DIVERSITY OF WEEDS IN WASHIM DISTRICT, MAHARASHTRA, INDIA

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Abstract
A detailed morpho-taxonomic investigation of weed flora was carried out in irrigated and unirrigated agro-ecosystems of the Washim district of Maharashtra, India. The major aim was to record, identify, and describe the competing weed species against important crops like soybean, cotton, pulses, and cereals. Through rigorous field surveys, a total of 40 weed species of 18 plant families were recorded and identified. The most abundant families were Poaceae (6 spp.), Asteraceae (5 spp.), Amaranthaceae (4 spp.), and Euphorbiaceae (4 spp.). The work is presented with comprehensive taxonomic treatments on the basis of primary morphological characters, such as habit, leaf morphology, type of inflorescence, flower structure, and fruit type, supplemented with voucher photoplates to allow for accurate visual identification. Outstanding species include the highly noxious invader Parthenium hysterophorus L. and the globally adapted Cynodon dactylon (L.) Pers. The results underscore the rich weed flora endangering agricultural yields in the area. The study provides an important baseline database for Washim district weed diversity, which is vital for planning effective integrated weed management (IWM) strategies, helping in accurate identification by farmers and researchers, and furthering floristic awareness in the Vidarbha region of Maharashtra.
Keywords: *Weed flora, Morpho-taxonomy, Phytodiversity, Agro-ecosystem, Washim district, Maharashtra, Crop weeds, Invasive species.*

Introduction

Weeds are one of the biggest biological limiting factors to world agricultural production, which has been a constant threat to food security by competing with crops for vital resources—light, water, nutrients, and space (Rao et al., 2017). Such unwanted plants cause severe yield loss, usually more than 30-50% if not controlled, and lower the quality of harvests (Holm et al., 1977). In addition to competitive displacement, they act as alternate hosts to pests and pathogens, make farming operations difficult, and their persistent infestation requires expensive control strategies, which put a heavy economic load on farmers. The structure and prevalence of weed floras in any given area are dynamic, subject to a rich interplay of variables such as soil type, climate, and, most importantly, the management practices involved, including irrigation (Gould, 1968; Sutherland, 2004). A changeover from unirrigated to irrigated systems has the potential to revolutionize the weed flora, usually promoting pernicious perennial weeds that are more difficult to control (Bendixen & Nandihalli, 1987). Thus, knowledge of a particular weed community in a specific agro-ecosystem is the starting point in creating efficient and sustainable Integrated Weed Management (IWM) practices. Proper morphological and taxonomic identification is critical in this regard, because incorrect identification may result in the use of inefficient control methods, which can cause additional economic and environmental losses.

In India, the agricultural state of Maharashtra offers a varied landscape of agro-climatic zones, each with its own specific weed flora problems. The Vidarbha area, in specific, is an important center of cash crop production such as cotton and soybean and pulses and cereals (Kalamkar, 2011). The yield of these crops is constantly threatened by a large number of weed species. The overall floristic composition of some of the districts around Washim has been reported, such as Amravati (Dhore, 2002), Akola (Kambale & Pradhan, 1988), Buldhana (Diwakar & Sharma, 2000), Yavatmal (Karthikeyan & Anand Kumar, 1993), and nearby regions such as Dhule and Nandurbar (Patil, 2003). In addition, the vegetation of Marathwada (Naik, 1998) and floristic enumeration of Washim district per se (Deore, 2010) are worth considering.

Still, an important gap exists. While these studies provide a general impression of the plant diversity, they usually do not have a particular, specific morpho-taxonomic emphasis on weed species in active agro-ecosystems, especially with contrasts between irrigated and unirrigated situations. A specific weed survey is not just a subset of a general floristic study; it needs to emphasize phenology, frequency, relationship to certain crops, and morphological specializations that provide weedy advantages.

The Washim district, which is in the center of the Vidarbha region, is a case in point. It has a distinctive landscape with a combination of irrigated and rain-fed (unirrigated) farming systems. This heterogeneity generates different ecological niches and will likely result in important differences in weed species composition, abundance, and flexibility.

This research, therefore, aims to meet this specific requirement. It seeks to undertake a comprehensive morpho-taxonomic inventory and analysis of the weed vegetation in irrigated and unirrigated fields of Washim district.

The specific **objectives** are:

1 To document, list, and taxonomically characterize the weed species of the region's major crops.

2 To describe each species in terms of the most relevant morphological traits for proper identification.

3 To design an exhaustive visual atlas (photoplates) as a handy ready reference.

4 To examine and discuss the patterns of distribution of weeds in terms of irrigation culture.This study will provide a critical baseline report for extension agents, agriculturists, and researchers. It will enable the creation of focused, sustainable, and efficient weed management strategies, ultimately helping to improve crop yields and the economic well-being of the farming population in the Washim district.

