**Weed management practices enhance weed control efficiency in direct seeded rice (DSR) under semi-dry conditions.**

**ABSTRACT**

A field experiment was carried out at ARS, Paramakudi, Tamil Nadu during 2017-18 to study the interaction between weed ecology, competition, management strategies in semi-dry Direct Seeded Rice. The fieldexperiment was laid out in split plot with irrigation in main plot and weed management in sub plot. The results revealed least weed density was recorded after irrigation when water level drops to 10cm below soil surface. Among weed management practices combinations of herbicide pendimethalin @1.0 kg / ha at 3DAS as pre –emergence fb bispyribac sodium @ 25 g / ha at 15 DAS has recorded the lowest weed density with highest WCE. Among the interaction, lowest weed density and highest weed control efficiency was recorded when water level drops to 10 cm below soil surface with combination of PE pendimethalin @1.0 kg / ha at 3DAS *fb* EPOE bispyribac sodium@ 25 g / ha at 15 DAS.

Keywords**:** weed density, weed control efficiency, Bispyribac sodium, Pendimethalin.

Introduction

Rice (*Oryza* sativa. L) is the stable food of our country and about more than 2/3rd population in India depends on rice foods. It is grown in 43 million hectares with a productivity of 2700 kg/ha (ICAR-Annual Report 2020). Traditionally, major growing area is under wetland transplanted ecosystem which requires huge labour wages for nursery raising, puddling and transplanting operations. But under rainfed ecosystem, direct sown rice is an alternative to transplanted ecosystem for *kharif* season. Direct seeding of rice offers certain advantages like labour saving by 34 percent (Ho and Romli, 2000), fast and easy establishment helps in timely sowing, less drudgery, early maturity of crop by 7-10 days, less water requirement to a tune of 12-35% (Kumar and Ladha, 2011), high tolerance to water deficit, often higher yield, low production cost with a saving of 29 percent (Ho and Romli, 2000)and more profit, better soil physical condition for following crops and also reduced methane emission (Balasubramanian and Hill, 2002). It also helps in water saving, facilitates higher nutrient uptake and increase land and water productivity (Sarkar, 2001).

Weed infestation causes yield loss around 15 million tonnes in India (Singh et al., 2018) and hence weed management is the major and difficult task in DSR due to simultaneous emergence of both, crop and weed. Weeds not only compete with crop for space, light, water and nutrients, but also affect its quality. Emergence weeds along with crop during initial stages of crop growth causes severe damage due to high competitive nature of weeds while emergence of weeds during later stages is not that much severe. Hence, timely weed management is indispensable for DSR. Nevertheless, manual weeding is the traditional method, increased wages and demand for during peak periods push farmers to seek alternative means of managing weeds in DSR. Hence, chemical weed management by the combination of pre and post emergence herbicides is highly efficient and cost effective method. With an idea to develop a suitable weed management practices in semi-dry DSR, it has been planned to conduct an experiment with the objectives of finding out the best herbicide, dose and time of application of herbicide with irrigation management techniques.

Materials and Methods

 ***Experimental Site***

The experimental trail was conducted at Agricultural Research Station, Paramakudi situated at 9°21 N latitude and 78°22 E longitudes with an altitude of 39.83 mean sea level. The site receives a mean annual rainfall of 840 mm in 43 rainy days, of which 400 mm is received through Northeast monsoon rains. The monthly mean maximum temperature ranges from 28°C to 38.5°C and monthly mean minimum temperature ranges from 21°C to 27.5°C. The soil type is clay loam with pH of 8.0. Experimental field was homogeneously fertile with even topography and uniform textural make up and was attached to the main irrigation channel connecting the farm tube well for life saving irrigation. Proper drainage facility was also provided in order to remove excess water during experimental period.

***Experimental material***

Use of field water tube for monitoring the water level drop so that we can easily determine the irrigation timing. “The tube was made of 30 cm long PVC pipe with a diameter of 15 cm, perforating on all sides. The tube was placed vertically to 20 cm depth inside the soil in a flat area of the field close to a bund for easy monitoring of water level drop in the tube”.

