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# Weed Management in Transplanted Paddy in Wetlands under Water Shortage with Alternate Wetting and Drying System of Irrigation

**Ganja Pavani Grace Paul [a++], P. A. Joseph [a#*], S. Praveena Katharine [a†], Anitrosa Innazent [a†] and P. Dinesh Kumar [a†]**

*[a] Department of Agriculture, School of Agricultural Sciences, Karunya Institute of Technology and Sciences, Coimbatore- 641114, India.*

***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

A field experiment was conducted during the *Rabi* season of 2023-2024 in the farm of Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu to find out an effective weed management system in transplanted paddy under alternate wetting and drying. The experiment was laid out in randomized block design with thirteen treatments and two replications.The results showed that at all stages of observations tallest paddy crop was produced in T13 (continuous submergence in paddy field). The height of paddy crop at harvest was 14.3 % more in T13 than in

[++] *M.Sc. scholar;*
[#] *Professor;*
[†] *Assistant professor;*
**Corresponding author: E-mail: josephpa@karunya.edu;*

unweeded control under alternate wetting and drying (T12). Highest number of tillers per plant (16.5) were recorded in T8 which received early post emergence application of Bispyribac sodium @ 0.03 kg ai/ha at 15 DAT + roto weeding at 35 DAT. By 90 DAT highest leaf area index was recorded by pre emergence application of Pyrazosulfuron ethyl along with one hand weeding at 35 DAT(T6), early post emergence spray of Bispyribac sodium alone (T7), and Bispyribac sodium with one roto weeding at 35 DAT (T8) and Bispyribac sodium and one hand weeding at 35 DAT (T9). By harvest the dry matter production was the highest in T8 (Bispyribac sodium with one roto weeding at 35 DAT) followed by T9 (Bispyribac sodium with one hand weeding at 35 DAT).Highest production of grains and straw (7362 and 15280 kg $ha^{-1}$) were also recorded in T8 (early post emergence application of Bispyribac sodium @ 0.03 kg ai/ha at 15 DAT + roto weeding at 35 DAT) closely followed by T9 (early post emergence application of Bispyribac sodium @ 0.03 kg ai/ha at 15 DAT + hand weeding at 35 DAT).

*Keywords: Alternate wetting and drying; growth and yield; paddy; weed management practices.*

## 1. INTRODUCTION

Rice (*Oryza sativa* L.) is the most important food crop of India and Tamil Nadu. India is the second largest producer of rice next to China in the world. Rice is the main staple food of the south Indian people especially the people of Andhra Pradesh, Kerala, Tamil Nadu and Karnataka. Globally 11 per cent of cultivable land is used for the rice cultivation. One third of the world's population consumes rice to fulfill their daily food requirements. In Tamil Nadu about 2.2 million ha area is under rice cultivation and average productivity is 2.8 tonnes $ha^{-1}$ [1]. ice is the staple food for over half of India's population and most of the people of Tamil Nadu. As the population increases day by day, there is a need to ensure the future demands of food to each individual. Increasing population needs to improve the productivity of rice and other food crops.

Rice is mostly cultivated in lowland fields under submergence. About 67 per cent of the paddy crop in India and 94 per cent in Tamil Nadu are irrigated. Paddy crop consumes large quantity of water compared to other crops. The average water requirement of all other crops are far less than that of paddy crop. The water requirement of crops like sorghum, maize, ragi, cotton, groundnut and black gram are in the order of 500,500,310,600,510 and 280 mm respectively [2].

Within Asia, the proportion of fresh water being used for rice irrigation is greater, with approximately 50 per cent of fresh water being used for rice irrigation. With global rice production needing to increase by 70 per cent by 2030 to feed an ever growing world population, demands on fresh water for irrigation of rice will only increase unless water management techniques that reduce water use are developed and implemented. These water management techniques, while decreasing total water loss, should maintain or increase yield. Due to urbanization, industrialization and less water availability, spending large amounts of water for paddy cultivation is under control nowadays. One of the water saving technologies in rice is alternate wetting and drying (AWD) which can reduce the periods of continuous flooding and improve water productivity and quality [3]. AWD in rice is an most important water saving technology [4].

