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RESEARCH ARTICLE

INVASIVE ALIEN SPECIES OF BILLAWAR, MAHANPUR AND BANI TEHSILS OF DISTRICT KATHUA, JAMMU AND KASHMIR, INDIA

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ABSTRACT

A case of Jammu and Kashmir is one of the biodiversity hotspots in India including many endemic plant species. One of the threats to the biodiversity of the region is the invasion of alien species. The invasive alien species have naturally introduced into the area from the adjoining Punjab plains. The damage caused by the invasive alien species in terms of biodiversity loss and disruption of natural ecosystems outweighs their benefits. The invasive alien species present there are seriously affecting the biodiversity of the region. Most of the invasive alien weeds were found to marginalize the native species with the result native species either fail to germinate or cannot compete with the aggressive invaders. Some alien weeds exhibit allelopathic effects thereby preventing the growth and multiplication of native species. The alien weeds have also been found to exert serious negative impacts on the agriculture and animal husbandry by reducing the crop yields, escalating the cost of produce and marginalizing grasslands and pastures. The management of invasive weeds requires co-ordinated efforts to control and eradicate them so as to prevent further damage to the biodiversity.

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INTRODUCTION

India is a mega-diverse nation, comprising around 10 percent of world's species. Jammu and Kashmir is one of the biodiversity hotspots in India including many endemic plant species. The biodiversity of Jammu & Kashmir has been subjected to degradation due to a number of reasons. Invasive species are recognized as one of the major threats to native species and ecosystems around the world (Kathiresan, 2004; Kathiresan *et al*., 2005). Among the major threats faced by native species, the one posed by the invasion of alien species is truly scaring. Species which are either introduced or spread outside of their native habitat may tend to out-compete native species and sometimes become invasive and noxious weeds causing huge economic loss or damage to the biodiversity of the region. Such species are designated as Invasive Alien Species (IAS). Some species also alter the environment in a manner that makes it more favourable for them, but less favourable for native species, often called as ecological facilitation. Invasive species have now affected almost every ecosystem and considered as the second greatest global threat (Essa *et al*., 2006).

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The damage caused by the invasive alien species in terms of biodiversity loss and disruption of natural ecosystems outweighs their benefits. Biological invasions are one of the main drivers of biodiversity loss. Invasive alien species may have far reaching and harmful effects on environment and natural resources for generations. United Nations General Assembly at its 65th session declared the period 2011-2020 to be " the United Nations Decade on Biodiversity" with a view to contribute to the implementation of the Strategic Plan for Biodiversity. Throughout the 'United Nations Decade on Biodiversity' governments are encouraged to document status survey of biodiversity for its overall conservation at regional, national and international level. However, in parts of Asia the issue of invasive alien species has low profile attention and priority due to a number of other priority concerns of socio-economic and political nature. The present study in part will support the implementation of the Strategic Plan for Conservation of Biodiversity. The present study was performed from 2014 onwards with the aim to document the invasive alien species prevalent in the region and also to determine their dispersal mechanisms, impact on biodiversity, toxic effects, control and eradication.

MATERIALS AND METHODS

The study followed a random sampling method so that no bias is introduced at the time of data collection. A list of all the villages and sub-urban localities was drawn. The survey areas were randomly selected in all the three tehsils of the area of study in the district. Each study unit was sub-divided into different land use types such as agricultural fields, forest areas, orchards, grasslands waste lands, disturbed areas and wet land. The various localities visited for the sampling include Kishanpur, Bhaddu, Malti, Sukrala Devi, Dharalta, Pallan, Seri, Dambra, Plail, Mahanpur, Talwar, Rehalta, Mara-patti, Poonda, Plassi, Basohli and Dhar-Jankhar. The survey and data collection on the invasive species of the study area was carried out from 2014 to 2016.