***Experimental design***

The test crop was rice and Anna (R) 4 variety was used. The weedicides used were pendimethalin (as pre emergence), bispyribac-sodium (as early post emergence) and Star weeder for manual weeding. The experiment was laid out in split plot design with eighteen treatment combinations and replicated thrice. Irrigation Management consists of three treatments *viz* I1- Irrigation when water level drops to at 10 cm below soil surface, I2 - Irrigation when water level drops to at 15 cm below soil surface, I3 - Irrigation when water level drops to at 20 cm below soil surface which formed the main plots. In subplots weed management treatments such as W1 -Pre-emergence pendimethalin @ 1.0 kg / ha at 3 days after sowing (DAS) *fb* (followed by) one hand weeding at 30 DAS,W2 –early post emergence bispyribac sodium 25 g /ha at 15 DAS *fb* one hand weeding at 30 DAS,W3-PE pendimethalin @ 1.0 kg / ha at3DAS *fb* Star weeder at 30DAS, W4- early post emergence bispyribac sodium 25 g / ha at 15DAS *fb* Star weeder at 30DAS,W5-Pre-emergence pendimethalin@1.0 kg / ha at 3DAS *fb* early post emergence bispyribac sodium@ 25 g / ha at 15 DAS,W6 -Hand weeding twice at 20 and 40 DAS.were assigned.

The observations on weed flora, weed density and weed control efficiency of grasses, sedges and broad leaved weeds were recorded at 15, 30 and 45 DAS. The data on weed density were recorded at15th, 30th and 45thday using one square meter quadrant. The quadrant was placed at random in each plot and the weeds encompassed within the quadrant were removed from the field, and categorized into grasses, sedges and broadleaved weeds. Then the collected weed samples were shade dried and kept in hot air oven at 65±5˚C for 72 hrs. to record dry weight of weeds and expressed in g ha−1.

Weed control efficiency(WCE) was calculated after Mani *et al*., (1973).

WCE %=WDC – WDTx 100

WDC

Where,

 WCE - weed control efficiency (percent)

 WDC - weed dry weight (g m‑2) in control plot

 WDT- weed dry weight (g m‑2) in the treated plot

***Statistical analysis***

 The various data generated on weeds were subjected to ANOVA for statistical significance. For statistical analysis of weed density and weed dry weight, the data were subjected to square root transformation √(x+0.5) before analysis and the critical difference was worked out at five percent probability level.

 **Results and Discussion**

***Weed flora in the field***

Weed flora of the experimental field during cropping period were primarily composed of grasses, sedges and broad leaved weeds. The grass species, *Echinochloa colonum*; the sedge, *Cyperus rotundus* and two broad leaved weeds such as *Trianthema protulacastrum* and *Eclipta alba* were dominant in the experimental site*.* This spectrum of weed flora was earlier reported by many workers (Bhullar *et al*. (2016), Ashraf*et al.* (2018), and Singh*et al.*, 2019).

***Effect of irrigation and weed management on weed density (No. m2)***

Weed density was significantly influenced by different treatments and the data on weed density of grasses, sedges and broad leaved weeds were given in Table1. Further, Irrigation scheduling also had significant influence on grasses, sedges and broad leaved weeds at15, 30 and 45 DAS. Irrigation when water level drops to at 10 cm below soil surface (I1) significantly recorded the lowest weed density (86.17/m2,23.50/m2 and 10.33/m2). Among all treatments at 15 and 30 DAS, Irrigation when water level drops to at 20 cm below soil surface (I3) recorded higher weed density of grasses and broad leaved weeds (22.5 and 8.22/m2, respectively) and also higher total weed density (98.17/m2 and 31.33/m2). The reasons for low density and dry weight of weeds might be due to the absence of submerged condition in rice field for longer period and saturated condition would increases the pressure on weeds (Bhagat*et al.,*1999). Alternate wetting and drying (AWD) method of irrigation treatments had recorded high weed density due to continuous germination and competition of weeds with crop for all growth factors (Kabir et al., 2008).

