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Summed dominance ratio-based analysis of weed diversity and dominance in maize fields

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ABSTRACT

Background: Maize (*Zea mays* L.) is an important food crop in Indonesia, but its productivity is frequently reduced by weed competition for essential growth resources. Weed composition and dominance vary with environmental and management conditions, highlighting the need for site-specific weed management. Understanding local weed communities is also important for developing sustainable weed control strategies that minimize environmental impacts while maintaining crop productivity. Therefore, this study aimed to characterize weed communities in maize fields across three locations in Rejang Lebong Regency by analyzing species composition, dominance structure using SDR, ecological interpretation, community similarity using the Community Coefficient (CC) analysis, and their implications for weed management, including potential allelopathic profiles of dominant weed species. **Methods:** The study was conducted in December 2025 using a 1 x 1 m quadrat method in three maize fields, with three sampling plots created at each location (n = 9 quadrats). Weed dominance was measured using density, frequency, the Importance Value Index (IVI), and the Summed Dominance Ratio (SDR), whereas community resemblance was assessed using the CC. **Findings:** A total of 16 weed species were found across the study areas. Ageratum conyzoides dominated locations 1 and 2, with SDR values of 28.53% and 34.85%, respectively, whereas Bidens pilosa (22.00%) and Setaria barbata (21.39%) co-dominated location 3. Broadleaf weeds were the most common functional group across all locales. Community resemblance between locations was low (CC = 29.28-48.47%), indicating diverse weed communities. **Conclusion:** Maize fields in Rejang Lebong were dominated by 16 weed species, with strong single-species dominance by Ageratum conyzoides (SDR up to 34.85%) at some sites, while Community Coefficient values below 75% indicated non-homogeneous weed communities among locations. These findings provide a quantitative baseline for regional weed management and highlight the importance of integrated, site-specific approaches that combine mechanical weeding, crop rotation, mulching, and selective herbicide use to improve weed control efficiency, reduce unnecessary herbicide inputs, and support sustainable maize production. **Novelty/Originality of this article:** This study demonstrates how integrating SDR and CC analyses improves the identification of dominant weed species and community variation, providing scientific evidence for site-specific weed management and more sustainable maize production.

KEYWORDS: *Ageratum conyzoides*; summed dominance ratio; vegetation analysis.

1. Introduction

Maize (*Zea mays* L.) is one of the major food commodities in Indonesia and plays a crucial role in national food security, ranking second only to rice in terms of importance (Dahlianah et al., 2019). As a primary source of carbohydrates, maize possesses significant strategic and economic value, contributing not only to household consumption but also to broader agricultural and industrial sectors (Harahap, 2019). Beyond its role as a staple food,

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maize is widely utilized as a key raw material in animal feed production, supporting the livestock industry (Rai et al., 2018), and as an essential input in various agro-industrial processes, including food processing and bio-based industries (Karenga et al., 2022). The multifaceted utilization of maize has led to a continuous increase in demand, both domestically and industrially. Consequently, these conditions highlight the urgency of improving maize productivity and sustainability to ensure stable supply and meet growing market needs.

However, weeds are one of the main limiting factors affecting the growth and productivity of maize crops (Duwadi et al., 2021). The presence of weeds in cultivated fields can cause a significant reduction in maize yield of up to 65% (Ehsas et al., 2016). Weeds directly compete with maize plants for essential resources such as water, light, nutrients, and growing space (Duwadi et al., 2021). Accordingly, uncontrolled weeds in maize cultivation can reduce yields by 20–80%, depending on the level of infestation and the duration of competition (Bilman, 2001). Weeds are serious competitors in nutrient uptake relative to crop plants; their percentage of the total uptake of macroelements from the soil by the maize crop and weeds combined was significant, averaging 35% for K, 27.3% for Ca, and 27.4% for Mg (Głowacka, 2011).

Weed diversity plays an essential role in formulating effective weed management strategies in agricultural cropping systems (Storkey & Neve, 2018). Knowledge of weed community composition and dominance is fundamental for developing sustainable weed management strategies. Such information enables more targeted control measures, reduces reliance on broad-spectrum herbicides, supports biodiversity conservation, and contributes to the sustainability of maize production systems (Storkey & Neve, 2018; von Redwitz et al., 2025). Variations in weed diversity are shaped by multiple environmental and agronomic factors, including light availability, soil nutrient status, and cultivation practices, all of which align with general plant population dynamics (Maclaren et al., 2020). The number and diversity of weed species are strongly influenced by soil characteristics and the type of crop grown (Ługowska et al., 2016). Moreover, weed composition is affected by crop density, soil fertility, cropping systems, and tillage methods. Environmental factors such as altitude have also been reported to influence weed community diversity (Fanfarillo et al., 2020). Furthermore, weed diversity across observation sites is shaped by various environmental and agronomic factors, such as light conditions, nutrient availability, soil tillage, cultivation techniques, plant spacing or density, and the age of citrus plants (Imaniasita et al., 2020).

Aside from direct resource competition, weeds are now known to initiate chemical signaling processes early in crop development that alter growth and physiology long before resource limitations occur, with dominant weed species producing allelochemicals that can reduce crop fitness in a species-specific manner. This highlights the need of accurately identifying locally dominant weed species as a prerequisite for establishing focused and successful management methods, especially in understudied maize-growing locations like Rejang Lebong, where baseline weed community data are currently unavailable. Several studies in Bengkulu Province have found that weed composition and dominance differ significantly among agroecosystems and elevation gradients. In the highland dryland areas of Kepahiang Regency, 31 weed species from 15 families were discovered, with broadleaf weeds dominating and *Ageratum conyzoides* having the highest SDR value (13.95%) (Rosmanah et al., 2016). Similar results were seen in oil palm farms in Bengkulu City, where *A. conyzoides* had the highest relative density and important value index, showing its strong adaptability and competitiveness in tropical production systems. *A. conyzoides* and *Setaria barbata* were found to be prominent weeds in coffee plantations in Rejang Lebong Regency, indicating that these species are widely dispersed across agricultural fields in Bengkulu (Apriantonedi et al., 2023). Then, the dominating functional category in Rejang Lebong's gerga citrus plantations was grass weeds, underlining that weed communities vary based on crop type, environmental conditions, and management approaches (Apriantonedi & Utami, 2023).

Previous research at Bengkulu concentrated on plantation crops, horticulture systems, the allelopathic potential of weeds, and weed management measures (Handayani et al., 2024). Weed interference research has demonstrated that delayed weed control can considerably affect crop growth and output, emphasizing the significance of correct weed identification for effective management. Despite the importance of maize as a vital food crop, quantitative data on weed vegetation structure and dominance in maize growing regions in Rejang Lebong Regency is still absent.

Implementing efficient weed control in maize cultivation requires detailed knowledge of existing weed diversity. Consequently, understanding the species composition and structural characteristics of weed vegetation is necessary. Vegetation analysis serves as an important tool to identify weed species with a strong ability to compete for growth resources and living space. In general, weeds that effectively exploit available resources are considered more dominant. However, crop species also contribute to the interaction, as certain crops may tolerate the presence of specific weed species even at relatively high population densities (Bajwa et al., 2017).

