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By
Sabiha Kazmi

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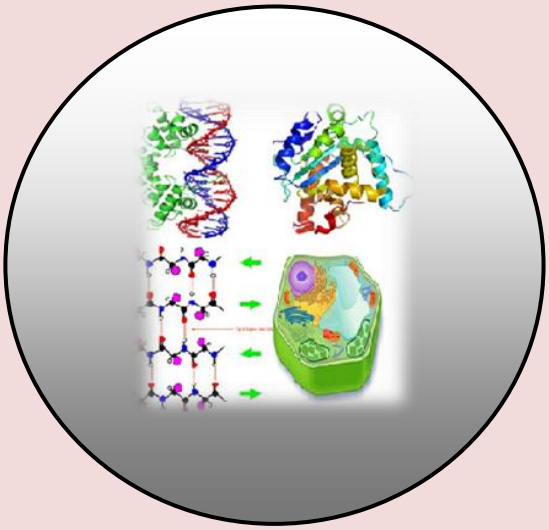

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Dr. Sabiha Kazmi
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jbiolchemres@gmail.com

RESEARCH PAPER

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Invasive Weed Species Vs. Ecosystem: A Study

Sabiha Kazmi
Department of Botany, Shia P.G. College, U.P., India

ABSTRACT

Alien species are very supportive in our agriculture and forestry, but several time alien species become invasive when they are introduced outside their natural habitats into new areas where they compete native species and become major threat to the plant biodiversity. Their control measures consume time and financial resources however many invasive species can be used for economic benefits, many botanists agreed that these species can be used to clean up metal contaminated ecosystem. The invasion of exotic species into a natural ecosystem can have undesirable impact on both the economic and ecological aspects of sustainability can imbalance the natural biodiversity, during course of investigation many species Parthenium hysterophorus, Ageratum conyzoides, Lantana camera, Cynodon dactylon, Euphorbia geniculate, Sida acuta, Phylinthus niruri, Trimfetta rhomboidea etc. were studied for their invasiveness and their management.

Keywords: Alien species, Parthenium hysterophorus, Ageratum conyzoides, Lantana camera and Cynodon dactylon.

INTRODUCTION

About 40% of the species in the Indian flora are alien, of which 25% are invasive alien species are non-native or exotic organisms that occur outside of their natural adapted ranges due to their dispersal potential. Many alien species support our farming and forestry systems. Alien species become invasive when they are introduced deliberately or unintentionally outside their natural habitats into new areas where they express the capability to establish, invade and out compete native species. Many of the plant species intentionally introduced in various countries in the past have become major threat to the forest biodiversity and their control measures consume substantial financial resources. Many of the invasive species can be used for economic benefits.

Scientists have emphasized that economic valuation of most of the invasive species is due and should be done on priority basis. Many Botanists have worked on the use of metalliferous invasive species to cleanup metal-contaminated ecosystems. The knowledge of how metalliferous invasive plants can specifically accumulate or exclude essential elements, bioavailability of metals, rhizospheric processes as well as translocation and processing and storage in the plant parts is essential for proper utilization of these plants. Common invasive species includes *Parthenium hysterophorus*, Ageratum conyzoides, and Lantana camera. Invasive species cause loss of biodiversity including species extinctions, changes the hydrology and other ecosystem functions. These invasive species also influence the flora regeneration. Differences between native and exotic plant species in their requirements and modes of resource acquisition and consumption may cause a change in soil structure, its profile, decomposition, nutrient content of soil, moisture availability, etc. Invasive species are thus a serious hindrance to conservation and sustainable use of biodiversity, with significant undesirable impacts on the goods and services provided by ecosystems. Biological invasions now operate on a global scale and will undergo rapid increase in this century due to interaction with other changes such as increasing globalization of markets, rise in global trade, travel and tourism. For effective management of invasive species, knowledge about their ecology, morphology, phenology, reproductive biology, physiology and phytochemistry is essential. India, one of the 12 mega-biodiversity centers of cultivated plants, is also one of the richest centers of biodiversity. Its rich diversity is attributed to varied climatic conditions and its geography. Over the last many decades, a number of Forest Invasive Species (FIS), without realizing the consequences, have been introduced in India knowingly or unknowingly. The FIS are further categorized as floral (weeds and plants having national and regional Distribution), entomological (insects) and pathogenic (fungi). Many of the invasive species have naturalized in India and are being used for various purposes ranging from medicinal uses, attachments to religious sentiments to be used in furniture, compositing etc. The success of these species in the alien and new environment may be attributed to several reasons. Many theories have been proposed in this direction. Possession of a set of traits by the invasive species as proposed in case of ideal weeds may not be always true because some species possessing only a subset of traits may be very invasive in nature (Williamson and Brown 1998). Among the theories proposed for the success of invasive species, absence of natural enemies (pathogens, predators, or pests) known as Natural Enemies Hypothesis or alternatively allelopathy (Heirro and Callaway 2003). Besides, invasive species also have an ability to undergo genetic changes due to selection pressure imposed by the alien environment and exhibit quick response to anthropogenic disturbances. It is thus essential to study the mechanism of invasiveness in alien environment especially regarding their colonization, expansion, establishment, and ecological impact so as to take timely action for their management. Invasions of exotic species in to natural ecosystems can have undesirable impacts on both the economic and ecological aspects of sustainability (Drake et. al, 1989; Brown et. al 1998), imbalance in natural and agricultural ecosystems and biodiversity (Fleischmann, 1997). In weed-infested areas, an abrupt decrease in vegetation compared with uninfected areas was noticed. The lognormal distribution for the uninfected areas indicates a normal curve of vegetation. The changed structure of vegetation in the infested areas may be due to the allelopathic influence of these weeds (Bais et al. 2003).

