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# Floristic composition and distribution of weeds in different crop ecosystems of Rewa in India

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## Abstract
The present communication pertains to major weeds of different crop ecosystems of Rewa in India. The study was based on extensive and intensive fields surveys made during different months of rainy and dry season 2020-2022. Surveys were made in five important crops ecosystems of total eight developmental blocks of Rewa district during both Kharif and Rabi seasons of the year. Vegetation data were collected followed by quadrat methods and analyzed for density, frequency, diversity and importance value index (IVI) for each crop ecosystems. Interspecific association was also analyzed for ten dominant weed species followed by Cole's index. During this period, a total of 82 weed species were reported of which 56 species were recorded from the transplanted Kharif rice fields, while 61 weed species were recorded from the Rabi crop fields. The five dominant weed families in the study area were Cyperaceae, Poaceae, Onagraceae, Asteraceae and Fabaceae.

**Keywords:** Wheat crop, weed, Rabi season, Rewa district

## Introductions
Farmers have long realized the interference of weed with crop productivity as weeds are regarded as old as agriculture itself and that eventually led to the co-evolution of agro-ecosystems and weed management (Ghersa *et al.* 1994, 2000) [1-2]. Worldwide yield loss due to weeds in rice field was found to be 15% (De Datta 1990) [3]. Weed competes with crops for natural and applied resources and reduces both quantity and quality of agricultural productivity (Rao and Nagamani 2010, Rao *et al*. 2015) [4-5]. It has also been reported that weeds are notorious yield reducers that are, in many situations, economically more important than insects, fungi and other pest organisms in agricultural fields (Savary *et al.* 1997, 2000) [6-7]. In India, weeds are one of the major biological constrains that limit crop productivity and reduce crop yields by 30.5% that amounts to 22.7% in winter and 36.5% in summer and Kharif season (Bhan *et al.* 1999) [8]. It has been reported that reduction of rice yield due to weed competition ranged from 9-51% and uncontrolled weed growth may cause 75.8, 70.6, 62.6% yield reduction in dry seeded rice, wet seeded rice and transplanted rice, respectively (Mani *et al.* 1968) [9].
The information on the presence, composition, abundance, importance and ranking of weed species is needed to formulate appropriate weed management strategies to produce optimum yields of rice (Begum *et al.* 2005) [10]. A thorough survey is necessary to address the current weed problems in cropping systems as it will help in developing target-oriented research programmes (Boldt and Devine, 1998) [11]. Specific sound knowledge on the nature and extent of infestation of weed flora is essential to plan the control measures and formulate target oriented research programme. The Rewa district falls under the Kaimoor Valley of Vindhyan region is characterized by the existence of hills, high land and plain land areas. Transplanted Kharif rice and different Rabi crops like black gram/green gram, pea, mustard, potato and different winter vegetables are the dominant agricultural crops of Rewa in India. The soil is drained by a number of perennial tributaries of the Sone, Bihar, Bichhiya rivers and pH ranges from 4.5 to 6.0. However, detailed information regarding the status and distribution of weeds are rare from the study area. Therefore, the present study was undertaken.

## Materials and Methods
Rewa is located at 24°32' N 81°18' E. It has an average elevation of 275 meters (902 feet). It is connected by all weather roads to Allahabad, Mirzapur, Sidhi, Shahdol, Satna, Katni and Sirmour.

Rewa town has its own importance on account of its location, where rich mineral deposits are found out of these three main rock formations; mirror sand, iron ore and Limestone are prominent.

Rewa district comprised of total eight developmental blocks. Repeated field survey was done followed by interaction with the farmers and agricultural officers prior to selection of study sites. Finally, five dominant crop ecosystems namely transplanted Kharif rice, mustard, mixed winter vegetables, green/black gram and potato were selected in study area and all the eight developmental blocks were surveyed. GPS reading were recorded for each sampling sites. Both quadrat and line transect methods (Akwee *et al.* 2010) [12] were used to collect data from study area. Quadrats of 1×1 m size were plotted in random systematic design for collection of data by following the method as described by Kent and Coker (1994) [13]. All the plant species enumerated in the quadrat, were identified and counted.

