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# Growth and Yield Attributes of Dry Sown Rice (*Oryza Sativa* L.) as Influenced by Irrigation Schedules and Weed Management Options

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**ABSTRACT**

A field experiment was carried out during Kharif 2016-17 at Agricultural Research Station, Jangamaheshwarapuram, Guntur, Andhra Pradesh to study the growth and yield attributes of dry sown rice (*oryza sativa* L.) to study the influence of irrigation schedules and weed management options. The treatments consisted of four irrigation schedules ($I_1$-1.5 IW/CPE ratio, $I_2$-2.0 IW/CPE ratio, $I_3$-3.0 IW/CPE ratio and $I_4$- continuous submergence) assigned to main plots and four weed management treatments ($W_1$-control, $W_2$ -hand weeding at 20 DAS and 35 DAS, $W_3$ - pendimethalin @ 1 kg a.i. ha$^{-1}$ (PE) *fb.* hand weeding at 25 DAS, $W_4$ - pendimethalin @ 1kg a.i. ha$^{-1}$ (PE) *fb.* bispyribac sodium 25 g a.i. ha$^{-1}$ at 15- 20 DAS, $W_5$ - pendimethalin @ 1 kg a.i. ha$^{-1}$ (PE) *fb.* bispyribac sodium 25 g a.i. ha$^{-1}$ at 15 – 20 DAS *fb.* metsulfuron methyl + chlorimuron ethyl 8 g a.i. ha$^{-1}$ at 35 – 40 DAS as sub plots. Continuous submergence ($I_4$) recorded significantly higher plant height at harvest (66.4 cm), more number of tillers m$^{-2}$ (621.7) and maximum drymatter accumulation at harvest (17443.5 kg ha$^{-1}$) when compared to all other treatments throughout the crop growth period. However, it was found to be on par with irrigation at 3.0 IW/CPE ratio. Similar trend was observed with yield parameters wherein, continuous submergence produced the higher yield parameters *viz.,* productive tillers m$^{-2}$ (515), grains per panicle (132), number of filled grains (122), grain yield (6307 kg ha$^{-1}$), straw yield (9604 kg ha$^{-1}$) and test weight (14.8 g) on par with that of irrigation scheduled at 3.0 IW/CPE ratio. Manual weeding twice at 20 and 35 DAS ($W_2$) followed by pendimethalin + one hand weeding at 25 DAS ($W_3$) recorded significantly higher growth and yield attributes *viz.,*plant height at harvest (69.1 cm), drymatter accumulation at harvest (17418.8 kg ha$^{-1}$), tillers m$^{-2}$ (632.5), productive tillers m$^{-2}$ (538), grains per panicle (138), number of filled grains (128), grain yield (6555 kg ha$^{-1}$), straw yield (9470 kg ha$^{-1}$) and test weight (15.5g) in dry sown rice and found superior to that of control and application of two herbicides *i.e*., pre-emergence application of pendimethalin *fb* postemergence application of bispyribac sodium.

**Key words**: *Dry sown rice, IW/CPE ratio, Continuous submergence, Hand weeding, Pre- emergence, Post emergence*

Rice (*Oryza sativa* L.) is the most important, staple and extensively grown food crop in India, occupying an area of 44.1 million hectares with a production of 105.5 million tones and productivity of 2500 kg ha$^{-1}$. Andhra Pradesh is the third largest rice growing states after West Bengal and Uttar Pradesh in India, where it is cultivated mainly as transplanted crop. In Andhra Pradesh it is grown in an area of 25.84 lakh hectares with a production of 9.18 million tones and productivity of 3.7 t ha$^{-1}$ (Agriculture action plan 2015-16).

In the present scenario, looming scarcity of water and labour due to population explosion and urbanization, poses a serious threat to sustainability of traditional methods of rice production. Direct-seeded rice (DSR) can address these problems, as it is economically feasible and technically viable alternative to transplanted rice (TPR), as cost of cultivation was 15% less in DSR. Moreover, technical efficiency of DSR was found to be 92% whereas it was 87% in case of TPR. It was observed that farmers could save 55% human labour, 10% machine labour and 33% irrigation water in DSR compared to transplanted rice (Mehala *et al*., 2016).