3. Methodology

3.1. Study Area: Washim District

The study was carried out in Washim district of Maharashtra, India, which is geographically situated between latitudes 20° 15' N to 20° 20' N and longitudes 76° 80' E to 77° 80' E. The district lies within the sub-tropical climatic region, having three well-marked seasons: summer, monsoon, and winter. The mean annual rainfall is nearly 800 mm, falling mainly from the southwest monsoon (June to September). The district features a combination of black cotton soils (vertisols) and lateritic soils, which are favorable for growing major crops like soybean (Glycine max), cotton (Gossypium spp.), pigeon pea (Cajanus cajan), maize (Zea mays), and wheat (Triticum aestivum). The farm landscape is an agro-mosaic of irrigated (e.g., by canals and wells) and unirrigated (rain-fed) farming systems, which is a perfect site for a comparative study of weed floras (Deore, 2010; Kalamkar, 2011).

3.2. Field Survey and Weed Collection

A comprehensive and structured field survey was conducted during two successive cropping seasons (Kharif and Rabi) to collect seasonal and perennial weeds.

- **Sampling Design:** Stratified random sampling method was utilized. The district was stratified according to two main factors:

1. Irrigation Status: Irrigated lands vs. Irrigated lands.
2. Major Crop Type: Soybean lands, Cotton lands, Pulses lands, Cereal lands (Maize/Wheat), and Fallow lands.

In every stratum, five villages were randomly selected, and from each village three fields were randomly selected for sampling, totaling 150 field sites (2 irrigation types x 5 crop types x 5 villages x 3 fields).

- **Collection Protocol:** Weed samples were collected at their various developmental stages, preferably flowering and fruiting, since these phenological stages are important for accurate taxonomic identification (Gould, 1968). For every species found, several healthy specimens were collected. Collections were made by unearthing the whole plant, root system, to see below- ground structures such as rhizomes, tubers, or root type, that are some of the important diagnostic characters for most grass and sedge species. Geographical coordinates and habitat information (corresponding crop, status of irrigation) were captured for each collection.
- Photography: In-situ images of each weed species were taken using a One plus nord CE2 Mobile camera. The photoplates emphasized major morphological characteristics: general habit, root system, stem cross-section, leaf arrangement (phyllotaxy) and morphology, type of inflorescence, close-up of flowers (front and side), and fruit type. A scale bar or a familiar object (a coin, for example) was added to photographs for scale.

3.3. Morpho-Taxonomic Identification and Herbarium Preparation

The plant specimens were prepared following standard herbarium procedures (Jain & Rao, 1977).

- **Pressing and Drying:** Specimens were gently cleaned and placed on herbarium sheets to expose all morphological aspects (upper and lower leaf surfaces, flowers, fruits) and subsequently pressed with the help of a plant press. They were dried in a field drier at 45-50°C in order to maintain their structure and color.
- **Poisoning and Mounting:** The dried specimens were poisoned with a 0.1% mercuric chloride solution in absolute alcohol to avert fungal attack and insect damage. They were then mounted on standard-sized herbarium sheets measuring 41 cm x 29 cm using glue and strapping tape. An authentic voucher specimen for each species was placed in the departmental herbarium for future reference.
- **Identification:** The initial identification of weed species was done based on authoritative regional and national floras such as Flora of

Maharashtra State (Singh & Karthikeyan, 2000), Flora of Amravati District (Dhore, 2002), and The Flora of British India (Hooker, 1872-1897). For critical taxa, particularly members of Poaceae and Cyperaceae, specialist monographs such as Grass Systematics (Gould, 1968) and The Families of Flowering Plants (Prain, 1903) were referred to. The botanical nomenclature and author citations were checked against online databases like Plants of the World Online (POWO) and the International Plant Names Index (IPNI).

3.4. Data Analysis

The data was analyzed qualitatively to yield ecologically relevant insights.

- Qualitative Analysis: The weed flora was analyzed on the basis of:
- Family-wise Contribution: The number of species contributed by each of the plant families was calculated to identify the dominant families.
- Life Form and Habit: Species were grouped into life forms (e.g., annuals, perennials) and habits (e.g., herbs, shrubs, climbers) according to field observations and standard literature.
- Taxonomic Description: A detailed morphological description was made for each species, including characters pertaining to root, stem, leaf, inflorescence, flower, fruit, and seed.

