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The new trends in wild edible plants valorization: commercial cultivation protocols, agronomic practices and future challenges

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The ongoing environmental crisis that takes place during the last years necessitates the adjustment of cultivations practices and their transition to sustainable and eco-friendly cropping systems system. In this context, the adoption of innovative techniques, as well as the integration of wild edible plants (WEPS) in modern farming systems is a promising strategy to cope with modern challenges that the agricultural sector has to face due to climate change. The Mediterranean basin is a valuable hotspot of WEPS and presents an abundant biodiversity of such species with several authors highlighting the potential prospects of valorizing WEPS as complementary/alternative crops due to their wide range of adaptability and the minimal requirements for agriculture inputs. Apart from the agronomic aspects, WEPS are highly appreciated for their numerous health benefits and they could be an interesting addition in the market niche for super and healthy foods that modern consumers are increasingly seeking. Therefore, their exploitation through commercial cropping systems could be a viable solution towards overcoming the ongoing climate crisis while safeguarding food security, especially in the arid and semi-arid regions of the Mediterranean basin where the cultivation of conventional crops is severely compromised. Considering the increasing scientific interest on WEPS during the last years, this review aims to highlight the recent scientific trends regarding the implementation of *in vitro* techniques for the propagation of these species. Moreover, the optimum cultivation practices and agronomic aspects of selected WEPS and sum up the most up-to date information regarding their integration in modern cropping systems as part of the climate mitigation strategies. The response of WEPS to abiotic stressors (e.g. salinity, heat, drought) is also discussed, considering the capability of these species to adapt under unfavorable conditions, as well as the potential use of WEPS for phytoremediation purposes. Finally, the future challenges and the next steps for further valorization of WEPS will be also discussed.

KEYWORDS

wild edible species, agrobiodiversity, farming systems, minor crops, climate change, small-scale farming

Introduction

Wild edible plants (WEPs) are plants that are usually found in harsh, coastal, semi-arid or uncultivated areas, while they are collected in the wild for their edible parts such as fruits, leaves, stems, shoots, flowers, roots and seeds that could be a significant alternative source of healthy and nutritious food (Duguma, 2020). These species were valuable in the rural areas during the harsh periods of history where adverse economic conditions and wars made the access to food difficult and for that reason WEPs are characterized as the food of the poor and are entitled as “famine food” or “poverty food” (Corrêa et al., 2020). Although it is estimated that 30,000 species can be used for food purposes only 7,000 of them have been valorized throughout the human history, while nowadays only 20 species provide 90% of the required food on a global scale (Bacchetta et al., 2016). Apart from culinary uses there are several wild edible plants that have played a crucial role to the cultural heritage of different regions of the world, especially in the Mediterranean basin where WEPs are abundant and they constitute

an integral part of the so-called Mediterranean diet (Romojaro et al., 2013) (Figure 1). However, nowadays most of these species are treated as noxious weeds in conventional crops and farmers tend to control them with mechanical or chemical means thus resulting in agrobiodiversity loss (Kubiak et al., 2022).

According to several ethnobotanical surveys, WEPs include more than 7000 species that have been utilized throughout the human history for their medicinal properties (Narzary et al., 2016), while lately the interest of consumers in such species has been rekindled due to their health benefits and their high content in valuable phytochemicals (Carvalho et al., 2016). Several recent reports have highlighted the nutritional profile of WEPs which are a rich source of vitamins, fibers, fatty acids and other health beneficial compounds such as polyphenols, alkaloids, terpenoids, organic acids and other bioactive compounds (Åhlberg, 2021; Kumar et al., 2022; Martins-Noguerol et al., 2023).

Considering that so far the access to such species is mainly through collection from the wild the increasing demands of consumers could be covered with the commercial cultivation of

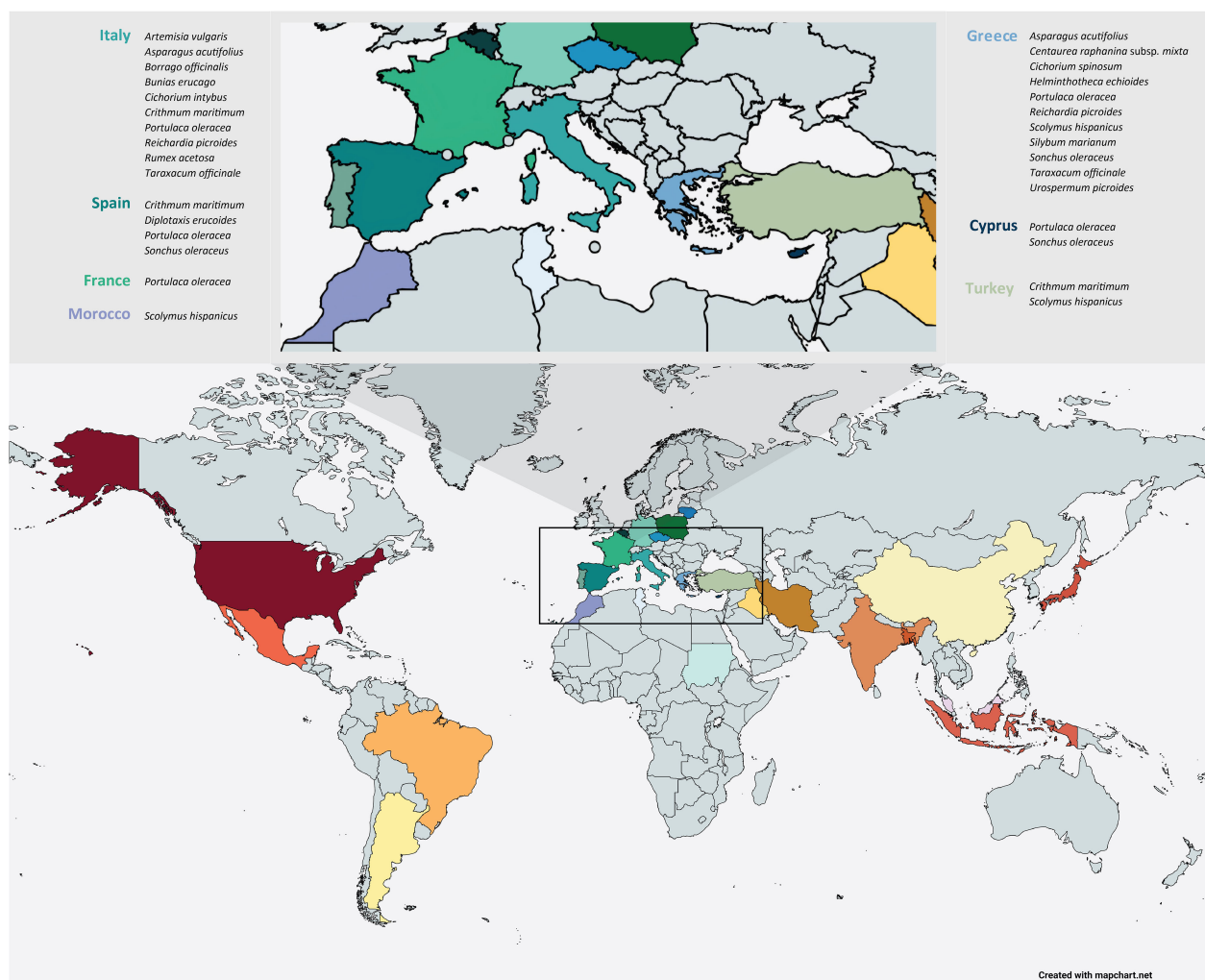


FIGURE 1
Distribution of wild edible species in the Mediterranean basin. (Photo credits: Dr. Vasiliki Liava).