Thus, it calls for timely steps to check their further spread. The implications of internationally or unintentionally introduced alien species have not been fully understood. The impact of alien's species on the native ones and naturalness of the ecosystem is immense, unpredictable and often irreversible. Economic loss could be enormous affecting the crop yield, promoting pathogens and pests and increasing the cost of production. Alien's species are aggressive colonists (invaders) and have a damaging effect on the ecosystem as a whole. This is distinctly different from an alien species, which only connotes a non-native, non-indigenous, foreign, exotic species, sub-species, or lower taxon occurring outside its natural range (past or present) and has dispersal potential and includes any part, gametes or propagule of such species that might survive or subsequently reproduce. In our country SFDs concerned are responsible for management of weeds which encompasses a task of stupendous magnitude and consume major chunk of funds allocated to the forestry sector. Presently no coordinated efforts are being made to prevent introduction of FIS, their early detection and rapid response to manage the same. International Union for Conservation of Nature and Natural Resources IUCN (2000) defines Alien Invasive species as an alien species which becomes established in natural or semi natural ecosystems or habitat, an agent of change, and threatens native biological diversity. These invasive species are widely distributed in all kinds of ecosystems throughout the world, and include all categories second only to that of habitat destruction (IUCN, 2000) in fact, invasive species are an important component of global change. Invasive species cause loss of biodiversity including species also influence the forest regeneration. The work exclusively as the exotic flora of Madhya Pradesh is very scanty. A notable work has done by Rao (1994) who enlisted 181 exotic weed species of the country. Choudhary (2005) has list out as many 229 species exotic to Assam. Another worth mentioning publication on exotic weeds in Barua and Gogoi (1994). Differences between native and exotic plant species in their requirements and modes of resource acquisition and consumption may cause a change in soil structure, its profile, decomposition, nutrient content of soil, moisture availability, etc. Many of the invasive species can be used for economic benefits. Scientists have emphasized that economic valuation of most of the invasive species is due and should be done and should be done on priority basis. In this context botanist have worked on the use of matalliferous invasive plants can specifically accumulate or exclude essential elements, bioavailability of metals, rhizospheric processes as well as translocation and processing and storage in the plant parts is essential for proper utilization of these plants includes *Parthenium hysterophorus, Ageratum conyzoides*, and Lantana camera (Anonymous 2003). Ecology of invasion requires information on the rate and mechanism of transport and movement of organism, on characteristics allowing a species to become successful invader and also on the properties of the ecosystem that make them susceptible to the invaders (V. Khanna, 2005). Probable traits favoring invasiveness in terrestrial plants include height tolerance against environment extremes and greater adaptability in wide range of environmental conditions; high water, light and nutrient use efficiencies; zero or very short dormancy period, high productivity; and high reproductive potential. Emerging mechanisms of plant invasion such as enemy release hypothesis and novel weapon hypothesis (allelopathy) was part of deliberations. Inderjit (2005) discussed the novel weapon hypothesis and concluded that a single theory does not account for the success of invaders in naturalized areas.