The selection of sampling units is an important factor to consider while conducting vegetation study. Data gathering typically employs two sorts of measuring methods to obtain the necessary information: destructive measures and non-destructive measurements. For research purposes and to maintain statistical validity, both measurement kinds must use appropriate sampling units. This is especially essential for researchers working in forest ecosystems that span broad areas. Researchers or surveyors can gather the essential data more efficiently, precisely, and at a lower cost and effort than if they conducted a thorough inventory or census of the entire population. For vegetation description, there are three important quantitative factors that are commonly measured within a plant community. For vegetation description, there are three essential quantitative parameters that are generally measured within a plant community type, namely density, frequency, and cover (Lisdayani et al., 2022).

Weed composition observation can help determine whether there is a shift in weed species, specifically the presence of weed species in a region before and after experimental treatments. The Summed Dominance Ratio (SDR), also known as the Dominant Number Ratio (NJD), describes the relationship between the dominance of a specific weed species and other weed species within a community, as weed communities frequently contain certain species that grow more dominantly than others (Nursa'adah & Akasah, 2024). Before implementing weed control, several variables must be examined, including the prevalent weed species, the primary farmed crop, accessible control choices, and their economic and ecological implications (Liebman et al., 2016).

Rejang Lebong Regency was chosen for this study because it is one of the most important highland agricultural areas in Bengkulu Province, with increasing maize agriculture activity and a variety of environmental factors that may influence weed composition. As a result, this study provides the first quantitative baseline data on weed species composition, dominance structure, and community similarity in Rejang Lebong Regency maize fields, which will help to design site-specific weed management strategies. Thus, the objective of this study was to identify and characterize weed communities in maize fields at three different locations in Rejang Lebong Regency, by analyzing species composition, dominance structure using Summed Dominance Ratio (SDR), the ecological interpretation of weed communities, community similarity through Community Coefficient (CC) analysis, dominant allelochemical compounds associated with the weed species, and their implications for weed management strategies.

2. Methods

2.1 Study area and site selection

This study was conducted on agricultural land consisting of three maize fields located in Rejang Lebong Regency, Bengkulu Province, Indonesia, in December 2025. Study sites were selected using purposive sampling, whereby fields were chosen based on the following criteria: (1) active cultivation of maize (*Zea mays* L.) at a uniform vegetative growth stage (3–4 weeks after planting); (2) accessibility for systematic sampling; and (3) representation of the dominant maize-growing conditions prevalent in the Simpang Nangka area. Each of the three fields was treated as an independent sampling block, hereafter referred to as location 1 (latitude -3.457352°, longitude 102.577907°, alititude 848.4 m), Location 2 (latitude 3.454388°, longitude 102.577078°, altitude 825 m), and location 3 (latitude -3.457090°, longitude 102.654666°, altitude 1,096.7 m).

Prior weed management at all three locations involved herbicide application as the primary control measure in the preceding cropping season. From a climatological perspective, Rejang Lebong Regency, Bengkulu Province, falls within a Non-ZOM (Non-Zone of One Monsoon) rainfall pattern with annual rainfall ranging from 1,001 to 1,500 mm (Meteorology, Climatology, and Geophysical Agency, 2022). This is further supported by the regional soil and climatic characteristics of Rejang Lebong Regency, which encompasses diverse soil types including Andosol, Regosol, Podsolik, Latosol, and Alluvial soils with pH ranging from 4.5–7.5, average rainfall of 233.75 mm/month, and temperatures of 17.73–30.94°C (Pemerintah Kabupaten Rejang Lebong, 2020).

2.2 Sampling design and weed identification

Vegetation analysis was performed prior to the study using the quadrat method (Ahmad et al., 2016; Lisdayani et al., 2022) with a plot size of 1 m × 1 m. The study was conducted during the vegetative growth stage of maize. In each block, three sample plots were established. The study evaluated weed abundance and fresh biomass as the main parameters. The sample plots were arranged diagonally, and each plot was demarcated using string. All weeds encountered were identified by species and counted according to the field and sample plot number. Weed sampling was done by hand, following standard weeding techniques. At each observation location, remove any adhering soil or debris from surrounding the root system. All sampling was completed within a single day at each location to minimize temporal variation in weed presence. The collected weeds were then identified using ocular observation of their physical traits and compared to appropriate reference literature. Each weed species found in the sampling plots was photographed, identified, and its dominance computed.

2.3 Fresh biomass measurement

Immediately after collection and cleaning, all weed specimens per species per plot were weighed using a digital analytical balance (precision: ±0.01 g) to record fresh (wet) weight. Weighing was performed on the same day as collection to minimize post-harvest moisture loss. No oven-drying procedure was applied. Fresh biomass was selected as a practical field parameter that reflects the actual competitive mass of weeds at the time of sampling and is consistent with methodological precedents in tropical weed ecology studies (Mahgoub, 2023).

2.4 Quantitative vegetation analysis

Quantitative analysis was subsequently carried out to determine Relative Density (RD), Relative Frequency (RF), and Relative Dominance (RDo), which together constitute the Summed Dominance Ratio (SDR). The calculations of weed density, frequency, and dominance were performed using the following formulas (Mahgoub, 2023):

Absolute Density (AD):

$$AD = [Number\ of\ individuals\ of\ a\ species\ /\ Total\ area\ of\ sampling\ plots] \quad \text{(Eq. 1)}$$

Relative Density (RD):

$$RD = [AD\ of\ a\ species\ /\ \Sigma\ AD\ of\ all\ species] \times 100\% \quad \text{(Eq. 2)}$$

Absolute Frequency (AF):

$$AF = [Number\ of\ plots\ occupied\ by\ a\ species\ /\ Total\ number\ of\ plots] \quad \text{(Eq. 3)}$$

Relative Frequency (RF):

$$RF = [AF\ of\ a\ species\ /\ \Sigma\ AF\ of\ all\ species] \times 100\% \quad \text{(Eq. 4)}$$

Absolute Dominance (ADo):

$$ADo = [Fresh\ biomass\ of\ a\ species\ /\ Total\ observation\ area] \quad \text{(Eq. 5)}$$

Relative Dominance (RDo):

$$RDo = [ADo\ of\ a\ species\ /\ \Sigma\ ADo\ of\ all\ species] \times 100\% \quad \text{(Eq. 6)}$$

Importance Value Index (IVI):

$$IVI = [RD + RF + RDo] \quad \text{(Eq. 7)}$$

Summed Dominance Ratio (SDR):

$$SDR = [RD + RF + RDo] / 3 \quad \text{(Eq. 8)}$$

2.5 Community similarity analysis

To evaluate the degree of floristic similarity in weed community composition among the three maize field locations, a Community Coefficient (CC) analysis was performed using SDR values as the measure of species dominance. Two intermediate statistics were computed. Summed Shared Dominance (SSD): For any two locations being compared, SSD was calculated as the sum of the minimum SDR values of each species occurring in both locations:

$$SSD = \Sigma \min [SDR_{1i}, SDR_{2i}] \quad \text{(Eq. 9)}$$

Where SDR_{1i} and SDR_{2i} are the SDR values of species i at location 1 and location 2, respectively. Species present in only one of the two locations contributed a minimum value of zero. Community Coefficient (CC) was calculated as:

$$CC = [2 \times SSD / (\Sigma SDR_1 + \Sigma SDR_2)] \times 100 \quad \text{(Eq. 10)}$$

A CC value of ≥75% was used as the threshold for classifying two locations as having relatively homogeneous weed vegetation, following Simangungsong et al. (2018). CC values below this threshold indicate heterogeneous weed community structure between the compared locations. All pairwise combinations of the three locations were evaluated (location 1 vs. 2, location 1 vs. 3, and location 2 vs. 3).