WEPS and their promotion in modern cropping systems, especially in small-scale farms that are the backbone of the cropping sector of the Mediterranean basin (Ceccanti et al., 2020b; Chrysargyris et al., 2023a). Moreover, the current changes in climate conditions combined with land degradation due to anthropogenic activities and the irrational use of fertilizers and natural resources have severe effects on the production of conventional crops thus putting at risk food security and making a necessity the valorization of novel/alternative crops (Molina et al., 2014; Clemente-Villalba et al., 2023; Catarino et al., 2024). Species such as spiny chicory (*Cichorium spinosum* L.), purslane (*Portulaca oleracea* L.), sea-fennel or rock-samphire (*Crithmum maritimum* L.), golden thistle (*Scolymus hispanicus* L.), common thistle (*Sonchus oleraceus* L.) are highly appreciated in rural areas of the Mediterranean for their valuable nutritional properties (Ceccanti et al., 2018, 2020a; Petropoulos et al., 2018b; Renna, 2018; Paschoalinotto et al., 2023). Recent research has also highlighted the great potential of utilizing wild species in modern cropping systems within the concept of climate mitigation strategy, since many of them can be adapted to harsh environmental conditions, including high salinity and drought stress, heavy metal toxicity and other abiotic stressors (Ozturk et al., 2021; Lombardi et al., 2022; Vidalis et al., 2023). Moreover, the wild species usually have minimal requirements in agronomic inputs (e.g. irrigation water and fertilizers) which makes them excellent candidates for cropping in sustainable and low input cropping systems and for introducing them as minor crops (Seifzadeh et al., 2020; Amoruso et al., 2022).

However, despite the high potential of utilizing wild species as novel crops further steps are needed to establish efficient cultivation protocols and standardize yield components and the quality of the obtained products (Bacchetta et al., 2016; Pinela et al., 2017; Pío León et al., 2017). So far, the cultivation of WEPS has taken place in both soil and soilless systems (e.g. floating and hydroponic systems, pot cultivation) aiming to evaluate the response of plants under different conditions and identify the optimum inputs that facilitate high yield and quality of the edible product (Sarrou et al., 2019; Maggini et al., 2021; Chrysargyris and Tzortzakos, 2023; Puccinelli et al., 2024).

Considering the increasing interest in wild edible species during the last few years, the present review aims to gather the latest information regarding the agronomic practices that can be applied under commercial cultivation conditions, the response of those species to different cropping systems and growing conditions and further explore the future requirements for the efficient valorization of this valuable and so far underutilized plant material. For this purpose, databases such as Scopus and Google Scholar were meticulously searched using the combinations of several relevant keywords, including “wild edible plants”, “wild edible species”, “farming systems”, “small-scale farming”, “heavy metal toxicity”, “phytoremediation”, “salinity stress”, “drought stress”, as well as the scientific and common names of specific wild edible plants, focusing on wild edible greens and on *C. spinosum*, *C. maritimum*, *S. hispanicus*, *Sonchus* sp. and *P. oleracea*. The selection of these species was based on the previous experience on our research team through the VALUEFARM project which evaluated the

integration of wild edible species in the farming systems of the Mediterranean basin. After the search, the relevant documents were selected including those that referred to seed germination and propagation of WEPS; various cultivation practices such as irrigation, fertilization, etc.; different cropping systems such as field and greenhouse cropping, soil and soilless cultivation, hydroponics; the response to heat, drought and salinity stressors; and the phytoremediation of heavy metals. From this shortlist, the reports of the last decade were mostly included. However, considering the novelty of the subject and the lack of literature reviews we also included some older key reports which provide valuable information for the readers.

Plant propagation

A critical step before introducing the “domestication” of wild species in commercial farms is the proper crop establishment which enables the commercial cultivation and makes economically viable the valorization of such species. Plant propagation in the wild can be achieved through sexual or asexual propagation, depending on the species, while several species are perennial and there is no need for their propagation on an annual base (e.g., *C. spinosum* L., *C. maritimum* L., *S. hispanicus* L., *Centaurea raphanina* subsp. *mixta* (DC.) Runemark, *Silybum marianum* (L.) Gaertn., *Urtica dioica* L., *Asparagus acutifolius* L. etc.) (Sánchez-Mata and Tardío, 2016). However, even in the case of perennial species the commercial cultivation could be performed by treating them as annual species with plants being propagated annually, depending on the species, using either seeds and vegetative parts or implementing novel techniques such as *in vitro* propagation (Figure 2). Therefore, knowing the requirements and the proper conditions for seed germination and/or asexual propagation is essential for the commercial valorization of wild edible greens. To overcome the limitations of the relatively low germination rate and seed dormancy that may occur, pre-germination treatments or vegetative propagation have been suggested as effective techniques for the production of seedlings (Conversa and Elia, 2009).

Seed germination

Wild plants are usually characterized by limited germination rates compared to conventional and domesticated crops, mostly due to seed dormancy that helps the perpetuation of plants under the harsh and unfavorable conditions where they usually grow (Ensslin et al., 2023). However, although seed dormancy is useful in wild ecosystems since it prevents germination at unfavorable conditions, this trait is undesirable when *ex situ* cultivation in commercial farms is needed (Benincasa et al., 2007; Ceccanti et al., 2018; Ensslin and Godefroid, 2020).

Environmental conditions such as air and soil temperature, photoperiod and soil moisture content (imposed dormancy) and/or internal factors that are associated with inherent dormancy (e.g., chemical inhibitors present in seed coats and physical



FIGURE 2

Seedlings of *Cichorium spinosum* (left) and *Crithmum maritimum* (right) (Credits: Prof. Spyridon A. Petropoulos).

barriers associated with seed coats) determine the ability of seeds to germinate under specific conditions (Sari and Tutar, 2009; Lamont and Pausas, 2023). For example, Kashmir et al. (2016) suggested that high and low temperatures (40°C and 15°C, respectively) and salinity levels higher than 100 mM NaCl significantly decreased germination of *S. marianum*. Moreover, the environmental conditions during seed development and the nutritional status of mother plant may also affect the germination rates of the obtained seeds, depending on the species (Finch-Savage and Leubner-Metzger, 2006; Sergio et al., 2012; Hassan et al., 2014). In order to overcome these limitations, it is required either to subject seeds to scarification that facilitate the breakage of dormancy and/or the prevalence of standard conditions that are necessary to allow seed germination (Lamont and Pausas, 2023). Seed priming is also a useful technique that has been used to increase the seed germination rate in various species where inert or imposed dormancy is present (Sadeghi and Robati, 2015). Lo Porto et al. (2019) reported that the pre-treatment of wild asparagus seeds (*A. acutifolius*) with cold plasma, stratification at different temperatures and treatments with sterilized water (soaking), polyethylene glycol (PEG) and GA₃ had a variable effect on germination rates, mean germination time and 50% of germination time, with plasma treatment for 1 and 15 min showing the best results. Similar results were reported by Katsenios et al. (2019) and Conversa and Elia (2009; 2010) who also suggested that proper pre-treatment of seeds is pivotal in species where dormancy is detected. Torabi et al. (2012) assessed the effects of increasing concentration of exogenous silicon (Na₂SiO₃) application on germination rate of *Borago officinalis* L. and they reported that the most effective concentration was 1.5 mM resulting in reduced germination time.