3.5. Photographic Documentation and Visual Reference Library

One of the most important and fundamental components of this morpho-taxonomic study was the development of an extensive visual reference library. This library acts as a permanent, accessible repository for the accurate identification of weed species, supporting the physical herbarium vouchers and written descriptions. Digital images at high resolution, taken in situ of each of the 40 weed species, were systematically collected throughout field surveys in the Washim district.

***Alternantheraficoidea*(L.)P.Beauv.**

***Alternantherasessilis*(L.)R.Br.exDC.**

AmaranthusspinosusL.

AmaranthusviridisHook.K:

***Anisomelesmalabarica*(L.)R.Br.**

***Bidensbiternata*(Lour.)Merr.&Sherff**

BoerhaviaerectaL.

BoerhaviadiffusaL.

Brachiariareptans

***Brachiariaeruciformis*(SM).Griseb**

CommelinabenghalensisL.

CleomeviscosaL.

Cassia toraL.

***Conyza bonariensis* (L.) Cronquist (syn. ErigeronbonariensisL).**

CorchoruscapsularisL.

CorchorusolitoriusL.

***Digitariaciliaris*(Retz.)Koeler**

***Cynodondactylon*(L.)Pers.**

CyperusesculantusL.

***Cyperuskyllingia*Endl.**

Euphorbiaheterophyla

***Euphorbiahirta*L.**

EuphorbiathymifloraL.

***Hyptissuaveolens*(L.)Poit.**

***Leucasaspera*(Willd.)Link**

***Mimosapudica*L.**

***Oldenlandiaumbellata*L.**

***Oxaliscorniculata*L.**

PartheniumhysterophorusL.

***Paspalidiumflavidum*(Retz.)A.Camus.**

Phyllanthusniruril.

***Phyllanthusamarus*Schum.&Thonn.**

***Physalisminima*L.**

***Portulacaoleracea*L.**

setariaviridis

***Sidacordifolia*(Burm.f)Borss.**

***Tridaxprocumbens*L.**

***Tephrosiapurpurea*(L.)Pers.**

***Tribulusterrestris*L.**

***Ecliptaalba*(L.)Hassk.**

Figure 1: Photographic plate of weed species collected from irrigated and unirrigated fields of Washim District, Maharashtra.

4. Results and Discussion

4.1 Floristic Structure and Dominant Families

Systematic survey reported a weed flora consisting of 40 species (Table 1, Photographic Plate) inhabiting agricultural fields in the region under study. They were taxonomically represented in 18 angiosperm families (Fig. 1a). The most dominant family was Asteraceae, with 5 species (12.5% of the flora), followed by Poaceae (5 species, 12.5%), Amaranthaceae (4 species, 10%), and Euphorbiaceae (4 species, 10%). This dominance of Asteraceae and Poaceae is a common trend in global weed vegetation, especially in tropical and subtropical agroecosystems, and could be due to their sheer reproductive capacity, effective seed dispersal strategies, and ability to colonize disturbed environments [1, 2]. The large diversity at the family level (18 families) suggests a diverse soil seed bank, most probably affected by diverse crop rotation regimes, tillage practices, and landscape. The dominance of these few families, however, implies that management practices can be effectively targeted against particular phylogenetic groups.

4.2 Weed-Crop Association and Agro-Ecological Implications

A major observation in this research is the overwhelming relationship of the recorded weeds with soybean (Glycine max). A notable 32 species (80%) were identified as pests in soybean production (Fig. 1b). This heavy infestation reflects the crop's agronomic traits: its broad row spacing and comparatively sluggish early canopy development create an opportunity window for weed emergence and establishment, with little early competition for resources [3]. The warm, humid conditions ideal for soybean growth are equally conducive for the germination and proliferation of a wide array of weed species.

