International Journal of Ecology and Environmental Sciences 42 (3): 209-215, 2016
ISSN: 2320-5199 (Online)

Acacia farnesiana (L.) Willd. -A Potentially Invasive Alien Species?

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ABSTRACT

Acacia farnesiana (L.) Willd. is a small tree that has become a severe pest on rangelands of Brazil, USA and other countries because it is expanding in density and range and is difficult to control. This study characterizes the current and potential distribution of *Acacia farnesiana* in the world by utilizing published literature and online databases. The study suggests a future of continued expansion, given its current range. This information should enhance the ability of landowners and managers around the world to prevent *Acacia farnesiana* invasion, thereby increasing favorable conditions for livestock and wildlife.

Key Words: Plant Invasion, Global Distribution, Huisache, Pest, Rangeland

RESUMO

Acacia farnesiana (L.) Willd. é uma pequena árvore que se tornou uma praga em muitos pastos em todo o mundo. Esta planta é um problema nos pastos do Brasil, Estados Unidos da América dentre outros países, porque se expande em número de indivíduos e alcance, além de ser difícil de controlar. O principal objetivo desta pesquisa foi caracterizar de forma mais completa possível a distribuição global atual da *Acacia farnesiana* no mundo, utilizando-se da literatura publicada e bancos de dados on-line idôneos. Assim, o estudo caracterizou plenamente a distribuição atual e potencial da *Acacia farnesiana* ao preencher lacunas em mapas de distribuição e sugere, um futuro de expansão continuada desta planta devido ao seu alcance atual. Esta informação deve aumentar a capacidade dos proprietários de terras e gestores em todo o mundo para evitar a invasão da *Acacia farnesiana*, assim promovendo condições favoráveis para o gado e animais selvagens.

Palavras-chave: Planta invasora, Distribuição global, Huisache, Praga, Pastagem

INTRODUCTION

Invasive Alien Species are plants or animals that are introduced by humans, accidentally or intentionally, outside of their natural geographic range into an area where they are not naturally present. They are often introduced as a result of the globalization of economies, e.g. by trade via ships, shipment of wood products infested with insects, or the transport of ornamental plants that then establish themselves into the wild and spread (IUCN 2015).

Such invasive alien species can negatively impact human health, economy (i.e. tourism, agriculture), and native ecosystems. Many papers about exotic species and the damage (ecological, social, and economic) they cause are available in literature (e.g., Cavalcante and Major 2001, CDB 2002, Davis 2009, Lowe et al. 2010, Veitch et al. 2011, Brunel et al. 2013, Zenni 2014).

Acacia farnesiana (L.) Willd. [also *Vachellia farnesiana* (L.) Wight & Arn.; huisache, sweet acacia, aromo, esponja etc.] currently occurs globally between 30° N. and 40° S. latitudes, especially in warmer regions of America, Africa, Asia and Australia (Martius et al. 1876, Pedley 2002, Kodela and Wilson 2006), where it may often form thickets (Rzendowski 1981). Its native range is not known, but believed to be tropical and subtropical areas of the Americas (Parrotta 2004). It grows best on well drained soils, but tolerates both clay and sandy soils (Parotta 2004) and it generally requires temperatures from 14-27 °C (Duke 1983). It grows in seasonally dry areas receiving 500-750 mm of precipitation and it readily resprouts from the base, making it disturbance and fire resistant (Webb et al. 1980). Its ability to respond to disturbance and create thickets make it especially troublesome in cattle-producing areas (Scifres et al. 1982).

Here, we assess the current geographical extent of *Acacia farnesiana* and infer new areas for invasion in the world, using online databases of the biggest botanical gardens of the world and relevant published literature.

CURRENT GEOGRAPHICAL EXTENT

Based on both published literature and online data from herbaria records (specimen), *Acacia farnesiana* occurs currently in sixty-four countries in the world (Figure 1). Literature documents at least sixty-three countries, while searches of online databases from globally significant herbaria provide evidence for thirty-five countries (Table 1).

