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Ecological Impact and Invasiveness of Alien Weed Species in Moradabad District

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Abstract

Eco-botanical research work on invasive alien weed species in Moradabad district deals with ecological invasiveness and ecological impact. 88 weeds under 66 genera, belonging to 27 APG-IV families, have been enlisted from Moradabad district of Uttar Pradesh. Among the reported families, the top eight dominated families are as Asteraceae 17spp.), followed by Amaranthaceae (9 spp.), Malvaceae (7 spp.), Poaceae, *Euphorbia*ceae, Fabaceae with 6 spp. each and, Convolvulaceae, Solanaceae with 5 spp. each. All the invasive weeds were arranged as per the APG-IV modern system of classification. Among the reported invasive weed species, 81% are herb, followed by 13% shrub, 3% climbing herb, 2% creeper herb, and 1% climbing shrub. The study reveals that 79% of weed species are reported as being in the category of ecological invasiveness, 13% as ecological impact, and 8% as being above both categories. Current work reveals that 43% of weed species are reported as ruderals and 34% as agrestals, while 23% are both types. In terms of origin, mostly weeds 49 spp., are related to tropical America.

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APG-IV; Ecological Impact; Invasive Alien Species; Moradabad; Weed.

Introduction

During the anthropocentric period, the expansion of species outside their original circulation range, breaching natural bio-geographical boundaries, had a significant environmental impact.[1] The global agricultural production system is facing numerous challenges, including the presence of numerous invasive alien species, including numerous weed species.[2] Imported alien species contribute to global ecological deterioration through land use and climate change, affecting biodiversity, ecosystems, and agricultural products through their combined native effects.[3,4] In recent decades, the agriculture sector has been endangered by international ecological shifts such as environmental degradation and biological invasions.[5,6]

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Invasive species are disintegrating the world's flora and fauna, contributing significantly to the planet's biodiversity loss.[7] Due to our mobile existence and the purposeful movement of decorative and food plants, alien plants can spread rapidly.[8] Alien species invasions can affect ecosystems, genes, and other layers of ecological complexity.[9] Agro-ecosystems are environments where invasive weed species have a real financial impact because they reduce crop yields.[10] In order to thrive in a range of habitats, IAS frequently demonstrates morphological, physiological, and demographic adaptability.[11] Indian flora contains about 40% alien species, of which 25% are IAS.[12] At least 300000 vascular plants on the planet, or 10% of all vascular plants, have the ability to invade other habitats and negatively or favourably impact native biota.[13] The absence of native predators or the presence of novel weapons like allelopathic have been cited as reasons for plant species' success in alien environments.[14] The spread of alien species causes severe ecological harm to native biodiversity and hastens the extinction of endemic and endangered taxa.[15,16] The agents of natural invasion are birds, animals, water, and wind. Examples of natural invasions are *Parthenium hysterophorus* and *Ageratum conyzoides.*[17] The more diversified plant groups' habitats were fiercely competitive and resisted invasion.[18] Several alien species imported for human benefit have been documented to devastate both the natural world and the economy.[19] *Opuntia stricta*, a high-risk alien species in the African region, would result in an annual economic loss of US$500–1000 per household.[20] Alien invaders were estimated to cause a US$1 billion annual economic loss to agricultural section of African countries. This damage was caused to agricultural crops.[21]

Parthenium hysterophorus L., sometimes known as Peterson's Curse, has been identified as a major cause of annoyance, a concern for human and animal health, a threat to biodiversity, and a danger to the environment.[22] Along with microbes (parasites, microorganisms, and so forth.), insects, rodents, nematodes, mites, birds, and other less serious animal pests, weeds frequently pose the greatest threat to declining agricultural output.[23] Weeds were blamed for more than 11 billion dollars in economic losses in just ten crops in India.[24] Invasive species like weeds reduce agricultural yields, raise farming costs, and cause major ecological damage.[25,26] Ruderal are weed plants that thrive around rubbish heaps, urban wastes, docks, footpaths, railway road edges, and other areas extensively touched by human habitation, industry, and trade.[27] Cattles are acutely poisonous to parthenium, and parthenin, which is similarly hepatotoxic, causes milk to taste bitter.[28] When compared to native species, invasive weeds grow more quickly and produce more biomass, have high reproductive efficiency, produce a lot of seeds, are effective dispersers, and can adapt to new environments.[29] Many of the invasive alien weed species are capable of allelopathic and have high levels of tolerance for various abiotic environments.[30]