One technique that has been developed to reduce total water for irrigation in rice is alternate wetting and drying (AWD). High water use efficiency with less amount of water in paddy is possible with cyclic submergence or alternate wetting and drying of wetland paddy fields instead of continuous submergence. By reducing the number of irrigation events required, alternate wetting and drying can reduce water use by paddy crop up to 35- 50% [5,6]. Alternate wetting and drying is a water-saving technology that farmers can apply to reduce their irrigation water consumption in rice cultivation without decreasing its yield. AWD method can even increase the grain yield due to enhancement in grain filling rate, root growth and remobilization of carbon reserves from vegetative tissues to grains. High yielding rice varieties developed for continuously flood irrigation rice system still produce high yield under safe AWD. The main advantage of AWD is to reduce water inputs by 30 per cent compared to continuously flooded rice systems [7].

In alternate wetting and drying system of water management, irrigation water is applied a few days after the disappearance of the ponded

water. Hence, the field gets alternately flooded and non-flooded. The number of days of non-flooded soil between irrigations can vary from 1 to more than 10 days depending on a number of factors such as soil type, weather, and crop growth stage. AWD method should be followed 1–2 weeks after the transplantation. From one week before to a week after flowering, the field should be kept flooded, topping up to a depth of 5 cm as needed. About 40 per centof rice farmers in China and 80% in Japan practice alternate wetting and drying system of water management in wetland paddy. On-farm experiments with alternate wetting and drying have shown reductions in $CH_4$ emissions by 20–70%.

Uncontrolled weed growth can reduce grain yield of paddy to the tune of 47 to 54 per cent in transplanted rice [8]. Flooding is an important strategy for weed control in paddy fields. Permanently flooded paddy field tends to have less weed growth than paddy field that is not permanently flooded [9]. Due to the excessive weed infestation under alternate wetting and drying system, farmers harvest lesser yields compared to the non-alternate wetting and drying system. A weed free period up to 40-45 DAS after transplanting is essential to augment the yield of rice.

## 2. MATERIALS AND METHODS

A field experiment was conducted in the farm of Karunya Institute of Technology and Sciences, Coimbatore, Tamil Nadu during the *Rabi* season of 2023-2024 to study the effect of "Weed management in transplanted paddy in wet lands under water shortage with alternate wetting and drying system of irrigation". The site of the field is located at 10.9362° N latitude and 76.744° E longitude at an elevation 474 m above mean sea level. The soil of the experimental site was silty clay loam soil with pH of 8.25, EC (0.36 $dSm^{-1}$), OC (0.76%), available nitrogen (271.6 kg $ha^{-1}$), phosphorus (34.72 kg $ha^{-1}$), potassium (331.2 kg $ha^{-1}$).

The experiment was laid out in Randomised blocked design (RBD) with two replications and 13 treatments. The paddy variety Bhavani was used for this experiment. The treatments consists of T1-Pre emergence application of pretilachlor @ 0.75 kg ai/ha at 3 DAT alone, T2- Pre emergence application of pretilachlor @ 0.75 kg ai/ha at 3 DAT + roto weeding at 35 DAT, T3-Pre emergence application of pretilachlor @ 0.75 kg ai/ha at 3 DAT + Hand weeding at 35 DAT, T4- Pre emergence application of Pyrazosulfuron ethyl @ 0.03 kg ai/ha at 3 DAT alone, T5- Pre emergence application of Pyrazosulfuron ethyl @ 0.03 kg ai/ha at 3 DAT + roto weeding at 35 DAT, T6- Pre emergence application of Pyrazosulfuron ethyl @ 0.03 kg ai/ ha on 3 DAT + Hand weeding at 35 DAT, T7-Early post emergence application of bispyribac sodium @ 0.03 kg ai/ha alone at 15 DAT, T8-Early post emergence application of bispyribac sodium @ 0.03 kg ai/ha at 15 DAT + roto weeding at 35 DAT, T9- Early post emergence application of bispyribac sodium @ 0.03 kg ai/ha at 15 DAT + Hand weeding at 35 DAT, T10-Weed free check, T11- Two hand weedings at 20 and 35 DAT, T12- Unweeded control and T13-Continuous submergence of paddy plots with water. The major weeds observed in the experimental plots were grasses like *Echinocloacrusgalli*, *Echinocloacolonum* and *Sac ciolepisinterrupta*, broad leaved weeds: *Ecliptaalba,Ludwigiaparviflora* and *Ammaniabacc ifera* and sedges: *Cyperusdifformis , Cyperusiria* and *Fimbristylismilacea*.

