

## Weed Vegetation Analysis in Lowland Rice Cultivation in South Minahasa Regency

Orbanus Naharia<sup>1\*</sup>

<sup>1</sup>Department of Biology, FMIPAK, Universitas Negeri Manado

Corresponding Author: [orbanusnaharia@unima.ac.id](mailto:orbanusnaharia@unima.ac.id)

Published: Desember, 2025

### ABSTRAK

Tujuan. Penelitian ini bertujuan untuk menganalisis komposisi, struktur dominasi, dan perubahan temporal vegetasi gulma pada budidaya padi sawah di Kabupaten Minahasa Selatan. Penelitian ini secara khusus berupaya mengidentifikasi spesies gulma dominan pada pengamatan awal, 21 hari setelah tanam (DAS), 45 DAS, dan 60 DAS, sebagai dasar untuk menentukan strategi pengelolaan gulma yang tepat selama siklus pertumbuhan padi. Bahan dan metode. Analisis vegetasi gulma dilakukan menggunakan parameter Kepadatan Mutlak (AD), Kepadatan Relatif (RD), Frekuensi Mutlak (AF), Frekuensi Relatif (RF), Bobot Kering Mutlak (ADW), dan Bobot Kering Relatif (RDW). Nilai-nilai ini diintegrasikan untuk mendapatkan Rasio Dominasi Spesies (SDR) pada empat tahap pengamatan. Pengambilan sampel gulma dilakukan menggunakan metode kuadrat standar, dan bobot kering ditentukan setelah sampel dikeringkan dalam oven pada suhu 80°C selama 72 jam. Hasilnya menunjukkan bahwa komposisi gulma berubah secara dinamis sepanjang fase pertumbuhan. Pada pengamatan awal, nilai SDR tertinggi tercatat pada jenis *Paspalum distichum*, *Marsilea crenata*, *Fimbristylis litoralis*, *Cyperus iria*, dan *Ludwigia octovalvis*. Pada umur 21 HST, gulma yang dominan adalah *P. distichum*, *Leersia hexandra*, *M. crenata*, dan *Echinochloa crus-galli*. Pada umur 45 HST, *P. distichum*, *E. crus-galli*, *L. octovalvis*, dan *L. hexandra* tetap mendominasi, sedangkan pada umur 60 HST, *E. crus-galli* menjadi spesies paling dominan, disusul *L. octovalvis*, *Limnocharis flava*, dan *P. distichum*. Secara keseluruhan, gulma jenis rumput menunjukkan nilai RD, RF, dan RDW yang tinggi secara konsisten, yang mengindikasikan kemampuan kompetitif yang kuat sepanjang siklus pertumbuhan padi. Temuan ini menegaskan bahwa dominasi gulma di sawah dataran rendah sangat dipengaruhi oleh tahap pertumbuhan tanaman, perkembangan kanopi, dan sifat kompetitif dari masing-masing spesies gulma. Gulma rumput, khususnya *E. crus-galli* dan *P. distichum*, menunjukkan kemampuan adaptasi dan efisiensi penggunaan sumber daya yang tinggi, sehingga menjadikannya pesaing yang gigih dalam ekosistem padi. Temuan ini memperkuat perlunya intervensi pengelolaan gulma yang tepat waktu dan spesifik tahap pertumbuhan, terutama selama periode kritis 3–8 minggu setelah tanam, untuk mencegah kehilangan hasil panen yang signifikan dan mendukung produksi padi berkelanjutan di Kabupaten Minahasa Selatan.

Kata kunci: pengawasan kesehatan masyarakat; kesehatan lingkungan; faktor risiko perilaku; hipertensi; sanitasi

### ABSTRACT

Goal. This study aims to analyze the composition, dominance structure, and temporal changes of weed vegetation in lowland rice cultivation in South Minahasa Regency. The research specifically seeks to identify dominant weed species at the initial observation, 21 days after sowing (DAS), 45 DAS, and 60 DAS, as a basis for determining appropriate weed management strategies during the rice growth cycle. Materials and methods. Weed vegetation analysis was conducted using the parameters of Absolute Density (AD), Relative Density (RD), Absolute Frequency (AF), Relative Frequency (RF), Absolute Dry Weight (ADW), and Relative Dry Weight (RDW). These values were integrated to obtain the Species Dominance Ratio (SDR) at four observation stages. Weed sampling was carried out using standard quadrat methods, and dry weight was determined after oven-drying samples at 80°C for 72 hours. The results showed that weed composition changed dynamically across growth phases. At the initial observation, the highest SDR values were recorded for *Paspalum distichum*, *Marsilea crenata*, *Fimbristylis litoralis*, *Cyperus iria*, and *Ludwigia octovalvis*. At 21 DAS, dominant weeds were *P. distichum*, *Leersia hexandra*, *M. crenata*, and *Echinochloa crus-galli*. At 45 DAS, *P. distichum*, *E. crus-galli*, *L. octovalvis*, and *L. hexandra* maintained dominance, while at 60 DAS, *E. crus-galli* became the most dominant species, followed by *L. octovalvis*, *Limnocharis flava*, and *P. distichum*. Overall, grass-type weeds showed consistently high RD, RF, and RDW values, indicating strong competitive ability throughout the rice growth cycle. The findings confirm that weed dominance in lowland rice is strongly influenced by crop growth stage, canopy development, and the competitive traits of individual weed species. Grass weeds, particularly *E. crus-galli* and *P. distichum*, demonstrate high adaptability and resource-use efficiency, making them persistent competitors in rice ecosystems. These findings reinforce the need for timely and stage-specific weed management interventions, especially during the critical period of 3–8 weeks after planting, to prevent significant yield loss and to support sustainable rice production in South Minahasa Regency.

Keywords : community health surveillance; environmental health; behavioral risk factors; hypertension; sanitation

© The Author(s). 2025 Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0>

---

## INTRODUCTION

Weeds are widely recognized as one of the most persistent biological constraints in rice production systems, particularly in tropical agricultural environments. As undesired plants that emerge and grow in areas managed for crop cultivation, weeds compete directly with crops for essential growth resources such as light, water, nutrients, carbon dioxide, and physical growing space (Moenandir, 1990; Salisbury & Ross, 1992). This competition, when unmanaged, causes substantial reductions in crop yield and productivity. In lowland rice ecosystems, which rely heavily on stable water and nutrient availability, the rapid proliferation of certain weed species can significantly disrupt plant physiological processes and overall crop development (Moody, 1983). Reports from various regions in Indonesia and other Asian rice-producing countries demonstrate that weed interference is among the primary factors limiting rice yield, with estimated yield losses reaching 11–82% depending on weed species, density, and management practices employed (Rahayu et al., 2003; Chauhan, 2013). These findings underscore the critical importance of understanding weed ecology and dominance dynamics in rice ecosystems to support sustainable agricultural productivity.