Materials and Methods

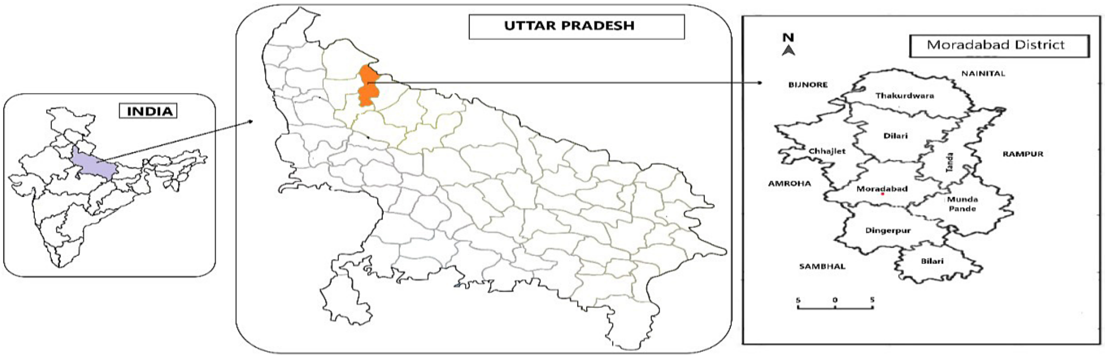

Fig.1: Study map

The study was conducted in Moradabad district (28°- 21' to 28°- 16´ Latitude North and 78°- 4´ to 79° East Longitude) of western Uttar Pradesh, India, from April 2021 to June 2022 in different eight blocks of 04 tehsils of Moradabad district to explore the ecological invasiveness and ecological impact of different invasive alien weeds (ruderals and agrestals). Information regarding ecological aspects of the weeds was collected from the field's survey and illustration of different types of ecosystems in the different villages of Moradabad district. The information was also gathered from knowledgeable locals, including landowners and elders. Field notes were taken on the plant, detailing its eco-botanical diagnostic charter. The collected weeds were identified using the documentation that was available, including the Flora of Uttar Pradesh vol. I.[31] and vol. II,[32] Handbook on Weed Identification,[33] weeds just reported from the Global Compendium of Weeds.[34] The collected weeds were arranged in different APG-IV families and grades according to the modern system of classification.[35]

Results

In the above botanical study of invasive alien weeds in Moradabad district, the ecological invasiveness and ecological impact on different ecosystems of the district. A study of weeds in different agricultural ecosystems and other ecosystems in Moradabad district shows that 88 weed plants belong to 27 families (Table 1) have been documented. 43% of the reported weed species are ruderals weeds, 34% agrestals weeds, and 23% both type weeds. 36% of the reported species were found in cropland ecosystems, followed by 36% on waste land and 28% along the roadside. In the above study, we followed the APG-IV system of classification, and the concern weed species were also arranged according to the concern grade system in this section. Grade Lamiids show the highest (21%), followed by Campanulids (20%), Superasterids (18%), Fabids (17%), Malvids (11%), and Eudicots (1%). In this study, with the help of the Global Weed Compendium, we also studied the origin of weeds, and the results show that 63% of weeds were concerned with the TAM, followed by 12% TAF, 10% SAM, 5% MR, 5% EU, 2% NAM, and 1% ML, BR, and PU. In the representation of the reported families (table 1), among the plants studied, most of them belonged to the Asteraceae 17 species, followed by Amaranthaceae 9 species, Malvaceae 7 species, Poaceae, *Euphorbia*ceae, and Fabaceae 6 species each, Convolvulaceae and Solanaceae 5 species each, Cactaceae and Apocynaceae 3 species each, Cyperaceae, Plantaginaceae, Pontederiaceae, and Portulacaceae 2 species each, and Polygonaceae, Papaveraceae, Cannabaceae, Cleomaceae, Acanthaceae, Verbenaceae, Brassicaceae, Onagraceae, Primulaceae, Nyctaginaceae, Lamiaceae, Oxalidaceae, and Zygophyllaceae 1 species each. In this study, 88 reported weed species belong to Lamiids (18spp.), Campanulids (17spp.), Superasterids (16spp.), Fabids (15spp.), Malvids (10spp.), Commelinids (10spp.), and Eudicots (1sp.), grade APG-IV. In the context of the life forms of the different reported invasive alien weed species, most of them are herb 81%, followed by shrub 13%, climbing herb 3%, creeping herb 2%, and climbing shrub 1%. In this current study, the authors also elaborate on the ecological invasiveness and ecological impact of different recorded invasive alien weed species in Moradabad, and we found that 79% of the reported weed species were categorised under the ecological impact category, 13% of the reported species were under the ecological invasiveness category, and 8% of the weed species were common in both of the above-mentioned ecological categories to analyse the effect of different invasive alien weed species. To elaborate on the proper ecological impact of different reported weed species, we further categorised them into three classes: ecological effect of the weeds on ecosystem function and services (W1), biodiversity loss (W2), and economic loss (W3), as done by the IAWS, and the results were that 40% of the weeds were representing the (W1), 40% (W2), and 20% (W3) classes of the ecological impact category of the weeds. According to the context of ecological invasiveness, four classes were organised to analyse the effect of invasive alien weed species on the basic botanical illustration, and the results were as follows: 48% showed multiple modes of dispersion (MMD), followed by 22% rapid multiplication and spread in different ecosystems (RMS), 18% multiple modes of reproduction (MMR), and 12% were invasive elsewhere.