A region by region analysis of *A. farnesiana* distribution may help in understanding its distributional limits. On the North American continent, *A. farnesiana* is absent only in Canada, where its absence can probably be attributed to low temperatures. It generally requires temperatures from 14-27° C (Duke 1983). Even in the US, it is present mostly in the southern tier of states, especially surrounding the Gulf of Mexico, where it continues into Mexico. It is officially present in California, Arizona, New Mexico, Texas, Louisiana, Mississipi, Alabama, Georgia, Florida, Hawaii, Puerto Rico, and the Virgin Islands (USDA 2013; Figure 2).

In Texas, at the turn of the twentieth century, *A. farnesiana* was found in heavy clay soils and especially along streams between Corpus Christi and Brownsville, while lighter soils were mostly open prairie (Bailey 1905). By the early 1960's *A. farnesiana* had infested 1.1 million ha of rangeland in Texas, primarily in the Coastal Prairies and South Texas Plains (Smith and Rachenthin 1964). According to vegetation surveys, *A. farnesiana* increased by 48% in Texas from 1964 to 1982 (USDA 1985). Though as yet undocumented in the literature, there is widespread concern that it has continued to expand in range and density since then.

The United States Department of Agriculture's Natural Resource Conservation Service's PLANTS profile for *A. farnesiana* currently has the species' native and naturalized distribution indicated in 50 of the 254 counties in the state of Texas. The data are based on herbarium specimens, literature, and confirmed observation (USDA 2013). Eighteen counties without record of *A. farnesiana* are located within and between two series of contiguous counties in south, south central, and southeast Texas that are recorded to have the species. In addition, six isolated counties in north, northeast, central, and west Texas are recorded to have *A. farnesiana*.

In South America, the plant has not been formally recorded from Chile, but we believe that the plant is already present, as it has been documented in both Argentina and Peru where environmental conditions are similar. In Brazil, the first publication about the Brazilian flora (Flora Brasiliensis), listed *A. farnesiana* as present in five states (Martius et al. 1876; Bahia, Minas Gerais, Pará, Pernambuco and Rio de Janeiro), with fifteen official records in these States. The establishment and spread of *A. farnesiana* has apparently increased over time. It was apparently introduced deliberately for silvicultural, soil fixing, ornamental or other reasons. Today, there are 348 official records and it occurs in twenty-two of the twenty-seven Brazilian States (Splink 2014; Figure 3). In Brazil, It can tolerate annual average total precipitation of 428.1 to 2290.0 mm and annual mean temperatures of 15.1 to 27.1° C.

As observed in our survey of published literature and online data from herbaria records, the plant seems to be strongly limited by low temperatures, as it is absent in Canada, the northern US, and southern Argentina's Patagonia region. It is also absent in the American Chihuahuan, Sonoran and Atacama deserts, where precipitation is limiting. We therefore suggest that the Amazonia region is possibly the last frontier on the American continent for invasion by *A. farnesiana*, due to favorable environmental conditions for plant establishment and the fact that *A. farnesiana* is already present in many of the surrounding areas. The absence today of *A. farnesiana* in the Amazon forest can be linked to the