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Weed Management in Transplanted Paddy under Alternate Wetting and Drying on Growth Parameters

Tiller production at maximum tillering (60DAT), height of paddy crop at harvest, LAI at panicle initiation stage (90 DAT) and dry matter production at harvest are presented in Table 1.Significant effects of treatments on number of tillers per plant was observed at 60 DAT corresponding to the maximum tillering stage. Maximum number of 16.5 tillers per plant was observed in T8 ( early post emergence application of bispyribac sodium @ 0.03 kg ai/ha at 15 DAT + roto weeding at 35 DAT) and it was at par with T5 (pre emergence application of Pyrazosulfuron ethyl @ 0.03 kg ai/ha at 3 DAT + roto weeding at 35 DAT), T6 (pre emergence application of Pyrazosulfuron ethyl @ 0.03 kg ai/ ha on 3 DAT + hand weeding at 35 DAT), T7 (early post emergence application of bispyribac sodium @ 0.03 kg ai/ha alone at 15 DAT), T9 (early post emergence application of bispyribac sodium @ 0.03 kg ai/ha at 15 DAT) and hand weeding and T13 (continuous submergence of paddy plots with water) . The lowest number of tillers per hill (9.0) was observed in T12

(unweeded control) and was significantly inferior to all the other treatments.

Though LAI at panicle initiation stage did not vary significantly, treatments T6, T7, T8 and T9 recorded higher LAI values than other treatments. The maximum leaf area index (6.81) was observed in T8 and the lowest leaf area index (5.10) in T12.The LAI in T8 was higher by 33.5 % than that of T12 (unweeded control). Second highest LAI of 6.65 was observed in T9.

At harvest tallest plants were produced in T13 (135.5cm) which received continuous submergence with water. Shortest plants were produced in T12 (116.3cm) which was unweeded control. Treatments did not influence the height of paddy crop significantly).

At harvest the highest dry matter production was in T8 (23341.8 kg $ha^{-1}$) and was significantly superior to all the other treatments. The lowest dry matter production (16532 kg $ha^{-1}$) was observed in T12 and was significantly inferior to all the other treatments.T8 produced 41 per cent more dry matter than T12. Second best dry matter production was in T9 (22316.5 $kgha^{-1}$). Early post emergence spray of bispyribac sodium + one roto weeding at 35 DAT (T8) and early post emergence spray of bispyribac sodium + one hand weeding at 35 DAT were the best treatments for higher dry matter production of paddy.

Similar positive results of Bispyribac sodium on improving growth parameters of paddy have been reported by Panneerselvam*et al*. [10].They observed that application of Bispyribac sodium in paddy crop enhanced AMF sporulation (1100 spores/100 g) and root colonization (86.68%) compared to other herbicides application and learning approaches through PCA found that application of Bispyribac sodium enhanced both above ground plant growth responses and soil microbial properties. Studies by Yadav*et al*. [11]also supported the beneficial effects of Bispyribac sodium on improving the growth and yield parameters of paddy crop. Growth parameters improved very much when the pre-emergence herbicides were supplemented with one rotoweeding or one hand weeding at 35DAT. The beneficial effect of roto weeding in paddy crop has also been observed by Mohanty and Bhuyan [12]. The beneficial effect of a hand weeding at 40 DAT along with the pre-emergence application of herbicide on better growth and production of paddy was evident in the studies of Patel and Ghosh [13].

