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Research Article

Phytosociological Exploration of Weed Flora in Two Agroforestry Systems in District Yamuna Nagar of Haryana, India

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Abstract

Weed flora of the rainy season has been explored for the study of phytosociological characters in two agroforestry systems in the district Yamuna Nagar of Haryana. The two sites selected were villages Bhojpur and Bhilpura, designated as sites I and II. Surveys of the sites were carried out from May to October 2025. The random quadrat sampling was done in the months of September and October to collect the data for community analysis. A total of 31 weed plants from 15 families and 26 weeds belonging to 12 families were collected from sites I and II, respectively. Family Poaceae was reported to have the highest number of weed species at both sites. *Eleusine indica* (L.) Gaertn. had the highest frequency and IVI value at site I, whereas these parameters were reported to be the highest for *Echinochloa crus-galli* (L.) P. Beauv. at site II. The higher Shannon index value of the two sites indicated that the healthy ecosystems had a rich diversity of weeds. The species were more evenly distributed at both sites as per the calculated value of Pielou's index. Moreover, the two agroforestry systems had higher similarity value, and many of the weed species were common in them. A phytosociological study of weed species helps us to enhance our understanding of the community structure. It also enables the farming practitioners and policy makers to evolve suitable strategies in order to have sustainable management of weeds

Keywords: *Phytosociological exploration, Weed species, Agroforestry, Yamuna Nagar.*

Introduction

A phytosociological study is an ecological assessment that simply aims to offer a detailed understanding of a plant community and the distribution of different plants within it. Such studies help to reveal patterns in the changing significance of plant populations within an agroforestry system and determine whether these variations are linked to specific agricultural practices. These insights can further contribute to the formulation of effective weed management strategies (Concenço *et al.,* 2013; Concenco *et al.,*2017). Phytosociological studies are crucial because they track the appearance and disappearance of plant species within cropping systems, guiding the selection of effective, economically viable, and sustainable weed-management strategies (Hetta *et al.,* 2022).

Although a small percentage of plant species across the globe act as weeds in different agroecosystems yet they adversely affect crop production. Sah *et al.,* (2020) in their study on wheat crop in Bundelkhand area observed that weedy species pose significant challenges to agriculture and ecosystem balance. They compete aggressively with crops for essential resources such as water, sunlight, soil nutrients, and growing space, often leading to substantial reductions in crop yield and quality. Sinha (2017) studied the weed diversity of Chhattisgarh, India and observed that the Importance Value Index (IVI) of twelve angiospermic families indicated that the dominant weed families in the dry-seeded rice system were Poaceae and Cyperaceae. Monocot families showed clear predominance, represented chiefly by species of Cyperaceae and Poaceae, respectively. Wheat, India's second most important staple crop after rice, faces severe and often irreversible

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yield losses due to heavy weed infestation driven by their competitiveness ability (Kumar *et al.,*2024). In an investigation on weedy plants in the reclaimed lands of Middle Egypt, Saeed *et al.,*(2025) found that the families Poaceae, Asteraceae, Brassicaceae and Amaranthaceae dominated and collectively accounted for a majority of the region's recorded weed diversity.

By identifying and quantifying the weed species that occur across various crops and cropping systems, it becomes possible to design practical weed-management strategies that are suitable even for marginal farmers. Because only certain species significantly shape weed communities, assessing quantitative attributes provides a clearer understanding of each species' ecological role (Nagaraju *et al.,*2014). Ndam *et al.,* (2014) in their study in South- Western Cameroon found that weed species in the maize fields hold great significance for botanists and weed scientists, as it provides essential insights for developing effective, long-term weed management strategies. The study of common weeds in Chanasma Taluka, Gujarat by Patel and Ant (2019) offers the importance of the structure and composition of the local weed community, which serves as an essential baseline for future research. Some weeds are useful as they provide food, fodder and have medicinal value (Sahrawat *et al.,* 2020, Nigam and Singh, 2025). The findings support improved weed management practices and open avenues for exploring the economic and medicinal potential of various species. This information is beneficial not only for farmers and researchers but also for anyone interested in weed-related studies. Notably, the area was largely dominated by annual weeds and those producing abundant seeds. Travlos *et al.,* (2018) evaluated weed species variability and diversity across various tillage and fertilization regimes and found that makeup and structure of weed communities are strongly shaped by various management practices, including tillage and fertilization.

