Weed Dynamics and Productivity of Direct Wet Seeded Rice under Different Weed Management Practices

M. Vasantha Kokilam¹, S. Rathika², T. Ramesh³, M. Baskar⁴

ABSTRACT

Background: Weeds are the major biotic constraint to reduce the rice productivity in direct wet seeded rice. Weed infestation and competition are severe in direct wet seeded rice as compared to transplanted rice, because of the simultaneous growth of both crops and weeds. The yield loss due to weeds varies from 40 to 100 per cent in direct seeded rice. Use of herbicides either singly or in combination with manual or mechanical weeding in puddled direct seeded rice has been highlighted by several workers. Use of alternative herbicides with wide spectrum control of the weeds in direct seeded puddled rice is the need of the present time. The present study aimed to evaluate different weed management practices in direct wet seeded rice under sodic soil.

Methods: A field experiment was conducted during Samba season (Rabi) 2016-17, to evaluate the weed management practices in direct wet seeded rice under sodic soil. The treatments comprised of different combination of weed management practices viz., pre emergence, early post emergence herbicides, mechanical weeding and hand weeding twice were tested. Total weed density and weed dry weight, weed control efficiency, yield parameters and yield of rice were recorded.

Result: Among the different weed management practices, the lowest total weed density, total weed dry weight and higher WCE, yield attributes, grain and straw yields were registered under application of PE pyrazosulfuron ethyl 25 g/ha fb EPOE bispyribac sodium 25 g/ha. This was followed by application of PE pretilachlor 0.75 kg/ha fb EPOE bispyribac sodium 25 g/ha.

Key words: Direct wet seeded rice, Herbicides, Weed control efficiency, Weed management, Yield.

INTRODUCTION

Rice (Oryza sativa L.) is the staple food for more than 60 per cent of the world population and its cultivation secures a livelihood for more than two billion people. It plays a major role in Indian economy by contributing 45 per cent of the total food grain production. In India, rice is grown in an area of 43.9 million hectares with a production of 109.7 million tones and an average productivity of 2.5 t/ha (FAO, 2016-17). Problems and prospects of rice production in different ecosystems vary greatly (Senthilkumar et al., 2007). Direct seeded rice may involve sowing of pre-germinated seeds in a puddled soil surface (wet-seeding) or into shallow standing water (water-seeding) or dry seeds into a prepared seedbed (dry-seeding) (Parameshwari et al., 2015).

Weeds are the major biotic constraint to reduce the rice productivity in worldwide (Manisankar et al., 2020). Weed infestation and competition are severe in direct wet seeded rice as compared to transplanted rice, because of the simultaneous growth of both crops and weeds (Sheeja and Elizabeth, 2017). Uncontrolled weeds decreased the yield by 96 per cent in dry DSR and 61 per cent in wet DSR. The yield loss due to weeds varies from 40 to 100 per cent in direct seeded rice (Rathika et al., 2020). Any delay in weeding will lead to increased weed biomass which has a negative correlation with yield. Though manual weeding is considered to be the best, non-availability of labour and escalating labour cost in many cases have made it imperative to use of new chemicals for weed control (Rathika and Ramesh, 2018). Moreover, rice herbicides presently used are mainly pre emergence and weeds emerging at later stages of crop growth are not controlled as effectively as at emergence stage. This warrants application of post emergence herbicide that will take care of weeds emerging at a later stage. The use of herbicides either singly or in combination with manual or mechanical weeding in puddled direct seeded rice has been highlighted by several workers (Hussain et al., 2008; Rathika and Ramesh, 2019). Use of alternative herbicides with wide spectrum control of the weeds in direct seeded puddled rice is the need of the present time (Nath et al., 2014). Hence, this study was undertaken to evaluate different weed management practices in direct wet seeded rice under sodic soil.
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MATERIALS AND METHODS

A field experiment was conducted in Anbil Dharmalingam Agricultural College and Research Institute, Thiruchirappalli, Tamil Nadu during Samba season (Rabi) 2016-17. The experimental site was located at 10° 45' N latitude, 78° 36' E longitude and at an altitude of 85 m above MSL. A total of 116.4 mm of rainfall was received in 10 rainy days during the cropping period. The mean maximum and minimum temperature recorded during the cropping season were 32.4°C and 22.1°C and the mean relative humidity ranged from 85 and 47 per cent.

The experimental soil was sandy clay loam in texture belonging Vetric Ustropept with pH of 9.1 and EC of 0.2 dS/m. The experimental soil was low in available nitrogen (229 kg/ha), medium in available phosphorus (14.5 kg/ha) and high in available potassium (285 kg/ha). The experiment was laid out in a randomized block design with nine treatments in three replications. The variety used for the experiment was ‘TNAU Rice TRY 3’.

