8, 20.3 and 22.5 cc plant^{-1} on AT, PI and flowering stages, respectively) which was comparable with, PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS (T_4) (14.5, 20.1 and 22.3 cc plant^{-1} , respectively), PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* HW on 40 DAS (T_1) (14.3, 19.7 and 21.8 cc plant^{-1} , respectively) and EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS *fb* HW on 40 DAS (T_2) (14.1, 19.4 and 21.2 cc plant^{-1} , respectively). Coir pith mulching @ 5 tons ha^{-1} on 3 DAS (T_7) (9.3, 12.9 and 14.9 cc plant^{-1} , respectively) and weedy check (T_{12}) (8.8, 12.3 and 14.1 cc plant^{-1} on AT, PI and flowering stages, respectively) recorded lower root volume than rest of the treatments.

3.4 Effect of Weed Management Practices on Productive and per Cent Unproductive Tillers

The yield attribute, productive tillers per unit area was significantly influenced by different chemical and non-chemical weed management practices. Hand weeding on 20 and 40 DAS (T_{10}) recorded higher number of productive tillers (297.3 m^{-2}) with 12.8 per cent unproductive tillers, which was comparable with the treatments, PE application of pendimethalin (1.0 kg ha^{-1}) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha^{-1}) on 20 DAS (T_4) with 293.5 productive tillers m^{-2} and 12.8 per cent

unproductive tillers, PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* HW on 40 DAS (T₁) with 284.2 productive tillers m⁻² and 13.1 per cent unproductive tillers and EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS *fb* HW on 40 DAS (T₂) with 273.5 productive tillers m⁻² with and 14.3 per cent unproductive tiller. Coir pith mulching @ 5 tons ha⁻¹ on 3 DAS (T₇) registered lower number of productive tillers (121.3 m⁻²) with higher per cent unproductive tillers (27.1 per cent) which was comparable with weedy check (T₁₂), which recorded 112.3 productive tillers m⁻² having 29.9 per cent unproductive tillers.

3.5 Effect of Weed Management Practices on Total Number of Grains and Filled Grains per Panicle

“Hand weeding on 20 and 40 DAS (T₁₀) recorded higher number of grains per panicle (151.7) which was at par with PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS (T₄)(150.2), PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* HW on 40 DAS (T₁) (146.8), EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS *fb* HW on 40 DAS (T₂) (145.7). The increased number of productive tillers m⁻², filled grain panicle⁻¹ and panicle weight might be due to increase in the availability of nutrients, water, light and space to the crops as a result of effective control on weeds” [6-8,2]. Shredded coconut waste mulching @ 5 tons ha⁻¹ on 3 DAS (T₈) recorded lower number of grains per panicle (121.8) which was on par with coir pith mulching @ 5 tons ha⁻¹ on 3 DAS (T₇) (117.2) and weedy check (T₁₂) (111.3).

Grain filling was considerably higher in hand weeding on 20 and 40 DAS (T₁₀) and chemical weed management treatments (except T₃), where hand weeding on 20 and 40 DAS (T₁₀) recorded 137.5 numbers of filled grains panicle⁻¹ with 90.6 per cent grain filling, which was on par with PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS (T₄) 136.0 grains panicle⁻¹ with 90.5 per cent grain filling, PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* HW on 40 DAS (T₁) (130.6 grains panicle⁻¹) with 89.0 per cent grain filling and EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS *fb* HW on 40 DAS (T₂) (129.2 grains panicle⁻¹) with 88.7 per cent grain filling. Shredded coconut waste mulching @ 5 tons ha⁻¹

on 3 DAS (T₈) recorded lower number of filled grain per panicle (93.7 grains panicle⁻¹) with 76.9 per cent grain filling which was comparable with coir pith mulching @ 5 tons ha⁻¹ on 3 DAS (T₇) (87.3 grains panicle⁻¹) with 74.5 per cent grain filling and weedy check (T₁₂) (82.2 grains panicle⁻¹) with 73.9 per cent grain filling.