In tropical lowland rice systems, the diversity and abundance of weeds are influenced by environmental conditions, water management, soil fertility, and farming practices that shape the ecological niche available for weed growth (Akobundu, 1987; IRRI, 2014). Many weed species possess competitive traits such as rapid vegetative growth, early reproduction, high seed production, and physiological adaptability to flooded environments. For example, *Echinochloa crus-galli*\*, *Paspalum distichum*\*, *Fimbristylis litoralis*\*, and *Cyperus iria*\* are consistently reported as dominant weeds in rice fields across Southeast Asia due to their ability to tolerate inundation and compete effectively with rice plants for sunlight and nutrients (Moenandir, 1996; Fue & Chauhan, 2015). These species demonstrate strong ecological resilience through mechanisms such as seedbank persistence, vegetative reproduction, and allelopathic interactions that further suppress rice growth. Given the intensification of rice production and the increasing shift toward reduced tillage and direct-seeded systems, weed pressure is expected to rise, thereby amplifying the urgency for detailed ecological studies on weed composition and dominance at different rice growth stages.

Despite the long-standing recognition of weeds as major constraints, several practical and theoretical challenges persist in weed management. From a practical standpoint, farmers in many rice-producing regions rely on generalized weed control methods without adequate consideration of species-

specific dominance patterns or critical competition periods—typically occurring between 3 and 8 weeks after planting (Moenandir, 1990; Syaifudin et al., 2022). Such generalized approaches often result in inadequate weed suppression, increased production costs, and prolonged labor requirements. Theoretical challenges also emerge in understanding weed population dynamics across temporal scales. Weed communities are not static; they shift depending on environmental factors, crop growth stages, and management interventions. Yet, systematic vegetation analyses that capture these temporal changes remain limited, particularly in localized rice production landscapes such as those in South Minahasa Regency. As a result, both the ecological understanding of weed succession and the evidence base for formulating location-specific weed management strategies remain insufficient.

The lack of detailed vegetation studies also hinders the development of integrated weed management (IWM) approaches, which require comprehensive knowledge of weed species composition, dominance hierarchy, and competitive ability. Effective IWM strategies depend on identifying not only which species are present but also how their competitiveness changes over time relative to rice growth. For instance, grasses such as *E. crus-galli* may be more dominant at early vegetative stages, whereas sedges like *F. litoralis* may persist under denser rice canopies in later phases. Without empirical data on these patterns, farmers often rely on broad-spectrum herbicides or late manual weeding, which may be suboptimal or even ineffective given the timing mismatch with the weed's critical growth period (Cramer, 1990; Anderson, 1977). Moreover, weed species with similar morphological characteristics to rice, such as *E. crus-galli*, are particularly challenging to control because they are often visually indistinguishable from rice until later stages, further complicating timely intervention (Soerjani et al., 1987; Rosyikin et al., 2021).

Recent scientific studies emphasize the importance of conducting vegetation analysis to characterize weed populations within specific rice-growing ecosystems. Tjitrosoedirdjo et al. (1984) introduced quantitative approaches for evaluating weed density, frequency, and biomass as indicators of ecological dominance. These parameters are integrated into the Species Dominance Ratio (SDR), a robust metric that captures the relative competitiveness of each weed species within a community. Vegetation analysis using SDR has been widely applied in various cropping systems, enabling researchers to identify key weed species that exert the greatest competitive pressure on crops (Lisdayani et al., 2022; Widya & Marwan, 2021). For lowland rice specifically, vegetation studies have shown that weed communities differ across planting phases due to shifts in water regime, canopy shading, and nutrient availability (Ulaan et al., 2015; Suryatirni, 2018). These temporal dynamics demonstrate that a snapshot of weed composition at a single time point is insufficient; rather, a multi-stage observation is crucial for devising effective and sustainable control strategies.

Several previous studies offer specific insights into weed pressure in rice ecosystems that inform the methodological foundation of this research. Naharia et al. (2005, 2018) emphasized the interactions

between water management, soil characteristics, and weed proliferation in determining rice field ecological outcomes. Meanwhile, Naung et al. (2014) demonstrated that plant spacing and weed control techniques significantly influence weed density and rice yield, supporting the argument that weed dominance is shaped not only by species traits but also by management interventions. Studies by Chauhan (2013) and Fue & Chauhan (2015) provide further evidence that early detection and targeted management of dominant weeds can significantly reduce yield losses. Together, these findings highlight the necessity of site-specific weed studies that account for local agroecological conditions, farming practices, and crop growth patterns.

Although existing research has extensively described general weed ecology and management principles, significant gaps remain—particularly in the context of South Minahasa Regency. As one of the major rice-producing regions in North Sulawesi, South Minahasa possesses diverse agroecosystem characteristics influenced by local hydrology, soil fertility, and farmers' cultivation practices. However, empirical studies on weed vegetation analysis in this region are remarkably scarce. Most existing research emphasizes fertilization technology, irrigation management, or pest and disease control, leaving weed ecology understudied. Consequently, there is limited scientific evidence to guide region-specific weed management strategies, and local extension programs often rely on generalized recommendations that may not reflect the actual weed dynamics present in farmers' fields.

Given these gaps, the present study aims to provide a comprehensive vegetation analysis of weed species in lowland rice fields of South Minahasa Regency across four critical stages of rice development: initial observation, 21 days after sowing (DAS), 45 DAS, and 60 DAS. This research contributes to the literature by offering empirical data on weed species composition, dominance structure, and temporal succession under local cultivation conditions. The novelty of this study lies in its multi-stage analysis of weed dominance patterns, which captures temporal ecological shifts that are often overlooked in weed management studies. By integrating density, frequency, and biomass parameters into SDR calculations, the study provides a nuanced understanding of weed competitiveness and potential yield impact. The findings are expected to inform the development of more effective, ecologically grounded, and locally relevant weed management strategies, ultimately supporting sustainable rice production in South Minahasa and contributing to broader regional food security initiatives.

## METHOD

According to Tjitrosoedirdjo, S., et al. I.H. (1984) that the analysis of the some dominant ratio of weed populations uses several variables as follows:

Absolute Density (AD) = Number of individual weed species specified in the sample plot

$$\text{Relative Density (RD)} = \frac{\text{AD certain species}}{\text{Number of AD of all species}} \times 100\%$$

Absolute Frequency (AF) = Number of sample plots containing certain weed species

$$\text{Relative Frequency (RF)} = \frac{\text{AF of certain species}}{\text{Total AF of all species}} \times 100\%$$

Determination of the dry weight of weeds is done by weighing the dry weight of weeds that have been dried in an oven at a temperature of 80°C for 3 x 24 hours. Weeds are grouped according to the same species.

Absolute Dry Weight (ADW) = Dry weight of a particular weed species

$$\text{Relative Dry Weight (RDW)} = \frac{\text{ADW of certain species}}{\text{Number of ADW for all species}} \times 100\%$$

Based on the results of this analysis, the Some Dominant Ratio can be determined.

Based on the results of this analysis, the Total Some Dominant Ratio can be determined.

$$\text{Some Dominant Ratio (SDR)} = \frac{\text{RD} + \text{RF} + \text{RDW}}{3}$$

## RESULTS AND DISCUSSION

### Results

#### 1. Initial weed observation results

From the initial weed observation, 17 weed species were identified. These consisted of nine broadleaf weed species, namely *Marsilea crenata*, *Ludwigia octovalvis*, *Limnocharis flava*, *Ipomoea aquatica*, *Monochoria vaginalis*, *Ludwigia adscendens*, *Alternanthera sessilis*, *Ludwigia angustifolia*, and *Ludwigia hyssopifolia*. Four species belonged to narrow-leaved or grass weeds, namely *Paspalum distichum*, *Echinochloa crus-galli*, *Leersia hexandra*, and *Echinochloa colona*. Additionally, four sedge weed species were identified: *Fimbristylis litoralis*, *Cyperus iria*, *Scirpus juncooides*, and *Cyperus difformis*.

