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RESEARCH ARTICLE

# AGRONOMIC MANAGEMENT STRATEGIES TO ENHANCE HIGHER PRODUCTION IN AEROBIC RICE (*ORYZA SATIVA L.*)

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**ABSTRACT**

A field experiment was carried out with graded levels of nitrogen and different weed management strategies to achieve higher productivity in aerobic rice cultivation in the Cauvery delta region. ANNA4 ruling variety was sown for two consecutive Kharif seasons. Growth parameters viz., plant height, leaf area index, Number of tillers $m^{-2}$ and yield parameters viz., panicles $m^{-2}$,Dry matter production at flowering, grain yield, straw yield were studied. The study revealed that $M_3S_2$ proved to be the best in terms of production 3.61 tons $ha^{-1}$ in the first season and 3.68 tons $ha^{-1}$ in the second season respectively. Plant height at different stages viz., maximum tillering, panicle initiation, flowering and harvest was highest in (125% of RDF Nitrogen+ Hand weedings twice at 15 and 30 DAS)on par with(125% of RDF Nitrogen+ Bispyribac sodium at 250 ml a.i. $ha^{-1}$ at 15 DAS followed by hand weeding on 30 DAS). Similar was the case with number of tillers, straw yield, panicles $m^{-2}$ and dry matter production at flowering stage. Leaf area index was highest for (125% of RDF Nitrogen+ Hand weeding's twice at 20 and 40 DAS)on par with (125% of RDF Nitrogen+ Bispyribac sodium at 250 ml a.i. $ha^{-1}$ at 15 DAS followed by hand weeding on 30 DAS). The Benefit cost ratio was high in (125% of RDF Nitrogen+ Bispyribac sodium at 250 ml a.i. $ha^{-1}$ at 15 DAS + hand weeding on 30 DAS)followed by (125% of RDF Nitrogen+ Hand weeding's twice at 20 and 40 DAS). The above results reveal that (125% of RDF Nitrogen+ Bispyribac sodium at 250 ml a.i. $ha^{-1}$ at 15 DAS followed by hand weeding on 30 DAS) is the most suitable weed management in aerobic cultivation in the economic aspect.



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# INTRODUCTION

Rice (*Oryza sativa* L.) is the widely cultivated and popular crop in the world. Approximately 60-70% of their energy requirement is met from rice and its derived products. Globally, rice is being cultivated in an area of 168 million hectares, with a production of 756.1 million tons and with the productivity of 4400 kg $ha^{-1}$(USDA, 2021). The crop occupies one third of the world's total area and more than two billion people are getting 60-70 per cent of their energy requirement from rice and its derived products (Rekha *et al*., 2015).India has largest area among the rice growing countries and ranks second in production, cultivated in an area of 45.5 million hectares and produces around 127.4million tons with the productivity of 2705 kg $ha^{-1}$during the year 2020–2021. (http://www.indiastat.com). Irrigated rice is typically transplanted into puddled paddy fields, which includes land preparation with 4-6 inches of standing water (Singh *et al*., 2021). By 2050, the worldwide water requirement is expected to increase by 55% (Connor, 2015; WWAP, 2016).The higher efficiency and better income from aerobic rice plays vital role in advertising the technology for further wide spread adoption of this technology and shifting from conventional to aerobic in water distress rice growing regions (Thejaswikumar *et al*., 2021).With a moderate application of fertiliser, aerobic rice types may maintain rapid development in soil with moisture content at or below field capacity and achieve yields of 4-6 tons $ha^{-1}$ (Parthasarathi *et al.,* 2012). Aruna and Prabhakar Reddy (2010) reported that applications of 100 per cent N through fertilizers (FN 100) recorded the highest values of yield attributes, grain yield and straw yield and net return. According to Directorate of Weed Research, Jabalpur, in 2016, losses caused by weeds in Indian agriculture are estimated to be 33%, followed by insects (26%) and diseases (20%). Recent estimate shows that weed causes an annual loss of 2000 crores rupees to Indian agriculture, which is more than the combined losses caused by insect pests and plant pathogens (Gharde *et al.,* 2018). According to Rajvirsharma (2007), two hand weeding one as early as possible i.e., 10-15 days after transplanting and the second 25-50 days later were generally sufficient in rice field. Higher weed control efficiency of 93.1 % was recorded in hand weeding treatments (Moorthy and Sanjoysaha.2002). Hand weeding twice at 20 and 40 DAT resulted in significantly lower weed density and dry weight (Bhanurekha*et al*., 2003), In India, herbicides are being used on more than 20 million hectares, which constitute about 10% of the total cropped area in the country (Choudhury *et al.,* 2016).This constraint forces the farming community to move towards a next viable option. In this context, chemical method of weed management is most effective and economical way of weed management (Sureshkumar and Durairaj, 2016).