3.6 Effect of Weed Management Practices on Test Weight, Panicle Length and Weight

There was no significant difference between different chemical and non-chemical weed management practices regarding panicle length and test weight. For panicle weight, hand weeding on 20 and 40 DAS (T₁₀) recorded higher panicle weight (2.9 g) and which was on par with PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS (T₄) (2.8 g). Substantial improvement in the sink could be achieved due to a conducive weed free condition to the crop by adoption of chemical weed management practices in combination with hand weeding or sequential application of two chemicals. Further the better growth environment in terms of availability of more space, light and nutrients by timely control of weeds might have also contributed to the increased values of yield attributes [9-13]. Differences among each other was due to difference in weed controlling ability of the treatments. Weedy check (T₁₂) registered lower panicle weight (0.9 g) which was comparable with coir pith mulching @ 5 tons ha⁻¹ on 3 DAS (T₇) (1.1 g) and shredded coconut waste mulching @ 5 tons ha⁻¹ on 3 DAS (1.3 g).

3.7 Effect of Weed Management Practices on Grain and Straw Yield

“Hand weeding on 20 and 40 DAS (T₁₀) recorded higher grain and straw yield (4298 and 5802 kg ha⁻¹) which was comparable with PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS (T₄) (4128 and 5697 kg ha⁻¹), PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* HW on 40 DAS (T₁) (4031 and 5512 kg ha⁻¹) and EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS *fb* HW on 40 DAS (T₂) (3987 and 5389 kg ha⁻¹ grain yield and straw yield, respectively). Higher grain yield might be attributed to the weed free environment provided by early control of weeds by PE application of pendimethalin/EPOE

