EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES

Pest Risk Analysis for *Euphorbia davidii* Sublis

Euphorbia davidii (Courtesy: S. Follak)

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The risk assessment follows EPPO standard PM 5/5(1) *Decision-Support Scheme for an Express Pest Risk Analysis* (available at http://archives.eppo.int/EPPOStandards/pra.htm), as recommended by the Panel on Phytosanitary Measures. The risk assessment uses the terminology defined in ISPM 5 *Glossary of Phytosanitary Terms* (available at https://www.ippc.int/index.php).

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Based on this PRA, *Euphorbia davidii* was added to the EPPO A2 List of pests recommended for regulation as quarantine pests in 2019. Measures for seed and grain of *Glycine max, Helianthus annuus* and *Zea mays* are recommended.

Pest Risk Analysis for
Euphorbia davidii

PRA area: EPPO region
Prepared by: Expert Working Group (EWG) on *Euphorbia davidii*
Date: 17-20 February 2025. Further reviewed and amended by EPPO core members and Panel on Invasive Alien Plants (see below).

Composition of the Expert Working Group (EWG)

CHAPMAN Daniel (Mr)	University of Stirling, United Kingdom
FOLLAK Swen (Mr)	Austrian Agency for Health and Food Safety (AGES), Institute for Sustainable Plant Production, Austria
KULAKOVA Yuliana (Ms)	All-Russian Plant Quarantine Center, Russian Federation
MARISAVLJEVIĆ Dragana (Ms)	Institute for plant protection and environment, Serbia
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The first draft of the PRA was prepared by Mr Swen Follak (AT).

Ratings of likelihoods and levels of uncertainties were made during the meeting. These ratings are based on evidence provided in the PRA and on discussions in the group. Each EWG member provided a rating and a level of uncertainty anonymously and proposals were then discussed together in order to reach a final decision. Such a procedure is known as the Delphi technique (Schrader *et al*., 2010).

Following the EWG, the PRA was further reviewed by the EPPO Core Members for PRA (Guillaume Fried (ANSES), Anastasia Korycinska (Defra), Alan MacLeod (Defra), Dmitrii Musolin (EPPO)).

The PRA, in particular the section on risk management, was reviewed and amended by the EPPO Panel on Invasive Alien Plants on 2025-05-13/15. EPPO Working Party on Phytosanitary Regulation and Council agreed that *Euphorbia davidii* should be added to the A2 List of pests recommended for regulation as quarantine pests in 2025.

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Describe the endangered area: The EWG considered that the endangered area includes agricultural environments in Pannonian, Continental, Steppic, Black Sea areas of the EPPO region, largely coinciding with the chernozem soil belt.			
Main conclusions: ***Euphorbia davidii*** has a moderate phytosanitary risk for the endangered area with a moderate uncertainty. The likelihood of new introductions to the EPPO region occurring via grain (*G. max, H. annuus, Z. mays*) for animal feed is high with a moderate uncertainty. The likelihood of further establishment outdoors is high with a low uncertainty. The potential for spread within the EPPO region is moderate with a high uncertainty. *E. davidii* can spread naturally though this is limited and the main spread pathway is via human assisted spread. The impact in the current area of distribution is high with a moderate uncertainty. This is based on data from where impacts have been shown in terms of a reduction of crop yield and increased management costs. The EWG considered the potential socio-economic impacts in the EPPO region will be moderate with a high uncertainty. High uncertainty for the EPPO region reflects difficulty in relating negative impacts seen in Argentina to the EPPO region due to different agricultural practises. The EWG consider that the level of impact in the EPPO region will increase with time if the species spreads and establishes in climatically suitable agricultural regions. The overall uncertainty is moderate as the endangered area reflects the most suitable agricultural areas, climate and soils for the species in the EPPO region.			
Phytosanitary risk for the *endangered area* (*Individual ratings for likelihood of entry and establishment, and for magnitude of spread and impact are provided in the document*)	Low ☐	**Moderate** X	High ☐
Level of uncertainty of assessment	Low ☐	**Moderate** X	High ☐
Other recommendations: • Monitor the rate of spread of *E. davidii* from existing populations in the EPPO region. • Conduct dedicated surveys of *E. davidii* in the EPPO region, in particular the endangered area. • Carry out scientific studies on the biology, impact and control of *E. davidii* in the EPPO region. • Promote awareness of the potential impacts of *E. davidii* in the EPPO region.			

EPPO Pest Risk Analysis:

Euphorbia davidii Subils

Prepared by: EPPO Expert Working Group
Date: 2025-02-17/20

Stage 1. Initiation

Reason for performing the PRA:
This PRA was conducted to determine the phytosanitary risk of *Euphorbia davidii* to the EPPO region. *E. davidii* is an annual plant with many functional traits that makes it highly competitive in agriculture. It has a rapid growth and can form dense stands in crop fields. *E. davidii* can build a large and persistent soil seed bank. *E. davidii* has been detected in the vicinity of harbours and along railway tracks, suggesting it has been introduced into the EPPO region as a contaminant of grain. Contaminated seeds for planting are also likely to have contributed to the introduction of the species. At present, transient and established occurrences of the species are known from a number of EPPO countries in disturbed areas and in crop fields where impact has been suggested. The EPPO Panel on Invasive Alien Plants added *E. davidii* to the EPPO Alert list in 2021 and it was transferred to the List of Invasive Plants in 2024 and considered a priority for PRA.

PRA area:
EPPO region (Albania, Algeria, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Guernsey, Hungary, Ireland, Israel, Italy, Jersey, Jordan, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Luxembourg, The Republic of North Macedonia, Malta, Moldova, Montenegro, Morocco, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Türkiye, Ukraine, United Kingdom, Uzbekistan).

(see https://www.eppo.int/ABOUT_EPPO/eppo_members)

Stage 2. Pest risk assessment

1. Taxonomy

Kingdom: Plantae, Division: Spermatophyta, Sub-Division: Angiospermae, Class Dicotyledonae, Order: Malpighiales, Family: Euphorbiaceae, Genus: *Euphorbia*, Species: *Euphorbia davidii* Sublis, in Kurtziana 17: 125 (1984)

Species within the genus *Euphorbia* are divided into well-defined major sections. *E. davidii* belongs to the section Poinsettia Euphorbia Linnaeus sect. Poinsettia (Graham) Baillon, Étude Euphorb. 284. 1858.

Note: Historically there was confusion on the proper identity of plants causing problems in crops in Argentina, Ukraine and the Russian Federation. The plants in Argentina have been identified as a separate species, namely *Euphorbia davidii* new to science and not *Euphorbia dentata* Michx. (Marchessi et al., 2011a). The plants reported from Ukraine and the Russian Federation are also *E. davidii* (Barina et al., 2013). Initially considered native to Argentina, *E. davidii* turned out to be native to North America and introduced into Argentina. Still today, this confusion exists in scientific publications and databases (e.g. POWO, 2025; USDA NRCS, 2025; F. Núñez Fré, pers. comm., 2025).

EPPO code: EPHDV (EPPO, 2024)

Synonyms (in chronological order):
Euphorbia dentata var. *gracillima* Millsp. in Pittonia 2: 90 (May 1890)
Euphorbia dentata var. *lancifolia* Farw. in Amer. Midl. Naturalist 8: 273 (1923)

This list of synonyms and names is based on Plants of the World Online (https://powo.science.kew.org/ and World Flora Online (http://www.worldfloraonline.org/).

Common names:
Bulgarian: давидова млечка, English: David's spurge, Portuguese Leiteiro, Russian: молочай Дэвида, Spanish: lecherón.

Plant type: Herb, annual, with taproot.

Related species in the EPPO region:
The genus *Euphorbia* L. (Euphorbiaceae) is a large genus of over 2 000 species of almost cosmopolitan terrestrial distribution (POWO, 2024). *Euphorbia* L. present in Europe include perennial and annual herbs and small shrubs with over 105 species listed in the Flora Europaea (Smith & Tutin, 1968). Some species are weedy and/or invasive, e.g. *Euphorbia heterophylla* L. (EPPO List of Invasive Alien Plants), *Euphorbia helioscopia* L. (a weedy species) and *Euphorbia esula* L. (Tanveer et al., 2013).

2. Pest overview

2.1 Introduction

Euphorbia davidii is an annual herbaceous plant native to North America: USA (Arizona, California, New Mexico) and Mexico (Northeast and Northwest) from where it has spread further on the continent (POWO, 2024; Flora of North America 2016; Mayfield, 1997). It has been introduced and become established in agriculture and disturbed areas in Australia, the EPPO region and South America (Argentina) (Barina et al., 2013; Mayfield, 1997). Flora of North America detail the species is introduced in China but no other information is available for this region. It has become an important weed in crop fields, especially in Argentina (Núñez Fre et al., 2014). The species has several invasive functional traits, e.g., prolific seed production, persistent seed bank and ability to form dense stands (Núñez Fre, 2019).

2.2 Description

The following description is primarily based on the Flora of North America (FNA, 2016), Vladimirov and Petrova (2009) and Mayfield (1997).

Roots: *Euphorbia davidii* has a taproot.

Stems: solitary, erect or ascending, 20–70 cm tall, up to 4 mm thick at base, with opposite, arcuately ascending branches.

Leaves: opposite, with 7 to 25 mm long petioles, blades 1–10 × 0.5–3.5 cm, lanceolate to broadly elliptic, widest in the middle, attenuate at base, bluntly acute to acuminate at apex.

Flowers: Synflorescence umbellate, flat-topped to slightly rounded, with numerous cyathia. Ray-leaves narrowly elliptic to lanceolate, shortly petiolate, paler at the base. Cyathia involucres cylindriform, glabrous, green, 2.5–3.0 × 1.3–1.8 mm; involucral lobes subsequently divided to 5–7 linear lobes with swollen apical cells. Glands 0.9 × 1.3 mm, solitary, cupped with oblong mouth, pale-yellow, stipitate glands, Staminate flowers 5–8 in a fascicle. Pistillate flower pedicel elongating to ca. 3 mm, exceeding cyathia, ovaries usually glabrous, seldom sparingly strigose.

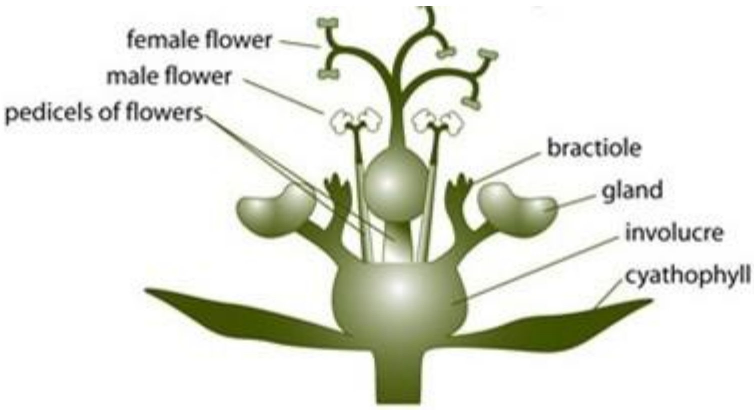

Figure 1. Generalised image of the inflorescence of *Euphorbia* (adapted from Euphorbiaceae.org).

Capsules: broadly ovoid, 2.9–3.3 × 4.0–4.8 mm, 3-lobed, glabrous.

Seeds: black to brown or pale grey, ovoid to triangular. For seed size see Table 1.

Euphorbia davidii has a gametophytic chromosome number of 2n = 56.

Images of *E. davidii* can be found in Appendix 2 and can also be retrieved from the EPPO Global Database (EPPO, 2025).

There is a high potential for misidentification between *Euphorbia dentata* Michx. (toothed spurge), *E. davidii* and *E. heterophylla,* another common contaminant in soybean imported into the EPPO region. Guides for the identification of the species should be consulted (Barina et al., 2013). *E. heterophylla* can be more readily distinguished due to its alternate leaf arrangement, more finely serrated margins, and distinctly different leaf shape A brief overview on the main distinguishing features can be found in Table 1.

Table 1: Morphological and cytological differences between *Euphorbia davidii, Euphorbia dentata* and *Euphorbia heterophylla* (adapted from Barina et al., 2013).

Feature	*Euphorbia davidii*	*Euphorbia dentata*	*Euphorbia heterophylla*
Trichomes of the lower leaf surface	strongly tapered with a broad basal cell	weak, lacking broad basal cell	no information
Length and form of seeds	2.7 ± 0.1 mm only a little longer than wide, triangular ovoid	2.37 ± 0.13 mm only a little longer than wide, smoothly ovoid	2.93 ± 0.16 mm broadly deltoid, bluntly apiculate
Cross section seeds	angular in transection	rounded in transection	rounded in transection

Feature	*Euphorbia davidii*	*Euphorbia dentata*	*Euphorbia heterophylla*
Seed surface	unevenly and bluntly tuberculate	evenly and sharply tuberculate	unevenly coarsely tuberculate, clearly visible rib on dorsal side
Top of seed (faset)	extensive, slightly convex	shallowly recessed, flat to slightly concave	narrowed
Caruncle on seeds	large, yellow, reniform	yellow, small, reniform	absent or point-based
Ploidy	tetraploid, 2n = 56	diploid, 2n = 28	diploid, 2n = 28

2.3 Life cycle
In general, there is relatively little information about the biology and ecology of *E. davidii*.

Euphorbia davidii is an annual species with a spring-summer cycle. In the EPPO region, flowering occurs from August to September and fruits are formed in September to October (Purger et al., 2015; Oprea et al., 2012; Vladimirov & Petrova, 2009).

In the Russian Federation, a vegetative period of 107 to 109 days has been observed (Kudryavtseva & Chernetsova, 1993). Under experimental field conditions in the botanical garden of Barnaul (Altai Krai, Western Siberia), the growing period of *E. davidii* was 75 to 85 days (Terekhina et al., 1999).

In Argentina (Buenos Aires province), *E. davidii* germinates from the seed bank in multiple peaks. Late September (early spring) cohorts are occasionally observed but are usually eliminated by frost (Núñez Fré pers. comm., 2025). After this, the first peak emerges in mid-October (mid spring), and the second peak in early November (late spring). The last cohort has a varied emergence pattern from late November till early January (early summer). When subjected to severe stressors such as sub-lethal herbicide dose, cold injury, or cutting, *E. davidii* plants have been observed to occasionally re-sprout and flower as early as the four-leaf stage (Núñez Fré et al., 2018a).

Seed production
Euphorbia davidii reproduces by seed. A single plant can form between 100 to 300 seeds (Petrova et al., 2013; F. Núñez Fré, pers. comm., 2025). Seed production (seeds per m^2) is influenced by population density that increases up to a density of 150 individuals per m^2. Núñez Fré *et al*. (2018a) showed that an average seed production in the first, second and third cohort was 5 700, 6 400 and 1 900 seeds m^{-2}, respectively (experimental site with no crop competition).

Soil seed bank
Euphorbia davidii builds up a large and persistent soil seed bank with several thousand seeds m^{-2}. More than 20 000 seeds m^{-2} were estimated in fields in Argentina (Núñez Fré, 2019; Núñez Fré et al., 2014). Generally, most seeds are found in the upper soil layer (0-5 cm), but this varies depending on the soil cultivation system (no-till vs. tillage). In soil samples from plots in the Olavarria district (Buenos Aires province, Argentina) where no-till is practiced, 79 % of the seeds were found at a depth of 0-5 cm, 14 % at 5-10 cm and the remaining 7 % at a depth of 10-20 cm. In soil samples from plots in the Azul district (Buenos Aires province) where tillage is practiced, a more homogeneous vertical distribution was observed. Here, 55 % of seeds were found at 0-5 cm, 24 % at 5-10 cm, 16 % at 10-15 cm and 5 % at 15-20 cm (Núñez Fré, 2019; Núñez Fré et al., 2014).

Euphorbia davidii exhibits strong seed dormancy, leading to substantial year-to-year variation in seedling emergence under field conditions. Field observations suggest that dry, cold winters (with numerous days below -5 °C) may break the dormancy and promote germination the following spring. While this hypothesis remains to be experimentally verified, laboratory studies have demonstrated that cold stratification, KNO_3 treatments, and gibberellic acid can partially overcome seed dormancy (F. Núñez Fré, pers. comm., 2025).

Seed longevity
Seeds can remain viable for several years. Marchessi *et al*. (2011b) investigated the germination capability of seeds harvested in 1995 (14 years old) and 2009 (2 years old), stored in laboratory conditions. The viability was determined using the triphenyl tetrazolium method, obtaining 40 % for seeds harvested in 1995 and 73.5 % for those harvested in 2009. A high viability of fresh seeds was observed with a

germination rate of 84 % (after 6 months of storage) (Juan and Saint André, 1995), again using the triphenyl tetrazolium method. Likewise, Kudryavtseva and Chernetsova (1993) reported that seeds of *E. davidii*, which were stored for 5 months under laboratory conditions, had a germinating capacity of 97 %.

2.4 Environmental requirements

Temperature

Germination starts in spring when temperatures exceed 6 °C at the soil depth where the seed is located (Juan & Saint André, 1995). The authors showed that, under light conditions, the optimum temperature for germination was 14 °C, with a germination rate of 76 % (under laboratory conditions). Under dark conditions, the optimum temperature for germination was in a range of 10°C to 17°C, with a germination rate of 58 % to 68 %. A low germination rate (less than 10 %) was observed at 6°C, and a significant decrease was observed at temperatures > 22 °C.

Similar results were found by Marchessi et al. (2011b) who demonstrated that the optimum germination range was between 11.5 and 22.0 °C, independent of the age of seed. The optimum germination temperature was 17 °C. The limit for the germination range was between 8.5 °C and 26.5 °C. Under field conditions, shade provided by the crop canopy occasionally allows for emergence of *E. davidii,* even during periods of high ambient temperatures.

The optimal temperature for vegetative growth is between 20 and 25°C. *E. davidii* grows until the first frost occurs. The growth of *E. davidii* is restricted at low temperatures (F. Núñez Fré, pers. comm., 2025). The species has been found to require approximately 1100-1200 growing degree days with base 8 °C (GDD8) to reach reproductive stage (Molinari et al., 2022; Núñez Fré et al., 2018).

Soil conditions

Euphorbia davidii is adapted to a wide range of soil conditions. In the EPPO region, *E. davidii* can be found on different substrates, such as chernozem-like soil or limestone gravel in places with sandy-clay soil (Purer et al., 2015; Oprea et al., 2012; Vladimirov & Petrova, 2009). In Argentina, *E. davidii* grows on the typical argiudoll soil type, which predominates in agricultural areas there. Both soil types (chernozem-like and argiudoll) are characterized by a high organic matter content (more than 3 %). However, the species is also well adapted to soils with lower organic matter content and sandy soils, which are characteristic of the western part of the Buenos Aires Province (F. Núñez Fré, pers. comm., 2024).

Preliminary laboratory trials indicated no germination at pH 3, 10 % germination at pH 5, optimal germination at pH 7, and no germination at pH 9 (F. Núñez Fré, pers. comm., 2025). Such tests should be replicated under field conditions. Germination decreases almost linearly with burial depth, but even at depths of 7 cm, approximately 30 % germination can be achieved. In sandy soils, *E. davidii* can germinate at rates of 40 % at depths of up to 10 cm (F. Núñez Fré, pers. comm., 2025).

Moisture

The species is adapted to tolerate dry conditions (Montana Field Guide, 2024; FNA, 2016). *E. davidii* can vary greatly in size with individuals growing larger on well-watered sites (Montana Field Guide, 2024). Soilborne pathogens, particularly those causing damping-off, can result in substantial plant stand loss when excessive moisture is present, especially in potted plants under greenhouse conditions (F. Núñez Fré, pers. comm., 2025).

