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EVALUATION OF THE PRE (PLANT RISK EVALUATION) INSTRUMENT IN THE SCREENING OF ORNAMENTAL PLANT SPECIES FROM ROMANIA USED IN URBAN LANDSCAPING

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ABSTRACT

The aim of our study is to test the applicability of the PRE (Plant Risk Evaluation) tool under the conditions of the temperate continental climate in Romania. This tool can provide a promising basis for the evaluation of ornamental plants used in urban landscaping in Romania. For testing, we used 10 alien species of ornamental plants declared invasive in Romania and 10 alien non-invasive ornamental species. For each species, we created an evaluation sheet that includes the questions, answers, score, degree of confidence and bibliographic list. The final score obtained using the PRE varied between 20-22 points for invasive plants, indicating a high risk of invasiveness and between 3-9 points for non-invasive plants, indicating a low degree of invasiveness.

INTRODUCTION

Over the past 20 years, studies have show that ornamental horticulture has significantly contributed to the introduction and spread of invasive plant species worldwide (Drew et al., 2010; Humair et al., 2015; Hulme et al., 2018; Bayón and Vilà, 2019). The global ornamental plant market is currently valued at USD 52.3 billion and is expected to grow by more than 50% in the next five years (Yin et al. 2023). The European landscape, especially the urban areas, has consistently been influenced by evolving horticultural trends, leading to the introduction of numerous alien plants with various ornamental characteristics. Romania is especially vulnerable to invasions by alien plant species, primarily due to its central geographical position in Europe and the intensity of trade with other countries (Anastasiu and Negrean, 2007; Sârbu et al., 2022).

Risk assessment tools use scientific data to predict which plant species, not yet introduced into a region, have a high potential to become invasive (Andreu &

Vilà, 2010; Whitney & Gabler, 2008), as well as species that are already invasive in certain areas. Risk assessments are considered the most reliable method for screening invasive plant species (Puth & Post, 2005). However, very few of these tools have been specifically designed to properly evaluate ornamental plants, making it difficult to assess the invasive potential of species before they are introduced to the market.

A risk assessment tool was developed in Australia (Pheloung et al., 1999) consisting of 49 questions. Although it had an accuracy rate of 90% in correctly identifying invasive plants, its accuracy in assessing known non-invasive plants varied significantly, ranging from 21% to 75%. These results led to a decline in its use (Onderdonk et al., 2010). In contrast, the United States Plant Protection and Quarantine (PPQ) developed a different risk assessment procedure, but it required 2 to 8 weeks to complete, compared to the 1-2 days required by the Australian tool. Both procedures also included questions regarding the environmental impact of the assessed ornamental species, which could not be answered until the plants had escaped cultivation and entered the wild. In 2015, a new Risk Assessment tool (PRE) was specifically designed for screening ornamental plants and for use by the U.S. horticultural industry (Conser et al., 2015). This tool consists of 19 questions and has an accuracy of 98% in determining the behavior of invasive plants and 95% for non-invasive plants (https://ccuh.ucdavis.edu/). Studies show that PRE can predict the invasiveness risk (low or high) of a given species or variety in each region of the United States, helping the horticultural industry market only non-invasive taxa (Conser et al., 2015).

The Plant Risk Evaluation (PRE) tool provides a promising basis for evaluating ornamental plants used in urban landscaping in Romania. The aim of our study is to test the applicability of this tool, originally developed for the U.S., under the conditions of Romania's temperate continental climate. This tool is essential for strengthening the regulation of horticulture, landscaping, and the plant trade. Additionally, information is provided on the basic characteristics of the tested species, including taxonomy, origin, life form, and invaded or potentially invaded habitats (Andreu & Vilà, 2010). According to Hulme et al. (2018), plant species that pass evaluation and are approved should be included in a national whitelist and labeled at points of sale with a "green" tag, indicating a low probability of becoming invasive. Conversely, species that are rejected and have already spread beyond cultivation should be labeled with a "red" tag, signaling a high risk of invasiveness, allowing consumers to make informed choices.

