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ASSESSING THE INVASIVE POTENTIAL OF SOME NON-NATIVE ORNAMENTAL PLANTS IN ROMANIA

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ABSTRACT

Non-native ornamental plants are widely used in urban landscapes, but however some non-native of these species may escape cultivation and become invasive, threatening native biodiversity. This study evaluates the invasive potential of ornamental taxa plant species currently cultivated, escaped, or naturalized in Romania. A set of nineteen diagnostic questions addressing species origin, reproductive traits, ecological adaptability, and documented invasiveness was applied using field observations and literature data. The results indicate that several ornamental species commonly employed in landscaping possess traits associated with high invasive potential, raising concerns for both urban ecosystems and adjacent natural habitats. The study underscores the necessity of incorporating standardized risk assessment tools into urban planning and horticultural practice. Integrating such evaluations into species selection can help prevent future invasions and contribute to sustainable landscape management.

INTRODUCTION

In recent decades, the ornamental horticultural industry has proven to be one of the main pathways for the introduction of alien species globally, playing a major role in facilitating biological invasion processes, particularly in urban environments (Mayer et al. 2017, Van Kleunen et al. 2018). Although many of the introduced ornamental garden species have not yet naturalized at the local level, numerous international examples highlight their invasive potential (Mayer et al. 2017). In the context of climate change, there is a risk that these species may become naturalized in new regions, including our own country (Mayer et al. 2017, Haeuser et al. 2018). Considering that cities represent the primary environments for the introduction of ornamental plants, they also become vulnerable hotspots for the naturalization and spread of alien species. The accelerated process of urbanization has profoundly altered the floristic composition of anthropogenic habitats, thereby facilitating the establishment and spread of these species in urban areas (Pyšek et al. 2010, Aronson et al. 2014).

Urban spontaneous flora contains a higher proportion of alien species compared to rural areas (Kühn et al. 2004, Aronson et al. 2014), a pattern influenced both by the intensity of human activities and by frequent disturbances of urban habitats. In addition, the flora planted in urban gardens and green spaces often includes a considerable number of cultivated alien species, selected for their ornamental value or adaptability (Kowarik 2005, Pergl et al. 2016, Gaertner et al. 2017). The interaction between spontaneous and cultivated flora can favor the naturalization and, eventually, the invasion of urban ecosystems by some of these species (Vilà et al. 2011, Pyšek et al. 2012, Mayer et al. 2017), with leading to negative consequences for native flora and ecosystem functioning.

At the same time, urban green infrastructure, including public and private gardens, parks, and other green spaces, plays a vital role in providing ecosystem services such as urban microclimate regulation (Wang et al. 2014, Lin et al. 2016), as well as aesthetic and recreational value (Lindemann-Matthies & Brieger 2016). Therefore, responsible management of urban plant composition is essential for maintaining a balance between aesthetic and functional benefits and the ecological risks posed by invasive species.

Currently, risk assessments are the most rigorous tools for identifying species with invasive potential (Vilà et al. 2010, Simberloff et al. 2013). However, only a limited number of these assessments have been specifically adapted for ornamental plants, limiting the ability to anticipate risks before species are introduced to the market (Keller et al. 2011). At the same time, research on invasive traits and the factors that determine invasion success provides a useful framework for identifying species with a reduced potential for invasiveness (Kumschick et al. 2013). Such species can be confidently recommended for use in horticultural trade, landscape design, and gardening, supporting responsible biodiversity management in urban environments (Dehnen-Schmutz 2011, Van Kleunen et al. 2020). In this context, the selection of ornamental species for urban environments should be guided by scientific criteria, in order to balance aesthetic and functional advantages with the imperative of biodiversity conservation.

The purpose of the study is to evaluate the invasive potential of certain ornamental plant species that are currently cultivated, have escaped, or are naturalized in Romania, using a Plant Risk Evaluation (PRE) tool.

