



Review Article

Invasive Species in Pakistan: Impacts, Challenges and Management Strategies

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Abstract Ecosystems around the world, including Pakistan, are becoming increasingly concerned about invasive species, both plant and animal. These species, which are non-native to the area, seriously threaten native biodiversity and disturb local ecosystems. Invasive species spread more quickly as a result of increased worldwide travel and trade, necessitating management and control. This review study examines the numerous facets of invasive species in Pakistan, illuminating their effects, methods of management, and related difficulties. The necessity to supply the demand for fuel wood, lumber, and animal feed has historically led to the introduction of exotic species into Pakistan. Even while invasive species are not as severe in Pakistan as they are in some other nations, their effects on the region's biodiversity are frequently overlooked. Significant ecological ramifications result from the roughly 700 foreign species of vascular plants that are found in Pakistan. These include high-impact invaders such as *Broussonetia papyrifera*, *Prosopis juliflora*, *Parthenium hysterophorus*, and *Lantana camara*. In Pakistan, invasive plants have significant negative effects on ecosystems and local flora displacement. For instance, the allelopathic effects of *Eucalyptus camaldulensis* have adversely affected the growth of grass and bushes in the Malakand highlands. In order to stop invasive species from spreading, many management techniques are used. These consist of chemical control with herbicides such as glyphosate, mechanical removal, and organic pesticides. The use of biological control agents has proven successful in certain situations.

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Introduction

Native to a certain area, invasive species are plants or animals that overrun a new ecosystem. Most often, humans plant them in new climates—either purposefully or inadvertently. An invasive alien species is one that has been introduced to a new location and starts to cause problems for its new environment.

These species represent a threat to native biodiversity because they outcompete local species for resources, and they are spreading more quickly due to an increase in international travel and trade. A recent study found that numerous biodiversity hotspots and one-sixth of the Earth's land surface are particularly vulnerable to invasion. Taxa that endanger biological variety, food security, human health, and well-being

when they are introduced and/or spread by human activity outside of their natural distribution. The term “alien” describes a species that has been introduced outside of its native range (exotic, “non-native,” and “indigenous” are synonyms for alien). Invasive refers to a tendency to spread into and alter newly imported habitats. As a result, a species can be invasive without being alien, or it can spread rapidly within a region and become foreign without actually being alien. The threat posed by invasive alien species (IAS) to many ecosystems has spread to the entire world. The escalating threat is causing great anxiety throughout the world. Several global activities and coverage through agreements, treaties, governments, and organizations.

In 1992, the Convention on Biological Diversity was approved by the United Nations. Invasive alien species have intensified as a severe issue in recent years, and the world community has committed to focusing on this issue as part of an international effort to lessen its negative effects. The second biggest danger to biodiversity is posed by invasive alien species. (Park et al., 2004) The biological kind of pollution known as biological invasion is undoubtedly more harmful than chemical pollution. (Khan et al., 2010) as a result, after habitat degradation, it is ranked as the second biggest danger to biodiversity worldwide. (Reddy, 2008). Invasive species are widely dispersed throughout the world’s ecosystems, where they coexist with all types of living things. (Raghubanshi et al., 2005) Nevertheless, the most prevalent invasive species in terrestrial ecosystems are plants, animals, and insects. (Hoenicka and Fladung, 2006). Due to their enormous biomass, plants are among the worst invaders in the world. (Holm et al., 1991). These species may have a variety of negative consequences on the environment, such as increased soil erosion, decreased soil value, altered natural flora and fauna, choked water bodies which influence water quality and fish populations, economic losses, and health risks for humans. (Marwat et al., 2010)(Table 1).

Negative effects of Invasive plants in Pakistan

Non-native animal and plant species have a long history of being introduced to Pakistan. The primary reason for the majority of existing foreign invasive species in Pakistan was to close the supply-demand gap for lumber, fuel wood, and feed. (Hussain and Zarif, 2003). Fortunately, Pakistan’s IAS is not as severe as it is in certain other countries, but sadly, the impact of foreign species on the local biodiversity

has not received much attention. (GOP, WWF-P & IUCN-P, 2000; Shinwari and Shinwari, 2010). There are 700 alien species of vascular plants listed in the limited studies done so far. (Khatoon and Ali, 1999); these can be classified as high impact land invasives, including *Broussonetia papyrifera*, *Prosopis juliflora*, *Parthenium hysterophorus*, and *Lantana camara*. (Hussain, 2003).

