

Role of *Eupatorium adenophorum* in forest fires

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Abstract: Anthropogenic fires are inextricable part of our ecosystem. Since the arrival of hominids, there are enough evidences of forest fires playing an important role in shaping the forest ecosystems. Increasing population and global climate change are constant sources of disturbances in the forests, increasing the risk of invasion by non-native species. Though, these plants serve a great purpose in local medicinal and ethno botanical purposes, this cause a great loss to natural biodiversity, some of them playing an important role in the spread of forest fires. *Eupatorium adenophorum* is one such noxious weed and is one of the very few found at higher altitudes. The blowout of *Eupatorium adenophorum* in Western Himalayas in last four decades has been unforeseen. Attributing to its prolific growth ability and enhanced use of resources this shrub now forms a major plant community in oak forests (*Quercus*). Under the increasing risks of fire in these regions, the role of *Eupatorium* in increasing the severity and also acting as a pyrophyte is discussed in the given article.

Keywords: Forest fires, Invasive species, *Eupatorium adenophorum*, Global Climate change

Objective of study: The objective of the current study is to determine the role of *Eupatorium adenophorum* in forest fire.

1. Introduction

Invasive species are non-indigenous species, which adversely affect the ecosystem and its biodiversity. Invasive species, habitat loss and global climate change are the three most pressing problems of 21st century (Becellato et al. 2012). Almost 1/6th of global land surface is currently highly vulnerable to invasion from alien species, including significant areas of developing economies and global biodiversity (Early et al 2016). Owing to specific superior characteristics such as prolific seed crop, small seed size, persistent soil seed bank, high offspring production, vegetative reproduction, relative high carbon dioxide production and shade tolerance invasive species are highly successful and pose as great threats to the ecosystem. Forest fires have radical effect upon the structure as well as biological, chemical and ecological functioning of forest ecosystem. It is generally defined as, 'uncontrolled wild fire' which can either be suppressed or not by artificial means, caused mainly due to human activities. Anthropogenic fires are as old as the arrival of humans on earth. Over the years, forests have been burning due to varying reasons resulting into altered structure of ecosystems. Regardless of how old forest fires are, with today's growing population and shrinking of resources, resulting into our increased dependence on forests, forest fires are now occurring at a much higher rate than before. In India and elsewhere in tropics, large areas which were once tropical dry forest, have been converted into anthropogenic grassland as a result of fire and also due to other uses. (Murphy and Lugo 1986; Sagar and Singh 2004). Forest fires create sites for secondary succession and the area becomes more susceptible for the invasion by invasive species. *Eupatorium adenophorum*, an invasive shrub found at higher altitudes is emerging as one of the dominant invasive species, already acquiring a considerable area in various provinces of China. In the current article, based on different researches we try to study the role of *E.adenophorum* in forest fires in Western Himalaya.

2. Review of Literature

Stutee Gupta, et.al in the year 2018 studied the 'Forest fires burnt Area assessment in biodiversity rich regions using Geospatial Technology', Uttarakhand forest fire events. Pramod Lamsal, et.al in 2018 studied the 'Invasive alien species dynamics in the Himalayan region under climate change'. In the year 2017, Bobby Moore Konsam et.al studied the 'Life after fire for understory plant community in subtropical chir pine forest of Garhwal Himalaya'. Wei Bin Wang, 2013 studied the 'High resource capture and use efficiency of *E.adenophorum*.' Menning KM, Stephens SL in 2007 analyzed the 'Fire climbing in forest , a semi qualitative, semi quantitative approach to assessing ladder fuel hazards.' RS Tripathi, et.al in 1981 studied the 'Allelopathic potential of *Eupatorium adenophorum*- a dominant ruderal weed of Meghalaya'.

3. Materials and Methods

The plant selected for current studies is *Eupatorium adenophorum*. This plant is commonly called as Crofton weed, which belongs to the family Asteraceae. It is found above 2200m mean sea level and is a shrubby perennial with woody rootstock and numerous branches.



Figure 1: *Eupatorium adenophorum*

The role of the studied plant for controlling forest fire was studied by direct observation. Using specific terms, searched the literature for *Eupatorium adenophorum*, vegetation in western Himalayas, and events of occurrence of fires in forests of Himalayas in Indian, Nepal and Chinese journals.