Data in Table 1 show that the five weed species with the highest density are *Paspalum distichum* (186), *Marsilea crenata* (168), *Fimbristylis litoralis* (89), *Cyperus iria* (43), and *Leersia hexandra* (28). The data in Table 1 also indicate that two weed species have the highest absolute frequency value of 9, namely *Marsilea crenata* and *Paspalum distichum*. They are followed by four species with an absolute frequency of 7, namely *Ludwigia octovalvis*, *Echinochloa colona*, *Fimbristylis litoralis*, and *Cyperus iria*. Three species recorded an absolute frequency of 6, namely *Monochoria vaginalis*, *Scirpus juncooides*, and *Cyperus difformis*. Two species, *Echinochloa crus-galli* and *Leersia hexandra*, had an absolute frequency of 5. The remaining species with an absolute frequency value below 5 include *Limnocharis flava*, *Ipomoea aquatica*, *Ludwigia adscendens*, *Alternanthera sessilis*, and *Ludwigia hyssopifolia*.

Table 1. Initial Weed Analysis

| No           | Weeds Species          | AD  | RD      | AF | RF      | ADW    | RDW    | SDR     |
|--------------|------------------------|-----|---------|----|---------|--------|--------|---------|
|              |                        |     | %       |    | %       | gr     | %      | %       |
| Broad leaves |                        |     |         |    |         |        |        |         |
| 1            | <i>M. crenata</i>      | 168 | 27.541  | 9  | 10.843  | 19.99  | 11.476 | 16.620  |
| 2            | <i>L. octovalvis</i>   | 18  | 2.951   | 6  | 7.229   | 17.09  | 9.811  | 6.664   |
| 3            | <i>L. flava</i>        | 14  | 2.295   | 8  | 9.639   | 10.28  | 5.902  | 5.945   |
| 4            | <i>I. aquatica</i>     | 5   | 0.820   | 2  | 2.410   | 1.98   | 1.137  | 1.455   |
| 5            | <i>M. vaginalis</i>    | 7   | 1.148   | 2  | 2.410   | 6.27   | 3.600  | 2.386   |
| 6            | <i>L. adscendens</i>   | 2   | 0.328   | 1  | 1.205   | 2.43   | 1.395  | 0.976   |
| 7            | <i>A. sessilis</i>     | 5   | 0.820   | 1  | 1.205   | 1.32   | 0.758  | 0.927   |
| 8            | <i>L. angustifolia</i> | 4   | 0.656   | 2  | 2.410   | 3.43   | 1.969  | 1.678   |
| 9            | <i>L. hyssopifolia</i> | 2   | 0.328   | 1  | 1.205   | 1.04   | 0.597  | 0.710   |
| Grass        |                        |     |         |    |         |        |        |         |
| 10           | <i>P. disticum</i>     | 186 | 30.492  | 9  | 10.843  | 37.76  | 21.677 | 21.004  |
| 11           | <i>E. crusgalli</i>    | 18  | 2.951   | 8  | 9.639   | 10.23  | 5.873  | 6.154   |
| 12           | <i>L. hexandra</i>     | 28  | 4.590   | 7  | 8.434   | 7.75   | 4.449  | 5.824   |
| 13           | <i>E. colonum</i>      | 7   | 1.148   | 3  | 3.614   | 4.76   | 2.733  | 2.498   |
| Sedge        |                        |     |         |    |         |        |        |         |
| 14           | <i>F. litoralis</i>    | 89  | 14.590  | 9  | 10.843  | 22.85  | 13.118 | 12.850  |
| 15           | <i>C. iria</i>         | 43  | 7.049   | 9  | 10.843  | 18.51  | 10.626 | 9.506   |
| 16           | <i>S. juncoides</i>    | 8   | 1.311   | 4  | 4.819   | 2.76   | 1.584  | 2.572   |
| 17           | <i>C. difformis</i>    | 6   | 1.311   | 2  | 2.410   | 5.74   | 3.295  | 2.339   |
|              |                        | 610 | 100.000 | 83 | 100.000 | 174.19 | 100.00 | 100.000 |

From the analysis of the Relative Dominance Structure (RDS) of the initial weed observations, the five weed species with the highest Relative Density (RD) values were identified as *Paspalum distichum* (30.492%), *Marsilea crenata* (27.541%), *Fimbristylis litoralis* (14.590%), *Cyperus iria* (7.049%), and *Leersia hexandra* (4.590%). Other weed species with RD values below 3% included *Cyperus difformis*, *Echinochloa colona*, *Scirpus juncoides*, *Echinochloa crus-galli*, *Ludwigia octovalvis*, *Ipomoea aquatica*, *Monochoria vaginalis*, *Ludwigia adscendens*, *Alternanthera sessilis*, *Ludwigia angustifolia*, and *Ludwigia hyssopifolia*. Data in Table 1 also show that the weed species with the highest Relative Frequency (RF) values were six species: *Marsilea crenata*, *Paspalum distichum*, *Fimbristylis litoralis*, and *Cyperus iria* (10.843%), and *Limnocharis flava* and *Echinochloa crus-galli* (9.639%). Other weed species with RF values below 8% included *Scirpus juncoides*, *Cyperus difformis*, *Leersia hexandra*, *Ipomoea aquatica*, *Monochoria vaginalis*, *Ludwigia adscendens*, *Alternanthera sessilis*, *Ludwigia angustifolia*, and *Ludwigia hyssopifolia*.

Based on the results of the initial vegetation analysis, the Absolute Dry Weight (ADW) values exceeding 20% were observed in *Paspalum distichum* (37.76%), *Fimbristylis litoralis* (22.85%), *Marsilea crenata* (19.99%), *Cyperus iria* (18.51%), and *Ludwigia octovalvis* (17.09%). Other weed species with ADW values below 20% included *Limnocharis flava*, *Ipomoea aquatica*, *Monochoria vaginalis*, *Ludwigia adscendens*, *Alternanthera sessilis*, *Ludwigia angustifolia*, *Ludwigia hyssopifolia*, *Echinochloa crus-galli*, *Leersia hexandra*, *Echinochloa colona*, *Scirpus juncoides*, and *Cyperus difformis*.

For the Relative Dry Weight (RDW), the five weed species with the highest values were *Paspalum distichum* (121.677%), *Fimbristylis litoralis* (13.118%), *Cyperus iria* (13.19%), *Marsilea crenata* (9.24%), and *Ludwigia octovalvis* (8.49%).