MATERIAL AND METHODS

For this study, ten ornamental plant species cultivated for decorative purposes in Romania were selected. Some of these species have escaped cultivation (e.g., *Helianthus decapetalus*, *Datura wrightii*), while others are already naturalized in Romania (e.g., *Albizia julibrissin*, *Oxalis debilis, Catalpa bignnonioides, Buddleja davidii, Euphorbia marginata, Echinacea purpurea, Valeriana rubra, Gaillardia aristata*). (Table 1). These ornamental species display a combination of horticulturally valuable traits, such as ease of propagation, resilience to pests and diseases, and tolerance to drought, which make them highly suitable for use in Romanian gardens, parks, and diverse urban green spaces.

In this study, the Plant Risk Evaluation (PRE) tool was employed, a screening questionnaire specifically developed for the assessment of ornamental plant species, designed for use by the horticultural industry in the United States (Conser et al. 2015). This tool has been successfully tested in the temperate continental climate of Romania (Raicu et al. 2025). The accuracy rate of the PRE tool was 100 %, which showed that

it can be successfully used in testing the invasiveness of ornamental plants present or to be introduced on the Romanian horticultural market.

For each evaluated species, an in-depth review of the scientific literature was carried out, supplemented by searches in various online databases. Based on the information gathered, a definitive ”Yes” or ”No” answer was provided for each question in the PRE tool. In cases where the available data were insufficient to allow a clear answer, the question was left unanswered, in accordance with the methodology described by Conser et al. (2015). For all ten ornamental plant species included in the study, an individual datasheet was prepared containing the evaluation tool’s questions, responses, scores, confidence levels of the answers, and the bibliographic references used to assign the responses,

The following were calculated per plant species evaluated:

- **Total score**, obtained by summing the points assigned for each answered question:
  - < 11: Accept (low risk of invasiveness)
  - 11–13: Further evaluation required
  - > 13: Reject (high risk of invasiveness)
- **Percentage of questions answered**. For the score to be considered valid, at least 16 questions must be answered:
  - ≥ 16: Valid (80 % or more of the questions answered)
  - ≤ 15: Invalid (insufficient number of questions answered)
- **Confidence level (Conf.),** regarding the quality of information used for each answered question, was also assessed. Additionally, an overall confidence level was assigned for each species, categorized as high, medium, or low based on the predominance of one of these three types of responses:
  - **H (High confidence)** – Reliable, high-quality data sources exist, and the information is neither controversial nor contradictory.
  - **M (Medium confidence)** – Some direct observational evidence is available, but certain information is inferred and/or data interpretation is somewhat ambiguous or contradictory.
  - **L (Low confidence)** – Information sources are considered low quality, or unreliable and/or no direct observational evidence exists; for example, only inferred data were used as supporting evidence.

RESULTS AND DISCUSSIONS

The scores obtained using the PRE (Plant Risk Evaluation) tool for the ten potentially invasive plant species ranged between 11 and 20 points. Eight of the ten species received scores >13, indicating a high risk of invasiveness, while two species (*Oxalis debilis* and *Euphorbia marginata*) scored between 11 and 13 (Fig. 1). According to the invasive risk assessment protocol, scores ranging from 11 to 13 require further evaluation by a specialist. Consequently, a second expert conducted an independent review, reassessing the relevant criteria. Following this re-assessment, the final score for *Oxalis debilis* was revised to 10, indicating a low risk of invasiveness.

The one-point difference between the initial and revised assessments resulted from a single question: *”Are the plant’s propagules frequently dispersed over long distances (>100 m) by mammals, birds, or domestic animals?”.*

According to the scientific literature consulted, propagule (bulbil) dispersal in *Oxalis debilis* occurs primarily through human-mediated activities: soil adhering to

digging tools, workers footwear, and transplanted plant roots. There is no clear or sufficient evidence in the scientific literature confirming frequent long-distance dispersal by birds, mammals, or domestic animals. Therefore, the negative response to this question was based on the lack of documented evidence regarding animal-mediated transport of propagules.