In a study on weeds of wheat crops in Indo-Gangetic plains, Kumar *et al.,* (2020) concluded that taxonomic and phytosociological data on weeds can be shared with relevant government and non-government agencies to help them develop effective weed management strategies and policies. Sai *et al.,*(2022) in their study on weeds of rice fields in Tamilnadu, emphasized the strong persistence shown by the dominant weed species across all phytosociological parameters that was closely linked to the morphological and developmental traits of their respective families. Most species exhibiting the greatest density, frequency, and abundance belonged to the Cyperaceae and Poaceae families.

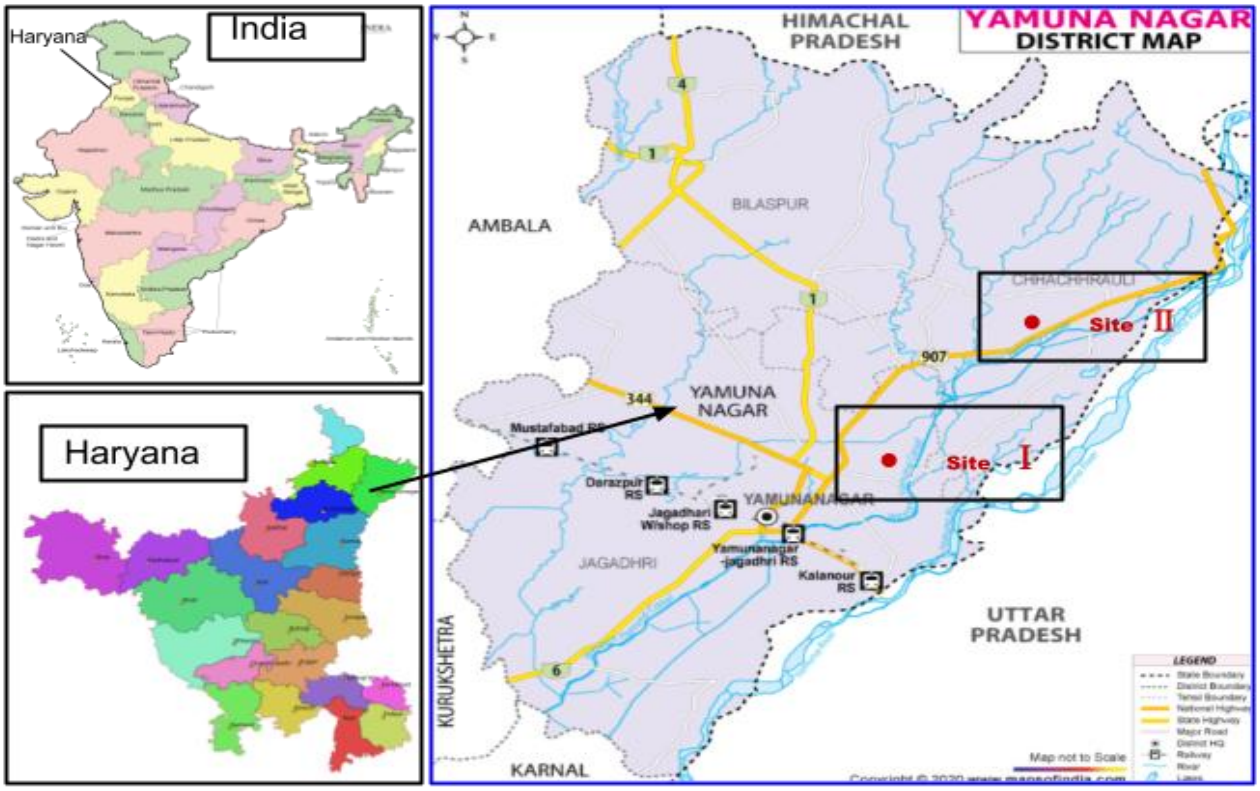

Figure 1- Location of the Study points in District Yamuna Nagar

Material and Methods

This exploration on weed species has been conducted in two agroforestry systems in the district Yamuna Nagar that lies between Latitudes 29° 55′ to 30° 28′ North and Longitudes 77° 04′ to 77° 36′ East, and the district has a total area of 1768 square kilometres (DCOH, 2011). The two selected site were village Bhojpur (Site-I) and Bhilpura (Site-II). These two sites are located at a distance of about 20 km. from each other. (Figure-1). The climate of the area is subtropical with the majority of rainfall taking place from mid-June to mid-September. The minimum and maximum temperatures and total rainfall have been presented in Figure 2. The area has a wheat-rice cropping system, but a few