Ann. For. Res. 65(1): 10123-10132, 2022
ISSN: 18448135, 20652445

ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

# EVALUATION OF PRE AND POST EMERGENCE HERBICIDES THROUGH HERBIGTION BASED WEED MANAGEMENT PRACTICES ON GROWTH AND YIELD OF DIRECT SOWN AEROBIC RICE (*Oryza sativa* L.)

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A Field experiment was conducted at Annamalai University experimental farm during the seasons of *Summer*, 2020. to find out the effect of herbigation based weed management practices in direct sown aerobic rice on growth and yield of rice. The experiment was laid out in randomized block design with eight treatments and replicated thrice. The results showed that among the different herbicidal treatments, PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha$^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL ha$^{-1}$ on 20 DAS recorded lower total weed density (48.70 m$^{-2}$) and dry weight of weeds (242.48 kg ha$^{-1}$), higher weed control index (84.02 %) on 60 DAS which contributed to receive higher growth attributes of plant height ( 145.2 cm), LAI (6.41) and yield parameters of no. of tillers m$^{-2}$ (454), no. of filled grains panicle$^{-1}$ (132), test weight ( 19.6 g) which increased the grain yield (6156 kg ha$^{-1}$) and straw yield (9334.9 kg ha$^{-1}$) due to effective management of weeds in rice crop and it was on par with PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha$^{-1}$ on 3 DAS *fb* HW on 30 DAS which was significantly superior to other treatments. However weedy check recorded lower values in terms of growth and yield attributes due to heavy weed infestation.

**Key words:** Drip Irrigation, Weed management, Herbigation, Direct sowing, Aerobic rice

## Introduction

India has the largest area among rice growing countries and ranks second in production. It produces 100 million tonnes of rice in an area of 43.97 million hectares with the productivity of 2.27 tonnes per hectare. Rice occupies about 26 per cent of total cropped area of the country and contributes 44 per cent of total food grain production and 45 per cent of total cereal production. As one of the prime food crop, rice is consumed by more than half of the world population providing around 20 per cent of the world's dietary energy supply. In Tamil Nadu, rice is grown in an area of 1.85 million hectare with a production of 6.95 million tonnes and productivity of 3.7 t ha$^{-1}$ (Anonymous., 2019) This is crucial for food security in many Asian countries including India. Food and water are two of the most important necessities for survival, but with an increasing demand for food and a looming water crisis, a shortage of both may be on the horizon unless innovative technologies are developed. About 90 per cent of rice grown in the world is produced and consumed in the Asian region. About 1.2 billion people live in areas where severe water shortages and scarcity challenge agriculture, with very high drought frequency in rainfed cropland and pastureland areas or very high water stress in irrigated areas. This means that about one out of six people on the planet face severe water shortages or scarcity in agriculture, with about 15 per cent of the rural population being at risk (FAO, 2020) Water supply to agriculture may be impacted due to increased demand for domestic, municipal, industrial, and environmental purposes in the near future. Shortage of water for irrigation may affect the rice production severely, particularly in the light of climate change (Vijayakumar *et al*., 2022). India where large and dense populations depend on subsistence agriculture (Thakur *et al*., 2014). In major rice growing areas, farmers are already facing a challenge to produce more rice with limited water in order to meet the food demand of the growing population. Recently, drip irrigation can be recommended for aerobic rice to increase the productivity besides saving water. Drip irrigated rice is a new innovative production system in which seeds are directly sown in well-drained and non puddled soil using mechanized multi-crop seed drills and the crop is grown in unsaturated soil moisture conditions for the entire crop duration (Sharda *et al*., 2017). It involves using high yielding varieties well-adapted to aerobic conditions and responsive to irrigation and fertigation, attaining high yields (Sharma *et al*., 2018). Direct-seeded aerobic rice is subject to more severe weed infestation than transplanted lowland rice, because in aerobic rice systems weeds germinate simultaneously with rice, and there is no water layer to suppress weed growth. In aerobic rice, weeds cause yield loss to an extent of 56.4 to 90.70 per cent (Paradkar *et al*., 1997). There is an equal competition between the crop and weeds in absorption of nutrients to avoid this weed management is an important agro-technique for successful cultivation of aerobic rice. Weed free condition during the critical period of competition is absolutely essential for obtaining maximum yield. This can be achieved by either application of pre emergence or post emergence or combination of both or manual weeding. Manual weeding although effective and most common practice of weed control in rice, increasing labour wages and scarcity of labour during peak period of agricultural operation lead to the search for alternative methods. Herbicides offer the most effective, economical and practical way of weed management. Herbigation is another technique, where herbicides are applied through ventury along with the irrigation water and applying through the irrigation system to crop, weed or field (Jagadish *et al.,* 2016). However, it requires detailed investigation. In drip irrigated aerobic rice, there is possibility to adopt herbigation through drip irrigation system along with other weed control methods, whose efficiency needs to be worked out. Hence, the present investigation was undertaken to study the effect of different herbicide combinations through herbigation along with manual weeding.