### 3.2 Effect of Weed Management in Transplanted Paddy under Alternate Wetting and Drying on Growth Parameters

Yield parameters of paddy like number of panicles per square meter, total grains per panicle, filling percentage and 1000 grain weight are presented in Table 2).

**Table 1. Growth of paddy as affected by weed management practices under alternate wetting and drying**

| Treatments | Tiller number per plant | LAI | Height at harvest (cm) | Dry matter yield at harvest ($kgha^{-1}$) |
|---|---|---|---|---|
| T1 | 12.0 | 5.20 | 124.8 | 19066.3 |
| T2 | 13.0 | 5.24 | 127.8 | 19429.6 |
| T3 | 13.0 | 5.32 | 127.2 | 19369.8 |
| T4 | 13.0 | 5.56 | 126.0 | 19590.7 |
| T5 | 15.0 | 5.88 | 128.0 | 20432.4 |
| T6 | 16.0 | 6.30 | 129.0 | 21135.8 |
| T7 | 14.5 | 6.55 | 127.9 | 21347.5 |
| T8 | 16.5 | 6.81 | 130.4 | 23341.8 |
| T9 | 16.0 | 6.65 | 129.5 | 22316.5 |
| T10 | 13.0 | 5.83 | 127.0 | 19678.1 |
| T11 | 13.0 | 5.85 | 127.8 | 19684.0 |
| T12 | 9.0 | 5.10 | 117.7 | 16532.0 |
| T13 | 15.0 | 5.85 | 137.3 | 19352.5 |
| SEm± | 0.73 | 0.48 | 3.04 | 235.9 |
| CD (0.05) | 2.25 | NS | NS | 726.89 |

Panicle number per square meter varied significantly between treatments.Panicle number per square meter was highest (348 each) in T6 and T8 and was at par with all the treatments except T12 (unweeded control) and T13 (continuous submergence). The lowest number of panicles per square meter (290) was observed in T12 and it was significantly lower than all the other treatments.

Total number of grains per panicle varied significantly between the treatments. The highest total number of grains per panicle (102) was observed in T8 and was at par with T9, T7, T6 and T5 and significantly superior to all the other treatments. The lowest total number of grains per panicle (91) was observed in T12 and was at par with T1, T2, T3, T4 and T13.

Filling percentage did not vary significantly between the treatments. The filling percentage varied between 96.8 in T12 to 98.2 in T7. The filling percentage observed in the experimental plots were very high probably due to good weather and less pest and disease attacks.

Thousand grain weight did not vary significantly between the treatments. The 1000 grain weight remained almost constant in the experimental treatments. It ranged from 21.4 in T4 to 21.7 in T3.

### 3.3 Effect of Weed Management in Transplanted Paddy under Alternate Wetting and Drying on Grain and Straw Yield

Data on grain and straw yield given in table 3 and Fig. 1 indicated that grain yield per hectare varied significantly between the treatments. The highest grain yield per ha (7362 kg) was observed in T8 and was at par with T5, T6, T7, and T9 and significantly superior overall the other treatments. The lowest grain per yield ha (5176 kg) was observed in T12 and was significantly inferior to all the other treatments. Thusunweeded control drastically affected grain yield in rice.

Among the application of herbicides alone, T7 (early post emergence application of Bispyribac sodium at 15 DAT) significantly gave higher grain yield per ha (7114 kg) over T1 which received pre-emergence application of Pretilachlor at 3 DAT (6563 kg) and T4 which received pre-emergence application of Pyrazosulfuron ethyl at 3 DAT (6699 kg). Thus the beneficial effect of early post emergence application of Bispyribac sodium is very much evident on its favorable effect on improving grain yield of paddy.