Ecological analysis of weed flora was done following quantitative measures as density, frequency dominance and their relative values were used to calculate the importance value index (IVI). Similarity coefficient of different weed community of different crop ecosystems was calculated using Sorenson Index (Janson and Vegelius, 1981) [14] to compare of species affiliation among weed Communities between crop ecosystems.

The inter-specific association among the dominant weed species occurring in the different crop ecosystem of entire study area was computed (Sutomo and Putri 2011) [15], to find out the inclination and repulsion effects among the weed species.

## Results and Discussion

Weed flora in transplanted Kharif rice Based on pooled data (2020-22), a total of 56 weed species were recorded in the transplanted Kharif rice crop ecosystem of Rewa district during the study; of which 17 were sedges, 10 grasses and 29 Broad-leaved weed (BLW) species (Table 1). Among the weed groups, highest density was recorded for BLW (627.30/m$^2$), followed by sedge (519.2/m$^2$) and grass (226.4/m$^2$) (Figure 1). Species richness was the maximum in BLW (29), followed by sedges (17) and grasses (10) (Figure 2). Among the weed flora recorded from rice fields *Fimbristylis miliacea* was the most widely distributed species with a frequency value of 73.10%, followed by *Rotala rotundifoilia* (50%) and *Isachne himalaica* (47.53%). During the study, high value of IVI was recorded for *Eleocharis acicularis* (32.77) followed by *Cyperus iria* (24.57), *I. himalaica* (24.49), *Fimbristylis miliacea* (22.86) and *Rotala rotundifolia* (19.41) (Table 1). In the present study, a significant difference was found in the weed types in rice fields of entire Rewa district ($F_{2, 873}$= 97.06, $p$<0.01). *F. miliacea* was the most common, widely distributed and the most serious weed with highest frequency, field uniformity and highest density values in the rice fields of different parts of the country (Baki 1993, Begum *et al.* 2005) [16, 10]. It has also been observed that the change of cultivation practice from transplanting to direct-seeding has no influence on *F. miliacea* (Tomita *et al.* 2003) [17]. In fact, because of the tremendous size of the soil seed bank accumulated over years of transplanting, *F. miliacea* would remain as a dominant weed species in direct-seeded rice areas (Azmi and Mashhor, 1996) [18].

**Table 1:** Consolidated account of different parameters of weed species in different crop ecosystems of Rewa in India

| Parameters | Transplanted Kharif rice | Winter vegetables | Potato | Mustard | Green and black gram |
|---|---|---|---|---|---|
| **Density (no./m$^2$)** | | | | | |
| Grass | 226.4 | 378.7 | 153.7 | 1296.6 | 436.6 |
| Sedge | 519.2 | 393.3 | 71.3 | 598.8 | 336.9 |
| BLW | 627.3 | 144.1 | 121.7 | 104.6 | 196.7 |
| **Species richness** | | | | | |
| Grass | 10 | 9 | 1 | 4 | 10 |
| Sedge | 17 | 11 | 4 | 9 | 11 |
| BLW | 29 | 27 | 7 | 12 | 28 |
| **Species with highest IVI** | | | | | |
| Five most dominant species (IVI) | *Eleocharis acicularis* (32.77) | *Cynodon dactylon* (39.16) | *Colocasia esculenta* (54.73) | *Cynodon dactylon* (59.93) | *Cynodon dactylon* (54.79) |
| | *Cyperus iria* (24.57) | *Ageratum houstonianum* (25.26) | *Ageratum houstonianum* (51.33) | *Cyperus compressus* (49.05) | *Cyperus compressus* (35.60) |
| | *Isachne himalaica* (24.49) | *Fimbristylis bisumbellata* (22.87) | *Cynodon dactylon* (48.51) | *Paspalum conjugatum* (26.54) | *Cyperus brevifolius* (14.79) |
| | *Fimbristylis miliacea* (22.86) | *Cyperus compressus* (19.20) | *Cyperus haspan* (24.16) | *Fimbristylis ittoralis* (26.03) | *Ludwigia perennis* (14.57) |
| | *Rotala rotundifolia* (19.41) | *Cyperus brevifolius* (17.20) | *Hygrophilla auriculata* (23.19) | *Eragrostis unioloides* (19.42) | *Fimbristylis littoralis* (14.48) |