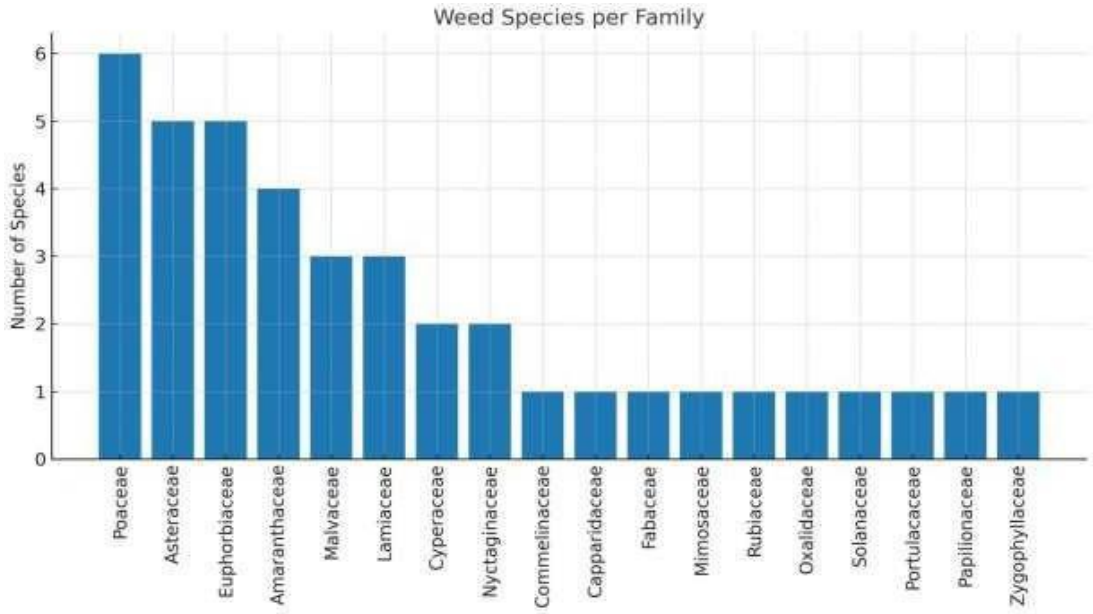
Cotton was the second most-associated crop, with 18 species (45%), followed by groundnut and others. Notably, two species were highlighted for their pervasive nature:

- Cynodon dactylon (L.) Pers. was appropriately identified as a "universal weed," infesting every crop because of its robust rhizomatous growth habit, rendering it incredibly difficult to manage.
- Parthenium hysterophorus L. was referred to as a "ubiquitous invasive weed." Its occurrence is a serious agronomic and ecological issue because of its allelopathic nature, which can hinder crop germination and growth, its high rate of colonization power, and its possible health threats to humans and animals [4].

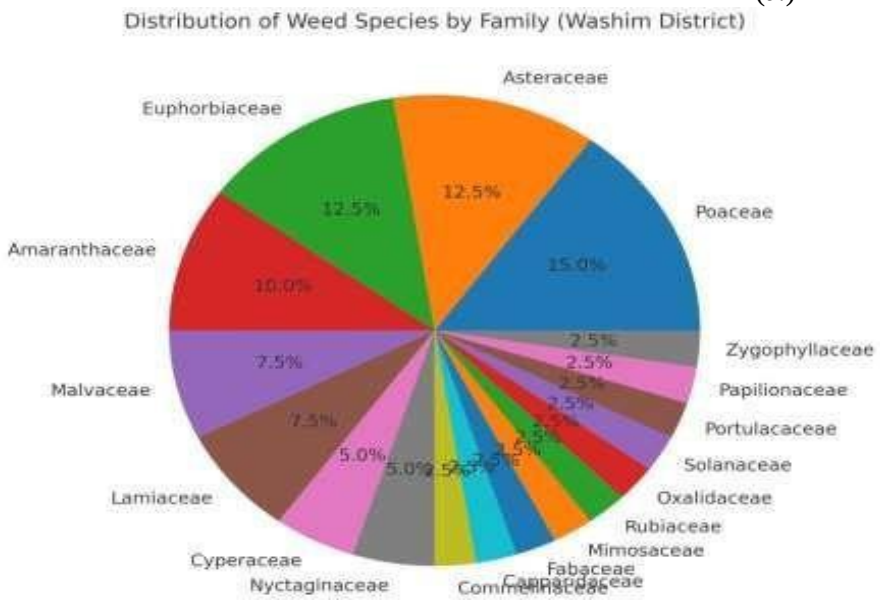
Table 1: List of Weed Species Identified in Washim District, Categorized by Habitat Type

Sr. No.	Scientific Name (with author citation)	Family	Common Name	Associated Crop(s)/Habitat
1	*Alternanthera ficoidea* (L.) P. Beauv.	Amaranthaceae	Pantandulja	Soybean, Cotton
2	*Alternanthera sessilis* (L.) R. Br. ex DC.	Amaranthaceae	Matsyakshi / Gadabheli	Soybean, Rice fields
3	*Amaranthus spinosus* L.	Amaranthaceae	Kateri Tandulja / Mutha	Soybean, Cotton, Maize
4	*Amaranthus viridis* Hook. K :	Amaranthaceae	Andhuliya	Soybean, Groundnut
5	*Anisomeles malabarica* (L.) R. Br.	Lamiaceae	Mahadron	Cotton, Pigeon pea
6	*Bidens biternata* (Lour.)Merr.&Sherff	Asteraceae	Bhend	Soybean, Cotton
7	*Boerhavia diffusa* L.	Nyctaginaceae	Punarnava	Soybean, Cotton, Sugarcane
8	*Boerhavia erecta* L.	Nyctaginaceae	Ubha Punarnava	Soybean, Cotton
9	*Brachiaria eruciformis* (SM). Griseb	Poaceae	Kangvi Gavat	Soybean