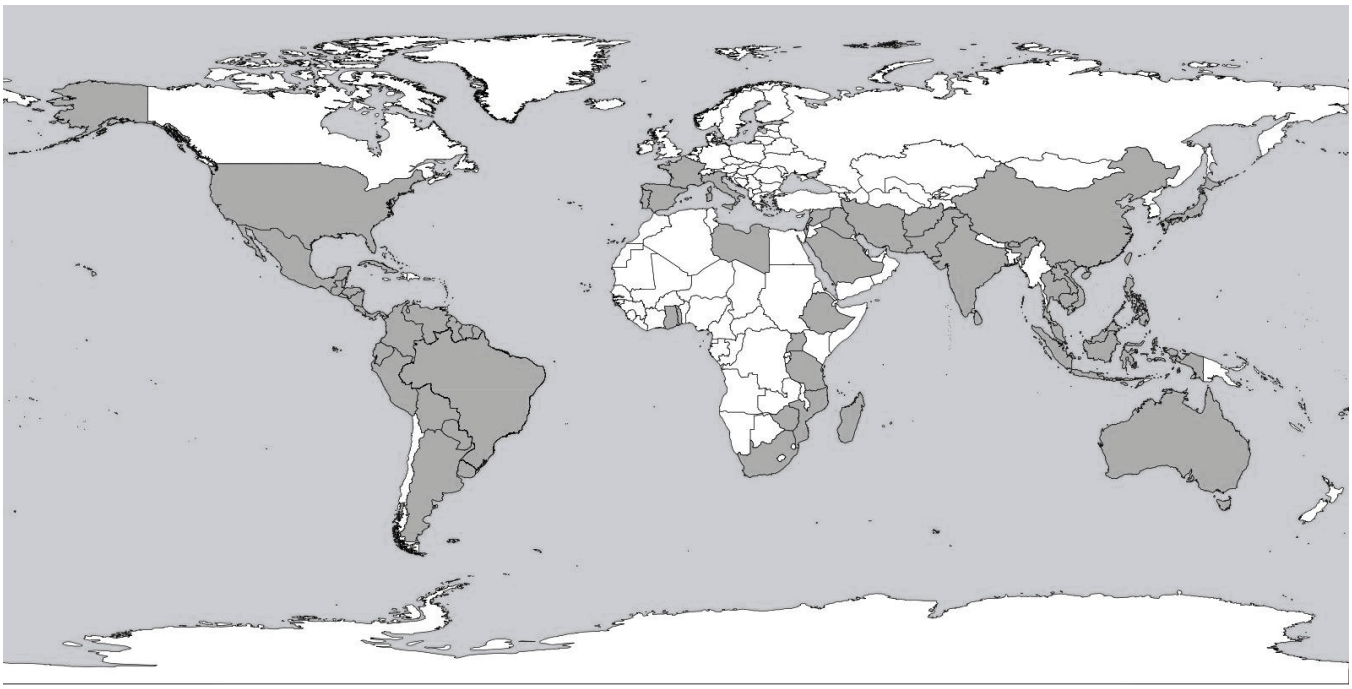

Figure 1. Map generated from on both published literature and online data from herbaria records, highlighting in gray the countries with *A. farnesiana* present currently.

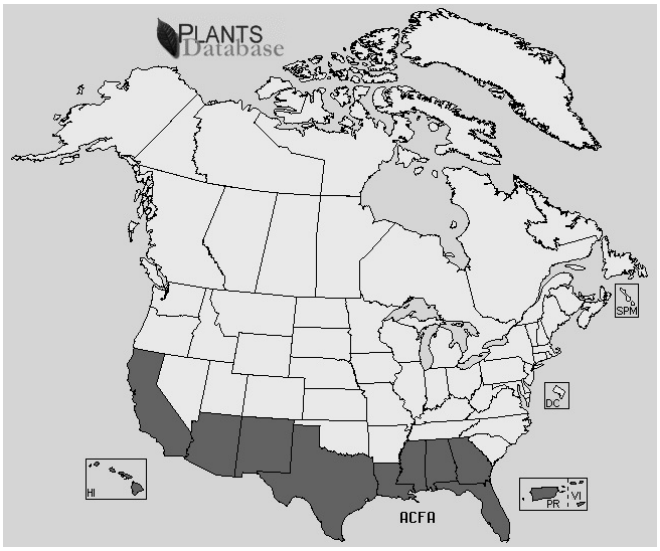

Figure 2. Map highlighting in gray the USA States with *A. farnesiana* present currently. (Source: www.plants.usda.gov)

difficulty of access by humans to the core of the forest and the lack of interest in the plant by humans, for a purposeful introduction.

In the Caribbean, the plant is absent from some island nations (i.e. Haiti, Jamaica etc.), but present in others (Cuba, Dominican Republic, Netherlands Antilles and Puerto Rico). In this case, it appears that the ocean can be an effective natural barrier to *A. farnesiana* dispersal, but it's also possible, as in Chile, that the plant already has been introduced, and is missing only a formalizing of its status.