3. Results and Discussion

3.1 Weed dominance and species composition at different maize field locations

Six weed species were identified at maize field location 1. *Ageratum conyzoides* showed the highest relative density (35.63%), relative dominance (28.53%), SDR (28.53%), and IVI (85.59%) (Table 1). *Bidens pilosa* ranked second in dominance, with an SDR of 23.44% and a high IVI (70.32%), reflecting its wide occurrence and substantial contribution to weed biomass. Similarly, *Digitaria ciliaris* and *Galinsoga parviflora* showed moderate but ecologically important dominance, with SDR values of 18.95% and 18.05%, respectively (Table 1).

Table 1. Weed dominance structure at maize field location 1

Weed Species	AD	RD (%)	AF	RF (%)	ADo	RDo (%)	IVI (%)	SDR (%)
Ageratum conyzoides	119	35.63	1.00	21.43	28.53	28.53	85.59	28.53*
Bidens pilosa	85	25.45	1.00	21.43	23.44	23.44	70.32	23.44
Digitaria caliaris	55	16.47	1.00	21.43	18.95	18.95	56.85	18.95
Galinsoga parviflora	49	14.67	1.00	21.43	18.05	18.05	54.15	18.05
Eleusine indica	19	5.69	0.33	7.14	6.42	6.42	19.25	6.42
Imperata cylindrica	7	2.10	0.33	7.14	4.62	4.62	13.86	4.62
Total	334	100		100		100	300	100

Note: * indicates the dominant weed species with the highest SDR value at this location

Furthermore, the weed community at maize field location 2 was strongly dominated by *Ageratum conyzoides*, which accounted for more than half of the total weed density (50.95%), showed the highest SDR value of 34.89% and very high IVI (104.68%) (Table 2). The remaining weed species contributed much smaller proportions to the community. *Bidens pilosa* represented 10.00% of the total weed density and had an SDR of 8.18%, while *Asystasia gangetica* contributed 9.52% with an SDR of 11.23%. *Onoclea struthiopteris* and *Imperata cylindrica* also showed moderate influence, with relative densities of 5.71% and 4.76% and SDR values of 9.34% and 8.87%, respectively (Table 2). The occurrence of the fern *O. struthiopteris* is particularly notable, as it indicates moist and less-disturbed microhabitats within the maize field. Other species such as *Spermacoce remota* (RD 3.33%, SDR 8.16%), *Eleusine indica* (RD 5.71%, SDR 5.98%), *Synedrella nodiflora* (RD 4.29%, SDR 5.35%), and *Calyptocarpus vialis* (RD 1.90%, SDR 4.16%) made only minor contributions to the overall weed structure (Table 2).

Table 2. Weed dominance structure at maize field location 2

Weed species	AD	RD (%)	AF	RF (%)	ADo	RDo (%)	IVI (%)	SDR (%)
Ageratum conyzoides	107	50.95	1.00	20.00	34.85	33.73	104.68	34.89*
Asystasia gangetica	20	9.52	0.67	13.40	11.01	10.78	33.70	11.23
Onoclea struthiopteris	12	5.71	0.67	13.40	9.11	8.92	28.03	9.34
Imperata cylindrica	10	4.76	0.67	13.40	8.63	8.45	26.61	8.87
Bidens pilosa	21	10.00	0.33	6.60	8.13	7.95	24.55	8.18
Spermacoce remota	7	3.33	0.67	13.40	7.92	7.75	24.48	8.16
Eleusine indica	12	5.71	0.33	6.60	5.98	5.85	18.16	6.05
Synedrella nodiflora	9	4.29	0.33	6.60	5.27	5.16	16.05	5.35
Calyptocarpus vialis	4	1.90	0.33	6.60	4.08	3.99	12.49	4.16
Total	210	100		100		100	300	100

Note: * indicates the dominant weed species with the highest SDR value at this location

Then, the dominance pattern of weeds at maize field location 3 was distributed across several key species rather than being controlled by a single dominant weed. *Bidens pilosa* showed the greatest contribution in terms of relative density (31.50%) and recorded an SDR of 22.00%. *Setaria barbata* followed closely, contributing 24.02% of the total weed population and exhibiting an SDR of 21.39%, supported by its high frequency of occurrence (18.75%), which reflects its wide distribution across the sampling plots (Table 3). *Murdannia nudiflora* represented 15.75% of the total weed density and had an SDR of 14.13%, while *Commelina difusa* accounted for 17.32% of the weed population with an SDR of 11.79% (Table 3). In contrast, *Ageratum conyzoides* was relatively scarce at this site, with a relative density of only 4.72% and an SDR of 8.61%, indicating that its competitive ability was much lower than in the other locations. *Spermacoce remota* contributed 3.15% of the total density and had an SDR of 7.83%, whereas *Acmella ciliata* (1.97%, SDR 4.11%), *Amaranthus spinosus* (0.79%, SDR 3.52%), and *Eleusine indica* (0.79%, SDR 3.52%) were present only in small proportions (Table 3).

Table 3. Weed dominance structure at maize field location 3

Weed species	AD	RD (%)	AF	RF (%)	ADo	RDo (%)	IVI (%)	SDR (%)
Bidens pilosa	80	31.50	0.67	12.50	22.00	22.00	66.00	22.00*
Setaria barbata	61	24.02	1.00	18.75	21.39	21.39	64.16	21.39*
Murdannia nudiflora	40	15.75	0.67	12.50	14.13	14.13	42.38	14.13
Commelina difusa	44	17.32	0.33	6.25	11.79	11.79	35.36	11.79
Ageratum conyzoides	12	4.72	0.67	12.50	8.61	8.61	25.83	8.61
Spermacoce remota	8	3.15	0.67	12.50	7.83	7.83	23.48	7.83
Acmella ciliata	5	1.97	0.33	6.25	4.11	4.11	12.33	4.11
Amaranthus spinosus	2	0.79	0.33	6.25	3.52	3.52	10.56	3.52
Eleusine indica	2	0.79	0.33	6.25	3.52	3.52	10.56	3.52
Total	254	100		100		100	300	100

Note: * indicates the dominant weed species with the highest SDR value at this location

The weed composition at location 1 may be associated with the open canopy condition during the vegetative stage of maize and recent soil disturbance, which provided favorable conditions for the establishment of fast-growing broadleaf and grass weeds. During the vegetative phase, incomplete maize canopy closure allowed greater light penetration and space availability, which may have contributed to the relatively diverse weed composition and balanced SDR distribution observed at location 1 (O'Hara, 2020). This pattern is consistent with previous studies showing that perennial weeds tend to persist across seasons, whereas annual weed composition may shift depending on cultivation timing and environmental conditions. The dominant weeds included *Polygonum orientale*, *Physalis minima*, *Avena ludoviciana*, *Chenopodium arvensis*, *Oldenlandia aquatic*, *Polygonum persicaria*, *Oxalis corniculata*, *Hydrocotyle ranunculoides*, *Polygonum pensylvanicum*, *Solanum nigrum*, *Ageratum conyzoides*, *Medicago denticulata*, and *Oldenlandia diffusa*, among others (Sharma & Rayamajhi, 2022).