On the Malakand hills, *Eucalyptus camaldulensis* was planted, and it has been noticed that this has negatively impacted the growth of grasses and bushes. Due to the allelopathic effects, *Dodonea viscosa*, one of the related species of the scrub forest, has completely disappeared.

Management strategies of Invasive Species in Pakistan

Invasive plant species are managed and controlled using a variety of management techniques, such as mechanical removal, chemical control, and biological control using the invasive species’ natural enemies. Prevention efforts include stricter regulations on the importation and trade of potentially invasive plants, early detection and rapid response programs, and manual and mechanical removal of existing invasive species.

It is efficiently controlled by mechanical tree cutting in combination with the administration of a non-selective herbicide like glyphosate in the case of small plants and through injectors in the case of big trees. (Marwat et al., 2010).

Chemical control

Different herbicides are being proposed such as Chwastox and Bucril Super (Javaid et al., 2006), Atrazil 38% SC, Ametryn+Atrazine 80WP, Bromoxynil+MCPA 40EC, Butachlor 60EC, Glyphosate 41SL (Javaid, 2007) Glyphosate, metribuzin, Primextra Gold 720 SC (Khan et al., 2013) against *Parthenium* weed.

Organic pesticides that could be used to control parthenium grass allelopathic aqueous extracts *Desmostachya bipinnata* (Javaid et al., 2005), *Dicanthium annulatum* Stapf., *Cenchrus pennisetiformis* Hochest, *Sorghum halepense* Pers. (Javaid and Anjum, 2006), aqueous leaf extracts of allelopathic trees viz., *Azadirachta indica* (L.) A. Juss., *Ficus bengalensis* L., *Melia azadarach* L., *Mangifera indica* L. and *Syzygium cumini* (L.) Skeels (Shafique et al., 2005) may be able to prevent

Table 1: Some Invasive Species in Pakistan.

S. No.	Botanical name	Common Name	Family	Native area	Habit
1	<i>Xanthium strumarium</i> L.	Common cocklebur	Asteraceae	North America	Herb
2	<i>Verbascum thapsus</i> L.	Jangli Tamak, Sfaid bhang	Scrophulariaceae	Eurasia	Herb
3	<i>Silybum marianum</i> (L.) Gaertn	Kandiari	Astraceae	China	Herb
4	<i>Sapium sebiferum</i> (L.) Roxb	Pahari Shisham	Euphorbiaceae	Japan, China	Tree
5	<i>Rumex crispus</i> L.	Curly dock	Polygonaceae	Europe	Herb
6	<i>Robinia pseudoacacia</i> L.	Black locust	Papilionaceae	North America	Tree
7	<i>Ricinus communis</i> L.	Arind	Euphorbiaceae	Africa	Shrub
8	<i>Datura stramonium</i> L.	Thorn apple, Dhatura	Solanaceae	Central USA	Herb
9	<i>Eichhornia crassipes</i> (Mart.) Solms.	water hyacinth, gul-e-bakauli	Pontederiaceae	Africa	Herb
10	<i>Prosopis juliflora</i> (Sw.) DC.	Kabuli kikar, valayati jand	Mimosaceae	North and South America	Tree
11	<i>Cannabis sativa</i> L.	Hemp, Mirijuaana, Bhang	Cannabaceae	Central Asia	Herb
12	<i>Lantana camara</i> L.	Panch phuli	Verbenaceae	America	Shrub
13	<i>Leucaena leucocephala</i> (tant.) De wit	ipil ipil, Kubabhhal	Mimosaceae	Mexico, central America	Tree
14	<i>Medicago sativa</i> L.	Alfalfa, Lusan	Papilionaceae	North Africa	Herb
15	<i>Nerium oleander</i> L.	Kunair, Ganira	Apocyanaceae	Australia	Shrub
16	<i>Parthenium hysterophorus</i> L. North	White top, Congress grass, Carrot grass	Asteraceae	Central America	Herb
17	<i>Phragmites australis</i> (Cay.) Trin. ex Steud.	Ditch Reed, Nal, Dila	Poaceae	Australia	Grass
18	<i>Phragmites karka</i> (Retz.) Trin. ex Steud	Drumbi, Nar, Nalu	Poaceae	Africa	Grass
19	<i>Pistia stratiotes</i> L. South	Water lettuce; Jal kumbi	Araceae	America	Herb
20	<i>Eucalyptus tereticornis</i>	Forest red gum	Myrtaceae	Smith Australia	Tree
21	<i>Eucalyptus citriodora</i> Hook.	Lemon eucalyptus	Myrtaceae	Australia	Tree
22	<i>Eucalyptus camaldulensis</i> Dehnh.	sufeda, lachi	Myrtaceae	Australia	Tree
23	<i>Carthamus oxyacantha</i> M. Bieb.	Pohli	Asteraceae	Native	Herb
24	<i>Cannabis sativa</i> L.	Hemp, Mirijuaana, Bhang	Cannabaceae	Central Asia	Herb
25	<i>Broussonetia papyrifera</i> (L.) L'Herit. ex Vent	Paper mulberry, Gul toot	Moraceae	South East Asia	Tree
26	<i>Arundo donax</i> L.	Nar, Nara, Nal.	Poaceae	Africa	Grass
27	<i>Amaranthus spinosus</i> L.	Spiny Amaranth	Amaranthaceae	Tropical America	Herb

