**Weed management in aerobic rice cultivation in South Gujarat**

**ABSTRACT**

The experiment was conducted at the Main Rice Research Centre, Navsari Agricultural University, Navsari, Gujarat during *kharif* 2020-2022 to evaluate the weed management *viz.* cultural, mechanical and chemical and study the sustainability and feasibility in aerobic rice cultivation with three replication and carried out in randomized block design. The results revealed that mechanical weeding using weeder- weeding thrice at 20 days after sowing and then at 15-20 days interval practice recorded lower weed population and dry weeds biomass; count higher weed control efficiency and gave higher yield. Thus, among different weed management practices, mechanical weeding method found sustainable, efficient and eco-friendly in aerobic system for rice production.

***Keywords****: Aerobic rice, weed management, yield, sustainable* *practice*

**1. INTRODUCTION**

Rice is an important staple food crop in India. It is mainly grown by manual transplanting of seedling into puddled soil. Aerobic rice system is the growing of rice in non-puddled and non flooded soil which add to water productivity by reducing the seepage, percolation and evaporation. Hence, aerobic rice is one of the options to minimize irrigation requirement of rice crop. However, it is subject to much higher weed pressure with a broader weed spectrum than flood-irrigated rice and land area under these systems is expected to increase in the future because of labour and water shortage. Herbicide is the economic tool to fight against weeds but continuous use of one herbicide for a long time may result in development of herbicide resistant weed biotypes and causing a shift in weed flora. Manual weeding alone is time consuming and costly. Further, single weed control approach may not be able to keep weeds below the economic threshold level and result in environmental hazard. Therefore, integrated approaches are suggested for weed control since it may found most practical and cost effective for reducing weed competition and sustainability of direct seeded rice. Considering the sustainable weed management approach, a field experiment was conducted to develop sustainable, economic and eco-friendly weed control during cropping period and to evaluate the feasibility of non-chemical weed management options in aerobic rice cultivation.

**2. MATERIAL AND METHODS**

A field experiment was conducted during *Kharif* 2020 to 2022 at Main Rice Research Centre Farm, Navsari Agricultural University, Navsari, Gujarat. The soil of the experiment field was clayey in texture, alkaline in nature, low in available nitrogen, medium in available phosphorus and high in available potassium. Experiment consisting 10 treatments as below:

T1- Mulching with paddy straw @ 5 t/ha at the time of sowing

T2- Mulching (paddy straw @ 5 t/ha) at the time of sowing + Bispyribac sodium 10 % SC, 10 ml/10 lit water at 20 DAS

T3- Mechanical weeding (thrice) using weeder

T4- Chemical weed control (Pre-pedimethalin @ 1.5 kg a.i./ha at 2-3 DAS and post- bispyribac sodium 10 % SC, at 20 DAS)

T5- Mechanical weeding + Bispyribac sodium 10 % SC, 10 ml/10 lit water at 20 DAS

T6- Pre emergence herbicide (pendimethalin @ 1.5 kg a.i./ha) followed by one mechanical weeding at maximum tillering stage of crop

T7- Intercropping in rice with sesbania (incorporation after 1 to 1.5 month of sowing)

T8- Raised bed system of cultivation with application of bispyribac-sodium @ 200-250 ml/ha at 2-3 leaf stage of weeds at 20-25 DAS

T9- Weed free

T10- Weedy check

The treatments were replicated thrice in randomized block design. In *kharif* season, ‘GNR-3’ rice variety was sown with seed rate of 50 kg/ha at spacing of 30 cm between rows. The recommended dose of fertilizer is 100-30-0 N:P2O5: K2O and nitrogen was applied in three splits viz., 40 % as basal, 40 % at tillering stage and 20 % at panicle initiation stage. Full dose of P was applied as basal to the crop. The other cultural operation and irrigations were given as common practices as per the recommendation for the rice. The data were statistically analysed using analysis of variance (ANOVA) following the standard procedure [5].

**3. RESULTS AND DISCUSSION**

**3.1 Weed flora**

The major weeds infesting in aerobic rice during experimental period were grasses *viz.,* *Echinochloa colona* L.*, Echinochloa crusgalli* L.*, Dactyloctenium aegyptium* L.*, Setaria glauca* L.; sedges *viz.,* *Cyperus iria* L.*, Cyperus difformis* L.*, Fimbristylis littoralis* L. and broad-leaf weeds *viz.,* *Eclipta alba* L.*, Marsilea quadrifolia* Linn.*, Rotala densiflora, Bergia carpensis* L.*, Celosia argentea* L. etc.

