



Review Article

Review on invasive rate, impacts and control measures of *Prosopis juliflora* in eastern Ethiopia

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ABSTRACT

Since its introduction into Ethiopia during 1970s, *Prosopis juliflora*, became an environmental issue in areas where it was first introduced to combat desertification. This review paper was aimed at reviewing some adverse effects of the plant on socioeconomic, environmental and biodiversity with its control practices in the eastern Ethiopia. Contrary to its purpose of introduction, this plant has been found to be highly invasive and, it imposed adverse effects on the native plant species. The plant is declared as an invader which has put impacts on socioeconomic, environment, and biodiversity of the eastern region of Ethiopia especially afar region and Dire Dawa; which became alarm for pastoralists, development agents, scientists, and policy makers. Though cultural practices such as burning and cutting were mainly practiced, the invasion could not be stopped.

Introduction

Prosopis juliflora (SW.) is an evergreen legume tree which typically grows best in arid and semi-arid regions across the world growing up to 10-15 m high. It is perennial, deciduous thorny shrub invasive plant. It is native to North, South, and Central America and the Caribbean (Pasiecznik et al. 2001). *P. juliflora* is a xerophyte plant with large open canopy and has a deep taproot, growing downwards in search of water tables up to 35 m depth and, it has a well-developed lateral root competing with grasses (Riveros, 1992). The plant can tolerate droughts, water logged areas, infertile soils, and highly saline and alkaline soils (CRC, 2003). The first introduction of *P. juliflora* in Africa was in 1822, in Senegal; which subsequently introduced in South Africa and Egypt in 1880 and 1900 respectively. Introduction of exotic species into new habitats has been a global phenomenon with serious consequences of ecological, economic and social systems (Primental et

al. 2000). After the introduction and establishment of such invasive species, control can often be difficult while eradication is usually impracticable in many cases (Primental et al. 2000). Moreover, their impact on natural communities, biodiversity and ecosystem processes can be very serious.

Exotic weeds can become very aggressive in their new habitat if the ecological conditions are favorable (Mack et al., 2000; Kolar and Lodge, 2001; Tamdo, 2001). Such weeds can become dominant in the new area in a relatively short time by successfully suppressing previously established species or plant communities. This is, mainly, because the weeds have escaped the antagonists that kept them in check, such as insects that feed on the plant and pathogens that cause diseases ((Hailu et al., 2004). A typical example of exotic invasive weeds is *P. juliflora* which has been introduced to and become dominant in in the tropics, including Ethiopia (LeHouerou, 1980; Asfaw and Thulin, 1989). According to Rezene (2006), *P. juliflora* became a problem on a farm land, pasture lands, range lands, irrigation which is directly opposite to the purpose the plant's introduction in Ethiopia. He also reported that the weed was rapidly invading the traditional agro and silvo-pastoral land of Afar and Isa ethnic groups in the region. This study was therefore aimed at reviewing and summarizing the impacts of the invasive tree, *P. juliflora*, on environment, biodiversity and on some of its impacts on socioeconomic status of the eastern region of Ethiopia.

Invasive rate of *Prosopis juliflora*

Thirty-one published papers on the invasive weed *Prosopis juliflora* were thoroughly reviewed. *Prosopis juliflora* was introduced into high-quality pasturelands and irrigable areas including the Awash River basin in the Afar National Regional State of East Ethiopia during 1970s by the former Ministry of Agriculture (MoA), but now Ministry of Agriculture and Natural Resources (MoANR) as a measure to control desertification and the high dust wind in the area (Alemayehu, 2006).

In Ethiopia, *P. juliflora* is a major problem in hotter regions such as Afar and Dire Dawa Administration where an area of about one million hectares in Afar and 12,000 hectares were covered by the weed (BoARD, 2009). According to the reports of EARO and HDRA (2005), the weed was expanding to the south-eastern and south-western parts of Ethiopia. In most developing countries, there is generally insufficient information regarding the invasion rate and impacts of *P. juliflora*, which arises from a lack of resources for conducting research and data collection (Witt, 2010). *P. juliflora* invasion exists in four of the five zones and 11 of the 29 districts of the Afar Region, Ethiopia (Table 1).

Table 1. Status of *Prosopis juliflora* in Afar Region, Ethiopia.

Zones	Districts	Status of invasion
Zone 1	Dubti	Severely invaded
	Mile	Severely invaded
	Logya	Partly invaded
	Hadar	Partly invaded
Zone 3	Gewane	Severely invaded
	Buremoditu	Severely invaded
	Amibara	Severely invaded
	Dulecha	Partly invaded
	Awash sebat kilo	Partly invaded
Zone 4	Yallo	Recently observed
Zone 5	Dalifagae	Recently observed

Source: Pastoral Agriculture and Rural Development Bureau (2016).