**Materials and Methods**

A Field experiment was conducted at Annamalai University experimental farm. during the seasons of Kharif 2020, to find out the effect of herbigation based weed management practices on growth and yield of direct sown aerobic rice. The field trial was conducted in the experimental field plot of Q8 Block at Annamalai University experimental farm. The experimental farm is situated at 11°24'N latitude, 79°41'E longitude at an altitude of 5 .79 m above mean sea level, the maximum temperature ranged from 38.4 ºC to 30.6 ºC with a mean of 34.3 ºC and minimum temperature ranged from 27.2 ºC to 20.9 ºC with a mean of 24.8 ºC. The relative humidity ranged from 92 to 75 per cent with a mean of 82.26 per cent. The bright sunshine hours and wind velocity ranged from 9.7 h $d^{-1}$ to 4.6 h $d^{-1}$ and from 6.9 km $h^{-1}$ to 1.3 km $h^{-1}$ with a mean of 7.7 h $d^{-1}$ and 3.55 km $h^{-1}$ respectively. The soil of the experimental field was clay loamy soil with pH of 7.2 and EC of 0.32 dS $m^{-1}$ and low in medium in available nitrogen, low in phosphorus, and high in potassium, contents respectively. The experiment was conducted in randomized block design with 8 treatments which are replicated thrice. $T_1$-PE herbigation of pendimethalin 1.0 kg $ha^{-1}$on 3 DAS *fb* HW on 30 DAS, $T_2$-PE herbigation of pyrazosulfuron ethyl 10 % WP @ 500 g $ha^{-1}$ on 3 DAS *fb* HW on 30 DAS, $T_3$-PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg $ha^{-1}$ on 3 DAS *fb* HW on 30 DAS, $T_4$-PE herbigation of pendimethalin 1.0 kg $ha^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribacsodium 10 % SC @ 200 ml $ha^{-1}$ on 20 DAS, $T_5$- PE herbigation of pyrazosulfuron ethyl 10 % WP @ 500 g $ha^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL $ha^{-1}$ on 20 DAS, $T_6$ - PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg $ha^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL $ha^{-1}$ on 20 DAS ,$T_7$- Weed free check, $T_8$-Weedy check. A medium duration variety AU 1 GSR was used in the trial. Manual line sowing of seeds has done in the finely prepared dry soil. Drip system was installed with the lateral spacing of 100 cm and emitter/dripper spacing of 60 cm. Discharge rate of drippers was 4.0 litre per hour. Irrigation was given at every three days based on Pan Evaporation from open pan evaporometer (USWB class A) situated at Agro meteorology observatory, Annamalai university, Chidambaram throughout the cropping period. Recommended dose of fertilizer (150:50:50 kg N P K $ha^{-1}$) was adopted as fertigation. Control valves were fixed in all the plots to facilitate controlling the water flow and application of herbicides as per treatments. Herbigation was preceded by drip irrigation for 30 minutes and the irrigation was done for 30 minutes after herbigation to get spread the chemicals completely and uniformly.

Biometric observations on weed flora, total weed count, weed dry matter production and weed control efficiency, grain yield and weed index were recorded. Weed count was recorded by using 0.25 $m^{-2}$ quadrate at four places in each plot and expressed as number $m^{-2}$. Weed dry weight in each treatment was worked out taking the weeds from net plot area, sundried followed by drying at 60 ºC till it attained constant weight. Square root transformation (x+0.5) was used to analyse the data on weeds.

Indices were calculated after reviewing the literatures. Formula of (Mishra and Tosh 1979) was adopted for computing the weed control efficiency. Indices calculated are as follows:

$$\text{(WCI)} = \frac{\text{Weed dry weight in control} - \text{Weed dry weight in treated plot}}{\text{Weed dry weight in control}}$$

**Statistical analysis:**

The data on weeds were statistically analysed (Gomez and Gomez, 1984). The data on weed density and weed dry weight were subjected to square root transformation $\sqrt{(x+0.5)}$ before analysis. The critical difference was worked out at five present probability level.