When the herbicide application was supported by one roto weeding or one hand weeding at 35 DAT, grain yield improved further. Pre-emergence application of Pretilachlor at 3 DAT+ one roto weeding at 35 DAT (T2) improved grain yield per ha by 197 kg over pre-emergence application of Pretilachlor alone at 3 DAT (T1). Pre-emergence application of Pretilachlor at 3 DAT + hand weeding at 35 DAT (T3) improved grain yield per ha by 163 kg over T1. Pre-emergence application of Pyrazosulfuron ethyl at 3 DAT + one roto weeding at 35 DAT (T5) improved grain yield per ha by 469 kg over pre-emergence application of Pyrazosulfuron ethyl alone at 3 DAT (T4). Pre-emergence application of Pyrazosulfuron ethyl at 3 DAT + hand weeding at 35 DAT (T6) improved grain yield per ha by 564 kg over T4. Early post emergence application of Bispyribac sodium at 15 DAT + one roto weeding at 35 DAT (T8) improved grain yield per ha by 248 kg over early post emergence application of Bispyribac sodium alone at 15 DAT (T7). Early post emergence application of Bispyribac sodium at 15 DAT + hand weeding at 35 DAT (T9) improved grain yield per ha by 132 kg over T7. Treatments T10 (weed free check) and 11 (hand weeding twice) also gave significantly higher per ha yields (6737 kg and 6750 kg respectively) over T12 (unweeded control). Though T13 (continuous submergence only) gave significantly higher per ha yield (5991 kg) over T12 (unweeded control) it was far less than that obtained in all the other treatments.

Straw yield per hectare varied significantly between the treatments. The highest straw yield per ha (15,280kg) was observed in T8 and was at par with T9 (15,071kg) and was superior to all the other treatments. The lowest straw yield per ha (11357kg) was observed in T12 and was significantly inferior to all the other treatments. Treatments T8 (early post emergence application of Bispyribac sodium at 15 DAT + roto weeding at 35 DAT) and T9 (early post emergence application of Bispyribac sodium at 15 DAT + hand weeding at 35 DAT) greatly improved straw yield.

Harvest index of paddy crop varied significantly between the treatments.The highest harvest index (35.1) was observed in T5 and was at par with T1, T2, T3, T4, T6 and T10 significantly

superior over the other treatments. T8 and T9 which produced the highest grain and straw yield recorded lesser harvest index. The lowest harvest index (31.4 each) were recorded by T12 (unweeded control) and T13 (continuous submergence).

**Table 2. Yield parameters of paddy as affected by weed management practices under alternate wetting and drying**

| Treatments | Panicles $m^{-2}$ | Total grains $panicle^{-1}$ | Filling % | 1000 grain weight (g) |
|---|---|---|---|---|
| T1 | 338 | 94 | 96.8 | 21.5 |
| T2 | 341 | 95 | 97.1 | 21.5 |
| T3 | 342 | 94 | 97.3 | 21.7 |
| T4 | 339 | 94 | 97.5 | 21.4 |
| T5 | 344 | 99 | 97.9 | 21.5 |
| T6 | 348 | 99 | 98.1 | 21.4 |
| T7 | 344 | 98 | 98.2 | 21.5 |
| T8 | 348 | 102 | 97.5 | 21.5 |
| T9 | 345 | 99 | 97.4 | 21.4 |
| T10 | 340 | 97 | 97.9 | 21.5 |
| T11 | 340 | 96 | 97.7 | 21.5 |
| T12 | 290 | 91 | 96.8 | 21.5 |
| T13 | 330 | 92 | 97.1 | 21.5 |
| SEm± | 4.3 | 1.44 | 0.5 | 0.2 |
| CD (0.05) | 13.26 | 4.43 | NS | NS |

