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Research Article

Helianthus tuberosus L. s. l. as a weed in agricultural fields and the associated impacts in Austria

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Abstract

Helianthus tuberosus L. s. l. (Asteraceae) is a perennial plant species native to North America. Based on an on-site survey in a study region near Graz and Leibnitz (southern Austria), the occurrence and agricultural impact of *H. tuberosus* was assessed. Fields where the species occurs in substantial populations were identified. Floristic relevés demonstrate that the species infests various crops, including maize, potatoes, soybeans, and oil pumpkin. *Helianthus tuberosus* is associated with other neophytes that are important weeds, such as *Cyperus esculentus* and *Sorghum halepense*. The species infests both the field edge and the field core. Several fields were heavily infested, suggesting that the species is likely to cause yield losses. Therefore, farmers should be made aware of this emerging weed species, and appropriate control measures should be implemented.

Key words: agriculture, distribution, impact, invasive alien plants

Introduction

Helianthus tuberosus (Asteraceae), commonly known as Jerusalem artichoke, is a perennial herbaceous species native to North America (POWO 2025). The species reproduces by seed and tuber-bearing rhizomes (Balogh 2008). In Europe, it was introduced in the 17th century into France as a cultivated plant to feed humans and livestock. Subsequently, the species was introduced to many other European countries. The first data on the escape of *H. tuberosus* from cultivation in Europe date back to the middle of the 19th century, and its spread and naturalization has been recorded since the middle of the 20th century (Balogh 2008; Filep et al. 2018). At present, *H. tuberosus* is widespread across Central Europe (EPPO 2025). The species regularly prefers moist or wet herbaceous communities along rivers, streams, and lakes. It also colonizes anthropogenically modified environments including ruderal habitats and abandoned land as well as agricultural fields (Balogh 2008; Žgančíková et al. 2012).

Helianthus tuberosus is considered a highly competitive weed in crops due to its ability to reproduce vegetatively, its regenerative capacity, its dense

formation of shoots, its height of up to 3.5 metres, and its allelopathic effects, which may lead to considerable losses in yield (Wyse et al. 1986; Swanton et al. 1992; Tesio et al. 2010). The occurrence of *H. tuberosus* in fields is probably facilitated by several factors. The species is likely to spread to nearby crops from habitats that have previously been invaded, or it enters the fields via the disposal of garden waste. The species spreads also in fields, especially where it has been cultivated as a crop in the past and where it has been allowed to spread in an uncontrolled manner (Tesio et al. 2010; Strgulc Krajšek et al. 2020).

So far, the occurrence and spread of *H. tuberosus* into fields and associated impacts have rarely been studied in Central Europe, although there are observations that the species can become a local problem in agriculture, such as in Hungary (Balogh 2008) and in Italy (Tesio et al. 2010). In Austria, *H. tuberosus* can be found scattered throughout the country, especially in warm lowland areas. It has been spreading since the mid-20th century (Essl and Walter 2005). The first documented occurrences in fields date back to 1989 and then from the mid-2000s onwards, especially in cereals and spring crops (Follak 2008; Glaser et al. 2022). A recent survey among Austrian farmers revealed that *H. tuberosus* was found as a weed on a number of farms (Glaser et al. 2024).

In this study, we explore the importance of *H. tuberosus* as a weed in selected agricultural areas in Austria. Specifically, the aims were to (1) determine its distribution and abundance in fields, and (2) to evaluate its agricultural impact based on an on-site survey.

Materials and methods

In 2025, the infestation of *H. tuberosus* in fields was surveyed in detail in a study region in southern Austria. It was selected based on the first author's previous observations in 2007 (Follak 2008) and in 2024 (Follak *pers. obs.* 2024) as well as data from iNaturalist (iNaturalist 2025). The study region was in Styria, between the cities of Graz and Leibnitz, and included four areas (A to D) that were a few kilometres apart from each other, with a total area of approximately 8.0 km^2 (Figure 1). Two of the four study areas are crossed by larger watercourses (C: Kainach; D: Sulm). In these intensively farmed areas, field crops such as maize, oil pumpkin, soybean, potato and vegtables are grown. The climate is temperate with an average annual temperature and precipitation being 9.8 °C and 841 mm, respectively (reference place: Graz airport, 46.98N, 15.44E; reference period: 1991–2020). The surveys were conducted in early August (study areas A to D) and mid-September 2025 (study area D only).