Moreover, Kibar and Kibar (2017) who evaluated the seed properties of some wild edible plants consumed as vegetables in the Middle Black Sea Region of Turkey reported a considerable variation in germination rates between the species *Malva neglecta*, *Polygonum cognatum* and *Trachystemon orientalis*, while significant differences were also recorded between localities of the same species. In the case of *S. hispanicus* seeds, Sari and Tutar (2009) who evaluated the impact of light-dark cycles (16-hour light and 8-hour dark and continuous dark conditions), cold storage (4°C ± 2°C, and selected

temperatures (10 – 25°C) in *S. hispanicus* seeds collected from three localities suggested the presence of dormancy which varied among the ecotypes and that cold stratification significantly improved germination rates. The same authors also suggested that 20 to 25°C is the optimum range of temperatures where increased germination rates were achieved (Sari and Tutar, 2009). Öğretmen et al. (2014) evaluated the impact of seed treatments (chemical treatments with ethylene, gibberellin (GA₃), mannitol, and seaweed extracts and cold pre-treatment) on seed germination and they suggested that the application of 300 ppm of GA₃ significantly increased germination rate at 7 days after sowing while cold-pre-treatment at -15°C and GA₃ application (at 300 ppm) showed the best germination rates at 27 days after sowing. Similarly, Ceccanti et al. (2018) who performed germination tests in several wild edible species, found a great variation in germination percentage and mean germination time among the studied species. However, they did not record any effect of light conditions (e.g. germination under dark and light conditions) on the studied parameters, except for *P. oleracea* and *Taraxacum officinale* where the rate was significantly reduced under dark conditions. Scarification of seed silicles with sand paper was also very effective in the case of *Bunias erucago* L., while the extraction of seeds and the application of GA₃ significantly improved germination rates of raw seeds (Canella et al., 2020).

Sonchus oleraceus L. is a commonly found weed in several crops and its germination requirements have been studied as a means to reduce chemical and mechanical control requirements. Chauhan et al. (2006) suggested that dark conditions, high osmotic potential (> 100 mM NaCl) and high pH (>10) significantly reduced seed germination, while Widderick et al. (2010) recorded reduced germination rates at water potential higher than -0.6 MPa. The latter authors also suggested that *Sonchus* seeds may germinate well in a broad range of temperatures (5°C to 35°C) which explains the emergence of plants throughout the year (Widderick et al., 2010). According to Lemna and Messersmith (1990), *S. arvensis* seeds do not exhibit inert dormancy and they are capable for germination directly after maturation. The same authors reported that seeds remain viable for approximately 3 years and they prefer temperatures between 25°C to 30°C for higher germination percentage, especially when imposed in alternating temperatures

(Lemna and Messersmith, 1990). Moreover, Lee et al. (2024) who evaluated the germination performance of *S. oleraceus* and *S. asper* reported that both species recorded high germination rates at temperatures between 20°C to 35°C during the day and 10°C to 25°C during the night. Finally, increasing osmotic and salt stress reduced germination rates for both species, especially at stress levels higher than -0.4 MPa and 80 mM of NaCl for osmotic and salt stress, respectively (Chauhan et al., 2006; Lee et al., 2024).

Purslane (*P. oleracea*) is a cosmopolitan weed which infests several crops throughout the world; therefore, germination requirements of the species have been widely studied aiming to increase the efficiency of control means. Purslane seeds can germinate over a broad range of temperatures (25°C to 35°C during the day and 15°C to 25°C during the night), while they prefer light, pH between 5 and 9 and low osmotic stress (Chauhan and Johnson, 2009). However, germination percentage may differ depending on collection site, the genotype, the time of harvest and the seed age (El-Keblawy and Al-Ansari, 2000), while priming with hot water (50°C), methanol (20%) or GA₃ (1000 ppm) may increase germination percentage and decrease mean germination time (Kaur et al., 2021; Akram et al., 2023). Fernández et al. (2008) also suggested that sowing purslane seeds in styrofoam trays at 25°C and 65% relative humidity and then transferring them in floating beds resulted in the highest germination percentage and germination index, although a genotype dependent response was observed. Moreover, Naik and Karadge (2017) suggested that germination was inhibited by high salinity and dark conditions, especially at 100 mM of NaCl or Na₂SO₄, while at milder stress levels a varied effect of light conditions was recorded depending on the salt source. Similar results were reported by Pham et al. (2023) and Huang et al. (2018) who also observed a negative impact of osmotic stress induced either by PEG or NaCl on germination parameters, although the effect of high levels of NaCl was more prominent than PEG suggesting ion toxicity of Na to purslane seeds. On the other hand, Franco et al. (2011) did not find a significant effect of high salinity on germination percentage, mean germination time and germination index at levels up to 10 dS/m, although the final germination percentage was lower compared to other studies.

Sea fennel (*C. maritimum* L.) is a halophyte commonly found in coastal areas across the Mediterranean basin. Considering the halophytic nature of the species, several studies have investigated the salinity threshold which may impair seed germination, providing useful information for the valorization of the species through marginal soils reclamation, within the context of saline agriculture. Recently, Martins-Noguerol et al. (2024a) reported that low germination of seeds at high salinity (>150 mM) is due to the presence of salt-induced dormancy, since seeds remain viable and germination may recover at the absence of the stressor. Moreover, Atia et al. (2010) reported that the spongy coat of seeds is responsible for germination inhibition due to high salinity, since Na and Cl are mainly accumulated in this structure, while this protective mechanism allows seeds to survive at saline conditions. According to Atia et al. (2011b), decreasing osmotic potential values (<-0.4 MPa) significantly reduced germination percentage and

velocity, although an ion specificity was detected with Na₂SO₄ and MgCl₂ having a stronger negative impact than NaCl, MgSO₄ and mannitol. In contrast, seed priming with low concentration of NaCl (50 mM NaCl) may increase germination percentage (Nimac et al., 2018), while supplementation of red light, GA₃ and KNO₃ (Atia et al., 2009b, a) and L-ascorbic acid and ethanol mitigated the negative effects of salt stress (Meot-Duros and Magné, 2008).

In vitro propagation

Apart from sowing seeds, the production of seedlings through asexual propagation is a valuable technique that may find use in those species where low germination rates and slow emergence of seedlings are observed, as well as in the cases where plant growth is very slow at the initial stages of the vegetative phase (Figure 3). For example, Martins-Noguerol et al. (2021) suggested the use of root cuttings for the propagation of *C. maritimum* which exhibits very low seed germination rates. Micropropagation is another technique that has been applied in *C. maritimum* by cutting plant shoot tops and growing them without leaves in Murashige and Skoog (MS) medium with sucrose (20%), agar (0.6%), pH=5.8 at 22 ± 2°C and 16 hours lighting with fluorescent lamps (40 μmol/m²/s) (Grigoriadou and Maloupa, 2008). According to Atia et al. (2011a), MS media seems to be more effective for the *in vitro* reproduction of *C. maritimum*, whereas Grigoriadou and Maloupa (2008) reported that B5 media was more effective in rooting. In addition, it has been reported that the production of shoots and rooting are favored by the addition of BA (6-Benzylaminopurine) and NAA (1-Naphthaleneacetic acid) in the growth medium, respectively (Atia et al., 2011a). On the other hand, Mitrofanova et al. (2022) suggested that the use of metatopoline (mT) induced the reaction of explants when added to the growing medium.