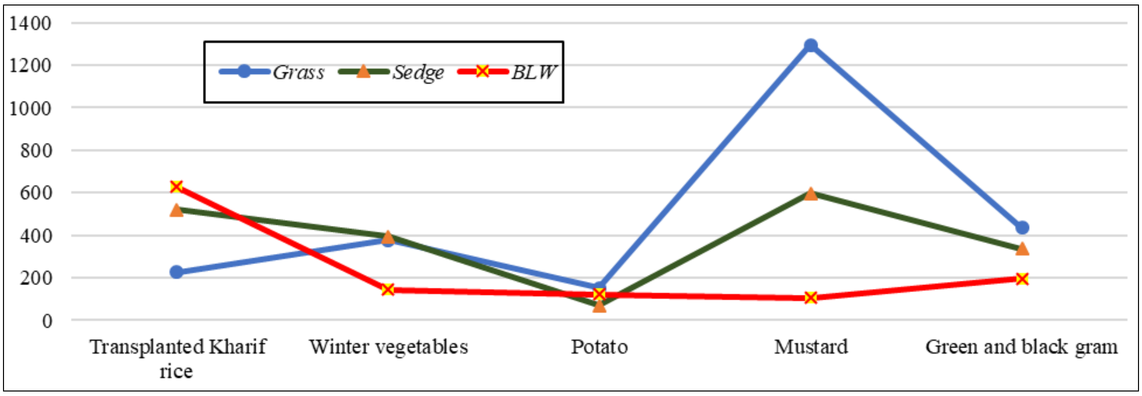


**Fig 1:** Weed density (no./m²) in different crop ecosystems of Rewa district

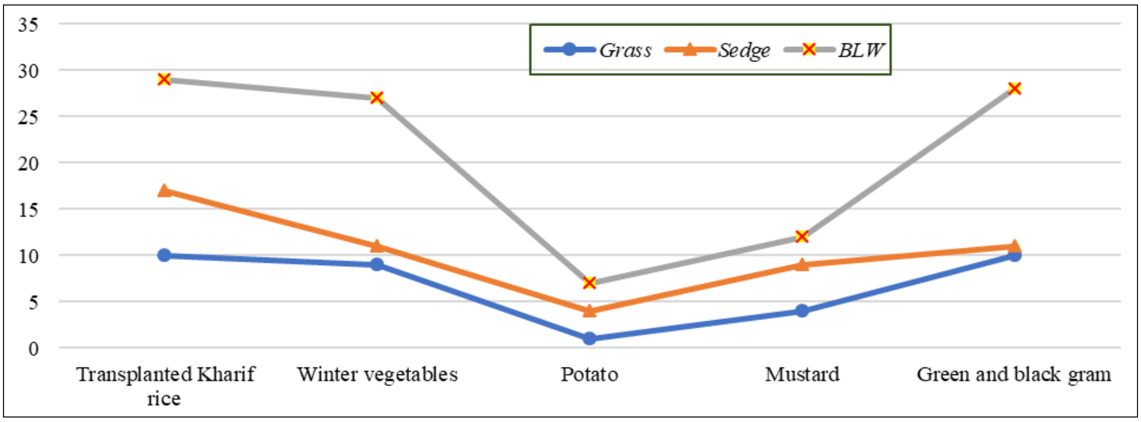


**Fig 2:** Weed species richness in different crop ecosystems of Rewa district

**Weed flora in major Rabi crops**

Out of the four major Rabi crops, 47 weed species were recorded in different mixed winter vegetables, 12 species from potato fields, 25 species in mustard and 49 weed species were recorded in the green gram/ black gram crop ecosystem in Rewa district (Table 1). Pumpkin, tomato, brinjal, radish, cauliflower, cabbage, garlic, bean etc. were cultivated as mixed winter vegetable crops in Rabi season in all the eight developmental blocks of Rewa, district. Among the weed groups, highest density was recorded for grasses in potato (153.60/m$^2$) followed by mustard (1296.67/m$^2$) and green gram/black gram cultivated fields (436.47/m$^2$). However, in winter vegetables, highest density was recorded for sedge (393.35/m$^2$). Among the weeds *Cynodon dactylon* had the highest IVI value 59.93 followed by *Colocasia esculenta* (54.73), *Ageratum houstonianum* (51.33), *Cyperus compressus* (49.05) and *Paspalum conjugatum* (26.54) in different Rabi season crop ecosystems of Rewa district, Madhya Pradesh (Table 1). These were the most dominant weed species with high density and wide distribution. Similar findings were reported in West Bengal, where *C. dactylon* was the dominant weed species in different winter crops like rapeseed mustard, wheat and potato fields (Duary *et al.* 2015) [19]. Pramanick *et al.* (2012) [20] also reported that, *C. dactylon* and *F. littoralis* were the most dominant and well distributed species in potato fields of West Bengal. Besides these, *F. littoralis*, *F. miliacea* and *F. bisumbellata* were reported as dominant species amongst the five dominant weed species from mixed winter vegetables, mustard, green gram and black gram cultivated fields with the exception of potato fields. Weed succession and distribution patterns in crop fields are dynamic in nature and composition of weed flora may differ depending on location (Begum *et al.* 2008) [21].