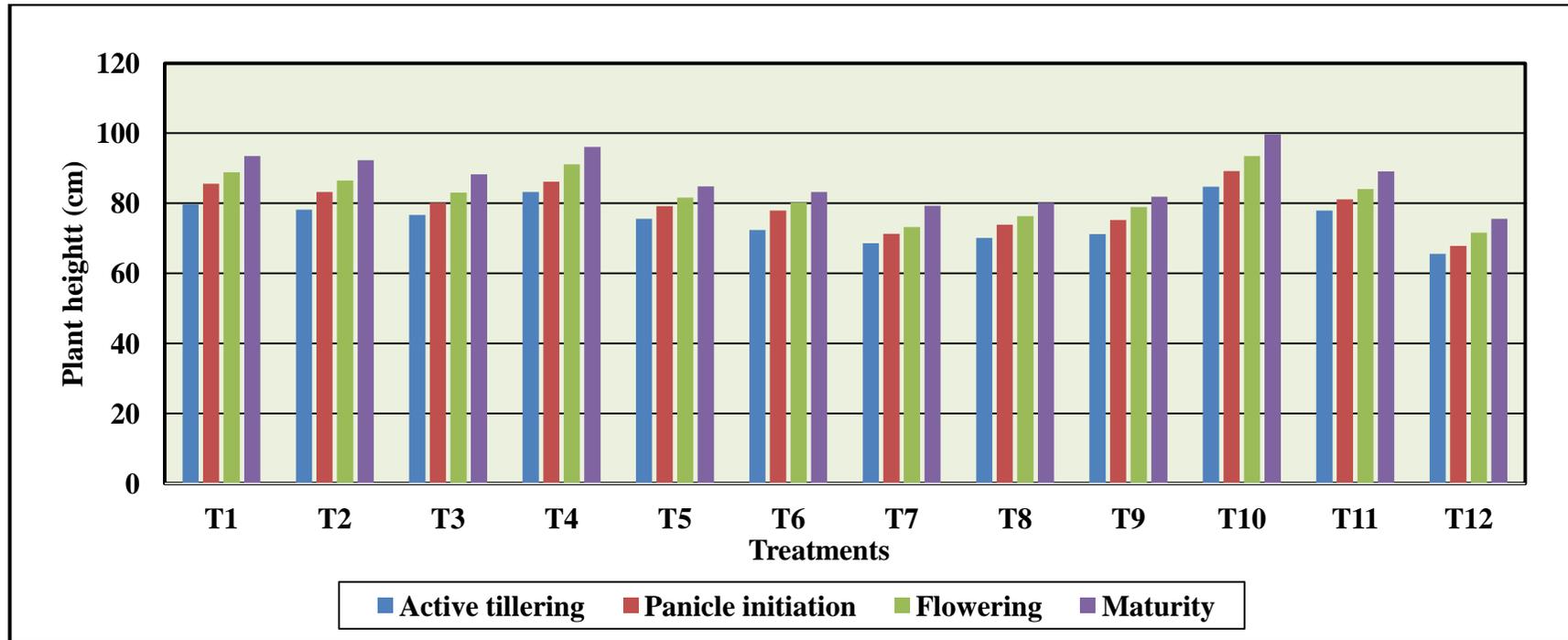


Fig. 1. Influence of chemical and non-chemical weed management practices on plant height of aerobic rice

Table 1. Influence of chemical and non-chemical weed management practices on root length (cm) of aerobic rice [5]

Treatments	Active tillering	Panicle initiation	Flowering
T ₁ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> hand weeding on 40 DAS	11.7	18.3	22.3
T ₂ : EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS <i>fb</i> hand weeding on 40 DAS	11.5	17.9	21.8
T ₃ : EPOE chlorimuron ethyl + metsulfuron methyl (4 g ha ⁻¹) on 2-3 leaf stage of weeds	9.7	15.3	19.5
T ₄ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS	11.9	18.7	22.7
T ₅ : <i>Daincha</i> intercropping (1:1) <i>fb</i> spreading on 30 DAS	9.5	15.1	19.2
T ₆ : Cowpea intercropping (1:1) <i>fb</i> spreading on 30 DAS	9.2	14.9	18.9
T ₇ : Coir pith mulching (5 tons ha ⁻¹) on 3 DAS	7.2	11.9	16.4
T ₈ : Shredded coconut waste mulching (5 tons ha ⁻¹) on 3 DAS	8.7	14.3	18.3
T ₉ : Mechanical weeding on 20 and 40 DAS	9.1	14.7	18.7
T ₁₀ : Hand weeding on 20 and 40 DAS	12.2	18.9	22.9
T ₁₁ : Mechanical weeding on 20 DAS <i>fb</i> hand weeding on 40 DAS	9.9	15.5	19.8
T ₁₂ : Weedy check	7.0	11.7	16.2
SEd	0.7	1.0	0.9
CD (P=0.05)	1.4	2.2	1.8

(PE – Pre emergent, EPOE – Early Post Emergence application, DAS – Days after sowing, *fb* – followed by)**Table 2. Influence of chemical and non-chemical weed management practices on root volume (cc plant⁻¹) of aerobic rice [5]**

Treatments	Active tillering	Panicle initiation	Flowering
T ₁ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> hand weeding on 40 DAS	14.3	19.7	21.8
T ₂ : EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS <i>fb</i> hand weeding on 40 DAS	14.1	19.4	21.2
T ₃ : EPOE chlorimuron ethyl + metsulfuron methyl (4 g ha ⁻¹) on 2-3 leaf stage of weeds	11.9	16.9	18.5
T ₄ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS	14.5	20.1	22.3
T ₅ : <i>Daincha</i> intercropping (1:1) <i>fb</i> spreading on 30 DAS	11.7	16.7	18.2
T ₆ : Cowpea intercropping (1:1) <i>fb</i> spreading on 30 DAS	11.4	16.4	17.9
T ₇ : Coir pith mulching (5 tons ha ⁻¹) on 3 DAS	9.3	12.9	14.9
T ₈ : Shredded coconut waste mulching (5 tons ha ⁻¹) on 3 DAS	11.2	15.8	17.3
T ₉ : Mechanical weeding on 20 and 40 DAS	11.6	16.1	17.7
T ₁₀ : Hand weeding on 20 and 40 DAS	14.8	20.3	22.5
T ₁₁ : Mechanical weeding on 20 DAS <i>fb</i> hand weeding on 40 DAS	12.3	17.1	18.7
T ₁₂ : Weedy check	8.8	12.3	14.1
SEd	0.7	1.0	1.1
CD (P=0.05)	1.6	2.1	2.3

