

Effect of various tillage practices and herbicides on growth and yield of rice (*Oryza sativa* L.)

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Abstract

The field experiment was conducted at Crop Research Farm, Department of Agronomy, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, U.P., during *kharif* season of 2013 and 2014. The experiment was laid out in split plot design with four tillage practices *viz.* Transplanted rice in puddled soil, Transplanted rice in non puddled soil, Direct seeded rice in puddled soil and Direct seeded rice in non puddled soil were in main plot and five weed management practices (Weed free, Pyrazosulfuron at 0.20 kg ha⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS, Tank mix application of Bispyribac sodium at 0.25 litre ha⁻¹ + Fenoxaprop at 1.00 litre ha⁻¹ at 18 DAT/DAS, Tank mix application of Bispyribac sodium at 0.25 litre ha⁻¹ + Ethoxysulfuron at 0.12 kg ha⁻¹ at 18 DAT/DAS, Tank mix application of Fenoxaprop at 1.00 litre ha⁻¹ + Ethoxysulfuron at 0.12 kg ha⁻¹ at 18 DAT/DAS) along with weedy check in sub plot with three replication. Highest plant height, plant dry weight, and Relative Growth Rate were recorded in Transplanted rice in puddled soil while Crop Growth Rate is in Direct seeded rice in puddled soil. Among the weed management practices, maximum plant height, plant dry weight, Crop Growth Rate and Relative Growth Rate was recorded in weed free followed by Pyrazosulfuron at 0.20 kg ha⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS. More number of healthy grains panicle⁻¹, highest seed yield, straw yield and harvest index was recorded in Transplanted rice in puddled soil. However, Pyrazosulfuron at 0.20 kg ha⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS recorded significant maximum performance of above these parameters.

Keywords: Rice, Pyrazosulfuron, Bispyribac sodium, Fenoxaprop, Ethoxysulfuron Tillage practices

Introduction

In India, the major rice cultivation method used is manual transplanting of nursery grown seedlings into puddled soil. Puddling, a process of cultivating soil in standing water and consumes a large amount of water. Moreover, as water resources are depleting due to intensive use of toxic pesticides and also resulting in scarcity of water in many part of the world, as there is competition between industrial and agricultural consumption of water resources (Mahajan *et al.*, 2011, 2012) [4, 6]. There is a great concern that Indian rice growers will probably have inadequate access to irrigation water in the future (Mahajan *et al.*, 2013) [5]. Hence, shortage of irrigation water, threatens the sustainability of rice production in irrigated conditions (Chauhan *et al.*, 2012, 2014) [1, 3]. Industrialization also threatens rice production due to migration of rural labour to cities in search of job, which causes shortage of manual labour during the peak period of rice cultivation. This results in late transplanting, less acreage under rice, low yield and delay in planting of the next crop. The scarcity of labour has led to use of herbicides for weed control as it is cost effective and easy to apply. Herbicides used in rice for weed control are either pre or post emergence spray. Many new herbicides are present in the market with different composition to control weeds, reduce problem of residue build up and also inhibit resistance of weeds to herbicides (Rajkhowa *et al.* 2006, Saha *et al.* 2006) [8, 9]. In the use of herbicide recent trends is to find out an effective

method by using low dose, high efficiency which will not only reduce the volume of herbicide but also the application become easier and economical (Pal and Banerjee 2007) [7]. The use of a single herbicide, however, does not provide effective weed control in DSR because of the complex mixture of weed species (Chauhan, 2012) [1]. So, there is high need to make combination of different herbicides for control of complex weed flora in different seeding techniques.

Materials and Methods

The field experiment was conducted during *kharif* season of 2013 at Crop Research Farm, Department of Agronomy, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, (U.P.). The soil was well drained, sandy loam in texture with pH 7.78. Mechanical and chemical analysis of soil was done before experiment to know the initial status of the soil. The soil was having 59.6% sand, 25.27% silt and 15.13% clay with 0.42% organic carbon, 238.12 kg/ha available N, 20.05 kg/ha available P and 256.44 kg/ha available K and electrical conductivity 0.29 ds/m² in the year of experiment. The total rainfall received during the crop season was 1061.90 mm distributed in 37 rainy days. Four seeding techniques *viz.* Transplanted rice in puddled soil, Transplanted rice in non puddled soil, Direct seeded rice in puddled soil and Direct seeded rice in non puddled soil were in main plot and five weed management practices (Weed free, Pyrazosulfuron at 0.20 kg ha⁻¹ as pre emergence + One hand