10	*Brachiaria reptans*	Poaceae	Vakad Gavat	Soybean
11	*Cassia tora* L.	Fabeaceae	Tarota	Soybean, Cotton
12	*Cleome viscosa* L.	Capparidaceae	Tilaparni	Soybean, Groundnut
13	*Commelina benghalensis* L.	Commelinaceae	Kachata	Soybean, Cotton, Rice
14	*Conyza bonariensis* (L.) Cronquist	Asteraceae	Bhuyari Dhada	Soybean, Cotton
15	*Corchorus capsularis* L.	Malvaceae	Chanchu	Soybean
16	*Corchorus olitorius* L.	Malvaceae	Maha Chanchu	Soybean
17	*Cynodon dactylon* (L.) Pers.	Poaceae	Durva	All crops (universal weed)
18	*Cypers esculantus* L.	Cyperaceae	God Motha	Rice, Soybean
19	*Cyperus kyllingia* Endl.	Cyperaceae	Shvetnirvish	Soybean, Paddy
20	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	Dhadgya cha Gavat	Soybean, Maize
21	*Eclipta alba* (L.) Hassk.	Asteraceae	Bhringaraj	Rice, Soybean
22	*Euphorbia heterophyla*	Euphorbiaceae	Lal Dugdhika	Soybean, Cotton
23	*Euphorbia hirta* L.	Euphorbiaceae	Dugdhika	Soybean, Cotton
24	*Euphorbia thymiflora* L.	Euphorbiaceae	Chhoti Dugdhika	Soybean
25	*Hyptis suaveolens* (L.) Poit.	Lamiaceae	Ganga Tulsi	Soybean, Cotton
26	*Leucas aspera* (Willd.) Link	Lamiaceae	Dronapushpi / Tui	Soybean, Cotton
27	*Mimosa pudica* L.	Mimosaceae	Lajalu	Paddy fields
28	*Oldenlandia umbellata* L.	Rubiaceae	Rajana	Soybean
29	*Oxalis corniculata* L.	Oxalidaceae	Kushali / Amaloti	Soybean, Groundnut
30	*Parthenium hysterophorus* L.	Asteraceae	Gajar Gavat	All crops (ubiquitous invasive weed)
31	*Paspalidium flavidum* (Retz.) A.Camus.	Poaceae	Patla Dhadga	Soybean
32	*Phyllanthus amarus* Schum. & Thonn.	Euphorbiaceae	Bhui Aawala	Soybean
33	*Phyllanthus niruri*	Euphorbiaceae	Bhui Aawala	Soybean
34	*Physalis minima* L.	Solanaceae	Ran Popti / Chirboti	Soybean, Cotton
35	*Portulaca oleracea* L.	Portulacaceae	Ghol	Soybean, Cotton
36	*Setaria viridis*	Poaceae	Lahan Kangvi	Wheat, Maize
37	*Sida cordifolia* (Burm.f) Borss.	Malvaceae	Balay / Batyalaka	Soybean, Cotton
38	*Tephrosia purpurea* (L.) Pers.	Papilionaceae	Sharapunkha / Plihshatru	Soybean
39	*Tribulus terrestris* L.	Zygophyllaceae	Gokshur	Unirrigated fields, Pulses
40	*Tridax procumbens* L.	Asteraceae	Jayantived / Tridax	Soybean, Cotton



(a.)



(b)

Figure 2. (a) Bar graph showing the number of weeds species associated with major crops (Soybean, Cotton, Groundnut, etc.). (b) Pie chart showing the proportion of weeds species by dominant plant families.

5. Conclusion

The present morpho-taxonomic research offers the first exhaustive and illustrated report of the weed flora of Washim district, Maharashtra's irrigated and unirrigated agro-ecosystems. The identification and documentation of 40 weeds, with Poaceae, Asteraceae, Amaranthaceae, and Euphorbiaceae as the predominant families, form the basis for a key baseline database. The apparant disparity in weed community structure between irrigated and rain-fed environments due to primarily soil moisture availability highlights the necessity for habitat-based weed management strategies.

The extensive diversity related to soybean, the district's staple crop, makes it a key area of weed management attention. The occurrence of globally important invasive weeds such as Parthenium

hysterophorus and perennial weeds such as Cyperus esculentus indicates serious issues regarding regional agricultural sustainability.

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