In comparison with other locations*,* *Ageratum conyzoides* showed greater dominance (Fig. 1), indicating that differences in disturbance intensity and field management may influence weed community composition, whereas numerous weeds from location 1 disappeared and new species emerged, indicating that tillage practice and soil disturbance were more important than elevation in forming the weed community at this location. Similarly, the presence of *Onoclea struthiopteris* at location 2 is consistent with findings from oil palm plantations in Sumatra, where fern species such as *Nephrolepis biserrata*, *Stenochlaena palustris*, and *Diplazium asperum* have also been recorded as part of the weed community, implying that ferns are common as minor weed components in humid tropical agroecosystems (Prasetyo & Zaman, 2016). Although location 2 had the same altitude as location 1, the weed composition was significantly different, most likely due to changes in land preparation and soil management between the two sites (Plaza et al., 2015). Then, the observed dominance values indicate that location 3 had a co-dominant weed structure, where grass and broadleaf species contributed relatively similar levels of dominance. This suggests that the competitive environment in the maize field was influenced by multiple weed species rather than being controlled by a single dominant species.

In maize cultivated on sandy and loamy soils, the most troublesome weed species included *Parthenium hysterophorus*, *Echinochloa colona*, *Ageratum conyzoides*, *Cyperus rotundus*, *Echinochloa crus-galli*, *Eclipta alba*, *Paspalum distichum*, and *Trianthema portulacastrum*. Furthermore, *Ageratum conyzoides* and *Cyperus esculentus* as the predominant weed species in maize fields in Nepal (Kiran & Rao, 2014; Ndam et al., 2014). Based on the results of (Pertiwi & Arsyad, 2018), the dominant weed in maize fields during the vegetative stage was barnyard grass (*Echinochloa colonum*), with an SDR value of 33%. In contrast, at the generative stage of maize (55 DAP), the highest SDR value was recorded for purple nutsedge (*Cyperus rotundus*), reaching 51%. Contrary to the vegetative stage, the study identified 24 weed species representing 11 families that were associated with maize during the generative phase at the Lampung Agricultural Training Center. Weed assessment revealed three species with the highest SDR values, namely *Digitaria sanguinalis*, *Richardia scabra*, and *Cyperus rotundus*, recording SDR values of 18.04%, 9.57%, and 8.75%, respectively. The dominant weeds were primarily grass species belonging to the Poaceae family (Shintarika, 2021).

Fig. 1. *Ageratum Conyzoides*

According to Radjabov et al. (2025), weeds typically cause yield reductions of 10–15% in maize, but under uncontrolled conditions, losses can increase dramatically to 20–80%. On the other hand, *Ageratum conyzoides* frequently becomes more dominant than other weed species in cultivated fields, thereby suppressing the growth of crops. Previous studies have reported that *Ageratum conyzoides* contains allelochemical compounds that may contribute to its competitive ability (Wardani et al., 2018). However, allelopathic activity was not evaluated in the present study. The allelopathic activity of *Ageratum conyzoides* has been attributed to the presence of three phenolic acids gallic acid, coumaric acid, and protocatechuic acid, which are phenolic compounds known to interfere with the growth of other plant species (Wardani et al., 2018). Furthermore, *Bidens pilosa* has been reported to significantly reduce crop yields by 18–80%, depending on weed density (Kato-Noguchi & Kurniadie, 2024), and *Eleusine indica* is among the most economically damaging weeds worldwide, with potential yield losses of up to 90% due to its high adaptability and strong competitive ability (Alcántara-de la Cruz et al., 2025).

Based on previous study, during monsoon season, maize fields were predominantly infested by grass weeds such as *Paspalum commersonii*, *Eleusine indica*, *Dactyloctenium aegyptium*, *Setaria viridis*, *Echinochloa colona*, and *Cynodon dactylon*. Broadleaf weeds *included Polygonum hydropiper*, *Amaranthus viridis*, *Physalis heterophylla*, *Phyllanthus niruri*, and *Amaranthus spinosus* (Reddy et al., 2012). In addition, Kumar et al. (2017) identified *Convolvulus arvensis*, *Parthenium hysterophorus*, *Cyperus rotundus*, *Anagallis arvensis*, *Chenopodium album*, *Argemone mexicana*, *Melilotus indica*, *Oxalis corniculata*, *Amaranthus viridis*, *Cynodon dactylon*, and *Rumex retroflex* as the predominant weed species. The study revealed the presence of 14 broadleaf weed species exhibiting high levels of species diversity, spatial distribution, dominance, and abundance. Among these, six species: *Amaranthus spinosus*, *Amaranthus gracilis*, *Synedrella nodiflora*, *Acalypha indica*, *Ageratum conyzoides*, and *Alternanthera philoxeroides* demonstrated greater competitiveness and higher relative weighted dominance compared to other weeds, resulting in maize yield reductions ranging from 5.56% to 21.90%. Consequently, effective control measures are required to manage these dominant weed species (Ngawit et al., 2024).

3.2 Weed type classification and dominance based on SDR values

Ageratum conyzoides was the most dominant species in locations 1 and 2, with SDR values of 28.53% and 34.85%, respectively. However, its dominance decreased significantly at location 3 (8.61%). *Bidens pilosa* had continuously high dominance at locations 1 and 3, although its contribution to place 2 was quite minor. In contrast, location 3 had a more diversified weed ecosystem, led by *Setaria barbata*, *Murdannia nudiflora*, and *Commelina difusa*. Several weed species demonstrated location-specific dominance, including *Asystasia gangetica* and *Onoclea struthiopteris* at location 2, and *Digitaria ciliaris* at location 1 (Table 4).

Table 4. Summed Dominance Ratio (SDR) of weed species across three maize field locations

Weed species	SDR (%) Location 1	Location 2	Location 3
Ageratum conyzoides	28.53*	34.85*	8.61
Bidens pilosa	23.44	8.13	22.00*
Digitaria ciliaris	18.95	0.00	0.00
Galinsoga parviflora	18.05	0.00	0.00
Eleusine indica	6.42	5.98	3.52
Imperata cylindrica	4.62	8.63	0.00
Asystasia gangetica	0.00	11.01	0.00
Onoclea struthiopteris	0.00	9.11	0.00
Spermacoce remota	0.00	7.92	7.83
Synedrella nodiflora	0.00	5.27	0.00
Calyptocarpus vialis	0.00	4.08	0.00
Setaria barbata	0.00	0.00	21.39
Murdannia nudiflora	0.00	0.00	14.13
Commelina difusa	0.00	0.00	11.79
Acmella ciliata	0.00	0.00	4.11
Amaranthus spinosus	0.00	0.00	3.52

Note: * indicates the dominant weed species with the highest SDR value at this location

The distribution of Summed Dominance Ratio (SDR) values across the three maize fields (Table 4) indicates that each location supports a distinct weed community shaped by different ecological processes. Taken together, these SDR patterns confirm that weed pressure in maize fields of Rejang Lebong is controlled primarily by the identity and dominance of key species rather than by overall weed diversity. Fields dominated by a single aggressive species represent simplified but highly competitive systems, whereas fields with several co-dominant species reflect more structurally complex weed communities. This variability highlights the importance of implementing site-specific weed management strategies based on the dominant weed ecology at each location.

