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Research Article

STUDIES ON THE IMPACT OF INVASIVE ALIEN SPECIES OF FAMILY CONVOLVULACEAE, FABACEAE AND AMARANTHACEAE IN RAJOURI DISTRICT OF JAMMU AND KASHMIR

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ABSTRACT

The present study aims to deal with impact of invasive alien plants species of families Convolvulaceae, Fabaceae and Amaranthaceae in Rajouri district (J&K, India) with background information on habit and nativity. A total of 07 invasive alien plant species have been recorded, which include *Ipomoea carnea* (Jacq.), *Ipomoea pes-tigridis* (Linnaeus), *Ipomoea purpurea* (L.) Roth, *Leucaena leucocephala* (Lam.) de Wit, *Cassia tora* (Linnaeus) *Chenopodium album* (Linnaeus), *Alternanthera philoxeroides* (Mart.) Griseb. The result reveals that most species have been introduced unintentionally through trade, agriculture and other anthropogenic activities. There is utmost need of proper methods for early detection to control and reporting of infestations of spread of new and naturalized weeds.

INTRODUCTION

An alien species "refers to a species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce" (CBD, 2002). These organisms are sometimes called "exotic", "non-native" or "non-indigenous species."

Invasive alien species are a growing threat throughout the world, causing losses in biodiversity, changes in ecosystems and impacts to economic enterprises such as agriculture, forestry, fisheries, power production and international trade. Those alien species that become established in a new environment, then proliferate and spread in ways that are destructive to human interests are considered "Invasive Alien Species"(IAS)."Invasive alien species have invaded and affected native biota in virtually every ecosystem type on earth. These species have contributed to many hundreds of extinctions. The environmental cost is the irretrievable loss of native species and ecosystems. Most nations are already grappling with complex and costly invasive species problems. Addressing the problem of invasive alien species is urgent because the threat is growing daily, and the economic and environmental impacts are severe.

The present study aims to act as a foundation stone for the advanced studies in invasion ecology and biology and would serve a benchmark for future assessment of extent of invasion not only in this biodiversity rich region of J&K state but also the rest of the country.

MATERIALS AND METHODS

Study Area

Jammu and Kashmir is the northern most state of India. It is located between 32° 17' to 37° 5' north latitude and 73° 26' to 80° 30'east longitude, occupying central position in the Asian continent.

It has three distinct climatic regions viz. arctic cold desert areas of Ladakh, temperate Kashmir valley and sub-tropical region of Jammu. There is a sharp rise of altitude from 1000 feet to 28,250 feet above the sea level within state's four degree of latitude. The climate varies from tropical in Jammu plains to semi-arctic cold in Ladakh with Kashmir and Jammu mountainous tracts having temperate climatic conditions. The annual rainfall also varies from region to region with 92.6 mm in Leh, 650.5 mm in Srinagar and 1,115.9 mm in Jammu. A large part of the state forms part of the western Himalayas.

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The present work is carried by the author in the Rajouri district of which is situated in the west of Jammu division. It is bounded by Poonch district in the north, Jammu district in the south, Udhampur district in the east and Pak occupied Kashmir (Mirpur area) in the west. It is located in the foothills of Pir Panjal Range. The general elevation of the district is in the range of 562-4800 m above mean sea level. Rajouri is the district headquarter, which is 160 km from Jammu, the winter capital of Jammu and Kashmir. This part of Jammu region encompasses extraordinary biotic communities which is attracting people from different regions and is being promoted as a tourist destination.

With the operationalization of improved roads and highways and better connectivity, the influx of traders, tourists, businessmen has increased manifold, thereby raising the threat of invasive alien species even more into this Pir Panjal range.

The main objectives of the present study are

1. Documentation and inventorisation of the alien flora of Rajouri district.
2. To record their origin, spread, introduction pathway and invasion status.
3. To spread public awareness on the impact of invasive alien species on environment and economy.

Extensive survey was carried out in Rajouri district during 2012 -2013. The field studies for documenting the spread of invasive alien species belonging to families Convolvulaceae, Fabaceae and Amaranthaceae in Rajouri district of Jammu Division were conducted in all the seven tehsils of the district viz. Rajouri, Nowshera, Kalakote, Sunderbani, Koteranka, Thannamandi and Darhal.