In Africa, *A. farnesiana* is officially present in ten countries (Cape Verde, Ethiopia, Ghana, Libya, Madagascar, Mozambique, South Africa, Tanzania, Uganda and Zimbabwe), being five coastal countries, two island countries and three inland countries. *A. farnesiana* appears to be currently concentrated along the east coast of the continent, from Ethiopia to South Africa. In the North, it's only present in Libya, Ghana and Cape Verde. It is likely that *A. farnesiana* is already present in many neighboring areas, especially along the east coast, and that it will continue to spread into the interior of the continent, due favorable environmental conditions to the establishment of plant, except perhaps in desertic areas like the Sahara and Namib deserts.

In Europe it is already present in France, Italy, Portugal and Spain. In the Middle East it is present in Iran, Iraq, Israel, Lebanon, Libya, Saudi Arabia and Syria. Finally, in Asian countries *A. farnesiana* is present in Afghanistan, Bhutan, Cambodia, China, India, Indonesia, Laos, Lebanon, Malaysia, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Syria, Taiwan, Thailand and

Table 1. Countries known to have *Acacia farnesiana* present as of 2015

Country	Literature	Online Database	Reference*
Afghanistan	x		Rico Arce (2007); Roskov et al. (2011)
Argentina	x	x	Rico Arce (2007); Roskov et al. (2011); MBG; IBODA
Australia	x	x	Kodela and Wilson(2006); MNHN; KEW; MBG; US
Belize	x		Balick *at al.* (2000); Roskov et al. (2011)
Bhutan	x		Rico Arce (2007); Roskov et al. (2011)
Bolívia	x	x	Jorgensen et al. (2014); MBG
Brazil	x	x	Martius (1876); Carmona et al. (2001); MNHN; NYBG; KEW; MBG
Cambodia	x	x	Rico Arce (2007); Roskov et al. (2011); MNHN
Cape Verde	x		Silva (2009)
China	x	x	Flora of China Editorial Committee (2010); US
Colombia	x	x	Rico Arce (2007); Roskov et al. (2011); US
Costa Rica	x	x	Holdridge and Poveda (1975); MBG; US
Cuba	x	x	Oviedo et al. (2012); NYBG
Dominican Republic	x	x	Roskov et al. (2011); NYBG; MBG
Ecuador	x	x	Jorgensen and León-Yánez (1999); NYBG; MBG
El Salvador	x	x	Linares (2005); MBG
Ethiopia	x		Rico Arce (2007); Roskov et al. (2011)
Fiji	x		Rico Arce (2007); Roskov et al. (2011)
France	x		Rico Arce (2007); Roskov et al. (2011)
French Guiana	x	x	Funk et al. (2007); MNHN; US
Ghana	x	x	Rico Arce (2007); Roskov et al. (2011); MBG; US
Guatemala	x	x	Standley and Steyermark (1946); MBG
Guyana	x	x	Funk et al. (2007); MNHN; NYBG
Honduras	x	x	Molina Rosito (1975); MBG
India	x	x	Rico Arce (2007); Roskov et al. (2011); MNHN; KEW; US
Indonesia	x		Rico Arce (2007); Roskov et al. (2011)
Iran	x		Rico Arce (2007); Roskov et al. (2011)
Iraq	x		Rico Arce (2007); Roskov et al. (2011)
Israel	x	x	Rico Arce (2007); Roskov et al. (2011); US
Italy	x		Rico Arce (2007); Roskov et al. (2011)
Japan	x		Rico Arce (2007); Roskov et al. (2011)
Laos	x		Rico Arce (2007); Roskov et al. (2011)
Lebanon	x		Rico Arce (2007); Roskov et al. (2011)
Libya	x		Rico Arce (2007); Roskov et al. (2011)
Madagascar	x	x	Baillon (1882); MNHN; NYBG; KEW
Malaysia	x	x	Rico Arce (2007); Roskov et al. (2011); KEW
Mauritius	x		Rico Arce (2007); Roskov *et al.* (2011)
Mexico	x	x	CONABIO (2009); MNHN; NYBG; KEW; MBG; US
Mozambique	x		Rico Arce (2007); Roskov et al. (2011)
Netherlands Antilles	x	x	Roskov et al. (2011); NYBG
Nicaragua	x	x	Stevens et al. (2001); MBG
Pakistan	x		Ali (1973)
Panama	x		Correa et al. (2004)
Paraguay	x	x	Zuloaga et al. (2008); MNHN; NYBG; MBG; IBODA
Peru	x	x	Brako and Zarucchi (1993); KEW; US
Philippines	x	x	Rico Arce (2007); Roskov et al. (2011); MNHN; KEW
Portugal		x	NYBG; US
Puerto Rico	x	x	Roskov et al. (2011); NYBG; MBG
Saudi Arabia	x		Rico Arce (2007); Roskov et al. (2011)
South Africa	x	x	Rico Arce (2007); Roskov et al. (2011); US
Spain	x		Rico Arce (2007); Paiva (1999)