For *S. oleraceus*, seeds have been used for the establishment of *in vitro* cultures after disinfection and immersion in MS nutrient medium with sucrose (87.7 mM) and agar (0.6%) and the use of microplants as explants donors (Mawalagedera and Gould, 2015).

The studies on *in vitro* propagation of *C. spinosum* and *S. hispanicus* are limited. However, reports for other species of the Asteraceae family, and particularly in the *Cichorium* genus, suggest that such a technique may help to address issues related to seed production, difficulties in seed germination and facilitate the genetic improvement of the plant species (Aldahak et al., 2021). According to Dolinski and Olek (2013) the young leaves of *C. intybus* can be used for callus production, by implementing combinations of different plant growth regulators (BA, 2,4-Dichlorophenoxyacetic acid (2,4-D), NAA and thiadizuron (TDZ), cytokinin (6-(γ,γ-Dimethylallylamino)Purine-2iP) and auxin (indole-3-acetic acid – IAA)) in the growing medium. In another study, Petrova et al. (2023) used *C. intybus* seeds for the establishment of *in vitro* cultures on semi-solid MS nutrient medium and then took stem segments for the production of microplants.

Shekhawat et al. (2015) performed *in vitro* cultures of *P. oleracea* using fresh shoots with 1–2 nodes as explants and growing them under aseptic conditions on a semi-solid MS media

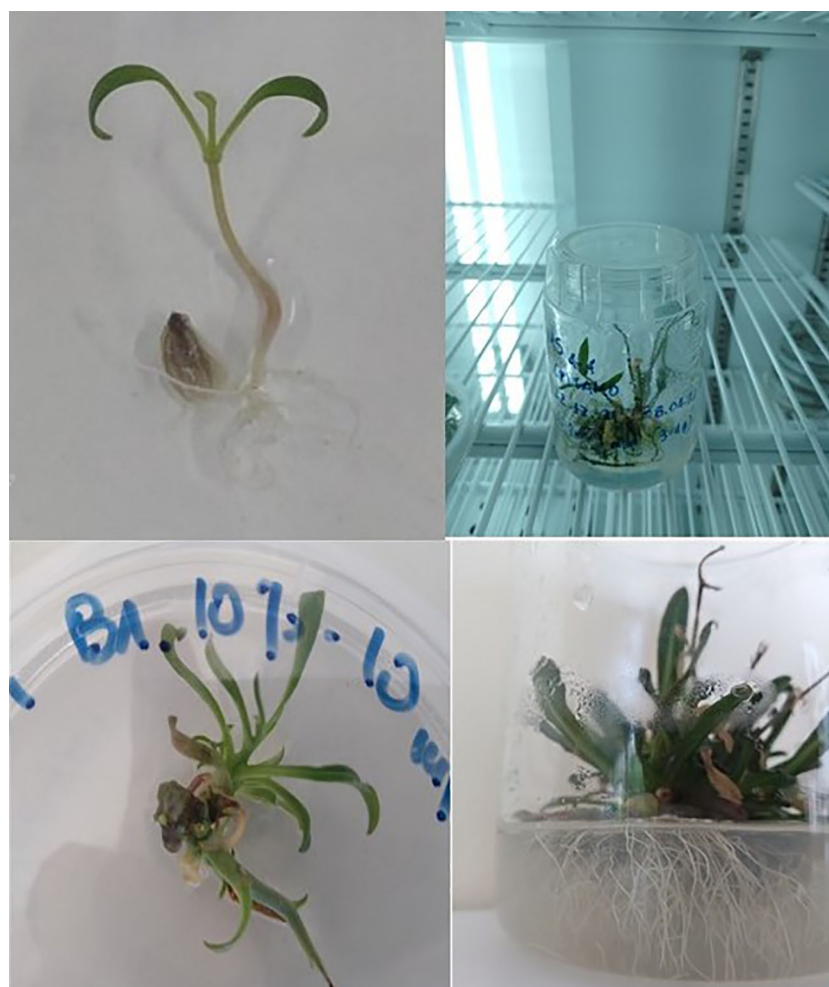


FIGURE 3

In vitro propagation of wild edible species. From upper left to right: *Crithmum maritimum* seedling obtained from *in vitro* cultivation of seed; *in vitro* cultivation of *C. maritimum* explant. From lower left to right: *Cichorium spinosum* explant; *in vitro* cultivation of *C. spinosum*. (Photo credits: Prof. Alexios A. Alexopoulos).

with cytokinins and auxins. Finally, Sedaghati et al. (2019) used purslane seeds for the establishment of *in vitro* cultures on semi-solid MS medium with 0.7% agar and 3% sucrose and pH=5.8 and suggested efficient plant regeneration.

Effect of cultivation practices on wild edible plants

Modern agriculture has to face several challenges, including climate change and the rapid increase of world's population which necessitate the increase in food production despite the yield losses due to unexpected weather events and the pressure from biotic and abiotic stressors (Campbell et al., 2016). Therefore, new strategies have to be adopted, including the introduction of wild edible species in farming systems. In this context, farmers have to reinvent the current agronomic practices and adapt them to the needs of these new crops aiming to establish cultivation protocols that are suitable for their commercial exploitation (Borelli et al., 2020; Singh et al.,

2020). Recently, the increasing trend for consumption of foods with high nutritional value and rich content in phytochemicals concerted scientific effort to study the effect of cultivation practices on the yield and quality of various wild edible species (Rakbar et al., 2024; Litskas et al., 2025; Neji et al., 2025).

Therefore, common practices such as nutritional and water inputs, the application of organic amendments, cultivation in growth substrates etc. have been evaluated so far. For example, Petropoulos et al. (2017b, 2018a) reported that nutrient solution composition and the growing season may affect the yield parameters and the quality of *C. spinosum*, while Karik (2019) found significant differences in the root length and root yield of golden thistle between different harvest dates. Similar results were recorded by Petropoulos et al. (2017a) for *C. spinosum* aerial biomass when different sowing dates and growing periods were tested and multiple harvests were implemented. Moreover, Benincasa et al. (2007) did not record significant effects of either plant density or genotype on yield and quality parameters of wild asparagus (*Asparagus acutifolius* L.), while they pointed out that

harvest efficiency was significantly improved when weeds were removed prior to harvest. On the other hand, Jankauskienė and Gruzdevienė (2015) suggested that planting density and crop age may affect green biomass production in *Urtica dioica* L. with lower densities resulting in higher biomass compared to denser planting. Similarly, Ebrahimi et al. (2010) reported that early planting (March 1) combined with low nutrients input through compost and chemical fertilizers significantly increased flower and grain yield and mucilage percentage in *Borago officinalis* L. plants. According to Andrzejewska et al. (2011) sowing date had no effect on fruit yield in *S. marianum* but it increased silymarin content, whereas increased sowing rates increased fruit yield without affecting silymarin content. Contradicting results were reported by Bielski (2021) and Rahimi and Kamali (2012) who observed a significant impact of sowing date on fruit yield for the same species.