In the present study, a significant difference in weed types (sedge, grass and BLWs) was found among different crop ecosystems in all the developmental blocks (Table 2). All the three weed types were found to be significantly different among eight developmental blocks in transplanted rice and green gram/black gram crop ecosystems, while BLWs and grass were not significantly different in winter vegetables (Table 3).

**Table 2:** Differences among weed types (sedge, grass and broad-leaved weed) in different crop ecosystems in eight developmental blocks of Rewa district, Madhya Pradesh (one-way ANOVA)

| Crop ecosystem | Developmental blocks | F value | df (Degree of freedom) | Result |
|---|---|---|---|---|
| Kharif rice | Rewa | 39.9 | 2105 | <0.01 |
| | Raipur K. | 63.25 | 2107 | <0.01 |
| | Gangeo | 72.94 | 2114 | <0.01 |
| | Sirmour | 97.97 | 2123 | <0.01 |
| | Naigarhi | 8.436 | 287 | <0.01 |
| | Jawa | 51.41 | 2.111 | <0.01 |
| | Teonthar | 117.4 | 2117 | <0.01 |
| | Mauganj | 6.255 | 272 | <0.01 |
| Winter vegetable | Rewa | 15.05 | 233 | <0.01 |
| | Sirmour | 10.05 | 272 | <0.01 |
| | Teonthar | 3.969 | 277 | <0.05 |
| | Mauganj | 5.336 | 233 | <0.01 |
| Potato Green gram/ Black gram | Rewa | 17.47 | 227 | <0.01 |
| | Raipur K. | 14.71 | 227 | <0.01 |
| | Sirmour | 4.227 | 227 | <0.01 |
| | Gangeo | 3.338 | 263 | <0.05 |
| | Mauganj | 6.289 | 236 | <0.01 |
| | Hanumana | 9.854 | 2.72 | <0.01 |

However, weed species diversity differed significantly among all the crop ecosystems of different developmental blocks of the entire study area (Table 4). On the other hand, there was a difference in the weed types among transplanted rice fields of Rewa district ($F_{2, 873} = 97.06$, $p<0.01$).

## Similarity analysis

Similarity analysis among the weed communities of different crop ecosystems of Rewa district recorded that the highest similarity (0.79%) was among the weed communities of mixed winter vegetable crop fields and greengram/blackgram crop fields followed by Mustard and greengram/blackgram (0.65%), rice and greengram/blackgram (0.57%) and mustard and mixed winter vegetables (0.56%) (Table 5). However, only 0.29% similarity could be found among the weed communities of potato and green gram/black gram cultivated fields of the study area.