Country	Literature	Online Database	Reference*
Sri Lanka	x		Rico Arce (2007)
Suriname	x	x	Funk et al. (2007); KEW; US
Syria	x		Rico Arce (2007)
Taiwan	x		Flora of China Editorial Committee (2010)
Tanzania	x		Rico Arce (2007); Roskov et al. (2011)
Thailand	x		Rico Arce (2007); Roskov et al. (2011)
Togo	x		Rico Arce (2007); Roskov et al. (2011)
Uganda	x		Rico Arce (2007); Roskov et al. (2011)
Uruguay	x	x	Izaguirre and Beyhaut (2003); IBODA
USA	x	x	Parrotta (2004);MNHN; NYBG; MBG; US
Venezuela	x	x	Funk et al. (2007); NYBG; IBODA
Vietnam	x	x	Rico Arce (2007); Roskov et al. (2011); KEW; MBG
Zimbabwe	x		Rico Arce (2007); Roskov et al. (2011)

*MNHN – Muséum National d'Histoire Naturelle; NYBG – The New York Botanical Garden; KEW - Royal Botanic Gardens; MBG - Missouri Botanical Garden; US - United States National Herbarium; IBODA - Instituto de Botánica Darwinion.

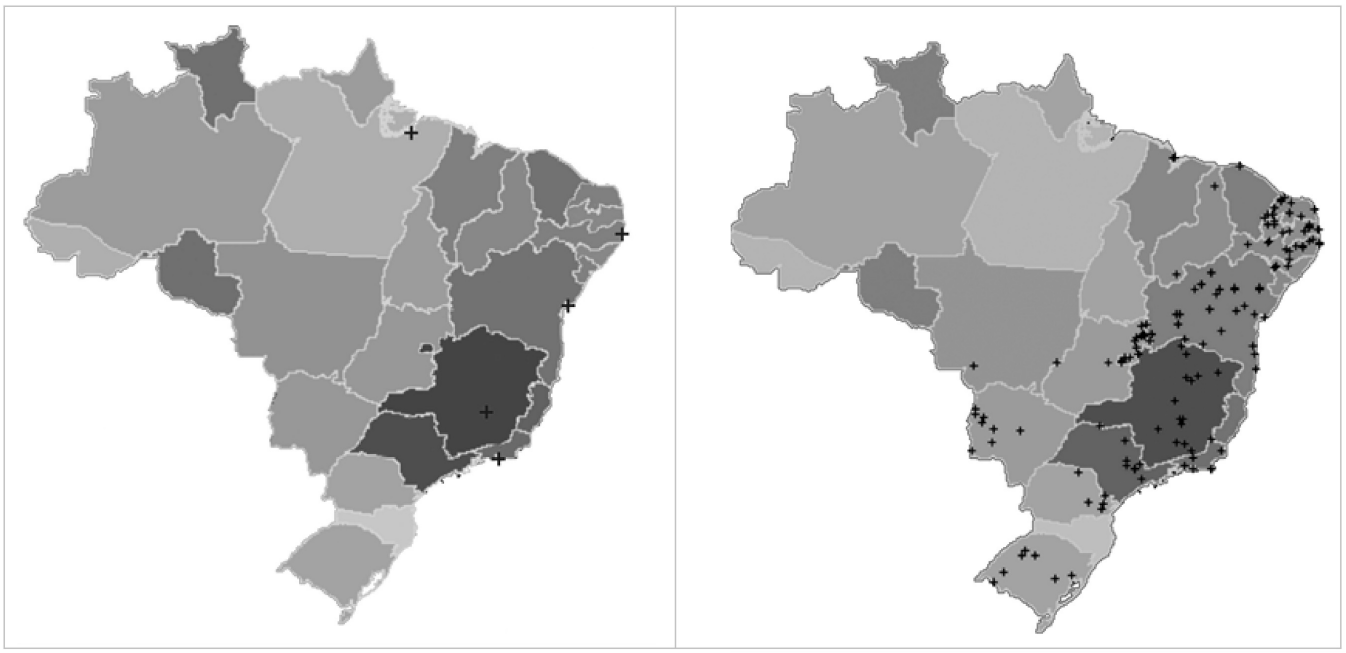

Figure 3. Presence of *A. farnesiana* plotted on map of Brazil with State divisions, it generated from Martius et al. (1876), on left, and adapted from Splink (2014), on right.

Vietnam. In Australia and many Pacific Islands like Fiji, French Polynesia, New Caledonia etc., *A. farnesiana* is present, and is often officially considered an invasive alien species (Pier 2014). On other continents and islands, considering Africa and the American continents as examples, the presence of *A. farnesiana* in new territories is limited by extreme cold, water availability, and the human interest to introduce it in that area.

THE POTENTIAL FOR DAMAGES

A. farnesiana is an important tree in many countries around the world. It has been used as an ornamental and silvicultural plant, as a nitrogen fixer to ameliorate poor soils, in the perfume industry because of its scented flowers, and also as wood, dye, fuel, condiment, construction, forage, medicine etc. (CONABIO 2009). However, because the plants are prolific seed producers

(Scifres 1974), the seeds often readily germinate after soil disturbance and plants grow rapidly (Mutz et al. 1978), *A. farnesiana* has been remarkably successful at colonizing many new locations, including agricultural areas, coastland, semiarid areas, range/grasslands, riparian zones, and ruderal/disturbed.