Subsequently, weeds are generally classified into three major groups: grasses, sedges, and broadleaf weeds (Caton et al., 2011). According to morphological classification, the weeds in the three maize field locations were primarily broadleaf weeds, followed by grass weeds, with fern species documented only in one location. Broadleaf weeds were the largest group in all areas, with the most species and the broadest spread, especially in locations 1 and 2. Several broadleaf species demonstrated site-specific occurrence, such as *Asystasia gangetica*, *Synedrella nodiflora*, and *Calyptocarpus vialis*, which were only found at location 2, whereas *Commelina difusa*, *Murdannia nudiflora*, *Acmella ciliata*, and *Amaranthus spinosus* appeared only at location 3. Furthermore, four grass weed species were represented, with *Digitaria ciliaris* restricted to location 1 and *Setaria barbata* to location 3, while *Eleusine indica* and *Imperata cylindrica* were found in multiple locations. Fern weeds were the least represented category, with *Onoclea struthiopteris* appearing only at site 2. This classification reveals significant variances in weed group composition between locales, which reflect variations in habitat conditions and field management strategies.

3.3 Ecological interpretation of weed dominance patterns

The three maize field locations differed in their geographic and environmental characteristics (Fig. 2), which may have contributed to the observed differences in weed dominance patterns and community composition. At location 1, dominance was concentrated in a small group of highly competitive species, namely *Ageratum conyzoides*, *Bidens pilosa*, *Digitaria ciliaris*, and *Galinsoga parviflora*. The high combined SDR of these species reflects a weed assemblage typical of intensively disturbed farmland, where rapidly growing pioneer weeds are favored. These species have the potential to compete strongly with maize for available resources, as reflected by their high SDR values. Location 2 showed an even more extreme pattern of dominance, where A*geratum conyzoides* alone accounted for more than one-third of the total weed influence. This indicates that the weed community at this site has shifted toward a single-species dominated system, in which one highly adaptive weed suppresses most other species. The presence of species such as *Asystasia gangetica* and the fern *Onoclea struthiopteris* suggests moist and less-disturbed soil conditions, which allow *A. conyzoides* to maintain its competitive advantage and create a relatively stable but ecologically simplified weed environment.

In contrast, location 3 exhibited a more evenly distributed dominance structure, with *Bidens pilosa* and *Setaria barbata* emerging as co-dominant species, supported by *Murdannia nudiflora* and *Commelina difusa*. This pattern reflects a more heterogeneous habitat in which grasses, upright broadleaf weeds, and creeping species compete simultaneously with maize. Such a multi-layered weed community results in complex competition for nutrients, light, and space, thereby reducing the dominance of *Ageratum conyzoides* at this site and creating a more balanced but still highly competitive weed system.

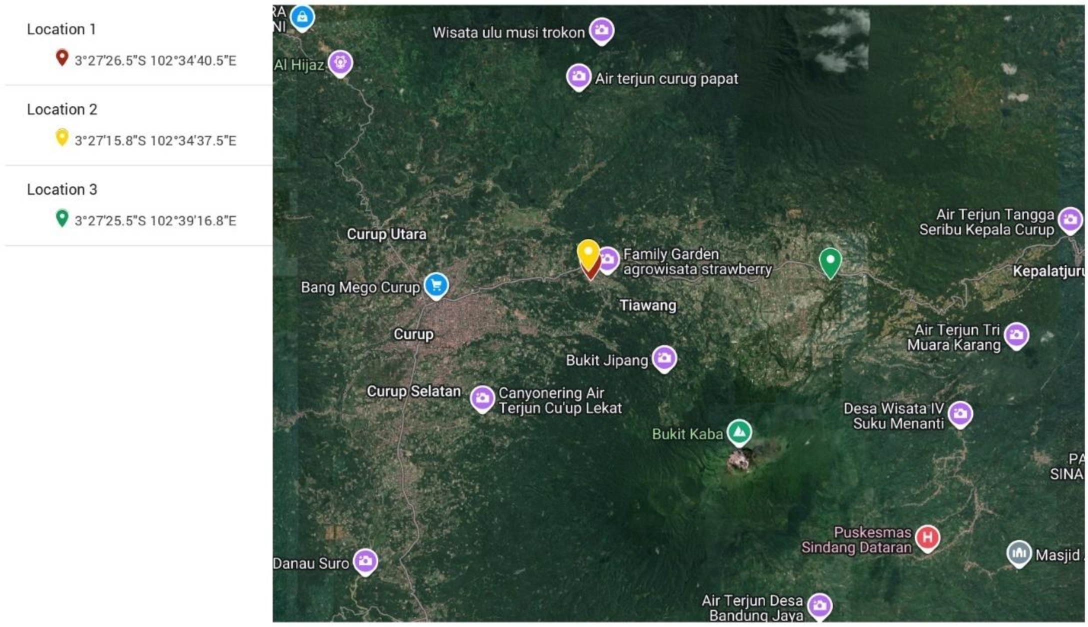

Fig. 2. Geographic location of the three maize field sampling site

The remarkable shift in *Ageratum conyzoides* dominance between the three locations is most likely due to differences in altitude and accompanying climatic factors. Location 3 was located at a significantly greater elevation (1,096.7 m above sea level) than locations 1 (848.4 m above sea level) and 2 (825 m above sea level), as seen in Fig. 3. Altitude is commonly acknowledged as a significant determinant of weed species distribution and community composition. Research conducted in wheat fields of northwest Iran demonstrated that altitude significantly reduced weed species diversity, with maximum richness observed at lower elevations, and that the first Canonical Correspondence Analysis axis showed a strong positive correlation with altitude (0.97%), confirming its dominance over weed distribution patterns (Hassannejad et al., 2014). Similarly, a study of 440 phytosociological plots in Tajikistan found that large variations in weed species composition were strongly influenced by altitude and temperature correlation, with crop type and altitude appearing as the principal environmental factors of weed community structure. Soil texture has been found to influence weed dispersion by affecting water-holding capacity, infiltration rate, and nutrient availability (Nowak et al., 2015). Although soil pH has been proposed as a potential driver of weed community composition, evidence from Tajikistan suggests that pH may have little influence on weed species distribution when their range is relatively uniform across sites, with altitude and temperature emerging as more important explanatory variables (Nowak et al., 2015).

