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## Influence of tillage and weed management practices on growth, yield attributes and productivity of dry direct seeded rice

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### Abstract

A field experiment was conducted during the *kharif* season at the Agricultural Farm of Palli Siksha Bhavana, Visva-Bharati, Sriniketan, Birbhum, West Bengal, to evaluate the influence of tillage and weed management practices on growth, yield attributes and yield of dry direct seeded rice. The experiment was laid out in split plot design with three replications. Two tillage practices, namely zero tillage and conventional tillage, were assigned to main plots, while eight weed management practices were allotted to sub-plots. The results revealed that tillage practices did not significantly influence plant height, number of tillers  $m^{-2}$ , dry matter accumulation, yield attributes and grain yield. However, weed management practices exerted a significant influence on crop growth and productivity. Sequential application of oxadiargyl 90 g  $ha^{-1}$  /b fenoxaprop-p-ethyl + ethoxysulfuron 90 + 15 g  $ha^{-1}$  recorded superior growth parameters, better yield attributes and the highest grain yield of 3636 kg  $ha^{-1}$ . It was statistically at par with oxadiargyl /b penoxsulam + cyhalofop-butyl and weed free check. The unweeded control recorded the lowest grain yield of 910 kg  $ha^{-1}$  due to severe weed competition throughout the crop growth period. The study indicated that sequential herbicide application improved crop growth and yield formation by reducing weed interference during critical stages of dry direct-seeded rice.

**Keywords:** Zero tillage, conventional tillage, direct-seeded rice, herbicide, weed management

### Introduction

*Oryza sativa* L. is a major cereal crop and an important source of food for many people around the world. Rice is grown in India, where it makes a significant contribution to the food security and employment of the rural population. Conventional farming includes transplanting rice seedlings after puddling of the main field, which ensures better establishment of the crop and reduces weed infestation. Such a practice uses more water, labour, and energy and thus is less cost-effective in situations when labour and water are scarce (Duary *et al.*, 2016) <sup>[2]</sup>. In such circumstances, dry direct seeding of rice became one of the most rational methods for the cultivation of rice. This practice includes planting of rice seeds in the main field without puddling and transplanting, thus economizing irrigation water, labour, time and energy. Direct-seeded rice could save water and labour and also ripen earlier than transplanted rice in good conditions (Pathak *et al.*, 2013) <sup>[6]</sup>. The technique could be used in the zero and conventional tillage systems. However, the success of this method is mainly determined by weed control since they grow simultaneously. Without puddling and standing water, weeds such as grasses, sedges, and broadleaf weeds emerge along with the crop, competing for nutrients, moisture, light, and space. Such competition results in shorter plants, fewer tillers, less leaf area development, reduced dry matter, and finally low grain yield. In India, depending on the type of weed, weed density, competition period, and cropping system conditions, weeds cause up to 20–85% of the yield losses in direct-seeded rice (Duary *et al.*, 2015) <sup>[3]</sup>. Because of its productivity requirements like adequate tillering, leaf area expansion, dry matter accumulation, and grain fill, the need for weed control at the earlier and later stages of rice is crucial. Pre-emergence herbicides are effective in controlling the initial emergence of weeds, while post-emergence herbicides help in managing the later-emerging weeds. Therefore, sequential applications of pre-

and post-emergence herbicides will result in better crop performance, higher productivity and yield of dry direct-seeded rice (Mahajan & Chauhan, 2013; Patel *et al.*, 2018; Dhanapal *et al.*, 2018; Saravanane *et al.*, 2020) [4, 5, 1, 8].

