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"ECOLOGICAL ANALYSIS OF WEED FLORA ASSOCIATED WITH PADDY CULTIVATION IN REWA DISTRICT, MADHYA PRADESH"

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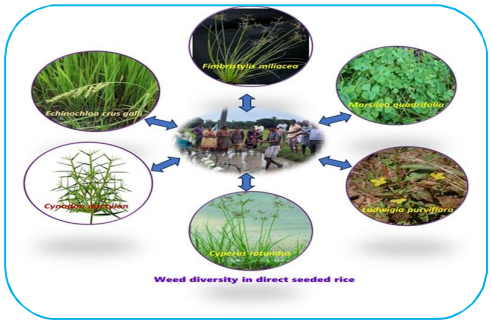
ABSTRACT



The present investigation was undertaken to assess the ecological diversity, floristic composition and phytosociological characteristics of weed flora associated with paddy (Oryza sativa L.) cultivation in Rewa District of Madhya Pradesh. Paddy-based agroecosystems provide a unique ecological habitat characterized by seasonal waterlogging, high soil moisture, intensive agricultural disturbance and continuous interaction between crop plants and associated weed communities. The study was conducted during the Kharif season in selected paddy-growing localities of Rewa District using systematic field surveys and quadrat-based vegetation analysis. The recorded weed flora was represented by grasses, sedges and broad-leaved herbaceous species belonging to different taxonomic families. The families Poaceae and Cyperaceae formed important components of the weed community, reflecting the favourable moist and semi-aquatic environmental conditions prevailing in paddy fields. The ecological analysis demonstrated considerable variation in species occurrence, density, frequency and abundance among different weed taxa and sampling sites. The diversity of weed communities was influenced by water regime, soil characteristics, crop establishment method, agricultural practices and the intensity of weed management. Grasses and sedges showed greater adaptability to moist and periodically inundated habitats, whereas broad-leaved weeds displayed greater heterogeneity in their distribution pattern. Commonly observed weed genera in paddy agroecosystems included Echinochloa, Cyperus, Fimbristylis, Ludwigia, Eclipta, Alternanthera, Amaranthus and Commelina.

KEYWORDS : *Weed flora, Paddy agroecosystem, Ecological diversity, Phytosociology, Species richness, Poaceae, Cyperaceae, Rewa District, Madhya Pradesh.*

INTRODUCTION :

Weeds are among the most important biological components of agricultural ecosystems and are widely recognized for their significant influence on crop productivity, biodiversity and ecological stability. In cultivated fields, weeds are generally defined as unwanted plant species that grow spontaneously and compete with crop plants for essential resources such as water, nutrients, light and physical space. Their ecological importance, however, extends beyond their negative influence on agricultural production. Weed communities constitute an important component of agro-biodiversity and provide valuable information regarding habitat conditions, soil characteristics, agricultural

disturbances and the overall ecological status of cultivated landscapes. Therefore, the study of weed flora is essential for understanding both crop–weed competition and the broader ecological functioning of agricultural ecosystems.

Rice or paddy (*Oryza sativa* L.) is one of the world's most important cereal crops and represents a major source of food and livelihood for a substantial proportion of the global population. In India, paddy is cultivated across diverse agro-climatic regions under different systems of water management and crop establishment. The ecological conditions of paddy fields are particularly suitable for the growth of a wide range of weed species because these habitats undergo continuous seasonal changes from terrestrial to semi-aquatic conditions. During the initial stages of crop establishment, open spaces, high soil moisture and nutrient availability facilitate rapid germination and growth of weeds. Subsequently, changes in water depth, crop canopy, soil aeration and agricultural management influence the composition and abundance of weed communities.

Weed infestation is considered one of the major factors responsible for yield reduction in paddy cultivation. The extent of crop loss caused by weeds depends upon several factors, including weed species, population density, duration of crop–weed competition, soil fertility, moisture conditions and crop management practices. Highly competitive weed species can significantly reduce the availability of nutrients and water to rice plants and may suppress crop growth during critical developmental stages. Therefore, proper identification and ecological assessment of dominant weed species are important prerequisites for designing effective weed management strategies.