The present investigation aims to identify and document the invasive alien species present in the Rajouri district of the Jammu region of J&K state. During the course of field study the authors have selected different tehsils and blocks of Rajouri district viz; Rajouri, Nowshera, Kalakote, Sunderbani, Budhal, Thannamandi, Darhal, Koteranka and Manjakote and the following steps were followed: visit to study sites, sample collection, preservation and identification. During this period enquiries were conducted from farmers and agriculturalists of each site about the invasive biota. Every site was divided into different land use types, and the division was made as follows: agricultural fields, forest areas, roadsides, fallow land, along the banks of water bodies, residential areas, low land, water bodies, waste lands, etc.

Each study site was intensively sampled for the invasive species, their numbers and other characters. The survey and data collection on the invasive alien species of Rajouri district followed a random sampling method so that no bias is introduced. The field books were maintained to record the following information : collection number, date of collection, local name, family, habit, habitat and impacts. The species were collected systematically, preserved and stored for identification. Existing literature and information from web based data, online identification system and ISSG database were used to determine the alien origin of the species.

Survey and Collection: A comprehensive survey was conducted by the author in various locations in Rajouri district for invasive plant species. Periodic survey were conducted during premonsoon, monsoon and postmonsoon seasons. All the available plant species were recorded and collected. Observations were made regarding occurrence, distribution of plant species, colonization modes and damage or changes to the ecosystem caused by the invasive plants. Field observations regarding individual plant species, site where it is growing and the potential damage it is causing to the ecosystem was recorded in the field notebook and photography of it was done with Sony Sony DSC-T20 digital still camera.

Preservation and Herbarium Records: The plant species collected during every field trip were carried to the laboratory and were properly pressed, dried and properly preserved and herbarium sheets were made using conventional methods of processing and drying.

Identification: After an extensive review of literature on global invasive species (Mooney and Drake,1987; Heywood, 1989; Cox, 1999, 2004; Cracroft and Francesca, 1999; D'Antonio and Vitousek, 1992; Drake *et al.*,1989; Randall *et al.*,1997; Huxel,1999; Jenkins, 1999; Lonsdale, 1999; Mooney, 1999; Elton, 2000; Mooney and Hobbs, 2000; Almeilla and Freitas, 2001;Cowie, 2001; McNeely *et al.*, 2005) and of India and their spread based on history, species origin, species behaviour and field observations, a list of 07 species plant invasives belonging to families Convolulaceae, Fabaceae and Amaranthaceae was prepared. The websites were also examined extensively for background information. Of these, some species may have invaded only a restricted region, but have a huge probability of expanding and causing great damage. Existing literature and information from web based data, online identification system and ISSG database were used to determine the alien origin of the species.

The identified voucher specimens were mounted in the herbarium file of the size 41.5 cm x 28.5 cm along with photographs and deposited in the museum of the Department of Zoology, University of Jammu, Jammu. Each plant species was provided with its botanical name, author citation and brief morphological description. Besides, help from other agencies were also undertaken.

RESULTS AND DISCUSSION

In view of the immediate importance of Invasive Alien Species, there is an apparent need for a regional and national authentic database for monitoring the spread and impact in various regions and for devising appropriate management strategies. The present study records first ever database on the invasive alien species of families Convolvulaceae, Fabaceae and Amaranthaceae. Rajouri district of Jammu division of J&K state. The survey yielded a total of 07 species of invasive alien plants, which include *Ipomoea carnea* (Jacq.), *Ipomoea pes-tigridis* (Linnaeus), *Ipomoea purpurea* (L.) Roth, *Leucaena leucocephala* (Lam.) de Wit, *Cassia tora* (Linnaeus), *Chenopodium album* (Linnaeus) and *Alternanthera philoxeroides (Mart.)* Griseb. Of these, *Cassia tora* (Linnaeus) and *Chenopodium album* (Linnaeus) are herbs, *Ipomoea carnea* (Jacq.) is a shrub, *Ipomoea pes-tigridis* (Linnaeus) and *Ipomoea purpurea* (L.) Roth are climbers while *Alternanthera philoxeroides (Mart.)* Griseb. is an aquatic plant**.** However, many more species have also been recorded from different

parts of Rajouri but their taxonomic status have so far not been determined. Efforts are on to get them identified and will be included in the database shortly. About 80% of these alien species were introduced from Europe, followed by North America.