It was emphasized that time and season of sampling also has strong influence on the observed results. The study concluded that in order to assess impact of invasive species, long-term studies are needed as adverse effects take time to appear. The impact of exotic species on native organisms is widely acknowledged, but poorly understood. Very few studies have empirically investigated how invading plants may alter delicate ecological interactions among resident species in the invaded range.

STUDY SITE

The study was conducted with given objectives in the district of Mohanlalganj, Lucknow, U.P.

METHODOLOGY

The invasive species though randomly laying out line transect of 1 km length. Travers on transect line and all invasive species were recorded. Identification the species were done and brief morphological behavior of the invasive species were recorded. Plant sample was collected and identified. Native and invasive species were documented.

RESULTS AND DISCUSSION

Over the last many decades, a number of Forest Invasive Species (FIS), without realizing the consequences, have been introduced in India knowingly or unknowingly. Checklist of known FIS is appended at Table 1. The FIS are further categorized as floral (weeds and plants having national and regional distribution), entomological (insects) and pathogenic (fungi). Approximately, 111 FIS have been identified under the above mentioned categories. No systematic studies have been carried out so far to inventorize the FIS available in its various biogeographical regions. However, India being a vast country, it would be possible to have a detailed inventory through some project support. Many of the invasive species have naturalized in India and are being used for various purposes ranging from medicinal naturalized in India and are being used for various purposes ranging from medicinal uses, attachments to religious sentiments to uses in furniture, compositing etc. Appropriate strategies will have to be devised for their control, eradication and management in connection with various stakeholders. One of the institutes of the ICFRE is one of the oldest forestry research organizations in South Asia and very well reputed for scientific research in forestry. Several collaborative projects with international organizations have been successfully completed in the past and several more are being implemented currently. Total 19 species have documented in the study area. The common invasive species for e.g. *Parthenium hysterophorus, Ageratum conyzoides, and Lantana camera.* A brief description of the above mentioned plants are given below:

1. ***Parthenium hysterophorus:*** It is an exotic species from Tropical America that has naturalized most of India because of its strong invasive potential. This weed was first reported in India in 1951 from Maharashta. The weed is an aggressive colonizer of degraded areas with poor groundcover and exposed soil such as fallow wastelands, roadsides and overgrazed pastures. It does not usually become established in undisturbed vegetation or in vigorous pastures, and there is a marked inverse relationship between existing plant cover and native wood density.

Parthenium hysterophorus is considered as noxious weed because of its prolific seed production and fast-spreading ability, allelopathic effect on other plants, strong competitiveness with crops and health hazard to humans as well as animals. The weed is highly allergenic and causes respiratory problems, dermatitis and asthma. However, except for allelopathic aspect and crop-weed interaction, almost no study is available on the impact of this weed on the ecosystem processes.

2. ***Ageratum conyzoides****:* It is an annual weed native to South America that has invaded and now naturalized in several parts of southern Asia including India. The invasive potential of weed is attributed to its fast growth, production of large number of small-sized wind and water-disseminated seeds and vegetative proliferation through stolons. The weed has become a problem in agro ecosystems.
3. ***Lantana camera:*** It is one of the ten worst weeds of the world, which is a native of tropical and subtropical America. The species was introduced in India as an ornamental shrub during AD 1809-1810. It is now found all over the India sub-continent, stretching from the sub montane regions of the outer Himalaya to southernmost part Of India, The plant is spreading fast due to the human disturbances such as cultivation, road construction and forest fragmentation and degradation. Important attributes of Lantana making it invasive fitness homestatis, phenotypic plasticity, benefits from destructive foraging activities, widespread geographical range, vegetative reproduction capabilities, fire resistance, better competitive ability and allelopathy. Low allocation of biomass to roots, and low wood density enable it to rapidly establish aboveground plant cover. High nutrient extraction efficiency contributes to its colonization on the eroded sites with shallow soils.

Cross-sectorial threats

The FIS not only affects the productivity of forests but also cause heavy losses to agricultural production, blocking of water bodies, water transport ways, affecting wildlife habitat in the forests and wetlands and commercial activities such as cultivation of medicinal plants etc.