As regards methods of weed management, chemical management significantly reduced the weed density over the other treatments. Pre-emergence application of herbicide pendimethalin@1.0 kg / ha at 3days after receipt of sowing rain followed by one hand weeding at 30days after receipt of sowing rain (W1) at 15th recorded significantly lower total weed density (14.00/m2). At 30th day of observation, pre-emergence application of herbicide pendimethalin @1.0 kg / ha at 3days after receipt of sowing rain followed by early

**Table 1. Effect of irrigation and weed management practices on total weed density (No./m2) in semi-dry direct seeded rice during 2017-2018**

|  |  |
| --- | --- |
|  | **Total weed density (No./m2)** |
| **Treatments** | **15 DAS** | **30 DAS** | **45 DAS** |
| **11** | **12** | **13** | **Mean** | **I1** | **I2** | **I3** | **Mean** | **I1** | **I2** | **I3** | **Mean** |
| **W1** | 3.58(12.33) | 3.98(15.33) | 3.85(14.33) | **3.80****(14.00)** | 6.01(35.67) | 6.04(36.00) | 6.31(39.33) | **6.12****(37.00)** | 2.04(3.67) | 0.71(0.00) | 0.71(0.00) | **1.15****(1.22)** |
| **W2** | 10.51(110.00) | 12.05(144.67) | 10.84(117.00) | **11.13****(123.89)** | 3.89(14.67) | 3.39(11.00) | 4.02(15.67) | **3.77****(13.78)** | 0.71(0.00) | 0.71(0.00) | 0.71(0.00) | **0.71****(0.00)** |
| **W3** | 3.72(13.33) | 4.53(20.00) | 4.38(18.67) | **4.21****(17.33)** | 4.88(23.33) | 5.55(30.33) | 6.77(45.33) | **5.74****(33.00)** | 4.34(18.33) | 4.92(23.67) | 5.67(31.67) | **4.97****(24.56)** |
| **W4** | 11.81(139.00) | 12.32(151.33) | 12.20(148.33) | **12.11****(146.22)** | 3.85(14.33) | 3.98(15.83) | 4.14(16.67) | **3.99****(15.44)** | 5.24(27.00) | 5.61(31.00) | 4.14(16.67) | **5.00****(24.89)** |
| **W5** | 3.67(13.00) | 4.06(16.00) | 4.26(17.67) | **4.00****(15.56)** | 2.27(4.67) | 2.68(6.67) | 2.86(7.67) | **2.60****(6.33)** | 0.91(0.33) | 2.80(7.33) | 0.71(0.00) | **1.47****(2.56)** |
| **W6** | 15.16(229.33) | 15.57(242.00) | 16.54(273.00) | **15.75****(248.11)** | 6.99(48.33) | 7.01(48.67) | 7.99(63.33) | **7.33****(53.44)** | 3.63(12.67) | 5.87(34.00) | 4.49(19.67) | **4.66****(22.11)** |
| **Mean** | **8.07****(86.17)** | **8.75****(98.22)** | **8.68****(98.17)** |  | **4.65****(23.50)** | **4.77****(24.67)** | **5.34****(31.33)** |  | **2.81****(10.33)** | **3.44****(16.00)** | **2.74****(11.33)** |  |
|  | **I** | **W** | **I at W** | **Wat I** | **I** | **W** | **I at W** | **Wat I** | **I** | **W** | **I at W** | **Wat I** |
| **SEd** | 0.12 | 0.13 | 0.24 | 0.23 | 0.09 | 0.08 | 0.15 | 0.13 | 0.10 | 0.09 | 0.18 | 0.16 |
| **CD(*P=0.05)*** | 0.32 | 0.27 | 0.53 | 0.47 | 0.26 | 0.16 | 0.35 | 0.27 | 0.27 | 0.19 | 0.40 | 0.32 |

**Note: \*** figures in parentheses are square root transformed values

**I1**: Irrigation when water level drops to at 10 cm below soil surface, **I2**: Irrigation when water level drops to at 15 cm below soil surface, **I3**: Irrigation when water level drops to at 20 cm below soil surface, **W1**: PE pendimethalin@ 1.0 kg / ha at 3DAS fb one hand weeding at 30 DAS, **W2**: EPOE bispyribac sodium 25 g /ha at 15 DAS fb one hand weeding at 30 DAS, **W3**: PE pendimethalin@1.0 kg / ha at3DAS fb Star weeder at 30DAS, **W4**: EPOE bispyribac sodium 25 g / ha at 15DAS fb Star weeder at 30DAS, **W5**:PE pendimethalin@1.0 kg / ha at 3DAS fb EPOE bispyribac sodium@ 25 g / ha at 15DAS, **W6**: Hand weeding twice 20 and 40 DAS.

