

Management strategies for quarantine and invasive weeds

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Due to invasive / noxious weed species, enormous losses have occurred in terms of quantity and quality of crop output, loss of native biodiversity, threats to the environment, and human health. The various approaches used to control these weed species are still insufficient. To combat the invasion of non-native weed species, actions such as creating early-warning systems, increasing invasive species control, quarantining alien species, and raising public awareness are required. Preventing weed invasion using a combination of strategies focused on reducing encroachment is the most effective method for managing invasive weeds. Thus, there is an urgent need to strengthen integrated weed management approaches against invasive and quarantine weeds across the country.

Keywords: Invasive weed, Noxious weed, Quarantine weed, Weed control

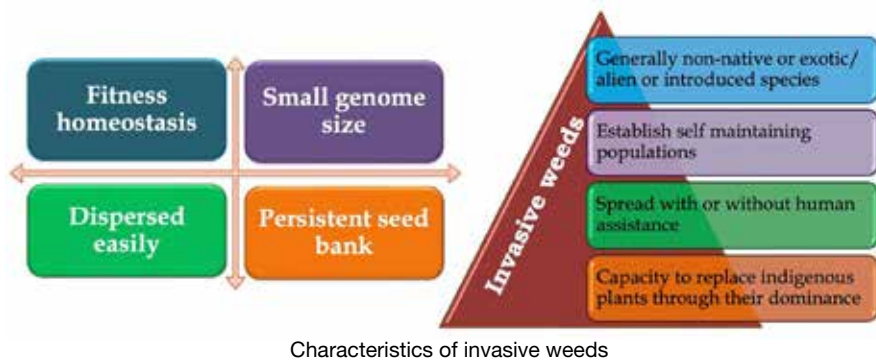
INVASIVE weeds are non-native plants that spread into natural ecosystems and harm those ecosystems. Many invasive weeds are noxious weeds. Not just noxious weeds, but also other plants that are not native to this area or the region where they are flourishing are considered invasive weeds. It quickly spread to take over a

site and are incredibly difficult to control. These weeds can be found in a variety of environments/habitats around the world. Weeds that are invasive have become a problem in Asian countries, particularly India. Invasive species contribute in the extinction of indigenous vegetation, as well as changes in hydrology and ecosystem function. In India,

173 introduced species have been identified, belonging to 117 genera and 44 families. The tropical American region contributes the most (with 128 species or 74%), followed by tropical Africa (11%). In both cropped and non-cropped environments, several weed control strategies are utilised to control these weeds. Despite the fact that



Major invasive and quarantine weeds in India



a vast number of exotics have been naturalised in India, only a few have had a significant impact on the ecosystem's structure and functioning.

Characteristics of invasive weeds

Invasive weed has persistent seed bank in soil with variable dormancy. These weed seeds also dispersed easily and transported to long distance through the action of wind, water, human, and animal. Invasive weeds also have the character of homeostasis fitness i.e. a feature of cells, organs, and organisms that permits them to maintain and regulate the stability and consistency required for proper function. Understanding of these weeds' habitat, anatomy, reproductive biology, physiology, and biochemistry is required for efficient control.

Spreading of invasive weeds

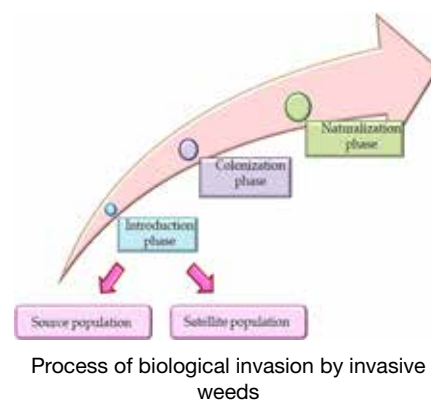
Invasive weeds have the ecological potential to invade nearly

all ecosystem. Invasive weeds are primarily spread by human activities, often unintentionally and also often distributed by birds, and wind. It persists and spreads abundantly not just along roads but in backyards also in natural environment. It frequently spreads outside of the plant's native habitat. Invasive weeds out-grow, out-spread and out-compete native plants.

Process of biological invasion

The spread of a weed plant into an area where it was previously absent, usually with negative consequences such as the extinction or displacement of native species, disruption of the invaded environment, and so on is known as biological invasion of weed. Invasive weeds are thus a severe impediment to biodiversity conservation and its sustainable use. Introduction, colonization, and naturalisation are the three separate

population dynamics that occur during biological invasions.