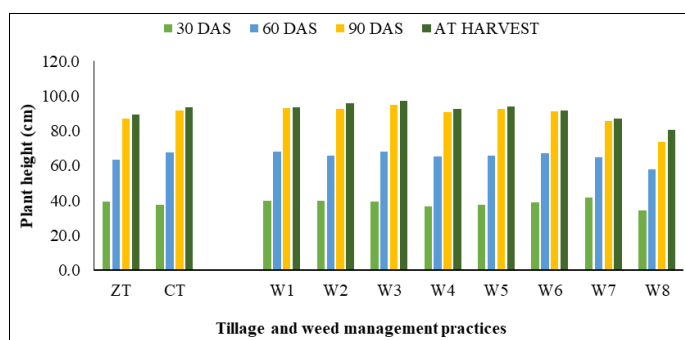
## Materials and Methods

The field experiment was conducted during kharif at the Agricultural Farm of the Institute of Agriculture, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, Birbhum, West Bengal, under lateritic soil conditions. The experiment was laid out in split plot design with three replications. Two tillage practices, namely zero tillage (ZT) and conventional tillage (CT), were assigned to main plots, while eight weed management practices were allotted to sub-plots i.e. W<sub>1</sub>- oxadiargyl fb bispyribac-sodium, W<sub>2</sub>- penoxsulam + cyhalofop-butyl, W<sub>3</sub>- oxadiargyl fb penoxsulam + cyhalofop-butyl, W<sub>4</sub>- fenoxaprop-p-ethyl + ethoxysulfuron, W<sub>5</sub>- oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron, W<sub>6</sub>- pendimethalin fb bispyribac-sodium, W<sub>7</sub>- weed free check and W<sub>8</sub>- unweeded control. Rice was sown directly under dry conditions. Pre-emergence herbicides were applied soon after sowing, while post-emergence herbicides were applied at 18 DAS. Recommended agronomic practices were followed uniformly in all treatments.

Observations were recorded on plant height, number of tillers m<sup>-2</sup>, yield attributes, grain and straw yield. The collected data were statistically analysed as per split plot design and treatment means were compared at 5 per cent level of significance.

## Results and Discussion

### Plant Height



Plant height, recorded at 30, 60, 90 DAS and at harvest, was not significantly influenced by tillage practices but was affected by weed management practices throughout crop growth. Plant height was higher under zero tillage at 30 DAS, whereas at 60, 90 DAS and harvest, conventional tillage recorded comparatively higher plant height than zero tillage.

At 30 DAS, the highest plant height was recorded in the weed-free plot (W<sub>7</sub>) (41.7 cm), which was at par with W<sub>1</sub>, W<sub>2</sub> and W<sub>3</sub> treatments. At 60 DAS, W<sub>3</sub> recorded the highest plant height (68.2 cm), comparable with all weed management treatments except the unweeded control (W<sub>8</sub>), which recorded the lowest

plant height (57.8 cm). At 90 DAS and at harvest, W<sub>3</sub> maintained higher plant height (95.1 and 97.2 cm, respectively), remaining at par with W<sub>1</sub>, W<sub>2</sub> and W<sub>5</sub>. The lowest plant height throughout all stages was observed in the unweeded control plot (W<sub>8</sub>).

### Number of tillers m<sup>-2</sup>

The Number of tillers m<sup>-2</sup> of rice was recorded at 30, 60 and 90 DAS, the results were statistically analysed and presented in Table 1. Higher number of tillers per square meter was observed at 60 DAS. Tillage had no significant effect on the number of tillers of DSR. However, conventional tillage produced more tillers per square meter by 2.12-4.62% as compared to zero tillage.