MATERIAL AND METHODS

To test the applicability of the PRE tool, we selected 10 species of ornamental plants declared invasive in Romania (Anastasiu et al., 2019) and 10 non-invasive ornamental species. Species that have not escaped cultivation in the last 30 years were considered non-invasive (Anastasiu & Negrean, 2007). For each species evaluated, we conducted a comprehensive literature review, supplemented by searches in online databases. Using the gathered information, we attempted to answer each question with a "yes" or "no" If insufficient information was available for a specific question, that question was left unanswered.

To ensure the most accurate responses, we utilized the guide developed by the California Horticultural Invasives Prevention (Cal-HIP) group (https://plantright.org/), which provides detailed clarification for each question.

For each plant species assessed, we calculated:

- **Total score:** The sum of the points for all answered questions. The classification criteria were:
  - < 11: accept (low risk of invasiveness)
  - 11-13: Further evaluation is required >13: rejection (high risk of invasiveness)
- **Percentage of questions answered:** A minimum of 16 answered questions (80%) is required for the score to be considered valid:
  - >= 16: valid (80% or more questions answered)
  - <= 15: invalid (not enough questions answered)
- **Degree of confidence (Conf.):** The degree of confidence in the information used to answer each question was also assessed. For each species, we calculated an overall confidence level (high, medium, or low) based on the predominance of one of the three response categories:
  - High (H): Reliable, high-quality data with no conflicting or controversial information.
  - Moderate (M): Some direct observational evidence, but part of the information is inferred or the interpretation of data is ambiguous or contradictory. Low (L): Low-quality or unreliable data sources and/or no direct observational evidence; only inferred data were used.
- **Study Accuracy Rate (Ac):** was calculated according to Conser et al. (2014) and represents the number of correct predictions for known invasive and non-invasive species.

  Ac = (TP + TN) / (IT + NT);

Where:

- TP (True Positives) represents true positives, or the number of invasive species correctly rejected as high risk of invasiveness.
- TN (True Negatives): represents true negatives, or the number of non-invasive species correctly accepted as low risk for invasiveness
  - IT is the total number of invasive species tested.
  - NT is the total number of non-invasive species tested.

RESULTS AND DISCUSSIONS

For each of the 20 species included in the study, we created an evaluation sheet that contains the test questions, the answers, the final score, the confidence level of the answers and the bibliographic sources used to support the answers.

The final score obtained using the PRE (Plant Risk Evaluation) tool for the invasive species ranged between 20 and 22 points. All 10 invasive species tested had scores >13, indicating a high risk of invasiveness (Fig. 1).

For the non-invasive species, the scores varied between 3 and 9 points, indicating a low risk of invasiveness for all tested species (Fig.1).