**Results and Discussion**

The predominant weeds observed in the field were weed species like *Echinocloa colona*, *Leptochloa chinensis*, *Panicum repens, Cynodan dactylon,* among grasses *Cyperus rotundus , Cyperus difformis* among sedges *Eclipta alba, Trianthema portulacastrum, Phyllanthus maderaspatensis, Phyllanthus niruri,* among Broad leaved weeds .whereas*, Chloris barbata Euphorbia prostrata, Commelena benghalensis, Portulaca olereceae* occurred only negligible proportions which are rare in occurrence . Similar weed species under direct sown aerobic rice were also reported by Kanimozhi (2019); Nambi (2017); Jagadish (2015).

**Effect on weeds:**

Application of pre emergence herbicides and post emergence herbicides had a significant effect on weed density, weed dry weight and weed control index (Table 1. and Fig. 1.) on 60 DAS. Among herbigation based weed management practices in direct sown aerobic rice $T_6$ - with PE application of PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6% GR @ 10 kg $ha^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL $ha^{-1}$ on 20 DAS registered significantly lower weed density (48.70 $m^{-2}$), Weed dry weight (242.48 kg $ha^{-1}$) and higher WCI (84.02) at 60 DAS .This is due to application of pretilachlor + bensulfuron methyl herbigation controlled the weeds effectively by preventing through inhibition of mitosis, cell division and acetolactate synthase (Sunil *et al*., 2010). compared to other herbigation treatments by preventing germination of suspectable weed species and also reduce the growth of germinated weeds. This is on par with by PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg $ha^{-1}$ on 3 DAS *fb* HW on 30 DAS. However, free recorded lower weed density, weed dry weight and higher WCI among all the treatments. Weedy check registered higher weed density (286.96 $m^{-2}$), dry weight (1517 kg $ha^{-1}$) and lower WCI on 60 DAS because of more weed population and its dominance in utilizing the sunlight, nutrients, moisture etc., similar observation was also recorded by (Yadav *et al*., 2012) These results are in line with the findings of Nagarjun *et al*., (2019) and Abhishek *et al*., (2017).

**Effect on crop growth and yield**

Growth and yield attributes of direct sown aerobic rice under drip irrigation varied significantly due to herbigation based weed management practices. Weed free plot treatment recorded significantly higher growth (Table 2. and Fig. 2.) and yield attributes (Table 3. and Fig. 3.) as compared to the other treatments. Among the herbigation based weed management practices of with PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6% GR @ 10 kg $ha^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 ml $ha^{-1}$ on 20 DAS recorded significantly highest plant height (145.2 cm), LAI (6.41) and number of tillers (454 $m^{-2}$), number of filled grains $panicle^{-1}$ (132) than all other treatments except weed free treatment. However, it was on par with PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg $ha^{-1}$ on 3 DAS *fb* HW on 30 DAS plant height (144.9 cm), LAI (6.39) and number of tillers (452 $m^{-2}$), number of filled grains $panicle^{-1}$ (132). The combination of two herbicides controlled the weeds both first flush as well as later emerged weeds. Application of bispyribac sodium 25 g $ha^{-1}$ interfered with production of a plant enzyme necessary for growth and development named acetolactate synthase (ALS) led to effectively controlled the emerged weeds during critical stages and maintain the weed free from crop weed competition resulted in lesser competition by weeds for nutrients, space and light ultimately increased plant growth and yield parameters and finally rain yield. These findings are in corroboration with the findings of Abhishek *et al*., (2017) who stated that pre emergent herbigation of pretilachlor + bensulfuron methyl 6.6 % GR @ 10 kg ha$^{-1}$ *fb* post emergent herbigation of bispyribac sodium 10 % SC at 200 mL ha$^{-1}$ + one hand weeding have resulted higher grain and straw yield of drip irrigated aerobic rice. The lowest plant height (130 cm), LAI (3.91) less number of tillers (365 m$^{-2}$), filled grains (112 panicle$^{-1}$) and Test weight of (19.54 gm) were recorded in weedy check plot. This was due to severe weed competition with crop plants for water, nutrients, light, space and atmosphere ($CO_2$) that reduced the plant growth and resulted in lower yield components and grain yield.