All fields in the study areas were surveyed for the occurrence of *H. tuberosus*. Crop type infested and field location of the main infestation (field edge [< 5m] vs. field core) were recorded. We used a nominal rating scale of I to III to

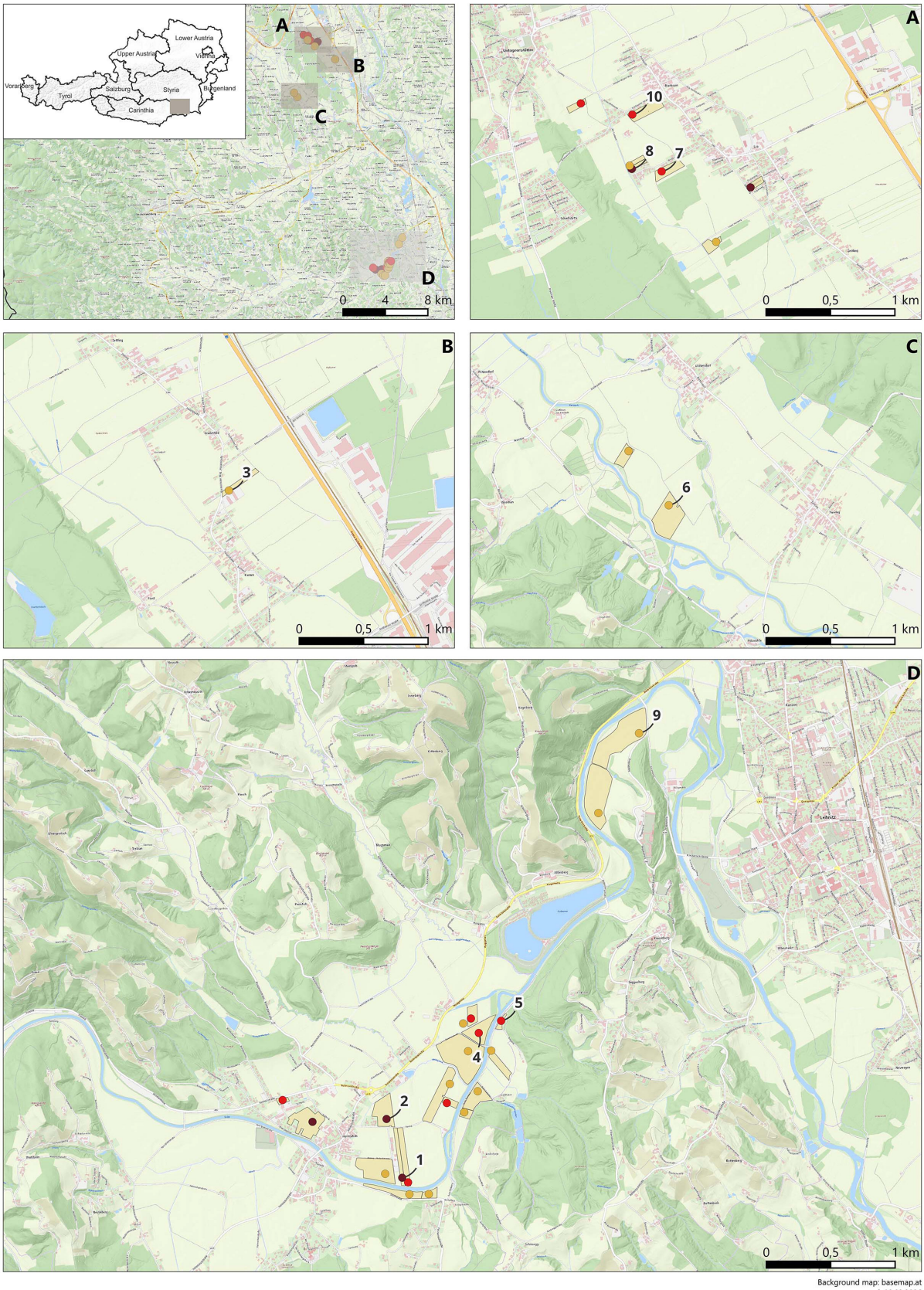


Figure 1. Maps of the location of the study region in Austria (overview) and of the study areas A to D showing the distribution and infestation of *Helianthus tuberosus* based on the observations from 2025. Different colors are according to population classification: yellow = I (few individuals, clusters at the field edge), red = II (clustered groups along the field edge, penetrating the field a few meters ± dispersed clusters throughout the field), dark red = III (large clusters, indicating substantial infestation). Field boundaries (if available) are taken from the INVEKOS database (Open Government Data 2025). Numbers correspond to the floristic relevés (see Table 1).