Contemplating the importance of studies on invasive alien species, especially in the areas the of high anthropogenic interference, present study was aimed at compiling the first ever inventorisation of the alien flora of Rajouri district, along with supplementation of each species with information on origin, habit, spread, introduction pathway and the invasion status.

Ipomoea carnea Jacq.

Order: Solanales ***Family:*** Convolvulaceae

Common Name: Pink morning glory, Bush morning glory.

Short Description: *Ipomea carnea* is a shrub which grows to 1-5 m high. The stem is thick and develops into a solid trunk over several years with many branches from base; leaves are rich green, heart-shaped or somewhat lanceolate and 10 -25cm long; flowers in clusters at the ends of branches, pale to deep pink and funnel shaped; fruit is brown, glabrous dehiscent capsule; plants bloom in all spring and summer long.

Habitat: It grows along the road sides, river banks, ponds, agricultural areas, railway tracks, canals, lakes. Common weed of marhsy lands and along the edges of tanks and ditches.

Biology/Ecology

Dispersal Mechanism: Spread primarily by means of seeds. Reclining stems in contact with the soil develop adventitious roots and detached portions can grow into new plants. Suckers are produced as well.

Reproduction: It reproduces by seeds. Fruits dehiscence occurs during winter by the splitting of the dry fruit wall and the hairy seeds are dispersed by wind and water. It produces 8000 to 10,000 seeds per plant. The seeds do not germinate immediately because of hard seed coat which is impervious to water. Germination is increased by the removal of seed coat and also varies according to temperature. It also propagates vegetatively via stems that come in contact with the soil, from roots and can develop into new plants.

Distribution

Native Range*:* Tropical America.

Introduced Range*:* It was introduced into areas outside the Neotropics. It is naturalised in China, India, Sri Lanka, Pakistan, East Africa, Malayan Archipelago, Indonesia, Okinawa. It was introduced to Egypt for ornamental purpose.

Distribution in India: Throughout.

Distribution in Jammu Division (Rajouri district)*:* Widespread.

Introduction Pathway: By man for ornamental purpose, by floods, soil and wind agency.

Impact: It is a localized weed and wherever it grows it dominates over the associated species. In India, it is a common weed in agriculture fields but is spreading very fast to other areas. It is highly toxic to sheep, cattle and goat (Bhattacharyya and Midya, 1979). It is able to cause severe nervous disorder when ingested by bovines, sheep or goats (Tokarnia *et al.*, 2000). It competes with native plants for various resources. The rapid growth rate, spread, and adaptability from aquatic to xerophytic habitats indicate that this plant may potentially become another ecological disaster in India like water hyacinth. It now causes serious invasions in wetland habitats of India and Pakistan where streams, mangroves and other ecosystems may be blocked, hampering irrigation. It spreads on land in many habitats and may cause obstruction and difficulties in the proper use of the land for cultivation. In water it affects irrigation, navigation and fisheries.

Threat level: High.

***Ipomoea pes-tigridis* (Linnaeus)**

Order: Solanales ***Family:*** Convolvulaceae

Common Name: Morning glory, Tiger foot morning glory, Bindweed, Cupid's flower.

Short Description : It is a slender, herbaceous annual, twining or sometimes prostrate twig, 0.5 -3 m long, all parts being more or less covered with rather long, spreading, pale, or brownish hairs. The leaves are 2 to 8 cm long, petioles stalked. The leaf blades are elliptical to circular in outline across, 2 to10 cm long and 3 to 13 inches wide. They are deep palm-like divided into five to nine segments. These are elliptical or elongated, tapered at both ends. The flowers occur in axillary head, usually only one opening at a time. The sepal tube is green and about 1 cm long. The flowers are white and 4 cm long. The fruit is brown, ovoid and 6-7 mm long capsules. Seeds black, 4 mm long, grey pubescent. Flowering and fruiting mainly occurs during July - February.