Table 2. Some Dominant Ratios of Initial Weed Observations

| No. | Species                       | SDR (%) |
|-----|-------------------------------|---------|
| 1   | <i>Paspalum distichum</i>     | 21.004  |
| 2   | <i>Marsilea crenata</i>       | 16.620  |
| 3   | <i>Fimbristylis litoralis</i> | 12.850  |
| 4   | <i>Cyperus iria</i>           | 9.506   |
| 5   | <i>Ludwigia octovalvis</i>    | 6.664   |
| 6   | <i>Echinochloa crusgalli</i>  | 6.154   |
| 7   | <i>Limnocharis flava</i>      | 5.945   |
| 8   | <i>Leersia hexandra</i>       | 5.824   |
| 9   | <i>Scirpus juncoides</i>      | 2.572   |
| 10  | <i>Echinochloa colonum</i>    | 2.498   |
| 11  | <i>Monochoria vaginalis</i>   | 2.386   |
| 12  | <i>Cyperus difformis</i>      | 2.339   |
| 13  | <i>Ludwigia angustifolia</i>  | 1.678   |
| 14  | <i>Ipomea aquatica</i>        | 1.455   |
| 15  | <i>Ludwigia adscendens</i>    | 0.976   |
| 16  | <i>Alternanthera sessilis</i> | 0.927   |
| 17  | <i>Ludwigia hyssopifolia</i>  | 0.710   |

Data in Table 2 show that the five weed species with the highest Species Dominance Ratio (SDR) values were *Paspalum distichum* (21.004%), *Marsilea crenata* (16.620%), *Fimbristylis litoralis* (12.850%), *Cyperus iria* (9.506%), and *Ludwigia octovalvis* (6.664%). Other weed species with SDR values below 6% included *Echinochloa crus-galli* (6.154%), *Limnocharis flava* (5.945%), *Leersia hexandra* (5.824%), *Cyperus difformis* (3.94%), *Monochoria vaginalis* (3.91%), *Leersia hexandra* (3.32%), *Scirpus juncoides* (2.572%), *Echinochloa colona* (2.498%), *Monochoria vaginalis* (2.386%), *Cyperus difformis* (2.339%), *Ludwigia angustifolia* (1.678%), *Ipomea aquatica* (1.455%), *Ludwigia adscendens* (0.976%), *Alternanthera sessilis* (0.927%), and *Ludwigia hyssopifolia* (0.710%). The weed species with the highest SDR values can also be seen in Figure 1.

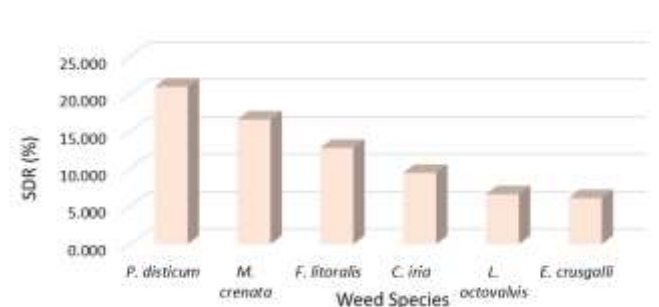


Figure 1. Weed Species with the Highest SDR at Initial Observation

## 2. Results of Weed Observation at 21 Days After Sowing (DAS)

Data in Table 3 show that there were three weed species with a density value (KM) greater than 80, namely *Paspalum distichum* (163), *Leersia hexandra* (113), and *Marsilea crenata* (110). The Frequency Value (FM) data indicate that three weed species had an FM of 9: *Marsilea crenata*, *Paspalum distichum*, and *Leersia*

*hexandra*. Two weed species had an FM of 7: *Monochoria vaginalis* and *Echinochloa crus-galli*. Two species had an FM of 6: *Limnocharis flava* and *Ludwigia adscendens*. Three species had an FM of 5: *Ludwigia octovalvis*, *Ipomoea aquatica*, and *Fimbristylis litoralis*.

Table 3. SDR Analysis at 21 Days After Sowing (DAS)

| No            | Weeds Species          | AD  | RD      | AF | RF      | ADW    | RDW     | SDR     |
|---------------|------------------------|-----|---------|----|---------|--------|---------|---------|
|               |                        |     | %       |    | %       | gr     | %       | %       |
| Broad :Leaves |                        |     |         |    |         |        |         |         |
| 1             | <i>M. crenata</i>      | 110 | 18.900  | 9  | 11.250  | 24     | 13.998  | 14.716  |
| 2             | <i>L. octovalvis</i>   | 28  | 4.811   | 5  | 6.250   | 19     | 11.082  | 7.381   |
| 3             | <i>L. flava</i>        | 19  | 3.265   | 6  | 7.500   | 9.87   | 5.757   | 5.507   |
| 4             | <i>I. aquatica</i>     | 8   | 1.375   | 5  | 6.250   | 4.49   | 2.619   | 3.414   |
| 5             | <i>M. vaginalis</i>    | 16  | 2.749   | 7  | 8.750   | 7.98   | 4.654   | 5.385   |
| 6             | <i>L. adscendens</i>   | 15  | 2.577   | 6  | 7.500   | 5.16   | 3.010   | 4.362   |
| 7             | <i>L. angustifolia</i> | 12  | 2.062   | 4  | 5.000   | 3.44   | 2.006   | 3.023   |
| 8             | <i>L. hyssopifolia</i> | 16  | 2.749   | 4  | 5.000   | 2.53   | 1.476   | 3.075   |
| Grass         |                        |     |         |    |         |        |         |         |
| 9             | <i>P. disticum</i>     | 163 | 28.007  | 9  | 11.250  | 27.12  | 15.818  | 18.358  |
| 10            | <i>E. crusgalli</i>    | 56  | 9.622   | 7  | 8.750   | 32.65  | 19.043  | 12.472  |
| 11            | <i>L. hexandra</i>     | 113 | 19.416  | 9  | 11.250  | 28.66  | 16.716  | 15.794  |
| 12            | <i>E. colonum</i>      | 15  | 2.577   | 4  | 5.000   | 3.9    | 2.275   | 3.284   |
| Sedge         |                        |     |         |    |         |        |         |         |
| 13            | <i>F. litoralis</i>    | 11  | 1.890   | 5  | 6.250   | 2.65   | 1.546   | 3.229   |
|               |                        | 582 | 100.000 | 80 | 100.000 | 171.45 | 100.000 | 100.000 |

The data above show that there were three weed species with Relative Density (RD) values greater than 9%: *Paspalum distichum* (28.007%), *Leersia hexandra* (19.416%), *Marsilea crenata* (18.900%), and *Echinochloa crus-galli* (9.622%). Other weed species had RD values ranging between 1.00% and 9.00%. The data also indicate that most weed species had Relative Frequency (RF) values between 5.00% and 7.00%, while some species, such as *Ludwigia octovalvis*, had RF values below 5%. From the data in Table 3, it was also found that four weed species had Relative Dry Weight (RDW) values greater than 10%: *Echinochloa crus-galli* (19.043%), *Leersia hexandra* (16.716%), *Paspalum distichum* (15.818%), and *Marsilea crenata* (13.998%). The RDW values of the other weed species were below 10%, ranging from 1.00% to 9.00%, including *Ludwigia octovalvis*, *Limnocharis flava*, *Ipomoea aquatica*, *Monochoria vaginalis*, *Ludwigia adscendens*, *Ludwigia angustifolia*, *Ludwigia hyssopifolia*, *Echinochloa colona*, *Fimbristylis litoralis*, *Cyperus iria*, and *Scirpus juncoides*.