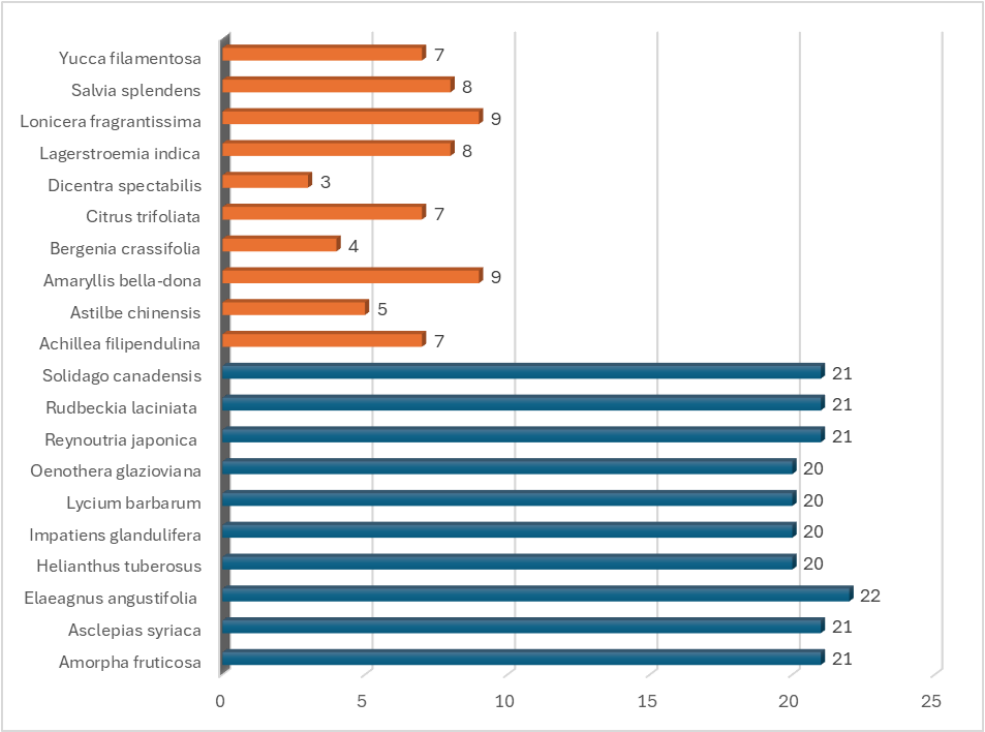

Figure. 1 The scores obtained after using the PRE tool for the 20 species used.

There were no cases where further evaluation was required. The minimum number of unanswered questions was two, ensuring that the proportion of questions answered exceeded 80% for all species, leading to the validation of all tests. For invasive species, there was only one case where a question could not be answered. In contrast, for non-invasive species, there were seven cases where responses were not possible due to a lack of information in the specialized literature. These questions mainly concerned seed-related data, such as viability and methods of natural propagation and spread. The question that received only "yes" answers for invasive species and only "no" answers for non-invasive species was question number 4: "Is the species listed as invasive anywhere in the world in a climate similar to Romania's (continental climate)?". We consider this one of the most relevant questions in the test, as climate suitability is a key factor for species that have already demonstrated invasive potential. Research by Sîrbu et al. (2022) indicates that more than half of the invasive species in Romania originate from Central and North America, regions with temperate climates.

Regarding the overall confidence level of the answers provided for each species, it was observed that for invasive species, the confidence was high across all species. However, for non-invasive species, most answers were classified with a medium level of confidence. This discrepancy can be attributed to the lack of detailed information in the literature, leading to many answers being inferred. For example, species growing near water bodies are likely spread by water or boats, while winged seeds or seeds with bristles are easily dispersed by wind.

The review of specialized literature reveals that studies on these species primarily focus on methods and factors that enhance the propagation of horticultural plants, which are beneficial for horticulturists aiming to increase plant production. Unfortunately, there is limited information regarding natural reproduction methods, such as the number of seeds produced per plant, the timing and viability of seed production in natural settings, and the mechanisms and distances involved in seed or vegetative organ dispersal, especially for species that reproduce vegetatively.

The precision rate of the PRE tool in this study was 100%, demonstrating its effectiveness in assessing the invasiveness of ornamental plants present or to be introduced on the Romanian horticultural market.

The tool produced no false positives (invasive species correctly identified as high risk) or false negatives (non-invasive species correctly identified as low risk).

Table 1

List of ornamental plant species included in the study

Species	Total score	% questions answered	Classification	Conf.
Invasive ornamental plants				
Solidago canadensis	21	100%	rejected	high
Helianthus tuberosus	20	100%	rejected	high
Amorpha fruticosa	21	100%	rejected	high
Oenothera glazioviana	20	100%	rejected	high
Asclepias syriaca	21	100%	rejected	high
Impatiens glandulifera	20	100%	rejected	high
Lycium barbarum	20	100%	rejected	high
Reynoutria japonica	21	100%	rejected	high
Rudbeckia laciniata	22	100%	rejected	high
Elaeagnus angustifolia	22	100%	rejected	high
Non-invasive ornamental plants				
Achillea filipendulina	7	94,73%	accepted	medium
Bergenia crassifolia	4	100%	accepted	medium
Lonicera fragrantissima	9	94,73%	accepted	medium
Lagerstroemia indica	8	89,47%	accepted	medium
Citrus trifoliata	7	94,73%	accepted	medium
Salvia splendens	8	100%	accepted	medium
Dicentra spectabilis	3	100%	accepted	medium
Yucca filamentosa	7	100%	accepted	high
Amaryllis bella-dona	9	100%	accepted	medium
Astilbe chinensis	5	94,73%	accepted	medium

CONCLUSIONS

The accuracy rate of the PRE tool for the species used in this study was 100%, demonstrating that it can be used successfully to assess the invasiveness of ornamental plants currently present or to be introduced on the Romanian horticultural market.

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