weeding at 40 DAT/DAS, Tank mix application of Bispyribac sodium at 0.25 litre ha⁻¹ + Fenoxaprop at 1.00 litre ha⁻¹ at 18 DAT/DAS, Tank mix application of Bispyribac sodium at 0.25 litre ha⁻¹ + Ethoxysulfuron at 0.12 kg ha⁻¹ at 18 DAT/DAS, Tank mix application of Fenoxaprop at 1.00 litre ha⁻¹ + Ethoxysulfuron at 0.12 kg ha⁻¹ at 18 DAT/DAS) along with weedy check in sub plot were replicated thrice. For the treatment with transplanted puddled rice and transplanted not puddled rice, the transplanting of 22 days old rice seedlings was done in the experimental field. For direct seeded rice (DSR), line sowing of dry and sprouted seeds of rice was done in non puddled soil and in puddled soil respectively. Manual puddler was used for puddling. Seeds were soaked in water and sprouted before sowing. The sprouted seeds with radicle length one to two millimeters were uniformly sown manually in the puddled field. Growth parameters *viz.* plant height, plant dry weight, Crop Growth Rate and Relative Growth Rate were observed from mean of five plants at 60 DAS. The variety Pusa Basmati-1 was sown on 17th June, 2013. The full dose of P and K with 50% N as per treatment were applied at the time of sowing. Rest of the N was applied in two splits. One part was applied at tillering stage and the other part at panicle initiation stage. Pre-emergence herbicide such as Pyrazosulfuron-ethyl was applied at 2 DAS/DAT and post-emergence herbicides such as Bispyribac-sodium, Ethoxysulfuron and Fenoxaprop-ethyl were applied at 18 DAS/DAT. The herbicides solution was sprayed uniformly with the help of knapsack sprayer fitted with flat fan nozzle. Other packages of practice rather than treatments were followed as per recommendation for rice crop.

Results and Discussion

Effect on growth attributes

Tillage practices and application of herbicides significantly affected the various growth parameter of rice crop at panicle initiation stage. P₁ (Transplanted rice in puddled soil) exhibited maximum plant height, plant dry weight and Relative Growth Rate. However, maximum Crop Growth Rate was recorded by P₃ (DSR in puddled soil). Further, analysis of the data showed that P₃ (DSR in puddled soil) was found to be at par with P₁ (Transplanted rice in puddled soil) in plant height, dry weight and Relative Growth Rate. Higher performance of these parameters in P₁ and P₃ could be attributed to better nutrient uptake (Singh *et al.*, 1997; Singh, 2012) [10, 11], beside favorable effect of puddling might have decreased weed competition and increased nutrient availability (Shan *et al.*, 2012) which enable plant to grow its potential and acquire maximum plant height, more plant dry weight and highest Relative Growth Rate. Among the weed management practices, significant maximum plant height, plant dry weight, Crop Growth Rate and Relative Growth Rate were recorded by W₂ (Weed free). Among the herbicides W₃ (Pyrazosulfuron

at 0.20 kg ha⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS) was found to be at par with W₂ (Weed free) and significantly superior to all tank mix application of herbicides. This result was closely confirmed with the result of Upasani *et al.*, (2012). This could be ascribed to the better weed control by this herbicide (Singh and Singh, 2013) and one hand weeding at 40 DAS/DAT causes late germination of weeds thus, providing weed free environment to plant (Singh *et al.*, 2012) and allow the crop to grow to its potential thereby increases the plant height, plant dry weight, Crop Growth Rate and Relative Growth Rate in respective treatment.

Yield and yield attributes

Yield and yield attributes were significantly affected by tillage practices and herbicides application. Maximum number of grains panicle⁻¹, seed yield, straw yield and harvest index were recorded by P₁ (Transplanted rice in puddled soil). However, P₃ (DSR in puddled soil) was found to be at par with P₁ (Transplanted rice in puddled soil). This may be attributed to the puddling operation in P₁ and P₃ since puddling has great significance in rice establishment method because it facilitates in increasing the availability of nutrient, ensure better plant establishment and control weeds. Prasad *et al.*, (2001) also reported similar result. Under the weed management practices maximum healthy grains panicle⁻¹, seed yield, straw yield and harvest index was recorded by W₂ (Weed free). It is clear from the data that herbicide W₃ (Pyrazosulfuron at 0.20 kg ha⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS) was found to be at par with W₂ (Weed free) in number of healthy grains panicle⁻¹, seed yield, straw yield and harvest index. The reason for higher performance of yield attributing characters in both the treatments was due to better photosynthesis efficiency of the crop plants under unshared favorable micro-ecological condition accompanied with improved carbohydrate metabolism in plant system under minimum crop weed competition. These values significantly decreased to the minimum in W₁ (weedy check) because the weeds exploited the favorable environment for their own growth and compete severely with the crop plants thus, restricting the supply of nutrients to the reproductive cells of the rice crop. These findings are in close conformity with the findings of Upasani *et al.*, (2012) and Chopra *et al.*, (2003).

Conclusion

It can be concluded that both T₁ (Transplanted rice in puddled soil) and T₃ (DSR in puddled soil) were the most suitable method for rice sowing which gave maximum seed yield and straw yield. Among the herbicides W₃ (Pyrazosulfuron at 0.20 kg ha⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS) was most effective and superior to all tank mix application of herbicides for controlling of weeds and achieving maximum seed and straw yield.