Table 1: Ecological Invasiveness and Impact of Different Invasive Alien Weeds

Sl .No.	Weed Name	APG-IV Family	Origin	Weed Status		Life Form	Ecological Invasiveness				Ecological Impacts			RE
				RW	AW		IE	RMS	MMR	MMD	W1	W2	W3	
1.	*Ageratum conyzoides* L.	Asteraceae	TAM	RW	AW	H	+	+	-	+	+	+	+	+
2.	*Alternanthera bettzickiana* (Regel) G. Nicholson	Amaranthaceae	TAM	RW	AW	H	-	+	-	-	+	+	-	+
3.	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	TAM	RW	AW	H	-	+	-	+	+	+	+	+
4.	Alternanthera sessilis (L.) R.Br. ex DC.	Amaranthaceae	TAM	RW	AW	H	+	+	+	+	+	+	+	+
5.	*Amaranthus spinosus* L.	Amaranthaceae	TAM	RW	AW	H	+	+	-	+	+	-	+	+
6.	*Antigonon leptopus* Hook. & Arn.	Polygonaceae	TAM	RW	-	CLS	-	-	+	+	+	-	+	+
7.	*Argemone mexicana* L.	Papaveraceae	SAM	RW	AW	H	-	+	-	+	+	+	+	+
8.	*Bidens pilosa* L.	Asteraceae	TAM	-	AW	H	+	+	-	+	+	-	+	+
9.	*Blumea lacera* (Burm.f.) DC.	Asteraceae	TAM	-	AW	H	-	-	-	+	+	+	+	+
10.	*Calotropis gigantea* (L.) W. T. Aiton	Apocynaceae	TAF	RW	-	S	-	-	-	+	+	+	+	+
11.	*Calotropis procera* (Aiton) W. T. Aiton	Apocynaceae	TAF	RW	-	S	-	-	-	+	+	+	+	+
12.	*Cannabis sativa* L.	Cannabaceae	N/A	RW	AW	H	-	+	-	+	+	-	+	+
13.	*Catharanthus pusillus* (Murray) G. Don	Apocynaceae	TAM	-	AW	H	+	+	-	+	+	-	+	+
14.	*Celosia argentea* L.	Amaranthaceae	TAF	-	AW	H	-	+	-	+	+	+	+	+
15.	*Cenchrus purpureus* (Schumach.) Morrone	Poaceae	N/A	RW	AW	H	-	+	+	-	-	+	-	+
16.	*Chenopodium album* L.	Amaranthaceae	EU	-	AW	H	-	+	-	+	+	-	+	+
17.	*Chrozophora rottleri* (Geiseler) Spreng.	*Euphorbia*ceae	TAF	RW	-	H	-	-	-	-	+	+	+	+
18.	*Cleome viscosa* L.	Cleomaceae	TAM	RW	AW	H	-	-	-	+	+	+	+	+
19.	*Corchorus aestuans* L.	Malvaceae	TAM	RW	-	H	-	-	-	+	+	-	+	+

20.	*Corchorus tridens* L.	Malvaceae	TAF	RW	-	H	-	-	-	+	+	-	+	+
21.	*Croton bonplandianus* Baill.	*Euphorbi*aceae	SAM	RW	-	H	-	+	-	+	+	-	-	+
22.	*Cuscuta chinensis Lam.*	Convolvulaceae	MR	RW	AW	CLH	-	-	+	+	+	+	+	+
23.	*Cuscuta reflexa* Roxb.	Convolvulaceae	MR	RW	-	CLH	-	-	+	+	+	+	+	+
24.	*Cyperus* difformis L.	Cyperaceae	TAM	RW	AW	H	+	+	+	+	+	+	+	+
25.	*Cyperus* iria L.	Cyperaceae	TAM	RW	AW	H	+	+	+	+	+	+	+	+
26.	*Datura innoxia* Mill.	Solanaceae	TAM	RW	-	H	-	-	-	+	+	-	+	+
27.	*Datura metel* L.	Solanaceae	TAM	RW	-	H	-	-	-	+	+	-	+	+
28.	*Dicliptera paniculata* (Forssk.) I. Darbysh.	Acanthaceae	TAM	RW	AW	H	-	-	-	+	+	-	+	+
29.	*Digera muricata* (L.) Mart.	Amaranthaceae	NAM	-	AW	H	-	+	-	+	+	-	+	+
30.	*Dinebra retroflexa* (Vahl) Panz.	Poaceae	TAM	RW	AW	H	-	-	-	+	+	-	+	+
31.	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	Amaranthaceae	N/A	-	AW	H	-	+	-	+	+	-	+	+
32.	*Echinochloa colona* (L.) Link	Poaceae	SAM	RW	AW	H	+	+	+	+	+	-	+	+
33.	*Echinochloa crus-galli* (L.) P.Beauv.	Poaceae	SAM	-	AW	H	+	+	+	+	+	-	+	+
34.	*Eclipta prostrata* (L.) L.	Asteraceae	TAM	RW	AW	H	-	-	-	+	+	-	+	+
35.	*Emilia sonchifolia* (L.) DC.	Asteraceae	TAM	RW	AW	H	+	-	-	+	+	+	+	+
36.	*Erigeron bonariensis* L.	Asteraceae	N/A	RW	AW	H	-	-	-	+	+	+	+	+
37.	*Erigeron canadensis* L.	Asteraceae	N/A	RW	AW	H	-	-	-	+	+	+	+	+
38.	*Euphorbia heterophylla var. cyathophora* (Murray) Griseb.	*Euphorbi*aceae	TAM	RW	-	H	-	-	-	+	+	+	+	+
39.	*Euphorbia hirta* L.	*Euphorbi*aceae	TAM	RW	AW	H	+	+	+	+	+	+	+	+
40.	*Euphorbia indica* Lam.	*Euphorbi*aceae	N/A	RW	AW	H	-	-	-	-	+	-	+	+
41.	*Evolvulus nummularius* (L.) L.	*Euphorbi*aceae	TAM	RW	AW	CRH	-	-	-	-	+	-	+	+
42.	*Gamochaeta americana* (Mill.) Wedd.	Asteraceae	TAM	RW	AW	H	-	-	-	+	+	+	+	+
43.	*Gamochaeta pensylvanica* (Willd.) Cabrera	Asteraceae	TAM	RW	AW	H	-	-	-	+	+	+	+	+
44.	*Gamochaeta purpurea* (L.) Cabrera	Asteraceae	TAM	RW	AW	H	-	-	-	+	+	+	+	+
45.	*Gnaphalium polycaulon* Pers.	Asteraceae	TAM	RW	AW	H	-	-	-	+	+	+	+	+