**3.2 Effect on weeds**

The results of total weed population (grasses, sedge and broad leaved weed (BLW)), dry weed biomass and weed control efficiency are presented in Table 1. The highest weed density and dry weed biomass were found in the weedy check plots, which was significantly higher than other treatments [3,4]. In three years pooled results, significantly lower weed population and dry weed biomass of grasses, sedges and broad leaved weeds were counted with weed free (T9) treatment followed by mechanical weeding (T3) than rest of the treatments. Higher weed control efficiency was observed under weed free plot (61.49) followed by thrice weeding using mechanical weeder (43.97). This might be due to greater reduction of weeds through timely control of weeds. The results of weed index is showed that weed index was also recorded lower under mechanical weed management practice (T3). This was mainly due to better control of weeds growth resulting in lower dry weed biomass.

**Table 1: Effect of weed management treatments on weed population and weed control efficiency (Pooled of three years)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | | **Total weed population (no/m2)** | | | **Weed control efficiency** |
| **Grasses** | **Sedges** | **BLW** |
| **T1** | Mulching with paddy straw @ 5 t/ha at the time of sowing | 2.38  (5.19) | 2.35  (5.04) | 2.72  (7.22) | 41.87 |
| **T2** | Mulching (paddy straw @ 5 t/ha) at the time of sowing + Bispyribac sodium 10 % SC, 10 ml/10 lit water at 20 DAS | 2.51  (5.81) | 2.49  (5.70) | 2.76  (7.41) | 34.33 |
| **T3** | Mechanical weeding (thrice) using weeder | 2.33  (4.92) | 2.32  (4.90) | 2.64  (6.74) | 43.97 |
| **T4** | Chemical weed control (Pre-pedimethalin @ 1.5 kg a.i./ha at 2-3 DAS and post- bispyribac sodium 10 % SC, at 20 DAS) | 2.48  (5.67) | 2.48  (5.63) | 2.75  (7.37) | 37.11 |
| **T5** | Mechanical weeding + Bispyribac sodium 10 % SC, 10 ml/10 lit water at 20 DAS | 2.51  (5.78) | 2.44  (5.45) | 2.75  (7.37) | 36.20 |
| **T6** | Pre emergence herbicide (pendimethalin @ 1.5 kg a.i./ha) + one mechanical weeding at maximum tillering stage of crop | 2.50  (5.74) | 2.51  (5.78) | 2.68  (7.00) | 32.42 |
| **T7** | Intercropping in rice with sesbania (incorporation after 1 to 1.5 month of sowing) | 2.46  (5.55) | 2.37  (5.11) | 2.66  (6.85) | 36.90 |
| **T8** | Raised bed system of cultivation with application of bispyribac-sodium @ 200-250 ml/ha at 2-3 leaf stage of weeds at 20-25 DAS | 2.44  (5.45) | 2.37  (5.11) | 2.73  (7.26) | 33.14 |
| **T9** | Weed free | 1.98  (3.41) | 2.00  (3.48) | 1.94  (3.56) | 61.49 |
| **T10** | Weedy check | 3.18  (9.63) | 3.08  (8.96) | 3.62  (12.89) | - |
| SEm ± | | 0.04 | 0.05 | 0.04 | - |
| CD (p=0.05) | | 0.11 | 0.13 | 0.13 | - |
| CV % | | 4.88 | 5.32 | 5.04 | - |

***Note***: *Figure out side parenthesis indicates √x+0.5 transformed values.*

**Table 2: Effect of weed management treatments on dry weed biomass and weed index (Pooled of three years)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | | **Total dry weed biomass (no/m2) at** | | | **Weed Index** |
| **Grasses** | **Sedges** | **BLW** |
| **T1** | Mulching with paddy straw @ 5 t/ha at the time of sowing | 7.64 | 7.18 | 11.80 | 15.87 |
| **T2** | Mulching (paddy straw @ 5 t/ha) at the time of sowing + Bispyribac sodium 10 % SC, 10 ml/10 lit water at 20 DAS | 8.52 | 8.37 | 13.05 | 13.49 |
| **T3** | Mechanical weeding (thrice) using weeder | 7.10 | 7.14 | 11.39 | 7.88 |
| **T4** | Chemical weed control (Pre-pedimethalin @ 1.5 kg a.i./ha at 2-3 DAS and post- bispyribac sodium 10 % SC, at 20 DAS) | 8.17 | 8.01 | 12.49 | 15.51 |
| **T5** | Mechanical weeding + Bispyribac sodium 10 % SC, 10 ml/10 lit water at 20 DAS | 8.43 | 8.07 | 12.55 | 14.26 |
| **T6** | Pre emergence herbicide (pendimethalin @ 1.5 kg a.i./ha) + one mechanical weeding at maximum tillering stage of crop | 8.80 | 8.71 | 13.21 | 17.94 |
| **T7** | Intercropping in rice with sesbania (incorporation after 1 to 1.5 month of sowing) | 8.76 | 8.09 | 11.59 | 15.05 |
| **T8** | Raised bed system of cultivation with application of bispyribac sodium @ 200-250 ml/ha at 2-3 leaf stage of weeds at 20-25 DAS | 9.37 | 8.23 | 12.74 | 16.76 |
| **T9** | Weed free | 5.79 | 5.11 | 6.10 | 0.00 |
| **T10** | Weedy check | 13.60 | 11.82 | 20.53 | 37.30 |
| SEm ± | | 0.24 | 0.23 | 0.36 | - |
| CD (p=0.05) | | 0.68 | 0.66 | 1.02 | - |
| CV % | | 8.61 | 8.76 | 8.95 | - |