Parthenium weed seedling germination and growth. The aqueous extract of *Tagetes erectus* root, stalk, and flower has anti-inflammatories. (Shafique and Shafique, 2011), *Alstonia scholaris* leaf and bark extracts (Javaid *et al.*, 2010b), aqueous extract from roots and shoots of *Datura metel* (Javaid *et al.*, 2010c; Shafique *et al.*, 2011), Shoots of *Withania somnifera* (Shafique *et al.*, 2011; Shafique *et al.*, 2011), leaves of *Azadirachta indica* (L.) A. Juss., *Ficus bengalensis* L., *Melia azadarach* L. and *Syzygium cumini* (Shafique *et al.*, 2005), metabolites of *Trichoderma spp.* can be exploited for the management of parthenium weed (Javaid *et al.*, 2013).

Biological control

The majority of the time, a traditional biological con-

trol strategy has been employed, which involves releasing native natural enemies as biological control agents after host range testing. However, the agent has occasionally been discovered to be present after an unintended or inadvertent introduction. There are few biological control methods available in Pakistan, and no agents have been purposefully introduced to control *parthenium* to yet. However, *Zygogramma bicolorata* Pallister, also referred to as the Mexican or *parthenium* leaf beetle, was discovered in Pakistan in 2006 and has since expanded widely there. It was purposefully brought from Mexico to India in 1983. (Dhileepan *et al.*, 2009).

Conclusions and Recommendations

In Pakistan's ecosystems, invasive species are becoming a major threat. Intentionally or inadvertently brought into the nation, these non-native species endanger the natural biodiversity and ecological equilibrium. This analysis clarified the effects of invasive species in Pakistan by highlighting a few high-impact invaders that cause disruption to local ecosystems and displacement of native flora, like *Broussonetia papyrifera* and *Parthenium hysterophorus*. Chemical control, mechanical removal, and the application of organic pesticides are strategies employed in the fight against invasive species. Notably, the introduction of biological control agents has demonstrated potential in managing these invaders, such as the Mexican parthenium leaf beetle. It is obvious that invading species need to be dealt with right away. To fully comprehend their impact and create management plans that work, ongoing research and monitoring are necessary. By doing this, we can lessen the ecological risks that these invaders pose and protect Pakistan's distinctive ecosystems and biodiversity for coming generations.