46.	*Gomphrena serrata* L.	Asteraceae	TAM	RW	-	H	-	-	+	+	-	-	+	+
47.	*Imperata cylindrica* (L.) Raeusch.	Poaceae	TAM	RW	-	H	-	-	+	+	+	+	+	+
48.	*Ipomoea eriocarpa* R.Br.	Convolvulaceae	TAF	RW	-	H	-	-	-	-	+	-	+	+
49.	*Ipomoea obscura* (L.) Ker Gawl.	Convolvulaceae	TAF	RW	-	H	-	-	-	-	+	-	+	+
50.	*Ipomoea pes-tigridis* L.	Convolvulaceae	TAF	RW	AW	CLH	-	-	-	+	+	+	+	+
51.	*Lantana camara* L.	Verbenaceae	TAM	RW	-	S	-	-	-	+	+	+	+	+
52.	*Lepidium didymum* L.	Brassicaceae	N/A	-	AW	H	-	+	+	+	+	-	+	+
53.	*Ludwigia octovalvis* (Jacq.) P. H. Raven	Onagraceae	TAF	-	AW	H	-	+	-	-	+	-	+	+
54.	*Lysimachia arvensis* (L.) U. Manns & Anderb.	Primulaceae	EU	-	AW	H	-	+	+	+	+	-	+	+
55.	*Malvastrum coromandelianum* (L.) Garcke	Malvaceae	TAM	RW	-	H	-	-	-	-	+	+	+	+
56.	*Mecardonia procumbens* (Mill.) Small	Plantaginaceae	TAM	RW	-	H	-	-	-	-	+	-	+	+
57.	*Melilotus albus* Medik.	Fabaceae	EU	-	AW	H	-	-	-	-	+	-	+	+
58.	*Mimosa pudica* L.	Fabaceae	BR	-	AW	H	-	-	-	+	+	-	+	+
59.	*Mirabilis jalapa* L.	Nyctaginaceae	PU	RW	-	H	-	-	+	+	+	-	+	+
60.	*Nicotiana plumbaginifolia* Viv.	Solanaceae	TAM	-	AW	H	-	-	-	-	+	-	+	+
61.	*Ocimum americanum* L.	Lamiaceae	TAM	-	AW	H	-	-	-	+	+	-	+	+
62.	*Opuntia dillenii* (Ker Gawl.) Haw.	Cactaceae	N/A	RW	-	H	-	-	+	-	+	+	+	+
63.	*Opuntia elatior* Mill.	Cactaceae	N/A	RW	-	H	-	-	+	-	+	+	+	+
64.	*Opuntia stricta* (Haw.) Haw.	Cactaceae	TAM	RW	-	H	-	-	+	-	+	+	+	+
65.	*Ouret lanata* (L.) Kuntze	Amaranthaceae	TAM	RW	-	S	-	-	-	+	+	+	+	+
66.	*Oxalis corniculata* L.	Oxalidaceae	EU	RW	AW	H	+	+	+	+	+	-	+	+
67.	*Parthenium hysterophorus* L.	Asteraceae	TAM	RW	AW	H	+	+	-	+	+	+	+	+
68.	*Physalis angulata* L.	Solanaceae	TAM	-	AW	H	-	-	-	+	+	-	+	+
69.	*Pontederia crassipes*	Pontederiaceae	TAM	RW	-	H	-	-	+	-	+	+	+	+

	Mart.													
70.	*Pontederia vaginalis* Burm.f.	Pontederiaceae	N/A	RW	-	H	-	-	+	-	+	+	+	+
71.	*Portulaca oleracea* L.	Portulacaceae	SAM	-	AW	H	-	+	+	-	+	-	+	+
72.	*Portulaca quadrifida* L.	Portulacaceae	TAM	-	AW	H	-	+	+	-	+	-	+	+
73.	*Saccharum spontaneum* L.	Poaceae	ML	RW	-	S	+	-	+	+	+	+	+	+
74.	*Scoparia dulcis* L.	Plantaginaceae	TAM	RW	AW	H	-	-	-	+	+	+	+	+
75.	*Senna obtusifolia* (L.) H. S. Irwin & Barneby	Fabaceae	TAM	RW	-	S	-	-	-	+	+	-	+	+
76.	*Senna occidentalis* (L.) Link	Fabaceae	SAM	RW	AW	S	+	-	-	+	+	+	+	+
77.	*Senna tora* (L.) Roxb.	Fabaceae	SAM	RW	-	S	-	-	-	+	+	-	+	+
78.	*Sesbania bispinosa* (Jacq.) W. Wight	Fabaceae	TAM	RW	-	S	-	-	-	+	-	-	+	+
79.	*Sida acuta* Burm.f.	Malvaceae	TAM	RW	AW	H	-	+	-	+	+	-	+	+
80.	*Solanum americanum* Mill.	Solanaceae	TAM	-	AW	H	-	+	-	-	+	-	+	+
81.	*Sonchus asper* (L.) Hill	Asteraceae	MR	RW	AW	H	-	-	-	-	+	+	+	+
82.	*Sonchus oleraceus* L.	Asteraceae	MR	RW	AW	H	-	-	-	-	+	+	+	+
83.	*Tribulus terrestris* L.	Zygophyllaceae	TAM	RW	AW	CRH	-	+	+	+	+	+	+	+
84.	*Tridax procumbens* L.	Asteraceae	TAM	RW	-	H	-	-	-	+	+	-	+	+
85.	*Triumfetta rhomboidea* Jacq.	Malvaceae	TAM	RW	-	S	+	+	-	+	+	-	+	+
86.	*Urena lobata* L.	Malvaceae	TAM	RW	-	H	-	-	-	+	+	-	+	+
87.	*Waltheria indica* L.	Malvaceae	TAM	RW	AW	H	+	-	-	+	+	-	+	+
88.	*Xanthium strumarium* L.	Asteraceae	SAM	RW	AW	S	-	-	-	+	+	+	+	+