Table 4. SDR at 21 Days After Sowing (DAS)

| No | Species                  | SDR %  |
|----|--------------------------|--------|
| 1  | <i>Paspalum disticum</i> | 18.358 |
| 2  | <i>Leersia hexandra</i>  | 15.794 |
| 3  | <i>Marsilea crenata</i>  | 14.716 |

|    |                               |        |
|----|-------------------------------|--------|
| 4  | <i>Echinochloa crusgalli</i>  | 12.472 |
| 5  | <i>Ludwigia octovalvis</i>    | 7.381  |
| 6  | <i>Limnocharis flava</i>      | 5.507  |
| 7  | <i>Monochoria vaginalis</i>   | 5.385  |
| 8  | <i>Ludwigia adscendens</i>    | 4.362  |
| 9  | <i>Ipomea aquatica</i>        | 3.414  |
| 10 | <i>Echinochloa colonum</i>    | 3.284  |
| 11 | <i>Fimbristilis litoralis</i> | 3.229  |
| 12 | <i>Ludwigia byssopifolia</i>  | 3.075  |
| 13 | <i>Ludwigia angustifolia</i>  | 3.023  |

Data in Table 4 show that the four weed species with the highest Species Dominance Ratio (SDR) values were *Paspalum distichum* (18.358%), *Leersia hexandra* (15.794%), *Marsilea crenata* (14.716%), and *Echinochloa crus-galli* (12.472%). Other weed species had SDR values ranging between 2.00% and 7.00%. These data can also be seen in Figure 2.

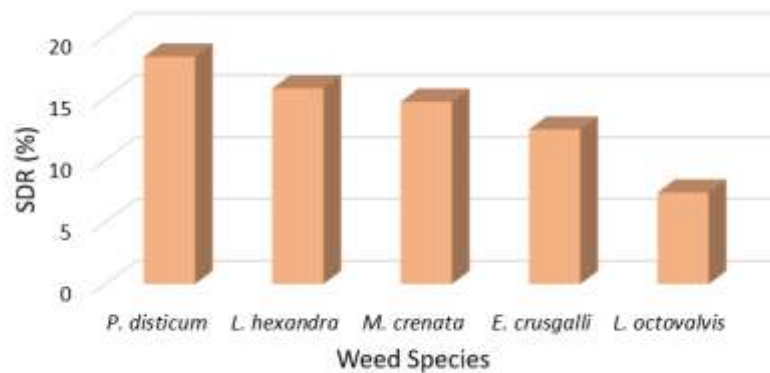


Figure 2. Weed Species with the Highest SDR at 21 Days After Sowing (DAS)

### 3. Results of Weed Observation at 45 Days After Sowing (DAS)

At 45 days after planting (DAP), there were three weed species with density (KM) values ranging from 17 to 45, and two weed species with KM values ranging from 2 to 6. Data in Table 7 also show that three weed species had Frequency (FM) values between 6 and 9, while seven weed species had FM values ranging from 3 to 5.

Table 5. SDR Analysis at 45 Days After Sowing (DAS)

| No           | Species              | AD | RD     | AF | RF     | ADW   | RDW    | SDR    |
|--------------|----------------------|----|--------|----|--------|-------|--------|--------|
|              |                      |    | %      |    | %      | gr    | %      | %      |
| Broad Leaves |                      |    |        |    |        |       |        |        |
| 1            | <i>L. octovalvis</i> | 5  | 2.809  | 7  | 11.864 | 21.14 | 18.373 | 11.015 |
| 2            | <i>L. flava</i>      | 7  | 3.933  | 4  | 6.780  | 4.6   | 3.998  | 4.903  |
| 3            | <i>M. vaginalis</i>  | 7  | 3.933  | 6  | 10.169 | 7.9   | 6.866  | 6.989  |
| 4            | <i>L. adscendens</i> | 7  | 3.933  | 3  | 5.085  | 3.9   | 3.390  | 4.136  |
| Grass        |                      |    |        |    |        |       |        |        |
| 5            | <i>P. distichum</i>  | 35 | 19.663 | 9  | 15.254 | 32.24 | 28.020 | 20.979 |
| 6            | <i>E. crusgalli</i>  | 49 | 27.528 | 5  | 8.475  | 10.12 | 8.795  | 14.933 |
| 7            | <i>L. hexandra</i>   | 34 | 19.101 | 5  | 8.475  | 8.6   | 7.474  | 11.683 |

| Sedge |                     |     |         |    |         |        |         |         |
|-------|---------------------|-----|---------|----|---------|--------|---------|---------|
| 8     | <i>F. litoralis</i> | 14  | 7.865   | 7  | 11.864  | 7.09   | 6.162   | 8.631   |
| 9     | <i>C. iria</i>      | 6   | 3.371   | 7  | 11.864  | 9.58   | 8.326   | 7.854   |
| 10    | <i>C. difformis</i> | 14  | 7.865   | 6  | 10.169  | 9.89   | 8.596   | 8.877   |
|       |                     | 178 | 100.000 | 59 | 100.000 | 115.06 | 100.000 | 100.000 |

Data in Table 5 show that there were three weed species with Relative Density (RD) values ranging from 8% to 23%, namely *Echinochloa crus-galli* (27.528%), *Paspalum distichum* (19.663%), and *Leersia hexandra* (19.101%). Three other weed species, *Fimbristylis litoralis* and *Cyperus difformis*, had RD values of 7.865%, while *Limnocharis flava*, *Monochoria vaginalis*, and *Ludwigia adscendens* had RD values of 3.933%. Additionally, *Cyperus iria* (3.371%) and *Ludwigia octovalvis* (2.809%) had RD values around 1.02%. Table 5 also shows that eight weed species had Relative Frequency (RF) values ranging from 8% to 16%, namely: *Paspalum distichum* (15.254%), *Fimbristylis litoralis*, *Cyperus iria*, and *Ludwigia octovalvis* (11.864%), *Monochoria vaginalis* and *Cyperus difformis* (10.169%), and *Echinochloa crus-galli* and *Leersia hexandra* (8.475%). The RF values of two other weed species were: *Limnocharis flava* (6.780%) and *Ludwigia adscendens* (5.085%). From Table 8, it can be seen that two weed species had high Relative Dry Weight (RDW) values, namely *Paspalum distichum* (28.020%) and *Ludwigia octovalvis* (18.373%).

Table 6. SDR at 21 Days After Sowing (DAS)

| No | Species                       | NJD (%) |
|----|-------------------------------|---------|
| 1  | <i>Paspalum disticum</i>      | 20.979  |
| 2  | <i>Echinochloa crusgalli</i>  | 14.683  |
| 3  | <i>Ludwigia octovalvis</i>    | 11.683  |
| 4  | <i>Leersia hexandra</i>       | 11.015  |
| 5  | <i>Cyperus difformis</i>      | 8.877   |
| 6  | <i>Fimbristylis litoralis</i> | 8.631   |
| 7  | <i>Cyperus iria</i>           | 7.853   |
| 8  | <i>Monochoria vaginalis</i>   | 6.989   |
| 9  | <i>Limnocharis flafa</i>      | 4.903   |
| 10 | <i>Ludwigia adscendens</i>    | 4.136   |

Data in Table 6 show that the five dominant weed species with the highest Species Dominance Ratio (SDR) values were *Paspalum distichum* (20.979%), *Echinochloa crus-galli* (14.683%), *Ludwigia octovalvis* (11.683%), and *Leersia hexandra* (11.015%). These data can also be seen in Figure 3.