(PE – Pre emergent, EPOE – Early Post Emergence application, DAS – Days after sowing, *fb* – followed by)

Table 3. Influence of chemical and non-chemical weed management practices on productive tillers m⁻² and per cent unproductive tillers of aerobic rice

Treatments	No. of productive tillers m ⁻²	Per cent unproductive tillers
T ₁ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> hand weeding on 40 DAS	284.2	13.1
T ₂ : EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS <i>fb</i> hand weeding on 40 DAS	273.5	14.3
T ₃ : EPOE chlorimuron ethyl + metsulfuron methyl (4 g ha ⁻¹) on 2-3 leaf stage of weeds	227.3	15.6
T ₄ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS	293.5	12.8
T ₅ : <i>Daincha</i> intercropping (1:1) <i>fb</i> spreading on 30 DAS	187.3	21.4
T ₆ : Cowpea intercropping (1:1) <i>fb</i> spreading on 30 DAS	172.5	22.1
T ₇ : Coir pith mulching (5 tons ha ⁻¹) on 3 DAS	121.3	27.1
T ₈ : Shredded coconut waste mulching (5 tons ha ⁻¹) on 3 DAS	149.3	24.7
T ₉ : Mechanical weeding on 20 and 40 DAS	162.1	22.6
T ₁₀ : Hand weeding on 20 and 40 DAS	297.3	12.8
T ₁₁ : Mechanical weeding on 20 DAS <i>fb</i> hand weeding on 40 DAS	243.5	14.6
T ₁₂ : Weedy check	112.3	29.9
SEd	13.1	-
CD (P=0.05)	27.4	-

(PE – Pre emergent, EPOE – Early Post Emergence application, DAS – Days after sowing, *fb* – followed by)

Table 4. Influence of chemical and non chemical weed management practices on number of grains panicle⁻¹, number of filled grains panicle⁻¹ and grain filling per cent

Treatments	No. of grains panicle ⁻¹	No. of filled grains panicle ⁻¹	Grain filling (%)
T ₁ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> hand weeding on 40 DAS	146.8	130.6	89.0
T ₂ : EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS <i>fb</i> hand weeding on 40 DAS	145.7	129.2	88.7
T ₃ : EPOE chlorimuron ethyl + metsulfuron methyl (4 g ha ⁻¹) on 2-3 leaf stage of weeds	134.0	108.7	81.1
T ₄ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS	150.2	136.0	90.5
T ₅ : <i>Daincha</i> intercropping (1:1) <i>fb</i> spreading on 30 DAS	123.4	99.5	80.6
T ₆ : Cowpea intercropping (1:1) <i>fb</i> spreading on 30 DAS	122.6	99.3	81.0
T ₇ : Coir pith mulching (5 tons ha ⁻¹) on 3 DAS	117.2	87.3	74.5
T ₈ : Shredded coconut waste mulching (5 tons ha ⁻¹) on 3 DAS	121.8	93.7	76.9
T ₉ : Mechanical weeding on 20 and 40 DAS	127.1	95.9	75.5
T ₁₀ : Hand weeding on 20 and 40 DAS	151.7	137.5	90.6
T ₁₁ : Mechanical weeding on 20 DAS <i>fb</i> hand weeding on 40 DAS	135.3	113.6	84.0
T ₁₂ : Weedy check	111.3	82.2	73.9
SEd	8.3	6.1	-
CD (P=0.05)	17.4	12.6	-

(PE – Pre emergent, EPOE – Early Post Emergence application, DAS – Days after sowing, *fb* – followed by)**Table 5. Influence of chemical and non chemical weed management practices on panicle length, panicle weight and test weight of aerobic rice**