farmers shift to agroforestry by planting *Populus deltoides* W.Bartram ex Marshall. In the systems under study, rice was transplanted during the first year after tree plantation, but thereafter, only wheat was sown during the Rabi season. This is because by the second year, the trees develop enough canopy and the shade does not allow crops to grow properly. In winter, the trees get defoliated and the wheat crop grows well.

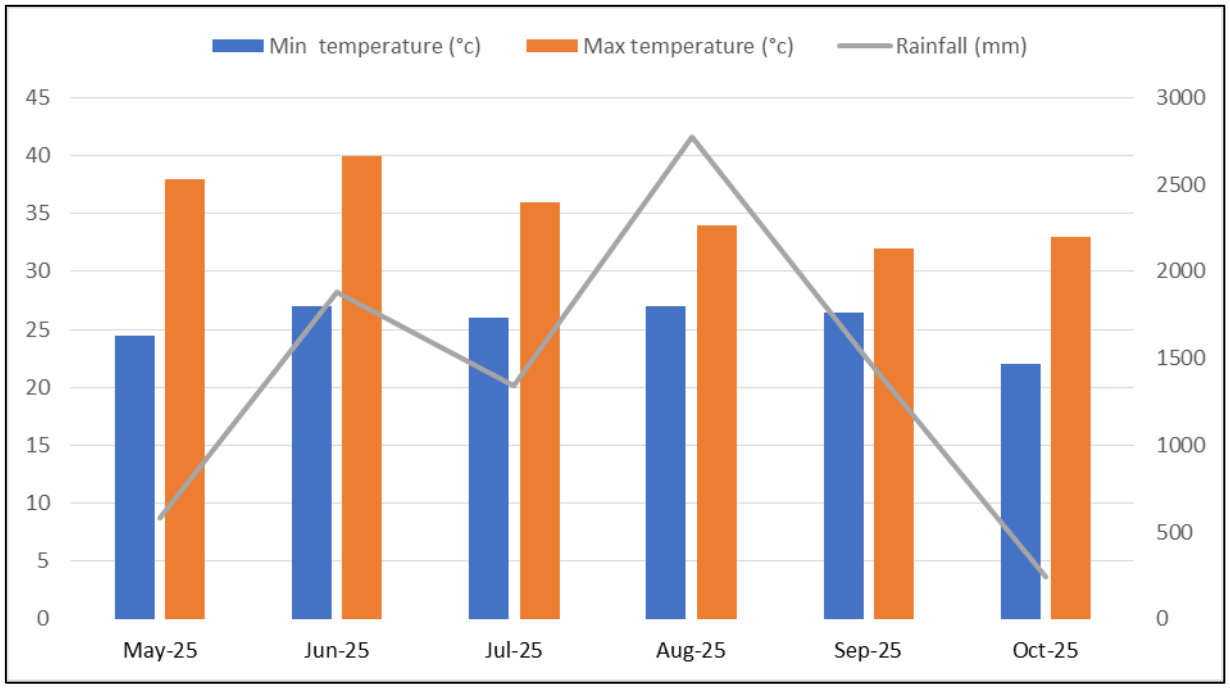

Figure 2- Mean monthly temperature and total rainfall of the area during the study period

The study has been carried out to analyse the weed flora of agroforestry systems during the rainy season. Fortnightly visits were paid to the sites during May to October 2025.The information data of weed species has been collected in September and October months as most weeds flower. The observations have been collected from the two sites using a 1.0 m^2 quadrat as a sampling unit placed at random and fifty such quadrats were laid at each site. The data has been analysed for calculating different quantitative characters viz-frequency, density and abundance of each species as described by Misra (1968). These values were further used for the calculation of their relative attributes and other phytosociological indices of weed diversity. The two study sites were also analysed for the determination of Shannon index, Pielou's index of evenness, Sorensen's index of similarity and dissimilarity. Different formulae used are given as under.