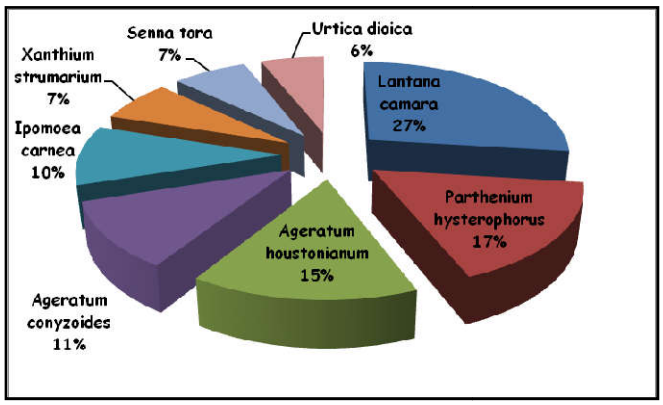

Fig. 1. Dominant Invasive Alien Species (IAS) present in the study area

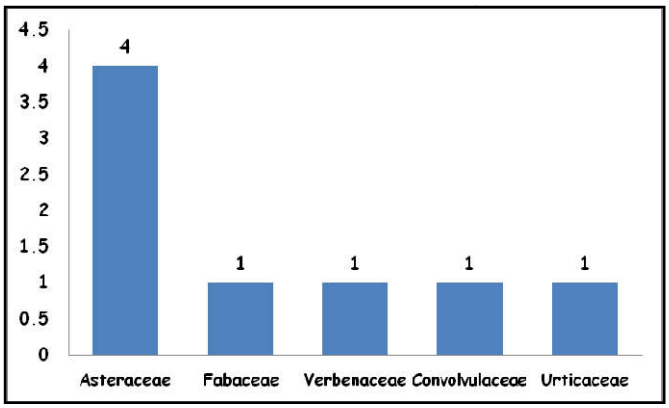

Fig. 2. Dominant families of Invasive Alien Species (IAS) present in the Area

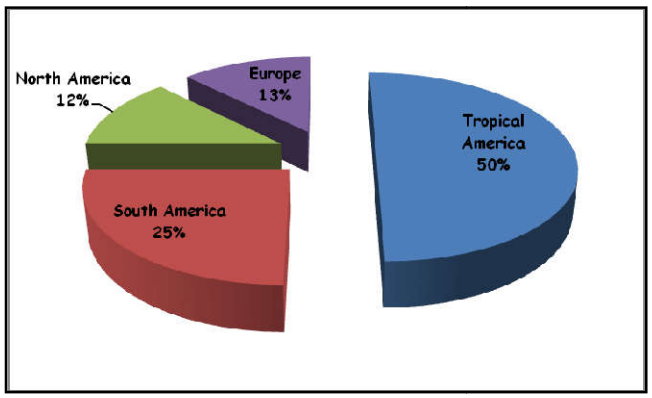

Fig-3 Native Range of Invasive Alien Species (IAS) present in the study area

The author has conducted many field trips in different villages of the research area. The units selected for the study were revisited many times of the year to record every stage of the species concerned like flowering, fruiting, seed dispersal etc. The samples and specimens were collected from the fields, systematically pressed and dried by using plant press and then preserved for identification and record. The plant specimens were also photographed in their wild form in the ecosystems of their occurrence. Photographs of almost every stage of plant species including flowering, fruiting, seeds were taken for record and identification.

The equipments, tools and other related material employed in the study include microscope, dissection microscope, camera lucida, magnifying lens, plant press, cutters, Photographic camera, field note-book and polythene bags. The plant specimens were identified by applying taxonomic keys and reference to the local floras. The identification was also facilitated by way of consultations with experts in the field of taxonomy and final confirmation was done by visiting to the local herbaria. Online identification system and ISSG database were also used to identify and determine the alien origin of species. The common names of the plants were ascertained by way of investigations from the elderly men in the vicinity. The information gathered by way of questioning to the farmers and native men was cross verified. The plant specimens and photographs of species explored during the course of study were handed over and kept for record in nearest concerned institution. Studies on various aspects of the problem like origin, impacts, toxicity levels and invasiveness were done and have been discussed.

RESULTS AND DISCUSSION

The invasive alien species prevalent in the region were found growing under different habitat such as forestland, grassland, fallow land, wasteland and agricultural areas. The habit, morphology, dispersal mechanisms and the impacts of invasive alien species on the native biodiversity besides agriculture and the people were observed, analyzed and recorded. The invasive alien species present in the area have their origin in South, Central or North America and Europe. All the invasive alien species present and studied in the area are discussed as under:

Ageratum conyzoides Linn.

Family: Asteraceae.

Common Name: Billy goat weed, White weed.

Native Range: South and Central America.

Description: An erect, softly hairy, annual herb with rank smell, stems 10-50 cm tall. Leaves ovate, crenate, cordate or cuneate, lamina 4-5 cm long. Heads pale-blue or pinkish purple or white, 6-10 mm in diam., in dense, terminal corymbs. Involucral bracts narrowly linear, ribbed, scarious margined, glabrous. Achenes black, hairy along the angles, pappus hairs concave below.

