

# Making smart use of woody alien plants

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## ABSTRACT

It is unquestionable that some alien woody plant species are a major issue for biodiversity conservation. However, being alien species generally adapted to warmer conditions than natives, they could be particularly suited to cope with the new environmental and climatic conditions that are also forecasted in the coming decades in Sicily. This poses an issue that is not easy to deal with, whether trying to use these species for the advantages they could bring, for instance in the new reforestation activities, while avoiding them becoming a serious problem for biodiversity conservation in natural and seminatural areas. Here, we present some study cases of non-native tree species which represent emblematic examples in that regard: *Acacia saligna* and *A. cyclops*, *Eucalyptus* spp., *Leucaena leucocephala*, *Opuntia ficus-indica* and *Ailanthus altissima*. These tree species are very invasive in some ecological contexts, while being useful to meet ecological services in others. A sound planning activity could help distinguish where planting these species could be not only possible but also desirable, from areas where their presence should be totally avoided.

## KEY WORDS

Invasive alien trees; Biodiversity; Mediterranean ecosystems; Invasive management.

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## INTRODUCTION

The spread of alien plants has assumed increasingly greater proportions in recent decades, thanks to the increase in global trade and human population, but also to the alterations and therefore the fragility of the habitats that host them (Gritti et al., 2006; Gallardo et al., 2024; Peller & Altermatt, 2024).

The spread of alien plants occurs to the detriment of native plants and therefore translates into a loss of biodiversity and not, as it is sometimes trivially written, into an overall advantage for species and ecosystems (La Mantia, 2020). However, just because of climate change effects and the large-scale alteration of soils, non-native trees, which have evolved in different environmental contexts, can also represent a resource for various

purposes not only productive, including the recovery of degraded environments (Quatrini et al., 2003). It is necessary to develop adequate methods for the management of these species to avoid making mistakes which will then be difficult to remedy. In this research, we performed a historical analysis of the main alien woody species present in Sicily in forest or agroforestry systems. Species used in agriculture were therefore excluded (*Citrus* spp. for example), with the exception of the prickly pear (*Opuntia ficus-indica* (L.) Mill.) which is not a woody species. Herbaceous species were excluded because their control is absolutely aleatory, and, although they have a great potential, their management or, better, their confinement, appears impossible (for example: *Cenchrus setaceus* (Forssk.) Morrone, Pasta et al., 2010).

## MATERIAL AND METHODS

A bibliographic search was carried out on alien woody species and their historical and potential use in the Sicilian territory. Although there have been several naturalization cases of alien woody species in Sicily, particularly in recent years (Pasta et al., 2012, 2016; Badalamenti & La Mantia, 2018; Badalamenti, 2021), the species taken into account were: *Acacia saligna* (Labill.) H.L.Wendl. and *A. cyclops* A. Cunn. ex G. Don, *Ailanthus altissima* (Mill.) Swingle, *Eucalyptus* spp., *Leucaena leucocephala* (Lam.) de Wit subsp. *glabrata* (Rose) Zárata and *Opuntia ficus-indica* (L.) Mill. No assessment was made of possible new introductions, considering it prudent not to proceed with any other, and, rather, trying to manage the numerous existing ones.

## RESULT AND DISCUSSION

### *Acacia saligna* and *A. cyclops*

Acacias are of ancient introduction in Sicily (Pasta et al., 2012) and, although present in many environments, few of them have shown the great adaptability of *Acacia saligna*. The species has undoubted advantages as it is capable of colonizing even difficult environments where native legumes would find it difficult to establish themselves. It has, in fact, been used in the recovery of landfills also resorting to nodulation with nitrogen-fixing bacteria (Quatrini et al., 2003). The species has been widely used in dune environments where interventions were mistakenly made to modify these peculiar habitats (La Mantia, 2011). Studies conducted in dune and back dune environments aimed at restoring or fostering the recovery of existing vegetation have proved the difficulty and caution with which interventions must be made to prevent the species from spreading further (Badalamenti et al., 2018a). It has been included among the invasive species of Union concern pursuant to the Invasive Species Regulation 1143 of 2014. The species is widely used in Tunisia as a multipurpose tree because it is browsed by sheep and goats and provides valuable wood resources for people living in villages (El-Euch, 2000; Jarradi & Louhaichi, 2017). *Acacia cyclops* has also been used in Sicily in reforestation as a preparatory species, especially in