Table 1. Floristic composition of weed communities (plot size 100 m^2) with occurrences of *Helianthus tuberosus* in the study region in Austria. Relevés were from oil pumpkin (1, 2, 3), maize (4, 5, 6), potato (7, 8) and soybean (9, 10). Percentage ground cover (0 to 100%) of each species was visually estimated. For information on geographic coordinates and site characteristics, see Table S1.

Relevés No.	1	2	3	4	5	6	7	8	9	10
Vegetation cover herbs	95	95	95	97	97	98	95	100	100	100
Cucurbita pepo L. (cult.)	40	40	65	.	.	.	.	.	.	.
Glycine max (L.) Merr. (cult.)	.	.	.	.	.	.	.	.	90	90
Solanum tuberosum L. (cult.)	.	.	.	.	.	.	40	50	.	.
Zea mays L. (cult.)	.	.	.	90	95	65	.	.	.	.
***Helianthus tuberosus* L.**	**55**	**30**	**12**	**40**	**15**	**20**	**8**	**80**	**30**	**20**
Calystegia sepium (L.) R. Br.	0.2	35	1	0.5	.	0.2	0.5	0.5	0.5	0.5
Chenopodium album L.	5	20	25	0.1	0.1	.	3	0.5	0.2	3
Stellaria media (L.) Vill.	.	0.1	0.1	0.1	0.3	0.1	0.2	0.2	.	0.2
Echinochloa crus-galli (L.) P. Beauv.	.	7	1	.	0.1	5	5	3	.	35
Setaria pumila (Poir.) Roem. & Schult.	.	2	2	.	.	55	5	5	.	0.1
Amaranthus powellii S. Watson	.	.	40	0.2	0.3	0.5	.	3	.	.
Chenopodium polyspermum L.	.	0.7	0.2	.	.	0.1	0.1	.	0.2	.
Equisetum arvense L.	.	0.5	.	.	0.2	.	.	3	0.5	0.2
Galinsoga quadriradiata Ruiz & Pav.	.	0.1	.	0.1	0.2	0.2	0.2	.	.	.
Persicaria lapathifolia (L.) Delarbre	.	0.5	0.2	.	0.1	.	.	0.2	0.2	.
Amaranthus retroflexus L.	2	.	.	.	.	0.5	.	3	.	1
Convolvolus arvensis L.	.	1	.	.	1	.	.	.	0.3	0.2
Capsella bursa-pastoris (L.) Medik.	.	.	0.1	.	.	.	0.1	.	.	0.1
Cirsium arvense (L.) Scop.	.	.	0.1	.	.	.	2	.	0.5	.
Elymus repens (L.) Gould	.	0.2	0.1	.	.	.	.	0.3	.	.
Sonchus arvensis L.	.	.	.	.	.	.	5	0.2	.	0.1
Sorghum halepense (L.) Pers.	.	2	.	5	0.1	.	.	.	.	.
Amaranthus hybridus L.	0.3	1	.	.	.	.	.	.	.	.
Cyperus esculentus L.	12	.	.	20	.	.	.	.	.	.
Digitaria sanguinalis (L.) Scop.	.	3	.	.	.	.	.	.	.	15
Fallopia x *bohemica* (Chrtek & Chrtková) J.P.Bailey	0.2	.	.	3	.	.	.	.	.	.
Galinsoga parviflora Cav.	.	.	2	.	.	.	.	.	.	8
Glechoma hederacea L.	.	.	.	.	.	.	.	0.5	0.1	.
Lamium purpureum L.	.	.	.	.	0.1	.	0.1	.	.	.
Mentha arvensis L.	.	.	.	.	0.1	.	20	.	.	.
Miscanthus sinensis (Thunb.) Andersson	10	0.2	.	.	.	.	.	.	.	.
Panicum dichotomiflorum Michx.	0.3	.	.	0.1	.	.	.	.	.	.
Portulaca oleracea L.	.	0.2	.	.	.	.	0.2	.	.	.
Rorippa palustris (L.) Besser	.	.	0.1	.	.	.	.	.	0.2	.
Solanum nigrum L.	.	0.2	.	.	.	.	50	.	.	.
Taraxacum sect. *Taraxacum* F.H.Wigg.	.	0.2	.	.	0.3	.	.	.	.	.
Veronica persica Poir.	.	0.1	.	.	0.2	.	.	.	.	.
Achillea millefolium agg.	.	.	.	.	.	.	.	.	.	2
Agrostis stolonifera L.	.	.	.	.	.	0.2	.	.	.	.
Amaranthus blitum L.	.	0.2	.	.	.	.	.	.	.	.
Ambrosia artemisiifolia L.	.	.	.	.	.	.	.	.	0.2	.
Arctium lappa L.	.	.	.	.	.	0.1	.	.	.	.
Armoracia rusticana G. Gaertn., B. Mey. & Scherb.	.	.	.	.	.	.	.	3	.	.
Carex hirta L.	.	.	.	.	.	.	.	0.2	.	.
Erigeron canadensis L.	.	.	.	.	.	.	.	.	.	0.1
Dactylis glomerata L.	.	.	.	.	0.1	.	.	.	.	.
Fagopyrum esculentum Moench	.	.	0.1	.	.	.	.	.	.	.
Fallopia japonica (Houtt.) Ronse Decr.	.	.	.	.	.	0.1	.	.	.	.
Galeopsis pubescens Besser	.	.	.	.	.	.	.	0.2	.	.
Hordeum vulgare L.	.	.	.	.	.	.	0.1	.	.	.
Lythrum salicaria L.	.	0.1	.	.	.	.	.	.	.	.
Nicandra physalodes (L.) Gaertn.	.	.	0.2	.	.	.	.	.	.	.
Oxalis stricta L.	.	.	.	.	.	.	0.5	.	.	.
Polygonum aviculare agg.	.	0.1	.	.	.	.	.	.	.	.
Potentilla reptans L.	.	.	.	.	.	.	.	0.3	.	.