Current Methods / techniques for prevention of monitoring control of weeds

Presently the following species specific methods are being employed for prevention and control of weeds:

Mechanical: Mechanical control involves hoes, cultivators. Harrows, rotary weeders, discs, ploughs, scythes, mowers and manual uprooting. The weeds are physically lifted from the soil, cut off or buried. In most of the forestry operations the FIS such as lantana, eupatorium, mikania, mimosa, etc. are uprooted manually and either burnt or buried. In some places, those are being used for making compost.

Chemical: This is one of the most common methods employed for controls of FIS. Most chemicals are species specific though their use is not always desirable due to environmental degradation and pollution that they often cause and their effects on other useful species.

Tillage: Tillage helps in the burial of most small annual weeds. If all growing points are buried, most annual weeds will be killed. Tillage also disturbs the rooting system of most of the perennial weeds. The root system is cut to enough depth so that the plant dies from desciccation before it can re-establish its roots. In moist soils or if it rains soon after tillage, the roots may quickly re-establish themselves. In effect one may transplant the weed with little or no injury. Mowing is effective on tall growing plants. Tall annual are mowed or scythed to reduce competition with crop plants and to prevent seed production.

Table 1. List of Forest Invasive Species (FIS) in Jabalpur districts.

S. No.	Name of species	Botanical Name	Family	Origin	Distribution Category
1		*Parthenium hysterophorus*			
2	Latjeera	*Achyranthus aspera*	Amaranthaceae		S
3	Mahakua	*Ageratum conyzoides*	Compositeae	Tropical America	C
4	Khaki	*Alternathera sessilis*	Amaranthaceae		S
5	Chakoda	*Cassia tora*	Leguminosae	India	C
6		*Corchorus aestuans*	Tiliaceae		S
7		*Corchorus olitorius*	Tiliaceae		S
8		*Cynodon dactylon*	Poaceae		S
9	Tinpatiya	*Desmodium triflorum*	Fabaceae		S
10	Dudh badi	*Euphorbia geniculata*	Euphorbiaceae	South America	S
11		*Euphorbia hirta*	Euphorbiaceae	Tropical America	S
12		*Hyptis suaveolence*	Lamiaceae	Tropical America	D
13	Jarayan	*Lantana camera*	Verbenaceae	Tropical America	D
14		*Mimosa pudica*	Fabaceae	Tropical America	S
15	Hazar dana	*Phyllinthus niruri*	Euphorbiaceae		S
16		*Sida acuta*	Malvaceae	Pan tropical invaded	C
17		*Sida cordifolia*	Malvaceae	Pan tropical invaded	C
18		*Trimfetta rhomboidea*	Tiliaceae	India	D
19	Bhui grass	*Oplismenan spp.*			D

Distribution categories
D=Dominant->80%
C=Co dominant->61-80%
S=Scattered-41-60%
R=Rare-<40%

Crop competition: Crop competition is one of the cheapest and most useful methods farmers can use. Often it means using the best crop production methods so favorable to the crop that weeds are crowded out. Actually competition makes full use of one of the oldest laws of naute-“Survival of the fittest”.

Sida cordifolia

Sida cordifolia

Sida acuta

Sida acuta

Phylinthus niruri

Phylinthus niruri

Parthenium hysterophorus

Parthenium hysterophorus

Lantana camara

Lantana camara

Hyptis suaveolence

Hyptis suaveolence

Ageratum comyzoides

Ageratum comyzoides

Weeds compete with crop plants for light, soil moisture, nutrients and carbon dioxide. One mustard plant (weed) requires twice as much nitrogen and phosphorus, four times as much potassium, and four times as much water as a well-developed oat plant. Early weed competition usually reduces crop yields far more than late season weedy growth. Therefore, early weed control is extremely important. Late weed growth may not seriously reduce yields, but it makes harvesting difficult, reduces crop quality, and rein fests the land with seeds and harbor insects and diseases. In planning a control programme, it is important to know the weed's life cycle.

If it is possible to interrupt the cycle it becomes very effective control. In crop production, this may be a shift in planting date or a well-timed chemical spray; thus the crop gets the upper hand or competitive advantage. Something with plastic, tar, paper, straw, saw dust or any other similar material is largely a matter of competition for light. Most weed seedlings cannot penetrate the thick coverings and die because of lack of light.