$$\text{Frequency (\%)} = \frac{\text{Number of sampling units in which the species was found}}{\text{Total of sampling units used}} \times 100$$

$$\text{Density} = \frac{\text{Aggregate of individuals of a species in all the sampling unit}}{\text{Total of sampling units used}}$$

$$\text{Abundance} = \frac{\text{Aggregate of individuals of a species in all the sampling units}}{\text{Total sampling units where the species was found}}$$

$$\text{Relative frequency (RF)} = \frac{\text{Frequency of a single species}}{\text{Sum of all the species frequency}} \times 100$$

$$\text{Relative Density (RD)} = \frac{\text{Density of a single species}}{\text{Sum of all the species density}} \times 100$$

$$\text{Relative Abundance (RA)} = \frac{\text{Abundance of a single species}}{\text{Sum of all the species abundance}} \times 100$$

Phytodiversity indices

The indices used for the analysis of phytosociological characters at two sites are listed below.

Importance Value Index (IVI): This value helps to determine the dominance and successful adaptability of the weed species**.** IVI of all the weed plants was calculated by the formula that was given by Phillips (1959) as:

IVI = R.F. + R.D. + R.A.

Shannon index (H): This is a common index used to measure species diversity at any site. Greater values indicate higher diversity, indicating the health of the ecosystem. It was calculated using this formula (Shannon and Weaver, 1963) as:

$H = -\sum_{i=1}^{n} pi(\ln pi)$

Where pi = Proportionate value of the species number

ln = Natural logarithm

Pielou's index (J): This value shows how evenly the species are distributed and the values range between 0 and 1 (Pielou's,1977). A lower value indicates that only a few species are dominant, while a value near 1 means more evenness. This index J was calculated as:

$J = \frac{H}{\ln S}$

H= Shannon index

S= Total of all the species

Sorensen's index (S): This is a good measure to study the diversity of species between two communities. It is also called the similarity index S (Sorensen, 1948). The values here are between 0 and 1. Values near 0 indicate low similarity and near 1 indicate higher similarity between communities.

$S = \frac{2C}{A+B}$

A = Total species at site I.

B = Total species at site II

C = Sum of species that are common at both the sites

Dissimilarity Index: This can be calculated from the values obtained in Sørensen's index using the formula:

Dissimilarity index = 1− S

S = Similarity index

Observations and Results

The observations on weed species from the two sites have been presented in Tables 1 and 2. An aggregate of 31 weed species from15 families (3 monocots and 12 dicots) were reported from site I. Similarly, there were 26 species from 12 families (2 monocots and 10 dicots) reported from site II. At site I, family Poaceae had 8 species that was the highest number, followed by Amaranthaceae and Asteraceae with 5 and 4 species respectively. Whereas the family Poaceae had 7 species, Amaranthaceae, Asteraceae and Malvaceae had 3 species each at site II. The number of species from each family is given in Table 3.

As per tables 1 and 2, *Eleusine indica* (L.) Gaertn. was having the highest frequency and density at site I, whereas *Echinochloa crus-galli* (L.) P. Beauv. had the highest frequency and density at site II. *Eragrostis*

tenella (L.) P. Beauv. ex Roem. & Schult and *Ammannia multiflora* Roxb. had the highest abundance at sites I and II respectively. At site I *Eleusine indica* (L.) Gaertn., *Echinochloa crus-galli* (L.) P. Beauv. and *Cyprus iri*a L. had the highest importance value index. Whereas *Echinochloa crus-galli* (L.) P. Beauv., Dactyloctenium aegyptium (L.) Willd. and *Sida acutifolia* Steud. had the higher values of IVI at site II. IVI values of weed species at two sites are shown in Figures 3 and 4.

The value of Shannon index for sites I and II was found to be 3.26 and 3.06 respectively. The calculated value of Pielou's index for site I was 0.95and for site II as 0.94. The Sorensen's index value indicating similarity in two communities was 0.77 and the dissimilarity index was 0.23 for the systems under study.

Table 1: Phytosciological data of weed species at village Bhojpur (Site-I) of district Yamuna Nagar, Haryana.