Total weed density and weed dry weight were recorded at 20, 40 and 60 days after sowing (DAS) by adopting standard procedure. Weed control efficiency (WCE) was worked out on the basis of weed dry matter recorded in each treatment by using formula as suggested by Mani et al. (1973). The yield parameters viz., productive tillers/m², total number of grains/panicle, filled grain percentage and 1000 grain weight and yield of rice were recorded at harvest stage as per the guidelines stipulated by All India Co-ordinated Rice Improvement Project (Haveten, 1977). All the recorded data were analyzed statistically as per the method suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect on weeds

Weed flora

Weed flora of the experimental field was composite in nature comprising of grasses, sedges and broad-leaved weeds (BLW). The major grass weeds were Echinochloa crus-galli (L.), Echinochloa colona (L.) and Cynodon dactylon (L.) and common sedges included Cyperus rotundus (L.) and Cyperus iria (L.). Among the BLW, Eclipta alba (L.) and Ammania baccifera (L.) were the dominant species in direct wet seeded rice ecosystem. Such broad spectrum of weeds in direct wet seeded rice ecosystem was also reported by Parameshwari et al. (2015), Raghavendra et al. (2015), Goswami et al. (2018) and Rathika and Ramesh (2019).

Table 1: Effect of weed management practices on total weed density and total weed dry weight in direct wet seeded rice.

| Treatments | Total weed density (No./m²) | Total weed dry weight (g/m²) |
|------------|-----------------------------|----------------------------|
|            | 20 DAS | 40 DAS | 60 DAS | 20 DAS | 40 DAS | 60 DAS |
| PE Prettilachlor 0.75 kg/ha fb EPOE Metsulfuron methyl + Chlorimuron ethyl 4 g/ha | 6.84(46.34) | 5.02(24.74) | 5.92(34.58) | 4.87(23.17) | 6.36(39.96) | 7.70(58.79) |
| PE Prettilachlor 0.75 kg/ha fb EPOE Bispyribac sodium 25 g/ha | 6.75(45.06) | 4.02(15.66) | 4.78(22.37) | 4.82(22.68) | 5.30(27.56) | 6.21(38.03) |
| PE Pyrazosulfuron methyl + Chlorimuron ethyl 4 g/ha EPOE Bispyribac sodium 25 g/ha | 6.45(41.15) | 4.93(23.82) | 5.70(32.00) | 4.59(20.58) | 6.41(40.56) | 7.41(54.40) |
| PE Pyrazosulfuron ethyl 25 g/ha fb EPOE Bispyribac sodium 25 g/ha | 6.34(39.65) | 3.81(14.00) | 4.54(20.15) | 4.51(19.83) | 5.23(26.84) | 5.90(34.26) |
| PE Pyrazosulfuron methyl + Chlorimuron ethyl 4 g/ha EPOE Bispyribac sodium 25 g/ha | 6.86(46.52) | 7.74(59.43) | 7.00(48.45) | 4.91(23.56) | 8.36(69.40) | 10.39(107.49) |
| PE Pyrazosulfuron methyl + Chlorimuron ethyl 4 g/ha EPOE Bispyribac sodium 25 g/ha fb Conoweeeder weeding on 20 and 40 DAS | 6.50(41.77) | 7.46(55.20) | 6.55(42.34) | 4.62(20.89) | 8.31(68.53) | 10.24(104.28) |
| Hand weeding on 20 and 45 DAS | 6.86(46.60) | 8.63(74.00) | 5.50(29.72) | 4.88(23.30) | 8.65(74.40) | 7.14(50.52) |
| Hand weeding on 20 and 45 DAS | 10.09(101.40) | 6.62(43.33) | 5.14(25.91) | 8.81(77.06) | 7.57(56.78) | 6.67(44.05) |
| Unweeded control | 10.21(103.67) | 11.42(129.98) | 12.82(163.91) | 9.02(80.86) | 14.04(196.50) | 15.95(254.06) |

CD (P=0.05) | 0.67 | 0.58 | 0.61 | 0.48 | 0.66 | 0.75 |

Figures in parentheses are original values.
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At 40 DAS, the lowest total weed density and dry weight was recorded in application of PE pyrazosulfuron ethyl 25 g/ha fb EPOE bispyribac sodium 25 g/ha and it was on par with PE pretilachlor 0.75 kg /ha fb EPOE bispyribac sodium 25 g/ha. This might be due to combined application of PE and EPOE herbicides, in which first flush of weeds were controlled by the PE herbicides pyrazosulfuron ethyl and pretilachlor. The late emerged weeds were controlled by EPOE herbicide bispyribac sodium. This is in conformity with the findings of Raghavendra et al. (2015).