Although wild species are naturally grown depending on the water which is available through precipitation, knowing the impact of irrigation on such species is crucial when aiming to introduce them in commercial farming systems. Therefore, the establishment of irrigation protocols can facilitate not only higher yield compared to plants grown in the wild but they can also improve the quality of the final edible product, especially through the increase of bioactive phytochemicals content. Recently, Seifzadeh et al. (2020) who tested different irrigation protocols in *B. officinalis* cultivation reported that drip irrigation is an economically viable practice that may improve not only yield parameters but also the net profit of the crop compared to rain-fed conditions and surface irrigation. Moreover, according to Polyzos et al. (2024) deficit irrigation (at 50% of field capacity) conditions did not impair the aerial biomass yield of *S. hispanicus*, whereas a negative impact on root growth was recorded. On the other hand, the same authors pointed out that deficit irrigation improved phytochemicals and bioactive compounds content without compromising the yield of fresh leaves (Polyzos et al., 2024).

Nutrients inputs though chemical and organic fertilizers is essential for conventional food crops to achieve high and profitable yields (Di Gioia et al., 2017; Verma and Yadav, 2024). However, this is not always the case for wild plants because they are adapted to unfavorable environmental conditions and minimal nutrient availability that commonly face in their natural habitats. The adoption of fertilization regimes commonly used in conventional leafy vegetables is not appropriate and it could lead in decreased quality of the edible product, as for example increased content of nitrates, as well as in severe implications to agroecosystems due to nutrients leaching, high carbon footprint and degradation of soil quality (Han et al., 2017; Ali and Bijay-Singh, 2025; Wang et al., 2025). Therefore, any fertilization protocols have to be designed having in mind that low amounts of nutrients are usually required to achieve high yields in wild species cultivation without having negative effects on the nutritional and bioactive profile of the edible products (Chatzigianni et al., 2020; Hajisolomou et al., 2024). Parameters such as the total amounts of nutrients applied, the source of nitrogen and the nitrate/ammonium nitrogen ratio should be considered when designing the fertilization protocols for such species. For example,

Chatzigianni et al. (2018, 2020) suggested that nitrogen source (low amounts of NH_4^+ in nutrient solution) and low amounts of applied nitrogen (4 mmol/L of N) may have a significant impact on *C. spinosum* yield and leaf quality (e.g., low nitrates content), as well as on plant metabolism. Similar results were also reported by Petropoulos et al. (2018c) who tested the impact of nutrient solution with different NH_4^+ to NO_3^- ratio on *C. spinosum*, although a significant combinatorial effect was also detected for growing season and harvesting stage of leaves. Nastou et al. (2021) suggested that increasing fertilization rates in nutrient solution (up to 600 ppm of N) had beneficial effects on growth parameters of pot grown *P. oleracea* plants in a genotype dependent manner. In contrast, *Centaurea raphanina* subsp. *mixta* showed the highest fresh biomass yield when low nitrogen rates were applied (200 ppm of N), whereas increased N rates resulted in high contents of oxalic acid which is considered an antinutritional factor (Petropoulos et al., 2020). Similar results were reported for *C. spinosum* and *S. hispanicus* where the highest yield (e.g., biomass of fresh leaves) was achieved when low amounts of N-P-K were applied (200–100–100 ppm and 200–200–200 ppm, for *C. spinosum* and *S. hispanicus*, respectively), while quality traits showed a varied response to nutrients amounts (Polyzos et al., 2022). The recent research of Hajisolomou et al. (2024) also suggested that the application of organic fertilization can be equally effective as inorganic fertilizers in terms of plant growth parameters of field grown *S. oleraceus* and *P. oleracea*, while having positive effects on soil physicochemical properties. On the other hand, Chrysargyris and Tzortzakis (2025) cultivated purslane in a hydroponic systems and suggested that the application of high P-K rates (105 and 525 mg/L, respectively) significantly increased the above-ground biomass yield compared to the recommended dose of P and K (e.g., 70 and 350 mg/L, respectively), whereas it had a negative impact on antioxidant activity and phenolic compounds content. Moreover, the form of fertilizer may also have an impact on the yield and quality attributes of domesticated wild species, as suggested by Liava et al. (2021) who tested the effect of conventional and controlled-release nitrogen fertilizers and reported that high rates of the latter form significantly increase fruit yield of *S. marianum*.

Lately, the use of organic waste as growing medium has been suggested as a viable substitute of conventional growing media (e.g., rockwool, peat, perlite etc.). For instance, Ammarellou (2012) tested four media (e.g., field soil, sand, small sand and water) for rooting and growing of *Urtica dioica* cuttings and found that water was the most efficient medium for root development, while field soil improved the vegetative biomass. In this context, Chrysargyris et al. (2023a) suggested the use of olive and grape-mill waste as a substitute of peat in the growing medium of pot cultivated purslane and common sowthistle plants, while the use of solid waste of essential oil production from aromatic plants was effective as a growing medium for soilless cultivation of purslane when implemented at amounts of 10% (v/v) (Chrysargyris et al., 2023b). Similarly, Montesano et al. (2018) highlighted the use of sea-weed based compost as a growth medium for pot cultivation of *C. maritimum* plants without negative effects on yield parameters. Moreover, the addition of organic matter through the application of

solid municipal waste compost increased the fresh aerial biomass of *C. spinosum* plants grown in a sandy soil, although a genotype dependent response was recorded.

The application of exogenous chemical compounds is also a cultivation practice of interest between the growers of wild edible plants. In this context, Ebrahimi and Miri (2016) suggested that humic acid application in increased concentrations (up to 30 g/L) significantly improved seed germination and seedling growth of *Borago officinalis*. Moreover, Si application mitigated the negative effects of salinity on purslane plants by increasing Na accumulation in leaves, while the opposite trend was recorded for K content (Kafi and Rahimi, 2011). In the same line, Mohamed et al. (2024) suggested that putrescine and salicylic acid application on purslane plants (at 200 mg/L) mitigated the negative effects of salinity (up to 171.2 mM of NaCl).

Cropping systems

So far, various cropping systems have been tested for the cultivation of several wild species aiming to domesticate them and valorize them in commercial crop production. Therefore, both soil and soilless systems have been implemented in experimental sites throughout the world in order to establish cultivation protocols and practices that could be extrapolated to commercial conditions and facilitate the promotion and integration of these species in modern agriculture as alternative/complementary minor crops.

Intercropping is the cropping system where the sowing of two or more crops in various layouts (e.g., row intercropping, strip intercropping and mixed intercropping and time periods (e.g., relay intercropping) may take place in the same space at the same growing period (Bavec and Bavec, 2016; Maitra et al., 2021). However, the complexity of these schemes and increasing intensification of cropping systems within the aim of achieving high yield while production is decreased (mostly through the mechanization of cultivation practices) has marginalized them in favor of monocropping (Kokkini et al., 2025). Therefore, the integration of new/alternative intercrops in rotation schemes over long time periods enables the sustainable safeguarding of agrobiodiversity and ecosystem services and secures food production in the ongoing climate change (Aviron et al., 2023).

According to Borelli et al. (2020) the exploitation of “orphan crops” (e.g., domesticated, semi-domesticated and wild species) through their integration in farming systems is of paramount importance towards the diversification of agroecosystems, the sustainable development of rural areas and the reinforcement of crop production against climate change. In this context, Ghamari et al. (2016) tested the intercropping of purslane and dragon’s head (*Lallemantia iberica* Fisch. and C.A. Mey) at various combinations and they reported that intercropping resulted in higher relative yield total compared to monoculture of purslane, especially when the scheme of 100% purslane and 50% dragon’s head was combined with the application of 50% of inorganic N and nitroxin. Moreover, Carrascosa-Robles et al. (2024) suggested that the inclusion of

purslane in crop rotation, intercropping and combinatorial schemes resulted in increased yield for purslane, while crop rotation and the combination of intercropping and crop rotation benefited soil enzymatic activity and modified the soil microbial composition and functionality.