[IE] = Invasive elsewhere, **[RMS]** = Rapid Multiplication & Spread in different ecosystems, **[MMR]** = Multiple Mode of Reproduction, **[MMD]** = Multiple Mode of Dispersion, **[W1]** = Affecting ecosystem functions and services, **[W2]** = Biodiversity loss, **[W3]** = Economic loss and health hazard, **[RE]** = Range extension. **[H]** = Herb, **[S]** = Shrub, **[CLH]** = Climbing herb, **[CRH]** = Creeper herb, **[CLS]** = Climbing shrub **[TAM]** = Tropical America, **[SAM]** = South America, **[EU]** = Europe, [MR] = Mediterranean region, **[NAM]** = North America, **[ML]** = Malaysia, **[TAF]** = Tropical Africa, **[BR]** = Brazil, **[PU]** = Peru **[RW]** = Ruderals weed, **[AW]** = Agrestals Weed

Discussion

53 terrestrial invasive alien plant species were reported in categories and criteria adopted for listing terrestrial invasive plants of India[36]- i.e., *Alternanthera bettzickiana, Alternanthera philoxeroides, Argemone mexicana, Bidens pilosa, Cannabis sativa, Cuscuta chinensis, Dinebra retroflexa, Dysphania ambrosioides, Erigeron bonariensis, Erigeron canadensis, Evolvulus nummularius, Ipomoea eriocarpa, Lantana camara, Opuntia dillenii, Opuntia elatior and Parthenium hysterophorus,* and similar above mentioned weed species were also reported in our study of Moradabad district in different categories of ecological invasiveness, impact and range extension phases on the basic of observation of different agricultural and non-agricultural fields of the district.

In our findings *Alternanthera bettzickiana* is found in all the categories of phase rest of IE, MMR, MMD & W3; *Alternanthera philoxeroides* & *Argemone mexicana* rest of IE, MMR; *Bidens pilosa* rest of MMR, W2; *Cannabis sativa* rest of IE, MMR, W2; *Cuscuta* chinensis rest of IE, RMS; *Dinebra retroflexa* IE, RMS, MMR,W2; *Dysphania ambrosioides* IE, MMR,W2; *Erigeron bonariensis* & *Erigeron canadensis* rest of IE,RMS,MMR; *Evolvulus nummularius*, *Ipomoea eriocarpar* rest of IE, RMS, MMR, MMD, W2; *Lantana camara* rest of IE, RMS,MMR; *Opuntia dillenii* & *Opuntia elatior* rest of IE,RMS,MMD & *Parthenium hysterophorus* rest of MMR, on the basic of different agro-ecosystems and available flora of the concern area.

Initial identification and swift intervention is a technique used to detect and eradicate invasive weeds before they spread, as per.[37] As a result, around 18% of India's plant life is foreign, with 55% being American, 30% being Asian and Malaysian, and 15% coming from Europe and Central Asia.[38] Plant species infestations in non-native environments affect ecosystems, threatening the ecological stability and profitability of the invaded region.[39] *Alternanthera bettzickiana,*[40] *Alternanthera philoxeroides Aligator weed,*[41,42,43] *Argemone Mexicana,*[44] *Bidens pilosa, Dysphania ambrosioides, Opuntia elatior,*[45] *Cannabis sativa,*[46] *Cuscuta chinensis, Dinebra retroflexa and Evolvulus nummularius,*[44,45] *Erigeron bonariensis, Erigeron Canadensis,*[47] *Ipomoea eriocarpa,*[44,45,48] *Lantana camara,*[40,49] *Opuntia dillenia,*[45,46] *Parthenium hysterophorus,*[40,50,51,52] weed species were reported in all the categories of ecological invasiveness, ecological impact and range extension phases on the basic of field observation and we also reported the same species in our findings. The 8% aqueous extract of *Alternanthera bettzickiana* weed significantly reduced the vigour of cowpea seedlings.[53] *Alternanthera philoxeroides* may develop fast under a variety of abiotic stressors, including prolonged submergence.[54] A. *sessilis* is an invasive weed that thrives in disturbed areas and moist and dry soils.[55] A. *sessilis*' allelopathic effects can be particularly harmful to paddy and other extensive irrigated crops.[56] *B. pilosa* has infected a variety of environments, including grasslands, forest edges, secondary forests, wetlands, streams, coastal regions, roadsides, railway sides, disturbed lands, grazing, plantations, and farm fields.[58,59,60,61] *B. pilosa* has the potential to rapidly grow and to form dense thickets. The species outcompetes crops in agricultural fields and eliminates indigenous plant species in introduced ranges by expanding the margins of its dense thickets.[57,58,62,59,60,63] Cannabis plant has been labelled invasive in 50 out of over 135 nations and territories.[64] *Cuscuta* spp. severely affect agricultural plants and are regarded the third-most harmful category of parasitic worms globally after Striga and Orobance.[65] *Evolvulus nummularius* thrives in wet environments such as roadside ditches, canal banks, riverbanks, shaded regions, grassy lawns, and athletic fields.[66] A high degree of Erigeron canadensis invasion resulted in a greater loss of plant variety than a low degree of E. canadensis invasion, because E. canadensis invasion can reduce the number of native species via competition, resulting in local extinction.[67] Lantana is already abundant in eastern Africa and has the potential to spread, particularly in Tanzania. 40% of responders indicated that lantana reduced animal fodder by more than 50%, while one-third reported a 26-50% loss in agricultural output.[68] Parthenium's allelopathic properties make it difficult for agricultural crops including wheat, rice, maize, pigeon pea, sorghum, and black gram to sprout and thrive, and their yields may decline by up to 40%.[69]