Crop Rotation: Certain weeds are more common in some crops than in others. Besides the annual weeds, for the parasitic weeds, such as striga in sorghum and orabanche in tobacco, the hosts are the crop species grown. Rotation of crops is an efficient way to reduce weed growth. A good rotation for weed control usually includes strong competitive crops grown in each part of the rotation. In growing mixed crops as in the tropics, the weed problem is eliminated to a greater extent in most of the irrigated crops.

Biological control: In biological weed control, a 'natural enemy' of the plant is used which is harmless to desired plants. Insects or disease organisms are the usual natural enemies. Also parasaitic plants, selective grazing by livestock, and highly competitive replacement plants are other forms of biological control. The outstanding example of biological weed control is the one on Cactus (*Opuntia* spp.) with a moth borer *Cactoblastic cactorum* and or Lantana camara with several kinds of caterpillars and a fly, which damages the berries. Researchers have located and tested numerous biological agents against *Parthenium* weed. These include a gall forming moth, leaf minor, weevil, beetles and a rust fungus.

Actions being considered to prevent introduction of FIS (India Country Report, 2005)

1. **Limit soil disturbances:** To limit the establishment of invasive plant infestations, prevent unnecessary soil disturbances, wherever possible.
2. **Immediate re-vegetation of disturbed sites:** To limit the potential establishment of invasive plants on disturbed ground, re-vegetate the area with approved species through a time bound plan. If the area has a known invasive plant population, it may be better to control the plants prior to re-vegetation.
3. **Use certified "Weed Free" Seeds for re-vegetation of disturbed sites:** To ensure virtually invasive plant free seed mix, a purchaser should request a "Certificate of Seed Analysis" the purchaser can request a larger seed sample analyzed, rather than the typical 25gm sample to improve the confidence of the analysis. Alternatively, one can start with pure seeds and then prepare the seed mix manually.
4. **Clean equipment and materials:** Practice due diligence by ensuring that all equipment, materials and vehicles are free of invasive plant seeds and plant parts before arriving on site. All agricultural implements or any equipment potentially exposed to invasive plants must be cleaned prior to use. Also equipment, materials and vehicles exposed to weeds are to be cleaned prior to leaving the infested site.
5. **Use of "Weed free" hay bales for erosion control and feed:** The use of straw bales for erosion control is discouraged. Unlike hay, it is very difficult to determine if the straw bales are free of invasive plant seeds. Therefore, certified "weed free" hay bales acquired from producers with a "Certificate of Inspection" should be used for erosion control. Hay imported for feed should as well be certified as "weed free."
6. **Early detection and eradication:** because a single plant and small infestations are much easier to control than large infestations, it is important to manage invasive plants proactively through continuous monitoring.

To do this effectively, field staff should be trained in the identification of restricted and noxious invasive plants, collection of survey information, and the importance of destroying individual invasive plants and reporting new infestations in a timely manner.

7. **Pre-activity invasive plant survey:** An invasive plant survey should be completed prior to the commencement of any land disturbing activity to identify potential problem areas. Sites with invasive plants identified should be taken note of in order to alter practices to limit their spread (e.g. control prior to land disturbance, cleaning of equipment and materials before leaving the site). As the pre-activity invasive plant survey acts as a heads up for potential infestations, a follow-up survey should be completed to assess the invasive plant conditions as a result of the activities.
8. **Limit seed introduction in Fill:** Inspect gravel pits, soil stockpiles or other fill sources for invasive plants prior to movement of the material to ensure the product has a low risk of introducing invasive plants.
9. **Communication:** Communication between various stakeholders and provincial and municipal government agencies is beneficial to transfer information for promoting regional awareness. Information such as the invasive plant history of certain locations or invasive plant infestation locations may be beneficial to all parties.
10. **Incorporate invasive plant management in planning phase:** Inventory of invasive plants should be considered in all operational plans to ensure effective and efficient management. Effective invasive plant management plans should incorporate education, survey, control, and prevention measures.
11. **Education and awareness:** Invasive plant education and awareness programmes developed co-operatively or individually by companies and agencies are essential in order to put the above prevention measure into practice. The people have to be made aware of the harmful effects of these weeds and how to utilize the eradicated raw materials for economics uses. The invasion of the weeds needs to be controlled and utilize their raw material foe economic uses. For example, the *Eichhornia* weed is being utilized for electricity generation and eupatorium for preparation of compost. Forest Research Institute has made furniture and buckets from Lantana camara wood.

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Corresponding author: Dr. Sabiha Kazmi, Department of Botany, Shia P.G. College, U.P., India