Why can this question make a 1-point difference? Dispersal mechanisms are critical in assessing a plant species' invasive potential. Frequent long-distance dispersal by animals significantly increases the likelihood of a species spreading beyond its original site of introduction. Scoring systems used in risk assessments (such as weed risk assessments) often assign specific points to such dispersal traits. A "yes" answer to this question typically adds one point, reflecting a higher invasive potential. Even a single point can shift the overall risk category, for example, from "low" risk to "moderate risk".

For *Euphorbia marginata*, the final score remained unchanged after re-evaluation, at 12 points. This species presents a somewhat unclear situation, as it has not been reported as naturalized in any country with a temperate continental climate. It is only cited as a casual species (Maslo & Šarić, 2018).

Valeriana rubra (Centranthus ruber), with a final score of 17 points, is native to Mediterranean climate regions in southern Europe and northwestern Africa, but it has also naturalized in temperate-continental zones. This expansion is likely favored by recent climate changes that are warming Central European regions and creating conditions like its native habitat. According to the scientific literature, the species does not currently exhibit invasive behavior in these areas; however, the evaluation score indicates a possible risk of invasiveness in the future if climate change continues.

The highest final score, 20 points, was recorded for *Gaillardia aristata* and *Helianthus decapetalus,* species native to North America. These species are well-documented, and a substantial amount of relevant information was available, which facilitated the completion of the assessment questionnaire.

Datura wrightii, a species native to the southwestern United States, received a final score of 19 points in the risk assessment, indicating a high invasive potential. We did not find clear information in the scientific literature confirming that it replaces native vegetation in the habitats where it establishes. It can reproduce vegetatively, but this is not a common method for this species; natural reproduction occurs primarily through seeds. All parts of *Datura wrightii* are toxic, containing dangerous alkaloids that can cause severe hallucinations, paralysis, respiratory failure, and even death, especially if seeds or leaves are ingested. Fatal poisonings have been reported in both humans and domestic animals.

Echinacea purpurea, a species highly valued in herbal medicine as well as an ornamental plant, received a final score of 14 points in the invasive risk assessment. Native to North America, it is predominantly found in temperate-continental climate regions, but it is not declared invasive anywhere in the world. The plant reproduces both vegetatively and by seeds; however, its low drought tolerance limits its distribution range, which is an important restricting factor. Propagules are not dispersed over long distances by animals or birds; only seeds may be transported by wind or through accidental contamination of seed packets with wildflower seeds. In conclusion, *Echinacea purpurea* has the potential to become invasive, but likely only in wetter areas where environmental conditions favor its growth and spread.

The questions that were the hardest to answer were related to seed biology—such as viability, germination rate, frequency of seed production within a

growing season, and dispersal mechanisms are often difficult to document, making these questions challenging to answer. Additionally, assessing questions regarding the climate in which a species has naturalized or become invasive is complicated due to the lack of clear data.

The percentage of questions answered for the ten analyzed species ranges from 84.21 % for *Albizia julibrissin*, to 89.47 % for *Catalpa bignonioides*, *Euphorbia marginata*, *Echinacea purpurea*, *Buddleja davidii*, *Helianthus decapetalus*, and *Datura wrightii*, up to 94.74 % for *Oxalis debilis*, while *Valeriana rubra* and *Gaillardia aristata* had 100 % of the questions answered. According to the validation criteria of the risk assessment protocol, tests are considered valid if responses are provided for at least 16 questions, corresponding to a minimum of 80 % answered questions. Therefore, all tests conducted in this study are valid.

In some cases, although specific data were not identified in the scientific literature, answers were inferred or based on personal experience, allowing the percentage of completed questions to exceed the 80% threshold. The most challenging species to evaluate were *Oxalis debilis* and *Euphorbia marginata*, while for *Valeriana rubra (Centranthus ruber)* and *Gaillardia aristata*, we were able to answer all questions, sometimes even based on personal experience. The analyzed species present an increased risk of invasiveness, especially considering their frequent use in urban green space design. Favorable conditions, such as anthropogenic influence, ecological disturbances, and urban microclimates, may accelerate the naturalization process and facilitate the spread of these species into surrounding habitats.