Dispersal: Propagation occurs through seeds formed in large numbers which are easily blown by wind to long distances. Seeds are also dispersed through animals, water and humans.

Fig. 4. Invasive Alien Species (IAS) in the various ecosystems of the study area

Impact: An aggressive invader of agricultural land, grasslands, forestlands, fallow land, orchards and by virtue of competition, habitat destruction and allelopathy the infestation reduces native plant species number and diversity. The toxicity effects in mammals include liver lesions and tumors.

Prevention and Control: (i) Due to its shallow rooted habit it is relatively easy to uproot and control by using mechanical means rather than hand-picking. (ii) It is susceptible to a wide range of standard herbicides like butachlor, 2,4-D, bentazone, oxidiazon, ametryne, terbutryne and acetochlor.

Parthenium hysterophorus Linn.

Family: Asteraceae.

Common Name: Congress grass.

Native Range: North America.

Description: An annual herb, stem 50-150 cm tall, rigid, branched, whitish hairy, longitudinally grooved. Leaves simple, pinnately and irregularly much dissected, alternate, forming rosette in younger plants, dissected tips acute, entire. Heads axillary and terminal, whitish with minute or hairy involucrate bracts, 4-5 mm across, heterogametic, ray florets usually 5, fertile, disc florets 50 or more. Achenes ellipsoid-obovate and dark brittle.

Dispersal: Propagation takes place through seeds formed in large numbers, about 10,000-15,000 per plant with high

longevity and dispersed by different agencies like wind, water, birds, and vehicles.

Impact: It is an invasive and allelopathic weed of crops, forest lands, grass lands, disrupting natural ecosystems by replacing native species and also drastically reduces crop yields. It is also toxic to cattle and humans causing dermatitis, respiratory disorders and occasional death.

***Prevention and Control*:** (i) The hand picking of weed is not advisable due to allergic effects. (ii) Eucalyptus oil is used as a natural herbicide. It is also susceptible to the standard broad leaved herbicides like 2,4-D, dicamba, glyphosate, atrazine, S-metolachlor etc. (iii) Biological control through leaf feeding beetle (*Zygogramma bicolorata*) seems useful to some extent.

Lantana camara L.

Family: Verbenaceae.

Common Name: Lantana, Tick berry.

Native Range: Central and South America.

Description: An aromatic straggling, gregarious shrub, branches prickly, 4-angled, densely interlaced into large impenetrable thickets. Leaves rugose, scabrid with rough hairs, ovate or ovate-oblong, 3-10 x 3-6 cm, base cordate, cuneate or rounded. Flowers variable, yellow or orange-red. Fruit black and shining.

Dispersal: Propagation occurs both vegetatively through axillary shoots and seeds dispersed by birds to long distances.
Impact: An aggressive colonizer of grassland, field margins, pastures, forest edges, fallow lands and degraded forestland, often forming permanent thickets which exclude native plant species and severely harm plant diversity.

***Prevention and Control*:** (i) It is susceptible to the selective application of broad-leaved standard herbicides. Often cleared areas are rapidly colonized through root sprouting or seed. (ii) A combination of mechanical and chemical treatment is more effective to control this weed. (iii) Biocontrol by using natural pests and pathogens need to be employed.

Ageratum houstonianum Mill.

Family: Asteraceae.

Common Name: Blue Weed, Mexican Paint Brush.

Native Range: Central America.

Description: An annual, hairy herb, 15-60 cm long, erect or decumbent, stem reddish to green, pubescent. Leaves ovate to deltoid, lower opposite, upper alternate, hairy, lamina 3-6 x 2-4 cm, crenate-serrate. Heads homogametic, in terminal corymbs, 5-8 mm across, several disc florets only, ray florets absent, corolla 5, tubular, lavender blue, pink, lilac or white. Involucral bracts stipitate glandular on outer surface. Achenes hairy, pappus scales 5, white.

Dispersal: Propagation occurs through seeds dispersed by wind, water, animals and vehicles.

Impact: An invasive and allelopathic weed which grows in dense patches in crops, forestlands, grass lands, and often displaces native plant species besides reducing crop yields and toxic to cattle.
Prevention and Control: (i) Hand picking is not advisable due to allergic effects. (ii) A 20% solution of common salt can be safely used in non-cropping areas. (iii) It is susceptible to the selective application of standard broad leaved herbicides like 2, 4-D, dicamba and metsulfuron-methyl. Diphenamid application to the soil also reduces the growth of the species.