Conclusion

Enlisted ecological invasiveness and impact-able baseline data regarding the different reported ruderals and agrestals weed species of Moradabad district will help in the proper management and regulatory pathway of the weed plant species in various agro and non-agro ecosystems. Due to a lack of baseline data, understanding, and effective management techniques for weed species. India requires a countrywide inquiry of invasive alien weed species to better comprehend economic losses, identify invasion pathways, and devise effective management techniques. Predicting the deadliest alien plants is critical for preventing and controlling their spread.

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The authors do not have any conflicts of interest.

Author's Contribution

Conceptualization of research work and designing of experiments (Sachin Sharma, S. P. Joshi); Execution of field experiments and data collection (Sachin Sharma, Manisha Pandey); Analysis of data and interpretation (Sachin Sharma, S. P. Joshi, Manisha Pandey); Preparation of manuscript (Sachin Sharma, S. P. Joshi, Manisha Pandey).

Data Availability Statement

Supporting data of this work derived from various sources and are comprehensively cited in the article. Readers can consult for detailed information and direct inquiries to the corresponding author for specific data points.

Ethics Approval Statement

The study does not involve any experiment on humans and animals.

References

1. Kueffer C. Plant invasions in the Anthropocene. *Sci.*2017;358(6364):724-725.
2. Paini D. R., Sheppard A. W., Cook D. C., De Barro P. J., Worner S. P., and Thomas M. B. Global threat to agriculture from invasive species. *Proc Natl Acad Sci.*2016;113(27):7575-7579.
3. Lopez B. E., Allen J. M., Dukes J. S., Lenoir J., Vilà M., Blumenthal D. M., and Bradley B. A. Global environmental changes more frequently offset than intensify detrimental effects of biological invasions. *Proc Natl Acad Sci.*2022;119(22): e2117389119.
4. Ravi S, Law D. J., Caplan J. S., Barron-Gafford G. A., Dontsova K. M., Espeleta J. F., and Huxman T. E. Biological invasions and climate change amplify each other's effects on dryland degradation. *Glob Chang Biol.*2022;28(1): 285-295.
5. Bang A., Cuthbert R. N., Haubrock P. J., Fernandez R. D., Moodley D., Diagne C., and Courchamp F. Massive economic costs of biological invasions despite widespread knowledge gaps: a dual setback for India. *Biol Invasions.*2022;24(7):2017-2039.
6. Pathak H. Impact, adaptation, and mitigation of climate change in Indian agriculture. *Environ Monit Assess.*2023;195(1): 52.
7. Hobbs R.J. Invasive species in a changing world. United States: Island press;2000. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en
8. Randall J.M., Marinelli J. Invasive Plants: Weeds of the Global Garden. United Kingdom: Brooklyn Botanic Garden:1996. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en
9. Parker I. M., Simberloff D., Lonsdale W. M., Goodell K., Wonham M., Kareiva P. M., and Goldwasser L. Impact: toward a framework for understanding the ecological effects of invaders. *Biol Invasions.*1999;1(1): 3-19.
10. Cousens R and Mortimer M. Dynamics of weed populations. Cambridge University Press; 1995. https://edepot.wur.nl/198217
11. Meekins J., and McCarthy B. C. Effect of

environmental variation on the invasive success of a nonindigenous forest herb. *Ecol Appl.*2001;11(5):1336-1348.