All these reviews clearly indicate that there is a need for research to identify the suitable nutrient management and weed management technologies to aerobic rice cultivation.

# MATERIALS AND METHODS

**Site description:** A field experiment was conducted over two consecutive kharif seasons (June to September) during the year 2019 and 2020. The experiment was carried out in Semmangudi village, Sirkazhi block of Mayiladuthurai district of Tamil Nadu. The texture of the soil in the experimental field was clay loam in nature.

**Experiment:** The field was thoroughly prepared using tractor drawn disc plough, cultivator and rotavator. The rice variety, ANNA4 were sown under dry condition and application of graded levels nitrogen and different weed management techniques was considered as treatments and a split plot design with main and sub treatments in three replications were carried out. The seeds were soaked in water for 12 hours and incubated for 10 hours. Sprouted seeds were line sown with a spacing of 20 x 15 cm. A fertilizer dose of 150:50:50 kg N, P, K per ha was adopted. The entire dose of P was applied as basal, whereas graded level of Nitrogen and K fertilizers were applied in four equal split doses on 15$^{th}$ day of sowing, tillering stage, panicle initiation stage and heading stage. Initial irrigation was done immediately after sowing and frequent irrigations were done followed by alternate wetting and drying. Two hand weeding were taken up on 20 and 40 DAS only for required beds and application of pre and post emergence herbicides at 3 and 15 DAS. The recommended package of practices for individual plot was followed for the rest of the management practices.

**Treatments details**

**i) Main plot treatments – (Graded nitrogen levels)**

| | |
|---|---|
| M1 | - 75% of RDF Nitrogen |
| M2 | - 100% of RDF Nitrogen |
| M3 | - 125% of RDF Nitrogen |
| M4 | -Control (Without Nitrogen) |

**ii) Sub-plot treatments – (Weed management practices)**

| | |
|---|---|
| S1 | • Weedy check (control) |
| S2 | • Hand weeding's twice at 15 and 30 DAS |
| S3 | • Pretilachlor @ 500 ml a.i. ha$^{-1}$at 3-5 DAS followed by hand weeding on 15 DAS |
| S4 | • Bispyribac sodium @ 250 ml a.i. ha$^{-1}$ at 15 DAS followed by hand weeding on 30 DAS |

**Measurement:** Growth parameters like plant height were measured in different growth stages like maximum tillering, panicle initiation, flowering and harvest. Similarly, leaf area index (LAI), were measured during flowering stage. Yield parameters like Panicles m$^{-2}$, dry matter production at flowering stage and grain yield were recorded.

**Statistical Analysis:** The experimental results were statistically analysed by analysis of variance method and the Critical Difference was worked out at 5% probability level.

# RESULTS

**Growth parameters of rice Anna4 under aerobic cultivation:** Plant height recorded during different growth stages viz., maximum tillering, panicle initiation, flowering and harvest are furnished in table 1. The highest plant height was recorded in the treatment $M_3S_2$ (37.85, 60.20,87.41) at growth stages viz., maximum tillering, panicle initiation, flowering, harvest respectively, which was on par with $M_3S_4$, and followed by $M_3S_3$.and the shortest plant stature was recorded in $M_4$ $S_1$with 80 kg N ha$^{-1}$. Leaf area index (LAI) was observed at flowering stage. $M_3S_2$ had the highest LAI of 4.27 and was on par with $M_3S_4$ (4.16) and this was followed by $M_3S_3$ (3.83). The lowest LAI was recorded in $M_4$ $S_1$ (2.71). Number of tillers-m$^2$ was observed at 30, 60 DAS. $M_3S_2$ had the highest tillers-m$^2$ of 188.75 60 DAS and was on par with $M_3S_4$ (187.05) and this was followed by $M_3S_3$ (180.32).The lowest number of tillers was recorded in $M_4S_1$ (163).

**Yield parameters of Anna4 rice under aerobic condition:** The yield parameters like panicles m$^{-2}$, DMP at flowering stage and grain yield were recorded and analysed (Table -2). The results indicated a significant difference in panicles per unit area for different treatments in aerobic rice. It was found that $M_3S_2$and $M_3S_4$ was significantly superior to other treatments with a higher dry matter production (7.0 tons ha$^{-1}$) on par with $M_3S_4$ (6.6 tons ha$^{-1}$) and number of panicles (339 m$^{-2}$), was found to be on par with $M_3S_4$(329 m$^{-2}$).The lowest dry matter production (2.0 tons ha$^{-1}$) and number of panicles(235m$^{-2}$) per unit area was recorded in $M_4$ $S_1$. The total grain yield was also significantly different among the treatments. $M_3S_2$ recorded the highest grain yield (3869 kg/ha) on par with $M_3S_4$ (3695 kg/ha), and followed by $M_3S_3$ (3133 kg/ha).