Early detection and fast response programs, as well as the employment of several management approaches like mechanical or manual removal, chemical control, and biological control using the invasive species' natural enemies, are used to identify and eliminate new invasive species.

- Encourage initiatives to educate stakeholders, legislators, and local populations about the risks posed by invasive species and the value of early detection and prevention.
- Invest in long-term monitoring programs to track the spread and effects of invasive species. This will improve research and monitoring. To help guide management decisions, support additional study on the effects these invaders have on the environment, the economy, and human health.
- Push for strict laws governing the importing and sale of animals and plants that may become invasive. Reduce the accidental introduction of invasive species by implementing quarantine and inspection protocols at ports and borders.
- Early Detection and Rapid Response (EDRR), Create and put into action EDRR programs to find and deal with invasive species early on in an infestation to stop them from spreading and establishing a foothold.

- Encourage the application of integrated management techniques, which are adapted to the unique invasive species and ecosystems of Pakistan. These techniques include mechanical removal, chemical control, and biological control.
- Assist local communities, government agencies, and conservation organizations in developing their capacity to handle invasive species and lessen their effects.
- Since invasive species frequently transcend borders and affect several countries, work with nearby nations and international organizations to address these species on a regional basis.
- Encourage the adoption of sustainable land use practices to lessen the disruption and fragmentation of natural ecosystems, which can provide invasive species with an opening to establish themselves.
- Engage local communities in invasive species management initiatives; their involvement and awareness are essential for effective control and prevention.
- Need frequent reports and updates to keep stakeholders and the public informed, promote frequent reporting and updates on the state of invasive species and control initiatives.

Novelty Statement

This review paper presents a comprehensive analysis of the impacts, challenges, and management strategies associated with invasive species in Pakistan, a topic that has been underexplored despite its significant ecological and economic implications. By synthesizing current knowledge and identifying gaps in research and policy, this work aims to provide a foundational framework for developing effective management practices tailored to Pakistan's unique environmental and socio-economic contexts.

Author's Contribution

Muhammad Farooq: Topic selection and collected data.

Sanam Zarif and Salim Saif Ullah: Reviewed the draft.

Basheer Ahmad: Data Analysis

Conflict of interest

The authors have declared no conflict of interest.