Table 1: Effect of tillage practices and herbicides on growth attributes of rice at panicle initiation stage

| Treatments | Plant height (cm) | Dry weight (g) | C.G.R. (g m ⁻² day ⁻¹) | R.G.R. (g g ⁻¹ day ⁻¹) |
|---|-------------------|----------------|---|---|
| Tillage practices (T) | | | | |
| T ₁ -Transplanted rice in puddled soil | 39.33 | 10.52 | 7.22 | 0.0697 |
| T ₂ -Transplanted rice in non-puddled soil | 37.63 | 9.82 | 6.76 | 0.0674 |
| T ₃ -DSR in puddled soil | 39.23 | 10.41 | 8.99 | 0.0695 |
| T ₄ -DSR in non-puddled soil | 38.89 | 10.22 | 8.80 | 0.0688 |
| F-test | S | S | S | S |
| S.Ed. (±) | 0.153 | 0.119 | 0.129 | 0.0006 |
| C.D. at 5% | 0.374 | 0.291 | 0.316 | 0.0015 |
| Herbicides (W) | | | | |
| W ₁ -Weedy check (control); | 35.78 | 8.34 | 6.42 | 0.0618 |
| W ₂ -Weed free | 40.03 | 11.13 | 8.67 | 0.0720 |
| W ₃ -Pyrazosulfuron at 0.20 kg ha ⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS | 39.81 | 10.88 | 8.46 | 0.0711 |
| W ₄ -Tank mix application of Bispyribac sodium at 0.25 litre ha ⁻¹ + Fenoxaprop at 1.00 litre ha ⁻¹ at 18 DAT/DAS | 38.66 | 10.06 | 7.77 | 0.0683 |
| W ₅ -Tank mix application of Bispyribac sodium at 0.25 litre ha ⁻¹ + Ethoxysulfuron at 0.12 kg ha ⁻¹ at 18 DAT/DAS | 39.06 | 10.40 | 8.08 | 0.0696 |
| W ₆ -Tank mix application of Fenoxaprop at 1.00 litre ha ⁻¹ + Ethoxysulfuron at 0.12 kg ha ⁻¹ at 18 DAT/DAS | 39.27 | 10.63 | 8.25 | 0.0703 |
| F-test | S | S | S | S |
| S.Ed. (±) | 0.328 | 0.143 | 0.152 | 0.0007 |
| C.D. at 5% | 0.662 | 0.289 | 0.306 | 0.0014 |

Table 2: Effect of tillage practices and herbicides on yield attributes and yield of rice at harvest

| Treatments | No. of healthy grains panicle ⁻¹ (No.) | No. of chaffy grains panicle ⁻¹ (No.) | Seed yield (kg ha ⁻¹) | Straw yield (kg ha ⁻¹) | Harvest index (%) |
|---|---|--|-----------------------------------|------------------------------------|-------------------|
| Tillage practices (T) | | | | | |
| T ₁ -Transplanted rice in puddled soil | 114.77 | 21.86 | 3585.99 | 5910.19 | 37.74 |
| T ₂ -Transplanted rice in non-puddled soil | 98.16 | 23.66 | 3115.47 | 5323.39 | 36.72 |
| T ₃ -DSR in puddled soil | 110.04 | 22.52 | 3479.46 | 5844.80 | 37.30 |
| T ₄ -DSR in non-puddled soil | 107.89 | 22.62 | 3358.25 | 5669.52 | 36.93 |
| F-test | S | S | S | S | NS |
| S.Ed. (±) | 1.814 | 0.274 | 31.872 | 32.818 | 0.338 |
| C.D. at 5% | 4.439 | 0.671 | 77.989 | 80.302 | 0.827 |
| Herbicides (W) | | | | | |
| W ₁ -Weedy check (control); | 67.80 | 31.39 | 2352.68 | 4309.55 | 35.19 |
| W ₂ -Weed free | 124.45 | 18.01 | 3811.15 | 6099.30 | 38.45 |
| W ₃ -Pyrazosulfuron at 0.20 kg ha ⁻¹ as pre emergence + one hand weeding at 40 DAT/DAS | 122.46 | 19.98 | 3748.51 | 6040.21 | 38.29 |
| W ₄ -Tank mix application of Bispyribac sodium at 0.25 litre ha ⁻¹ + Fenoxaprop at 1.00 litre ha ⁻¹ at 18 DAT/DAS | 104.67 | 22.39 | 3440.49 | 5879.43 | 36.91 |
| W ₅ -Tank mix application of Bispyribac sodium at 0.25 litre ha ⁻¹ + Ethoxysulfuron at 0.12 kg ha ⁻¹ at 18 DAT/DAS | 112.39 | 22.56 | 3460.58 | 5888.59 | 37.01 |
| W ₆ -Tank mix application of Fenoxaprop at 1.00 litre ha ⁻¹ + Ethoxysulfuron at 0.12 kg ha ⁻¹ at 18 DAT/DAS | 114.50 | 21.66 | 3495.35 | 5904.77 | 37.18 |
| F-test | S | S | S | S | S |
| S.Ed. (±) | 2.557 | 0.651 | 49.648 | 53.342 | 0.412 |
| C.D. at 5% | 5.169 | 1.315 | 100.343 | 107.808 | 0.833 |

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