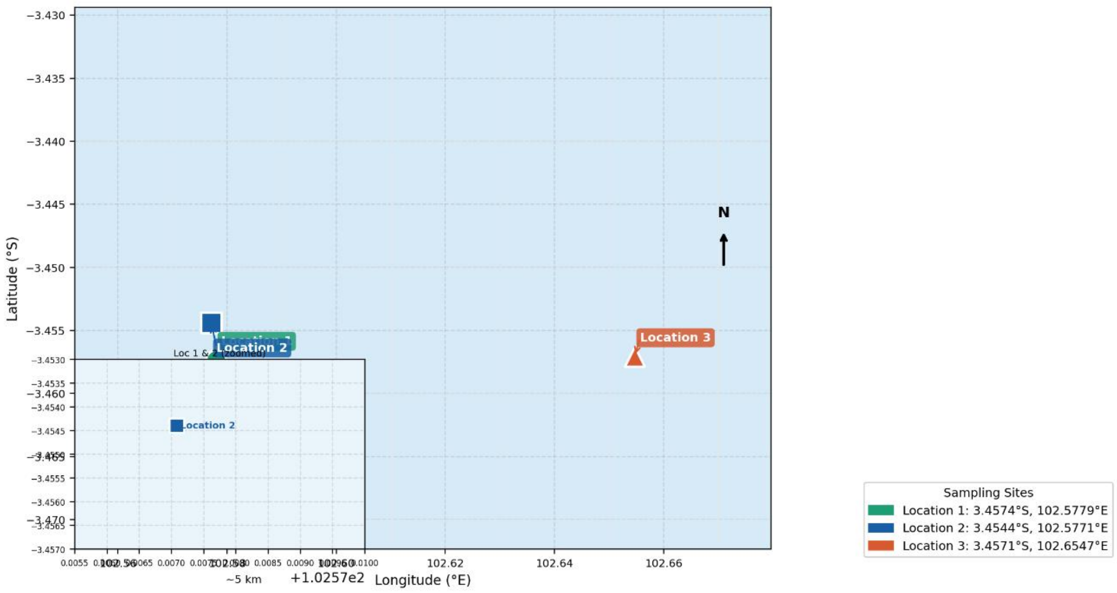

Fig. 3. Coordinate plot of the three maize field sampling sites

Lower-altitude sites 1 and 2 have warmer temperatures, more light availability, and more disturbed soil conditions, all of which are known to promote the establishment and domination of *A. conyzoides*, a heliophytic and disturbance-adapted broadleaf weed. location 3's higher altitude, on the other hand, is likely to have resulted in lower temperatures and possibly increased soil moisture, making it less conducive to *A. conyzoides* domination. Due to its higher altitude, these conditions disfavored warm-adapted species and triggered a near-complete community turnover, with a distinct set of upland-adapted weeds replacing those that dominated at lower elevations (Wallace et al., 2017). Furthermore, prior herbicide application at all three locations during the previous cropping season may have had varying effects on weed community composition depending on local soil conditions and residual herbicide activity, potentially contributing to the observed weeds differences between sites. The more balanced co-dominance observed at location 3, where *Bidens pilosa* and *Setaria barbata* emerged as co-dominant species, supported by *Murdannia nudiflora* and *Commelina difusa*, reflects a more heterogeneous competitive environment at higher elevation, consistent with findings that species richness and community evenness may respond differently to altitude depending on local management intensity and soil fertility (Hassannejad et al., 2014). Collectively, these findings show that dominance transitions occur not just through changes in relative abundance, but also through a complete restructuring of the competing species pool caused by climatic variation, canopy development, and soil management methods (Nursa'adah & Akasah, 2024).

Agronomically, the dominance of broadleaf weeds suggests intense competition for light, nutrients, and growing space during maize's early growth stage, which may reduce crop output. Furthermore, the larger leaf surface of broadleaf weeds can hold smaller herbicide droplets, limiting spray penetration efficiency and impacting weed control effectiveness (Creech et al., 2018). Because of differences in plant form and physiology, grass and broadleaf weeds use distinct competing strategies. Grass weeds compete vigorously for nutrients and growing space from the start of planting, whereas broadleaf weeds compete more on light through their canopy structure, which shades the primary crop (Nursa'adah & Akasah, 2024).

In this study, no sedge-type weeds were observed. The absence of sedge weeds could be attributed to maize canopy conditions during the vegetative stage, which limited light access to the soil surface. Many sedge species, particularly C4 weeds like *Cyperus rotundus*, require high light intensity for optimal growth, and shadowing from maize plants might reduce their establishment and competitiveness. Furthermore, past herbicide use and upland field conditions may have reduced sedge occurrence at the research sites (Ngawit & Fauzi, 2021). This finding differs from previous research, which reported that the weed community was dominated *Cyperus iria* from the sedge group, with an SDR value of 23.8% (Bayyinah et al., 2022). Moreover, among the sedge weeds, *Cyperus rotundus* was the dominant species, with an SDR value of 10.43% (Farida et al., 2022).

Previous research in Indonesia has found variations in weed composition and dominance in maize farming among regions. In Banyumas Regency, Central Java, the major weeds in maize fields were *Synedrella nodiflora*, *Cyperus iria*, *Cynodon dactylon*, and *Eclipta prostrata* (Bayyinah et al., 2022). In Pasaman Regency, West Sumatera, *Borreria alata* and *Cuphea carthagenensis* were found to be prevalent species in dryland and paddy field maize agriculture. Meanwhile, studies in Kutai Timur Regency, Kalimantan, identified *Hedyotis corymbosa*, *Phyllanthus niruri*, and *Ageratum conyzoides* as prominent broadleaf weeds in maize fields (Rusdi et al., 2019). These data show that weed communities in maize agriculture are heavily impacted by environmental factors and cultivation practices.

This finding is consistent with previous research showing that weed vegetation in maize fields varies significantly across spatial gradients due to changes in agricultural practices and habitat conditions. Studies from Central Europe have demonstrated that maize fields exhibit strong differences in weed species richness and composition from field edges to interior zones, influenced by light availability, moisture, nutrient status, and landscape context. Weed species richness and cover typically decline toward the field interior, while species turnover reflects environmental gradients and management intensity. Such evidence supports the observed location-specific weed distributions in this study and highlights the role of habitat heterogeneity and crop management in shaping weed community structure in maize agroecosystems (Essl et al., 2025).

3.4 Community coefficient analysis based on summed shared dominance

Table 5 summarizes the similarity of weed communities among the three maize field locations using Summed Shared Dominance (SSD) and the Community Coefficient (CC). The SSD values were derived from the lower Summed Dominance Ratio (SDR) of weed species occurring in both locations, while CC values were used to assess the level of similarity in community composition. The comparison between location 1 and location 2 resulted in the highest similarity, with an SSD of 47.26 and a CC of 48.47%, indicating a moderate but non-homogeneous weed community. In contrast, comparisons involving location 3 exhibited lower cc values, namely 34.67% for location 1–location 3 and 29.28% for location 2–location 3 (Table 5), reflecting greater differences in weed dominance patterns. Thus, based on the community coefficient analysis, none of the maize field locations showed homogeneous weed vegetation (CC ≥ 75%), suggesting considerable variation in weed community structure among the maize fields.