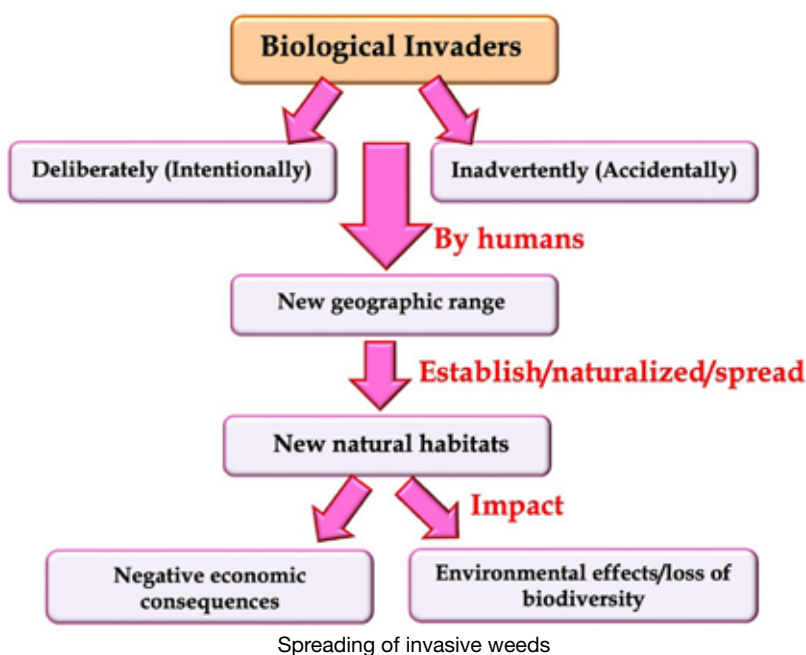


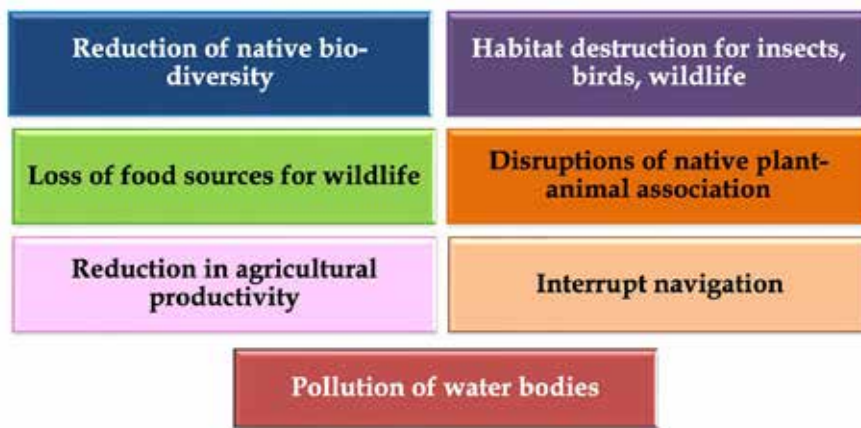
Ecological impacts caused by invasive weeds

Invasive species lead to the extinction of species, as well as changes in hydrology and ecosystem function. Ecosystems are disrupted and the environment is harmed. The ecosystems goods and services provided by native vegetation is drastically reduced by invasive weeds. Decreasing biodiversity from native ecosystems, modification of ecosystem, decline in number and diversity of native plants, and change in community structure are the major characteristics of invasive weeds. The threat is not limited to biodiversity loss; it also extends to the environment, economies, and people's health. Globally, the agricultural production is decreased by 5% due to invasive weed species. In India, many invasive weed species entered crop lands including orchards. In annual crop, the 30% yield loss due to invasive weed is reported. These weeds also disturb aquatic ecosystem including navigation. The flow of water is interrupted by invasive weeds. Contamination/pollution of water body cause large scale loss to farmers.