markedly thermoxerophilous environments also because of its higher resistance to aridity compared to *A. saligna* (Pasta et al., 2012). The observations made in Lampedusa, certainly an ideal experimental site for the study of desertification processes in the Mediterranean (see LIFE DesertAdapt project: <http://www.desert-adapt.it/index.php/it/>), confirm the role of improving soil fertility, while posing risks to biodiversity (Badalamenti et al., 2014).

### *Eucalyptus* spp.

*Eucalyptus* spp. were introduced to Sicily and to other parts of Italy and the world initially for their extraordinary ability to use water by drying up swamps and therefore making them less hospitable to malaria vector mosquitoes (La Mantia, 2013). The “discovery” of a forestry potential came later and, as it has now been established, was also the result of overestimations if not mystifications (La Mantia, 2013; Badalamenti et al., 2020b). Over the decades, some species have shown an ability to adapt which has led to evident naturalization phenomena; this especially affected *Eucalyptus camaldulensis* Dehnh., commonly known as the river red gum, that showed strong invasive characteristics especially in rivers (Badalamenti et al., 2018b). Nonetheless, the species is one of those most suitable for producing wood in Sicily (Badalamenti et al., 2020b); some caution is therefore necessary in choosing the places where to plant it which must be sufficiently far from rivers. It is also necessary that the planting systems preserve soil fertility, therefore favoring mixed plantings with the presence of legumes.

### *Leucaena leucocephala*

The condition of Sicilian pastures is generally highly degraded and there is a lack of active management policies for degraded pastures, which, due to the spread of non-pabular species and fires, are becoming increasingly degraded. Research is identifying management techniques for silvopastoral systems suitable for guaranteeing the productivity of pastures but also the conservation of the environmental and ecosystem values that they preserve (Bianchetto et al., 2015; Bueno et al., 2023). However, this research concerns the pastures affected by secondary successions while it is the degraded pastures, especially *Ampelodesmos mauritanicus*

(Poir.) T. Durand & Schinz grasslands, which, for the reasons mentioned above (overgrazing and wildfires), need immediate interventions, including the use of improving species such as legumes. In this context, woody exotics such as the acacias seen above, but also *Leucaena leucocephala*, a highly invasive species but of great interest (Badalamenti et al., 2020a, 2022) for use as a forage species, can play an important role. The management of the species to reduce its invasive potential appears easy where the species is prevented from distributing the seeds, and this can be obtained considering that the animals are fond of green legumes. The observations made (Badalamenti and La Mantia, personal data) show that, at the moment, the species has only spread in marginal areas not subject to grazing such as roadsides and abandoned places, while no spread phenomena are known in grazed areas.

#### *Opuntia ficus-indica*

*Opuntia ficus-indica* is an alien species which, due to its wide diffusion and importance in Sicily,

is part of the iconography of the island. However, the widespread diffusion in cultivation makes the inclusion among alien species almost a stretch. The species spreads spontaneously because the seeds are spread by birds, but it is overwhelmed by native vegetation (shrubs and trees) when this is not subject to disturbance and can evolve. Only in some peculiar contexts it is invasive and actually harmful to the spontaneous flora, such as in the south-facing cliffs of various areas of Sicily. The fact of being a cactus, however, makes it suitable for growing in conditions of strong environmental aridity where it also manages to play a facilitating role in secondary succession processes, favouring the establishment of native woody species, both shrubs and trees (Fig. 1) (Bueno et al., 2024).

#### *Ailanthus altissima*

A controversial case is that of tree of heaven (*Ailanthus altissima*), the species that more than any other is linked to the concept of invasive alien species. In fact, for these reasons, it has been in-



Figure 1. *Opuntia ficus-indica* plays an important role to facilitate the growth and establishment of tree species (*Quercus ilex*, *Q. suber*, etc.).