# DISCUSSION

**Growth parameters of Anna4 rice under aerobic cultivation:** Plant height recorded during different growth stages viz., maximum tillering, panicle initiation, flowering and harvest are furnished in table 1. The highest plant height was recorded in the treatment $M_3S_2$ (37.85, 60.20, 87.41) at growth stages viz., maximum tillering, panicle initiation, flowering, harvest respectively, which was on par with $M_3S_4$, and followed by $M_3S_3$. Similar study was carried out by Sandhu *et al.,* (2019), who reported that the mean plant height of aerobic rice breeding lines at different experimental locations were 97 to 129 cm (IRRI), 93 to 112 cm (Bangladesh), 95 to 120 cm (Nepal) and 93 to 112 cm (India).Similar results were reported by Narayanhebbal *et al*., (2015) who reported that the plant height increased up to 120 kg N ha$^{-1}$,which was, comparable with 140 kg N ha$^{-1}$ and shortest plant stature was recorded with 80 kg N ha$^{-1}$.The lowest plant height was recorded in $M_4$ $S_1$. Leaf area index (LAI) was observed at flowering stage. $M_3S_2$ had the highest LAI of 4.27 and was on par with $M_3S_4$ (4.16) and this was followed by $M_3S_3$ (3.83). Chandrika *et al.,* (2017) reported that the leaf area index (LAI) ranged from 0.57 to 0.82, 2.07 to 3.89, 3.79 to 4.23 and 3.69 to 4.11 at 30, 60, 90 DAS and harvest respectively. The lowest LAI was recorded in $M_4$ $S_1$ (2.71). A larger leaf area in relation to the mass of the leaves means a higher specific leaf area, and to support this relative increase in leaf area it requires a greater investment in the stem (De groot *et al*., 2002).Number of tillers-m$^2$ was observed at 30 and 60 DAS. $M_3S_2$ had the highest tillers-m$^2$ of 188.75 on 60 DAS and was on par with $M_3S_4$ (187.05) and this was followed by $M_3S_3$ (180.32).The lowest number of tillers was recorded in $M_4S_1$ (163). Manzoor *et al*., (2006) reported that plant height, number of productive tillers per hill, panicle length, number of grains per panicle, 1000 grain weight and paddy yield showed increasing trend from 0 kg N/ha up to 175kg N/ha.

**Yield parameters of Anna4rice under aerobic condition:** The yield parameters like panicles m$^{-2}$, DMP at flowering stage and grain yield were recorded and analysed (Table -2). The results indicated a significant difference in panicles per unit area for different treatments in aerobic rice. It was found that $M_3S_2$and $M_3S_4$ was significantly superior to other treatments with a higher dry matter production (7.0 tons ha$^{-1}$) on par with $M_3S_4$ (6.6 tons ha$^{-1}$)and number of panicles (339 m$^{-2}$), was found to be on par with$M_3S_4$(329 m$^{-2}$) .The lowest dry matter production(2.0 tons ha$^{-1}$) and number of panicles (235m$^{-2}$) per unit area was recorded in $M_4$ $S_1$. The total grain yield was also significantly different among the treatments. $M_3S_2$ recorded the highest grain yield (3869 kg/ha) on par with $M_3S_4$ (3695 kg/ha), and followed by $M_3S_3$ (3133 kg/ha). The similar results reported in Pradhan *et al.,* (2016) the yield obtained with aerobic rice varieties varied from 3.5 to 6.0 t ha $^{-1}$, which is almost double that obtained with upland rainfed varieties, and 25% to 30% less than that obtained with irrigated lowland varieties grown under flooded conditions. varieties and develop systems which are sustainable and viable for aerobic rice and also disseminate this technology to areas with high yield potential