S.no.	**Plant Name**	**Family**	**F**	**D**	**A**	**RF**	**RD**	**RA**	**IVI**
1	*Eleusine indica* (L.) Gaertn.	Poaceae	68	1.42	2.09	9.04	10.41	3.90	23.35
2.	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	44	0.84	1.91	5.85	6.16	3.57	15.58
3	*Echinochloa crus-galli* (L.) P. Beauv.	Poaceae	52	1.22	2.35	6.91	8.94	4.39	20.24
4	*Cyprus iria* L.	Cypreceae	48	1.00	2.08	6.38	7.33	3.89	17.60
5	*Ageratum conyzoides* L.	Asteraceae	18	0.32	1.78	2.39	2.35	3.33	8.07
6	*Cyprus rotundus* L.	Cypreceae	14	0.24	1.71	1.86	1.76	3.19	6.81
7	*Panicum repens* L.	Poaceae	36	0.70	1.94	4.79	5.13	3.62	13.54
8	*Phylanthus niruri* L.	Phylanthaceae	20	0.42	2.10	2.66	3.08	3.92	9.66
9	*Digitaria sanguinalis* (L.) Scop.	Poaceae	28	0.48	1.71	3.72	3.52	3.19	10.43
10	*Ammannia multiflora* Roxb.	Lythraceae	24	0.34	1.42	3.19	2.49	2.65	8.33
11	*Megathyrus maximus* (Jacq.) B.K. Simon & S.W.L. Jacobs.	Poaceae	20	0.36	1.80	2.66	2.64	3.36	8.66
12	*Ludvigia hyssopifolia* (G.Don) Exell.	Onagraceae	24	0.34	1.42	3.19	2.49	2.65	8.33
13	*Physalis angulata* L.	Solanaceae	12	0.20	1.67	1.60	1.47	3.12	6.19
14	*Euphorbia hirta* L.	Euphorbiaceae	18	0.26	1.44	2.39	1.91	2.69	6.99
15	*Eclipta alba* (L.) Hassk.	Asteraceae	20	0.22	1.10	2.66	1.61	2.05	6.32
16	*Cassia occidentalis* L.	Fabaceae	16	0.22	1.38	2.13	1.61	2.58	6.32
17	*Achyranthus aspera* L.	Amaranthaceae	16	0.28	1.75	2.13	2.05	3.27	7.45
18	*Chenopodium album* L.	Amaranthaceae	24	0.40	1.67	3.19	2.93	3.12	9.24
19	*Urena lobata* L.	Malvaceea	16	0.24	1,50	2.13	1.76	2.80	6.69
20	*Sida acutifolia* Steud.	Malvaceae	18	0.34	1,89	2.39	2.49	3.53	8.41
21	*Mazus pumilus* (Burm. f.) Steenis	Mazaceae	22	0.34	1.55	2.93	2.49	2.90	8.32
22	*Commelina benghalensis* L.	Commelinaceae	16	0.30	1.88	2.13	2.20	3.51	7.84
23	*Bidens pilosa* L.	Asteraceae	16	0.26	1.63	2.13	1.91	3.05	7.09
24	*Acmella uliginosa* (Sw.) Cass.	Asteraceae	18	0.24	1.33	2.39	1.76	2.48	6.63
25	*Alternenthera sessilis* (L.) R.Br. ex DC	Amaranthaceae	14	0.20	1.43	1.86	1,47	2.67	6.00
26	*Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult.	Poaceae	18	0.52	2.89	2.39	3.81	5.40	11.60
27	*Digeria muricata* (L.) Mart.	Amaranthaceae	16	0.18	1.13	2.13	1.32	2.11	5.56
28	*Amaranthus viridis* L.	Amaranthaceae	30	0.54	1.80	3.99	3.96	3.36	11.31
29	*Cucumis callosus* (Rottler) Cogn.	Cucurbitacaeae	12	0.14	1.17	1.60	1.03	2.19	4.82
30	*Cleome viscosa* L.	Cleomaceae	30	0.58	1.93	3.99	4.25	3.60	11.84
31	*Setaria viridis* (L.) P.Beauv.	Poaceae	24	0.50	2.08	3.19	3.67	3.89	10.75