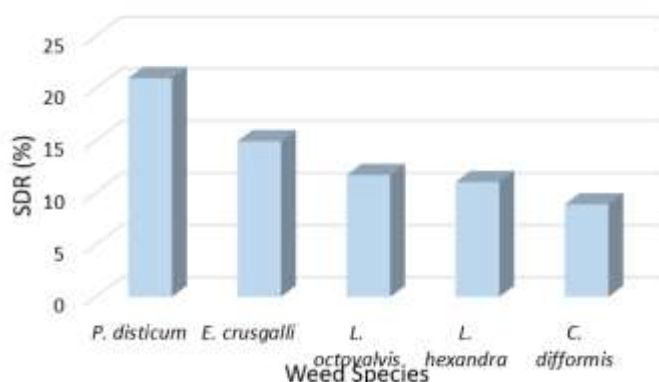


Figure 3. Weed Species with the Highest SDR at 45 Days After Sowing (DAS)

#### 4. Results of Weed Observation at 60 Days After Sowing (DAS)

Data in Table 7 show that only eight weed species grew in the rice field at 60 days after planting (DAP). The highest density (KM) value was found in *Echinochloa crus-galli* at 14, while the lowest KM value was recorded for *Scirpus juncooides* at 3. The highest frequency (FM) value was observed in *Echinochloa crus-galli* at 5, whereas the lowest FM value was found in *Scirpus juncooides* at 2.

Table 7. SDR Analysis at 60 Days After Sowing (DAS)

| No           | Species              | AD | RD      | AF | RF      | ADW   |  | RDW     | SDR     |
|--------------|----------------------|----|---------|----|---------|-------|--|---------|---------|
|              |                      |    | %       |    | %       | gr    |  | %       | %       |
| Broad Leaves |                      |    |         |    |         |       |  |         |         |
| 1            | <i>L. octovalvis</i> | 7  | 13.462  | 3  | 11.538  | 24.31 |  | 31.874  | 18.958  |
| 2            | <i>L. flava</i>      | 7  | 13.462  | 4  | 15.385  | 9.28  |  | 12.167  | 13.671  |
| 3            | <i>M. vaginalis</i>  | 4  | 7.692   | 4  | 15.385  | 4.74  |  | 6.215   | 9.764   |
| Grass        |                      |    |         |    |         |       |  |         |         |
| 4            | <i>P. disticum</i>   | 7  | 13.462  | 3  | 11.538  | 11.54 |  | 15.130  | 13.377  |
| 5            | <i>E. crusgalli</i>  | 14 | 26.923  | 5  | 19.231  | 21.43 |  | 28.098  | 24.750  |
| 6            | <i>L. hexandra</i>   | 6  | 11.538  | 3  | 11.538  | 3.13  |  | 4.104   | 9.060   |
| Sedge        |                      |    |         |    |         |       |  |         |         |
| 7            | <i>F. litoralis</i>  | 4  | 7.692   | 2  | 7.692   | 0.98  |  | 1.285   | 5.557   |
| 8            | <i>S. juncooides</i> | 3  | 5.769   | 2  | 7.692   | 0.86  |  | 1.128   | 4.863   |
|              |                      | 52 | 100.000 | 26 | 100.000 | 76.27 |  | 100.000 | 100.000 |

From the data in Table 7, it was found that the highest Relative Density (RD) values were observed in narrow-leaved or grass-type weeds, namely *Echinochloa crus-galli* at 26.923%, followed by *Paspalum disticum*, *Ludwigia octovalvis*, and *Limnocharis flava* at 13.462%, and *Leersia hexandra* at 11.538%. The RD values of sedge-type weeds (*Fimbristylis litoralis* and *Scirpus juncooides*) were 7.692% and 5.769%, respectively. Broad-leaved weed species had RD values below 4%. There was a similarity in Relative Frequency (RF) values among some weed species at 60 DAP: *Limnocharis flava* and *Monochoria vaginalis* at 15.385%, and *Leersia hexandra*, *Paspalum disticum*, and *Ludwigia octovalvis* at 11.538%. The highest Relative Dry Weight (RDW) values were found in narrow-leaved or grass-type weeds: *Ludwigia octovalvis* at 31.874%, *Echinochloa crus-galli* at 28.098%, and *Paspalum disticum* at 15.130%, followed by *Limnocharis flava* at 12.167%. The lowest RDW value was recorded for *Scirpus juncooides* at 1.128%.

Table 8. SDR at 60 Days After Sowing (DAS)

| No | Species                       | SDR(%) |
|----|-------------------------------|--------|
| 1  | <i>Echinochloa crusgalli</i>  | 24.750 |
| 2  | <i>Ludwigia octovalvis</i>    | 18.958 |
| 3  | <i>Limnocharis flafa</i>      | 13,671 |
| 4  | <i>Paspalum disticum</i>      | 13.377 |
| 5  | <i>Monochoria vaginalis</i>   | 9.764  |
| 6  | <i>Leersia hexandra</i>       | 9.060  |
| 7  | <i>Fimbristilis litoralis</i> | 5.557  |
| 8  | <i>Scirpus juncooides</i>     | 4.863  |

Data in Table 8 show that the highest Species Dominance Ratio (SDR) values were found in narrow-leaved or grass-type weeds, namely *Echinochloa crus-galli* at 24.75% and *Ludwigia octovalvis* at 18.958%. The

lowest SDR value was recorded in a broad-leaved weed, *Scirpus juncooides*, at 4.86%. This can also be seen in Figure 4.

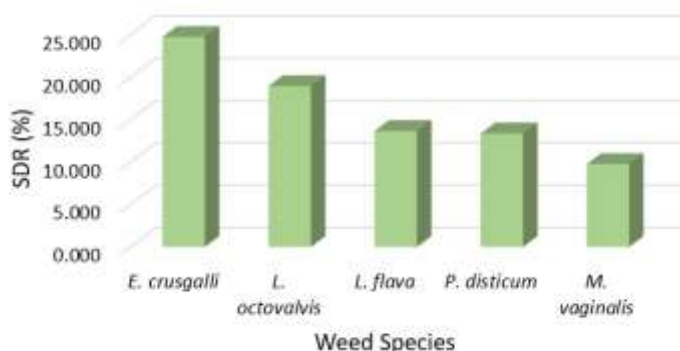


Figure 4. Weed Species with the Highest SDR at 60 Days After Sowing (DAS)

## Discussion

### 1. Initial Weed Observation

From the results of the initial weed observation as shown in Table 3, it can be seen that the dominant weeds in the broadleaf group are *Marsilea crenata* with an SDR of 16.620%, in the narrow-leaf or grass group are *Paspalum disticum* with an SDR of 21.004%, and in the sedge group are *Fimbristylis litoralis* with an SDR of 12.850%. The high dominance value of *Marsilea crenata* with an SDR of 16.620% is due to this weed species having adequate growth resources because there is no competition yet from the cultivated crop, which is rice. With the availability of growth resources such as sunlight, growing space, water, CO<sub>2</sub>, nutrients, and other growth factors still sufficient, the species can thrive.