**Table 3:** Difference of weed types in Kharif rice, mixed winter vegetables, green gram/ black gram cultivated fields among different developmental Blocks of Rewa district (one-way ANOVA)

| Crop ecosystem | Weed type | F value | df (Degree of freedom) | Result |
|---|---|---|---|---|
| Kharif rice | Sedge | 17.4 | 7284 | <0.01 |
| | Broad-leaf | 93.69 | 7284 | |
| | Grasses | 11.25 | 7284 | |
| Winter vegetable | Sedge | 8.286 | 462 | |
| | Broad-leaf | 0.61 | 462 | NS* |
| | Grasses | 1.251 | 462 | NS* |
| Green gram/ black gram & Mustard | Sedge | 10.35 | 475 | |
| | Broad-leaf | 4.017 | 475 | |
| | Grasses | 2.869 | 475 | <0.05 |

NS* = Non significant

**Table 4:** Difference of weed species diversity among different Developmental blocks of Rewa district in different crop ecosystem (one-way ANOVA)

| Crop ecosystem | F value | df (Degrees of freedom) | Result |
|---|---|---|---|
| Kharif rice | 16.57 | 7274 | <0.01 |
| Mixed winter vegetables | 6.893 | 561 | <0.01 |
| Greengram, blackgram and mustard | 6.339 | 673 | <0.01 |

## Interspecific association

The positive and negative association was analyzed for the ten most dominant (highest IVI value) weed species found in different crop ecosystems of Rewa district. Out of ten of positively associated weed pairs, *Fimbristylis miliacea* showed high degree of positive association with *Elocharis accicularis* (0.292 ± 0.001; $p < 0.01$). Similarly, significant positive association was recorded between *Rotala rotundifolia* and *Isachne himalaica* (0.351 ±0.002), *Cynodon dactylon* and *Ageratum haustonianum* (0.272 ± 0.001), *Fimbristylis miliacea* and *Cyperus iria* (0.237 ± 0.001) and so on (Table 6). Gupta and Khare (2022a&b) [22-23] studied the association among different weed groups in rice cultivated areas in Satna district. Positive association between various species pairs can be attributed to their similar requirement for growth and development (Sundriyal, 1991) [24] and the competition between them in fairly stable habitat is not to eliminate one by the other from the area (Smith and Cottam, 1967) [25].

**Table 5:** Similarity index of weed communities among different crop ecosystems of Rewa in India

| Crop ecosystems | Rice | Mixed winter vegetables | Potato | Mustard | Greengram/ blackgram |
|---|---|---|---|---|---|
| Rice | *** | | | | |
| Winter vegetables | 0.54 | *** | | | |
| Potato | 0.32 | 0.34 | *** | | |
| Mustard | 0.42 | 0.56 | 0.37 | *** | |
| Greengram/black gram | 0.57 | 0.79 | 0.29 | 0.65 | *** |

However, out of nine negatively associated weed pairs, broad-leaved weed *Rotala rotundifolia* showed high degree of negative association with *Cynodon dactylon* (0.702 ± 0.007; $p < 0.01$) followed by *E. accicularis* and *C. dactylon* (0.727 ± 0.012), *F. miliacea* and *C. dactylon* (0.336 ± 0.003) and *F.littoralis* and *F.miliacea* (0.335 ± 0.003) (Table 6). Interspecific association is that if species are independent to each other, they will occur together more or less by chance, while if they are not dependent they will occur together more often or less often than can be expected by chance, which is expressed in terms of Coles index (Brey, 1956) [26]. The positive association between species is due to habitat suitability, requirement of shade by herbaceous species and requirement of light, space and nutrition (Mishra and Mishra, 1981) [27]. Several factors might have attributed to the negative associations of the weeds of rice fields as well as different winter crop ecosystems in the present study area, and the major factor might be the divergence of niches. Higher degree of negative associations between different *Fimbristylis* species with other sedges, BLW weeds and grass species were recorded in both the cropping season (monsoon and post monsoon) in Rewa district, Madhya Pradesh. The other important factors might be topography, site condition, microclimate, differential growth pattern, allelopathy and management and other biotic pressures (Gupta and Khare, 2022a&b) [22-23]. Whatever may be, these species had wider ecological and sociological amplitude in the weed communities of different crop fields of Rewa district, Madhya Pradesh.