Table 2: Phytosciological data of weed species at village Bhilpura (Site II) of district Yamuna Nagar, Haryana

S.No	**Plant Name**	**Family**	**F**	**D**	**A**	**RF**	**RD**	**RA**	**IVI**
1	*Echinochloa crus-galli* (L.) P. Beauv.	Poaceae	58	1.12	1.93	7.65	8.43	4.24	20.32
2	*Mazus pumilus* (Burm.f.) Steenis.	Mazaceae	28	0.46	1.64	3.69	3.47	3.60	10.76

3	*Panicum repens* L.	Poaceae	28	0.44	1.57	3.69	3.31	3.45	10.45
4.	*Eleusine indica* (L.) Gaertn.	Poaceae	34	0.58	1.71	4.49	4.37	3.76	12.62
5	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	46	0.72	1.57	6.07	5.36	3.45	14.88
6	*Sida acutifolia* Steud.	Malvaceae	40	0.70	1.75	5.28	5.27	3.85	14.40
7	*Ammannia multiflora* Roxb.	Lytharaceae	20	0.46	2.30	2.64	3.46	5.05	11.15
8	*Ageratum conyzoides* L.	Asteraceae	34	0.58	1.71	4.49	4.37	3.76	12.62
9	*Euphorbia hirta* L.	Euphorbiaceae	30	0.54	1.80	3.96	4.07	3.96	11.99
10	*Eragrostis* sp.	Poaceae	28	0.58	2.07	3.69	4.37	4.55	12.61
11	*Digitaria sanguinalis* (L.) Scop.	Poaceae	34	0.70	2.06	4.49	5.27	4.53	14.29
12	*Setaria virigis* (L.) P. Beauv.	Poaceae	36	0.58	1.61	4.75	4.37	3.54	12.66
13	*Phylanthus niruri* L.	Phylanthaceae	28	0.44	1.57	3.69	3.31	3.45	10.45
14	*Cleome viscosa* L.	Cleomaceae	20	0.32	1.60	2.64	2.41	3.52	8.57
15	*Corchorus aestuans* L.	Malvaceae	26	0.46	1.77	3.43	3.46	3.89	10.78
16	*Scoparia dulcis* L.	Plantaginaceae	24	0.42	1.75	3.17	3.16	3.85	10.18
17	*Cyperus iria* L.	Cyperaceae	28	0.58	2.07	3.69	4.37	4.55	12.61
18	*Cassia tora* (L.) Roxb.	Fabaceae	22	0.32	1.45	2.90	2.41	3.19	8.50
19	Eclipta alba (L.) Hassk.	Asteraceae	22	0.30	1.36	2.90	2.26	2.99	8.15
20	*Cassia occidentalis* L.	Fabaceae	28	0.46	1.64	3.69	3.46	3.60	10.75
21	*Achyranthus aspera* L.	Amaranthaceae	18	0.30	1.67	2.37	2.26	3.67	8.30
22	*Urena lobata* L.	Malvaceae	34	0.58	1.71	4.49	4.37	3.76	12.62
23	*Bidens pilosa* L.	Asteraceae	18	0.32	1.78	2.37	2.41	4.91	8.69
24	*Digeria muricata* (L.) Mart.	Amaranthaceae	28	0.42	1.50	3.69	3.16	3.30	10.15
25	*Euphorbia prostrata* Aiton.	Euphorbiaceae	24	0.46	1.92	3.17	3.46	4.22	10.85
26	*Amaranthus viridis* L.	Amaranthaceae	22	0.44	2.00	2.90	3.31	4.39	10.60

Abbreviations- F = Frequency, D = Density, A = Abundance, RF = Relative Frequency, RD = Relative Density. RA= Relative abundance, IVI = Importance Value Index