The diversity of weed flora in paddy ecosystems is influenced by environmental and anthropogenic factors. Soil texture, organic matter content, moisture availability, rainfall, irrigation practices and nutrient status play important roles in determining the establishment and persistence of weed species. Agricultural operations such as ploughing, puddling, transplanting, direct seeding, fertilizer application, manual weeding and herbicide use further modify the composition of weed communities. As a result, weed flora often differs among fields, localities and cropping systems. The study of such variation provides important insights into the ecological behaviour and adaptive capacity of weed species.

From an ecological perspective, weed communities represent dynamic plant assemblages that respond rapidly to environmental disturbances. Species capable of producing large numbers of seeds, growing rapidly and tolerating repeated disturbance generally become dominant in agricultural fields. Paddy ecosystems are particularly favourable for species belonging to families such as Poaceae and Cyperaceae because many members of these families are well adapted to moist and waterlogged habitats. Broad-leaved weeds belonging to families such as Asteraceae, Amaranthaceae, Onagraceae, Euphorbiaceae and Commelinaceae also contribute significantly to the floristic diversity of paddy fields.

The Rewa District of Madhya Pradesh forms an important agricultural region within the Vindhyan landscape. Agriculture is one of the major sources of livelihood in the rural areas of the district, and paddy is extensively cultivated during the monsoon season. The regional environmental conditions, including monsoonal rainfall, seasonal variation in soil moisture and diverse agricultural practices, create suitable ecological conditions for the development of diverse weed communities. Despite the agricultural importance of the region, detailed ecological documentation of weed flora associated with paddy cultivation remains necessary for establishing baseline information on species composition and ecological behaviour.

Ecological analysis of weed vegetation using phytosociological parameters such as frequency, density and abundance provides a scientific basis for evaluating the distribution and dominance of individual species. Diversity indices such as the Shannon–Wiener index and Simpson's index further assist in measuring species diversity, dominance and evenness within plant communities. These approaches are widely used in vegetation ecology and are particularly useful for comparing weed communities among different agricultural habitats.

The present study was therefore undertaken to investigate the floristic diversity and ecological characteristics of weed flora associated with paddy cultivation in Rewa District, Madhya Pradesh. The study aims to document the major weed species, analyse their taxonomic composition, evaluate their

ecological distribution and provide baseline information for future studies related to weed ecology, agro-biodiversity and sustainable agricultural management.

MATERIALS AND METHODS:

Study Area

The present investigation was carried out in selected paddy-growing agricultural fields of Rewa District, Madhya Pradesh, India. Rewa is located in the northeastern part of Madhya Pradesh and forms a significant component of the Vindhyan Plateau region. The district is characterized by a predominantly monsoonal climate with three major seasons, namely summer, rainy season and winter. Paddy cultivation is mainly undertaken during the Kharif season when sufficient rainfall and favourable soil moisture conditions are available.

The agricultural landscape of Rewa District consists of cultivated fields, seasonal wetlands, ponds, irrigation channels, fallow lands and rural settlements. Such habitat heterogeneity creates diverse ecological conditions that influence the composition of agricultural weed flora. Paddy fields are generally characterized by moist to waterlogged soils during the early and middle stages of crop growth, while the later stages may experience gradual reduction in water availability. These changing environmental conditions strongly influence the emergence, growth and persistence of different weed species. For ecological comparison, paddy fields representing different agricultural conditions and localities were selected for field observations. The selection of sampling sites was based on the presence of actively cultivated paddy fields, accessibility and variation in habitat conditions. Observations were carried out during the active growth period of the paddy crop to record maximum weed diversity.