Among different herbigation based weed management practices highest grain yield (9,160 kg ha$^{-1}$) and straw yield ( 9,335 kg ha$^{-1}$ ) were recorded at harvest with PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha$^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL ha$^{-1}$ on 20 DAS (Table 3), where 55 % of higher grain yield was noticed this was due to better control of weeds as this weed free condition resulted in availability of more amount of space, nutrients, moisture and light to the crop which in turn put forth better growth in terms of higher functional leaf area, more number of tillers m $^{2}$ , more number of panicles m$^{-2}$, higher number of grains panicle$^{-1}$ and higher test weight which contributed for higher grain yield and straw yield . This was due to better control of all types of weeds during most part of the crop growth which was next to weed free treatment. Weedy check recorded lowest grain and straw yield. However there is no significant difference in harvest index.

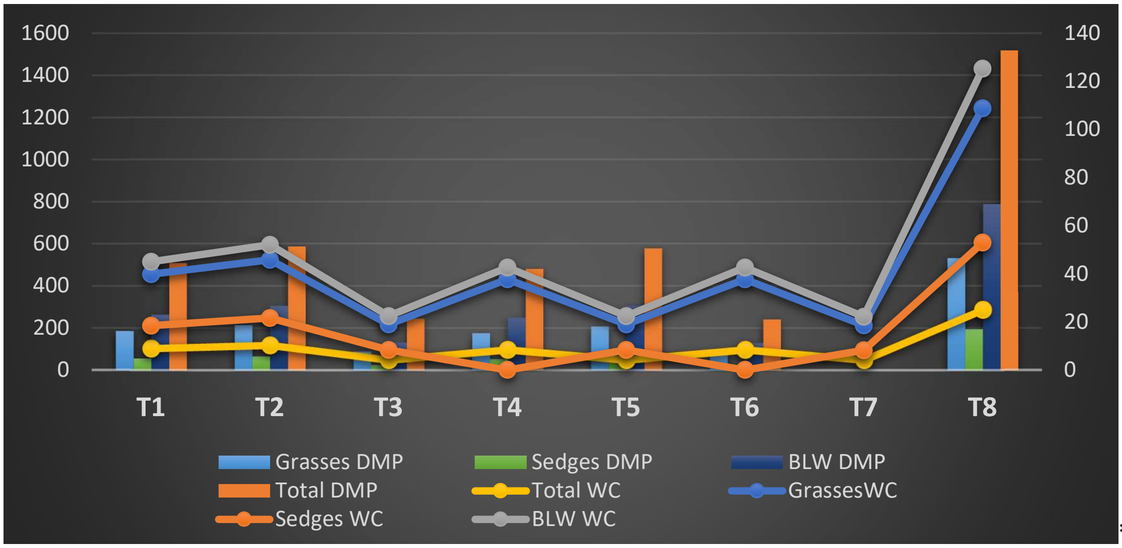
**Conclusion:**

The above study indicates that PE herbigation of pretilachlor 6% + bensulfuron methyl 0.6 % GR @ 10 kg ha$^{-1}$ on 3 DAS *fb* PoE herbigation of bispyribac sodium 10 % SC @ 200 mL ha$^{-1}$ on 20 DAS has recorded significantly higher plant height, LAI, no. of tillers and total grains panicle $^{-1}$, while it recorded lowest weed density and weed dry matter production with highest WCI test weight were not affected by different weed management practices. This treatment also found statistically superior in terms of grain yield and straw yield and it was on par with PE herbigation of pretilachlor 6 % + bensulfuron methyl 0.6 % GR @ 10 kg ha$^{-1}$ on 3 DAS *fb* HW on 30 DAS. The experiment concluded that there was a reduction of yield by 55.4 % due to presence of weeds as compared to weed free plot. Hence, it is recommended to practice the above herbicide combination through herbigation in drip irrigated aerobic rice to get efficient control of weeds to receive higher grain yield.