2.5 Habitats

In its native range, in North America, *E. davidii* has been found in forests, along stream and riverbanks, prairies (grassland), roadsides, and open disturbed areas (FNA, 2016). It is also considered to be a weed in agricultural areas (FNA 2016, Verloove, 2013). For example, in Montana (USA), the species was recorded along roadsides at interstate junction and in city parks (Montana Field Guide, 2024).

Association with crops

Euphorbia davidii can persist and thrive in crops and vineyards. It has been found in fields of several crop types in the introduced range (See section 7, Table 4).

2.6 Existing PRAs

The EWG did not find any existing PRAs for *E. davidii.*

3. Is the pest a vector? Yes ☐ No X

4. Is a vector needed for pest entry or spread? Yes ☐ No X

5. Regulatory status of the pest
There is no information on its regulatory status in EPPO Global Database (EPPO, 2025).

Euphorbia dentata is listed as a quarantine pest for the Eurasian Economic Union (EPPO, 2025). However, this is considered to be a historical misapplied name and the actual species that should be listed is *E. davidii* (Y. Kulakova, pers. comm., 2025). Additionally, *E. dentata* is listed as a quarantine pest in China (IPPC, 2022) and other countries (EPPO, 2025), this may be a historical misapplied name.

6. Distribution
Euphorbia davidii is native to USA (Arizona, California, and New Mexico) and Mexico (Northeast and Northwest) (Table 2; POWO, 2024). In the Flora of North America (FNA, 2016) it is stated that *E. davidii* is native from the southwestern United States and northern Mexico north through the southern Great Plains; it apparently is introduced elsewhere.

Note: There is some confusion on the status of the species *E. davidii.* It is considered an alien species in Argentina (Marchessi et al., 2011a). *E. davidii* was described in 1983 from Argentina (Sublis, 1984) and it was widely believed that the species originated from there. Likewise, the POWO (2024) indicates Argentina as the native range for the species. Misinterpretations of the taxonomy presented by Mayfield (1997) by the databases BONAP (Kartesz, 2015) and the USDA NRSC (2024) have led to the erroneous concept that *E. davidii* in North America is non-native.

Asia
It is possible that the plants reported from China (e.g., Ma & Liu, 2003) could be *E. davidii* and not *E. dentata*. The Flora of North America cites China for *E. davidii.* Moreover, data from iNaturalist (https://www.inaturalist.org/) shows that the species occurs in Japan. However, the EWG could not verify the data with certainty.

Oceania
Euphorbia davidii is established in Australia and it has been recorded as a weed in agriculture (Randall, 2007). Observations are available from South Australia, Victoria, New South Wales, Queensland (Atlas of Living Australia, 2024). It occurs in heavily disturbed areas such as roadsides and inland from Sydney though it is not considered a major invader. The species is classified differently across states, e.g., as an “emerging weed” in NSW and as naturalised in Victoria (J. Le Roux, pers. comm., 2025).

South America
Euphorbia davidii was detected in Argentina in the Buenos Aires province (Azul district) in 1983, located in isolated pockets, and currently, the species is distributed over 85% of the agricultural area of that district. Its presence has also been recorded in several other districts of the province (Marchessi et al., 2011a; Juan et al., 1996; Juan and Saint André, 1995). The species has also been found as a weed in the provinces of Córdoba and San Luis (Rauber et al., 2018; F. Núñez Fré, pers. comm., 2024).

EPPO Region
Euphorbia davidii (as *E. dentata*) was first reported in Europe in 1961 from the territory of the Russian Federation (Herbarium of Moscow State University, 2024), whereas most records of the species were observed in the 1990s onwards. The species has been detected in numerous countries in the EPPO region (Fig. 2). At present, established populations occur in a few EPPO countries (France, Hungary, Italy, Russia, Serbia, Spain, Ukraine, Uzbekistan; Table 2). The species is distributed in a band between 43° and 60°N, mainly at low elevations (below 400 m altitude) (Barina et al., 2013).

Readers should refer to EPPO (2025) for up-to-date information on the global distribution of *E. davidii.*

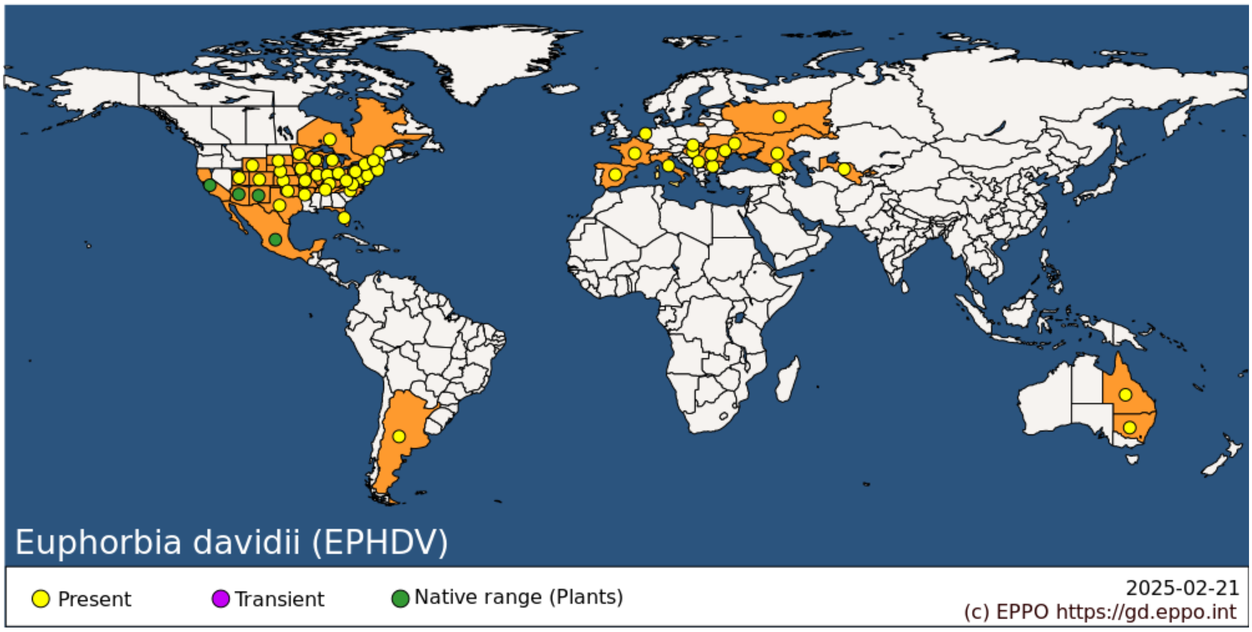

Figure 2. The global distribution of *Euphorbia davidii* (EPPO, 2025). Green dots show the native range, and yellow dots show the introduced range.

Table 2. Distribution and status of *Euphorbia davidii*.

Region	Distribution	Status	References
North America			
Canada	Ontario, Québec	Introduced	POWO (2024)
Mexico	Chihuahua, Coahuila, Sonora	Native	Flora of North America (2020)
USA	Arizona	Native	Flora of North America (2020); POWO (2024)
	Arkansas	Introduced	Flora of North America (2020); POWO (2024)
	California	Native	Flora of North America (2020); POWO (2024)
	Colorado	Introduced	Flora of North America (2020); POWO (2024)
	Florida	Introduced	Flora of North America (2020); POWO (2024)
	Illinois	Introduced	Flora of North America (2020); POWO (2024)
	Idaho	Introduced	Flora of North America (2020); POWO (2024)
	Indiana	Introduced	Flora of North America (2020); POWO (2024)
	Iowa	Introduced	Flora of North America (2020); POWO (2024)
	Kansas	Introduced	Flora of North America (2020); POWO (2024)
	Kentucky	Introduced	Flora of North America (2020); POWO (2024)
	Louisiana	Introduced	Flora of North America (2020); POWO (2024)
	Maryland	Introduced	Flora of North America (2020); POWO (2024)
	Massachusetts	Introduced	Flora of North America (2020); POWO (2024)
	Michigan	Introduced	Flora of North America (2020); POWO (2024)

Region	Distribution	Status	References
	Minnesota	Introduced	Flora of North America (2020); POWO (2024)
	Missouri	Introduced	Flora of North America (2020); POWO (2024)
	Nebraska	Introduced	Flora of North America (2020); POWO (2024)
	New Jersey	Introduced	Flora of North America (2020); POWO (2024)
	New Mexico	Native	Flora of North America (2020); POWO (2024)
	New York	Introduced	Flora of North America (2020); POWO (2024)
	North Carolina	Introduced	Flora of North America (2020); POWO (2024)
	Ohio	Introduced	Flora of North America (2020); POWO (2024)
	Oklahoma	Introduced	Flora of North America (2020); POWO (2024)
	South Dakota	Introduced	Flora of North America (2020); POWO (2024)
	Tennessee	Introduced	Flora of North America (2020); POWO (2024)
	Texas	Introduced	Flora of North America (2020); POWO (2024)
	Utah	Introduced	Flora of North America (2020); POWO (2024)
	Vermont	Introduced	Flora of North America (2020); POWO (2024)
	Virginia	Introduced	Flora of North America (2020); POWO (2024)
	West Virginia	Introduced	Flora of North America (2020); POWO (2024)
	Wisconsin	Introduced	Flora of North America (2020); POWO (2024)
	Wyoming	Introduced	Flora of North America (2020); POWO (2024)
South America			
Argentina	Buenos Aires (province)	Introduced (established)	Juan et al. (2011), Marchessi et al. (2011a)
EPPO region			
	Belgium	Introduced (Transient)	Verloove (2024)
	Bulgaria	Introduced (established	Petrova et al. (2013)
	Georgia	Introduced (status unclear)	Raab-Straube & Raus (2020)
	France	Introduced (established)	Girod & Fried (2011), G. Fried, per. comm., 2024)
	Hungary	Introduced (established)	Pinke et al. (2012), S. Follak, pers. comm. (2024)
	Italy	Introduced (established)	Portal to the Flora of Italy (2024)
	Moldova	Introduced (status unclear)	Barina et al. (2013)
	Netherlands	Introduced (transient)	Van Oostroom & Reichelt (1965)
	Romania	Introduced (status unclear)	Oprea et al. (2012)
	Russian Federation	Introduced (established)	Geltman (2012, 2020)
	Serbia	Introduced (established)	Purger et al. (2015), D. Marisavljević, pers. comm. (2024)
	Slovakia	Introduced (status unclear)	Dudáš et al. (2019)
	Spain	Introduced (established)	Aymerich & Sáez (2019)
	Switzerland	Introduced (status unclear)	Hoffer-Massard (2011)
	Ukraine	Introduced (established)	Shevera et al. (2023); Bondarenk & Myroonov (2021)
	Uzbekistan	Introduced (established)	Makhkamov et al. (2024), Najmiddinov et al. (2024)

Region	Distribution	Status	References
Oceania			
	Australia	Introduced (established)	Randall (2007)

Specific details about the distribution in selected EPPO countries

Belgium (transient)
Euphorbia davidii (as *E. dentata*) is considered a rare and ephemeral species. It was first recorded in 1986 in the port of Ghent. Then, it was observed twice at the Ghent Grain Terminal at the Rodenhuizedok (in 1996 and 1999), most probably as a soybean alien (single specimens). Finally, it was recorded on a dump in Rumbeke-Roeselare in 2003 and on the verge of an unloading quay near a grain mill in the port of Roeselare in 2004 (Verloove, 2024).

Bulgaria (established)
Euphorbia davidii was found in 2009 in the vicinity of Razdelna railway station and the harbour complex west of Beloslav town, Varna district (Black Sea Coast).

France (established)
The first record of *E. davidii* occurred in 1997 in a vineyard in the vicinity of Nîmes in the Mediterranean region. Regular monitoring confirmed its presence in this area until 2009 (G. Fried, pers. obs., 2009), and it is likely that it still occurs there. Since its initial detection, the species has been reported in 25 additional locations, primarily in the southern part of France (Southwest and Mediterranean France) and, less frequently, in the Paris region and Burgundy (see Appendix 3).

Georgia (status unclear)
Euphorbia davidii was found in Tbilisi in 2017 in road and path margins around a petrol station (Raab-Straube and Raus, 2020).

Hungary (established)
This species was discovered in Hungary in a crop field in 2008 in Igar (Fejér county) (Pinke et al., 2012). In 2024, the species was still present at this site (S. Follak, pers. comm., 2024).

Italy (established)
The species has been present since about 1995 (Galasso et al., 2011) and currently, considered established in several Italian regions (Emilia-Romagna, Friuli Venezia Giulia, Lazio, Liguria, Lombardia, Piemonte, Trentino-Alto Adige, Toscana, Veneto) (Portal to the Flora of Italy, 2024).

Moldova (status unclear)
Euphorbia davidii (as *E. dentata*) was reported in the vicinity of the village of Goyany, Dubasari district (Transnistria), in 1978, where it grew on roadsides. It is likely that seeds of *E. davidii* entered Moldova in Soviet times through the territory of Ukraine (Myrza, 1991; Shevera et al., 2023).

Netherlands (transient)
The species has been reported and documented twice for the Netherlands as *E. dentata*. A first record in 1964 as a casual in a roadside (E8 near Bodegraven) and underneath a hedge of a parking area in 1984 (Utrecht) (Van Oostroom & Reichelt, 1965; https://www.verspreidingsatlas.nl/9150). The herbarium specimens at Naturalis Leiden have been reidentified as *E. davidii* by Leni Duistermaat in 2025.

Romania (status unclear)
Euphorbia davidii was observed recorded in 1997 (as *E. dentata*) in the railway station of Socola (city of Iaşi). Later, it was also found in the railway stations of Buzău (Buzău County), Tecuci, and Movileni (both Galaiț County).

Russia (established)
Euphorbia davidii was first collected in 1961 in North Ossetia (Herbarium of Moscow State University, 2024). Following this, the species was collected in row crops and vineyards around Pyatigorsk in 1968 and then in Mineralnye Vody city (North Caucasian Federal District) (as *E. dentata*) (Mikheev, 1971). At

present, it has been recorded in St. Petersburg (port), Moscow region, Chuvashia and Udmurtia, Rostov region, Belgorod region, Saratov region, Astrakhan region, Volgograd region, Krasnodar and Stavropol Krais, Karachaevo-Cherkessia Republic, Kabardino-Balkaria Republic, North Ossetia Republic, Dagestan Republic, Chechenskaya Republic) (Geltman, 2012; Shhagapsoev et al., 2017, Berezutsky, 2017; Mallaliev, 2018, Tokhtar & Kurskoy, 2019; Geltman, 2020; Shkhagapsoev, 2022, Murtazaliev, 2024; Kulakova et al., 2018; Plantarium, 2024).

Serbia (established)
Euphorbia davidii was recorded in 2007 in two localities in Vojvodina on arable fields (Purger et al., 2015). The species still persists in this area (D. Marisavljević, pers. comm., 2024).

Slovakia (status unclear)
Euphorbia davidii has been found for the first time in 2012 in southeastern Slovakia on railway tracks in Maťovské Vojkovce, very close to the Ukrainian border (Jehlik et al., 2013). Recently, in 2019, the species was found at two other locations in eastern Slovakia, namely at the railway station in Bánovce nad Ondavou and along railway tracks near Trebišov (Dudáš et al., 2019).

Spain (status unclear)
Euphorbia davidii is established in the coastal area of Catalonia where it is considered rare (Aymerich & Sáez, 2019).

Switzerland (status unclear)
Euphorbia davidii was recorded in an industrial zone in Bussigny-près-Lausanne in 2011 (Hoffer-Massard, 2011). No further locations are known (InfoFlora, 2024).

Ukraine (established)
The first record is from the area of Odessa port on the Black Sea in 1989 (Shevera et al., 2023). This information was first summarized in the publication by Huzik et al. (1997). All identified localities of the species at that time were confined exclusively to the railroad tracks at railway stations or, less often, other areas where railroad transportation is also used. From 2009 onwards, new localities of *E. davidii* were discovered in other administrative regions of Ukraine (e.g. Poltava, Kharkiv, Mykolajiw, and Crimea) (Shevera et al., 2023) (Fig. 3).

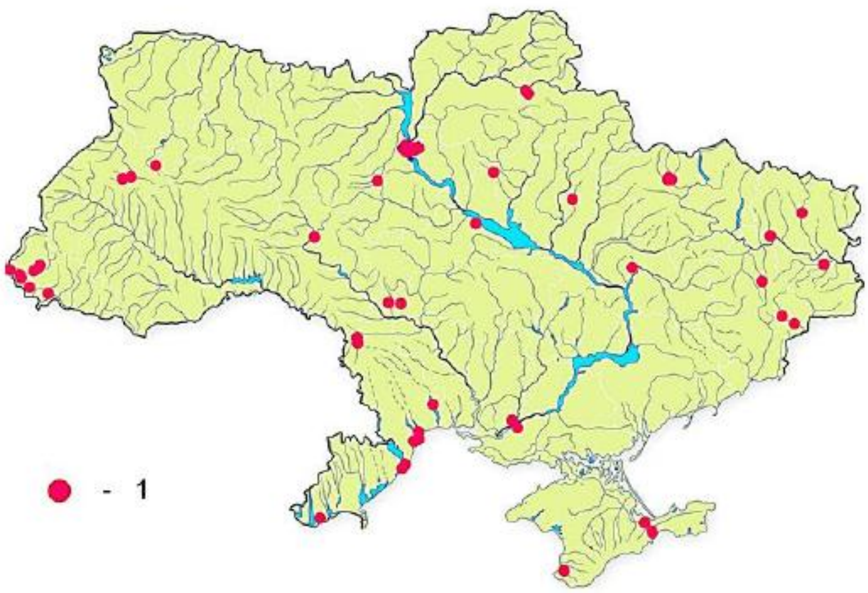

Figure 3. Map of the distribution of *Euphorbia davidii* in Ukraine (red dot = localities) (taken from Shevera et al., 2023).

Uzbekistan (established)
Euphorbia davidii is considered invasive in Uzbekistan in the vicinity of Fergana (Makhkamov et al., 2024).

7. Habitats and where they occur in the PRA area

(Habitat classification based on EUNIS habitat types, Version from 2021: https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification-1)

Table 3. Habitats of *Euphorbia davidii.*

Habitat (main)	**Classification**	**Status of habitat**	**Is the pest present in the habitat in the PRA area (Yes/No)**	**Comments (e.g., *major/minor habitats* in the PRA area)**	**Reference**
Q: Wetlands	Q6 Periodically exposed shores	Protected in part	Yes	Moderate	Q6 Conservatoire botanique national méditerranéen (2024)
V: Vegetated man-made habitats	V1 Arable land and market gardens V2 Cultivated areas of gardens and parks V5 Shrub plantations (= V54 Vineyards)	Not protected	Yes	Major	V1 Juan et al. (1996), Purger et al. (2015), Pinke et al. (2012) V2 F. Núñez Fré pers. comm. (2024), Montana Field Guide (2024), Conservatoire botanique national méditerranéen (2024) V54 Girod & Fried (2011)
Transportation networks, cargo handling areas	Roadsides, railway tracks, port areas [no EUNIS classification]	Not protected	Yes	Moderate	Shevera et al. (2023), Verloove (2024), Montana Field Guide (2024), Conservatoire botanique national méditerranéen (2024)

Suitable habitats occur for *E. davidii* in the PRA area.