**Table 1:** No. of tillers of DDSR under different tillage and weed management practices

| Treatment                                                         | No. of tillers m <sup>-2</sup> |        |        |
|-------------------------------------------------------------------|--------------------------------|--------|--------|
|                                                                   | 30 DAS                         | 60 DAS | 90 DAS |
| <b>Tillage practices</b>                                          |                                |        |        |
| T <sub>1</sub> -Zero tillage                                      | 277                            | 301    | 268    |
| T <sub>2</sub> -Conventional tillage                              | 282                            | 315    | 281    |
| S.Em (±)                                                          | 6                              | 3      | 5      |
| LSD (P=0.05)                                                      | NS                             | NS     | NS     |
| <b>Weed management practices</b>                                  |                                |        |        |
| W <sub>1</sub> -Oxadiargyl fb bispyribac-sodium                   | 285                            | 315    | 280    |
| W <sub>2</sub> -Penoxsulam + cyhalofop-butyl                      | 245                            | 255    | 230    |
| W <sub>3</sub> -Oxadiargyl fb penoxsulam + cyhalofop-butyl        | 314                            | 361    | 322    |
| W <sub>4</sub> -Fenoxaprop-p-ethyl + ethoxysulfuron               | 266                            | 297    | 274    |
| W <sub>5</sub> -Oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron | 318                            | 364    | 329    |
| W <sub>6</sub> -Pendimethalin fb bispyribac-sodium                | 284                            | 309    | 267    |
| W <sub>7</sub> -Weed free check                                   | 311                            | 351    | 315    |
| W <sub>8</sub> -Unweeded control                                  | 210                            | 213    | 182    |
| S.Em (±)                                                          | 13                             | 16     | 10     |
| LSD (P=0.05)                                                      | 39                             | 46     | 30     |
| <b>Interaction</b>                                                | NS                             | NS     | NS     |

\* DAS = Day after sowing

Among herbicide treated plots, penoxsulam + cyhalofop-butyl (W<sub>2</sub>) recorded the lowest number of tillers 245, 255 and 230 m<sup>-2</sup> at 30, 60 and 90 DAS, respectively. Oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron (W<sub>5</sub>) recorded the highest tillers per unit area (318, 364 and 329 no. m<sup>-2</sup> at 30, 60 and 90 DAS, respectively) at par with oxadiargyl fb penoxsulam + cyhalofop-butyl (W<sub>3</sub>). Among weed management practices, unweeded control (W<sub>8</sub>) exhibited the lowest number of tillers 210, 213 and 182 m<sup>-2</sup> at 30, 60 and 90 DAS, respectively.

### Yield attributes

The data on yield attributes of dry direct seeded rice as influenced by tillage practices and weed management practices are presented in the Table.2

**Table 2:** Yield attributes of DDSR under different tillage and weed management practices

| Treatment                            | Yield Attributes    |                              |                                    |                                     |                 |
|--------------------------------------|---------------------|------------------------------|------------------------------------|-------------------------------------|-----------------|
|                                      | Panicle length (cm) | No. Panicles m <sup>-2</sup> | Total grains panicle <sup>-1</sup> | Filled grains panicle <sup>-1</sup> | Test weight (g) |
| <b>Tillage practices</b>             |                     |                              |                                    |                                     |                 |
| T <sub>1</sub> -Zero tillage         | 21.71               | 229                          | 78                                 | 58                                  | 22.75           |
| T <sub>2</sub> -Conventional tillage | 22.91               | 239                          | 86                                 | 60                                  | 22.99           |
| S.Em (±)                             | 0.46                | 6                            | 2                                  | 1                                   | 0.25            |
| LSD (P=0.05)                         | NS                  | NS                           | NS                                 | NS                                  | NS              |