Table 1. Continued

Relevés No.	1	2	3	4	5	6	7	8	9	10
Robinia pseudoacacia L. (juv.)	.	.	.	.	0.1	.	.	.	.	.
Rorippa sylvestris (L.) Besser	.	.	.	.	.	.	0.2	.	.	.
Senecio vulgaris L.	.	0.1	.	.	.	.	.	.	.	.
Solanum carolinense L.	10	.	.	.	.	.	.	.	.	.
Solanum tuberosum L.	.	.	0.1	.	.	.	.	.	.	.
Sonchus oleraceus (L.) Hill	.	.	0.1	.	.	.	.	.	.	.
Stachys palustris L.	.	.	.	.	.	.	0.2	.	.	.
Vicia cracca L.	.	.	.	.	.	.	.	0.1	.	.
Zea mays L.	.	0.5	.	.	.	.	.	.	.	.

classify population sizes of *H. tuberosus* (adapted from Essman et al. 2021). Rating levels were I = few individuals, clusters at the field edge, II = clustered groups along the field edge, penetrating the field a few meters ± dispersed clusters throughout the field, III = large clusters, indicating substantial infestation. The entire field was considered in the visual assessment, and the most prevalent *H. tuberosus* distribution within the field (or average) was used to determine the rating. Further, we mapped the distribution and infestation of fields in the study areas. In addition, we recorded floristic relevés (n = 10) from the main crops infested by *H. tuberosus* to characterize the floristic composition and its cover. A plot of a standard size of 100 m^2 (10 × 10 m) was randomly established in the fields. Percentage ground cover (0 to 100%) of each plant species in the plots was visually estimated (Andújar et al. 2010). Taxonomical nomenclature and syntaxonomic classification followed POWO (2025) and Mucina et al. (2016), respectively.

To identify *H. tuberosus* we used morphological traits described by Balogh (2008) and Fischer et al. (2008). In our study, we list the observed populations as *Helianthus tuberosus* L. *sensu lato* (including wild and cultivated forms [i.e., *H. tuberosus* s. str.] and hybrids, such as *Helianthus* × *laetiflorus* Pers. [hybrid formula: *H. rigidus* × *H. tuberosus*]) (Hohla 2022). Floristic observations have shown that these species are present in Austria including the study region (e.g., Melzer 1971; Hohla et al. 2002).