According to the analysis of Barina et al. (2013), European records are associated with railways (65.5 % of the known occurrences), followed by agricultural land (17.2 %), and other habitat types (6.9 %, incl. vineyards and other ruderal environments). Within the EPPO region, the species is largely associated with vegetated man-made habitats, especially with transportation networks and cargo handling areas in ports and railway stations (e.g., Galasso et al., 2019; Bondarenko & Myronov, 2021; Shevera et al., 2023; Verloove, 2024; Conservatoire botanique national méditerranéen, 2024) as well as crop fields and vineyards (Pinke et al., 2012; Barina et al., 2013; Purger et al., 2015).

In France, *E. davidii* has been observed in five habitat types, including vineyards, summer crops (four sites, particularly soyabean and maize), riverbanks (four sites in the Mediterranean), roadsides (six records), and railway ballast and surrounding areas (six records) (G. Fried, pers. comm., 2024; see Appendix 3).

Habitat in its native range is described in section 2.5.

Specific details: Ruderal habitats, transport networks

Euphorbia davidii occurs regularly along the railroads from coastal areas in France, near Marseille to the Cévennes via Avignon (Girod et al., 2007; Girod & Fried, 2011; Conservatoire botanique national méditerranéen, 2024; Lobelia, 2024; iNaturalist, 2024). *Euphorbia davidii* was recorded in Romania in 1997 (as *E. dentata*) in the railway station of Socola (city of Iaşi). Later, it was also found in the railway stations of Buzău (Buzău County), Tecuci, and Movileni (both Galaiț County) in Romania. *Euphorbia davidii* is usually found along railway tracks in Italy (Galasso et al., 2011, 2019). *Euphorbia davidii* has been found for the first time in 2012 in southeastern Slovakia on railway tracks in Maťovské Vojkovce, very close to the Ukrainian border (Jehlik et al., 2013). Recently, in 2019, the species was found at two other locations in eastern Slovakia, namely at the railway station in Bánovce nad Ondavou and along railway tracks near Trebišov (Dudáš et al., 2019). Most localities of the species occur along railways and tracks in the Russian Federation (Y. Kulakova, pers. comm., 2024). In Ukraine, early identified localities of the species were confined to railroad tracks at railway stations and, less often, other areas where railroad transportation was also used (Huzik et al. 1997).

In Switzerland *E. davidii* was recorded in an industrial zone in Bussigny-près-Lausanne in 2011 (Hoffer-Massard, 2011). *E. davidii* was recorded on a dump site and on the verge of an unloading quay near a grain mill in a port in Belgium (Verloove, 2024). *E. davidii* was found in Tbilisi in road and path margins around a petrol station in Georgia (Raab-Straube and Raus, 2020).

In Uzbekistan, it occurs in ruderal habitats and rocky habitats (i.e., cliffs and rock outcrops with very shallow or no soil; Makhkamov et al., (2024).

Specific details: crop fields

Association with crops

Euphorbia davidii can persist and thrive in crops and vineyards. It has been found in fields of several crop types in the EPPO region (Table 4).

Table 4. Main crops infested by *Euphorbia davidii* globally.

Crop	Country	Reference
Cereals	Argentina, Hungary, Serbia, the Russian Federation	Kudryavtseva & Chernetsova (1993), Juan et al. (1996), D. Marisavljević, pers. comm. (2024), S. Follak, pers. comm., (2024)
Maize	Argentina, France, Hungary, Serbia	Juan et al. (1996), Girod & Fried (2011), Pinke et al. (2012), Vajgand et al. (2014), Rauber et al. (2018)
Soybean	Argentina, France, Italy	Girod & Fried (2011), Viggiani (2015), Juan et al. (2003) Rauber et al. (2018)
Sunflower	Argentina, Ukraine, the Russian Federation	Juan et al. (1996), Moysiyenko et al. (2020), Y. Kulakova, pers. comm. (2024)
Vegetables (onion)	the Russian Federation	Kudryavtseva & Chernetsova (1993)
Grape	France, Russia	Mikheev (1971), Girod & Fried (2011), Barina et al. (2013)
Brassica	the Russian Federation	Kulakova pers. comm. (2024)
Apple	Uzbekistan	Najmiddinov et al. (2024)
Apricot	Uzbekistan	Najmiddinov et al. (2024)

8. Pathways for entry

The following pathways for entry of *E. davidii* are discussed in this PRA. Pathways in bold are studied in section 8.1; other pathways were considered as having a very low likelihood of entry and are detailed in section 8.2:

- **Grain**
- **Seed (for planting)**
- Seed mixtures and native seeds
- Bird seed (grain)
- Contaminant of used machinery and equipment
- Soil and other growing media (on its own or associated with plants for planting other than seeds)
- Natural spread

8.1 Pathways studied

All the pathways are considered from areas where the pest has been reported to be present, into the EPPO region. Pathways are also relevant from areas where it occurs in the EPPO region into countries where it does not occur in the EPPO region.

Examples of prohibition or inspection are given only for some EPPO countries (in this express PRA the regulations of all EPPO countries were not fully analysed). Similarly, the current phytosanitary requirements of EPPO countries in place on the different pathways are not detailed in this PRA (although some were considered when looking at management options). EPPO countries would have to check whether their current requirements are appropriate to prevent the introduction of the pest.

Table 5. Grain of *Glycine max*, *Helianthus annuus* and *Zea mays*

Pathway	**Grain of *Glycine max*, *Helianthus annuus* and *Zea mays***
Coverage	Seeds of *E. davidii* may be a contaminant in grain imported for (1) animal feed mixture and (2) human consumption, including for processing from areas where the pest occurs. The grain imported for human consumption is likely to be less contaminated than for animal consumption as regulations are stricter. Grain for human consumption is cleaned to a very high standard to ensure quality and consistency for the end product. In addition, the processing of grain for human consumption may be partially or totally destructive. This is different for the processing of grain for animal feed where the standards are less restrictive, and grain may be cleaned and processed to a lesser degree. In addition, grain may be used whole for animal feed. Therefore, although the entry into the EPPO region would be the same for both human consumption and animal feed, differences in processing in the importing country should be taken into account. Both commodities would be transferred to a processing facility and then separated for the two different uses. Cereal grain was not included as the crop is harvested too early in the season for seed of *E. davidii* to be present. This pathway includes movement from countries within the EPPO region where the pest is present to countries where it is not present.
Pathway prohibited in the PRA area?	No. The EU Directive 2002/32/EC has requirements on the purity of the grain for animal feed.
Pathway subject to a plant health inspection at import?	No. The EWG was not aware of plant health regulations imposing inspection at import in the EPPO region on these commodities.
Pest already intercepted?	*E. davidii* has been intercepted along this pathway. *E. davidii* has been intercepted in grain (*G. max*) from the USA to Canada (Wilson et al., 2016). *E. davidii* has been identified from *Z. mays* grain intended for local distribution in Argentina (Núñez Fre, pers. comm., 2025). In the EPPO region, the species has been recorded in port areas where grain and oilseeds are handled and/or processed. In Ukraine, the initial introduction of *E. davidii* was associated with imported grain cargo (Shevera et al., 2023). In Belgium, it was most likely introduced as a soybean alien (Verloove, 2024) based on observations and locations of the plant in the port areas. The spread of *E. davidii* is associated with railway lines (Barina et al., 2013), indicating that goods (i.e., grain) contaminated with seeds play a significant role here. There is information on its congener *E. dentata* available. China reported detecting 36 different species of weed seeds in US soybean shipments including *E. dentata* (Dellis and Galasso, 2017). In another study, Ying et al. (2010), found seeds of *E. dentata* in imported soybean as well. Due to the misapplied naming of the species (as noted in section 1), *E. dentata* interceptions may be *E. davidii*. *Euphorbia* spp. seeds were commonly found in samples of soybeans exported to Russia from South America in the period 2016-2018 (Y. Kulakova, pers. comm., 2025).
Most likely stages associated with the pathway	Seeds (or fruits) of *E. davidii* is the most likely stage to be associated with the pathway.

Pathway	Grain of *Glycine max*, *Helianthus annuus* and *Zea mays*
	In South America (Argentina), *E. davidii* is a serious weed of soybean, maize and sunflower, (e.g. Juan et al., 2011). In North America, *E. davidii* has been mentioned as a weed in agricultural systems (FNA 2016, Verloove 2024), however precise information on abundance and infested crops is lacking.
Important factors for association with the pathway	The probability that seeds of *E. davidii* are associated with the pathway at the point of origin depends mainly on the crop species concerned and on the exact origin of the imported product and the degree of infestation of this region by *E. davidii.* The species grows in spring crops such as maize, soybean, and sunflower, and seeds will be present on *E. davidii* plants when these crops are being harvested. The seeds can be released during the harvesting process meaning that grain can become contaminated at harvest in the area of origin. Mixture of grains from different origins present a higher risk of contamination because of lack of traceability. The likelihood that *E. davidii* seeds are associated with the pathway at origin greatly depends on the effectiveness of the management measures implemented during cultivation and the cleaning procedures that can be implemented at origin before export.
Survival during transport and storage	The seeds of *E. davidii* can remain viable for several years (>10 years, Marchessi et al., 2011b) enabling their survival along the pathway.
Trade	There is a trade of grain (animal feed and human consumption) from countries where *E. davidii* occurs into the EPPO region. The figures in Appendix 4 from Eurostat provide information on imports reported by some EPPO countries.
Will the volume of movement along the pathway support entry?	It is likely that the volume of movement of the commodity will support entry. Appendix 4 shows volumes of grain (soybean, maize and sunflower) entering the EPPO region from the Argentina and USA. Potentially, these figures may contain volumes for various uses (including potential industrial use), but the main volume would be for animal feed or human consumption. The figures for soybean and maize grain imports show a high volume and reasonably consistent volume of import from Argentina and the USA into the EPPO region.
Will the frequency of movement along the pathway support entry?	The frequency of movement along the pathway is likely to support entry. Although there are no figures to highlight the frequency of movement of *E. davidii* seeds as a contaminant of grain it is likely that movement with volumes of the commodity will support entry. Grain is frequently imported into the EPPO region from Argentina and the USA (Appendix 4). The timing or season is not crucial as even if imports only occur in the winter, seed can survive and germinate in the spring.
Transfer to a suitable habitat	In the areas of introduction, such as ports where grain for industry or livestock pass through, any seeds falling to the ground can become established as shown by species' records on such sites (Shevera et al., 2023; Verloove, 2024). Spillage may also occur onto railway tracks. Grain lots may be sorted after import before processing to remove external matters such as weed seeds. Animals may be fed unprocessed grain of soy/sunflower/maize while outdoors. If the waste from the sorting is disposed of in fields, they may become infested. There may also be deviation from the intended use (i.e., imported as grain but used as seed).

Pathway	**Grain of *Glycine max*, *Helianthus annuus* and *Zea mays***
Likelihood of entry and uncertainty	The EWG noted that the entry of grain into the EPPO region may differ for different EPPO countries. Grain may be processed for animal feed or human consumption before it is exported, or it may be imported unprocessed andseparated at points of entry in the EPPO region. Therefore, the EWG decided to score both separately. Grains for livestock: **High likelihood with a moderate uncertainty.** ***Justification for rating***: Regular volumes of imports from where the pest occurs. Direct use in suitable habitat. Pest intercepted on pathway. Presence of the pest in grain ports of entry and associated transport systems is indirect evidence of it occurring on the pathway in the EPPO region. ***Justification for uncertainty***: Lack of direct information on interceptions in the EPPO region though this is due to the lack of monitoring of the pathway and confusion between *E. davidii* and *E. dentata*. Grains for human consumption and processing purposes: **Low likelihood with a moderate uncertainty.** ***Justification for rating***: Lower likelihood compared to animal feed: lower volumes imported, higher quality standards, and not used directly in suitable habitat. ***Justification for uncertainty***: Lack of direct species information with interceptions though this is due to the lack of monitoring of the pathway, confusion with *E. davidii* and *E. dentata*, different quality standards compared to that of animal feed, cleaning process can be performed after import.

Table 6. Seed for planting

Pathway	**Seed for planting**
Coverage (short description why it is considered a pathway)	This pathway covers both certified and uncertified seeds from areas where the pest occurs. Seed lots can be infested by seeds of *E. davidii*. Seed lots of soybean, maize and sunflower are most at risk of being contaminated. Seed of *Glycine max*, *Helianthus annuus* and *Zea mays* is included in the pathway. Seeds of cereals were not included because the crops are harvested too early in the season for seed of *E. davidii* to be present. This pathway includes movement from countries within the EPPO region where the pest is present to countries where it is not present.
Pathway prohibited in the PRA area?	No, this pathway is not prohibited in the PRA area. There are some requirements at EU level in marketing Directives for seed: https://ec.europa.eu/food/plant/plant_propagation_material/legislation/eu_marketing_requirements_en
Pathway subject to a plant health inspection at import?	Yes, partly in some EPPO countries.
Pest already intercepted?	*E. davidii* has not been intercepted along this pathway. There is only indirect evidence that the species has moved along this pathway First appearance in crop fields (e.g., in Hungary) are not likely associated with any other pathway. It has been speculated that the species was likely introduced as a contaminant of maize seeds in Hungary (Pinke et al., 2012).
Most likely stages associated with the pathway	Seeds of *E. davidii* may become associated with seeds of *G. max*, *Z. mays* or *H. annuus* at harvest. In Argentina, *E. davidii* is a serious weed of soybean, maize and sunflower (e.g., Juan et al., 2011). There are no data on *E. davidii* as a weed of crops in North America, but it can be assumed that the species also occurs in fields.
Important factors for association with the pathway	The probability that seeds of *E. davidii* are associated with the pathway at the point of origin depends mainly on the crop species concerned. The species grows in spring crops such as soybean and maize, and on the exact origin of the imported product and the degree of infestation of this region by *E. davidii.* Seeds will be present on *E. davidii* plants when crops are being harvested. The seeds can be released during the harvesting process. The likelihood that *E. davidii* seeds are associated with the pathway at the point of origin greatly depends on the effectiveness of the management measures implemented during cultivation and the sorting procedures that can be implemented at the origin before export. There will be lower risk of contamination in certified seed. Seed is sorted after harvest, and submitted to quality requirements when they are certified, which will reduce the probability of association (EU marketing directives, OECD Standards). For *G. max* and *H. annuus*, the following requirements apply: Maximum 5 seeds of other plant species in a sample of 1 kg of *G. max* and *H. annuus* seeds. Council Directive 2002/57/EC of 13 June 2002 (updated 24 December 2024) on the marketing of seed of oil and fibre plants:

Pathway	Seed for planting
	https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02002L0057-20200216&from=EN For *Z. mays*: Maximum 0 seeds of other plant species in a sample of 1 kg. Council Directive 66/402/EEC of 14 June 1966 (updated 01 September 2022) on the marketing of cereal seed https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01966L0402-20220201&from=EN
Survival during transport and storage	The seeds of *E. davidii* can remain viable for several years (>10 years, Marchessi et al., 2011b) enabling their survival along the pathway.
Trade	There is a trade of seed (for planting) from countries where the *E. davidii* occurs into the EPPO region. The figures in Appendix 5 (from Eurostat, imports reported by EPPO countries) give an indication of the existence of a trade for seed of maize and soybean from the USA and Argentina. The EWG consider there is a trade in sunflower seed entering the EPPO region.
Will the volume of movement along the pathway support entry?	It is likely that the volume of movement of the commodity will support entry. Appendix 4 shows volumes of seed (soybean and maize) entering the EPPO region from the Argentina and USA. The figures for soybean and maize seed imports show a high volume and reasonably consistent volume of import from Argentina and the USA into the EPPO region.
Will the frequency of movement along the pathway support entry?	Although there are no figures to highlight the frequency of movement of *E. davidii* seeds as a contaminant of seed it is likely that movement with volumes of the commodity will support entry. Seed is frequently imported into the EPPO region from the USA and Argentina (Appendix 5). Timing is not crucial as even if imports only occur in the winter, seed can survive and germinate in the spring.
Transfer to a suitable habitat	Transfer to a suitable habitat is very likely. Seed for sowing contaminated by *E. davidii* would be directly sown in agricultural fields, which is an optimal habitat for this species.
Likelihood of entry and uncertainty	Seed of *G. max*, *Z. mays* and *H. annuus*: Certified seeds: **Low with low uncertainty .** ***Justification for rating***: High quality standards associated with certified seed. ***Justification for uncertainty***: Seed is certified. Non-certified seed: **Moderate with high uncertainty**. ***Justification for rating***: Low quality standard, low imports into the EPPO region, pathway prohibited in many countries. ***Justification for uncertainty***: Low quality standard (seed is not certified), low imports into the EPPO region, movement of seed prohibited in many countries, pathway prohibited in many countries..

8.2 Pathways with insufficient data to fully assess

- **Seed mixtures and native seeds**
  Seed mixtures for conservation, pollination and seed mixtures for forage plants for mammals for hunting, or for horticultural purposes can be imported to the EPPO region from North America, and for EU countries all imported seeds should be accompanied with a phytosanitary certificate mentioning the seed species included in the mixture (Regulation EU 2016/2031). However, it may not be the case for every EPPO country. It cannot be ruled out that *E. davidii* is present in fields where seed is produced, and that contamination occurs during the harvesting process. Although there is no evidence of interceptions of contaminated seed mixtures and native seeds with *E. davidii* seed, in France, *E. davidii* (as *E. dentata*) has been found in set-aside areas sown with wildlife-friendly seed mixtures (Cadet et al., 2007). Information on traded volume is lacking; however, the EWG considered that such mixtures are imported in lower quantities than seeds of crops.

  The EWG allocated a low likelihood of entry with a high uncertainty for this pathway.

- **Bird seed**
  In France, at least one observation suggests accidental introduction with bird seed (*Phalaris canariensis*) from Canada: "As I have parakeets and I give them seeds that come from elsewhere (including canary grass, which is Canadian), I'm beginning to understand that it's a seed that was in the seeds given to the birds and that they didn't eat it", H. Gros (2014) (G. Fried, pers. comm., 2024; see Appendix 3). In Belgium, one potential pathway has been reported as a "bird seed alien" (Verloove, 2024). There is no further data on this pathway for *E. davidii* (or *E. dentata*) in the relevant literature (Van Denderen et al., 2010; EPPO, 2007).

  The EWG allocated a low likelihood of entry with a moderate uncertainty for this pathway.

8.3 Pathways with a very low likelihood of entry

- **Soil and other growing media (on its own or associated with plants for planting other than seeds)**
  Import of growing media is prohibited in most EPPO countries, e.g. importation of soil and growing medium as such is prohibited in the EU and many other EPPO countries, and is regulated when associated with plants (Regulation (EU) 2019/2072; see ISPM 40; IPPC, 2017).

  The EWG allocated a low uncertainty for this pathway.

- **Used machinery and equipment**
  Seeds of *E. davidii* may become a contaminant of machinery and equipment. Agricultural machinery will likely be used in suitable habitats. Seeds of *E. davidii* are likely to survive on this pathway. However, there is probably very little movement of used machinery from the countries where the pest occurs into the EPPO region and if there is, it is probable that such equipment would undergo phytosanitary procedures such as decontamination (e.g., in the EU, machinery and vehicles imported from third countries other than Switzerland and which have been operated for agricultural purposes should be cleaned and free from soil and plant debris (Regulation (EU) 2019/2072)). This pathway is covered by an International Standard for Phytosanitary Measures (ISPM 41) (IPPC, 2017).

  The EWG allocated a moderate uncertainty for this pathway.

- **Natural spread**
  Taking into consideration the current area of distribution (see section 6), it is not possible that *E. davidii* can naturally spread from outside of the PRA into the PRA area. However, there is the potential of existing populations in the EPPO region spreading to areas where it is currently absent (see section 11).