Figure 2. *Ailanthus altissima* has invaded not only disturbed areas but also semi-natural areas and forest habitats.

cluded among the invasive species of Union concern pursuant to the Invasive Species Regulation 1143 of 2014 and, as such, it is effectively a prohibited species throughout the territory of the European Union. Therefore, it has been excluded from this list because it cannot be used. However, given its widespread diffusion and high productivity (unpublished data), we provide a brief description. It is the non-native tree species that has undergone the most rapid spread in Sicily (Badalamenti et al., 2012) and is the most dangerous for native habitats, including forests (Campagnaro et al., 2022) (Fig. 2). The reason for this success also depends on the biological strategies adopted by the species (Badalamenti et al., 2015b; Ciolfi et al., 2023). Some control techniques have been developed and tested (Badalamenti & La Mantia, 2013; Badalamenti et al., 2015a); however, the species that has now invaded also natural environments sees the city and its suburbs as the original source of diffusion. The species should therefore be totally eradicated, only then we could think about the possibility of developing techniques for the sustainable use, but exclusively of male plants (unpublished data).

## CONCLUSIONS

The conservation of biodiversity is a global priority and, certainly, the spread of alien species is one of the major threats to this goal (Stohlgren et al., 1999; Badalamenti et al., 2018b; La Mantia, 2020; Castro-Díez et al., 2021), also affecting forest habitats (Campagnaro et al., 2022; Sitzia et al., 2019). However, climate change itself forces a scientific and non-dogmatic approach to evaluating the risks and opportunities of alien woody plants. The recent ban on the use of prickly pear in a project to combat desertification on an island where the prickly pear is widely cultivated is an example of a non-scientific approach to the problem. It is certainly necessary to avoid introducing new alien species that can potentially escape control even if they have apparent positive potential, for instance herbs and shrubs.

## REFERENCES

- Badalamenti E. & La Mantia T., 2013. Stem-injection of herbicide for control of *Ailanthus altissima* (Mill.)