Results

Local distribution and infestation levels

In total, 30 infested fields have been documented in the study region in 2025. Most infested fields were in study area D (> 60%), while fields in the other three study areas (A, B, C) were considerably less infested (Figure 1). *Helianthus tuberosus* was most frequently recorded in maize (57% of all infested fields recorded), followed by oil pumpkin (23%) and others (20%). The number of infested fields with small infestations was 53%, while fields with medium-sized infestation accounted for 30%, respectively. Five fields (17%) were heavily infested (Table 1, e.g. relevé no. 1., Figure 2F). Fifteen of the fields were infested both in the core and at the edges, while thirteen of the fields were only infested at the edges (e.g., Figure 2D).



Figure 2. Images of *Helianthus tuberosus* occurrences in different crops in the study region: maize (A – early August; B – mid-September), soybean (C, relevé no.10; D, relevé no. 9), oil pumpkin (E, relevé no. 2; F, relevé no. 1) (© S. Follak).

Floristic characterization and cover values

The relevés and detailed information on locality and site characteristics are provided in Table 1 and Supplementary material Table S1, respectively. The weed communities belong to the classes *Papaveretea rhoeadis* S. Brullo et al. 2001 and *Digitario sanguinalis-Eragrostietea minoris* Mucina, Lososová et Šilc in Mucina et al. 2016 (Mucina et al. 2016), which are widespread in Central Europe (FloraVeg.EU 2023). The most frequent species were *Chenopodium album* L., *Calystegia sepium* (L.) R. Br., *Echinochloa crus-galli* (L.) P. Beauv., *Stellaria media* (L.) Vill., *Setaria pumila* (Poir.) Roem. & Schult and *Amaranthus* spp. (*A. hybridus* L., *A. powellii* S. Watson,

A. retroflexus L.). The study species is regularly associated with other neophytes that are considered to be important weeds, such as *Cyperus esculentus* L., *Sorghum halepense* (L.) Pers. and *Solanum carolinense* L. Other species commonly used as ornamental plants can also be found in the fields, such as *Miscanthus sinensis* (Thunb.) Andersson (e.g., relevé no. 1). In study areas A and D, relevé sites are mainly located at valley bottoms, where high groundwater levels prevail (BFW 2023). Consequently, *H. tuberosus* co-occurs with species that prefer moist sites, such as *Rorippa sylvestris* (L.) Besser, *Mentha arvensis* L. and *Lythrum salicaria* L. (e.g., relevés no. 2 and 7). The highest cover values of *H. tuberosus* recorded in the plots were 80% for potatoes, 55% for oil pumpkins and 40% for maize (Table 1, Figure 2F).

Discussion

Distribution in agricultural fields

Helianthus tuberosus is not yet widespread as a weed in Austrian agriculture, because larger contiguous areas of infestation are not known (Holzner and Glauninger 2005). Further, scattered observations in fields were recorded in the literature in recent years (Follak 2008; Fragner 2010) or listed in databases and reporting platforms (e.g., Glaser et al. 2022; ZOBODAT 2025; iNaturalist 2025). However, our detailed survey in an intensively farmed area in southern Austria reveals that, locally, the invasion of *H. tuberosus* into fields is more advanced. Here, the species has successfully established in different crops and has become an important element of the local weed flora.

Helianthus tuberosus is typically associated with perennial ruderal herbaceous vegetation (class: *Artemisietea vulgaris* Lohmeyer et al. in Tx. ex von Rochow 1951) (e.g., Rendeková et al. 2021). The species is also invading tall-herb semi-natural perennial vegetation (class *Epilobietea angustifolii* Tx. et Preising ex von Rochow 1951) (Essl and Walter 2005). Its spread into segetal vegetation characterized by annual weed species seems to be atypical. However, once established, *H. tuberosus* rapidly increases in height, number of leaves and tubers during its life cycle. Moreover, shoots can emerge from tubers buried as deep as 30 cm. These characteristics enable it to persist also in fields (Swanton et al. 1992). Moreover, it can be assumed that *H. tuberosus* particularly benefits from the specific site conditions in the study region. The species is a moisture demanding species and the study region is mainly characterized by soils that are influenced by high groundwater levels and high annual precipitation.