Habitat: It occurs in grasslands, waste places, fields, thickets, occasionally in teak forests, also in sandy soils near river and lake banks.

Biology/Ecology

Dispersal Mechanism*:* It is mainly spread by seeds and also from herbaceous stem cuttings.

Reproduction: This species reproduces by seeds and it has the ablity to set seeds quickly and in enormous quantities. It also reproduces by vegetative propagules.

Distribution

Native Range: Native to tropical East Africa.

Introduced Range: It is naturalised in China, Indonesia, India, Malaysia, Myanmar, Nepal, New Guinea, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam, Africa and Australia.

Distribution in India: Throughout.

Distribution in Jammu Division (Rajouri district): Widespread across all the tehsils of Rajouri district.

Introduction Pathway: Introduced to new areas by contaminated agricultural tools, water movements, wind, soil and human activities.

Impact: Ipomoea pes-tigridis aggressively colonises open, sunny, grassy places such as roadsides, pastures, old clearings in forest, and edges of cultivated fields. The twinning stem of this weed twist around the crop plants and help them to climb up. Once these weeds climb up the crop plants they use maximum proportion of sunlight and compete with them for resources, resulting in their stunted growth which in turn affects the yield of agricultural crops. This weed crawl around the maize plants and cover their canopy from all the sides. The vegetative growth of these weeds is so vigorous that whenever their weight become excess they breaks the crop plants and cause heavy loss of crops.

Threat level: Moderate To High.

Ipomoea purpurea* (L.) *Roth

Order: Solanales ***Family:*** Convolvulaceae

Common Name: Common morning glory, Morning glory, Purple morning glory, Tall morning glory.

Short Description: *Ipomoea purpurea* is a herbaceous annual twining climber. Stems are hairy and may be trailing or twinning. The leaf blade is ovate, entire or 3-lobed, acuminate at the apex, heart-shaped at the base, glabrous or pubescent. Flowers are solitary or in few-flowered cymes. The stalk of the inflorescence is up to 12 cm long. Sepals finely pubescent all over; corolla is white, pink or magenta and white below. The blooming period occurs from mid-summer to fall and lasts 2-3 months. Each flower open in the early morning and close before noon each day during the blooming season The large seeds are dark-colored and wedge-shaped. Single plant can produce upto 26,000 seeds/plant (Crowley and Buchanan,1982).

Habitat: *Ipomoea purpurea* invades waste and cultivated ground mainly in riparian, roadsides, railroads, wetland and coastal habitats.

Biology/Ecology

Dispersal Mechanism: This plant spreads by reseeding itself. Seed dispersal is by wind, rain action and gravity (Danielson, 1970). Seeds also can be spread by birds and by human activities, by way of contaminated crop and flower seeds.

Reproduction: It has perfect flowers and is capable of reproducing both through selfing and outcrossing. It relies primarily on insect pollination but is also capable of self-fertilization. About 30% of the flowers are self-pollinated; lighter colored flowers more often are self-pollinated / self-fertilized. Cross pollination occurs mostly by bumblebees and reportedly small butterflies; darker colored flowers have a higher degree of outcrossing and thus provide for variation within the species (Chang and Rausher, 1999; Defelice, 2001).

Distribution

Native Range: Native to tropical America (Mabberley, 1997; United States Department of Agriculture, Forest Service: Iverson 2002).

Introduced Range: It is naturalized throughout warm temperate and subtropical regions of the world.

Distribution in India: Throughout.

Distribution in Jammu Division (Rajouri district): Widespread.

Introduction Pathway: By Birds, movement of water, wind agency and by human activities.