12. Singh K. P. Invasive alien species and biodiversity in India. *Curr Sci.*2005;88(4): 539
13. Singh J.S., Gupta S.R., and Singh S.P. Ecology environment and resource conservation. Anamaya Publishers; 2006. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en
14. Hierro J. L., and Callaway R. M. Allelopathy and exotic plant invasion. *Plant Soil.*2003;256:29-39.
15. Reddy C. S. Catalogue of invasive alien flora of India. *Life Sci.*2008;5(2): 84-89.
16. Yadav V., Singh N. B., Singh H., Singh A., and Hussain I. Allelopathic invasion of alien plant species in India and their management strategies: a review. *Trop Plant* Res.2016;3(1): 87-101.
17. Naithani H.B., Shah R., and Rasaily S.S. Study on qualitative and quantitative survey of invasive species in Dehradun district. Dehradun, Uttarakhand: Uttarakhand Biodivesity Board; 2017. https://hindi.icfre.gov.in/UserFiles/File/Books/Invasive%20Species.pdf
18. Premakumari P. D., Sarayu M. G., Das G. G. M., Babu K. V. D., Krishnan R., Lawarence B., and Murugan K. Invasive Exotic Plant Species and Their Influence on The Environment, Ecosystem Services, Economy And Health: A Search. *J Adv Sci Res.*2022;13(01): 64-74.
19. Souza A. O., Chaves M. D. P. S. R., Barbosa R. I., and Clement C. R. Local ecological knowledge concerning the invasion of Amerindian lands in the northern Brazilian Amazon by *Acacia mangium (Willd.). J Ethnobiol Ethnomedicine.*2018;14(1): 1-14.
20. Shackleton R. T., Witt A. B., Piroris F. M., and van Wilgen B. W. Distribution and socio-ecological impacts of the invasive alien cactus *Opuntia stricta* in eastern Africa. *Biol Invasions.*2017;19: 2427-2441.
21. Sileshi G. W., Gebeyehu S., and Mafongoya P. L. The threat of alien invasive insect and mite species to food security in Africa and the need for a continent-wide response. *Food Secur.* 2019;11(4): 763-775.
22. Knox J., Jaggi D., and Paul M. S. Population dynamics of *Parthenium hysterophorus* (Asteraceae) and its biological suppression through *Cassia occidentalis* (Caesalpiniaceae). *Turk J Bot.*2011;35(2): 111-119.
23. Oerke E. C. Crop losses to pests. *J Agric Sci.*2006;144(1): 31-43.
24. Gharde Y., Singh P. K., Dubey R. P., and Gupta P. K. Assessment of yield and economic losses in agriculture due to weeds in India. *Crop Prot.* 2018; 107:12-18.
25. Sinden J., Jones R., Hester S., Odom D., Kalisch C., James R., and Griffith G. The economic impact of weeds in Australia. *Nebr tech ser.* 2004;8.
26. Rao A. N., Singh R. G., Mahajan G., and Wani S. P. Weed research issues, challenges, and opportunities in India. *J Crop Prot.*2020;134: 104-451.
27. Frenkel R.E. Ruderal vegetation along some California roadsides (Vol. 20). United State: University of California Press;1977. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en
28. Kohli R. K., and Rani D. Exhibition of allelopathy by *Parthenium hysterophorus* L. in agroecosystems. *Trop Ecol.*1994;35(2):295-307.
29. Simberloff D., Parker I. M., and Windle P. N. Introduced species policy, management, and future research needs. *Front Ecol Environ.* 2005; 3(1):12-20.
30. Sharma G. P., Singh J. S., and Raghubanshi A. S. Plant invasions: emerging trends and future implications. *Curr Sci.*2005;726-734.
31. Singh K. and Sinha (eds.) Flora of Uttar Pradesh Ranunculaceae – Apiacaeae. (Vol. I). Kolkata:Botanical Survey of India; 2016.
32. Sinha, and Shukla (eds.) Flora of Uttar Pradesh Araliaceae – Ceratophyllaceae. (Vol. II).Kolkata: Botanical Survey of India; 2020.
33. Naidu, V. S. G. R. Hand Book on Weed Identification. Jabalpur: Directorate of Weed Science Research: 2012. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en
34. Randall, R. P. A global compendium of weeds (Ed. 3). Australia: RP Randall; 2017. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en
35. Chase M. W., Christenhusz M. J., Fay M. F., Byng J. W., Judd W. S., and Stevens P.

F. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Bot J Linn Soc.*2016;181(1):1-20.