Treatments	Panicle length (cm)	Panicle weight (g)	Test weight (g)
T ₁ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> hand weeding on 40 DAS	22.8	2.5	20.4
T ₂ : EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS <i>fb</i> hand weeding on 40 DAS	22.7	2.3	20.5
T ₃ : EPOE chlorimuron ethyl + metsulfuron methyl (4 g ha ⁻¹) on 2-3 leaf stage of weeds	21.9	1.9	20.2
T ₄ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS	23.1	2.8	20.8
T ₅ : <i>Daincha</i> intercropping (1:1) <i>fb</i> spreading on 30 DAS	21.2	1.8	20.2
T ₆ : Cowpea intercropping (1:1) <i>fb</i> spreading on 30 DAS	21.3	1.6	19.9
T ₇ : Coir pith mulching (5 tons ha ⁻¹) on 3 DAS	19.9	1.1	18.9
T ₈ : Shredded coconut waste mulching (5 tons ha ⁻¹) on 3 DAS	20.9	1.3	19.3
T ₉ : Mechanical weeding on 20 and 40 DAS	21.5	1.5	20.1
T ₁₀ : Hand weeding on 20 and 40 DAS	23.5	2.9	21.0
T ₁₁ : Mechanical weeding on 20 DAS <i>fb</i> hand weeding on 40 DAS	21.8	2.1	20.2
T ₁₂ : Weedy check	19.8	0.9	18.7
SEd	1.2	0.15	0.93
CD (P=0.05)	NS	0.32	NS

(PE – Pre emergent, EPOE – Early Post Emergence application, DAS – Days after sowing, *fb* – followed by)

Table 6. Influence of chemical and non-chemical weed management practices on grain and straw yield and harvest index of aerobic rice

Treatments	Grain yield (kg ha⁻¹)	Straw yield (kg ha⁻¹)	Harvest index
T ₁ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> hand weeding on 40 DAS	4031	5512	0.42
T ₂ : EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS <i>fb</i> hand weeding on 40 DAS	3987	5389	0.43
T ₃ : EPOE chlorimuron ethyl + metsulfuron methyl (4 g ha ⁻¹) on 2-3 leaf stage of weeds	3006	4589	0.40
T ₄ : PE pendimethalin (1 kg ha ⁻¹) on 3 DAS <i>fb</i> EPOE bispyribac sodium (25 g ha ⁻¹) on 20 DAS	4128	5697	0.42
T ₅ : <i>Daincha</i> intercropping (1:1) <i>fb</i> spreading on 30 DAS	2576	3940	0.40
T ₆ : Cowpea intercropping (1:1) <i>fb</i> spreading on 30 DAS	2426	3789	0.39
T ₇ : Coir pith mulching (5 tons ha ⁻¹) on 3 DAS	1840	2840	0.39
T ₈ : Shredded coconut waste mulching (5 tons ha ⁻¹) on 3 DAS	2212	3489	0.39
T ₉ : Mechanical weeding on 20 and 40 DAS	2321	3612	0.39
T ₁₀ : Hand weeding on 20 and 40 DAS	4298	5802	0.43
T ₁₁ : Mechanical weeding on 20 DAS <i>fb</i> hand weeding on 40 DAS	3286	4700	0.41
T ₁₂ : Weedy check	1670	2794	0.37
SEd	179	310	-
CD (P=0.05)	371	643	-

(PE – Pre emergent, EPOE – Early Post Emergence application, DAS – Days after sowing, *fb* – followed by)

application of bispyribac sodium and subsequent establishment of weed free condition either manually or by spraying chemicals in the respective treatments at later stage. Coir pith mulching @ 5 tons ha⁻¹ on 3 DAS (T₇) recorded 1840 and 2840 kg ha⁻¹ grain yield and straw yield, respectively" [5].

4. CONCLUSION

Weeds cannot be managed by a single weed control method. Herbicides provided the most efficient means of controlling weeds, ensured greater crop growth, and eventually increased crop production. PE application of pendimethalin (1.0 kg ha⁻¹) on 3 DAS *fb* EPOE application of bispyribac sodium (25 g ha⁻¹) on 20 DAS was found to be effective in aerobic rice.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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