Field Survey and Sampling Procedure

Systematic field surveys were conducted during the Kharif cropping season in selected paddy-growing areas of Rewa District. Repeated field visits were undertaken at different stages of crop growth to record changes in weed composition and abundance. The study focused on documenting weeds occurring within the cultivated paddy fields and analysing their ecological distribution.

Quadrat sampling was employed for quantitative vegetation analysis. Quadrats of appropriate dimensions were randomly placed at different locations within each selected agricultural field. The use of random sampling helped reduce observational bias and ensured representation of different microhabitats within the paddy ecosystem. In each quadrat, all weed species were recorded and the number of individuals of each species was counted wherever possible.

Field observations included species occurrence, number of individuals, growth form, habitat condition and relative dominance. Weed specimens were collected carefully and preserved for taxonomic identification. Field notes were also maintained regarding soil moisture, water availability, crop growth stage and visible agricultural disturbances. The weed species were subsequently classified into three major ecological categories, namely grasses, sedges and broad-leaved weeds. This classification was useful for understanding the ecological structure of the weed community and identifying the major functional groups associated with paddy cultivation.

Identification and Taxonomic Classification

Collected weed specimens were identified on the basis of morphological characters such as habit, root system, stem characteristics, leaf arrangement, inflorescence, flowers and fruits. Identification was carried out using standard taxonomic literature, regional floras and botanical keys. The identified species were arranged according to their families and genera. Particular attention was given to the representation of major families commonly associated with agricultural habitats. The taxonomic analysis provided information regarding family dominance and the relative contribution of different plant groups to the overall weed flora.

RESULTS AND DISCUSSIONS:

Floristic Composition of Weed Flora

The ecological survey of paddy fields in Rewa District revealed the occurrence of a diverse assemblage of weed species associated with the rice agroecosystem. The recorded weed flora represented a mixture of grasses, sedges and broad-leaved herbaceous plants. This pattern reflects the ecological heterogeneity of paddy fields, where soil moisture, periodic waterlogging and agricultural disturbance create favourable conditions for different groups of weeds. The floristic composition of the weed community varied among different agricultural fields. Some species showed widespread distribution and occurred in several sampling sites, whereas others were restricted to particular fields or specific microhabitats. This variation may be attributed to differences in soil conditions, water availability, cropping practices and the intensity of weed control measures. The weed flora was dominated by herbaceous species with rapid growth and high reproductive capacity. Such plants are ecologically well adapted to agricultural environments where repeated disturbances occur through ploughing, transplanting, irrigation and harvesting.

Taxonomic Diversity

The weed flora recorded from paddy cultivation fields belonged to several taxonomic families. Among these, Poaceae and Cyperaceae were prominent, indicating the importance of grasses and sedges in moist agricultural habitats. Members of Poaceae are generally adapted to open and disturbed environments and can establish rapidly in cultivated fields. Similarly, many members of Cyperaceae are well adapted to saturated and periodically inundated soils. Broad-leaved weeds belonging to families such as Asteraceae, Amaranthaceae, Euphorbiaceae, Onagraceae, Commelinaceae and Convolvulaceae also contributed substantially to the overall diversity of the weed community. The taxonomic diversity observed in the study area indicates that paddy fields function as important agricultural habitats supporting multiple plant species. Although agricultural fields are frequently viewed primarily as production systems, they also maintain considerable levels of plant diversity.

Ecological Distribution of Grasses

Grass weeds formed an important ecological group in the studied paddy fields. Their dominance may be attributed to their ability to tolerate repeated agricultural disturbance and exploit favourable conditions during the early stages of crop growth. Species belonging to genera such as *Echinochloa* were particularly important because of their close ecological similarity with rice. These species can establish rapidly under moist conditions and may compete effectively with the crop. Other grass genera commonly associated with agricultural habitats also occurred in different fields depending upon soil moisture and management conditions.

The frequency and density of grass weeds varied among sampling sites. Fields experiencing lower intensity of weed management generally showed greater occurrence of grasses, whereas regularly managed fields exhibited comparatively reduced populations. The ecological adaptability of grass weeds makes them important components of the paddy weed community. Their rapid growth and efficient utilization of nutrients can increase competitive pressure on rice plants, particularly during the early stages of crop development.