Soilless cultivation is ideal to evaluate nutrient requirements and pH and EC levels that are appropriate for the cultivation of each species or to regulate chemical composition and the content of phytochemicals, either the content of toxic and antinutritional compounds such as nitrates (Santamaria, 2006), or beneficial compounds such polyphenols (Martins-Nogueiro et al., 2021). Hydroponic farming is an intensive cropping system that increases water and nutrient use efficiency, while it is ideal for increased yields and better availability of the final product through out of season cultivation (Ceccanti et al., 2018). Moreover, these systems are capable for very high yields due to increased plant density and the shorter cropping period, while less labor is needed for weed management (Zanin et al., 2009). In this context, hydroponic systems have been used for the cultivation of various species, including *C. spinosum*, *S. oleraceus*, *P. oleracea* among others (Alam et al., 2015; Chatzigianni et al., 2018; Chrysargyris and Tzortzakis, 2023; Chrysargyris et al., 2023b). Recently, Vidalis et al. (2023, 2024) tested the cultivation of *Urospermum picroides*, *Reichardia picroides*, *Plantago coronopus* and *Hedypnois cretica* under three cropping systems, namely pot cultivation indoors and outdoors and in a floating hydroponic system) and they suggested a varied response depending on the species. According to Papadimitriou et al. (2022) *S. hispanicus* can be cultivated in a hydroponic system and facilitate the out of season production of edible products using minimum amounts of nutrients and irrigation water of marginal quality (e.g., brackish water), while the tailor-made composition of nutrient solution may facilitate the biofortification of the edible parts of plants with health beneficial elements such as Se (Puccinelli et al., 2021).

Recently, various wild edible species have been suggested for microgreens production as novel functional foods due to their nutritional profile, the rich content in bioactive compounds and the attractive sensory attributes (Caracciolo et al., 2020; Rouphael et al., 2021). In this context, purslane was highly appreciated as an ideal species for this cropping system due to its short life cycle, low nutrients requirements and tolerance to saline conditions which facilitates the use of brackish water for microgreens production (Corrado et al., 2021; Plocek et al., 2023; Bonasia et al., 2024). Moreover, Kyriacou et al. (2019) and Giménez et al. (2021) reported that the proper choice of spectral bandwidths in microgreens production under controlled environments may regulate the biosynthetic pathways of bioactive compounds and increase the content of health beneficial compounds (e.g. polyphenols).

Pot cultivation is another option for soilless cultivation when plants are grown in growing media other than soil (Figures 4, 5). For example, Calone et al. (2021) evaluated the cultivation of six underutilized halophytic species (namely, *Artemisia absinthium* L., *A. vulgaris* L., *Atriplex halimus* L., *Chenopodium album* L., *Salsola komarovii* Iljin, and *Sanguisorba minor* Scop.) in pots containing peat moss under saline conditions (up to 600 mM



FIGURE 4

Field (left) and pot cultivation (right) of *Scolymus hispanicus*. (Credits: Prof Spyridon A. Petropoulos).

NaCl) and recorded promising results in terms of crop performance for *A. halimus* and *C. album*. Moreover, the recent research of Tsoumalakou et al. (2023) and Vlahos et al. (2019) highlighted the potential of cultivating *C. spinosum* in aquaponics systems within the circular economy approach where aquaculture is combined with hydroponics. Finally, wild edible species have been suggested for green roofs due to their tolerance to drought stress and their limited water requirements (Azeñas et al., 2019; Martini and Papafotiou, 2025).

Considering that most of these wild species are usually found as weeds in various agroecosystems, their evaluation under field conditions is of major importance to obtain information about their response to various agronomic practices that could be extrapolated in commercial cropping systems (Figures 4, 5). Recently, Litskas et al. (2025) showcased the cultivation of *S. hispanicus* under commercial conditions and suggested that the

species can contribute to sustainable production of food due to low inputs and environmental impacts. The ongoing climate change necessitates the reduction of inputs in crop production, especially the irrigation water which becomes scarce and water use efficiency of crops has to be improved. For this purpose, Polyzos et al. (2024) suggested that deficit irrigation can be applied in *S. hispanicus* cultivation without compromising yield parameters while improving phytochemicals and bioactive compounds content. Moreover, Bvenura and Afolayan (2013) suggested that the combined application of goat manure (8.13 t/ha) and inorganic fertilizer (100 kg of N/ha) resulted in the highest yield of *Solanum nigrum* plants grown under field conditions. In the same line, Zenobi et al. (2021) suggested that drip irrigation alone or combined with fertigation significantly increased fresh biomass yield of field-grown *C. maritimum* plants compared to the untreated ones. Gómez-Bellot et al. (2021) also suggested the use



FIGURE 5

Field cultivation of *Portulaca oleracea*. (Credits: Prof Spyridon A. Petropoulos).

of recycled wastewater and brine for the irrigation of soil grown *C. maritimum* plants without affecting plant development and physiological parameters.

The response of wild edible plants to abiotic stressors

Salinity stress

Climate change has led to soil salinization which is associated with devastating effects on crop production around the globe, especially in arid and semi-arid areas in the Mediterranean basin (Raza et al., 2019). Saline water used by farmers for irrigation purposes has led to an increase of Na^+ and Cl^- , resulting in tremendous morphological, physiological and metabolic changes such as stomatal closure and reduced photosynthetic activity, and consequently in sickly plant growth and development and loss of yield and product quality (Cleydson et al., 2025). Plants present different responses to saline conditions, with most of conventional vegetable crops being considered susceptible to salinity stress (Chele et al., 2021). On the other hand, wild species are adapted to harsh environmental conditions due to protective mechanisms that they have developed over the course of time to safeguard their perpetuation (Qiu et al., 2022), although their response may vary depending on the species or the ecotype within the same species (Bonasia et al., 2017; Alexopoulos et al., 2021). Lately, the tolerance of wild edible plants under biotic and abiotic stressors, including salinity, has been the subject of several studies aiming to reveal the protective mechanisms that lie behind and further introduce them in saline agriculture as cash crops (Alam et al., 2015; Ltaief et al., 2021; Alexopoulos et al., 2023; Sogoni et al., 2024). However, further research is needed considering the high genetic variability between and within the species, especially when considering the vast number of different ecotypes and the adaptation mechanisms that have been developed at specific growth conditions. According to Gkotzamani et al. (2024), *S. oleraceus* is a moderately salt-tolerant species since plant growth was impaired only at high salinity levels (e.g., 80 and 100 mM NaCl) where both leaf and root fresh weight was significantly reduced compared to control. Similar results were reported by Sergio et al. (2012) for wild chicory where a reduction in plant growth was recorded at salinity levels higher than 100 mM NaCl, while Poursakhi et al. (2019) reported significant changes in physiological parameters when chicory plants were treated with saline water (130 mM NaCl). Klados and Tzortzakos (2014) also highlighted the tolerance of hydroponically grown spiny chicory (*C. spinosum*) plants to high salinity (up to 120 mM NaCl), especially when rockwool was the growth medium, while lower salinity levels (40 mM NaCl) did not affect plant growth, regardless of the ecotype (Chatzigianni et al., 2019). *Scolymus hispanicus* could be also considered as a moderately tolerant wild edible green since according to Papadimitriou et al. (2020) salinity levels up to 3.8 dS/m did not affect plant growth and fresh biomass yield.