  The EWG allocated a high uncertainty for this pathway

Overall rating of the likelihood of entry combining the assessments from the individual pathways considered:

The EWG considered the overall rating based on the worst case scenario: Grain for livestock. Seed of *E. davidii* can be present in grain as a contaminant from areas where the pest occurs. This grain can be used in a suitable habitat.

Rating overall	Very low ☐	Low ☐	Moderate ☐	**High X**	Very high ☐
Rating of uncertainty			Low ☐	**Moderate X**	High ☐

9. Likelihood of establishment outdoors in the PRA area

Euphorbia davidii is locally established in Bulgaria, France, Hungary, Italy, the Russian Federation, Serbia, Spain, Ukraine and Uzbekistan.

For example, in Bulgaria the species is considered established with the density of adult plants in the invaded populations reached 20–200 individuals/m² (Vladimirov and Petrova, 2009; Petrova et al., 2013). In France the species is considered established exhibiting a persistent presence for a period exceeding ten years across a multitude of sites, e.g. confirmed by monitoring presence between 1997 and 2009 near Nîmes. In Hungary establishment was confirmed by re-visiting the location of the initial report of the species from 2008 in a crop field in Igar (Fejér county) (Pinke et al., 2012). Upon revisiting the site in 2024, the species was still present, with several thousand specimens in two fields (S. Follak, pers. comm., 2024). Likewise, in Serbia establishment was confirmed by an inspection of two localities where the species was found in 2007 in Vojvodina on arable fields (Purger et al., 2015). The inspection in 2024 revealed that the species still occurs there (in cereals, soya and sunflower) (D. Marisavljević, pers. comm., 2025).

Habitats which are suitable for *E. davidii* are detailed in section 7. These habitats are widespread within the EPPO region and further establishment is likely in regions where habitats, soils and climatic conditions are conducive for establishment.

9.1 In the natural environment

The overview of Barina et al. (2013) does not list any records of *E. davidii* in the natural environment. However, in France, distribution data shows that *E. davidii* has infrequently been found along riverbanks (Conservatoire botanique national méditerranéen, 2024). It can be assumed that the species is rather rare in natural habitats in the EPPO region. In stable, intact natural habitats, germination is difficult and interspecies competition may limit establishment unless vegetation is sparse.

9.2 In the managed environment

It is likely that *E. davidii* can establish in the managed environment. In ruderal and agricultural environments, it is likely that reduced competition with other plants would allow the establishment of the species. Records of *E. davidii* are mainly from railway stations, railway tracks or other places associated with railways and roads. *E. davidii* is capable of invading different crop types, such as maize and soybean as well as cereals and vineyards (Barina et al., 2013; Shevera et al., 2023; Table 4).

The high frequency of spring crops in the crop rotation system in many EPPO countries is a factor that may strongly favour the establishment of *E. davidii* once the field has become infested. In crops, common weed control methods may not be sufficient to limit the development of the species due the low efficacy of chemical treatments associated with early stage treatment (Juan et al., 2011; Núñez Fre, 2019). Vajgand et al. (2014) noted that row cultivation and herbicide treatments generally applied against other common weeds were unsuccessful in suppression of *E. davidii* in Serbia.

9.3 Factors affecting establishment

Climate conditions
A species distribution model was developed for this PRA (see Appendix 6). In the EPPO region, the model predicts a large suitable area spanning most lowland parts of Europe (Fig. 5, Appendix 6) between latitudes of approximately 40 and 54 °N, with the greatest suitability in the central and eastern parts of this region (i.e. in northern Italy, the Pannonian plain, Ukraine and neighbouring parts of the Russian Federation) (Fig. 5). The species is already established at locations spanning the most of this highly suitable region. However, the region predicted suitable (but slightly less so) in north and west Europe (e.g., northern France, Germany, Czech Republic and Poland) has no records of establishment. It is uncertain whether this is due to lack of introduction, or poor model performance in northwest Europe.

The model mainly uses low growing season temperatures to define unsuitable areas in northern Europe, though low winter temperature may be more important in the far east of the region. In more southern parts of the EPPO region, the model uses low summer precipitation to define unsuitable areas around the Mediterranean basin.

Climate change
Predictions of the model for 2041-2070, under both the moderate SSP1-2.6 and more extreme SSP3-7.0 climate change scenarios suggests a potential for northwards expansion of the suitable region extending into parts of the British and Ireland, Scandinavia and the Baltic countries, and expanding northwards and westwards into the Russian Federation. In contrast, there is little change in suitability in the southern parts of the EPPO region. Note that these projections assume no change in the human footprint or soil pH (Appendix 6).

These results are reflected in the suitability of different European Biogeographical Regions (Bundesamt fur Naturschutz (BfN), 2003). Regions highly suitable for establishment in the current climate include the Pannonian, Continental, Steppic, Black Sea, Atlantic and Mediterranean. By 2041-2070, overall modelled suitability increases or remains high in all of these, albeit with a small decrease in the Mediterranean. Suitability also notably increases markedly in Alpine and Boreal areas.

Competition with other plant species
The absence of other plant species growing among high densities of this plant (greater than 300 individuals/m²) suggests the possible involvement of allelopathy (EWG opinion). Studies have been conducted on the phytotoxicity of *Euphorbia* sp. extracts. Aqueous extracts of stems, leaves and roots of different *Euphorbia* sp. inhibited germination and seedling growth of wheat, peas and several other species (Tanveer et al., 2013). There are no studies on *E. davidii*, but an allelopathic effect of the species can be assumed. This can act to promote its local establishment.

Soil conditions
Soil conditions are suitable for the species in the EPPO region. *E. davidii* tolerates a wide range of soil types (Vladimirov and Petrova, 2009; Oprea et al., 2012; Purger et al., 2015) though it is well-adapted to nutrient rich soils, especially organic-rich chernozem black soil.

Natural enemies
Specific natural enemies are not known to occur on *E. davidii* within the EPPO region. Generalist natural enemies may potentially attack the plant, but these are unlikely to cause enough damage to influence establishment. In Argentina, thrips, grasshoppers, and whiteflies can attack this species. However, significant increases in mortality are only observed when these attacks occur during the early stages of its life cycle, particularly under conditions of severe drought.

In general, the genus *Euphorbia* produces latex, which is rich in secondary metabolites. They are naturally defensive compounds in plants, which have significant antifeedant and growth-inhibitory effects on herbivorous insects.

The EWG rated the likelihood of establishment as high with a low uncertainty in areas of the EPPO region where it is not currently found. The justification for a high rating was: already established in the EPPO region, many countries have suitable habitats, climate projections show a wide area for potential establishment. Justification for low uncertainty: two different climate change scenarios (both moderate and extreme) predicted that the suitable area within the EPPO region would increase in future. species already established in many countries in the EPPO region.

Rating of the likelihood of establishment outdoors in the PRA area	Very low ☐	Low ☐	Moderate ☐	**High X**	Very high ☐
Rating of uncertainty			**Low X**	Moderate ☐	High ☐

10. Likelihood of establishment in protected conditions in the PRA area

Protected conditions, such as in greenhouses or polytunnels used to grow crops (e.g., vegetables or ornamentals), can provide a suitable micro-climate for *E. davidii*. The management of temperatures under protection maintains average temperatures between 20 and 35 °C which would be favourable for the development of the species.

It cannot be excluded that seeds of *E. davidii* are introduced into facilities under protected conditions. However, no evidence was found of the accidental presence of *E. davidii* under protected conditions in the EPPO region or other regions so far. Moreover, under protected conditions, crops are produced in highly managed systems (with possible rotation) that would limit the likelihood of establishment. However, it should be noted that plants can flower at the early four leaf stage which could adapt to shorter cycles, though the EWG considered this will not increase the likelihood of establishment as the species would be removed as a weed.

The EWG considered that the likelihood of *E. davidii* establishing in protected conditions in the EPPO region is low with a moderate uncertainty. *E. davidii* is unlikely to occur in protected conditions, lack of information, variation of protected conditions in EPPO region.

Rating of the likelihood of establishment in protected conditions	Very low ☐	**Low X**	Moderate ☐	High ☐	Very high ☐
Rating of uncertainty			Low ☐	**Moderate X**	High

11. Spread in the PRA area

Data from a few countries, where the species has been introduced, show that the species can spread locally and regionally.

In Argentina, a high rate of spread following introduction has been documented. *E. davidii* was first detected in 1983 in the Azul district in the Province of Buenos Aires located in isolated outbreaks. The species currently occupies approximately 250 000 ha (85% of the agricultural area) in this district (Juan et al., 1996). Since then, it has then spread into several other district of the Province of Buenos Aires as well as to other provinces (Córdoba, San Luis) (Núñez Fré, 2019; Rauber et al., 2018; F. Núñez Fré, pers. comm., 2024).

In Ukraine, the species has spread to many localities in the country since its first record in 1989. There are currently about 50 known locations of *E. davidii* in 17 administrative regions of Ukraine (Shevera et al., 2023). Records from Ukraine indicate recent spread into agricultural areas, e.g. in sunflower crops, and in an industrial area (scrap metal dump; Moysiyenko et al., 2020).

In Serbia, *E. davidii* was recorded in four crop fields (maize) distributed in several patches over a total area of 3 ha (2007). In 2013, the area of distribution had expanded to 7 ha (Purger et al., 2015). Data from the field indicated that in the area where is first found it has spread considerably (D. Marisavljević, pers. comm. 2025).

In France gradual spread around established populations has been observed (G. Fried, pers. obs., 2009), but spread rates or distances are not quantified.

Natural spread
The natural seed dispersal of *E. davidii* is confined to low distances (Barina et al., 2013).

The species spreads naturally via seeds. Individuals produce 100 to 300 seeds (Núñez Fré et al., 2018a). However, seeds have no structures (wings, plumes, etc.) on their seeds or fruit that facilitate long-distance dispersal. The species can disperse through elastic dehiscence at fruit maturity. Most seeds fall near the parent plant (within the first meter), whereas some seeds can reach up to 3 meters (F. Núñez Fré, pers. comm, 2024).

Seed can be spread along waterways and seed may be spread by rain on sloping soils (F. Núñez Fré, pers. Comm., 2025).

Other vectors
The presence of *E. davidii* under trees in public squares and parks could be associated with seed dispersal through bird droppings (F. Núñez Fré, pers. comm., 2025). Some studies suggest that game birds (galliformes) could consume and disperse seed of the genus *Euphorbia* (Wald et al., 2005), but evidence is limited. For example, seeds of milky spurge (*Euphorbia* spp.) were found in the crops of the two ring-necked pheasants (*Phasianus colchicus*) (Severin, 1933 cited in Wald et al., 2005). Ants can move seed short distances from the parent plant (F. Núñez Fré, pers. comm., 2025).

Human assisted spread
Seeds of *E. davidii* can be spread by agricultural machinery, by contaminated soil attached to farm implements, such as disc, harrow or plough within fields and from field-to-field. As seeds are still attached to the plant at the time of harvest, *E. davidii* could also be dispersed by combine harvesters, which may then transfer the seeds from field to field.

There are several reports of human-assisted spread of the species within the EPPO region associated with transportation networks. The initial introduction of *E. davidii* to Ukraine was associated with imported grain cargo, and early records of the species were confined to railroad tracks at railway stations or, less often, other areas where railroad transportation Huzik et al. (1997). It is considered likely that the species was imported into Bulgaria from Ukraine as contaminant in seeds of crops (Vladimirov & Petrova, 2009; Petrova et al., 2013). The species was likely introduced to Slovakia through the Eastern migration route, probably from Ukraine, and recent records are also located along railway tracks (Dudáš et al., 2019). In Romania, the species was most likely introduced with the transportation of goods (Oprea et al., 2012). Records of the species are also reported as being associated with railway tracks in France (Girod et al., 2007; Girod & Fried, 2011; Conservatoire Botanique National Méditerranéen, 2024; Lobelia, 2024; iNaturalist, 2024),Italy (e.g., Viggiani, 2015; Galasso et al., 2011, 2019) and the Russian Federation (Y. Kulakova, pers. comm., 2024). The EWG note that some of the occurrences in the EPPO region which are suggested to have spread from populations, may in fact be new introductions in countries. This may act to confuse the situation on spread. Management and/or construction works in habitats that act as corridors for spread (e.g., roadsides and railway tracks) may facilitate the spread of the species. Propagules of *E. davidii* may also be spread via the movement of soil.

The EWG rated the magnitude of spread as moderate with a high uncertainty. The justification for a moderate rating was: limited natural dispersal, however, human assisted spread is indicated from several countries. Justification for high uncertainty: occurrences in countries may be due to new introductions rather than spread.

Rating of the magnitude of spread	Very low ☐	Low ☐	**Moderate X**	High ☐	Very high ☐
Rating of uncertainty			Low ☐	Moderate ☐	**High X**

12. Impact in the current area of distribution (excluding the PRA area)

12.1 Impacts on biodiversity

The EWG has evaluated the literature and did not find any reports on *E. davidii* negatively affecting biodiversity within the current area of distribution.

12.2 Impact on ecosystem services

Euphorbia davidii has an impact on ecosystem services within the current area of distribution (Table 7).

Table 7. *Euphorbia davidii* - impacts on ecosystem services

Ecosystem service	Does the pest impact on this Ecosystem service? Yes/No	Short description of impact	Reference
Provisioning	Yes, negatively	The species can reduce the productivity of cropping areas	Pinke et al. (2012), Molinari et al. (2022)
Regulating	No information		
Supporting	No information		
Cultural	No information		

12.3 Socio-economic impact

Information and scientific data on socio-economic impact is mainly available from Argentina. The economic consequences associated with the presence of *E. davidii* are considered important for agriculture, as it is a weed in several crops and affects yield and quality.

In North America, *E. davidii* has been mentioned as a weed in agricultural systems (FNA 2016, Verloove 2024). However, the EWG reviewed the (weed science) literature and found no scientific data on the abundance and impact of *E. davidii* in crops but this can also be attributed to misidentification. Its congener *E. dentata* was described as a weed of cereals and maize (Vangessel et al., 1995; Jones et al., 2001; Wicks et al., 2003). The EWG considers that in North America, there remains confusion on the proper identity of both weeds, whether *E. davidii* or *E. dentata* is present in the crop fields (see section 1). *E. dentata* (or *E. davidii*) is not considered a significant weed in the north central region of the USA. The species occurs along the edges of crop fields but rarely increases to numbers that warrant changes in management practices (B. Hartzler, pers. comm., 2025).

In Argentina, *E. davidii* is mainly found in soybean, but also in other summer crops, such as sunflower and maize. It was also reported in cereals (wheat) (Juan et al., 1996; Rauber et al., 2018). *E. davidii* is considered a highly competitive species and difficult to control due to the low efficacy of most chemical treatments associated with the great dependence of the phenological stage of the weed at the time of control (Juan et al., 2011; Núñez Fre, 2019). Núñez Fre et al. (2022) also showed that the nutritional status of the soil (phosphate, nitrogen and sulfur contents) could influence the efficacy of glyphosate treatments.

Population density in the fields can be very high and has increased in recent years. Studies conducted on agricultural plots reported weed densities ranging between 20 and 200 plants m^{-2} (Juan et al., 1996), while recent surveys indicated densities of *E. davidii* ranging from 300 to 900 plants m^{-2} most likely resulting from difficulties in controlling the plant (Juan et al., 2011; Núñez Fré et al., 2014).

Few studies have documented effect of various densities of *E. davidii* on soybean yield. A field study carried out by Juan et al. (2003) in the Buenos Aires Province (Azul district) reported that in soybean, 100 plants m^{-2} of *E. davidii* caused yield losses close to 700 kg/ha, representing more than 30 % yield reduction with respect to the weed-free control. Significant effects have already been observed from densities of 8 to 10 plants m^2 indicating a high competitive ability of the weed. The main yield component affected was the number of pods per plant, which showed a 15% difference with respect to the control at a weed density of 20 plants m^2 (Juan et al., 2003). Significant variations were detected also in indicators such seeds/pod, number of trifoliate leaves and, to a lesser extent, the weight of 1000 seeds (Juan & Saint André, 1995; Juan et al., 2003).

Tanveer et al. (2013) summarized from the literature that a yield reduction of 4 to 85 % has been reported in field crops with different *Euphorbia* species and distinct occurrence densities.

In Argentina, high infestations of *E. davidii* significantly impeded harvest operations in some wheat and barley fields (Núñez Fre, pers. comm., 2025). The abundant, sticky latex produced by this weed adhered to the straw, causing substantial operational difficulties for harvesting machinery.

Another study showed how important it is to control the species to secure yield and income. Molinari et al. (2022) demonstrated using a crop–weed simulation model that the inclusion of cultural management practices (soybean crop varieties, sowing dates, row spacing, and sowing densities) could reduce weed competition by 46 to 97% and weed seed production by 40 to 89%. An increment in both expected crop yield, by 6 to 20%, and annual gross margin, by 44 to 199 USD/ha, was obtained.

Populations of *E. davidii* with a different sensitivity to glyphosate have been described, which can make it difficult to control the species. Resistance ratio for the population tested from the districts Azul, Olavarria and Barrow were 1.76, 2.39 and 2.48, respectively (with a value of >10 equating to a significant resistance, HRAC 2025(Núñez Fre et al., 2018b). The experiment show that the plants are developing gradual increase in resistant levels within populations. The change in the production system since the mid-1990s, based on the use of herbicides (mainly glyphosate) to control weeds in soybean, is likely responsible for the occurrence of resistant *E. davidii* biotypes (Oreja et al., 2024).

Some related species (e.g., *E. heterophylla*) have developed resistance to herbicides with different mode of actions (ALS- and PPO-inhibitors, and glyphosate) in Brazil (International Herbicide Resistant Database, https://www.weedscience.org/Home.aspx). The EWG considers this is a future concern for *E. davidii*.

The EWG notes that nowadays in Argentina, with the use of new GMO varieties of soybean (Enlist E3) which are tolerant to 2,4-D choline, glyphosate and glufosinate, the control of *E. davidii* has been much improved.

The EWG considered that the magnitude of impact in the current area of distribution (excluding the EPPO region) was high with a moderate uncertainty. The justification for high is there are well documented socio-economic impacts in Argentina. The EWG considered the uncertainty is moderate when considering its total non-native range as reports on negative impacts are lacking. However, if considering only Argentina, the uncertainty would be low.

Rating of magnitude of impact in current area of distribution	Very low ☐	Low ☐	Moderate ☐	**High X**	Very high ☐
Rating of uncertainty			Low ☐	**Moderate X**	High ☐

13. Potential impact in the PRA area

Will impacts be largely the same as in the current area of distribution? **No**

Information on the socio-economic impacts of *E. davidii* comes from Argentina. The agricultural system in Argentina differs from that in the EPPO region. It is largely based on conservation tillage systems (e.g., minimum tillage, non-tillage), a reduced crop rotation and herbicide application together with the cultivation of genetically modified glyphosate-resistant crops (e.g. soybean). This has led to a change in the weed communities favouring grass weeds and specific dicot weeds including *E. davidii* (Oreja et al., 2024).

In the EPPO region, in many countries, the sizes of the crop fields are smaller and the tillage systems are more diverse as well as the crop rotation. In many EPPO countries, GMO crops are prohibited. In some countries, e.g., Ukraine and the Russian Federation, the size of crop fields might be large and can be comparable to that of Argentina. In the EPPO region, direct seeding is less common but in some countries, it is increasing (e.g. Serbia) (D. Marisavljević, pers. comm., 2024). In addition, IPM methods are widely adopted (e.g., selection of cultivars and mechanical control).

The above considerations are likely to have an effect on the impact of the species in the EPPO region.