**Table 6:** Chi-square ($\chi 2$) values (*, $p < 0.05$; **, $p<0.01$) showing association and Cole's index showing degree of association of different weed pairs in different crop fields of Rewa district, Madhya Pradesh

| Name of the species | Cole's index ± Standard error | Chi- square Value |
|---|---|---|
| *Positive association Cynodon dactylon* x *Ageratum haustonianum* | 0.272 ± 0.001 | 60.55** |
| *Cyperus compressus* x *Cynodon dactylon* | 0.563 ± 0.013 | 24.65** |
| *Fimbristylis miliacea* x *Cyperusiria* | 0.237 ± 0.001 | 56.93** |
| *Fimbristylismiliacea* x *Eleocharis accicularis* | 0.292 ± 0.001 | 69.62** |
| *Ishacne himalaica* x *Eleocharisaccicularis* | 0.179 ± 0.001 | 21.52* |
| *Ishachne himalaica* x *Fimbristylismiliacea* | 0.425 ± 0.006 | 28.67** |
| *Rotala rotundifolia* x *Eleocharisaccicularis* | 0.220 ± 0.001 | 37.10** |

| | | |
|---|---|---|
| *Rotala rotundifolia* x *Isachnehimalaica* | 0.351 ± 0.002 | 66.69** |
| *Schoenoplectella juncoides* x *Fimbristylis miliacea* | 0.519 ± 0.011 | 24.70** |
| *Schoenoplectella juncoides* x *Ishacne himalaica* | 0.321 ± 0.004 | 27.87** |
| *Negative association Eleocharis accicularis* x *Ageratum haustonianum* | 0.743 ± 0.021 | 26.08** |
| *Eleocharis accicularis* x *Cynodon dactylon* | 0.727 ± 0.012 | 43.66** |
| *Fimbristylis miliacea* x *Cynodon dactylon* | 0.336 ± 0.003 | 38.64** |
| *Fimbristylis littoralis* x *Fimbristylis miliacea* | 0.335 ± 0.003 | 35.75** |
| *Isachene himalaica* x *Ageratum haustonianum* | 0.515 ± 0.015 | 17.76* |
| *Rotala rotundifolia* x *Ageratum haustonianum* | 0.480 ± 0.013 | 17.71* |
| *Rotala rotundifolia* x *Cynodon dactylon* | 0.702 ± 0.007 | 66.13** |
| *Schoenoplectella juncoides* x *Ageratum haustonianum* | 0.827 ± 0.026 | 26.26** |
| *Schoenoplectella juncoides* x *Cynodon dactylon* | 0.563 ± 0.015 | 21.24* |

Overall, the study revealed that, grasses were the most dominant weed groups in different winter crop ecosystems of Rewa in India and *C. dactylon* was one of the most dominant and well distributed species followed by different BLW species and sedge. Similar findings had been reported by Tiwari *et al.* (2014) [28] from Bilaspur district, Chattisgarh where they found Poaceae as the dominant family followed by BLW families like Asteraceae, Fabaceae, Amaranthaceae and Cyperaceae (sedge). The dominance of sedge was slightly lesser in winter crop ecosystems as compared to the transplanted Kharif rice in Rewa in India. As the different winter crops were cultivated in upland situation in the postmonsoon season of the year, therefore, the dominance of sedges were comparatively lesser in Rabi crops. While, it was higher in transplanted Kharif rice in the study area, as all experimented rice fields were inundated about 5-10 cm in water. In rice, water and weeds are often considered to be closely interlinked. Bhagat *et al.* (1999) [29] reported that weed species respond differently to changing water regimes and the dominance of grass species was favoured by saturated and below saturated conditions, whereas aquatic broad-leaved weeds and sedges grow rapidly when soil was submerged with water (Bhagat *et al.* 1999, Juraimi *et al.* 2011) [29, 30]. This may be the most important factor for grass dominance over sedge and broad-leaved weeds in different winter crop ecosystems of Rewa in India.

Different crop ecosystems are infested by various problematic weeds for which modern technology should be used to address the issue and ensure increased crop productivity in a sustainable way, with the minimum of environmental degradation and loss of diversity of many important plant species. Weed control must be done to increase the crop productivity but there are some weeds and some situations in which more may be lost than gained by their destruction (Hillocks 1998) [31].

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