In Texas, USA, for instance, huisache decreases livestock productivity by outcompeting and displacing grasses and forbs. On the Coastal Prairie of Texas, annual production of grasses decreased with an increase in huisache canopy cover beyond 30% (Scifres et al. 1982). Heavy infestation may also reduce the amount of available water in rangeland watersheds, and the reduction in grass cover can cause increased soil erosion, lowering the quality of surface water runoff (Welch 1991). In Goiás, Brazil, it is considered very problematic in pastures, appearing in dense populations and greatly reducing pasture productivity (Carmona et al. 2001). In Australia, it occurs along watercourses on rangeland and farmland limiting access to water (DAFF 2014). In essence, *A. farnesiana* threatens native habitats by competing with indigenous vegetation, replacing grass communities, reducing native biodiversity and increasing water loss from riparian zones.

Therefore, the current geographical range of *A. farnesiana* reaches all continents except Antarctica. The establishment and spread of *A. farnesiana* has increased over time, both through deliberate introductions and more natural spread. Today at least sixty-five countries have this plant and, in many them, it has become a pest. Areas of potential future expansion, given its current range, are expected to be areas in tropical forests such as the Amazon. So, we believe that *A. farnesiana* presents high potential as an invasive alien species around the world. It is a real threat for various natural or artificial ecosystems, requiring attention and urgent control.

ACKNOWLEDGEMENTS

We thank Capes, a Foundation affiliated with the Ministry of Education of Brazil, for the postdoctoral research scholarship and the Department of Natural Resources Management at Texas Tech University for logistic support.

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Received 7 July 2016
Accepted 25 September 2016