Factors influencing weed dominance include microclimatic conditions, edaphic factors related to soil fertility, and technical cultural practices applied in plantation management. These factors were subsequently analyzed to examine whether relationships or correlations existed in determining dominant weed species within a given area (Simangungsong et al., 2018). In the previous study, the weed composition between open land and coffee plantations showed a community coefficient (C) of 47.1%, indicating a similarity of 47.1% and a difference of 52.9%. Similarly, the comparison between cocoa plantations and open land resulted in a community coefficient of 73.2%, reflecting a similarity of 73.2% and a difference of 26.8%. Meanwhile, the weed composition between sugarcane fields and open land produced a community coefficient of 46.2%, indicating a similarity of 46.2% and a difference of 53.8% (Widiyani et al., 2023). These findings suggest that weed distribution varies across land-use types. Most weed species are highly adaptive, making them a potential threat due to competition with crops. Weeds can influence plant growth and development by competing with crops for nutrients, environmental resources, plant age, and varietal characteristics, thereby limiting optimal crop performance.

Table 5. Summed Shared Dominance (SSD) and Community Coefficient (CC) values of weed communities across maize field locations

Comparison	SSD	CC (%)	Interpretation
L1 – L2	47.26	48.47	Moderate similarity
L1 – L3	34.13	34.67	Low similarity
L2 – L3	28.09	29.28	Low similarity

3.5 Potential allelopathic compounds reported in dominant weed species

The information presented in this section is based on previous studies and is intended to provide a secondary synthesis of the potential allelochemical characteristics of dominant weed species. Allelopathic activity was not directly tested in the current study; thus, the following commentary is provided merely to contextualize the putative ecological effects of prominent weed species reported in the literature. Allelopathy, also known as an interaction-based phenomena, is a biological process in which plants produce bioactive compounds that can have direct or indirect beneficial or negative impacts on nearby plants and microbes (Qu et al., 2021). These allelochemicals are released via a variety of mechanisms, including root exudation, transpiration-related secretions, and the degradation of plant leftovers in the soil (Tsytsiura & Sampietro, 2024).

Weed communities in maize fields are not only important competitors for resources but also potential sources of allelopathic interactions that influence crop growth and ecosystem dynamics. Allelopathy refers to the release of bioactive compounds by plants that can affect the germination, growth, and development of neighboring plants. Table 6 presents major allelochemical compounds identified in several weed species commonly found in maize fields, along with supporting references. This information highlights the diversity of chemical substances produced by weeds and their potential ecological implications in agricultural systems.

Among the listed species, *Ageratum conyzoides* is one of the most widely studied weeds with strong allelopathic potential. This species produces a variety of secondary metabolites, including alkaloids, flavonoids, chromenes, benzofurans, and terpenoids (Syngkli & Rai, 2024). These compounds are known to interfere with physiological processes in plants, such as seed germination and root elongation, making *A. conyzoides* a highly competitive weed in cropping systems. Similarly, *Bidens pilosa* produces phenolic acids, which have been reported to inhibit the growth of surrounding plants by disrupting cellular metabolism and enzyme activity (Balah et al., 2024). Phenolic compounds are widely recognized as major allelochemicals due to their stability in soil and their ability to affect multiple biological pathways.

The grass weed *Digitaria ciliaris* contains compounds such as eratric acid, maltol, and (−)-loliolide, which have been associated with allelopathic effects on plant growth (Biramahire et al., 2022). These compounds indicate that even monocotyledonous weeds, often overlooked in allelopathic studies, may contribute significantly to chemical interference in maize fields. Likewise, *Galinsoga parviflora* produces 1,4-cyclohexanedicarboxylic acid (CHDA) and trehalose, which have been reported to influence plant interactions and stress responses (Cheng et al., 2025). The presence of such compounds suggests that allelopathic effects are not limited to a single class of weeds but occur across diverse taxonomic groups.

Table 6. Reported allelochemical compounds of dominant weed species based on previous studies

Weed species	Major Allelochemical Compounds	References
Ageratum conyzoides	Alkaloids, flavonoids, chromenes, benzofurans, and terpenoids	Syngkli & Rai, 2024
Bidens pilosa	Phenolic acids	Balah et al., 2024
Digitaria ciliaris	Eratric acid, maltol, and (−)-loliolide	Biramahire et al., 2022
Galinsoga parviflora	1,4-cyclohexanedicarboxylic acid (CHDA) and trehalose	Cheng et al., 2025
Eleusine indica	Flavonoids (vitexin, isovitexin, schaftoside), phenolic acids (p-coumaric acid), and the benzofuranoid loliolide	Sukor et al., 2022
Imperata cylindrica	Fatty acids, terpenoids, simple phenolics, benzoic acids, phenolic acids, phenolic aldehydes, phenylpropanoids, flavonoids, quinones and alkaloids	Kato-Nagochi, 2022
Asystasia gangetica	Indole-3-carboxaldehyde and 6R,9S)3-oxo-α-ionol	Suzuki et al., 2019
Synedrella nodiflora	Ketone 3-(5-(1-(3-methylpentyloxy) propyl)-tetrahydro-2-oxofuran-3-yl)-dihydrofuran-2(3H)-one	Ghayal et al., 2013
Calyptocarpus vialis	Flavonoids, phenolic acids, tannins, and others (lignans and neolignans, and nephthaquinones);	Lal et al, 2021
Murdannia nudiflora	Flavonoids, saponins, tannins, organic acids, alkaloids, and coumarins	Vu et al., 2025
Commelina diffusa	Alkaloids, flavonoids, saponins, tannins, cardiac glycosides, terpenoids, and steroids	Rahman et al., 2021
Amaranthus spinosus	Phenols, flavonoids, ketones and terpenoids	Sarkar & Chakraborty, 2015

Imperata cylindrica is another species with a broad spectrum of allelochemicals, including fatty acids, terpenoids, simple phenolics, benzoic acids, phenolic acids, phenolic aldehydes, phenylpropanoids, flavonoids, quinones, and alkaloids (Kato-Nagochi, 2022). The complexity of its chemical profile explains its strong competitive ability and persistence in agricultural lands. Similarly, *Asystasia gangetica* produces compounds such as indole-3-carboxaldehyde and (6R,9S)-3-oxo-α-ionol, which have been associated with inhibitory effects on plant growth (Suzuki et al., 2019). These findings indicate that both herbaceous broadleaf weeds and creeping species may exert allelopathic influences in maize ecosystems.

Some species listed in Table 6, such as *Synedrella nodiflora* and *Calyptocarpus vialis*, also contain unique allelochemicals. *Synedrella nodiflora* produces complex lactone derivatives that may affect plant growth and microbial activity in soil (Ghayal et al., 2013). Meanwhile, *Calyptocarpus vialis* contains a wide range of secondary metabolites, including flavonoids, phenolic acids, tannins, lignans, neolignans, naphthoquinones, alkaloids, and terpenoids (Lal et al., 2021). The diversity of these compounds suggests that this species has considerable biochemical potential to influence plant interactions in cropping systems.