Another species with a high SDR is a narrow-leaf or grass-type weed, *Paspalum disticum*, with an SDR of 21.004%. This weed is dominant because it grows well in open conditions without shading, allowing maximum sunlight for photosynthesis. A characteristic of grass-type plants is that they grow well on land without shading. Thus, *Paspalum disticum* can grow vigorously in rice fields. The dominant species in the sedge group is *Fimbristylis litoralis* with an SDR of 12.850%. *Scirpus juncooides* is a plant with the characteristic of being physically short. In the observed area, most of the vegetation growing before planting was low-growing, allowing *Scirpus juncooides* to compete effectively for growth resources.

### 2. Weed Observation at 21 Days After Sowing (DAS)

At 21 DAS, a total of 16 weed species were observed. The highest SDR was found in narrow-leaf or grass-type weeds, namely *Paspalum disticum*, *Leersia hexandra*, *Marsilea crenata*, and *Echinochloa crusgalli*. The high SDR in narrow-leaf or grass-type weeds is likely due to the fact that these three weeds share similar traits with rice plants, namely their ability to grow well in open, unshaded areas. At 21 DAS, the rice plants are physically still short, so these three weed species can still obtain adequate growth resources such as CO<sub>2</sub> and sunlight for photosynthesis. Water is also sufficiently available as a medium for nutrient transport through the roots. At 21 DAS, the available growing space for these three weeds is still

abundant because the rice tillers have not yet developed densely. The available space allows the narrow-leaf or grass-type weeds to grow well.

Broadleaf weed species, such as *Ludwigia hyssopifolia*, are unable to compete with narrow-leaf or grass-type weeds and rice plants because in the competition for growth resources—especially sunlight—these broadleaf weeds are outcompeted. This is also due to the fact that both broadleaf weeds are physically short, so they are shaded by the narrow-leaf or grass-type weeds and rice plants, resulting in a low population of these broadleaf species.

### 3. Weed Observation at 45 Days After Sowing (DAS)

At 45 DAS, 10 weed species were observed in the rice field. Compared to the 21 DAS observation, six weed species were no longer present. The highest SDR was found in narrow-leaf or grass-type weeds and sedge-type weeds. Narrow-leaf or grass-type weeds such as *Paspalum disticum*, *Echinochloa crusgalli*, *Ludwigia octovalvis*, and *Leersia hexandra* had high SDR values because these weed species share similar physical characteristics with rice plants. In addition, these species grow well in open, unshaded areas. Another possible reason is that the seed bank of these weeds in the soil is abundant, so under favorable environmental conditions, these species can thrive. *Fimbristylis litoralis* and *Cyperus iria* are two sedge-type weeds that also have high SDR values. This is likely because these species efficiently utilize light for photosynthesis. Another possible reason is their competitive ability to utilize growth resources alongside cultivated crops. The decrease in the number of weed species observed at 45 DAS is primarily due to some species being outcompeted by the rice plants, particularly those with low physical stature. The rice canopy can shade low-growing weed species, thereby reducing their population in the field.

### 4. Weed Observation at 60 Days After Sowing (DAS)

At 60 DAS, only 8 weed species were observed growing in the rice field. The dominant weed species belonged to the grass group, namely *Echinochloa crusgalli*. This is because *Echinochloa crusgalli* is physically similar to rice plants, making the two almost indistinguishable. This similarity makes it very difficult for farmers to control the weed. *Echinochloa crusgalli* can be clearly distinguished around 70 DAS, when the weed grows taller than the rice plants and produces panicles containing dark brown seeds. *Paspalum disticum* is the second-highest in SDR after *Echinochloa crusgalli*. This is due not only to its strong adaptability in utilizing available growing space but also because it grows well in fields with sufficient water.

Other weed species with high SDR values belong to the sedge group. This is likely due not only to a large seed bank in the soil but also to the effective use of sunlight and the ability to compete for available growing space. *Fimbristylis litoralis* is a sedge species that produces few tillers and tends to survive under rice cultivation with dense tillers and a thick canopy. The nine weed species that did not grow in the rice field at 60 DAS were likely limited by extrinsic competition or weak competitive ability against other

plant species. This competition involves access to growth resources such as sunlight, CO<sub>2</sub>, water, growing space, and other essential growth factors.

## CONCLUSION

Based on the results of the observations and discussion, the following conclusions can be drawn:

1. The weed species with the highest SDR at the initial observation in the rice field were *Paspalum disticum*, *Fimbristylis litoralis*, *Marsilea crenata*, *Cyperus iria*, and *Ludwigia octovalvis*.
2. The weed species with the highest SDR at 21 DAS were *Paspalum disticum*, *Echinochloa crusgalli*, *Fimbristylis litoralis*, *Marsilea crenata*, and *Leersia hexandra*.
3. The weed species with the highest SDR at 45 DAS were *Paspalum disticum*, *Fimbristylis litoralis*, *Cyperus iria*, *Echinochloa crusgalli*, and *Leersia hexandra*.
4. The weed species with the highest SDR at 60 DAS were *Echinochloa crusgalli*, *Paspalum disticum*, *Fimbristylis litoralis*, *Scirpus juncoides*, and *Scirpus juncoides*.

## REFERENCE

- Akobundu, I.O. 1987. *Weed Science in the Tropics: Principles and Practices*. New York: John Wiley & Sons.
- Anderson. P.W. 1977. *Weed Science Principles*. West Publisher Company. St. Paul. Los Angeles.
- Anggi, S.R., Elly K., yamsul B., dan Joko P., 2014. *Kumpulan Deskripsi Varietas Padi*. Badan Pengkajian Teknologi Pertanian Jawa Tengah. BPTP Jateng
- Anggiu I. Y., Sartika. A. M., 2020. Analisis Vegetasi dan Potensi Pemanfaatan Jenis Gulma Pasca Pertanaman Jagung. *Jurnal Agroteknologi Merdeka Pasuruan* Vol. 6. Nomor 2. Hal 20-28.
- Chauhan, B. S. (2013). Strategies to manage weeds in modern rice production. *Crop Protection*, 48, 52–58. Elsevier
- Cramer, H.G. 1990. *Plant Protection and Weed Management*. Berlin: Springer-Verlag.
- Departemen Pertanian. (2011). *Pedoman Pengendalian Gulma pada Padi Sawah*. Jakarta: Direktorat Jenderal Tanaman Pangan.
- Due, S., & Chauhan, B. S. (2015). Weed management in direct-seeded rice systems. *Crop Protection*, 71, 46–52. Elsevier.
- Klingman, G.C. 1961. *Weed Control as a Science*. New York: John Wiley & Sons.
- Lisdayani, Dibisono Y., Mustika P.S., dan Susanti R. 2022. Analisis Vegetasi Gulma Di Lsahsn Pertanian Kelurahan Simalingklar B Tuntungan. *Jurnal Online Agroteknosains* Vol. 6, No. 2.
- Moenandir, J. 1996. *Pengelolaan Gulma pada Sistem Pertanian sebagai Upaya Peningkatan Hasil Tanaman Pangan*. Pidato Pengukuhan Guru Besar dalam Ilmu Gulma. Universitas Brawijaya. Malang. pp. 44.
- Moenandir. J. 1990. *Pengantar Ilmu Gulma Dan Pengendalian Gulma*. Rajawali Press. Jakarta
- 
- 14635 | Journal of Innovative and Creativity, 5(3) 2025