Ecological Distribution of Sedges

Sedges represented another major ecological component of the weed flora. Their occurrence was particularly associated with moist and waterlogged conditions characteristic of paddy cultivation. Species belonging to the genera *Cyperus* and *Fimbristylis* were important representatives of this ecological group.

The abundance of sedges was influenced by water availability and soil moisture. Fields maintaining higher levels of moisture for longer periods generally provided favourable conditions for the establishment of sedge populations. The distribution pattern of sedges also reflected their ecological tolerance to agricultural disturbance. Many sedge species possess effective reproductive strategies and

are capable of surviving under changing environmental conditions. Their persistence within paddy fields makes them important competitors and significant components of the overall weed community.

Broad-Leaved Weed Diversity

Broad-leaved weeds constituted a diverse and ecologically heterogeneous component of the paddy weed flora. Unlike grasses and sedges, broad-leaved weeds belonged to several different taxonomic families and exhibited considerable variation in morphology, growth form and habitat preference. Species belonging to genera such as *Ludwigia*, *Eclipta*, *Alternanthera*, *Amaranthus*, *Commelina* and *Phyllanthus* were commonly associated with moist agricultural habitats. Their occurrence depended upon local ecological conditions and agricultural management practices. Some broad-leaved weeds were widely distributed and occurred throughout the cropping season, whereas others appeared only during particular growth stages of the crop. This seasonal variation highlights the dynamic nature of weed communities in paddy agroecosystems.

Species Richness and Ecological Diversity

The presence of multiple weed species belonging to different families indicates considerable floristic diversity within the paddy agroecosystem of Rewa District. Species richness varied among sampling sites, suggesting that local environmental conditions and agricultural practices play important roles in determining the structure of weed communities. Fields with greater habitat heterogeneity generally supported a higher number of weed species. Variations in water depth, soil moisture, nutrient availability and surrounding vegetation may create multiple ecological niches that allow different species to coexist. Weed diversity also changed during different stages of paddy cultivation. The early stages of crop growth generally provide greater availability of open space and sunlight, allowing the emergence of several weed species. As the crop canopy develops, competition for light and space increases, potentially affecting the survival and abundance of certain weed species. The Shannon–Wiener diversity index is particularly useful in understanding such ecological variation because it incorporates both species richness and relative abundance. A diverse weed community may indicate heterogeneous environmental conditions, whereas strong dominance by a few species may reflect selective environmental pressures or intensive agricultural management.

Phytosociological Characteristics

The phytosociological analysis revealed differences in frequency, density and abundance among individual weed species. Species occurring in a high proportion of quadrats demonstrated broad ecological distribution and greater adaptability to the prevailing agricultural conditions. High-density species contributed significantly to the total weed population and may have greater competitive influence on the paddy crop. Such species require special attention when developing weed management programmes. Abundance values provided information regarding the local concentration of individual species. Some weeds occurred in relatively few quadrats but were highly abundant where they were present, indicating aggregated distribution. Other species occurred across a larger number of quadrats but with comparatively lower abundance. The variation in these ecological parameters demonstrates that weed communities are not uniformly distributed throughout agricultural fields. Instead, their occurrence is influenced by local environmental conditions, soil moisture, agricultural disturbance and species-specific ecological requirements.

Influence of Environmental Factors

The ecological structure of weed communities was strongly influenced by environmental conditions. Soil moisture emerged as one of the most important factors determining the occurrence of grasses, sedges and broad-leaved weeds. Paddy fields undergo seasonal changes in water availability, and different weed species respond differently to these conditions. Waterlogged environments favour species adapted to saturated soils, while temporary drying of field surfaces may encourage the growth of terrestrial and semi-aquatic broad-leaved weeds. The variation in water regime among agricultural

fields can therefore produce differences in weed composition. Soil fertility also influences weed growth. Nutrient-rich agricultural soils may support rapid growth of competitive weed species. Similarly, the application of fertilizers intended for crop growth may also indirectly enhance the growth of associated weeds. Climatic factors, particularly rainfall and temperature, further influence seed germination, vegetative growth and reproductive development. Seasonal rainfall patterns determine the availability of water and influence the emergence of different weed species.