On the other hand, several species, such as *Onoclea struthiopteris*, *Spermacoce remota*, and *Setaria barbata*, do not have reported allelochemical compounds. This does not necessarily indicate the absence of allelopathic potential; rather, it reflects the limited availability of specific scientific studies focusing on the allelopathic properties of these species. The lack of documented allelochemicals highlights an important research gap in weed ecology and allelopathy studies, particularly in tropical agricultural systems. Future investigations are needed to identify and characterize the chemical compounds produced by these species and to evaluate their potential effects on maize growth and soil microbial communities.

Finally, *Amaranthus spinosus* is known to produce phenols, flavonoids, ketones, and terpenoids, which have been reported to exhibit allelopathic activity (Sarkar & Chakraborty, 2015). These compounds are commonly associated with inhibitory effects on seed germination and plant development, further emphasizing the ecological role of weeds as chemical competitors in agricultural environments. Table 6 demonstrates that weed species in maize fields possess diverse allelochemical profiles, which may contribute to their dominance and competitive ability. However, the absence of information for several species indicates that allelopathic research is still incomplete. To date, no studies have explicitly researched the allelochemical substances of *Onoclea struthiopteris*, *Spermacoce remota*, and *Setaria barbata*, leaving the allelopathic potential of these three weed species completely unexplored and calling for future phytochemical research. Understanding the chemical interactions between weeds and crops is essential for developing sustainable weed management strategies and improving maize productivity. Therefore, further studies on the allelopathic potential of understudied weed species are crucial for advancing ecological knowledge and enhancing agricultural practices.

3.6 Weed management

Weeds are aggressive, fast-growing plants with extensive root systems that strongly compete with crops for resources, leading to significant yield losses. In maize, weed competition can reduce yields by approximately 37% globally, with losses ranging from 20–80%, particularly during the critical period of 4–7 weeks after sowing. Weeds have a great adaptation capacity, allowing them to tolerate harsh agroclimatic conditions while causing significant production and quality losses in maize. Their endurance is aided by a hardy soil seed bank, which allows for quick reinfestation under favorable conditions. Deep tillage, mulching, raised-bed planting, crop rotation, cover crops, and targeted fertilizer delivery are examples of integrated management practices that can reduce weed seed banks while increasing maize yield (Lee & Thierfelder, 2017; Mo et al., 2017). Furthermore, Abella (2020) found that soil cover treatment of the canopy and grass weed biomass was effective in totally suppressing the population of annual broadleaf weeds.

Although chemical weed control is widely used due to labor constraints, excessive reliance on herbicides has caused environmental degradation and reduced soil productivity. Sequential herbicide application like atrazine at 0.5 kg a.i. ha^{-1} as pre-emergence followed by early post-emergence topramezone at 25.2 g a.i. ha^{-1} or tembotrione at 122 g a.i. ha^{-1}, effectively controls weeds by suppressing early emergence and subsequent flushes, thereby reducing competition and improving maize performance compared with single post-emergence applications (Lavanya et al., 2021). While herbicides such as atrazine and pendimethalin may increase short-term returns, they are insufficient for long-term sustainability (Sharma & Rayamajhi, 2022).

Previous research suggests that fern weeds may necessitate specific management strategies due to their propensity to regenerate and remain following herbicide administration. Effective suppression frequently necessitates repeated control methods and follow-up management to avoid regrowth and fresh spore establishment. According to studies, metsulfuron herbicide paired with follow-up management can effectively control fern weeds by suppressing regrowth and spore establishment (Hutchinson & Langeland, 2012). As a result, the presence of *Onoclea struthiopteris* in maize fields may necessitate additional weed management strategies in the future.

However, these approaches frequently raise production costs and necessitate extensive agroecological knowledge, which is still inadequate in many developing countries (Maqsood et al., 2020). In addition to crop residues that remain in the field, weeds can also serve as a source of soil organic matter when incorporated back into the soil. The biomass of weeds in cultivated fields can reach up to 10 tons per hectare of fresh weight, equivalent to approximately 2.5 tons of compost derived from weeds. Consequently, weeds may contribute around 50% of soil organic matter within a single growing season, or approximately 5.0–7.5 tons per hectare per year (Paiman, 2020). Therefore, integrated weed management is recommended, as it combines multiple control strategies to enhance effectiveness, reduce herbicide dependence, and support sustainable maize production.

4. Conclusions

The weed communities found in maize fields of Simpang Nangka, Rejang Lebong Regency were not determined primarily by how many species were present, but by which weeds were able to dominate the system. Even though 16 species were recorded, only a few species exerted strong ecological control at each site, as shown by their high Summed Dominance Ratio (SDR) values. Two distinct patterns of weed dominance were observed. At locations 1 and 2, the weed flora was heavily dominated by *Ageratum conyzoides*, which reached very high SDR values (28.53–34.85%), demonstrating its superior ability to capture light, nutrients, and growing space. Such a pattern reflects highly disturbed maize fields where a single aggressive broadleaf weed can suppress both the crop and other weed species. Conversely, location 3 exhibited a more even dominance structure, with *Bidens pilosa* and *Setaria barbata* sharing dominance (22.00% and 21.39%), indicating a more heterogeneous habitat where grasses and broadleaf weeds compete together with maize. Then, Community Coefficient analysis showed that weed communities among maize field locations were not homogeneous, with all CC values remaining below 75%.

Broadleaf weeds consistently formed the main functional group across all locations, confirming their major role in limiting maize growth in this region. However, the appearance of site-specific grass weeds, such as *Digitaria ciliaris* at location 1 and *Setaria barbata* at location 3, shows that local environmental and management conditions strongly influence weed composition, making uniform weed control strategies less effective. The occurrence of the fern *Onoclea struthiopteris* at location 2 further suggests that high soil moisture and lower disturbance created ecological niches for non-typical agricultural weeds, increasing the structural complexity of the maize weed community. Overall, weed problems in Rejang Lebong maize fields are driven mainly by the intensity of dominance of key species rather than total weed diversity. This study provides the first SDR-based ecological baseline for the area and underlines the importance of location-specific, dominance-focused weed management to achieve more effective and sustainable maize production.

Based on these findings, early-season weed control (4–7 weeks after sowing) using atrazine followed by topramezone or tembotrione is recommended, especially at Locations 1 and 2 dominated by *Ageratum conyzoides*, while location 3 requires combined broadleaf- and grass-targeted treatments given its co-dominant weed structure. The presence of *Onoclea struthiopteris* at location 2 warrants metsulfuron-based applications with follow-up monitoring to prevent fern regrowth and spore re-establishment. Integrated practices such as mulching, tillage, and crop rotation are also recommended to improve long-term weed control under the high-rainfall conditions of Rejang Lebong. Nonetheless, this study is restricted by its small spatial scale, single sampling time point, and lack of soil and microclimate data; future research should include bigger sampling areas and repeated seasonal observations to improve generalizability.

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Author Contribution
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Conflicts of Interest
The authors declare no conflict of interest.

Declaration of Generative AI Use
During the preparation of this work, the author(s) used Quillbot to assist in improving grammar, clarity, and academic tone of the manuscript. After using this tool, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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