13.1 Current and potential impacts on biodiversity in the PRA area

The EWG did not find reports on *E. davidii* negatively affecting biodiversity within the EPPO region.

In France, distribution data shows that *E. davidii* has been found along riverbanks (Conservatoire Botanique National Mediterranean, 2024). However, the EWG considers this is not the primary habitat for the species and any impact is likely to be low.

For Uzbekistan, Najmiddinov et al. (2024) note that *E. davidii* currently does not pose a threat to local biodiversity, but at the same time, it is highly likely that in the near future it may spread more widely covering new habitats.

13.2 Current and potential impact on ecosystem services in the PRA area

There is no information on *E. davidii* negatively affecting regulating and supporting ecosystem services within the PRA area. Impacts on provisioning ecosystem services are dealt with in the following section.

13.3 Current and potential socio-economic impact in the PRA area

The potential economic impact of *E. davidii* in the EPPO region could be significant if the species spreads and establishes in further areas.

Euphorbia davidii has the potential to colonise crop fields and infest various crops. Numerous observations of occurrences of the species in fields from EPPO countries are known (Table 2). However, there are no specific data on the effects on crop yield and quality.

If agricultural land is left fallow, *E. davidii* may have the potential to colonise fallow fields and build up a seed bank. This can incur additional economic impact to revert the land back to its former state (EWG opinion).

The species can occur in high densities. In France, densities of thousands of individuals have been recorded in maize fields (Lobelia, 2024). Likewise, in Hungary, in maize, the ground cover of *E. davidii* varied within the field ranging from 0.1 to 30.0 % (Pinke et al., 2012).

In Serbia, it has invaded crop fields (Purger et al., 2015). Here, according to observations (i.e., not based on experiments), the populations of *E. davidii* had some effects on the crops cultivated (Pinke et al., 2012; Vajgand et al., 2014). Vajgand et al. (2014) reported that maize plants and ears were smaller.

In sunflower, the crop ripened approximately 15 to 20 days earlier than plants in the same field without *E. davidii* and sunflower heads were much smaller. In some fields infested with *E. davidii* in Serbia, sunflower cultivation has stopped on 300 ha of agricultural land but another less economically important crop is grown (D. Marisavljević, pers. comm., 2024). In Ukraine, *E. davidii* has been found in a sunflower field (Moysiyenko et al., 2020) though there are no reports of impact.

In the Russian Federation and Uzbekistan, *E. davidii* (as *E. dentata*) has been observed as a weed of sunflower, onions, cereals and row crops as well as in vineyards (Mikheev, 1971; Kudryavtseva & Chernetsova, 1993). The weed density of the abandoned *Brassica* field in North Ossetia contained more than 30 plants per m^2 (Y. Kulakova, pers. comm., 2025).

In Italy, *E. davidii* has infested soybean fields (Viggiani, 2015). The author reported 50 to 300 plants/m^2, which indicates strong competition with the crop and suggests yield losses for soybeans.

Euphorbia davidii is difficult to control with the commonly used herbicides available in the EPPO region. The EWG consider that herbicide tolerant populations may already be present in the EPPO region, making management more expensive and may have an impact on the environment (mixtures of herbicides and higher doses). At present, there are no confirmed cases of resistance in the EPPO region. If resistance to herbicides increases in populations in the EPPO region this may have increased socio-economic impacts.

The EWG has not found any information on yield losses in the EPPO region.

The EWG consider that the level of impact in the EPPO region will increase with time if the species spreads and establishes in climatically suitable agricultural regions. A high population occurrence, and hence high impacts are expected in chernozem soils.

The EWG considered the magnitude of impact in the PRA area is moderate with a high uncertainty. The justification for a moderate rating is potential negative impact on crop in the EPPO region, partially based on observations and present occurrences. Justification for a high uncertainty is there is no published information on socio-economic impacts of the pest. It is difficult to relate negative impacts seen in Argentina to the EPPO region due to different agricultural practises.

Rating of the magnitude of impact in the area of potential establishment	Very low ☐	Low ☐	**Moderate X**	High ☐	Very high ☐
Rating of uncertainty			Low ☐	Moderate ☐	**High X**

14. Identification of the endangered area

The EWG considered that the endangered area includes agricultural environments in Pannonian, Continental, Steppic, Black Sea regions of the EPPO region, largely coinciding with the chernozem soil belt.

15. Overall assessment of risk

***Euphorbia davidii* has a moderate phytosanitary risk for the endangered area with a moderate uncertainty.**

The likelihood of new introductions to the EPPO region occurring via grain (*G. max, H. annuus, Z. mays*) for animal feed is high with a moderate uncertainty. The likelihood of further establishment outdoors is high with a low uncertainty. The potential for spread within the EPPO region is moderate with a high uncertainty. *E. davidii* can spread naturally though this is limited and the main spread pathway is via human assisted spread. The impact in the current area of distribution is high with a moderate uncertainty. This is based on data from where impacts have been shown in terms of a reduction of crop yield and increased management costs. The EWG considered the potential socio-economic impacts in the EPPO region will be moderate with a high uncertainty. High uncertainty for the EPPO region reflects difficulty in relating negative impacts seen in Argentina to the EPPO region due to different agricultural practises. The EWG consider that the level of impact in the EPPO region will increase with time if the species spreads and establishes in climatically suitable agricultural regions. The overall uncertainty is moderate as the endangered area reflects the most suitable agricultural areas, climate and soils for the species in the EPPO region.

Table 8. Summary of ratings and uncertainties

Section	Likelihood	Uncertainty
Entry (overall)	High	Moderate
Grain	High	Moderate
Seed (certified)	Low	Low
Seed (non-certified)	Moderate	High
Establishment outdoors in the PRA area	High	Low
Establishment in protected conditions in the PRA area	Low	Moderate
Spread	Moderate	High
Impact in the current area of distribution	High	Moderate
Potential impact in the PRA area	Moderate	High

Stage 3. Pest risk management

16. Phytosanitary measures

The results of the risk assessment show that *E. davidii* has a moderate phytosanitary risk to the endangered area with a moderate uncertainty.

Phytosanitary measures should be recommended for grains for relevant crops (mentioned in section 16.1). Measures for grains are considered in detail in Appendix 1.

Seed is already regulated in many EPPO countries and if certified seed is used it should not pose a risk to the endangered area.

Recommendations by the EWG are the following:

16.1 Measures on individual pathways to prevent entry

Possible pathways *(in order of importance)*	**Measures identified**
Grain of *Glycine max, Zea mays, Helianthus annuus*	Grain has been produced in a pest-free area (PFA) for *E. davidii,* established and maintained according to the requirements outlined below **OR** Grains have been produced in a Pest free production site (PFPS) or Pest free place of production (PFPP)* for *E. davidii* established and maintained according to the requirements detailed in Appendix 1 + treatment of the consignment: sorting **OR** Grains have been sampled according to ISPM 31 and inspected, and the grain lot has been found free from *E. davidii* **OR** Grains have been devitalized according to an appropriate method
Seed of *Glycine max, Helianthus annuus* and *Zea mays*	Use certified seed

**The choice between pest free place of production and pest free production site is a decision to be taken by the NPPO based on the operational capacities of the producers and biological elements.*

Requirements for establishing a PFA:

- To establish and maintain the PFA (ISPM 4, ISPM 29), a general surveillance in the area prior to establishment of the PFA and continued every year may be sufficient.
- In specific cases, specific surveillance should also be carried out in the zone between the PFA and known infestation area to demonstrate pest freedom. The detection surveys to establish and maintain the PFA should be targeted for the pest and should be based on visual examination of the crop.
- There should be restrictions on the movement of soil associated with the pest and equipment used (originating from areas where the pest is known to be present) into the PFA, and into the area surrounding the PFA, especially the area between the PFA and the closest area of known infestation.

16.2 Eradication and containment

National measures
Early detection is important to identify new occurrences of the species. *E. davidii* should be monitored and eradicated, contained or controlled where it occurs in the area of potential establishment in the EPPO region. In addition, public awareness campaigns to prevent spread from existing populations in countries at high risk are necessary.

Management of *Euphorbia davidii*

Eradication
Eradication measures provided in this section should be promoted where feasible with a planned strategy to include surveillance, containment (see the following paragraph), treatment and follow-up measures to assess the success of such actions. Regional cooperation is essential to promote phytosanitary measures and information exchange in identification and management methods. NPPOs should facilitate collaboration with all sectors to enable early identification including education measures to promote citizen science and linking with universities, land managers and government departments.

Eradication is possible for *E. davidii* in case of early detection of small populations including digging up or uprooting individual plants, for further options see the section containment.

Euphorbia davidii should be eradicated before it completes one life cycle and builds up a persistent seed bank.

It is recommended that member countries eradicate this species where feasible to prevent further spread and impact.

Containment
NPPOs should provide land managers and stakeholders with identification guides including information on preventive measures and control techniques.

An integrated weed management strategy will be required to effectively manage *E. davidii.* Some specific information to control *E. davidii* is available in the literature (Storrie & Cook, 1996; Juan et al. 2011; Vajgand et al., 2014).

Cultural control
In general, planting crops with different life cycles (e.g. winter crops), places *E. davidii* in a disadvantage to germinate and survive. Moreover, this can allow a greater variety of herbicides and other weed management strategies to be used. Individual crops should be managed to enhance their competitive ability. Depending on crops, this would include row spacing, planting density and planting date.

Tillage can affect the number of seeds in the shallow seed bank (Núñez Fre, 2019).

Herbicides
Herbicides can be used to control *Euphorbia* spp. (Storrie & Cook, 1996; Vajgand et al., 2014; Araldi de Castro et al., 2023). In Argentina, glyphosate is used to control the species as transgenic glyphosate-resistant soybeans are mainly grown. However, a great variability has been observed in the control effectiveness obtained with glyphosate applied in the range of doses (Juan et al., 2011). In general, control efficacy of *E. davidii* depends strongly on the developmental stage at the time of application. From the branching stage, particularly at flowering it becomes harder to achieve controls over 75 % at label doses of glyphosate applied (Juan et al., 2011). Moreover, recent studies have reported different sensitivities of populations of *E. davidii* to glyphosate (Núñez Fre et al., 2018b).

Istilart et al. (2015) reported that the application of glyphosate in mixtures with some active ingredients with different mechanisms of action (e.g., fluroxypyr), allowed to reach acceptable levels of control (Argentina, Buenos Aires Province). In Serbia, Vajgand et al. (2014) evaluated the efficacy of several herbicides. Only the application of glyphosate on (wheat) stubble was efficient.

The availability of effective herbicides to control *E. davidii* is restricted in some crops, e.g. sunflower.

Local populations in ruderal habitats, ornamental gardens
Mulching can be used to prevent the light to reach the seedlings. Manual uprooting or low mowing prior to seed-formation are also effective. The species does not withstand competition with tufted grasses, so thickening the grass cover eliminates spurge (Petrova et al., 2013).

17. Uncertainty

The EWG used the categories of main sources of uncertainties (under development) discussed by the Panel on Phytosanitary Measures in October 2023:

- *Key uncertainties*: likely to significantly affect the overall conclusions (including overall risk and overall uncertainty) of the PRA (i.e., the determination of whether the pest has the characteristics of a quarantine pest, and the pathways that should be managed),
- *Other main uncertainties*: not likely to affect the overall conclusions of the PRA but likely to impact conclusions of individual part(s) of the risk assessment or risk management.

Key uncertainties	**Other main uncertainties**
	Misidentification of *E. davidii* with *E. dentata*
	Limited scientific information on the impact on crops in the EPPO region
	Impact in North America
	Herbicide resistance in populations in EPPO region
	Uncertainty if populations are the result of spread or repeated introductions

18. Remarks

The EWG recommends:

- Monitor the rate of spread of *E. davidii* from existing populations in the EPPO region.
- Conduct dedicated surveys of *E. davidii* in the EPPO region, in particular the endangered area.
- Carry out scientific studies on the biology, impact and control of *E. davidii* in the EPPO region.
- Promote awareness of the potential impacts of *E. davidii* in the EPPO region.

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Appendix 1. Consideration of pest risk management options

The table below summarizes the consideration of possible measures for the pathways Grain (for animal feed mixtures, human consumption and processing purposes).

For measures, grains are considered for crops in which *E. davidii* may grow and propagules may be a contaminant at harvest. When a measure is considered appropriate, it is noted "*yes*", or "*yes, in combination*" if it should be combined with other measures in a systems approach (see after the table). "*No*" indicates that a measure is not considered appropriate. A short justification is included.

Table 1 Evaluation of possible phytosanitary measures for the main identified pathways, using EPPO Standard PM 5/3

Option	**Grains of *Glycine max, Helianthus annuus* and *Zea mays***
Existing measures in EPPO countries	Partly, see Section 8.
Inspection at place of production	**Yes, in combination*** (for measures marked with '*', see after the table). The place/site of production when inspected at pre-harvest should be free from *E. davidii*. Detection by visual inspection is unlikely to be completely effective at the place of production in plants used to produce grains and needs to be used within a systems approach.
Testing at place of production	**No** There are no known molecular tests for the identification of *E. davidii.*
Treatment of crop	**Yes, in combination*** No weed management strategy is considered to be 100% effective against *E. davidii*.
Resistant cultivars	**No** Not relevant for invasive alien plants.
Growing the crop in glasshouses/ screenhouses	**No** Not relevant for grain production.
Specified age/size of plant, growth stage or time of year of harvest	**No** When *E. davidii* is present in the field, it will produce fruit with seeds during the harvesting period.
Produced in a certification scheme	**No** Not relevant for grains.
Pest free production site	**Yes** Pest free production site could be established for a time period before planting of grain production. For example, 1-2 years and then recognised as a pest free production site. To establish and maintain the PFPS, detailed surveys and monitoring should be conducted in the area and continued every year. Pest free production site will not be able to be formed where *E. davidii* has been reported in the last five years. A buffer zone could be established where any *E. davidii* plants are eradicated. Conditions in the buffer zone would include no presence of *E. davidii* and cleaning of machinery and equipment. The EWG considered that due to the high seed production, the longevity of the soil seed bank and the spread potential, a pest-free production site is not a feasible option in an area where *E. davidii* is present and has been established for five years or more.

Option	Grains of *Glycine max, Helianthus annuus* and *Zea mays*
Pest free place of production	**Yes** As recommended by the EPPO Panel on Phytosanitary Measures, the choice between PFPP and PFPS is a decision to be taken by the NPPO based on the operational capacities of the producers and biological elements. As for PFPS, if fulfilled by all the individual sites of the place of production.
Pest-free area	**Yes** (but difficult to maintain) To establish and maintain the PFA, detailed surveys and monitoring should be conducted in the area and continued every year. If climatic conditions in the PFA are suitable for the establishment of *E. davidii*, the PFA should not include any area where the species has been reported in the last five years. Surveys should include high risk locations, such as summer crops, key transportation roads, ports, areas around grain storage facilities etc. Where climatic conditions in the PFA are suitable for the establishment of *E. davidii*, there should be restrictions on the movement of the identified pathways for entry into the PFA, and into the area surrounding the PFA, especially the area between the PFA and the closest area of known infestation.
Treatment of the consignment: sorting	**Yes, in combination*** Automatic sorting (e.g. optical, density, with vibrating mesh, rotary drum, with aspirator, etc.) can be performed, especially in grain with a very different size, weight and/or colour. The efficiency of screening depends on the sorting methodology used (e.g. type of screens) and the seed size of grain and weeds. The efficiency of screening could be checked by inspecting the consignment (see below).
Treatment of the consignment: devitalization	**Yes** Note: Technically feasible (e.g. heat treatment) but economically unrealistic for large bulk quantities.
Inspection of consignment and confirmation by testing	**Yes** (and in combination) Seeds of Glycine max, Helianthus annuus or Zea mays should be sampled in accordance with ISPM 31 etc. Remark: because of the size of *E. davidii* seeds, they will not be equally distributed in the grain commodity – take samples from the bottom of the sample. Remark: this may not be cost-effective.
Pre or Post-entry quarantine	**No** Not relevant for grain.
Limited distribution of consignments in time and/or space or limited use	**No** Not relevant. The use of grains cannot be limited to reduce the probability of introduction: processing grain could be partially or totally destructive but seeds of *E. davidii* may be spread during storage and transportation. Soybean are often packaged and the risk can be reduced if it remains packaged until the processing facility.
Only surveillance and eradication in the importing country	**No** Eradication is difficult.

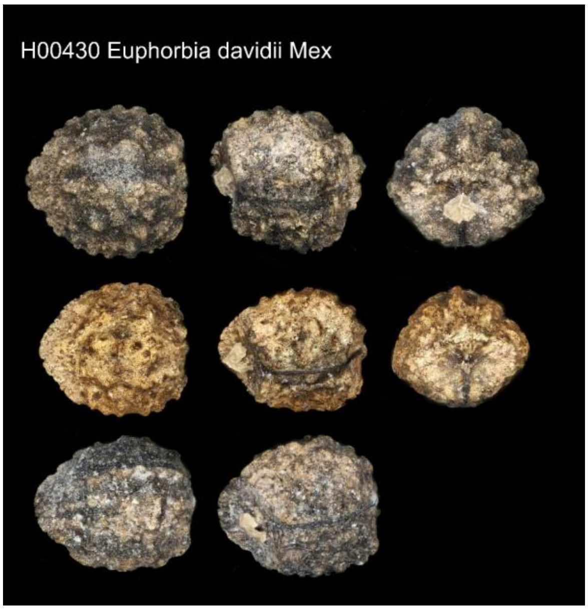
*The EWG considered whether the measures identified above as 'Yes, in combination' (listed below) could be combined to achieve a suitable level of security. The EWG thought that a PFPS/PFPP + Treatment of consignment: sorting could achieve a suitable level of security

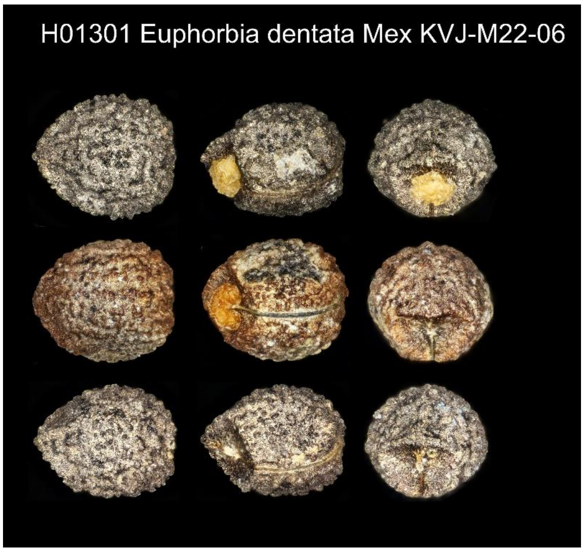
Grains of *Glycine max*, *Helianthus annuus* and *Zea mays*
Inspection at place of production
Treatment of crop
Treatment of the consignment: sorting
Inspection of consignment

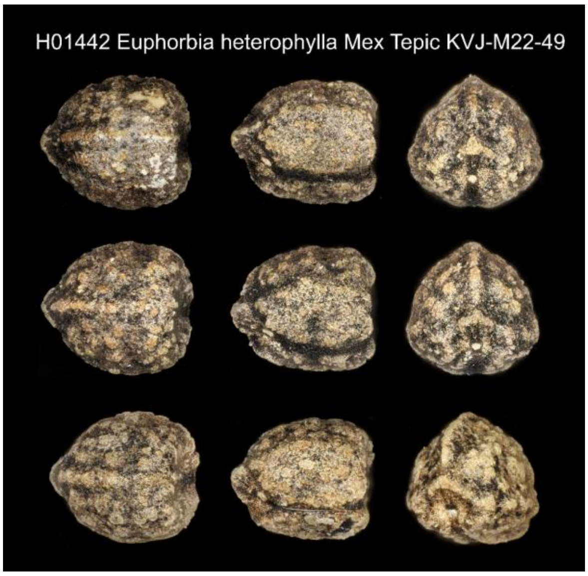
Appendix 2. Images of *Euphorbia davidii*

Figure 1. Growth habit (A) and inflorescence (B) of *Euphorbia davidii*. Mass stand (C) on a harvested field and individuals of *E. davidii* on a stubble field (D). Location: Igar, Hungary (Photos: Swen Follak, 2024).