Crithmum maritimum is a facultative halophyte which means that saline conditions are not imperative for plant growth and development (Ben Amor et al., 2005), since plants may accumulate high amounts of ions in leaf tissues for osmotic regulation (Ciccarelli et al., 2016). In the study of Ben Hamed et al. (2007) where *C. maritimum* plants were subjected at salinity levels up to 300 mM NaCl, it was suggested that the biomass of leaves and roots was significantly reduced at 300 mM NaCl and 100 mM NaCl, respectively, while the evaluation of antioxidant enzymes activity indicates that protective mechanisms are more efficient in leaves than in roots. Moreover, Blažević et al. (2025) suggested that plant survival rates significantly decreased when plants were subjected to salinity levels up to 512 mM NaCl.

Purslane is also registered as halophyte with high capacity of ion accumulation (especially Na) (Kafi and Rahimi, 2011) due to adaptation mechanisms related to enhanced antioxidant enzymes activity and physiological changes (e.g., shift from C4 to CAM photosynthesis) and changes in metabolic profile (Camalle et al., 2020; Zaman et al., 2020). On the other hand, Guevara-Olivar et al. (2024) suggested that high salinity (up to 1 M of NaCl) resulted in a significant decrease of fresh biomass, mainly due to a reduction in stems weight, whereas the weight of leaves and roots remained unaffected. Sdouga et al. (2019) reported a variable response to salinity (up to 150 mM NaCl) for four purslane genotypes with the negative effects of stress being evident at the highest salinity level via reduced root length and diameter and smaller and fewer leaves. The same authors suggested that salinity up to 50 mM NaCl has a stimulatory effect on plant growth and could be considered as an eustress for increased yield parameters (Sdouga et al., 2019). Similar results were recorded by Tang et al. (2020) who also observed negative effects on purslane growth at salinity levels higher than 100 mmol/L NaCl, due to reduced length of both shoots and roots. However, according to Alam et al. (2015) there is a genotypic variability of the species to salinity stress which was evidenced in dry matter content and bioactive compounds accumulation in different accessions. Moreover, Mulry et al. (2015) suggested that the increase of proline or betalain content also depends on the genotype.

Heat stress

Climate change implications on plants and crop production are related to extreme temperatures which become more and more frequent throughout the world (Jagadish et al., 2021). Heat stress affects seed germination, photosynthesis rate, water use efficiency and grain yield and quality of cultivated and wild plants and eventually has an impact on agroecosystems and biodiversity (Haider et al., 2021; Semeraro et al., 2023). For example, Mathieu et al. (2014) studied the effects of high temperature (35°C day/28°C night) on the development of *C. intybus* and recorded reduced growth and early flowering induction, as well as changes in chemical composition of roots (Mathieu et al., 2018). Moreover, high temperatures may reduce or hamper seed germination and

seedling growth of several species, including wild ones such as *S. marianum* (Kashmir et al., 2016), *P. oleracea*, *B. officinalis* and *Hypericum perforatum* (Descamps et al., 2018).

Tolerance to heat stress is associated with the expression of specific genes, as *CiXTH29*, *CiLEA4* and *CiFL1* and phytohormones in *C. intybus* (Mathieu et al., 2020; De Caroli et al., 2023), which protect physiological processes and increase antioxidant compounds content (Delfine et al., 2022). According to Yang et al. (2012), purslane is a thermotolerant species which retains an operation photosynthetic apparatus under high temperature and high humidity due to the overexpression of heat protective proteins.

Drought stress

Water stress in crop production is associated with limited availability of irrigation water during specific time periods or at specific growth stages that are critical for achieving high yields and high quality end-products (Hussain et al., 2018). Water shortage may affect plants at different levels, namely morphology (growth and leaf area reduction), physiology (closure stomata and oxidative stress increase) and biochemistry (proline accumulation and ROS generation) (Seleiman et al., 2021). Wild plants are usually well-adapted to stressed conditions like water scarcity. Nevertheless, there are several reports stating the damages caused by drought in wild plants. For instance, reduced water supply to *Cichorium intybus* resulted in a drastic decrease in biomass, total leaf area and stomatal conductance, whereas water use efficiency and leaf soluble sugar concentration showed a significant increase (Vandoorne et al., 2012). According to Martins-Noguerol et al. (2024b), drought stress combined with increased temperatures decreased plant growth of different populations of *C. maritimum* with significant effects on both aerial and root biomass depending on the genotype. Moreover, Azeñas et al. (2019) suggested that *C. maritimum* plants can be exploited in green roofs when subjected to mild water stress (75% of field capacity), while more severe stress (50% of field capacity) reduced root growth and increased the aerial senescent biomass. Purslane is another hardy succulent species which can tolerate prolonged drought periods and easily recover when rehydrated due to multiple defensive strategies, including physiological and molecular ones (Jin et al., 2015). Similarly, Jia et al. (2018) carried out an experiment with three different wild *Sonchus* species, e.g. *S. oleraceus*, *S. wightianus*, and *S. uliginosus* subjected to drought conditions and they suggested a varied response among the species due to differences in the activity of antioxidant enzymes such as superoxide dismutase (SOD) and peroxidase (POD).

Phytoremediation

Phytoremediation (PR) is the process according to which marginal problematic soil are improved with the use of plants. This term is mostly used for the improvement of contaminated

soils, where the effort is either to (a) introduce hyperaccumulator plants with the aim to absorb high concentrations of toxic compounds from soils (phytoextraction) or (b) introduce tolerant excluder plants with the aim to stabilize toxic compounds in soil while plants are not affected (phytostabilization) (Antoniadis et al., 2017a). However, very often, phytoremediation is linked to the former process rather than the latter, and efforts are concentrated into identifying hyperaccumulators. Over the years PR has gained a lot of credit since it is a non-destructive process, as opposed to other means of soil remediation involving topsoil excavation, *ex situ* transfer in industrial units for washing and disinfection and then put back to its ecosystem. Such processes are very expensive and can only be applied to limited acreage, while their associated with dramatic aesthetic degradation of the problematic area (Antoniadis et al., 2017a). Moreover, the remediated soil returning back to its former position is the same only in terms of chemical properties and mineral composition, but otherwise it is destroyed concerning its physical properties, like structure and aggregate architecture and stability. This makes it particularly prone to degradation processes, such as erosion and desertification. On the other hand, PR is non-destructing, aesthetically pleasing, requires no energy input (the only energy needed is supplied by sun for plant photosynthesis), and can be applied to vast areas. However, there is an important disadvantage that often seems to slip from the attention of the scientific community: the time needed to be completed is enormous (Muthusaravanan et al., 2018). The reason is that hyperaccumulators are often weeds of low productivity; hence, even if high concentrations of toxic substances (e.g., heavy metals) are absorbed by plants, the net uptake (i.e., mass of absorbed substance, as a product of concentration $\times$ yield) is very low. Another issue that proves to be an obstacle towards selecting a plant species as a suitable phytoremediation species is the requirement for a rather unreasonably high root-to-shoot translocation (measured with translocation factor, $TF = \text{concentration in shoot over concentration in root}$) and soil-to-plant transfer (transfer coefficient, $TC = \text{concentration in plant over concentration in soil}$). TF is required to be higher than 1.0 and TC as high and as close to 1.0 as possible. Such requirements are not difficult to be achieved in hydroponics experiments, but they are seldom reported in experiments where plants are grown directly in soil, either in pot or open field tests.