Helianthus tuberosus mainly infests fields from adjacent previously invaded habitats, or much less frequently, because the species was previously cultivated on the land. Rivers and small watercourses, along which *H. tuberosus* grows regularly (Essl and Walter 2005), play an important role. From there, the species can easily encroach into adjacent fields. This particularly may apply to study area D, which is dissected by the Sulm River (Figure 1D),

where *H. tuberosus* has been present for a long time (Melzer 1971; Maurer 1996). *Helianthus tuberosus* can then be spread across fields or to other fields through tillage or through fragments of the tuber-bearing rhizomes attached to agricultural machinery. A process that has also been attributed to the spread of other rhizomatous and tuberous geophytes (e.g., *Cyperus rotundus* L., *Sorghum halepense* (L.) Pers.) (Fanfarillo et al. 2019).

Agricultural impact

Our results show that individual fields were heavily infested and low-growing crops such as oil pumpkin and potatoes, as well as highly competitive crops such as maize, were affected (Table 1, e.g., relevés no. 1 and 4). The high competitiveness of *H. tuberosus* was clearly evident (i.e., forming dense, monospecific stands, overgrowing the crop, Figure 2). Similar to our findings, Fragner (2010) found *H. tuberosus* in summer crops, such as oil pumpkin and maize in southern Austria, demonstrating that it primarily infested the edges of fields and that these populations exhibited high cover values. Weed control in oil pumpkin is more challenging compared to other crops, as there are only a limited number of registered herbicides applicable and its growth habit makes mechanical control difficult (Pinke et al. 2018). In maize, control of *H. tuberosus* may fail due to gaps in the effectiveness of the most widely used herbicides. Similarly, in potato, it is likely that weed control measures used were less effective, as the overall weed infestation was also often severe. In this respect, in a survey among Austrian farmers, almost 50% of respondents (farmers who had occurrences of the species) claimed that managing *H. tuberosus* required a medium to high effort (Glaser et al. 2024).

Reports on *H. tuberosus* from North America suggest that the species can be a serious threat to successful crop production (Swanton et al. 1992). For example, Wyse et al. (1986) showed that densities of one, two, and four tubers per meter of row reduced soybean seed yield by 31, 59, and 71%, respectively. Soybean height, the number of branches, seed pods per plant, and seed weight were reduced by all three weed densities. A density of four tubers per meter of row reduced maize yields by 16% to 25% (Wyse and Young 1980). Similar yield losses in infested fields can be expected under Central European conditions.

Further monitoring and management

Although infestations of *H. tuberosus* in fields are currently only of local importance, farmers should be made aware of the species, and this study provides a basis for this. To determine further spread of *H. tuberosus*, it is suggested to repeat the survey in the study region in several years. At the same time, surveys in other intensively farmed areas are advisable, where the species regularly occurs along rivers and streams. In addition, quantifying yield loss under the local conditions is necessary to better assess the impact on agriculture. Recommended control options include preventive (cleaning

of the machines), indirect (crop rotation, intensive tillage and/or cover crops in the post-harvest period) and direct methods (inter-row hoeing, herbicide use) (Swanton et al. 1992; Melander et al. 2012; Švehláková et al. 2021). Managing field margins (e.g., through repeated mowing) is essential to prevent *H. tuberosus* spreading into fields. Moreover, the species is increasingly cultivated in gardens because the tubers are tasty. Uncontrolled disposal can lead to new founder populations in fields or in nearby habitats. It is therefore essential that garden owners are made aware of the importance of correctly disposing of garden waste. Effective methods for garden owners are described by Strgulc Krajšek et al. (2020) and include drying the tubers or composting them on open heaps.

The study shows that *H. tuberosus* occurs locally as a weed in agriculture in Austria. Effective measures are needed there to contain the further spread of this weed and prevent yield losses.

Authors' contribution

SF and FE conceived the study, conducted the field surveys and data collection. SF and FE wrote the manuscript and MS produced the maps.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Floristic relevés: Recording date, habitat, plot size, habitat, exposition, altitude, coordinates and locality.

This material is available as part of online article from:
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