- Swingle: A practical source of power for drilling holes in stems. *iForest*, 6: 123–126.
- Badalamenti E., 2021. First record of *Heptapleurum arboricola* Hayata (Araliaceae) as a casual non-native woody plant in the Mediterranean area. *BioInvasions Records*, 10: 805–815.  
<http://dx.doi.org/10.3391/bir.2021.10.4.05>
- Badalamenti E. & La Mantia T., 2018. *Handroanthus heptaphyllus* (Bignoniaceae) in Sicily: a new casual alien to Italy and Europe. *Flora Mediterranea* 28: 331–338.  
<http://dx.doi.org/10.7320/FlMedit28.331>
- Badalamenti E., Barone E., Pasta S., Sala G. & La Mantia T., 2012. *Ailanthus altissima* (Mill.) Swingle (fam. Simaroubaceae) in Sicilia e cenni storici sulla sua introduzione in Italia. *Il Naturalista siciliano*, 36: 117–164.
- Badalamenti E., Novara A., Gristina L., La Mantia T., Lauteri M., Pasta S., Fernandes P., Correia O. & Máguas C., 2014. Relationship between recruitment and mother plant vitality in the alien species *Acacia cyclops*. *Forest Ecology and Management*, 331: 237–244.  
<http://dx.doi.org/10.1016/j.foreco.2014.08.016> 0378-1127/
- Badalamenti E., Barone E. & La Mantia T. 2015a. Seasonal effect on mortality and resprouting ability of stems treated by glyphosate in the invasive tree *Ailanthus altissima* (Mill.) Swingle. *Arboricultural Journal*, 37: 180–195.
- Badalamenti E., La Mantia T. & Quatrini P., 2015b. Arbuscular mycorrhizal fungi positively affect growth of *Ailanthus altissima* (Mill.) Swingle seedlings and show a strong association with this invasive species in Mediterranean woodlands. *Journal of the Torrey Botanical Society*, 142: 127–139.  
<http://dx.doi.org/10.3159/TORREY-D-14-00034.1>
- Badalamenti E., Bueno R.S., Campo O., Gallo M., La Mela Veca D.S., Pasta S., Sala G. & La Mantia T., 2018a. Pine stand density influences the regeneration of *Acacia saligna* (Labill.) H.L. Wendl. and native woody species in a Mediterranean coastal pine plantation. *Forests*, 9: 359.  
<http://dx.doi.org/10.3390/f9060359>
- Badalamenti E., Cusimano D., La Mantia T., Pasta S., Romano S., Troia A. & Iardi V., 2018b. The ongoing naturalisation of *Eucalyptus* spp. in the Mediterranean Basin: new threats to native species and habitats. *Australian Forestry*, 81: 239–249.  
<http://dx.doi.org/10.1080/00049158.2018.1533512>.
- Badalamenti E., Pasta S., Sala G., Catania V., Quatrini P. & La Mantia T., 2020a. The paradox of the alien plant *Leucaena leucocephala* subsp. *glabrata* (Rose) S. Zárate in Sicily: another key threat for the native flora or a valuable resource? *International Journal of Plant Biology*, 11: 8637.
- Badalamenti E., Sferlazza S., La Mela Veca D.S., Maetzke F., Sala G. & La Mantia T., 2020b. Which are Southern Italy's fastest growing tree species? Lessons from the past for future perspectives, with a special focus on Sicily. *Annals of Silvicultural Research*, 45: 31–43.  
<http://dx.doi.org/10.12899/asr-1845>
- Badalamenti E., Maggio A., Dardi A., Palumbo Piccionello A. & La Mantia T. 2022. Low mimosine content and nutrient-rich foliage of two *Leucaena leucocephala* varieties: a potential fodder resource in Mediterranean agroforestry systems. *Plant Biosystems*, 156: 606–612.  
<http://dx.doi.org/10.1080/11263504.2022.2048277>
- Bianchetto E., Buscemi I., Corona P., Giardina G., La Mantia T. & Pasta S., 2015. Fitting the Stocking Rate with Pastoral Resources to Manage and Preserve Mediterranean Forestlands: A Case Study. *Sustainability*, 7: 7232–7244.  
<http://dx.doi.org/10.3390/su7067232>. ISSN 2071-1050
- Bueno R.S., Badalamenti E., Gristina L., Novara A. & La Mantia T., 2023. The role of almond-leaved pear *Pyrus spinosa* Forssk. in carbon storage and land restoration of Mediterranean woodlands. *Land* 2023, 12: 2135.  
<http://dx.doi.org/10.3390/land12122135>
- Bueno R.S., Badalamenti E., Sala G. & La Mantia T., 2024. A crop for a forest: *Opuntia ficus-indica* as a tool for the restoration of Mediterranean forests in areas at desertification risk. *Frontiers in Forests and Global Change*, 7: 1343069.  
<http://dx.doi.org/10.3389/ffgc.2024.1343069>
- Campagnaro T., Brundu G., Burrascano S., Celesti-Grappow L., La Mantia T., Sitzia T. & Badalamenti E., 2022. Tree invasions in Italian forests. *Forest Ecology and Management*, 521: 120382.  
<http://dx.doi.org/10.1016/j.foreco.2022.120382>
- Castro-Díez P., Alonso Á., Saldaña-López A., & Granda E., 2021. Effects of widespread non-native trees on regulating ecosystem services. *Science of the Total Environment*, 778: 146141.
- Ciolfi M., Chiocchini F., Pollegioni P., Badalamenti E., Volterrani C., La Mantia T. & Lauteri M., 2023. Investigating the invasion mechanisms of *Ailanthus altissima* (Mill.) Swingle by means of remote sensing, stable isotopes and soil metagenomic sequencing techniques. The 5th Euro-Mediterranean Conference for Environmental Integration (EMCEI-2023). Rende, Italy, 2-5 October 2023
- El-Euch F., 2000. The role of *Acacia cyanophylla* in livestock nutrition in Tunisia. *Cahiers Options Méditerranéennes*, 45: 431–434.
- Gallardo, B., Bacher, S., Barbosa, A. M., Gallien, L., González-Moreno, P., Martínez-Bolea, V., Sorte, C.,