Various WEPs have been used over the years as potential species for phytoremediation of soils contaminate with potentially toxic elements (PTEs, also known referred to as “heavy metals”) (Bacchetta et al., 2016). Antoniadis et al. (2017b) suggested the use of spiny chicory (*C. spinosum*) for the remediation of a soil spiked with 100 mg/kg of the highly toxic Cr(VI). These authors found that plants absorbed up to 250 mg/kg Cr(VI), and although various toxicity symptoms were evident to physiological functions and plant growth, it was calculated that the time needed to halve the initial added Cr(VI) concentration would be 481 cycles of harvests. Pietrelli et al. (2022) also tested another *Cichorium* species (*C. intybus*), among many others, and found that Cr exhibited the

higher TC value among all other studied metals, i.e., 0.6, while TF was lower than 1.0. Moreover, Bursztyn Fuentes et al. (2018) evaluated the potential of using *C. intybus* to remediate a contaminated dredged sediment enriched with Cr (1010), Zn (1023), and Pb (488 mg/kg) and amended with mobilizing agents (like EDTA, citric acids) and they suggested that the Cr TC was 1.2 and TF 3.1. The time needed to reduce Cr levels down to the agricultural limits was 17 years, while the time needed for Zn and Pb was 103 and 81 years, respectively.

Another wild species tested for soil phytoremediation was purslane (*P. oleracea*). Thalassinos et al. (2021) spiked a pristine soil with 150 mg/kg Cr(VI) and reported a concentration of 4 mg/kg in the aerial parts of purslane plants, while roots had a content of up to 600 mg/kg. Reporting on the same experiment, Thalassinos et al. (2022) calculated a TC of 0.025 and TF of 0.01, while the time needed to absorb all added Cr(VI) was equal to 405 harvest cycles. Hammami et al. (2016) cultivated purslane in a soil spiked with up to 80 mg/kg Cd and they recorded 16.3 mg/kg in shoot and 44.1 mg/kg in root, with TC=0.76 and TF=0.37. Moreover, Thalassinos et al. (2023) tested purslane in Pb-contaminated soil (spiked with up to 900 mg/kg Pb) and they suggested a concentration of up to 1300 mg/kg in roots, while in the aerial biomass the concentration of Pb was ca. 130 mg/kg, with TC and TF values in the range of 0.1 to 0.2. In the same study, the time needed to halve the initial added Pb was 131 harvests. Moreover, Antoniadis et al. (2021) tested three WEPs, e.g. *Silene vulgaris* (bladder campion), *Artemisia vulgaris* (mugwort), and *Urtica dioica* (common nettle) in a soil already contaminated (i.e., not spiked) with a variety of PTEs, among which Cd at 9 mg/kg and Zn at 880 mg/kg. These authors found that Cd TF for *A. vulgaris* was 1.5, while that of *S. vulgaris* was 2.3; TC for Cd was 7 for *A. vulgaris*, 2.5 for *S. vulgaris*, and only 0.5 for *U. dioica*; the time needed to halve the current PTE concentrations was only 8 harvests of *A. vulgaris* for Cd and 104 for Zn, while that of *S. vulgaris* was 71 for Cd and 347 for Zn; and for *U. dioica* was 125 for Cd and 644 for Zn. On the other hand, in many reports WEPs have been tested to phytostabilize soil PTEs. For example, Han et al. (2022) added wheat straw biochar in a soil spiked with up to 10 mg/kg Cd, and found a concentration of 30 mg/kg in the aerial parts of purslane, which was reduced to half in the amended soil at 5% biochar. Also, Zanganeh et al. (2022) cultivated purslane in a soil with Cr(VI)=13 and Zn=104 mg/kg and added with wood biochar at concentrations up to 5% in and they found that the concentrations of both metals decreased significantly, and so did TC and TF, which were found well below 1.0.

Cultivation of wild edible plants is also associated with soil improving properties that could be valorized for arable land reclamation, as well as for the increase of yield and quality parameters of conventional crops. In this context, Hassan et al. (2018) incorporated dried aerial parts of *S. oleraceus* in the soil at two rates (150 and 300 g/m²) and recorded a significant increase in the quality and yield parameters of *Phaseolus vulgaris* L. plants when supplemented at the highest rate due to better availability of N and P and the increase in total phenolic compounds and the organic carbon and organic matter content.

Future remarks and conclusions

Nowadays, there is a tug of war between food security and increasing world population on the one hand and climate change and agricultural land loss on the other hand. Extreme changes in climate conditions are more and more evident by the farmers as they present devastating effects on crop production in terms of yield loss, land degradation, increased agricultural inputs and limited availability of irrigation water. It is of paramount importance to turn our interest at new complementary/alternative solutions for a modern sustainable agriculture. These species display a remarkable potential to be exploited as novel crops since they present a wide range of adaptability to different soil types, low demands for agrochemical inputs and tolerance to biotic and abiotic factors. Another perspective arises from the global market trends for novel healthy and functional foods, while the high nutritional value, rich content in phytochemicals and bioactive compounds have attracted the intention of pharmaceutical and nutraceutical industries for the design/production of new products.

In this context, the valorization of wild edible species through their integration in farming systems is a sustainable solution to overcome the challenges that modern agriculture has to face. Considering the vast number of species that could be valorized for food purposes and the existing information from ethnobotanical surveys which highlight the recorded uses for such species over the centuries, further research is needed to support the safe use of traditional and new species, as well to establish protocols regarding the growing conditions required for commercial cultivation. Moreover, the great variability among the ecotypes within the same species in terms of growth parameters and chemical profile point out the high potential for selection of elite genotypes that could be used in breeding programs aiming to improve yield parameters, the nutritional profile of the edible parts and the bioactive compounds content of health beneficial phytochemicals.

However, the valorization of wild edible species requires multiple steps to be followed in the near future. Firstly, there is scarce literature regarding the seed germination of wild edible plants and the wide inter- and intra-species variation in germination rates and environmental requirements, which necessitates further research to be conducted to establish germination protocols that will make feasible the successful establishment of commercial cropping of such species. Moreover, future research should focus on the evaluation of agronomic practices such as intercropping and crop rotation schemes, irrigation regimes, biostimulant application and fertilization regimes, as well as the application of various cropping systems aiming to standardize the cultivation protocols required for the cropping of these species under commercial conditions. Another aspect to be considered is the integration of such species in breeding programs to make easily available and affordable to farmers the propagational material needed for crop establishment, while techniques such as *in vitro* propagation and micropagation could be useful tools, especially for those species that exhibit low germination rates.

In conclusion, wild edible species are a valuable material that has to be exploited for the alleviation of climate change effects on crop production and the environment through their integration in small-scale farming systems, especially in arid and semi-arid region of the world where the impact on food security and the environment is imminent.

Author contributions

NP: Writing – original draft, Writing – review & editing. VL: Writing – original draft, Writing – review & editing. VA: Writing – original draft, Writing – review & editing. PG: Writing – original draft, Writing – review & editing. AA: Visualization, Writing – original draft, Writing – review & editing. SP: Conceptualization, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing.

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