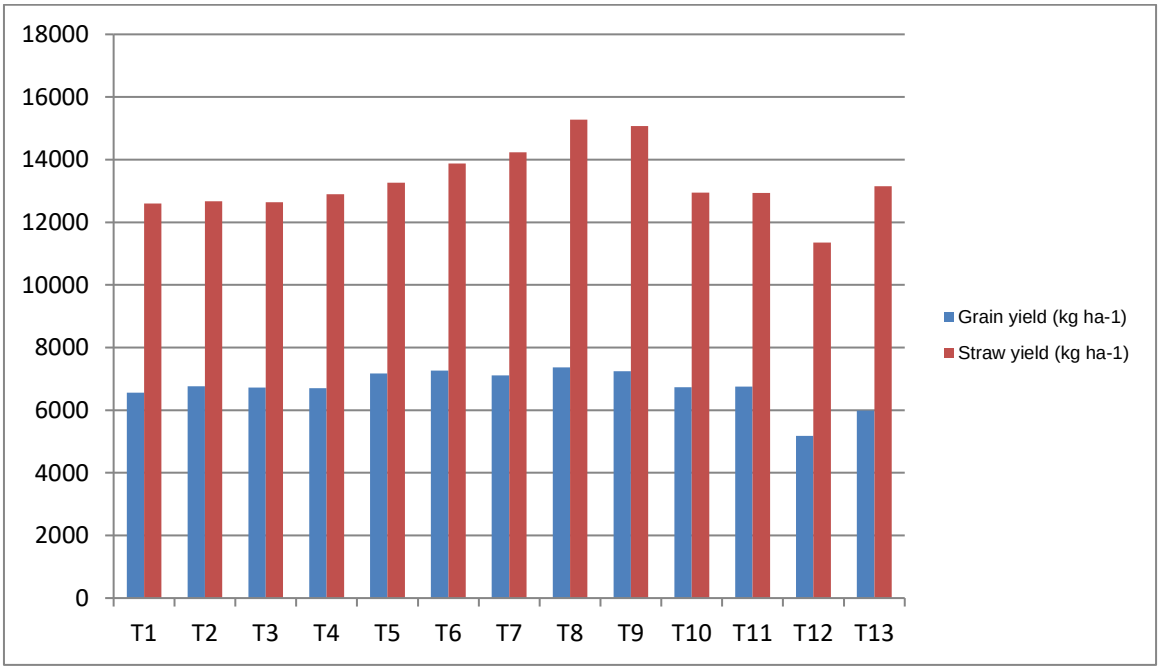


**Fig. 1. Grain and straw yield (kg $ha^{-1}$)**

**Table 3. Yield of grain and straw of paddy as affected by weed management practices under alternate wetting and drying**

| Treatments | Grain yield ($kgha^{-1}$) | Straw yield ($kgha^{-1}$) | Harvest index |
|---|---|---|---|
| T1 | 6563 | 12604 | 34.2 |
| T2 | 6760 | 12671 | 34.8 |
| T3 | 6726 | 12644 | 34.8 |
| T4 | 6699 | 12892 | 34.2 |
| T5 | 7168 | 13265 | 35.1 |
| T6 | 7263 | 13873 | 34.4 |

| Treatments | Grain yield (kgha$^{-1}$) | Straw yield (kgha$^{-1}$) | Harvest index |
|---|---|---|---|
| T7 | 7114 | 14234 | 33.3 |
| T8 | 7362 | 15280 | 32.6 |
| T9 | 7246 | 15071 | 32.6 |
| T10 | 6737 | 12942 | 33.9 |
| T11 | 6750 | 12934 | 33.6 |
| T12 | 5176 | 11357 | 31.4 |
| T13 | 5991 | 13152 | 31.4 |
| SEm± | 91.45 | 231.65 | 0.41 |
| CD (0.05) | 281.78 | 713.78 | 1.27 |

## 4. CONCLUSION

Under alternate wetting and drying system of paddy cultivation highest production of tillers, LAI, dry matter, number of panicles per square meter, biggest panicles, grain and straw yield of paddy were observed in the treatment which received early post emergence of bispyribacsodium @ 0.03 kg ai/ha at 15 DAT + one roto weeding at 35 DAT (T8). Second best treatment was early post emergence of bispyribac sodium @ 0.03 kg ai/ha at 15 DAT + one hand weeding at 35 DAT (T9).

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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