Comparison of *Euphorbia davidii, E. dentata* and *E. heterophylla* seed (no scale shown).







Appendix 3. Localities, dates of first and last sightings and habitats in France (compiled by G. Fried, 2024)

Localities	Region	Years	Abundance	Habitat	References
Rodilhan	Occitanie	1997-2009	Present	Vine	[1, 3]
Saint-Rome	Occitanie	2004-2024	Present	Cultivated field	[4]
Avignon	PACA	2006-2020	Present	Railway ballast	[1, 4]
Fleurey-sur-Ouche	Bourgogne -Franche-Comté	2006-2009	Present	Maize (fodder for wildlife)	[2, 3]
Saint-Paul-le-Jeune	AURA	2008-2009	Present	NA	[5]
Berrias-et-Casteljau	AURA	2009	Present	NA	[5]
Carry-le-Rouet	PACA	2009	Present	Rocky place along the railway	[1]
Draguignan	PACA	2010-2018	Present	Embankment and ditch	[1]
Courry	Occitanie	2012	Present	Roadside	[1]
Montclus	Occitanie	2012	Present	Pebble banks on the Cèze	[1]
Rabsestens	Occitanie	2012-2016	Present	Soybean	[5]
Saint-André-de-Cruzières	AURA	2012	Present	NA	[5]
Tarascon	PACA	2012	Present	Railway embankment (TGV)	[1]
Eyragues	PACA	2014	Present	Garden	[1]
Frontignan	Occitanie	2015	Over more than 150 m	Abandoned vineyard and roadside	[1]
Laudun-Lardoise	Occitanie	2017-2012	Present	Riverbank and wasteland	[1]
Belvezet	Occitanie	2018	Present	Roadside	[1]
Molières-sur-Cèze	Occitanie	2020	Present	Railway track edge	[1]
Pantin	Île-de-France	2020	Present	NA	[5]
Saint-Ambroix	Occitanie	2020	Present	Railway tracks	[1]
Saint-Julien-de-Cassagnas	Occitanie	2020	Present	Railway tracks	[1]
Brignac	Occitanie	2022	Present	Riverbank	[1]
Pujaut	Occitanie	2022-2024	Present	Road ditch	[1, 4]
Quissac	Occitanie	2023	Present	Pebble banks	[1]
Usseau	Nouvelle-Aquitaine	2023	Abundant (more than thousand individuals)	Maize	[5] and A. Caillonpers. com. (2024)
Villeneuve-les-Avignon	Occitanie	2024	Present	Roadside	[4]

[1] Conservatoire botanique national méditerranéen (2024) SIMETHIS - module Flore [online]. http://simethis.eu (accessed the 29/10/2024)

[2] Girod, C., Cadet, E., Fried, G., 2007. *Salvia reflexa* Hornem. (Lamiaceae), adventice nouvelle pour la France, découverte en Côte-d'Or. *Le Monde des Plantes* 493: 24-26.

[3] Girod, C. & Fried, G., 2011. *Euphorbia davidii* Subils, an agricultural emerging invader in France? [Poster] 3rd International Sympolsium of Environmental Weeds and Invasive Plants. October 2 to 7 2011. Monte Verità, Ascona, Switzerland

[4] https://www.inaturalist.org/home (accessed the 29/10/2024)

[5] Lobelia SI des CBNBP, CBNFC-ORI, CBNMC, CBNPMP, CBNSA (2024) https://lobelia-cbn.fr/ (accessed the 29/10/2024).

Appendix 4. Data on grain imports into specified countries in the EPPO region

Table. 1. Mazie grain imported into specified EPPO countries (HS code: 100590) (FAO Stats)

Maize excluding for sowing from Argentina (kg)			Maize excluding for sowing from USA (kg)		
	2022	**2023**		**2022**	**2023**
Austria	5,180	11,680	**Austria**		3
Belgium	307,732	1,370,158	**Belgium**	209,537	162,080
Bulgaria	654,702	1,317,010	**Bulgaria**	65,000	90,602
Croatia	433,240	643,513	**Cyprus**	25,401	72,882
Cyprus	232,900	180,320	**Denmark**	166,667	166,339
Czechia	26,000	729,200	**Estonia**	39,123	
Denmark	3,792,824	2,843,360	**Finland**	5	35
France	174,332	844,034	**France**	62,326	2,071,881
Germany	10,085,110	252,116	**Germany**	702,652	13,679,657
Greece	1,840,661	2,676,800	**Greece**	55,074	279,051
Hungary	4,225,140	3,467,920	**Hungary**	40,279	662,714
Ireland	7,491,967	413,140	**Ireland (Eire)**	68,854,976	17,831,344
Italy	3,769,592	3,908,867	**Italy**	70,281,430	12,598,495
Latvia		2	**Latvia**	30,270	56,270
Lithuania	51,500	52,000	**Lithuania**	40,824	20,412
Malta	13,400	9,500	**Malta**	12	1
Netherlands	23,017,374	21,671,813	**Netherlands**	81,627,905	67,391,847
Poland	71,420,975	33,975,693	**Poland**	1,205,324	1,867,932
Portugal	516,740	363,401	**Portugal**	25,032,921	19,780,893
Romania	152,980	617,970	**Romania**	5,103,646	342,012
Spain	26,052,221	20,552,886	**Slovenia**	20,412	1
Sweden	5,317	2,246	**Slovakia**	3	
Serbia	50	36,068	**Spain**	502,963,411	58,390,617
Albania	171,312		**Sweden**	302,078	336,992
Georgia	52,000	52,000	**Serbia**		2,179
North Macedonia	633,310	542,944	**Ukraine**		4,234,600
Montenegro	182,720	222,234	**Montenegro**		2,419
Bosnia and Herzegovina	262,260	541,500	**Moldova, Republic of**		17
Switzerland	982	1,129	**Bosnia and Herzegovina**	2,860	3,632
Norway	86,440	192,452	**Switzerland**	281,334	387,560
			Norway	111,624	436,156
Sum	**155,653,781**	**97,491,956**	**Sum**	757,225,094	200,868,623

Table. 2. Soya bean grain imported into specified EPPO countries (in kg) (HS code: 120190)

Soya bean from Argentina (kg)			Soya bean from the USA (kg)		
	2022	**2023**		**2022**	**2023**
Bulgaria	5		**Austria**	2	400
Denmark	23,150		**Belgium**	39,943	5,048,021
France	28		**Bulgaria**	506,388	53
Germany	1,036	451	**Cyprus**		1
Greece		2	**Denmark**	334	
Netherlands	32,246,971	11,266	**Finland**	2,321,970	190,000
Poland	4		**France**	33,251,316	59,383,222
Portugal	168		**Germany**	1,513,111,465	2,009,000,901
Spain	17	1	**Greece**	30,057,522	7,187,119
			Ireland	8,083,804	5
			Italy	321,426,630	413,845,272
			Netherlands	1,761,542,248	1,407,659,550
			Poland	9	3
			Portugal	272,719,951	263,832,110
			Romania	40,000,000	3,661
			Slovenia		2
			Spain	849,232,925	1,535,649,533
			Sweden	4,769	18
			Ukraine	1,575,000	4,262,065
			Norway	2,850	32,503,269
Sum	32,271,379	11,720	**Sum**	4,838,877,126	5,738,565,205

Table. 3. Sunflower seed imported into specified EPPO countries (kg) (HS code: 100510)

Sunflower seed from Argentina (kg)			Sunflower seed from USA (kg)		
	2022	**2023**		**2022**	**2023**
Austria	50,000		Austria	124,867	
Belgium	560,602	126,993	Belgium	77	22,966
Bulgaria	422,344	698,661	Bulgaria	111,162	73,786
Cyprus		22,113	Cyprus		1
Denmark		8	Czechia	8	
France	557,414	20,022,186	Denmark	37,577	2,900
Germany	1,869,066	300,178	Finland		3
Greece	197,070	233,840	France	2,974,590	4,567,717
Hungary	249	138	Germany	115,061	2,864
Ireland (Eire)	10,160	3,475	Greece	634,666	339,286
Italy	339,751	419,700	Hungary	53,170	1,441,417
Lithuania		1	Ireland	33	93
Netherlands	151,027	30,219	Malta	1	1
Poland	16,800		Netherlands	2,689,105	683,860
Portugal	32,196,348	43,000	Poland		1
Romania	296,100	593,769	Romania	150	16,899
Spain	33,249,673	5,874,562	Spain	6,285,378	5,239,421
Serbia	2,116	142	Sweden	33	24
Moldova, Republic of		14,442	Serbia	78,421	122,657
Bosnia and Herzegovina	619		Albania	31	
Norway	108	21,120	North Macedonia		870
			Moldova, Republic of		115,583
			Switzerland	403	1
			Norway	66	675

Appendix 5. Data on seed imports into specified countries in the EPPO region

Table. 1. Maize seed for sowing imported into specified EPPO countries during 2022 and 2023 (kg) (HS code: 100510)

Mazie seed for sowing from Argentina (kg)		
EPPO Country	Year	
	2022	**2023**
Bulgaria	4	
France	44	645
Germany	1,395	3,285
Hungary		12
Ireland (Eire)	1,390	877
Netherlands	1	16
Romania		2
Spain	6	1.
Sweden		
Serbia	324	50

Mazie seed for sowing from USA (kg)		
EPPO country	Year	
	2022	**2023**
Austria	1,680	1,254
Belgium	49	8
Croatia	4,175	3,084
Denmark	19	18
Finland	1	
France	20,870	24,272
Germany	1,935	5,802
Greece		879
Hungary	49,987	99,703
Ireland	48	29
Italy	5,214	5,645
Netherlands	373,853	1,515,492
Poland	18	12
Portugal	3,130	1,340
Romania	84,779	28,055
Spain	796	10,408
Sweden	5,618	131
Serbia	3,825	5,024
Albania		29,281
Georgia	19,950	
North Macedonia	50	
Switzerland	250	259
Norway	192	175

Table. 2. Maize seed for sowing imported into specified EPPO countries (kg) (HS code: 100510)

Soya bean seed from Argentina		
	2022	**2023**
Belgium	78	39
France	26	1
Hungary	23,555	173
Italy	4,365	201

Soya bean seed from USA		
	2022	**2023**
Austria	106	80
Belgium	446	108
France	1,945	520
Germany	20,198	16,139
Ireland	43	16
Italy	8,279,712	7,758,813
Netherlands	3,800,872	1,938,012
Romania	575,471	824,400
Spain		2
Sweden		1
Serbia	45	133
Switzerland	2,803	

Appendix 6. Climatic suitability modelling for *Euphorbia davidii* establishment in the EPPO region

Aim
To project the climatic suitability for potential establishment of *E. davidii* in Europe and the Mediterranean region, under current and predicted future climatic conditions.

Data for modelling
Species occurrence data were primarily obtained from the Global Biodiversity Information Facility (GBIF.org, 2024) with additional occurrence records obtained from Atlas of Living Australia, Integrated Digitized Biocollections (iDigBio), Portal to the Flora of Italy (https://floritaly.plantdata.eu/), Ukrainian Biodiversity Information Network (https://ukrbin.com/) and other reliable records of established populations provided by the Expert Working Group performing the risk assessment.

The records were scrutinised to remove any considered of dubious quality (e.g., known casual or cultivated occurrence, imprecise or bad coordinates, no date or older than 1970, co-located with herbaria or botanic gardens, country or province centroids), including use of R package CoordinateCleaner to remove dubious records (Zizka et al., 2019). Records were also removed if lacking coverage of one or more model predictor layers.

Based on information in the PRA and Plants of the World Online (https://powo.science.kew.org/), records were assigned as being native if occurring inside the USA states of Arizona, California, and New Mexico, or in the Mexican regions of Baja California, Baja California Sur, Sonora, Sinaloa, Chihuahua, Durango, Coahuila, Nuevo León, Tamaulipas, Zacatecas, San Luis Potosí, Guanajuato, Hidalgo and Querétaro. Records outside these areas were considered non-native.

The records were gridded at a 1/12 degree resolution for modelling (5 arc minutes, approximately 6 x 9 km in central Europe) (Fig. 1a). This resulted in 945 grid cells containing valid records of *E. davidii* (194 native and 751 non-native, Fig. 1a), which is considered a good number for distribution modelling.

Predictor variables were selected based on the life history and habitat requirements of *E. davidii* and likely limiting factors for establishment in Europe. Predictors included climate from 1981-2010 from the Chelsa database V2.1 (Karger et al., 2017), soil variables at 5-15 cm depth from the SoilGrids 2.0 database (Poggio et al., 2021) and land cover in 2020 from ESA-WorldCover (Zanaga et al., 2021). Highly right-skewed variables were log transformed to reduce the leverage of very extreme values on the models.

- **Growing degree days heat sum above 10°C** (gdd10 °C), as a measure of growing season thermal regime. As detailed in the PRA, optimal temperatures for growth occur between 20 and 25 °C and the species has been found to require approximately 1100-1200 growing degree days with base 8 °C (gdd8) to reach reproductive stage (Molinari et al., 2022; Núñez Fré et al., 2018).
- **Mean minimum temperature of the coldest month** (bio6 °C). *E. davidii* seed germination has been found to be promoted by exposure to cold temperature.
- **Mean monthly precipitation amount of the warmest quarter** (bio18, mm month^{-1} log(x+1) transformed) reflecting summer moisture availability.
- **Mean monthly precipitation amount of the coldest quarter** (bio19, mm month^{-1} log(x+1) transformed) reflecting winter moisture availability.
- **Soil pH**. Studies have shown optimal seed germination of *E. davidii* at pH 7, with little germination below pH 5 or above pH 9 (F. Núñez Fré, pers. comm., 2024).
- **Human footprint index** (log(x+1) transformed) (Venter et al., 2016) estimating the direct and indirect human pressures on the environment, including built-up environments, population density, electric power infrastructure, crop lands, pasture lands, roads, railways, and navigable waterways. This captures the major habitats of *E. davidii* as described in the main PRA text.

To estimate the effect of climate change on the potential distribution, equivalent modelled future climate conditions for 2041-2070 were obtained for two IPCC Coupled Model Intercomparison Project 6 (CMIP6) scenarios or Shared Socioeconomic Pathways (SSPs) (Meinshausen et al., 2020):

- SSP1-2.6 is an optimistic low-emissions scenario in which atmospheric CO_2 concentration peaks below 450 ppm in the mid-21st century and then falls slightly. The estimated warming by around 2050 is 1.7 °C.
- SSP3-7.0 is a high emissions scenario for a world that fails to act to limit warming. Atmospheric CO_2 concentrations rise to approximately 850 ppm by 2100. The estimated warming by around 2050 is 2.1 °C.
-

For both SSPs, the climate variables for modelling were obtained as averages of outputs of five Global Climate Models (NOAA's GFDL-ESM4, UK Met Office's UKESM1-0-LL, Max Planck Institute's MPI-ESM1-2-HR, Institut Pierre Simon Laplace's IPSL-CM6A-LR, and Meteorological Research Institute's MRI-ESM2-0), downscaled and calibrated against the Chelsa baseline.

Finally, as a proxy for spatial recording effort bias the recording density of vascular plants (phylum Tracheophyta) on Global Biodiversity Information Facility was obtained (Fig. 1b).

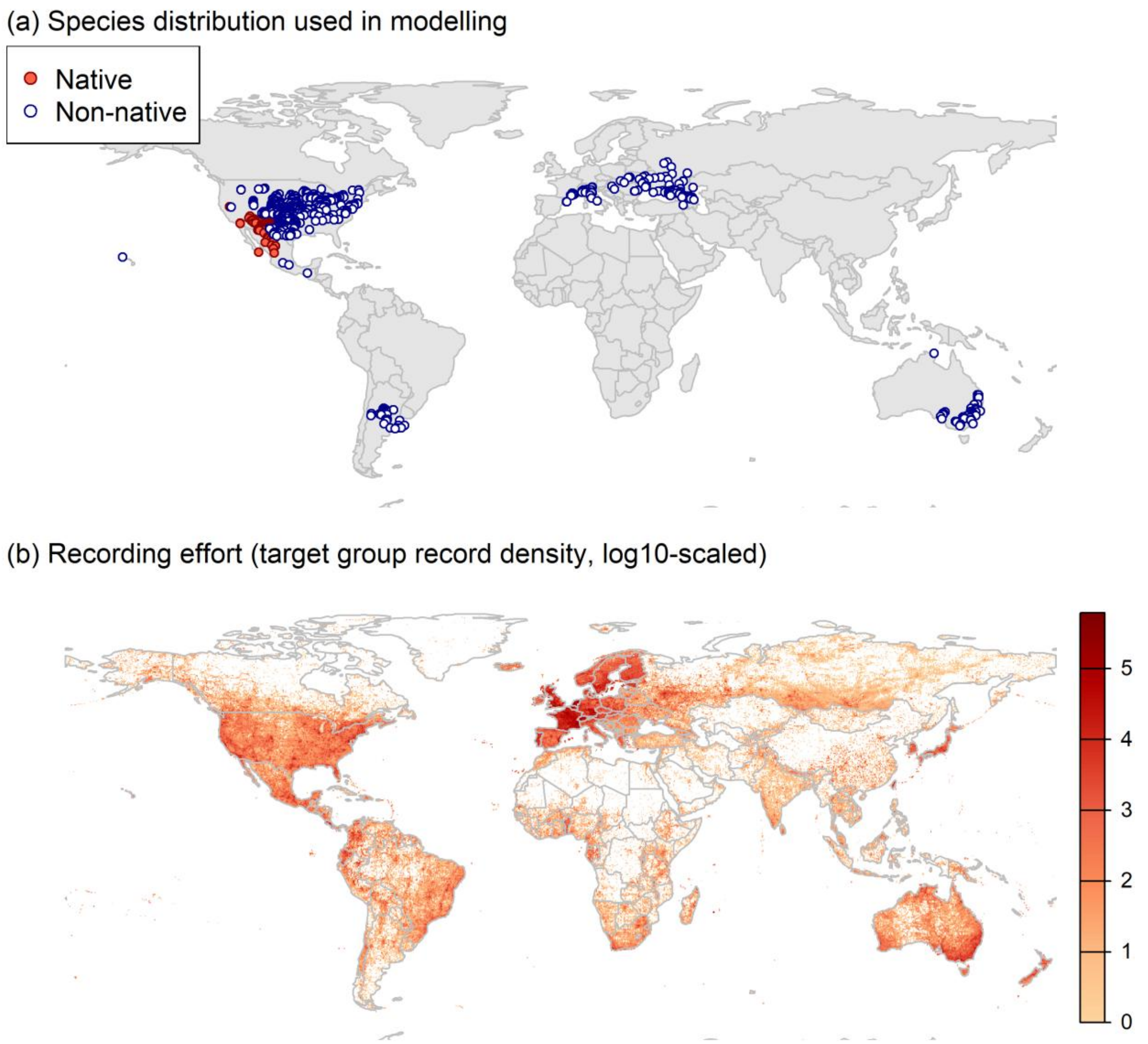


Figure 1. (a) Occurrence records used for modelling *Euphorbia davidii*, showing the native and non-native records. (b) A proxy for recording effort – the number of post-1970 vascular plant (Tracheophyta) records held by the Global Biodiversity Information Facility, displayed on a $\log_{10}$ scale. White areas have no Tracheophyte records.