Impact: *Ipomoea purpurea* is mainly a weed of agricultural areas and disturbed sites (e.g. crops, roadsides, parks, gardens, fence-lines and waste areas). However, it also invades bushland and riparian zones and can be a serious environmental invasive species in warm moist areas, where it chokes out native plants. Once established in areas of indigenous vegetation,it is able to outcompete native species for nutrients, water and sunlight. It spreads mainly along riparian zones. The seed are poisonous if ingested. The damage is caused by inhibiting photosynthesis of the trees they climb on and cover and by breaking branches by their weight. It is able to both self-fertilize and cross-fertilize, insuring there is some seed set if there is lack of pollinators. It has the capability to produce large numbers of seeds; it strongly competes with cotton plantations (Crowley and Buchanan, 1982).

Threat level: Moderate to high.

***Leucaena leucocephala* (Lam.) de Wit**

Order: Fabales ***Family:*** Fabaceae

Common Name: Horse tamarind, Lead tree, White lead-tree, White popinac, Wild tamarind, Coffee bush.

Short Description: *Leucaena leucocephala* usually grows upto 2-10 m tall, but occasionally reaching 15 m or more in height with bipinnate leaves. The younger stems are green and usually densely covered with fine greyish coloured hairs and pubescence. Older stems have a relatively smooth, greyish or greyish-brown, bark with numerous small raised spots. Flowers grow in cluster on the end of branches. Individual flowers are white, turning brown at maturity. It is a prolific seed producer. The dark brown seed pods are flat, roughly 4 to 6 inches long, with about 20 seeds. Seeds are glossy brown, oval, flat, 6 mm long.

Habitat: A very troublesome weed of riparian zones and roadsides. It is also found in open woodlands, gardens, parks, waste areas, disturbed sites and on coastal foreshores and offshore islands.

Biology/Ecology

Dispersal Mechanism: The seeds are often dispersed by small animals and cattle. The light pods may also be spread short distances by wind and water.

Reproduction: The flowers are self-fertile, and most seed results from self-pollination. Flowering and fruiting occur throughout the year as long as moisture permits; fruiting is associated with suppression of vegetative growth. Arboreal cultivars have been selected for lower flowering rate. Fruits ripen in 10-15 weeks.

Native Range: Native to Mexico and Central America.

Introduced Range: It is naturalised in South America, Asia, Southern Europe, Australia and Africa.

Distribution in India: Throughout.

Distribution in Jammu Division (Rajouri district): Widespread.

Introduction Pathway: By man, animals, water flow, and by wind agency. Widely promoted by national and international agricultrual and forestry development agencies for agroforestry and agricultural use.

Impact: It is an environmental weed in many parts of the world. It grows very fast in suitable sites. In areas where it is considered an invasive, it forms dense thickets that are difficult to control once established. Disturbed, cleared areas, coastal strands, outskirts of forests and canopy gaps are some locations regularly invaded by this species. Invaded areas become unusable and inaccessible with most other vegetation being replaced. Once it establishes itself it displaces native vegetation and can promote suitable conditions for the establishment of even more aggressive invaders. The mimosine in the leaves of *L. leucocephala* can cause hair loss, infertility and stomach problems in livestock, especially those that are not ruminants.

It has been nominated as among 100 of the "World's Worst" invaders.

Threat level: High

Cassia tora (Linnaeus)

Order: Fabales ***Family:*** Fabaceae

Common Name: Foetid cassia, Sickle senna, Wild senna, Chinese senna, Java bean, Stinking cassia, Coffee pod, Ringworm plant.

Short Description: An erect annual herb, grows up to 90 cm in height, stems are usually hairless or sparsely hairy. Leaves are compound and are arranged alternately along the stems and are borne on relatively long stalks 20-45 mm long. The leaves (50-75 mm long) have two to four pairs of leaflets that are egg-shaped in outline with the narrower end attached to the stalk. The leaflets (10-55 mm long and 10-35 mm wide) have rounded tips and their margins are lined with tiny hairs. Flowers are yellow in colour and are borne on short stalks. The flowers are arranged in pairs in the leaf forks and are mostly found near the tips of the branches. Flowering occurs mostly from late summer through to early winter. The fruit is a very slender, sickle-shaped pod. These pods turn brownish-green as they mature and are slightly indented between each of the numerous seeds. The seeds are striped olive and brown (about 3 mm long), shiny in appearance and flattened or irregularly shaped.

Habitat: A weed of disturbed sites, waste areas, roadsides, waterways, agronomic crops and pastures.