At 60 DAS, application of PE pyrazosulfuron ethyl 25 g/ha fb EPOE bispyribac sodium 25 g/ha resulted in greater reduction in density and dry weight of total weeds because first and second flush of weeds were controlled by pre emergence and early post emergence herbicide application. The next lowest total weed density and dry weight was found in application of PE pretilachlor 0.75 kg /ha fb EPOE bispyribac sodium 25 g/ha. Effective control of weeds in these treatments might be due to application of two herbicides in sequence could be more useful have resulted in decreased weed seed reserve in the soil. This is in line with the findings of Ajay Singh et al. (2017) and Rathika and Ramesh (2019).

EPOE application of bispyribac sodium 25 g/ha along with PE herbicide significantly reduced the density and dry weight of weeds in direct wet seeded rice. It indicated that bispyribac sodium is a selective herbicide, it is effective for the control of grasses, sedges and broad-leaved weeds in rice and is effective as a soil or foliar treatment (Schmidt et al., 1999). It is a member of the pyrimidinylbenzoic acid synthetic family and inhibits the enzyme acetolactate synthase (ALS) in susceptible plants. This ultimately reduces transport of photosynthate from source leaves to roots, resulting in root

Table 2: Effect of weed management practices on weed control efficiency (%) and weed index (%) in direct wet seeded rice.

| Treatments | Weed control efficiency (%) | Weed index (%) |
|------------|-----------------------------|---------------|
|            | 20 DAS          | 40 DAS        | 60 DAS        |
| PE Pretilachlor 0.75 kg/ha fb EPOE Metsulfuron methyl + Chlorimuron ethyl 4 g/ha | 67.9           | 74.3           | 76.9           | 20.8           |
| PE Pretilachlor 0.75 kg/ha fb EPOE Bispyribac sodium 25 g/ha | 68.1           | 81.4           | 85.0           | 6.2            |
| PE Pyrazosulfuron ethyl 25 g/ha fb EPOE Metsulfuron methyl + Chlorimuron ethyl 4 g/ha | 70.9           | 73.8           | 78.6           | 18.1           |
| PE Pyrazosulfuron ethyl 25 g/ha fb EPOE Bispyribac sodium 25 g/ha | 71.8           | 81.9           | 86.5           | -              |
| PE Pretilachlor 0.75 kg/ha fb Conoweeder weeding on 20 and 40 DAS | 68.1           | 55.3           | 57.7           | 36.0           |
| PE Pyrazosulfuron ethyl 25 g/ha fb Conoweeder weeding on 20 and 40 DAS | 70.6           | 55.7           | 59.0           | 30.0           |
| PE Pretilachlor 0.75 kg/ha fb Hand weeding on 40 DAS | 67.7           | 48.5           | 80.1           | 12.6           |
| Hand weeding on 20 and 45 DAS | 4.5            | 65.5           | 82.7           | 11.5           |
| Unweeded control | -              | -              | -              | 53.3           |

Data not statistically analyzed

Table 3: Effect of weed management practices on yield parameters and yield of direct wet seeded rice.

| Treatments | Yield parameters | Yield |
|------------|------------------|-------|
|            | Productive tillers / m² | Total grains / panicle | % filled grains | Panicle length (cm) | 1000 grain weight (g) | Grain yield (Kg/ha) | Straw yield (Kg/ha) |
| PE Pretilachlor 0.75 kg/ha fb EPOE Metsulfuron methyl + Chlorimuron ethyl 4 g/ha | 313 | 95 | 91 | 25.0 | 25.0 | 3693 | 5170 |
| PE Pretilachlor 0.75 kg/ha fb EPOE Bispyribac sodium 25 g/ha | 392 | 110 | 94 | 25.8 | 26.0 | 4375 | 6300 |
| PE Pyrazosulfuron ethyl 25 g/ha fb EPOE | 337 | 97 | 92 | 25.2 | 25.2 | 3819 | 5461 |
| PE Pretilachlor 0.75 kg/ha fb EPOE Metsulfuron methyl + Chlorimuron ethyl 4 g/ha | 409 | 118 | 95 | 26.0 | 26.3 | 4665 | 6531 |
| PE Pyrazosulfuron ethyl 25 g/ha fb EPOE Bispyribac sodium 25 g/ha | 283 | 79 | 91 | 24.3 | 24.9 | 2986 | 4300 |
| PE Pyrazosulfuron ethyl 25 g/ha fb Conoweeder weeding on 20 and 40 DAS | 298 | 81 | 91 | 24.6 | 24.9 | 3267 | 4639 |
| PE Pyrazosulfuron ethyl 25 g/ha fb Hand weeding on 40 DAS | 366 | 101 | 93 | 25.6 | 25.2 | 4075 | 5950 |
| PE Pretilachlor 0.75 kg/ha fb Conoweeder weeding on 20 and 40 DAS | 380 | 106 | 93 | 25.8 | 25.3 | 4128 | 6109 |
| Hand weeding on 20 and 45 DAS | 182 | 70 | 87 | 24.1 | 24.7 | 2174 | 3152 |
| Unweeded control | 28 | 10 | - | NS | NS | 325 | 481 |