Species distribution model

The modelling methodology was a modification of standard presence-background (presence-only) ensemble distribution modelling intended to model emerging invasive non-native species at global scale (Chapman et al., 2019). This method attempts to account for dispersal constraints on non-equilibrium invasive species' global distributions. It does this by excluding locations that may be environmentally suitable but where the species has not been able to disperse to.

As such, background samples (pseudo-absences) were sampled from two distinct background regions:

- An **accessible background** includes places close to *E. davidii* populations, in which the species is likely to have had sufficient opportunity to disperse to (Barve et al., 2011). Based on potential for long-distance seed dispersal, the accessible background was defined as a 200 km buffer around the native range (minimum convex polygon bounding native occurrences) and a 10 km buffer around non-native occurrences (capturing a 4-cell neighbourhood of the non-native occurrences). Sampling was more restrictive from the invaded range to account for stronger dispersal constraint over a shorter residence time. In previous testing of the model approach alternative buffer radii did not substantively affect the model projections (Chapman et al., 2019).

- An **unsuitable background** includes places expected to be physiologically unsuitable for the species, so that absence will be irrespective of dispersal constraints. Values were either defined by ecophysiological data from the literature or extreme values at the occurrence locations. Unsuitable areas were defined based on at least one of the following conditions being met:

    - Annual growing degree days with base 10 °C **gdd10 < 600**, assumed to be too cold during the growing season. *E. davidii* requires approximately 1100-1200 gdd8 to reach reproductive stage (Molinari et al., 2022; Núñez Fré et al., 2018), which would equate to a lower threshold value of gdd10. The chosen lower value reflected the coldest known occurrences.
    - Growing degree days **gdd10 > 4000**, assumed to incur too much heat stress based on the warmest occurrences.
    - Mean temperature of the coldest quarter **bio6 < -14 °C**, based on the coldest occurrences and assumed cold enough to delay germination beyond the optimal time period in spring. Seed germination is known to be delayed by cold temperatures and suppressed below 6 °C (Juan et al., 2003).
    - Mean temperature of the coldest quarter **bio6 > 9 °C**, assumed too warm in winter for seed germination based on the warmest occurrences. As stated in the PRA main text *E. davidii* has strong seed dormancy with germination promoted by cold winter conditions.
    - Precipitation of the warmest quarter **bio18 < 50 mm month^{-1}**, based on the driest occurences. Even though *E. davidii* is well adapted to dry conditions (S. Follak, per. comm., 2024), we assumed this was the minimum required.
    - **Soil pH < 5**, which is likely to inhibit seed germination (F. Núñez Fré, pers. comm., 2024).
    - **Soil pH > 8.5**, which is likely to inhibit seed germination (F. Núñez Fré, pers. comm., 2024).
    -

Of the 945 occurrences, 18 (1.9%) fell in the unsuitable background.

For modelling, five random background samples were obtained as follows:

- From the **accessible background** 945 samples were drawn, which is the same number as the occurrences. Sampling was performed with realistic recording bias using the target group approach (Phillips et al., 2009) in which sampling was weighted by GBIF Tracheophyte recording density (Fig. 1b). Taking the same number of background samples as occurrences ensured the background sample had the same level of bias as the data and balanced the presences and background points within the main environmental range of the samples.
- From the **unsuitable background** 2000 simple random samples were taken. Sampling was not adjusted for recording biases as we are confident of unsuitability in these regions.

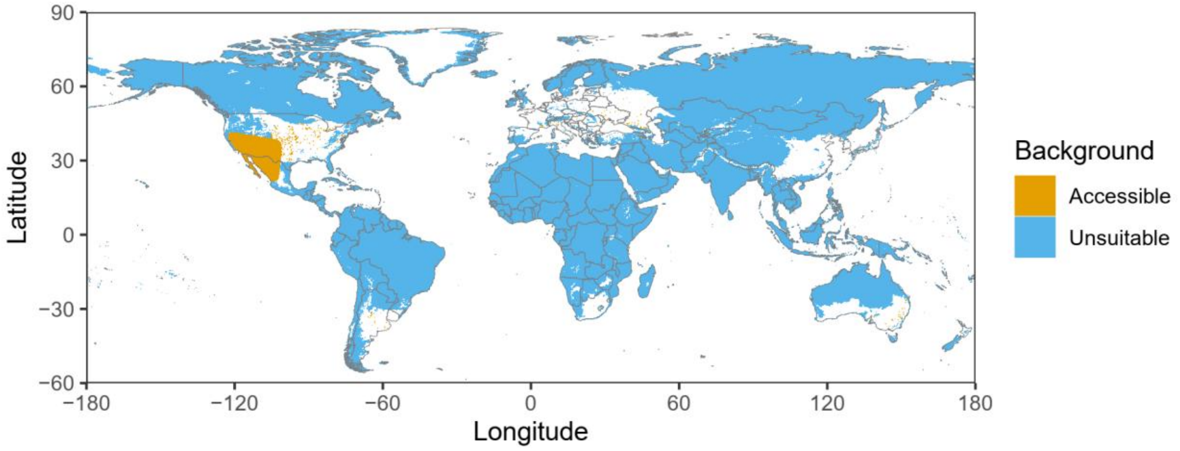


Figure 2. The background regions from which 'pseudo-absences' were sampled for modelling. The accessible background is assumed to represent the range of environments the species has had chance to sample. The unsuitable background is assumed to be environmentally unsuitable for the species.

Using these data, a presence-background (presence-only) ensemble modelling strategy was employed using the BIOMOD2 R package v4.2-5-2 (Thuiller et al., 2024). Each dataset (presences and each individual background sample) was randomly split into 80% for model training and 20% for model evaluation. With each training dataset, the following statistical algorithms were fitted with the default BIOMOD2 'bigboss' algorithm settings:

- **GLM:** Generalised linear model with linear and quadratic terms for each predictor
- **GBM:** Generalised boosting model
- **GAM:** Generalised additive model
- **ANN:** Artificial neural network
- **CTA:** Classification tree algorithm
- **RF:** Random forest
- **Maxnet:** Maximum Entropy (Maxent) in the maxnet R package (Phillips, 2021)
- **XGBOOST:** eXtreme Gradient Boosting Training.

Prevalence weights were applied to give equal overall importance to the occurrences and the background. Normalised variable importance was assessed and variable response functions were produced using BIOMOD2's default procedure. Model predictive performance was assessed by calculating the True Skill Statistic (TSS, i.e. sensitivity + specificity - 1) and Area Under the Receiver-Operator Curve (AUC, i.e. probability a background point has a lower suitability than an occurrence point) for model predictions on the evaluation data reserved from model fitting.

An ensemble model was created by rejecting poorly performing algorithms and then averaging the predictions of the remaining algorithms, weighted by TSS. To exclude poorly performing algorithms from the ensemble, TSS values were converted into modified z-scores based on their difference to the median TSS across all algorithms, normalised by the median absolute deviation (Iglewicz & Hoaglin, 1993). Poorly performing algorithms with unusually low TSS ($z < -1$) were rejected.

Global model projections of the ensemble model were made for the current climate and for the two climate change scenarios. 'Clamping' was used to avoid model extrapolation beyond the ranges of the input variables.

The ensemble predictions were partitioned into suitable and unsuitable regions using a threshold that ensured a required sensitivity of 0.95 (i.e. 95% of occurrences predicted as suitable).This was done so that the there was high confidence that the areas highlighted as suitable are likely to potentially support occurrence of the species (Freeman & Moisen, 2008).

Limiting factor maps were produced following Elith et al. (2010). Limiting factors for each grid cell were estimated as the variable giving the greatest increase in suitability when it was changed to a presumed near-optimal value (median value in the occurrence grid cells).

Results and Discussion
The ensemble model suggested that suitability for *E. davidii* at the global scale and resolution of the model was strongly determined by climate and with an appreciable effect of the human footprint index (Table 1). The strongest predictors were growing season thermal sum (gdd10) and winter temperature (bio6), with preferences for moderate values of both (Table 1, Figure 3). There was also relatively strong preferences for higher summer precipitation (bio18) and areas with a higher human footprint (Table 1, Fig. 3). Winter precipitation (bio19) and soil pH had very little importance in the model (Table 1, Fig. 3).

Global projection of the ensemble model in current climatic conditions using a 95% sensitivity suitability threshold of 0.5, produced the map in Fig. 4. The native region in north America appeared well delineated, with the model also capturing the non-native adventive occurrence of the species in central and eastern USA and central Mexico. Limiting factor analysis of the model (Fig. 6a) suggested that western USA was unsuitable mainly due to low summer precipitation (bio18), while the northern adventive range expansion of the species was limited in the model by low winter temperature (bio6). The model defined the southern edge of the native range mainly based on high temperature in the growing season (gdd10) and winter (bio6).

The model also captured the invaded area of South America and Australia well, and suggested a high potential for establishment if introduced to currently-uninvaded regions including southern Africa and east Asia (Fig. 4).

In the EPPO region, the model predicts a large suitable area spanning most lowland parts of Europe (Fig. 5) between latitudes of approximately 40 and below 54 °N, with the greatest suitability in the central and eastern parts of this region (i.e. in northern Italy, the Pannonian plain, Ukraine and neighbouring parts of the Russian Federation) (Fig. 5). The species is already established at locations spanning the most of this highly suitable region. However, the region predicted suitable (but slightly less so) in northwest Europe (e.g. northern France, Germany, Czech Republic and Poland) has no records of establishment. It is uncertain whether this is due to lack of introduction, or poor model performance which could be caused by additional un-modelled predictors limiting suitability in northwest Europe.

The model mainly uses low temperatures (gdd10) to define unsuitable areas in northern Europe, though low winter temperature may be more important in the far east of the region (Fig. 6b). In more southern parts of the EPPO region, the model uses low summer precipitation (bio18) to define unsuitable areas around the Mediterranean basin (Fig. 6b). Crops may be irrigated at least in some low summer precipitation areas, and this may affect the model predictions (i.e. potential for findings in unsuitable areas)

Predictions of the model for 2041-2070, under both the moderate SSP1-2.6 and more extreme SSP3-7.0 climate change scenarios (Figs 7 and 8) suggests a potential for northwards expansion of the suitable region extending into parts of Britain and Ireland, Scandinavia and the Baltic countries, and expanding northwards and westwards into the Russian Federation. In contrast, there is little change in suitability in the southern parts of the EPPO region. Note that these projections assume no change in the human footprint or soil pH.

These results are reflected in the suitability of different European Biogeographical Regions (Bundesamt fur Naturschutz (BfN), 2003) (Fig. 9). Regions highly suitable for establishment in the current climate include the Pannonian, Continental, Steppic, Black Sea, Atlantic and Mediterranean. By 2041-2070, overall modelled suitability increases or remains high in all of these (Fig. 9), albeit with a small decrease in the Mediterranean. Suitability also notably increases markedly in Alpine and Boreal areas.

Table 2 provides a similar breakdown by EPPO member state, identifying many countries with substantial suitable areas, and projected suitability increases for northern countries under climate change.

Caveats and uncertainties
Modelling the potential distributions of range-expanding species is always difficult and uncertain. In this case study, uncertainty arises because:

- There is uncertainty about the delineation of the native and non-native ranges in North America. A few isolated points near the western coast of USA and Mexico were treated as native may actually have been non-native. It is not clear how sensitive the model predictions are to any errors in defining the native and non-native range.

- There was not time to test the sensitivity of the modelling to all methodological choices (e.g. sizes of accessible background, definition of unsuitable background, use of target group bias correction, choice of suitability threshold).

Table 1. Summary of the cross-validation predictive performance (AUC = Area Under the Receiver-Operator Curve and TSS = True Skill Statistic) and variable importances (%) of the fitted model algorithms and the ensemble of the best performing algorithms. Importance values are the averages from models fitted to five different background samples of the data, normalised to sum to 100%.

Algorithm	**AUC**	**TSS**	**In the ensemble**	**Variable importance (%)**					
				Growing degree days (gdd10)	**Minimum temperature of the coldest quarter (bio6)**	**Precipitation of the warmest quarter (bio18)**	**Precipitatin of the coldest quarter (bio19)**	**Soil pH**	**Human footprint**
GBM	0.8882	0.6776	yes	41.6	26.9	18.5	0.8	2.5	9.6
MAXNET	0.8976	0.6760	yes	34.8	32.5	17.7	3.6	3.4	8.0
GLM	0.8950	0.6730	yes	24.6	38.2	17.9	2.0	3.7	13.7
XGBOOST	0.8890	0.6390	yes	25.8	34.2	15.8	2.0	2.6	19.7
CTA	0.8272	0.6368	yes	33.6	29.6	12.1	0.0	0.0	24.7
GAM	0.8280	0.5604	no	27.8	21.7	14.5	0.2	19.9	15.9
RF	0.8626	0.5084	no	20.2	21.7	17.9	11.7	11.5	17.0
ANN	0.6610	0.3212	no	46.0	38.6	4.9	1.1	5.3	4.0
Ensemble	0.8958	0.6906		31.4	34.5	16.8	0.7	1.5	15.1

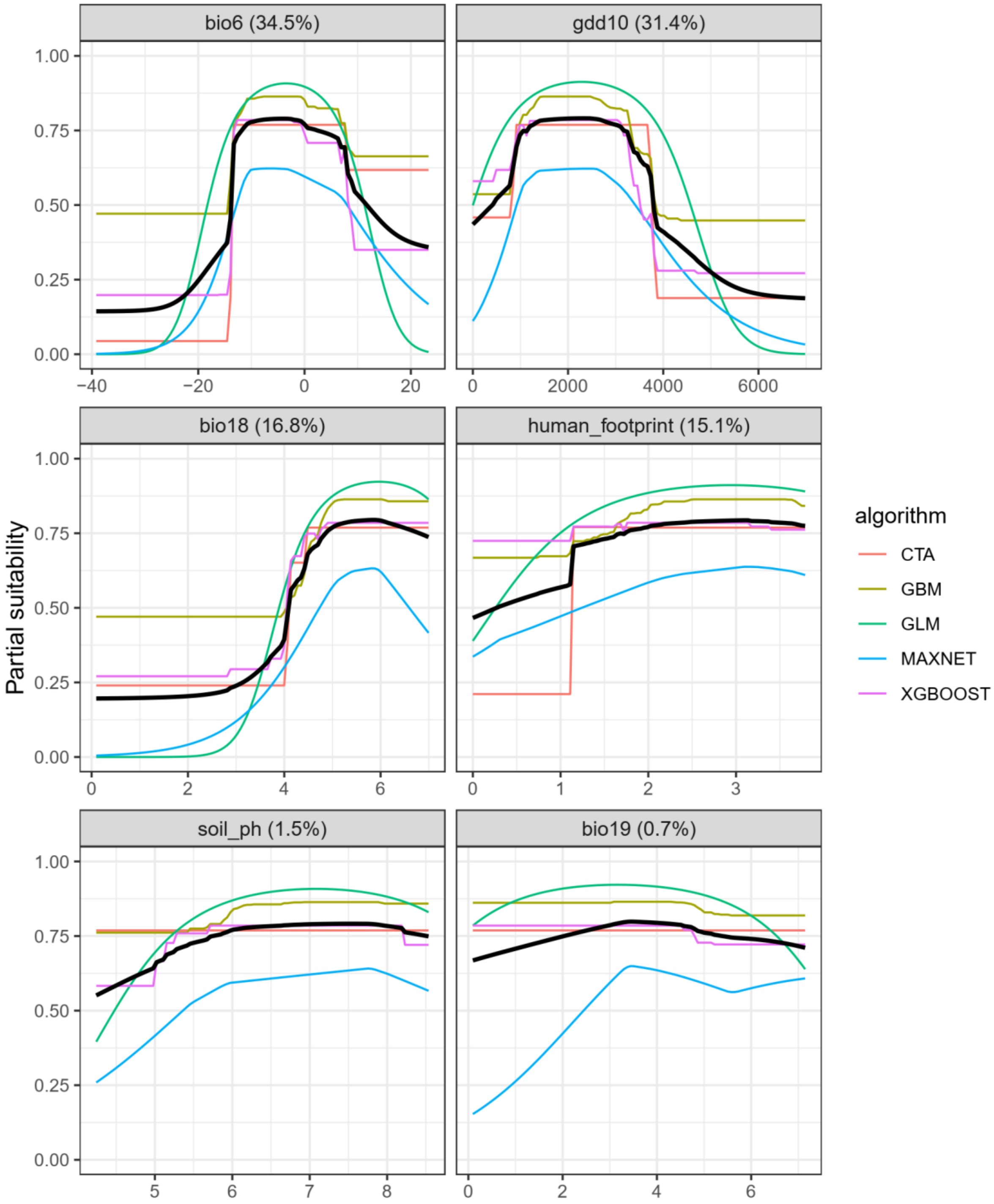


Figure 3. Partial response curves from the individual algorithms and ensemble model (thick black lines), ordered from most to least important. In each plot, other model variables are held at their median value in the training data. Variable codes are as in Table 1.

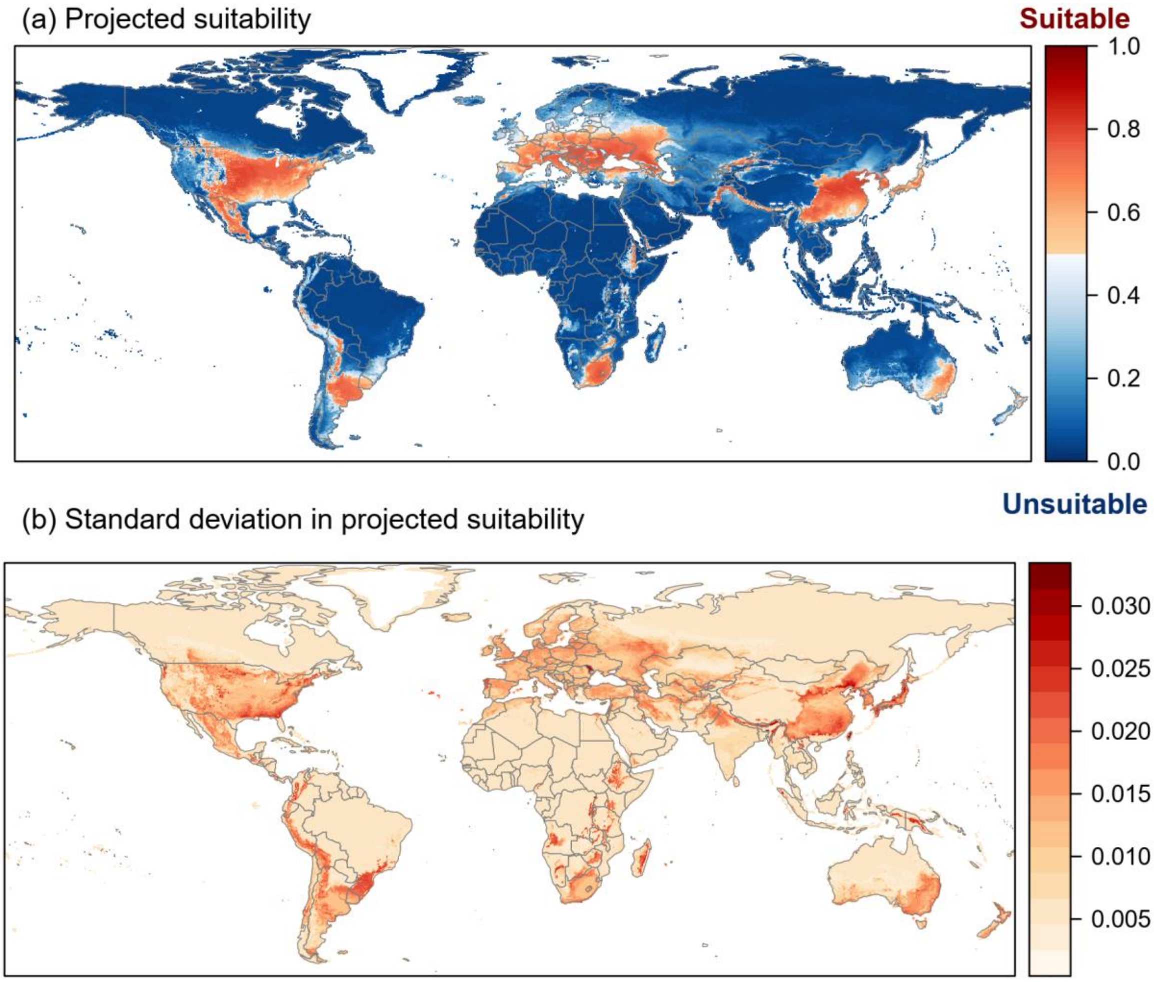


Figure 4. (a) Projected global suitability for *Euphorbia davidii* establishment in the current climate. For visualisation, the projection has been aggregated to a 0.25 x 0.25 degree resolution, by taking the maximum suitability of constituent higher resolution grid cells. Red shading indicates suitability, according to the selected threshold. (b) Uncertainty in the suitability projections, expressed as the standard deviation of projections from different algorithms in the ensemble model.