In India, 7.1 million ha rice is under direct seeding (Moorthy and Saha, 2002). In direct seeding, there are two methods (dry and wet seeding) based on the physical condition of seedbed preparation and seed (pre germinated or dry). Direct seeding of rice however, offers certain advantages like timely sowing, less drudgery, early crop maturity by 7-10 days, high tolerance to water deficit, low production cost, less methane emission etc., It also preserves natural resources especially underground water and maintains physical properties of soil. Whenever, hairline cracks appear on the soil, it is the criteria for irrigation scheduling in DSR. However, exact time interval for irrigation depends on particular soil type and evaporation demand in the atmosphere at that place. Weeds are the major hurdle for cultivation of direct-seeded rice. Weeds compete with direct-sown rice and reduce yield upto 30.17 per cent (Singh *et al*., 2005). The simultaneous

emergence of weeds with rice seedlings makes weed control in dry sown rice a complex phenomenon due to over lapping of planting and need for weed control. Manual weeding in direct-seeded rice fields is laborious and expensive. The traditional hand weeding practice needs to be substituted by chemical weed control which is timely and economical.

## MATERIAL AND METHODS

A field trail was conducted during *kharif*, 2016, which was laid out in the B - block of Agricultural Research Station, Jangamaheswarapuram, Gurazala, Guntur district, Andhra Pradesh. The experimental site was situated at an altitude of 349 m above the mean sea level, $16^0$ 31' Northern latitude and $79^0$ 38' Eastern longitude. It is located in the Krishna Agro-climatic zone of Andhra Pradesh. The experimental soil was sandy loam in texture, strongly alkaline ($p^H$ 8.57) in reaction with low organic carbon (0.49%) and available nitrogen (142 kg $ha^{-1}$), high in available phosphorus (56 kg $ha^{-1}$) and available potassium (435 kg $ha^{-1}$). The experiment was laid out in split plot design with irrigation schedules in main plots and weed management treatments in sub plots with three replications. The treatments consisted of $I_1$-1.5 IW/CPE ratio, $I_2$-2.0 IW/CPE ratio, $I_3$-3.0 IW/CPE ratio and $I_4$- continuous submergence) as main plots and $W_1$- control, $W_2$ - hand weeding at 20 DAS and 35 DAS, $W_3$ - pendimethalin @ 1 kg a.i. $ha^{-1}$ (PE) *fb*. hand weeding at 25 DAS, $W_4$ - pendimethalin @ 1kg a.i. $ha^{-1}$ (PE) *fb*. bispyribac sodium 25 g a.i. $ha^{-1}$ at 15- 20 DAS, $W_5$ - pendimethalin @ 1 kg a.i. $ha^{-1}$ (PE) *fb*. bispyribac sodium 25 g a.i. $ha^{-1}$ at 15 – 20 DAS *fb*. metsulfuron methyl + chlorimuron ethyl 8 g a.i. $ha^{-1}$ at 35 – 40 DAS as sub plots. The test variety BPT 5204 (Samba Mahsuri) was sown on 2nd August 2016. A total of 905.7 mm rainfall received during crop growth period. Sowing was done manually by dibbling. The irrigations water scheduled on the basis of pan evaporation data using (USWB class A pan evaporimeter). Irrigation was given as and when the Cumulative Pan Evaporimeter (CPE) reached to 40mm, 30mm and 20mm in the treatments 1.5, 2.0 and 3.0 IW/CPE ratios, respectively. The depth of irrigation water applied at each irrigation was fixed at 60mm. Under continuous submergence treatment, 5 cm depth of water was maintained throughout the crop growth period. Pendimethalin @ 1kg a.i. $ha^{-1}$ was applied immediately after sowing as pre-emergence application; bispyribac sodium @ 25g a.i. $ha^{-1}$ was applied as post emergence application at 15-20 DAS and metsulfuron methyl + chlorimuron ethyl @ 8 g a.i. $ha^{-1}$ at 35-40 DAS. Hand weeding operation was also carried at 20, 25 and 35 DAS as per the treatment. The data on plant height, drymatter accumulation, tillers per $m^{-2}$ and yield attributes were recorded as per standard statistical procedures adopting Gomez and Gomez (1984) standard procedures.