Table 3: Families with the number of species at two sites of study

Site I				**Site** II		
S.No.	**Name of the family**	**Monocot/ Dicot**	**No. of species**	**Name of the family**	**Monocot/ Dicot**	**No. of species**
1	Poaceae	M	8	Poaceae	M	7
2	Asteraceae	D	4	Mazaceae	D	1
3	Cyperaceae	M	2	Malvaceae	D	3
4	Phylanthaceae	D	1	Lytharaceae	D	1
5	Lythraceae	D	1	Asteraceae	D	3
6	Onagraceae	D	1	Euphorbiaceae	D	2
7	Solanaceae	D	1	Phylanthaceae	D	1
8	Euphorbiaceae	D	1	Cleomaceae	D	1
9	Fabaceae	D	1	Plantaginaceae	D	1
10	Amaranthaceae	D	5	Cyperaceae	M	1
11	Malvaceae	D	2	Fabaceae	D	2
12	Mazaceae	D	1	Amaranthaceae	D	3
13	Commelinaceae	M	1			
14	Cucurbitaceae	D	1			
15	Cleomaceae	D	1			

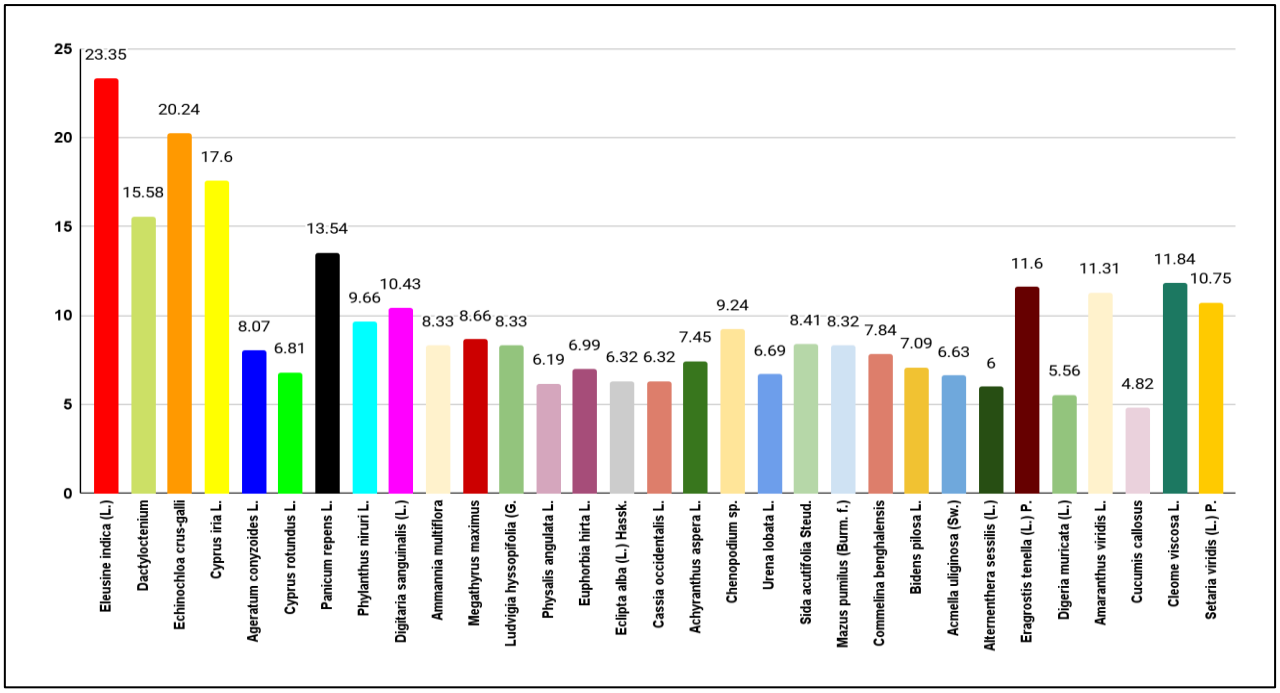

Figure 3- Weed species with their Importance Value Index at Site I

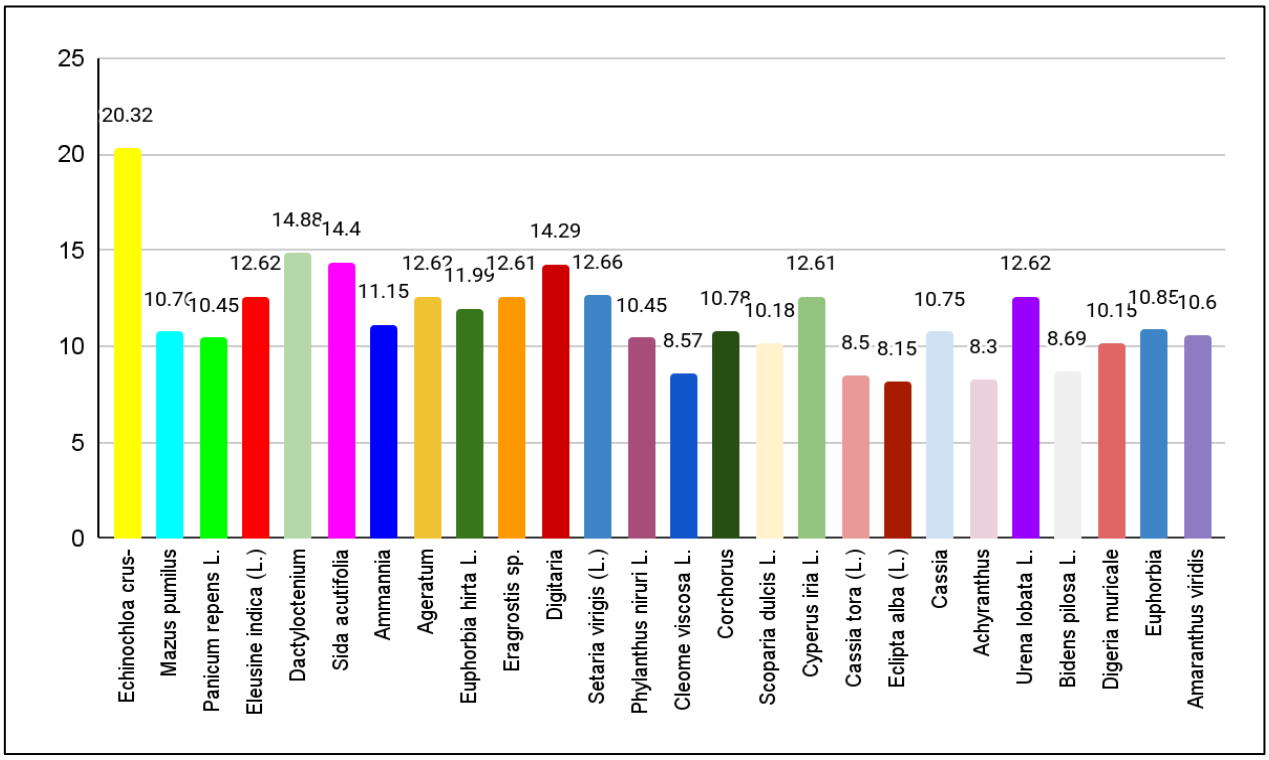

Figure 3- Weed species with their Importance Value Index at Site II

Discussion

A perusal of the observations indicates that the family Poaceae is the most dominant, having the highest number of weed species at both sites. This is because the plants in this family produce seeds in large numbers and they remain viable in the soil over different climates and grow on the arrival of a suitable season. Families Poaceae, Amaranthaceae and Asteraceae accounted for 55% of total weed species at site I. Similarly, at site II, Poaceae, Malvaceae. Asteraceae and Amaranthaceae had 62% of weed plants. Monocot weeds had the highest frequency and IVI at both sites in agroforestry systems. These reports are similar to the studies on weed diversity by Saeed *et al.,* (2025) in reclaimed sites in Middle Egypt.

The values of the Shannon index on the diversity of weed species in both sites are more than 3. It indicates that both the systems have rich phytodiversity and healthier environmental conditions. As the value of Pielou's index is near 1, meaning that distribution of species is more even. Sujatha et al (2021) had similar observations while studying the weed diversity in the Vishakhapatnam tribal area of Andhra Pradesh. For Sorensen's index, the value is 0.77, which means a substantial number of species are common at two places, and a lower value is recorded for the dissimilarity index. These indices help the ecologist to understand the patterns of distribution of regional phytodiversity and plan for conservation strategies.

Conclusion and Future Prospects- Weedy plants are supposed to be a nuisance as they impact the crop output. But many weeds have the potential to be used as food, fodder and for medicinal purposes. Therefore, such studies shall be helpful for the development of proper weed management plans that are suitable for the farming community in the near future.

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