CD (P=0.05)
growth inhibition which leading to death of weeds (Ferrero et al., 2002) and (Sheeja and Elizabeth, 2017).

**Weed control efficiency**

The highest WCE as registered in application of PE pyrazosulfuron ethyl 25 g/ha fb EPOE bispyribac sodium 25 g/ha and PE pretilachlor 0.75 kg/ha fb EPOE bispyribac sodium at 25 g/ha. This might be due to lesser competition of weeds achieved by effective control of first and second flush of weeds which resulted in reduction in weed density and dry weight. PE herbicide along with EPOE herbicide effectively reduced the weed biomass. This is in agreement with the findings of Bhagat Singh et al. (2009) and Rathika and Ramesh (2019) who reported that weeds in DSIR could be kept at lower level by herbicides.

**Weed index**

The minimum weed competition treatment i.e. plot with application of PE pyrazosulfuron ethyl 25 g a.i. ha-1 fb EPOE bispyribac sodium 25 g/ha was taken as base to work out weed index as maximum grain yield was obtained by this treatment. PE application of pretilachlor 0.75 kg/ha fb EPOE bispyribac sodium 25 g/ha resulted in minimum weed index of 6.2 per cent. This was followed by HW twice on 20 and 45 DAS and PE pretilachlor 0.75 kg/ha fb HW on 40 DAS. However, other treatments recorded W1 ranging from 18.1 to 36.0 per cent. The unweeded control registered higher W1 of 53.3 percent. This corroborated with the findings of Ajay Singh et al. (2017).

**Effect of weed management practices on rice**

**Yield parameters**

The yield parameters viz., productive tillers/m², total grains/panicle and filled grain percentage were altered significantly by adoption of weed management practices. Application of PE pyrazosulfuron ethyl 25 g/ha fb EPOE bispyribac sodium at 25 g/ha registered more number of productive tillers/m², total grains/panicle and increased filled grain percentage and it was followed by PE pretilachlor 0.75 kg/ha fb EPOE bispyribac sodium 25 g/ha. The effective control of weeds in these treatments resulted in lesser competition by weeds for nutrients, space and light ultimately resulting in increased number of productive tiller/m². PE herbicide application controlled weeds at early stage and supplemental EPOE herbicide controlled weed growth at later stage which resulted in higher WCE and yield attributes. This is in agreement with the findings of Manisankar et al. (2019). Unweeded control resulted in reduced yield parameters due to severe crop weed competition coupled with reduced uptake of nutrients by crop and increased uptake of nutrients by weeds. Panicle length and 1000 grain weight was not significantly influenced by different weed management practices. This corroborates with the findings of Rathika and Ramesh (2019).

**Grain and straw yield**

Adoption of different weed management practices were significantly influenced the grain and straw yields. The highest grain (4665 kg/ha) and straw (6531 kg/ha) yields were recorded with PE pyrazosulfuron ethyl 25 g/ha fb EPOE bispyribac sodium 25 g/ha and it was followed by PE pretilachlor 0.75 kg/ha fb EPOE bispyribac sodium 25 g/ha. This might be due to cumulative effect of increased levels of yield attributes was due to lesser crop weed competition, better light transmission for photosynthesis, reduced nutrient removal by weeds and increased nutrient uptake by crop. These results were in conformity with the findings of Nath et al. (2014), Ajay Singh et al. (2017) and Manisankar et al. (2019).

**CONCLUSION**

Based on the experimental results, it could be concluded that application of PE pyrazosulfuron ethyl 25 g/ha fb EPOE bispyribac sodium 25 g/ha was found to be better in controlling weeds and higher productivity of direct wet seeded rice under sodic soil.

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