**Table 1. Effect of herbigation based weed management practices on weed density and dry matter production weed control index on 60 DAS in direct sown aerobic rice**

| Treatments | Total weed count (no. $m^{-2}$) 60 DAS | | | | Dry matter production (kg $ha^{-1}$) 60 DAS | | | | WCI (%) 60 DAS |
|---|---|---|---|---|---|---|---|---|---|
| | Grasses | Sedges | BLW | Total weed count | Grasses | Sedges | BLW | Total | |
| $T_1$ | 6.35 (39.79) | 4.34 (18.37) | 6.74 (44.93) | 10.18 (103.09) | 187.01 | 56.94 | 265.08 | 509.04 | 66.46 |
| $T_2$ | 6.80 (45.77) | 4.70 (21.56) | 7.24 (51.96) | 10.94 (119.29) | 215.12 | 66.83 | 306.56 | 588.51 | 61.22 |
| $T_3$ | 4.41 (18.97) | 2.97 (8.30) | 4.78 (22.36) | 7.08 (49.63) | 89.16 | 25.73 | 131.92 | 246.81 | 83.74 |
| $T_4$ | 6.18 (37.67) | 4.24 17.46) | 6.56 (42.51) | 9.91 (97.64) | 177.05 | 54.12 | 250.80 | 481.984 | 68.24 |
| $T_5$ | 6.70 (44.44) | 4.57 (20.38) | 7.25 (52.12) | 10.84 (116.94) | 208.87 | 63.13 | 307.50 | 579.554 | 61.81 |
| $T_6$ | 4.36 (18.52) | 2.93 (8.08) | 4.75 (22.10) | 7.01 (48.70) | 87.04 | 25.0 | 130.39 | 242.48 | 84.02 |
| $T_7$ | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.71 (0.00) | 0.00 | 0.00 | 0.00 | 0.00 | 98.39 |
| $T_8$ | 10.45 (108.80) | 7.31 (52.92) | 11.21 (125.24) | 16.95 (286.96) | 533.12 | 195.81 | 789.01 | 1517.9 | 0.00 |
| S.Ed | 0.13 | 0.09 | 0.14 | 0.21 | 4.10 | 1.3 | 5.97 | 11.43 | NA |
| $CD_{(p=0.5)}$ | 0.29 | 0.20 | 0.31 | 0.46 | 8.70 | 2.8 | 12.6 | 24.22 | NA |

* *Figures in parenthesis indicates original values, DAS-Days after sowing, BLW- Broad leaved weeds,NA- statistically not analysed.




**WC-Weed Count DMP-Dry matter production

Fig 1: Weed density and weed dry matter production on 60 DAS as influenced by various herbigation based weed management practices in direct sown aerobic rice

**Table-2 Effect of herbigation based weed management practices on plant height, leaf area index, no. of tillers m$^{-2}$, total no. of filled grains panicle$^{-1}$, test weight.**

| Treatments | Plant height (cm) | Leaf area index | No. of tillers m$^{-2}$ | No. of filled grains$^{-1}$ | Test weight (g) |
|---|---|---|---|---|---|
| $T_1$ | 138.1 | 4.95 | 439 | 128 | 19.58 |
| $T_2$ | 133.9 | 4.58 | 418 | 116 | 19.56 |
| $T_3$ | 144.9 | 6.39 | 452 | 132 | 19.59 |
| $T_4$ | 139.2 | 4.99 | 440 | 129 | 19.59 |
| $T_5$ | 134.2 | 4.66 | 430 | 117 | 19.58 |
| $T_6$ | 145.2 | 6.41 | 454 | 132 | 19.60 |
| $T_7$ | 146.3 | 6.43 | 470 | 133 | 19.60 |
| $T_8$ | 130.0 | 3.91 | 365 | 112 | 19.54 |
| S.Ed | 3.06 | 0.15 | 12.5 | 3.7 | NS |
| $CD_{(p=0.5)}$ | 6.51 | 0.32 | 25.6 | 7.9 | NS |