**3.3 Effect on crop growth and yield**

Weed management practices had a significant effect on rice yield and yield parameters (Table 3). Number of panicle/m2 and panicle weight was also recorded significantly higher under weed free condition and at par with weeding with mechanical weeder (T3). Grain yield was significantly influenced due to different weed management practices; weed free (T9) and mechanical weeding using weeder (T3) practice found equally effective and at par with each other in increasing grain yield of rice (5040 and 4731 kg/ha, respectively) over rest of the treatments. The increased yield in mechanical weeding practices could be due to higher productive panicles and grain-filling percentage [1]. Further, three times mechanical weeding in both directions was capable to produce higher yields. Mechanical weeding may be effectively buries and incorporates the weeds into soil and minimizes the weed competition. Further it improves the soil aeration, root development, nutrient absorption and more number of tillers, which favoured the crop growth, yield attributes and resulted in higher grain yield [6]. Significantly higher straw yield was recorded with T9 (weed free) which was at par with treatments T2, T3, T4, and T5. Mechanical weeding technique avoid use of herbicides and increased grain yield, promoted rice growth, provided an efficient and non chemical weeding method for rice production [2].

**Table 3: Effect of weed management treatments on yield and yield parameters of aerobic rice (Pooled of three years)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Panicle/m2** | **Panicle weight**  **(g)** | **Test weight**  **(g)** | **Grain yield (kg/ha)** | **Straw Yield (kg/ha)** |
| T1 | 206 | 4.74 | 30.98 | 4227 | 7122 |
| T2 | 201 | 4.49 | 29.95 | 4349 | 6545 |
| T3 | 211 | 5.31 | 31.75 | 4731 | 7556 |
| T4 | 207 | 4.74 | 30.00 | 4242 | 7089 |
| T5 | 206 | 4.94 | 31.07 | 4322 | 6925 |
| T6 | 192 | 4.83 | 30.59 | 4115 | 6449 |
| T7 | 200 | 4.41 | 31.16 | 4270 | 6674 |
| T8 | 191 | 4.88 | 29.46 | 4171 | 6808 |
| T9 | 228 | 5.50 | 32.49 | 5040 | 7828 |
| T10 | 168 | 3.45 | 27.99 | 3166 | 5516 |
| SEm ± | 6 | 0.13 | 0.87 | 112 | 203 |
| CD (p=0.05) | 17 | 0.37 | 2.47 | 318 | 574 |
| CV % | 8.70 | 8.24 | 8.55 | 7.88 | 8.87 |

**4. Conclusion**

Based on results of the experiment, mechanical weeding using weeder (weeding thrice at 20 days after sowing and then at 15-20 days interval) approach gave higher grain yield; found efficient for controlling weed, sustainable and eco-friendly for weed management in aerobic rice system under south Gujarat.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

**REFERENCES**

1. Akbar, N., Jabran, K., & Ali, M.A. (2011). Weed management improves yield and quality of direct seeded rice. *Australian Journal of Crop Science*, 5, 688-694.

2. Liu, C., Yang, K., Chen, Y., Gong, H., Feng, X., Tang, Z., Dengbin, Fu., & Long, Qi. (2023). Benefits of mechanical weeding for weed control, rice growth characteristics and yield in paddy fields. *Field Crop Research*, 293, 108852.

3. Mandal, M.K., Duary, B., & De, G.C. (2013). Effect of crop establishment and weed management practices on weed growth and productivity of Basmati rice. *Indian Journal of Weed Science*, 45(3): 166–170.

4. Mitra, B.K., Karim, A.J.M.S., Haque, M.M., Ahmed, G.J.U., & Bari, M.N. (2005). Effect of weed management practices on transplanted Aman rice. *Journal of Agronomy,* 4 (3): 238– 241.

5. Panse, V.G., & Sukhatme, P.V. (1957). Publication and information division Statistical Indian methods for agricultural workers. Council of Agricultural Research. New Delhi. pp. 87-89.

6. Roy, S. (2012). Effect of age of seedling and weed management practices on the productivity of rice under system of rice intensification (SRI), *KrishKosh.eagranth.ac.in*.