Ipomoea carnea (Mart. Ex Choisy) Austin.

Family: Convolvulaceae.

***Common Name*:** Morning glory.

Native Range: Tropical America.

Description: A robust, perennial shrub, up to 3 m tall, erect or sub-erect, gregarious, diffuse, milky latex present in all parts, stem slender, woody, hollow, glabrous, light-brown in older parts. Leaves simple, alternate, petiolate, ovate, cordate, entire, acute, pubescent, 12-26 x 5-15 cm. Flowers purplish-pink, terminal cymes, trumpet like, 7-8 x 6-7 cm., sepals 5, free, petals 5, gamopetalous, funneliform, stamens 5.Capsule ovoid, 1.5 x 1.2 cm. Seeds black, densely silky with long and brownish hairs.

Dispersal: Propagation occurs more commonly through stem fragments and also by seeds dispersed through wind and water.
Impact: It is an invasive weed grows gregariously in swamps, pools, ponds, ditches as well as on land. The dense growth and allelopathic effects result in loss of aquatic habitat and negative impact on native biodiversity.

Prevention and Control: (i) Manual and mechanical removal is not effective in the aquatic environment. (ii) Although the weed is susceptible to the commonly used herbicides but their use is restricted in aquatic habitat due to the harmful effects on other organisms.

Senna tora (L.) Roxb.

Family: Fabaceae,

Common Name: Sickle Senna,

Native Range: Tropical America.

Description: An erect under-shrub, 30-75 cm tall, gregarious annual, strong unpleasant odour. Stem cylindrical, branched, glabrous or sparsely puberulent. Leaves pinnately compound, alternate, leaflets usually in 3 pairs, obovate-oblong, 2-6 x 1-3.5 cm, apex obtuse, margins ciliate. A rod like gland is situated between each of the lowest two pairs of leaflets. Flowers about 1.2 cm long, pedicellate, axillary, solitary or in pairs, sepals 5, free, corolla of 5 petals, free, unequal, yellow, fertile stamens 7, staminodes 3, carpel 1, ovary superior. Fruit a legume, slender, falcate, 12-20 cm long, imperfectly septate between the seeds, brown. Seeds many, cylindric, obliquely truncate, brownish, shinning.

Dispersal: Propagation occurs through seeds dispersed by water, animals, contaminant of agricultural produce and human activities.

Impact: It is an invasive weed which grows gregariously in fallow lands, waste lands, grasslands, forest lands, agricultural crops where it out-competes other native species of the ecosystems with negative impact on plant diversity. It also reduces crop yields.

Prevention and Control: (i) The uprooting of seedlings reduces infestation. A light tillage of the affected land at the seedling stage controls the aggressive colonization of weed. (ii) It is susceptible to selective application of a wide range of standard herbicides like picloram, butachlor, 2, 4-D, dicamba, diuron and terbutryne. (iii) Biological control by way of the introduction of seed bruchid *Sennius instabilis* is useful. The fungal pathogens- *Pseudocercospora nigricans* and *Pseudoperonospora cassiae* with herbicidal effects are also useful to control the infestation.

Urtica dioica L.

Family: Urticaceae.

Native *Range*: Europe.

Common Name: Stinging Nettle, European Nettle.

Description: A stinging herbaceous perennial, 80-175 cm. Stem robust, upright, grooved, pubescent, fibrous arising from basal rhizomes. Leaves simple, opposite, 5-10 cm, lower ovate and the upper ones lanceolate, base cordate, acuminate, coarsely serrate, petiolate, petiole not more than half as long as the lamina, stipules free, four at each node 1–2 mm wide, lanceolate, lamina with conspicuous stinging hairs at least on the upper surface, non-stinging hairs relatively coarse and sparse. Inflorescences axillary, spike-like, four per node, many-flowered, flowers small, greenish and unisexual, male and female flowers are found on separate plants, flowers tiny, greenish, the males more upright or patent and the females tending to be pendent, the male with four perianth segments and four stamens, the female with two smaller and two larger perianth segments and a one-celled ovary with a sessile tufted stigma. Fruits single seeded achenes, flattened, encircled by persistent perianth.