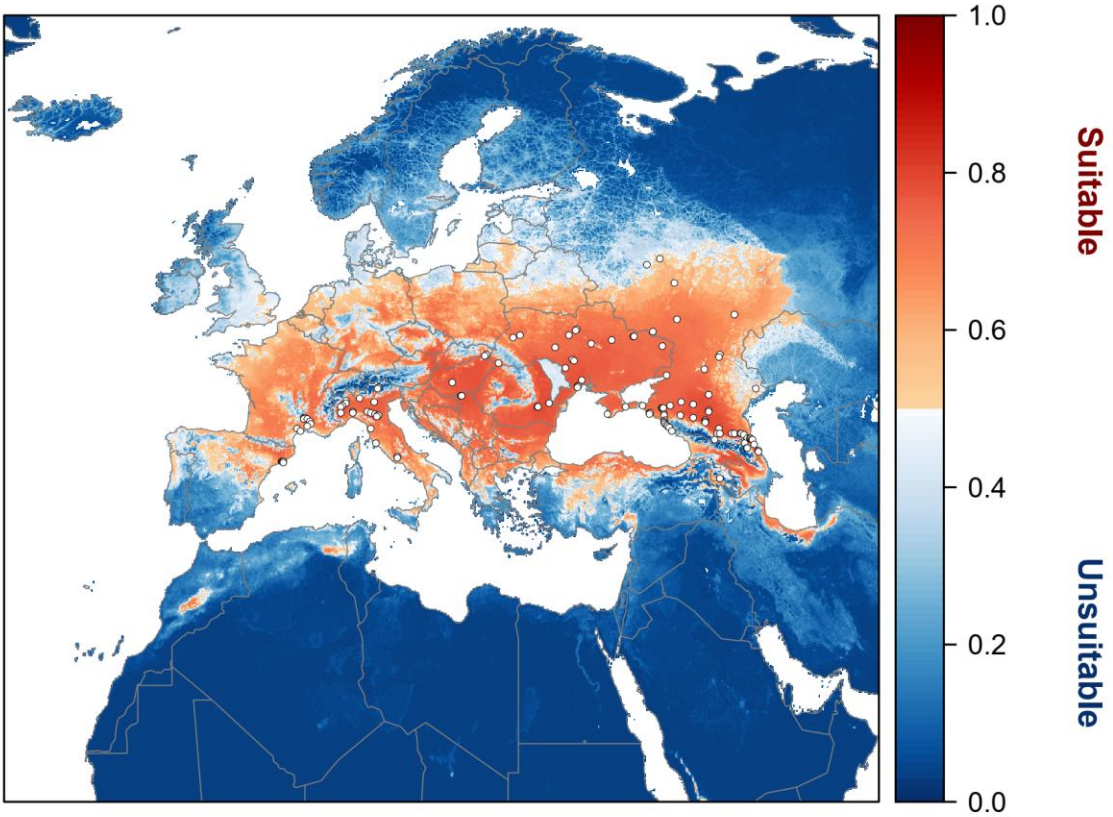


Figure 5. Projected current suitability for *Euphorbia davidii* establishment in Europe and the Mediterranean region. White points show occurrences used in the modelling.

(a)

(b)

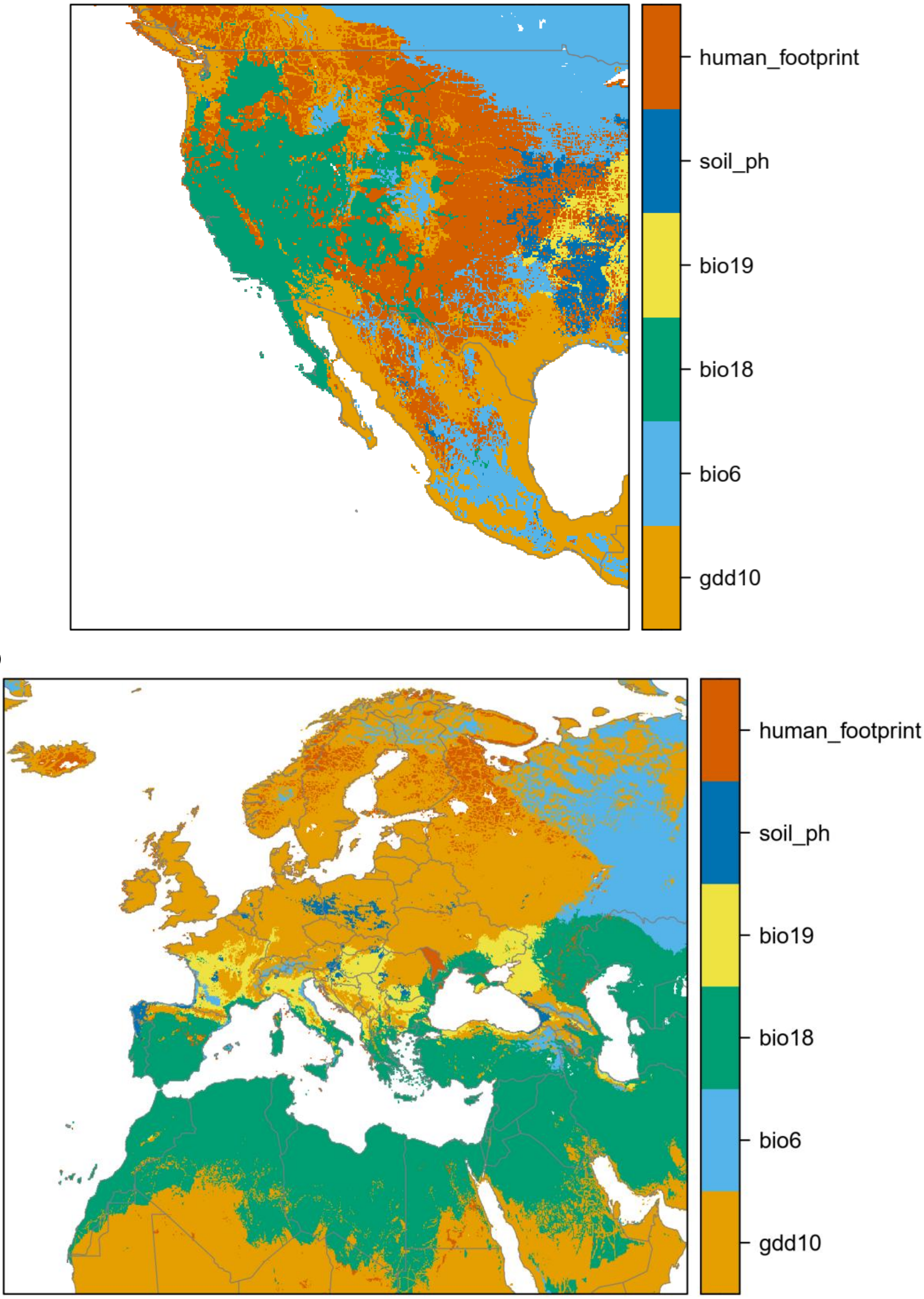


Figure 6. Limiting factor maps projected by the model for *Euphorbia davidii* in (a) its native region and (b) Europe and the Mediterranean region, under the current climate and land use. Colours show the variable most strongly limiting suitability in the model.

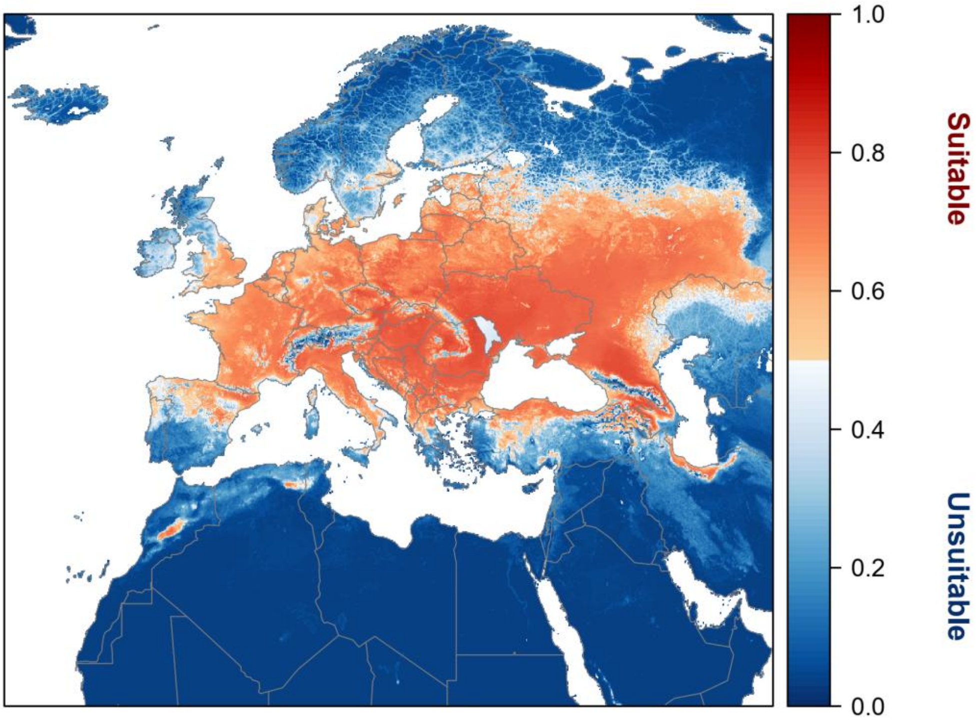


Figure 7. Projected suitability for *Euphorbia davidii* establishment in Europe and the Mediterranean region for 2041-2070 under the moderate climate change scenario SSP1-2.6.

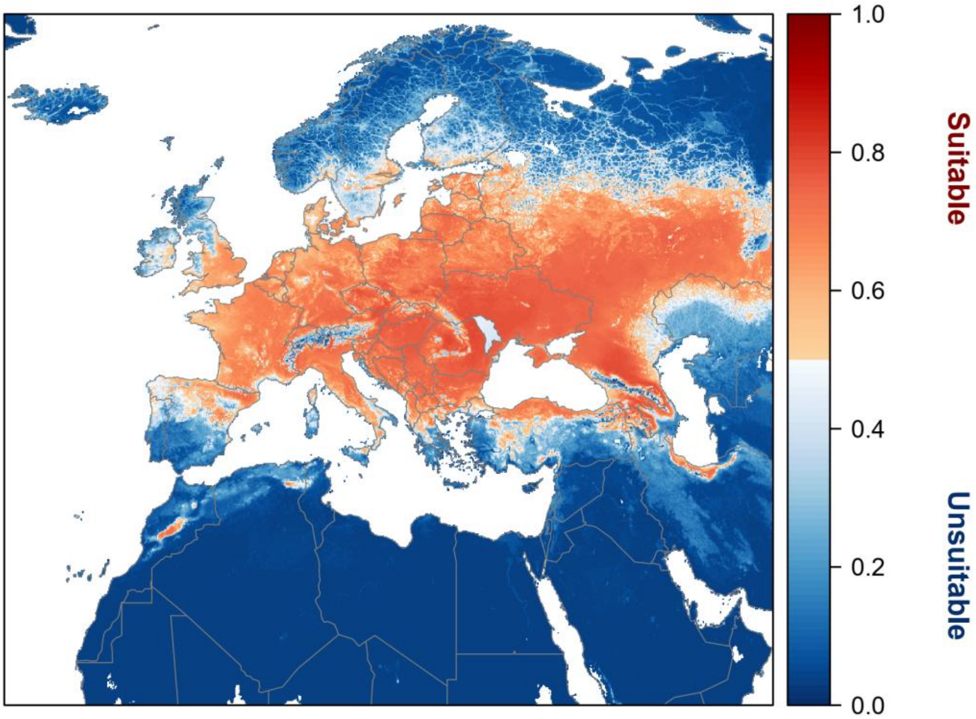


Figure 8. Projected suitability for *Euphorbia davidii* establishment in Europe and the Mediterranean region for 2041-2070 under the climate change scenario SSP3-7.0.

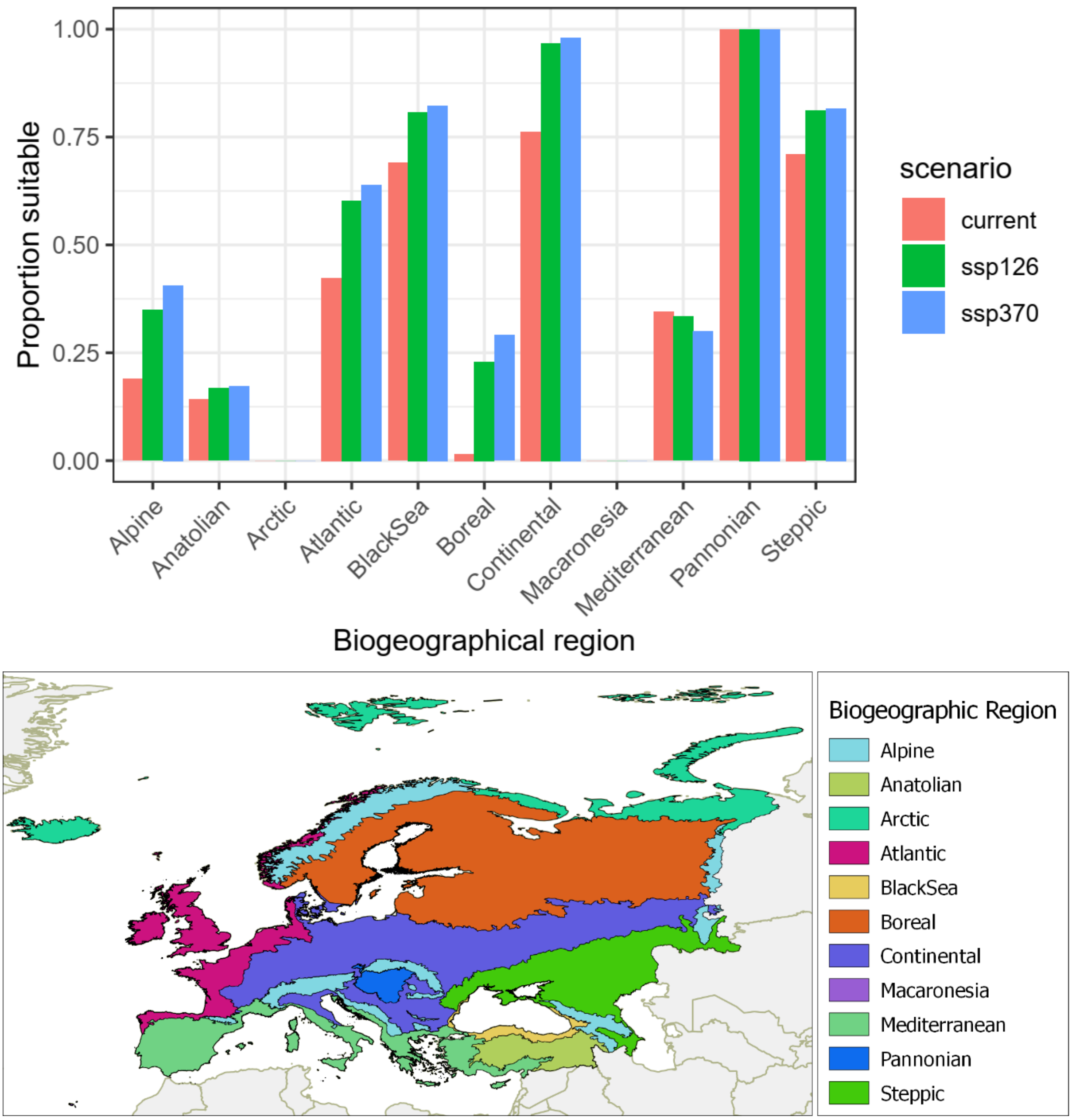


Figure 9. Variation in projected suitability among Biogeographical regions of Europe (Bundesamt fur Naturschutz (BfN), 2003). Bar plots show the proportion of grid cells in each region classified as suitable in the current climate (1981-2010) and projected climate for 2041-2070 under scenarios SSP1-2.6 and SSP3-7.0. The coverage of each region is shown in the map below.

Table 2. Projected % suitability among EPPO member countries, sorted from high to low in the current climate. Values are the % of grid cells in each country classified as suitable in the current climate (1981-2010) and projected climate for 2041-2070 under scenarios SSP1-2.6 and SSP3-7.0.

EPPO country (ISO3)	Current	SSP1-2.6	SSP3-7.0	EPPO country (ISO3)	Current	SSP1-2.6	SSP3-7.0
HUN	100	100	100	CHE	33	47	52
UKR	97	98	99	ESP	28	30	27
HRV	94	98	97	TUR	23	25	25
SRB	93	100	100	MDA	17	18	17
BGR	91	96	98	KGZ	11	20	23
MKD	87	96	98	PRT	8	9	4
ALB	86	87	83	RUS	6	11	13
FRA	82	91	92	LVA	5	89	96
ROU	82	91	94	GBR	4	39	46
BIH	82	99	100	KAZ	3	7	20
POL	78	99	99	MAR	2	3	3
SVN	77	91	94	DNK	1	70	89
NLD	71	98	98	TUN	1	0	0
ITA	66	65	66	EST	1	75	89
DEU	66	96	98	DZA	0	0	0
BEL	64	93	98	UZB	0	0	0
SVK	63	88	92	SWE	0	6	10
CZE	61	93	95	JEY	0	57	71
LUX	57	100	100	IRL	0	0	14
MNE	51	84	93	FIN	0	1	4
AZE	50	50	44	NOR	0	0	1
BLR	49	100	100	CYP	0	0	0
GEO	48	63	67	GGY	0	67	0
AUT	38	56	63	ISR	0	0	0
GRC	34	35	30	JOR	0	0	0
LTU	34	100	100	MLT	0	0	0

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