Management of invasive weeds

There are not many predators or natural controls for invasive weeds. Nothing can eat it, and nothing can outperform it. Preventing the introduction of invasive weeds is the most important and cost-effective strategy to control them. Seeds, as well as complete plants, cannot be imported into the state unless they





Ecological impacts caused by invasive weed



Management of invasive weeds

meet quarantine requirements. Need to follow strict quarantine procedure in airport and other shipping areas. The second most significant and cost-effective way of controlling invasive weeds is early detection with rapid response. When dealing with invasive weeds, the strategy of 'eliminate them before they spread' is a good one. You can also help to prevent the spread of invasive weeds by being cautious with clothing and equipment that has been worn or used when moving from one location to another. Invasive weeds can be transported by vehicles, animals and pets, and clothing. Check for invasive weeds in any planting materials (nursery) you buy or sell. By not purchasing and growing seeds or plants that are known to be invasive in the wild in your own yard, you can restrict the spread of invasive weeds. Weed infestations often start on roads, trains, and waterways, thus a consistent preventive and containment programme should be in place. Weed seed formation must be stopped at all costs. Chemical

applications do not usually prevent seed production once weeds have produced a flower, so hand removal is usually required. Plants that have been removed by hand should be destroyed by burning. The weed infested field area should be labelled on a map, continuously monitored, and managed during successive surveys. Establishing competing desirable grasses in regions prone to invasion is yet another strategy to prevent invasion. By consuming weeds' resources, competitive grasses prevent weed populations from establishing and growing.

- Limiting weed seed dispersal (control it before weed seed production)
- Containing neighbouring weed infestations (good agriculture practices)
- Minimizing soil disturbances (zero tillage, minimum tillage)
- Detecting and eradicating weed introductions early (awareness programme)
- Establishing competitive grasses
- Properly managing grasses



Strategies for controlling invasive and quarantine weeds

National Early Warning & Rapid Response System

The National Early Warning & Rapid Response System is a crucial initiative aimed at safeguarding agricultural landscapes from invasive weeds. With a focus on public education, effective information dissemination, and disaster response, the system strives to prevent the establishment of quarantine weeds, ensure early detection, and facilitate swift eradication or containment of invasive species. By encouraging regional collaboration and implementing proactive measures, the system aims to create a resilient framework that protects agricultural ecosystems and promotes sustainable farming practices. The key objectives of the National Early Warning & Rapid Response System are centered around proactive weed management. Firstly, the system aims to prevent the introduction and establishment of quarantine weeds, focusing on measures that hinder their entry and proliferation. Secondly, an emphasis is placed on early detection and reporting, empowering swift responses to emerging invasive weed threats. The system prioritizes eradication or containment efforts immediately following the establishment of invasive species to minimize their impact. Additionally, a crucial aspect involves regional collaboration for prevention and mitigation, fostering a collective approach to weed management for more effective outcomes.



Options for creating public awareness

Control of major invasive weeds

***Parthenium hysterophorus* (Congress grass, white top, goat weed, Gajar Ghans):** Various strategies can be employed for the control of *Parthenium hysterophorus*, a problematic weed. One biological approach involves the use of the Chrysomelid beetle (*Zygogramma bicolorata*), which has shown effectiveness in controlling *Parthenium* populations. Additionally, the application of pathogens such as *Fusarium pallidoseum* and *Sclerotium rolfsii*, targeting different parts of the *Parthenium* plant, has proven to be a viable control method. Chemical methods also play a role in managing *Parthenium*. The use of herbicides such as Bromacil, Diuron, and Terbacil at a rate of 1.5 Kg/ha has demonstrated efficacy. Alternatively, Diquat at 0.5 Kg/ha, applied at all stages of *Parthenium* growth, has shown effective control. For seedling control, herbicides like 2,4-D Na salt or MCPA at a rate of 2 Kg/ha have been found to be successful. These integrated approaches provide a comprehensive strategy

for effectively managing and controlling the growth of *Parthenium hysterophorus*.

***Chromolaena odorata* (devil weed or Siam Weed):** Effective control measures involve a combination of physical, chemical, and biological methods. In highly infested areas, manual slashing and the use of bush cutters or tractor-drawn implements are employed as physical methods to clear and reduce the weed's biomass. For chemical control, Ticlopyr has proven to be the most effective herbicide against *Chromolaena odorata*. Additionally, the spraying of a mixture containing 2,4-D Amine and Picloram, particularly after the removal of flower heads, has been found to effectively kill the top growth of the weed. Biological control methods have also shown promise. The larvae of *Pareuchaetes pseudoinsulata* are known to effectively defoliate pure stands of *Chromolaena odorata*, contributing to its control. Furthermore, the stem gall fly, *Cecidochares connexa*, has been identified as an effective biological agent in managing *Chromolaena* populations.