There are small-scale control and management measures being implemented by local communities either individually or collectively through cooperatives with limited support from governmental and nongovernmental organizations. However, to date, the rate of invasion and the current socioeconomic impacts of the plant are not well documented.

Impacts of *Prosopis juliflora*

Prosopis juliflora as an invasive alien has economic, environmental and/or social impacts. Among the impacts reduction of grazing lands, arable lands, threat to biodiversity, disruption of water flow, poison to animals and transport problem due to the compact impenetrable canopy (Anderson, 2005). The impacts of invasive alien species are often considerable. The effects of these species can result change in the availability of resources and ecosystem structure and function. The change in ecosystem function can brought about extinction of indigenous species (Abdillahi et al. 2005). Indigenous species may be threatened directly by the proliferation of invasive species. In fact, the degree of effects depends on the density and size of the plant's canopy; those with larger and greater densities have significant negative effect than those with smaller and less dense canopies.

Wittenberg (2004) stated that the environmental impacts of alien invasive species can be divided into four major factors. These are competition, predation, hybridization, and transmission of diseases. All these factors alone or together with other factors can decrease biodiversity and cause extinction. The most obvious examples for competition are between introduced and native plants for nutrients, water supply, and exposure to sunlight. *P. juliflora* can grow as high as 20 m with a diameter of 1 m under favorable growing conditions (Pasieszik et al. 2001; Jorn, 2007). The tree *P. juliflora* is not totally with negative effects; it has also positive effects such as erosion control, shade, fuel wood, and building material in arid and semi-arid regions. Because of such parallel negative and positive effects, the plant is usually considered to be 'conflict' species.

Impacts on animals

The thick thorns of *P. juliflora* can prevent mature birds from flying across the plants to hunt. The thorns are also damaging the hooves of desert animals like camel. Eyes of such animals are highly vulnerable to these thorns which cause inflammation. The thorns are also known to tear vehicle (Abdillahi et al. 2005; Abiyot and Getachew, 2006). Although the seed pods are indeed palatable to livestock, the chemical content is thought to cause problems for goats, cattle, and camel; which are the main life driving activities of the eastern people. A diet high in pods can cause mortality in sheep and goats due to digestive problems. Cattle can die if they feed heavily on *P. juliflora* leaves over a prolonged period of time owing to its tannin contents (Mwangi and Swallow, 2005). The chemical investigation of the extracts showed that the allelopathic chemical compounds are phenolic in nature. The accumulation of leaf litter below *P. juliflora* result in toxic substances in the soil layers which inhibits grow other species (El-Keblawy and Al-Rawai, 2006). The pods of *P. juliflora* contain cytotoxic alkaloids which are toxic to animals when taken in high level. Such problems were reported in USA, Peru and Brazil (Silva et al. 2007; Tabosa et al. 2006; Camara et al. 2009; Assis et al. 2010).

Socio economic impacts

In addition to the biodiversity impacts, many invasive alien species (IAS) also cause enormous economic costs. These costs can arise through direct losses of agricultural and forestry products and through increased production costs associated with control measures (Pimentel et al., 2000). According to Geesing et al. (2004), such invasive alien species have severe impact on basins and soil moisture. Prosopis species have invaded over 4 million hectares in Africa (Witt, 2010). A recent estimate shows that such invasions cost the world economy hundreds of billions of dollars each year (CBD, 2010). Another earlier study estimated this cost to be as high as US\$ 1.5 trillion annually (Pimentel, 2000).

Control measures

There are three main strategies to control or eradicate invasive species viz., physical (where plants are mechanically removed), chemical (where herbicides are used against plants), and biological (where predators or pathogens are used to control the invading plant's reproduction) (Hobbs and Humphries, 1995; Geesing et al. 2004). Although a range of different control measures (biological, mechanical, and chemical) exist (Zimmerman, 1991; Bleton, 2008), most of them are less applicable in the context of developing countries such as Ethiopia because they are either expensive or require a high skill level and/or because even if the technologies were available, the policy and institutional environment and capacity are generally too weak to facilitate the implementation of such measures (Anagae et al. 2004). However, to date, no cost-effective methods for containing and managing broad-scale *P. juliflora* invasions have been found (van Auken, 2000).

Conclusion

Exotic plant species have been introduced worldwide due to their economic, environmental or aesthetic values. Some accidental introductions have also occurred through time. Nevertheless, introduction of new species is not always a success and one of the problems linked to this is the possibility of these species becoming invasive. Understanding the arrival, survival, and establishment and spread characteristics is better to understand the colonization and ecosystem impacts of the invasive species. Appropriate controlling mechanism should be implemented to eradicate and/or minimize the risk posed by *P. juliflora* on the native flora. Moreover, no systematic study has been conducted to identify management measures previously implemented by the community and to assess whether these measures have been effective.

Conflicts of Interest

Authors declare no conflict of interest.

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