## RESULTS AND DISCUSSION

### Effect of irrigation:

The influence of irrigation schedules on plant height was found to be non significant at different stages of crop growth. Among the different irrigation treatments applied, continuous submergence ($I_4$) recorded significantly highest plant height (Table.1), which was on par with the irrigation treatment at 3.0 IW/CPE ratio, over irrigation with 1.5 and 2.0 IW/CPE ratios. The highest number of tillers produced due to continuous submergence was found to be on a par with that of irrigation at 3.0 IW/CPE ratio. Similarly, drymatter accumulation at irrigation levels $I_4$ and $I_3$ was found to be at par with each other at harvest. Similarly, there was no significant difference between the treatments $I_1$ and $I_2$ in accumulation of drymatter at harvest. Earlier Shekara *et al*., (2010) also concluded that higher drymatter accumulation due to increased frequency of irrigation that led to effective uptake of water and nutrients. The maximum number of productive tillers recorded under continuous submergence was significantly higher than irrigation with IW/CPE ratios 2.0 and 1.5; though, it was found to be on a par with that of irrigation at 3.0 IW/CPE ratio. The productive tillers produced under irrigations at IW/CPE ratios 1.5, 2.0 and 3.0 were at par among themselves. The number of filled grains $panicle^{-1}$ recorded with irrigation at 3.0 IW/CPE ratio ($I_3$) i.e, (Table.2) was found comparable with that of continuous submergence which in turn recorded the maximum number of grains per panicle. On the other hand, differences were not significant among irrigation levels through IW/CPE ratios of 3.0, 2.0 and 1.5 in increasing number of filled grains per panicle. This might be due to the fact that increased frequency of irrigation might have led to effective uptake of water and nutrients by the rice plants. Ramamoorthy *et al*., (1998) and Shekara *et al*., (2010) reported similar increase in filled grains per panicle with higher frequency of irrigations to upland direct-seeded rice. Among the irrigations given based on IW/CPE ratio, irrigation at 3.0 IW/CPE ratio ($I_3$) resulted in significantly higher grain yield over other two irrigation levels. The maximum grain yield produced under continuous submergence ($I_4$) was comparable with that of 3.0 IW/CPE ratio ($I_3$). Difference between irrigation levels scheduled at IW/CPE ratio 1.5 ($I_1$) and 2.0 ($I_2$) was not significant in increasing the grain yield. Similarly, the straw yield produced by irrigation at $I_3$ (3.0 IW/CPE) found significantly superior to other irrigation levels ($I_2$ and $I_1$). Continuous submergence ($I_4$) recorded the maximum straw yield and was found significantly

**Table 1: Growth and yield parameters in dry sown rice as influenced by irrigation schedules and weed management options.**

| Treatments | Plant height (cm) at harvest | Drymatter accumulation at harvest (kg ha-1) | Tillers $m^{-2}$ at 130 DAS | Productive tillers(m-2) |
|---|---|---|---|---|
| Irrigation schedules | | | | |
| $I_1$ - 1.5 IW /CPE ratio | 66.3 | 14428.8 | 573.3 | 484.5 |
| $I_2$ - 2.0 IW /CPE ratio | 66.3 | 15109.2 | 586.3 | 489.8 |
| $I_3$ - 3.0 IW /CPE ratio | 66.9 | 15986.8 | 612.3 | 502.6 |
| $I_4$- Continuous submergence | 66.4 | 17443.4 | 621.7 | 515.7 |
| SEm± | 1.29 | 330.51 | 10.03 | 6.35 |
| CD (p=0.05) | NS | 1143.7 | 34.7 | 21.9 |
| CV (%) | 7.5 | 8.1 | 6.4 | 4.9 |
| Weed management options | | | | |
| $W_1$- Control | 62.7 | 14121.8 | 562.9 | 465 |
| $W_2$ -2 HW at 20 & 35 DAS | 69.1 | 17418.8 | 632.5 | 538.3 |
| $W_3$ -Pendimethalin + HW at 25 DAS | 67.8 | 16405.9 | 609.2 | 516 |
| $W_4$ -Pendimethalin + Bispyribac Sodium | 66 | 14850.1 | 584.6 | 473.3 |
| $W_5$- Pendimethalin + Bispyribac sodium + Metsulfuron & Chlorimuron | 66.8 | 15913.7 | 602.9 | 498.3 |
| SEm± | 1.06 | 285.08 | 10.52 | 9.05 |
| CD (p=0.05) | 3 | 818.8 | 30.1 | 26 |
| CV(%) | 5.5 | 6.2 | 6 | 6.3 |
| Interaction (I×W) | NS | NS | NS | NS |

superior to that of all other irrigation schedules. Though maximum harvest index was recorded with irrigation with 1.5 IW/CPE ratio, the differences in harvest index among the irrigation schedules based on IW/CPE ratios were not significant. Continuous Flooding (CF) provides a favorable water and nutrient supply under anaerobic conditions. However, the conventional system consumes a large amount of water approximately 1900 to 5000 liters of water to produce 1 kg of grain (Haefele *et al*., 2009). On the other hand, irrigation at 3.0 IW/CPE ratio found equally effective as that of continuous submergence in increasing grain yield and higher harvest index was observed under irrigation schedules based on IW/CPE ratio over continuous submergence. This clearly indicates that submerged paddy field is not necessarily the only solution for optimum production. These findings are in accordance with the findings of Oliver *et al*., (2008) and Balasubramanian and Krishnarajan (2001).