Biology/Ecology

Dispersal Mechanism: This plant is mainly spread by seeds. The seeds can disperse upto 5m from the plant. Long distance seed dispersal in nature is mostly by stream flow, water movements over the soil surface or in mud attached to the feet and fur of animals. Many animals like cattle, horses and goat ingest the seeds, some of which survive passage through the gut and are spread in the dung dispersal.

Reproduction: Cassia tora reproduces only by seed. A single plant is capable of producing numerous sickle shaped fruits, each containing many seeds.

Distribution

Native Range: This plant is native to tropical South America.

Introduced Range: It is naturalised throughout the tropical and subtropical regions of the world.

Distribution in India: Throughout.

Distribution in Jammu Division (Rajouri district): Widespread.

Introduction Pathway: It is introduced to new places by contaminated agricultural produce (i.e. fodder and pasture seeds), wind, water, transportation and translocation of machinery/equipments.

Impact: *Cassia tora* is an obnoxious, aggressive, annual, herbaceous weed of the family Leguminosae. It grows very aggressively, competing with crops for environmental resources and releasing toxic chemicals into the surrounding soil. This plant has been referred to as the most economically destructive invasive species throughout the country (Oudhia, 1999). Chemical analysis of this species, however, has indicated the presence of a large number of compounds that are allelopathic in nature. The aqueous extract of the whole plant and leaves produces an inhibitory allelopathic effect on many plants (Sarkar *et al.*, 2012). It is considerably phytotoxic to the growth and development of mustard plantations.

Threat Level: High

Chenopodium album (Linnaeus)

Order: Caryophyllales ***Family:*** Amaranthaceae

Common Name: Antigua hay grass, Fat hen, Goosefoot, Lamb's quarters, Nandi blue grass, Nawai grass, Pigweed, Silver grass, White goosefoot.

***Short Description*:** Erect annual herb up to 1.5(-4) m tall; The stems are ridged longitudinally. They are upright green to reddish in colour, with a grey mealy surface. Leaves are alternately arranged with leaf stalks 0.5-5 cm long. The flowers are small, greenish- white and crumb-like in appearance. They are borne on branched inflorescences on the upper part of the plant. When mature, the fruit are often enclosed by papery sepals. Seeds are shiny black discs measuring 1.2-1.8 mm across. The blooming period can occur from mid-summer through the fall.

Habitat: Common and widespread invasive species found in cultivation, gardens and along roadsides and footpaths.

Biology/Ecology

Dispersal Mechanism: There is no special system of seed dispersal so that most of the seeds drop to the ground. They are not buoyant, but surface water may wash them into ditches where they can be moved long distances. They are also dispersed through dung and droppings of animals and birds.

Reproduction: It reproduces by seeds. Single mature plants can produce upto 500,000 seeds**.** Seeds have been known to survive from 30 to 40 years in soil (Holm *et al.*, 1977).

Distribution

Native Range: European origin (Wagner *et al.*, 1999).

Introduced Range: It is widespread throughout the temperate and tropical regions of the world. It has widely invaded Africa, Australia, Asia and North America.

Distribution in India: Throughout.

Distribution in Jammu Division (Rajouri district): Widespread.

Introduction Pathway: Translocation of machinery/equipment, water movements and by dung and droppings of animals and birds.

Impact: It is one of the most widely distributed invasive species in the world and is a very successful coloniser of habitats that have been recently affected by disturbance. It is one of the more robust and competitive species, capable of inducing crop losses. It thrives on all soil types and over a wide range of pH values. Its pollen can contribute to hay fever-like allergies. It is one of the most serious weeds of a range crop species (e.g., potatoes, sugar beets, carrots, and soybeans). It may act as a host to insect pests including the invasive black bean aphid. It can also serve host to many of the deadly plant viruses.

Threat Level: Moderate to high.

Alternanthera philoxeroides (Mart.) Griseb

Order: Cryophyllales ***Family:*** Amaranthaceae

Common Name: Alligator grass, Alligator weed, Pig weed.