36. Sandilyan, S. Meenakumari, B. Babu, C.R. and Mandal, R. 2019. Invasive Alien Species of India. National Biodiversity Authority, Chennai; 2019. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en
37. Reaser J. K., Burgiel S. W., Kirkey J., Brantley K. A., Veatch S. D., and Burgos-Rodríguez J. The early detection of and rapid response (EDRR) to invasive species: a conceptual framework and federal capacities assessment. *Biol Invasions.*2020; 22: 1-19
38. Nayar M. P. Changing patterns of the Indian flora. *Nelumbo.*1977;19(1-4): 145-155.
39. Pimentel D., McNair S., Janecka J., Wightman J., Simmonds C., O'connell C., and Tsomondo T. Economic and environmental threats of alien plant, animal, and microbe invasions. *Agric Ecosyst Environ.*2001; 84(1): 1-20.
40. Sankaran, K. V. Suresh, T. A. and Sajeev, T. V. Handbook on invasive plants of Kerala: Kerala State Biodiversity Board; 2013.
41. Masoodi A., Sengupta A., Khan F. A., and Sharma G. P. Predicting the spread of alligator weed (*Alternanthera philoxeroides*) in Wular lake, India: A mathematical approach. *Ecol Model.*2013; 263: 119-125.
42. Masoodi A. and Khan A.F. Invasion of alligator weed (*Alternanthera philoxeroides*) in Wular Lake, Kashmir, India. *Aquat Invasions*.2012; 7(1): 143–146.
43. Chatterjee A. and Dewanji A. Peroxidase as a metric of stress tolerance and invasive potential of alligator weed (*Alternanthera philoxeroides*) growing in aquatic habitats. *Management of Biol Invasions.*2012; 3(2): 65–76.
44. Naithani H.B., Shah R. and Rasaily S.S. Study on qualitative and quantitative survey of invasive species in Dehradun district. Uttarkhand Biodiversity Board: 108, Phase- II, Vasant Vihar, Dehradun;2017.
45. K Chandra S. Invasive alien plants of Indian Himalayan region—diversity and implication. *American J Plant Sci.*2012.
46. Khuroo A. A., Reshi Z. A., Malik A. H., Weber E., Rashid I., and Dar, G. H. (2012). Alien flora of India: taxonomic composition, invasion status and biogeographic affiliations. *Biol Invasions.*2012; 14: 99-113.
47. Inderjit P. J., van Kleunen M., Hejda M., Babu C. R., Majumdar S., and Pyšek P. (2018). Naturalized alien flora of the Indian states: biogeographic patterns, taxonomic structure and drivers of species richness. *Biol Invasions.*2018;20:1625-1638.
48. Reddy, C. S. Catalogue of invasive alien flora of India. *Life Sci J.*2008; 5(2):84-89.
49. Sundaram B., and Hiremath A. J. *Lantana camara* invasion in a heterogeneous landscape: patterns of spread and correlation with changes in native vegetation. *Biol Invasions.*2012;14:1127-1141.
50. Aneja K. R. Deadly weed *Parthenium hysterophorus* and its control-a review. Botanical Researches in India.1991;258-269.
51. Gunaseelan V. N. Impact of anaerobic digestion on inhibition potential of Parthenium solids. *Biomass and Bioenergy.*1998;14(2):179-184.
52. Singh K., Kour J., Mahadevappa M., and Patil V. C. Parthenium menace in Jammu and Kashmir and its possible control measures: In First International Conference on Parthenium Management; 1997; Dharwad, India: University of Agricultural Sciences (pp. 16-19).
53. Alex T., Menon M.V. Invasiveness of *Alternanthera bettzickiana*–Is Allelopathy a Factor?. *Int J of Plant Soil Sci.* 2022; 34(20):730-738.
54. Fan S., Yu H., Liu C., Yu D., Han Y., Wang L. The effects of complete submergence on the morphological and biomass allocation response of the invasive plant *Alternanthera philoxeroides*. *Hydrobiologia.* 2015;746:159-169.
55. Abbasi S., Tabassum-Abbasi Ponni G., Tauseef S. Potential of joyweed Alternanthera *sessilis* for rapid treatment of domestic sewage in SHEFROL® bioreactor. *Int J Phytoremed*. 2019;21(2):160-169.
56. Kumar A., Singh S., Gaurav A. K., Srivastava, S., Verma J. P. Plant growth-promoting bacteria: biological tools for the mitigation of salinity stress in plants. Front Microbiol. 2020;11:1216.
57. Global Invasive Species Database, *Bidens pilosa*. https://www.google.

co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en (accessed on 4 May 2024).

58. Invasive Species Compendium, *Bidens pilosa*. https://www.google.co.in/books/edition/Invasive_Plants/PkDCv9guLwwC?hl=en (accessed on 4 May 2024).
59. Sankaran K.V., Suresh T.A., FAO Regional Office for Asia and the Pacific. No.2013/06 213, Bangkok, Thailand. http://www.fao.org/asiapacific/rap/publications/pub-rap results/en/ (accessed on 4 May 2024).
60. Davidse G., Sousa-Sánchez M., Knapp S., Chiang F., Ulloa U.C., Pruski J.F. Flora Mesoamericana, Vol. 5, Part 2: Asteraceae; *Missouri Botanical Garden Press:* St. Louis, MO, USA, 2018: pp. 1–608.
61. Queensland Government, Weeds of Australia, Biosecurity Queensland Edition. Australia: QueenslandGovt. http://keyserver.lucidcentral.org/weeds/data/media/Html/search.html (accessed on 4 May 2024).
62. Plants of the World. Royal Botanical Gardens-Kew, *Bidens pilosa*. https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:32564-2 (accessed on 4 May 2023).
63. Ng C.C., Wu S.J., Wang C.Y., Tzeng W.S., Shyu Y.T. Emergence and growth of beggarticks (*Bidens pilosa* var. radiata) in different plant communities under experimental field conditions. *J Agric Sci Technol.* 2011;1: 950–962.
64. Canavan S., Brym Z. T., Brundu G., Dehnen-Schmutz K., Lieurance D., Petri T., Flory S. L. Cannabis de-domestication and invasion risk. *Biol. Conserv.* 2022;274:109-709.
65. Costea M., Spence I., Stefanović S. Systematics of *Cuscuta chinensis* species complex (subgenus Grammica, Convolvulaceae): evidence for long-distance dispersal and one new species. *Org Div Evo.* 2011;11:373-386.
66. Iqbal I. M., Shabbir A., Shabbir K., Barkworth M. E., Khan S. M. *Evolvulus nummularius* (L.) L. (Convolvulaceae): a new alien plant record for Pakistan. *BioInvasions Rec.* 2020;9(4).
67. Wu B., Zhang H., Jiang K., Zhou J., Wang C. Erigeron canadensis affects the taxonomic and functional diversity of plant communities in two climate zones in the North of China. *Ecol Res.* 2019;34(4): 535-547.
68. Shackleton R. T., Witt A. B., Aool W., Pratt C. F. Distribution of the invasive alien weed, Lantana camara, and its ecological and livelihood impacts in eastern Africa. *Afr J Range Forage Sci.*2017;34(1):1-11.
69. Dukpa R., Tiwari A., Kapoor D. Biological management of allelopathic plant Parthenium sp. *Open Agriculture.* 2020;5(1):252-261.