Effect of Agricultural Practices

Agricultural practices significantly influence weed diversity and community structure. Tillage can disturb the soil seed bank and stimulate the germination of buried seeds. The method of crop establishment, including transplantation and direct seeding, may also influence the composition of weed communities. Manual weeding and herbicide application can reduce the population of dominant weeds, but repeated use of specific control methods may alter species composition by favouring tolerant or resistant species. Therefore, weed management practices may not only reduce weed abundance but also influence the long-term ecological structure of weed communities. Differences in field management among farmers may explain some of the variation observed in species richness and weed dominance. Fields subjected to intensive weed control generally support lower weed biomass and reduced abundance of dominant species, whereas less intensively managed fields may maintain greater weed diversity.

Ecological Importance of Weed Flora

Weeds are traditionally considered harmful because of their competitive relationship with crop plants. However, from an ecological perspective, they also perform several important functions within agricultural ecosystems. Weed species contribute to the maintenance of plant biodiversity and may provide food and habitat for insects, pollinators and other organisms. The vegetation cover provided by certain weed species can contribute to soil protection and may reduce erosion during periods when crop cover is sparse. Weeds can also participate in nutrient cycling through the decomposition of plant biomass. However, the ecological benefits of weed diversity must be balanced against the potential negative effects of excessive weed infestation on crop productivity. Understanding the ecological characteristics of individual weed species is therefore important for developing management strategies that minimize crop losses while maintaining environmental sustainability.

Implications for Sustainable Weed Management

The ecological information generated through the study has important implications for sustainable weed management in paddy cultivation. Identification of dominant and widespread species is necessary for selecting appropriate control strategies. Rather than relying exclusively on chemical herbicides, integrated weed management approaches should combine cultural, mechanical, biological and chemical methods. Practices such as timely weeding, proper water management, crop rotation and appropriate crop establishment techniques may help reduce excessive weed infestation. Regular ecological monitoring of weed communities is also important because changes in agricultural practices and climate conditions can influence species composition over time. The development of site-specific weed management strategies based on local ecological conditions may provide more effective and environmentally sustainable outcomes.

CONCLUSION:

The present ecological investigation demonstrates that paddy fields in Rewa District, Madhya Pradesh, support a diverse and dynamic assemblage of weed species. The weed flora is composed primarily of grasses, sedges and broad-leaved herbaceous species, with Poaceae and Cyperaceae representing important taxonomic components of the paddy agroecosystem. The composition and distribution of these weed communities are influenced by multiple ecological factors, including soil moisture, water regime, seasonal climatic conditions and agricultural disturbance. The analysis of

ecological parameters such as frequency, density and abundance provides valuable information regarding the distribution and dominance of individual weed species. Species occurring with high frequency and density are ecologically more important and may exert greater competitive pressure on the paddy crop. Diversity analysis further indicates that weed communities vary spatially and temporally according to environmental conditions and field management practices. The study highlights the dual ecological role of weeds in agricultural landscapes. While excessive weed growth can negatively influence crop productivity, weed communities also contribute to plant diversity and ecological functioning. Therefore, effective management should focus on controlling economically important and highly competitive species while adopting environmentally sustainable agricultural practices. The present study provides baseline information on the ecological diversity of weed flora associated with paddy cultivation in Rewa District. Further long-term investigations involving seasonal monitoring, quantitative phytosociological analysis, soil parameters and comparisons between different cultivation practices would provide a more comprehensive understanding of weed ecology in the agricultural landscapes of the Vindhyan region.

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