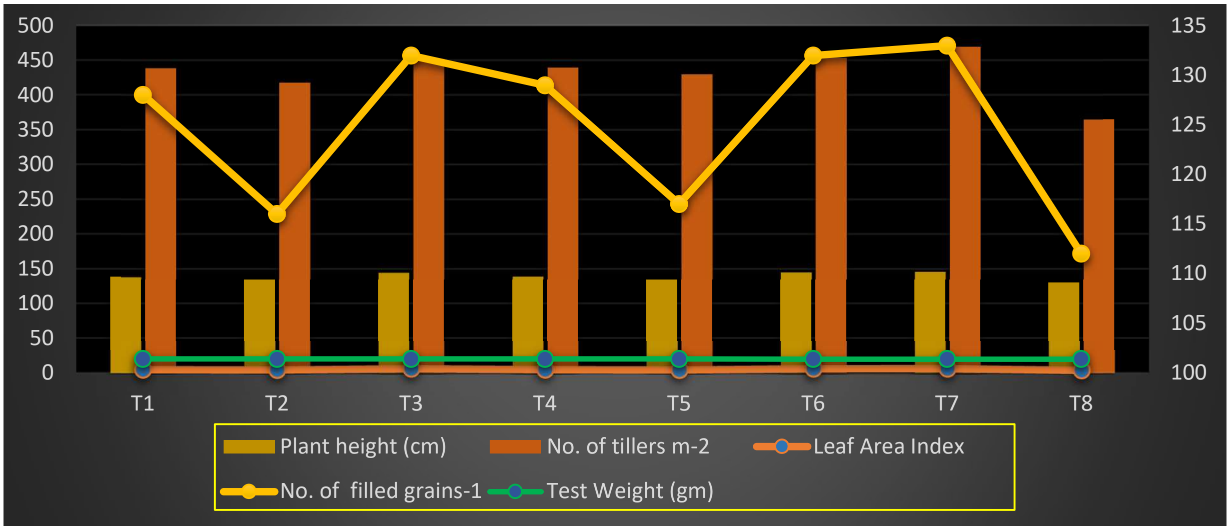



**Fig 2.** Plant height (cm), Leaf area index, No. of tillers m$^{-2}$, Total no. of filled grains panicle$^{-1}$, Test weight (g) as influenced by various herbigation based weed management practices in direct sown aerobic rice

**Table 3. Effect of herbigation based weed management practices in direct sown aerobic on Grain yield (kg ha$^{-1}$), Straw yield (kg ha$^{-1}$), Harvest index.**

| Treatment | Grain yield (kg ha$^{-1}$) | Straw yield (kg ha$^{-1}$) | Harvest index |
|---|---|---|---|
| $T_1$ | 5451.8 | 8504.7 | 39 |
| $T_2$ | 4100.5 | 6437.8 | 39 |
| $T_3$ | 6107.1 | 9160.6 | 40 |
| $T_4$ | 5544.9 | 8650.0 | 39 |
| $T_5$ | 4415.5 | 6932.3 | 39 |
| $T_6$ | 6156.6 | 9334.9 | 40 |
| $T_7$ | 6318.7 | 9478.1 | 40 |
| $T_8$ | 3500.2 | 5775.3 | 38 |
| S.Ed | 150.4 | 243.0 | NS |
| $CD_{(p=0.5)}$ | 314.6 | 494.0 | NS |

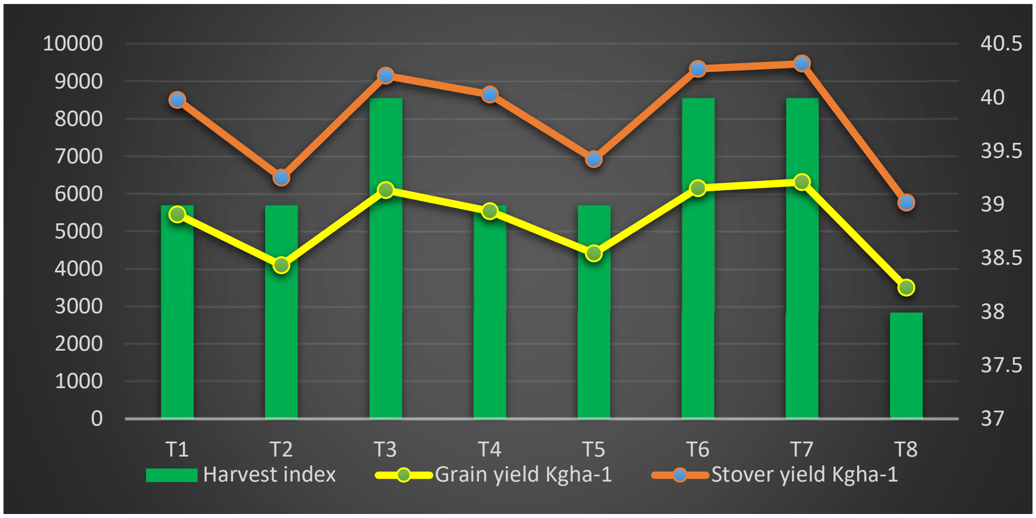



Fig 3. Grain yield, Straw yield and Harvest index as influenced by various herbigation based weed management practices in direct sown aerobic rice

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