**Effect of weed management options:**

Manual weeding twice at 20 and 35 DAS ($W_2$) followed by pendimethalin + one hand weeding at 25 DAS ($W_3$) recorded higher plant height compared to other treatments. The differences in plant height were significant throughout the crop growing period. A significant increase in number of tillers $m^{-2}$ were observed with two hand weedings ($W_2$) at 20 and 35 DAS (Table. 1) over rest of the weed management treatments. It was followed by application of pre-emergence herbicide + hand weeding ($W_3$) and sequential application of herbicides ($W_4$ and $W_5$) at most of the crop growing period and found on a par with each other.

The maximum drymatter accumulation recorded with application of pendimethalin *fb* hand weeding ($W_3$) over pendimethalin + bispyribac sodium ($W_4$) and control ($W_1$). Treatmental differences with respect to increasing productive tillers were not significant between two hand weedings at 20 and 35 DAS ($W_2$) and pendimethalin + hand weeding ($W_3$). The number of grains and filled grains per panicle were more with hand weeding twice at 20 and 35 DAS ($W_2$) (Table.2) and found to be on a par with application of pendimethalin + one HW at 25 DAS ($W_3$). The differences between herbicides alone treatments ($W_4$)

**Table 2: Yield parameters in dry sown rice influenced by irrigation schedules and weed management options**

| Treatments | Total Grains Panicle $^{-1}$ | Filled Grains Panicle $^{-1}$ | Test weight (g/1000 grains) | Grain yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|
| Irrigation schedules | | | | | | |
| $I_1$ -1.5 IW /CPE ratio | 121.5 | 111.6 | 13.9 | 5431 | 7569 | 42 |
| $I_2$ - 2.0 IW /CPE ratio | 124.8 | 113 | 14.2 | 5632 | 7890 | 41.9 |
| $I_3$ -3.0 IW /CPE ratio | 128.2 | 116.9 | 14.6 | 6142 | 8606 | 41.9 |
| $I_4$ -Continuous submergence | 132.2 | 122.5 | 14.8 | 6307 | 9604 | 39.2 |
| SEm± | 2.86 | 2.06 | 0.2 | 113.01 | 118.2 | 0.4 |
| CD (p=0.05) | NS | 7.1 | NS | 391 | . 409 | 1.4 |
| CV (%) | 8.7 | 6.8 | 5.3 | 7 | 5 | 3.7 |
| Weed management options | | | | | | |
| $W_1$- Control | 116.1 | 105.8 | 13.6 | 5298 | 7300 | 42.3 |
| $W_2$ -2 HW at 20 & 35 DAS | 138.2 | 128.3 | 15.5 | 6555 | 9470 | 41.2 |
| $W_3$ -PM + HW at 25 DAS | 132.7 | 120.6 | 14.6 | 6061 | 8831 | 41.1 |
| $W_4$ -PM + Bispyribac Sodium | 120.8 | 111.3 | 14 | 5648 | 8143 | 41.1 |
| $W_5$ -PM + Bispyribac sodium + Metsulfuron &Chlorimuron | 125.5 | 114 | 14.2 | 5827 | 8342 | 41.4 |
| SEm± | 2.06 | 3.22 | 0.23 | 95.89 | 162.78 | 0.6 |
| CD (p=0.05) | 5.9 | 9.2 | 0.6 | 275 | 467 | NS |
| CV(%) | 5.6 | 9.6 | 5.4 | 5 | 6 | 5.8 |
| Interaction (I×W) | NS | NS | NS | NS | NS | NS |

and ($W_5$) was not significant in increasing total grains per panicle. Whereas, in case of filled grains the differences were not significant among the treatments $W_3$, $W_4$ and $W_5$.

The highest grain yield and straw yield were recorded with two hand weedings ($W_2$) and found significant over all other treatments. Application of pendimethalin + hand weeding which recorded significantly higher grain yield over herbicides alone treatments ($W_4$ and $W_5$). Whereas, the differences between the weed management options, i.e., sequential application of herbicide treatments ($W_4$ and $W_5$) were not significant in increasing grain and straw yields. For season long protection to dry sown rice from weeds sequential herbicides applications of either two or three herbicides may be needed. Earlier Helms *et al.,* (1995), Kim and Ha, (2005) and MCauley *et al.*(2005) also expressed the importance of pre and post emergence herbicide application in DSR.

## CONCLUSION

Overall, pre emergence herbicide application along with manual weeding ($W_3$) which has the highest Weed Control Efficiency or sequential application of herbicides ($W_4$ and $W_5$) with alternate irrigations based on 3.0 IW/CPE ratio which received more frequent irrigations was found to be advantageous comparatively with higher growth, yield parameters and yield of dry sown rice.

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