| Weed management practices                                         |       |     |    |    |       |
|-------------------------------------------------------------------|-------|-----|----|----|-------|
| W <sub>1</sub> -Oxadiargyl fb bispyribac-sodium                   | 23.04 | 246 | 89 | 66 | 22.62 |
| W <sub>2</sub> -Penoxsulam + cyhalofop-butyl                      | 21.90 | 189 | 68 | 51 | 22.65 |
| W <sub>3</sub> -Oxadiargyl fb penoxsulam + cyhalofop-butyl        | 22.91 | 277 | 88 | 67 | 23.59 |
| W <sub>4</sub> -Fenoxaprop-p-ethyl + ethoxysulfuron               | 22.51 | 233 | 76 | 54 | 22.87 |
| W <sub>5</sub> -Oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron | 22.95 | 291 | 86 | 66 | 23.04 |
| W <sub>6</sub> -Pendimethalin fb bispyribac-sodium                | 22.28 | 223 | 79 | 59 | 23.27 |
| W <sub>7</sub> -Weed free check                                   | 22.81 | 273 | 93 | 69 | 23.10 |
| W <sub>8</sub> -Unweeded control                                  | 20.07 | 139 | 73 | 40 | 21.82 |
| S.Em (±)                                                          | 0.52  | 8   | 4  | 3  | 0.28  |
| LSD (P=0.05)                                                      | 1.50  | 23  | 13 | 8  | 0.81  |
| Interaction                                                       | NS    | NS  | NS | NS | NS    |

\* DAS = Day after sowing; S= Significant; NS= Non-significant

Among the tillage practices, conventional tillage recorded slightly higher values for all the yield attributes compared to zero tillage. The panicle length was higher under conventional tillage (22.91 cm) than zero tillage (21.71 cm). Similarly, the number of panicles m<sup>-2</sup> was higher in conventional tillage (239) compared to zero tillage (229). Total grains panicle<sup>-1</sup> and filled grains panicle<sup>-1</sup> were also higher under conventional tillage, with values of 86 and 60, respectively, compared to 78 and 58 under zero tillage. Test weight was also marginally higher in conventional tillage (22.99 g) than in zero tillage (22.75 g). However, the differences between tillage practices were found to be non-significant for all the yield attributes, indicating that tillage practices did not significantly influence panicle length, number of panicles m<sup>-2</sup>, total grains panicle<sup>-1</sup>, filled grains panicle<sup>-1</sup> and test weight.

Among weed management practices, there was significant variation in all yield attributes. From the treatments, W<sub>1</sub> showed the highest panicle length (23.04 cm) and W<sub>5</sub> the highest panicles m<sup>-2</sup> (291). The highest total grains panicle<sup>-1</sup> and filled grains panicle<sup>-1</sup> were registered from W<sub>7</sub>, which is weed-free check (93 and 69, respectively). The highest test weight was obtained from W<sub>3</sub> (23.59 g). On the other hand, W<sub>8</sub>- unweeded control had the lowest yield attributes except for panicle length, implying that competition between the crop and weed for nutrients, moisture, light and space was severe. In general, better weed management practices increased yield attributes through reducing competition and improving resources. The interaction effect between tillage practices and weed management practices was found to be non-significant for all the yield attributes, indicating that the response of weed management practices was similar under both zero tillage and conventional tillage conditions. Overall, the results indicated that tillage practices did not significantly influence yield attributes, whereas weed management practices had a significant effect. Among the weed management treatments, W<sub>5</sub>- Oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron, W<sub>3</sub>- Oxadiargyl fb penoxsulam + cyhalofop-butyl and W<sub>7</sub>- weed-free check performed better in improving yield attributes of dry direct seeded rice.

The improvement in yield attributes under effective weed management practices might be due to better weed control during the critical crop growth period, which reduced crop-weed competition for nutrients, moisture, light and space. This helped in better tillering, panicle formation and grain filling. The lower values under unweeded control may be due to severe weed infestation, resulting in poor crop growth and reduced translocation of photosynthates to grains. Similar findings were reported by Singh *et al.* (2016) [9] and Rao *et al.* (2008) [7].

#### Grain and Straw Yield

There was no significant difference between tillage practices for grain and straw yield of DDSR, as shown in Table 3. However,

conventional tillage recorded slightly higher grain yield and straw yield than zero tillage by 1.82 and 9.74 per cent, respectively. This might be due to better soil tilth, improved root growth and greater nutrient availability under conventional tillage.