post emergence application of bispyribac sodium @ 25 g/ha at 15days after receipt of sowing rain (W5) had better control of all types of weeds (grasses, sedges and broad leaved weeds) and had recorded significantly lower total weed density (6.33/m2). Pre-emergence application of herbicides prevented the emergence of weeds and also controlled the weed growth during earlier stages of rice growth and weeds emerged at later stages of crop growth were not controlled effectively (Begum *et al.*, 2008). Goswami *et al*. (2017) observed that pendimethalin@1 kg a.i/ha *fb* bispyribac- sodium @ 25 g a.i /ha recorded significantly lower total weed density and dry weight than other weed management in direct seeded rice. Higher total weed density (53.44/m2) was observed in hand weeding twice 20 and 40 DAS(W6). Pre emergence application of pendimethalin *fb* early post emergence application of bispyribac sodium was effective in weed management as pendimethalin belongs to dinitroaniline group of herbicide that prevents the cell division and elongation which inhibits root and shoot growth of grasses and certain broadleaved weeds as reported by Bhullar *et al.* (2016).Further, bispyribac sodium belongs to pyrimidinyl carboxy group of herbicide which controls diversified weed flora by inhibiting the amino acid bio synthesis and bispyribac sodium lowers the density of certain sedge weeds in the rice ecosystem as observed by Chakraborti *et al.* (2017).

 Irrigation and weed management has profound influence on weed density at 30th DAS. Irrigation when water level drops to at 10 cm below soil surface along (I1) with application of pre-emergence herbicide pendimethalin @1.0 kg / ha on at 3 days after receipt of soaking sowing rain *fb* early post emergence bispyribac sodium at 25 g/ha at 15 days after receipt of soaking rain (I1W5) recorded lowest weed density. This was due to interactive effect and better weed control practices on weeds.

***Weed control efficiency (WCE %)***

Pre-emergence application of pendimethalin @1.0 kg / ha at 3 days after receipt of sowing rain *fb* early post emergence bispyribac sodium at 25 g/ha at 15 days after receipt of sowing rain (W5) had proved their effectiveness in weed control with higher WCE of 96.44%. While lower WCE (82.63%) was recorded application of herbicide pre-emergence pendimethalin @1.0 kg / ha at 3 days after receipt of sowing rain*fb* Star weeder at 30days after receipt of sowing rain.

The efficiency of treatment on control of weed in terms of dry weight was given in fig1. The higher weed control efficiency (87.56%) on Irrigation when water level drops to at 10 cm below soil surface (I1). These results were attributed owing to reduced weed population, weed dry weight of different weed flora resulted in increased weed control efficiency. Irrigation when water level drops to at 20 cm below soil surface (I3) recorded lower weed control efficiency (83.44%).

The Interaction was significant and the treatment (I1) irrigation when water level drops to at 10 cm below soil surface with pre-emergence pendimethalin @1.0 kg / ha at 3days after receipt of sowing rain *fb* early post emergence bispyribac sodium at 25 g/ha at 15days after receipt of sowing rain (I1W5) recorded the maximum WCE (97.30%). The minimum (75.89%) was found in irrigation when water level drops to at 20 cm below soil surface with pre-emergence application of pendimethalin @ 1.0 kg/ha at 3 DAS *fb* star weeder at 30days after receipt of sowing rain.

**Figure 1: Effect of irrigation and weed management on weed control efficiency at 30 DAS**



**W1**: PE pendimethalin@ 1.0 kg / ha at 3DAS fb one hand weeding at 30 DAS, **W2**: EPOE bispyribac sodium 25 g /ha at 15 DAS fb one hand weeding at 30 DAS, **W3**: PE pendimethalin@1.0 kg / ha at3DAS fb Star weeder at 30DAS, **W4**: EPOE bispyribac sodium 25 g / ha at 15DAS fb Star weeder at 30DAS, **W5**:PE pendimethalin@1.0 kg / ha at 3DAS fb EPOE bispyribac sodium@ 25 g / ha at 15DAS, **W6**: Hand weeding twice 20 and 40 DAS.

**Conclusion**

 From the study it is concluded for better weed control and management in semi dry Direct seeded rice, pre-emergence application of pendimethalin@ 1.0 kg/ha on 3DAS *fb* early post-emergence application of bispyribac sodium @25 g/ha at 15 DAS was found to be highly effective in controlling the weeds.

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