The ability of *A. philoxeroides* to persist in terrestrial, semi-aquatic, and aquatic environments, the ability to rapidly take root along waterway banks, ability to propagate via vegetative fragmentation and waterborne dispersal of vegetative propagules all contribute to its success as an invasive species.

Short Description: A long-lived aquatic, semi aquatic or terrestrial herbaceous plant with a creeping, semi-upright or free-floating growth habit. The stems of this weed often grow as runners along the ground or creeping below the ground surface. They may also spread out over the surface of water bodies and tend to form dense mats of vegetation (up to 1 m thick). These aquatic stems usually become hollow as they mature, which aids in floatation. The production of roots from the nodes of these stems is quite common. Stems can be up to 10 m long and mats of vegetation can be formed up to 15 m out over the water surface. Younger stems are light green to reddish in colour, hairless, and have slightly swollen nodes. The dark green leaves are borne in pairs along the stems and usually do not have any leaf stalks. They are elongated in shape with entire margins and pointed tips. The leaves are hairless and have a somewhat waxy appearance. The whitish flowers are borne in dense globular clusters at the top of stalks. These flower clusters are usually produced in the forks of the upper leaves. Each flower has five small white 'petals' and five yellow stamens. Flowering occurs from late spring through to early autumn. The small fruiting 'capsules' (i.e. utricles) are brownish in colour, bladder-like in appearance, and contain a single seed. The seeds are smooth in texture and oval in shape. Seeds rarely develop, and those that do are seldom viable.

Habitat: It usually grows in aquatic habitats (e.g. canals, rivers, swamps, lakes, dams, ditches, etc.), being rooted to the ground and emerging above the water surface. However, it can also be found free-floating in dense mats on the water surface or growing in terrestrial habitats. It is also a potential weed of wetter pastures and irrigated crops.

Biology/Ecology

Dispersal Mechanism: This plant is spread through fragmentation. Each node or fragment with a node is capable of producing a new plant. Plants are highly competitive and have rapid growth rates.

Reproduction: Reproduction is predominantly through vegetative means; individuals rarely produce seeds, and when they do, the seeds are typically non-viable. Vegetative growth occurs at the apical stem buds, axillary stem and root buds.

Distribution

Native Range: Native to South America.

Introduced Range: North America, Asia, Australia, New Zealand and Europe.

Distribution in India: Throughout.

Distribution in Jammu Division (Rajouri district): Widespread.

Introduction Pathway: Stem segments, which have the ability to float, are easily dispersed by floods and water currents. They may also be spread by boats and other water craft, in dumped garden waste and by animals or vehicles.

Impact: It is considered to be one of the worst aquatic weeds in the world. (Gunasekera, 1999).

Economic Damage: Alligator weed disrupts many economic uses of water (Holm *et al.*, 1997). Thick mats prevent drainage canals, ditches, streams, and other small waterways from emptying rapidly during periods of heavy water load, thus causing flooding. If mats break loose, they create obstructions by piling up against bridges, dams, and sharp bends in waterways. Thick mats also increase mosquito habitat. Navigation of small waterways is obstructed, as is shoreline navigation in large waterways. Efficiency of irrigation systems is decreased. A perusal of various commercial Internet sites in April, 2001 indicated that costs would be approximately $170 to $370/ha for control of alligator weed with the herbicides glyphosate and fluoridone.

Ecological Damage: Alligator weed, like many other invasive aquatic plants, displaces native plants in ditches, along banks, and in shallow water (Holm *et al.*, 1997) It disrupts water flow causing increased sedimentation, and it shades submerged plants and animals causing reduced oxygen levels beneath the mat (Quimby and Kay, 1976). It can also prevent access to and use of water by livestock and humans, damage pumping and irrigation equipment, disrupt various recreational activities (e.g. recreational water sports, boating, fishing and swimming), degrade the natural aesthetics of invaded areas, and promote health problems by providing habitat for disease-carrying

mosquitoes. It is seen as a major threat to irrigated crops, particularly rice crops.

Threat Level: High.

CONCLUSION

In conclusion, our study indicates that such anthropogenic influences along with wanton axing of forests, unregulated grazing, pollution, climate change etc, have promoted invasion by non-native species

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