- Moody, K. 1983. *Weeds of Rice in Asia*. Manila: International Rice Research Institute (IRRI).
- Naharia, O. 2003. Kontribusi Olah Tanah Konservasi untuk Mitigasi Emisi Gas Metana pada Budidaya padi Sawah. *Jurnal Gulma Tropika*. Vol. 1 No. 2. Hal. 83-89.
- Pudjogonarto, W.S., D. Suroto dan Warsoko. 2001. Pengaruh Jarak Tanam dan Dosis Glifosat terhadap Pertumbuhan Gulma dan Hasil Jagung. *Pros. Konf. HIGI*. 423-429.
- Sastroutomo. 1990. *Ekologi Gulma*. PT. Gramedia Pustaka Utama. Jakarta
- Sukman Y dan Yakup., 2002. *Gulma Dan Teknik Pengendaliannya*. Raja Grafindo Persada
- Tjitrosoedirdjo, S., I.H. Utomo, J. Wiroatmodjo. 1984. *Pengelolaan Gulma di Perkebunan*. Gramedia Jakarta.
- Hamid A., 2004. Penentuan Jumlah Benih Padi Sebar Langsung Untuk Menekan Pertumbuhan Gulma. <http://www.pustaka-deptan.go.id>. Diakses tanggal 15 Juni 2023.
- Husain M., Hasjim S., Widodo N., and Harsita P. A. 2019. Analisis Nilai Penting Gulma pada Tanaman Padi Dalam Rangkas Pemilihan Pengendalian Ramah Lingkungan. *Agrimeta*. Vol. 09. No. 17.
- IRRI. (2014). *Weed management in rice. IRRI Technical Bulletin Series*. Los Baños, Philippines: International Rice Research Institute.
- Jamilah. 2017. Padi Sebagai Penyedia Beras dan Pakan Ternak Menunjang Kedaulatan Pangan. Universitas Taman Siswa Padang.
- Moenandir, J. (1993). *Pengantar Ilmu dan Pengendalian Gulma*. Jakarta: Rajawali Press.
- Noor E.S., 1997. Pengendalian Gulma di Lahan Pasang Surut. <http://www.pustaka-deptan.go.id>. Diakses tanggal 10 Juni 2023.
- Naharia, O. 2005. Teknologi Pengairan dan Pengolahan Tanah pada Budidaya Padi Sawah untuk Mitigasi Gas Metana (CH<sub>4</sub>). *Berita Biologi*. Vol. 7. Pusat Penelitian Biologi – LIPI. Jakarta.
- Naharia, O. Setyanto P, Arsyad M, Burhan H, and Aswad M., 2018. The Effect of Water Regime and Soil Management on Methane (CH<sub>4</sub>) Emission of Rice Field. *IOP Conference Series: Earth and Environmental Science* 157 (1) 0120 12.
- Naharia, O. Setyanto P, Irianto M.Y., Burhan H, 2005. The effect of water regime and soil management on methane emission from rice field. (Proceedings, The 20<sup>th</sup> Asian – Pacific Weed Science Society Conference, Ho Chi Minh City Vietnam)
- Naung S., Naharia O, Wurarah M. 2014. Pengaruh Jarak Taman dan Cara Pengendalian Gulma Terhadap Produksi Padi sawah. *Sain dan Pendidikan PPS Unima* 2 (3).
- Pujiharti, Barus Y, Junbita W, dan Bambang. 2008. *Teknologi Budidaya Padi*. Balai Besar Pengkajian dan Pengembangan dan Teknologi Pertanian.
- Rosyikin, A. Z., Widiarti, W., & Wijaya, I. (2021). Eksplorasi dan identifikasi gulma pada padi sawah di Kabupaten Lumajang. *Jurnal Callus*, 10(2), 115–124.
- Sastroutomo, S. S. (1990). *Ekologi Gulma*. Jakarta: Gramedia.

- Salisbury, F.B., & Ross, C.W. 1992. *Plant Physiology*. 4th Edition. Belmont, California: Wadsworth Publishing Company.
- Sembodo, D. R. J. (2010). *Ilmu Gulma dan Pengelolaannya*. Yogyakarta: Graha Ilmu.
- Soerjani, M., Kostermans, A. J.G. H., & Tjitrosoedirdjo, S. 1987. *Weeds of Rice in Indonesia*. Jakarta: Balai Pustaka.
- Soerjani, M., Tjitrosoedirdjo, S., & Kostermans, A. J. G. H. (1987). *Weeds of Rice in Indonesia*. Jakarta: Balai Pustaka.
- Sedonda M., Naharia O, Kapahang A,. 2015. Pengaruh Teknologi Pengairan dan Premupukan Terhadap Produksi Padi sawah (*Oryza sativa* L.). Sains dan Pendidikan PPS Unima 1 (2).
- Suryatrini L. 2018. Analisis Keragaman dan Komposisi Gulma pada Tanaman Padi Sawah. Jurnal Sains dan Teknologi. Vol 7. No 1.
- Syaifudion E.A., Sofian and Rizky A. P. 2022. Identification of Weeds in Local Rice Swamp Fields in East Kalimantan in Rapak Lambur Village, Tenggarong District. Jurnal Agroteknology Tropika Lembab. Vol. 5 No. 1. Hal: 34-40.
- Tjitrosoedirdjo, S., Utomo, B., & Setyanti, Y. 1984. *Pengantar Ilmu Gulma*. Bogor: Institut Pertanian Bogor (IPB Press).
- Tjitrosoedirdjo, S. (2005). *Manajemen Gulma di Indonesia*. Bogor: IPB Press.
- Ulaan, M., Naharia O., J, J. Mamangkey. 2015. Pengaruh Teknologi Pengairan dan Pemupukan Terhadap Pertyumbuhan Padi Sawah (*Oryza sativa* L.). Sains dan Pendidikan PPS Unima 1 (1)
- Utomo, M dan Nazaruddin., 2007. Bertanam Padi Sawah Tanpa Olah tanah. Penerbit Penebar Swadaya, Jakarta.
- Widya S., dan Marwan A., 2021. Analisis Vegetasi Gulma Padi Pandanwangi (*Oryza sativca* L Aromatic). Pro-Stek. Vol. 3. No.1.
- Yuliana A.I., dan Ami M.S. 2021. Keragaman dan Potensi Pemanfaatan Vegertasi Gulma Pasca Pertanian Padi Di Desa Penggaron Kecamatan Mojowarno Kabupaten Jombang. Saintekbu. Jurenal Sains dan Teknologi. Vol: 13 No. 01.