**Table 3:** Yield of dry direct-seeded rice under different tillage and weed management practices

| Treatment                                                         | Yield (kg ha <sup>-1</sup> ) |             |
|-------------------------------------------------------------------|------------------------------|-------------|
|                                                                   | Grain yield                  | Straw yield |
| <b>Tillage practices</b>                                          |                              |             |
| T <sub>1</sub> -Zero tillage                                      | 2527                         | 4333        |
| T <sub>2</sub> -Conventional tillage                              | 2574                         | 4801        |
| S.Em (±)                                                          | 38                           | 121         |
| LSD (P=0.05)                                                      | NS                           | NS          |
| <b>Weed management practices</b>                                  |                              |             |
| W <sub>1</sub> -Oxadiargyl fb bispyribac-sodium                   | 2633                         | 5502        |
| W <sub>2</sub> -Penoxsulam + cyhalofop-butyl                      | 1406                         | 3615        |
| W <sub>3</sub> -Oxadiargyl fb penoxsulam + cyhalofop-butyl        | 3483                         | 5635        |
| W <sub>4</sub> -Fenoxaprop-p-ethyl + ethoxysulfuron               | 2538                         | 3801        |
| W <sub>5</sub> -Oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron | 3636                         | 5716        |
| W <sub>6</sub> -Pendimethalin fb bispyribac-sodium                | 2274                         | 4933        |
| W <sub>7</sub> -Weed free check                                   | 3526                         | 5367        |
| W <sub>8</sub> -Unweeded control                                  | 910                          | 1968        |
| S.Em (±)                                                          | 119                          | 178         |
| LSD (P=0.05)                                                      | 346                          | 517         |
| Interaction                                                       | NS                           | NS          |

Grain yield of DDSR was significantly influenced by weed management practices. The highest grain yield was recorded with oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron (W<sub>5</sub>) (3636 kg ha<sup>-1</sup>), which was statistically at par with weed free check (W<sub>7</sub>) (3526 kg ha<sup>-1</sup>) and oxadiargyl fb penoxsulam + cyhalofop-butyl (W<sub>3</sub>) (3483 kg ha<sup>-1</sup>). The lowest grain yield was recorded in unweeded control (W<sub>8</sub>). Oxadiargyl fb penoxsulam + cyhalofop-butyl (W<sub>3</sub>) recorded 59.63 per cent higher grain yield than penoxsulam + cyhalofop-butyl (W<sub>2</sub>). Similarly, oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron (W<sub>5</sub>) produced 30.19 per cent higher grain yield than fenoxaprop-p-ethyl + ethoxysulfuron (W<sub>4</sub>). Weed competition reduced the grain yield of DDSR by 74.97 per cent.

Straw yield was also significantly affected by weed management practices. The highest straw yield was obtained with oxadiargyl fb fenoxaprop-p-ethyl + ethoxysulfuron (W<sub>5</sub>) (5716 kg ha<sup>-1</sup>), which was statistically at par with oxadiargyl fb penoxsulam + cyhalofop-butyl (W<sub>3</sub>) (5635 kg ha<sup>-1</sup>).

Higher grain and straw yield under effective weed management was mainly due to reduced weed competition, better resource availability, improved tillering, grain filling and dry matter

production. Lower yield in unweeded control was due to severe crop-weed competition (Singh *et al.*, 2016; Rao *et al.*, 2008) <sup>[9, 7]</sup>.

## Conclusion

The study concluded that tillage practices did not significantly affect the growth, yield attributes and yield of dry direct seeded rice, as zero and conventional tillage performed similarly. However, weed management practices had a significant influence on crop performance. Sequential application of oxadiargyl followed by fenoxaprop-p-ethyl + ethoxysulfuron recorded superior growth and yield, followed by oxadiargyl fb penoxsulam + cyhalofop-butyl and weed free check. The poor performance of unweeded control indicated that weed competition was the major constraint in dry direct seeded rice. Therefore, oxadiargyl followed by suitable post-emergence herbicide combinations may be recommended for improving productivity under lateritic soils of eastern India.

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