4. Results and Discussion

Eupatorium adenophorum and Himalayan forest's Kala bans, a native to Mexico was introduced to India via Nepal through eastern border (M.Negi). Studies reveal that this shrubby perennial's invasion in last 3-4 decades in Himalayas has been revealing with its max spread in the oak forests (Banj oak > Rianj oak) followed by its presence in Chir Pine (*Pinus roxburghii*) and mixed forests. Higher elevations serve as a great habitat for *Eupatorium adenophorum*. Sekar, Manikaran and Srivastava show that the altitudinal analysis of invasive species in Uttarakhand suggests that about 96% are found in low altitudes. Only 3 species are found in >2500 m altitude, *Eupatorium adenophorum* being one of them. Global climate change rising as a major issue, continues to impact the dynamics of invasive species. Under global climate change, *E.adenophora* will expand more in lower belts of Uttarakhand, Himanchal Pradesh and Jammu and Kashmir by 2070 (Prمود Lansal, Lalit Kumar, Achyut Aryal, Kishor arya). Taking *Quercus seminarpifola* forests in concern, the growth, present and future impact of this species can be understood. Oak forests in Garhwal occur at an altitude of 800m to the highest elevation of the area. The main species are *Quercus seminarpifola*, *Rhododendron* at times mixed with *Pinus roxburghii*.

E.adenophorum and forest fires

The species density for Kala Bans in Kumaon forests (Uttarakhand) ranges from 250-1583 hectare with maximum spread in banj oak, and has emerged as the plant with maximum density due to high proliferation . (MS Negi). The severity of forest fires have increased in last five years in Uttarakhand, the most severe being in 2016. Fuel plays an important role in forest fires. With a stem density of 7-8/ meter square in invaded forests (compared to only 2-3 in non-invaded areas), *E.adenophorum* produces a lot of litter which serves as fuel in forest fires. A comparative analysis of invaded and non-invaded areas suggested that moisture, ash and ignition point were higher in uninvaded land. Forests fires being more prone in drier areas, this shrubby perennial helps in fast spread of fire. Ignition point refers to the minimum temperature at which fire can occur. The invaded areas had lower ignition point. *Eupatorium adenophorum* produces much greater dead litter, which could increase the fuel heat value, and ash (Wang and Nui, 2013). Amount of biomass burnt in forest fires, is a vital tool to learn the presence or absence of any invasive species. A higher biomass burnt was observed in the invaded areas. This invasive species has better strategy of survival than other native species. In winter, when native species shed leaves (leafless) this shrub maintains a large living area for leaves and this helps them achieve high amount of daily carbon. This carbon with water attributes to total biomass of invader. Winter season works as prolonged growth season for *Eupatorium adenophorum*. (Wang et al , 2013). Forest fires can be classified into ground, surface, crown based

upon fuel strata where burning occurs (Pyne et al). The surface fires sometimes reaches the crown area and increase the fire severity. *E.adenophorum* plays an important role in this and hence , is considered as LADDER FUEL. The height of this plant varies from 30-200 cm and can serve as a link between surfaces to canopy fires. Menning and Stephens; Niu and Wang, suggest that, it may turn low intensity fire into severe canopy fires, thereby facilitating active crown fires. A comparative analysis of various studied factors is given below:

Factors- Invaded Area vs Uninvaded Area

Factors	Invaded area	Uninvaded area
Biomass	High	Low
Ignition point	Low	High
Dead litter	High	Low
Moisture	Low	High
Stem density	High	Low

Fire cycle of *Eupatorium adenophorum*

Given the evolutionary link between fire and native savannah, the word over it is not surprising that fire as a disturbance is particularly implicated in success and persistence of invading species (Hiramath and Sundaram, 2005). After the fires, the ability of *E.adenophorum* to re-sprout and by efficiently making the use of scarce resources for their growth, reproduction and proliferation helps it in increasing its area of acclimatization. Producing a large number of seeds provides it with larger area for growth as most of the species are regenerated by seeds (Shyam S Phartyal). According to Li and Feng, 2009, Due to genetic differentiation and plasticity in seed size and germination, traits in different population of *E.adenophorum*, it helps the species to acclimatize different elevation levels and facilitate its invasiveness. A hypothetical *E.adenophora* fire cycle in Himalayan forests can be drawn from the above information.

5. Conclusion

Unlike most of the invasive species, Kala bans is present at higher altitudes and with its penetration risks getting higher with global climate change, it is becoming a greater threat to Himalayan forest ecosystem. The above details suggest that *E.adenophorum* should play an important role in the spread of forest fires. Attributing to higher stem density, low ignition point, high biomass, and its role as ladder fuel , studies suggest that the level of *E.adenophorum* does not fall rather rises after forest fires becoming a threat by acquiring a greater possession of land.

The invasive species dominate hence decreasing the natural biodiversity. Disturbance caused by fire creates a site for secondary succession by invasive species.

Invasive species (*E.adenophorum*), Increased invasion, Change in structure of forest ecosystem, High fire frequency.

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