**Table.1 Effects of Nitrogen in graded levels, different weed management on growth parameters of aerobic rice**

| Treatments | Plant Height (cm) | | | LAI | Number of tillers | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | at flowering | 30 DAS | 60 DAS |
| $M_1S_1$ | 22.45 | 43.31 | 67.1 | 3.06 | 69.41 | 158.45 |
| $M_1S_2$ | 33.12 | 53.21 | 77.02 | 3.75 | 76.31 | 169.4 |
| $M_1S_3$ | 26.12 | 47 | 71.02 | 3.3 | 73.12 | 163.5 |
| $M_1S_4$ | 30.01 | 51.2 | 74.35 | 3.56 | 75.4 | 167.85 |
| $M_2S_1$ | 24.69 | 46.75 | 72.3 | 3.36 | 75.71 | 165.85 |
| $M_2S_2$ | 35.38 | 57.01 | 82.2 | 3.97 | 83.41 | 177.4 |
| $M_2S_3$ | 28.55 | 50.28 | 76.2 | 3.6 | 85.46 | 170.84 |
| $M_2S_4$ | 32.68 | 54.5 | 79.59 | 3.86 | 81.1 | 175.5 |
| $M_3S_1$ | 26.89 | 50.21 | 77.58 | 3.65 | 81.41 | 173.24 |
| $M_3S_2$ | 37.85 | 60.28 | 87.48 | 4.27 | 90.45 | 185.34 |
| $M_3S_3$ | 30.82 | 54.15 | 81.35 | 3.89 | 67.16 | 178.15 |
| $M_3S_4$ | 34.94 | 57.95 | 85.09 | 4.16 | 89.43 | 182.85 |
| $M_4S_1$ | 20.1 | 39.68 | 61.7 | 2.76 | 60.21 | 150.65 |
| $M_4S_2$ | 30.84 | 50.45 | 71.5 | 3.35 | 70.15 | 160.5 |
| $M_4S_3$ | 23.83 | 43.85 | 65.8 | 3.01 | 42.05 | 155.12 |
| $M_4S_4$ | 27.61 | 47.22 | 69.12 | 3.27 | 69.35 | 159.1 |
| SE.d | 1.03 | 1.50 | 2.44 | 0.13 | 1.13 | 2.02 |
| **CD(P=0.05)** | 2.18 | 3.15 | 5.13 | 0.29 | 2.38 | 4.25 |

**Table 2. Effects of Nitrogen in graded levels, different weed management on yield parameters of aerobic rice**

| Treatments | Panicles ($m^{-2}$) | DMP (Kg $ha^{-1}$) | Grain yield (Kg $ha^{-1}$) |
|---|---|---|---|
| $M_1S_1$ | 255.2 | 4472.0 | 2315.3 |
| $M_1S_2$ | 301.2 | 6228.8 | 3215.1 |
| $M_1S_3$ | 272.9 | 5669.5 | 3008.1 |
| $M_1S_4$ | 290.1 | 5977.2 | 3150.2 |
| $M_2S_1$ | 273.1 | 5312.4 | 2875.4 |
| $M_2S_2$ | 320.5 | 6647.8 | 3450.4 |
| $M_2S_3$ | 293.0 | 6252.0 | 3210.2 |
| $M_2S_4$ | 310.4 | 6636.0 | 3375.1 |
| $M_3S_1$ | 293.2 | 5555.2 | 3098.8 |
| $M_3S_2$ | 339.9 | 7057.5 | 3680.1 |
| $M_3S_3$ | 312.1 | 6549.0 | 3415.6 |
| $M_3S_4$ | 329.7 | 6979.0 | 3598.6 |
| $M_4S_1$ | 235.1 | 3930.0 | 2070.4 |
| $M_4S_2$ | 280.1 | 6152.3 | 3015.1 |
| $M_4S_3$ | 252.8 | 5639.7 | 2800.4 |
| $M_4S_4$ | 270.1 | 5835.2 | 2930.8 |
| SE.d | 8.14 | 93.54 | 94.71 |
| **CD(P=0.05)** | 17.10 | 196.45 | 198.90 |

Similar results were reported by Murthy *et al.,* (2012), variable application of nitrogen scheduling significantly influenced plant height. The plant dry matter produced by the crop increased with the advancement of crop growth. The increased nitrogen doses from 90 to 150 kg N $ha^{-1}$ increased the plant dry matter at all the stages of crop growth but this increase was significant only at maturity. At 30, 60 and 90 days after sowing, dry matter (45, 389 and 627gm$^{-2}$respectively) was more with 150 kg N $ha^{-1}$and at maturity, nitrogen @150 kg N $ha^{-1}$ produced the highest plant dry matter (771gm$^{-2}$) which was significantly higher as compared to remaining treatment. Increased dry matter with increasing N doses might be due to increased photosynthetic efficiency of crop.

## CONCLUSION

The present study after analysing the growth and yield parameters of different nitrogen and weed management under aerobic condition concludes that rice varieties ANNA 4 .The study revealed that treatment$M_3S_2$ (125% of RDF Nitrogen + Hand weeding's twice at 15 and 30 DAS) performed better in the terms of grain yield and DMP. Growing rice with water-saving techniques such as aerobic rice has great potential in India. Considering the scope of aerobic rice, more research need to be done in terms of breeding suitable rice

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