References

- Anjum, T., Bajwa, R., Javaid and A. 2005. Biological Control of *Parthenium* I: Effect of *Imperata cylindrica* L. on distribution, germination and Seedling growth of *Parthenium hysterophorus* L. *Int. J. Agric. Biol.*, 7(3): 448-450. www.dawn.com.pk (Invasive alien species: Threat to Biodiversity 2009)
- Anwar, W., Khan, S.N, Tahira, J.J. and Suliman, R. 2012. *Parthenium hysterophorus*: An emerging threat for *Curcuma longa* fields of Kasur district, Punjab, Pakistan. *Pak. J. Weed Sci. Res.*, 18(1): 91-97.
- Baig, M.B. and Al-Subaiee, F.S. 2009. Biodiversity in Pakistan: *Key issues*. *Biodiversity*, 10(4): 20-29. <https://doi.org/10.1080/14888386.2009.9712858>
- Dhilepan, K., and Senaratne, K. 2009. How widespread is *Parthenium hysterophorus* and its biological control agent *Zygodium bicolorata* in South Asia. *Weed Research*, 49, 557-562. <https://doi.org/10.1111/J.1365-3180.2009.00728.X>.
- Government of Pakistan, World Wide fund for nature, Pakistan, International Union for Conservation of Nature and Natural Resources, Pakistan. Biodiversity action plan for Pakistan. 2000. A framework for conserving our natural wealth, Imprint (Pvt.) Ltd., Rawalpindi Cantt., Pakistan.
- Hoenicke, H. and Fladung, M. 2006. Biosafety in *Populus Spp.* and Other Forest Trees: From Non-Native Species to Taxa Derived From Traditional Breeding and Genetic Engineering. *Trees: Structure and Funct.*, 20(2):131-144. <https://doi.org/10.1007/s00468-005-0023-5>
- Holm, L.G., Plucknett, D.L., Pancho, J.V. and Herberger, J.P. 1991. *The World's Worst Weeds: Distribution and Biology*. Krieger Publishing Co. Fla.,
- Hussain, A. and Zarif. R.M. 2003. Invasive alien tree species - A Threat to Biodiversity. *Pak. J. For.*, 53(2): 127-141.
- Hussain, A. 2003. Pakistan. In: Pallewatta, N., J. K. Reaser and A.T Gutierrez (eds). *Invasive Alien Species in South-Southeast Asia: National Reports and Directory of Resources*. Pp: 70-79. *Global Invasive Species Programme*, Cape Town, South Africa.
- Javaid, A. and Anjum, T. 2006. Control of *Parthenium hysterophorus* L. by aqueous extracts of allelopathic grasses. *Pak. J. Bot.*, 38(1): 139-145.
- Javaid, A. and Riaz, T. 2007. Spread of aggressive alien weed *Parthenium hysterophorus* L. in district Okara, Pakistan. *J. Anim. Plant Sci.*, 17(3- 4): 59-60.
- Javaid, A., Bajwa, R. and Anjum, T. 2005. Biological Control of *Parthenium* II: Allelopathic effect of *Desmostachya bipinnata* on distribution and early seedling growth of *Parthenium hysterophorus* L. *Int. J. Biol. Biotechnol.*, 2: 459-463.
- Javaid, A., Shafique, S. and Shafique, S. 2010. Herbicidal effects of extracts and residue incorporation of *Datura metel* against *parthenium* weed. *Nat. Prod. Res.*, 24(15):1426-1437. <https://doi.org/10.1080/14786410903075440>
- Javaid, A., Shafique, G., Ali, S. and Shoaib, A. 2013. Effect of culture medium on herbicidal potential of metabolites of *Trichoderma* species against *Parthenium hysterophorus*. *Int. J. Agric. Biol.*, (15):119-124.
- Khan, M.A., Qureshi, R.A., Gillani, S.A., Ghufuran, M.A., Batool, A. and Sultana, K.N. 2010. Invasive Species of Federal Capital Area Islamabad, Pakistan. *Pak. J. Bot.*, 42(3): 1529-1534.
- Khan, H., Marwat, K.B. and Adkins, S. 2013. Distribution and management of *Parthenium* weed In The Peshawar Valley, Northwest-Pakistan. *Int. Parthenium News*.
- Khatoon, S. and Ali, S.I. 1999. Alien invasive species in Pakistan, University of Karachi.
- Marwat, K.B., Hashim, S. and Ali, H. 2010. Weed Management: A case study from North-West Pakistan. *Pak. J. Bot.*, 42: 341-353.
- Reddy, C.S. 2008. Catalogue of Invasive Alien Flora of India. *Life Sci. J.* 5(2), 84-89.
- Raghubanshi, A.S., Raj, L.C., Gaur, J.P. and Singh, J.S. 2005. Invasive Alien Species and Biodiversity in India. *Curr. Sci.*, 88: 539-540.
- Shinwari, M.I. and Shinwari, M.I. 2010. Botanical Diversity in Pakistan; Past Present And Future. *Proceedings of Seminar on World Environment Day*. Pak. Eng. Congr. Lahore. 85-104.
- Park, K. 2004. Assessment and Management of Invasive Alien Predators. *Ecology and Society*, 9. <https://doi.org/10.5751/ES-01208-090212>.
- Shafique, S., Bajwa, R., Javaid, A. and Shafique, S. 2005. Biological control of *Parthenium* iv: Suppressive ability of aqueous leaf extracts of

some allelopathic trees against germination and early seedling growth of *Parthenium hysterophorus* L. Pak. J. Weed Sci. Res., 11(1-2): 75-79.

Shafique, S., Shafique, S. and Javaid, A. 2011. Use of Solanaceous Plants Extracts as Alternate Herbicides For The Management Of Parthenium. *3rd International Symposium on Weeds and Invasive Plants*, October 2- 7, 2011 in Ascona, Switzerland.