***Mikania micrantha* (Bitter Vine):** *Mikania micrantha*, commonly known as the mile-a-minute weed, poses a challenge for control due to its prolific seed production and the ability of new plants to emerge from tiny stem fragments. Integrating physical, chemical, and biological control methods is crucial for developing a comprehensive strategy to manage and control the spread of *Mikania micrantha*, mitigating its impact on ecosystems. Physical methods include cutting the basal portion of the plant, but eradication is challenging given its resilient nature. The plant's ability to regenerate from small stem fragments adds to the difficulty of control efforts. Chemical methods have been employed, with Glyphosate and 2,4-D proving effective when applied before flowering. Additionally, Paraquat has shown efficacy when applied at the seeding stage, targeting the early growth of *Mikania micrantha*. Biological control methods also play a role in managing this invasive weed. The parasitic plant *Cuscuta campestris* has been found to effectively suppress the growth and invasiveness of *Mikania micrantha*. Furthermore, *Liothrips mikaniae*, a species of thrips, shows promise as a potential biological control organism that is specific to *Mikania micrantha*.

***Eichhornia crassipes* (water hyacinth):** Mechanical control includes manual removal or the use of motor-operated weed cutters to physically clear and reduce the infestation. Chemical control strategies incorporate a mixed application of herbicides. A combination of 2,4-D Na salt (4 Kg/ha) and Paraquat (1.0 Kg/ha), or 2,4-D Na salt with Glyphosate (1 Kg/ha), has proven effective in controlling the growth of water hyacinth, providing an efficient means of reducing its population. Biological control methods have also been employed. The snail *Pomacea canaliculata* retards the growth and flowering of water hyacinth by engaging in root pruning. Additionally, *Neochetina bruchi*, a biological control agent, has demonstrated effectiveness in

controlling the population of water hyacinth.

Weed management in plantation crop: Introducing cover crops such as Calapogonium, Centrosema, and Pueraria helps in suppressing weed growth by providing ground cover. These cover crops compete with weeds for resources and contribute to soil fertility. Planting shade-providing crops like Coffee and Cocoa alongside the main plantation helps create a canopy that suppresses weed growth. The shading effect not only inhibits weed development but also enhances the microenvironment for the main crops. Applying husk or straw as mulch on the plantation floor serves as a physical barrier, preventing weed emergence and reducing the need for herbicide use. Mulching also helps retain soil moisture and regulate temperature. Regular slashing of vegetation helps control weed growth and prevents soil erosion. This mechanical method is particularly effective in managing weed populations between plantation rows and maintaining a clean, organized environment. The use of herbicides is a common practice in weed management. Effective herbicides such as Diuron (2-3 Kg/ha), Glyphosate (1.5-3.0 Kg/ha), Paraquat (0.6 Kg/ha), 2,4-D Na salt (1.0-1.5 Kg/ha), and Metsulfuron-

methyl (1.0-3.0 Kg/ha) are applied judiciously to control specific weed species while minimizing the impact on the main crops.

Control of invasive weeds in orchards: The use of bullock or tractor-drawn ploughs facilitates mechanical cultivation, particularly effective for controlling annual weeds up to 10 years of age. This method helps disrupt weed growth and reduces competition for resources. Other physical methods, such as mulching, mowing, and flaming, are utilized to manage weed populations. Mulching helps suppress weed growth, while mowing and flaming serve as effective means of cutting and controlling weeds in designated areas. Integrating cover crops like pulses or oilseeds, along with intercropping vegetables such as cucurbits, provides a dual advantage. These practices not only help control weeds but also offer additional income for orchard owners. Pre-emergence herbicides play a crucial role in controlling annual broadleaf and grassy weeds in orchards. Simazine and Diuron, applied at rates of 1.5-2.0 Kg/ha, prove effective in preventing the emergence of these weeds. For targeted control of specific weed types, selective herbicides are

employed. Paraquat, at rates of 0.5-1.0 Kg/ha, is effective against grasses, while 2,4-D (1.0 Kg/ha) targets broadleaf weeds. Glyphosate (1.0 Kg/ha) and Dolopan (3-4 Kg/ha) are used to control perennial grasses in orchard settings.

CONCLUSION

Invasive weeds lead to the extinction of species, as well as changes in hydrology and ecosystem function. Strict legislation might prevent the entry of invasive alien weeds, in addition to maintaining the country's great biodiversity. The most cost-effective and environmentally friendly technique of controlling invasive/noxious weeds is to avoid their invasion by following the suggestions below. The spread of invasive weeds must be limited, and nearby weed infestations must be managed. Soil disturbances must be kept to a minimum. New weed invasions must be identified and eliminated as soon as possible. Finally, competitive grass establishment and maintenance must be carried out properly.

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TECHNICAL SPECIFICATIONS

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