Dispersal: Propagation takes place through underground rhizomes and seeds formed in large numbers. Seeds are dispersed through different agencies like wind, water and animals.

Impact: Generally seen in large patches in places like wastelands, fallow lands, grasslands, orchards, roadsides and often forming monospecifc stands which besides its horizontal spread through rhizomes destroys habitat and restricts or prevents the growth of native species. The stinging trichomes cause irritation, pain and burning sensation related health problems in humans and animals.

***Prevention and Control*:** The control and eradication of stinging nettle is difficult due to stinging leaves and a large root mass. (i) It can be controlled to some extent by repeated tillage and cultivation of the infested area. Repeated cutting also prevents monospecific stand formation. (ii) Repeated and selective herbicide treatment by using picloram, 2, 4-D, clopyralid, triclopyr and dicamba. (iv) Biocontrol by using natural pests and pathogens like *Eupateryx urticae, Liocoris tripustulatus, Dasinura urticae* and *Trioza urticae* needs to be employed.

Xanthium strumarium Linn**.**

Family: Asteraceae.

Common Name: Cocklebur

Native Range: South and Central America.

Description: A stout, foetid, coarse annual up to 1m tall with purple spotted stem. Leaves long petiolate, undulate, scabrid, obscurely lobed, toothed, lamina 5-12 cm long. Heads discoid, green, males about 6 mm in diam., towards the top of inflorescence, female involucres with 2-enclosed apetalous florets. Fruiting involucres ovoid, hard, 1.5-2 cm long, clothed with hooked prickles. Achenes black, ribbed on the faces.

Dispersal: Propagation occurs through seeds which remain viable up to 5 years. The spiny burs get attached to animals, human clothing and also dispersed by water.

Impact: An invasive weed of agricultural lands, grass lands, fallow lands, disturbed lands, open lands, usually seen in thick stands and often displaces native species besides drastically reducing soil fertility and crop yields. The glandular hairs on leaves and stem cause dermatitis and also considered poisonous to mammals.

Prevention and Control: (i) Cultivation of land reduces the invasiveness, adoption of zero tillage can reduce population because burs seldom germinate on the soil surface (ii) It is susceptible to most of broad-leaved herbicides like glyphsate, 2, 4-D, dicamba, paraquate and triazines. (iii) Biocontrol by using natural insect pests and fungal pathogens like *Puccinia xanthii* and *Alternaria helianthi* is useful to check the growing populations.

Conclusion

Forests, agriculture and allied activities play a vital role in a nation's economy. But weeds of invasive nature have vigorously occupied all these domains. The invasive alien weeds have naturally introduced into the area from the adjoining Punjab plains. Many of the introduced alien weeds have successfully colonized in the area. They exhibit high growth rate, rapid multiplication, high dispersal ability and phenotypic plasticity with the result majority of them have become invasive in the new environment. The invasive alien weeds which have been listed and described are the cause of immediate concern in the study area, leaving much more scope for further investigation. All of them have been seriously affecting the local biodiversity of the region in one way or the other. Most of the invasive alien weeds were found to marginalize the native species, such species either fail to germinate or cannot compete with the aggressive invaders. Some alien weeds also exhibit allelopathy thereby preventing the growth and multiplication of native species.

All the invasive alien weeds listed and described are the aggressive colonizers in different habitats of the study area, out-compete the native flora and marginalize the native species with the result many native species are near to extinction. *Ipomoea carnea* has engulfed most of the village ponds, ditches and marsh lands in the area due to its lead role in hydrarch. *Lantana camara* has replaced a significant area of bush-lands by its monoculture thickets with serious effects on growth and diversity of the native species. *Parthenium hysterophorus, Ageratum conyzoides* and *Ageratum houstonianum* have also seriously affected the area and among *Ipomoea carnea* and *Lantana camara* proving difficult to control. *Parthenium hysterophorus* is directly related to be the cause of a number of deaths due to its toxicity. The invasive alien weeds have also been found to exert serious negative impacts on the agriculture and animal husbandry by reducing the crop yields, escalating the costs of produce and marginalizing grasslands and pastures. There is a lack of co-ordinated efforts to control and eradicate the invasive weeds. The management of invasive weeds requires a thorough knowledge of their ecology, reproductive biology, physiology besides following the appropriate guidelines of their control and eradication so that the conservation of fragile biodiversity of the region is restored.

Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this paper. All the contents of this article including observations, results, discussion, conclusion and figures are based on the original research work of the author.

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