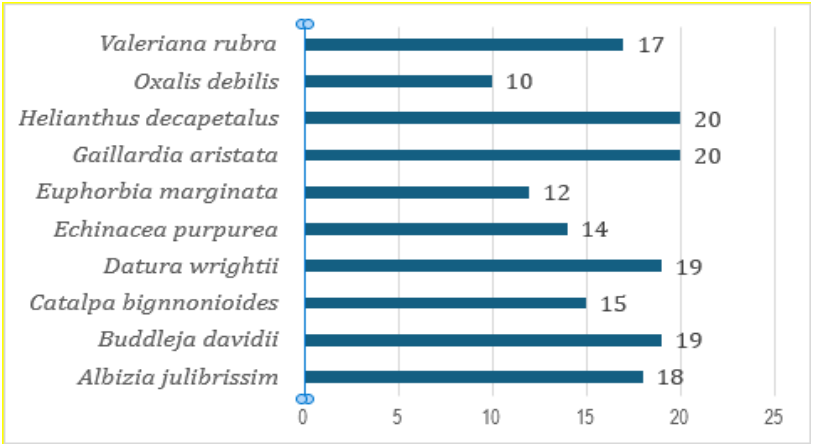

Figure 1. Scores obtained using the PRE tool for the 10 species evaluated

Table 1

List of the ten ornamental plant species included in the study

Specia	Total score	% Questions answered	Conf.
Albizia julibrissin	18	84,21 %	high
Buddleja davidii	19	89,47 %	high
Catalpa bignnonioides	15	89,47 %	high

Datura wrightii	19	89,47 %	medium
Echinacea purpurea	14	89,47 %	high
Euphorbia marginata	12	89,47 %	low
Gaillardia aristata	20	100 %	high
Helianthus decapetalus	20	89,47 %	high
Oxalis debilis	10	94,74 %	high
Valeriana rubra (Centranthus ruber)	17	100 %	high

CONCLUSIONS

Testing the 10 ornamental plant species using the PRE tool provided a clear picture of the invasive potential of each species.

For *Oxalis debilis* and *Euphorbia marginata*, which initially scored in the intermediate range (11–13), expert re-evaluation was essential for accurately determining the level of invasiveness risk. As a result, the score for *Oxalis debilis* was adjusted to 10 (low risk), while for *Euphorbia marginata*, it remained unchanged at 12 points (moderate risk).

The absence of clear evidence in the scientific literature, as seen in the cases of the two species above, highlights the need for further studies and a cautious, well-documented approach in risk assessment.

Gaillardia aristata and *Helianthus decapetalus* received the highest possible score (20 points), indicating a high risk of invasiveness. The availability of extensive and relevant data allowed for a complete and well-supported evaluation.

Datura wrightii (19 points) presents an increased risk not only from an ecological perspective but also a sanitary one, as it is a toxic species for both humans and animals, which requires increased caution in its cultivation and management in open spaces.

Valeriana rubra (17 points) exemplifies how climate change can facilitate the expansion of certain species beyond their natural range, although there is currently no clear evidence that it is becoming aggressively invasive.

Echinacea purpurea (14 points) is a species with medium invasive potential; however, its ability to spread is limited by its low drought tolerance and the lack of effective long-distance dispersal mechanisms.

The results emphasize the importance of continuous monitoring of ornamental species used in urban green spaces, particularly those with high invasive potential or uncertain status, in order to prevent negative impacts on local ecosystems.

All risk assessment tests conducted for the ten analyzed species are valid, as the percentage of questions answered exceeded 80%, providing a reliable basis for interpreting the results.

The level of response completion reflects variability in the availability of scientific information for each species. In some cases, answers were supplemented by expert judgment or personal experience, compensating for gaps in the published literature.

The evaluated species exhibit a high invasive potential, particularly due to their frequent use in urban landscaping. Specific urban environmental conditions, including anthropogenic influence, ecological disturbances, and urban microclimates, may facilitate and accelerate the naturalization process and expansion into surrounding habitats.

Given the increased risk of invasiveness, close monitoring of these species in urban and peri-urban areas is recommended to prevent and manage potential negative impacts on local ecosystems.

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