- Vimercati, G., & Vilà M., 2024). Risks posed by invasive species to the provision of ecosystem services in Europe. *Nature Communications*, 15: 2631.
- Gritti E.S., Smith B. & Sykes M.T., 2006. Vulnerability of Mediterranean Basin ecosystems to climate change and invasion by exotic plant species. *Journal of Biogeography*, 33: 145-157.
- Jarradi S. & Louhaichi M., 2017. Managing rangelands: promoting sustainable native tree species: *Acacia cyanophylla*: a multipurpose tree mainly used for reforestation of degraded landscapes. Tunisia, Tunisia: Direction Générale des Forêts (DGF) Factsheet, ICARDA publication.  
<https://hdl.handle.net/20.500.11766/7801>
- La Mantia T., 2011. I rimboschimenti delle dune. In "I cambiamenti nell'ecosistema della Riserva Naturale di Vendicari e gli effetti sull'avifauna (Ientile R., Rühl J., La Mantia T., Massa B.), Edizioni Danaus, Palermo, pp. 97-109.
- La Mantia T., 2013. Storia dell'eucalitticoltura in Sicilia. *Il Naturalista siciliano*, 37: 587-628.
- La Mantia T., 2020. Uomini, altri animali, piante, razze e invasioni aliene: per un nuovo modello di sviluppo. Pp. 225-255. In "*Crescere/Svilupparsi*. Teorie e rappresentazioni fra mondo antico e scienze della vita contemporanee" a cura di Giorgianni F., Li Causi P., Maggio M.C., Marchese R.R.. GenerAzioni - Letteratura e altri saperi - 4. Palermo University Press.
- Pasta S., Badalamenti E. & La Mantia T., 2010. Tempi e modi di un'invasione incontrastata: *Pennisetum setaceum* (Forssk.) Chiov. (Poaceae) in Sicilia. *Il Naturalista siciliano*, 34: 487-525.
- Pasta S., Badalamenti E. & La Mantia T., 2012. *Acacia cyclops* A. Cunn. ex G. Don (Leguminosae) in Italy: first cases of naturalization. *Anales del Jardín Botánico de Madrid*, 69: 193-200.  
<http://dx.doi.org/10.3989/ajbm.2314>
- Pasta S., Badalamenti E., Sala G. & La Mantia T., 2016. *Nicodemia madagascariensis* (Lam.) R. Parker (fam. Scrophulariaceae) a casual alien plant new to Italy. *Webbia*, 71: 155-162.  
<http://dx.doi.org/10.1080/00837792.2016.1160662>
- Peller T. & Altermatt F., 2004. Invasive species drive cross-ecosystem effects worldwide. *Nature Ecology & Evolution*.  
<https://doi.org/10.1038/s41559-024-02380-1>
- Quatrini P., Scaglione G., Incannella G., Badalucco L., Puglia A. M. & La Mantia T., 2003. Microbial inoculants on woody legumes to recover a municipal landfill site. *Water, Air and Soil Pollution: Focus*, 3, 189-199.
- Sitzia T., Campagnaro T. & La Mantia T., 2019. Capitolo 3.6 Specie arboree esotiche invasive: il caso di Robinia e Ailanto. In Ferretti et al., "Boschi di neoformazione in Italia: approfondimenti conoscitivi e orientamenti gestionali". Rete Rurale Nazionale 2014-2020, Scheda n. 22.2 - Foreste, Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria, Roma, pp. 41-45. I  
<https://www.reterurale.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/19648>.
- Stohlgren T.J., Binkley D., Chong G.W., Kalkhan M.A., Schell L.D., Bull K.A., Otsuki Y., Newman G., Bashkin M. & Son Y., 1999. Exotic plant species invade hot spots of native plant diversity. *Ecological monographs*, 69: 25-46.  
[https://doi.org/10.1890/0012-9615\(1999\)069\[0025:EPSIHS\]2.0.CO;2](https://doi.org/10.1890/0012-9615(1999)069[0025:EPSIHS]2.0.CO;2)