Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2021, 11(9), 1-5, doi: 10.15421/2021_286

ORIGINAL ARTICLE

Evaluation of the success and prospects of introduction for cultivation of medicinal aromatic Asteraceae plants in central Pollysia (Ukraine)

I.V. Ivashchenko[1*], D.B. Rakhmetov[2], L.A. Kotyuk[1], O.A. Sayuk[1]

[1]*Polissia National University, Staryi Boulevard 7, Zhytomyr, 10008, Ukraine*

[2]*M.M. Gryshko National Botanical Garden of the NAS of Ukraine, Timiryazevska St, 1, Kyiv, 01014, Ukraine*

**Corresponding author E-mail: kalateja@ukr.net*

Received: 01.10.2021. Accepted: 10.11.2021.

The objective of the research is to assess the success of the introduction was and to determine the prospects for the cultivation of the Asteraceae family rare medicinal and aromatic species of the Asteraceae family, under conditions of Central Polissia in Ukraine. Introduction research was carried out during 2013-2021 in the Botanical Gardens of Polissia National University using laboratory, field and introduction methods. The studies of annual and perennial species of the Asteraceae family Asteraceae allowed achieving a comprehensive assessment of biological, ecological and productive potential of the plants. The research also revealed the seasonal rhythms of growth, development, and stability of plants, peculiarities of their reproduction, and helped to evaluate the success of the introduction success and prospects for the cultivation of new aromatic and medicinal plants from the Asteraceae family in conditions of Central Polissia of Ukraine. According to a comprehensive assessment of the success of the introduction success of the Asteracae family in Central Polissia, highly promising perennial and annual species belong: *Serratula coronata* L., *Artemisia austriaca* Jacq., *Artemisia abrotanum* L. (form 1), *Helenium aromaticum* (Hook.) Bailey, L.H. Bailey, *Glebionis coronaria* var. *discolor* (d'Urv.) Turland, *G. coronaria* var*. coronaria.* The following species are evaluated as promising: *Artemisia dracunculus* L. (forms 1, 2, 3), *Artemisia abrotanum* L. (form 2), *Artemisia maritima* L., *Tanacetum balsamita* var. *balsamitoides* (Sch. Bip.) P. D. Sell., *T. balsamita* var. *tanacetoides.* The collection of medicinal and aromatic plants introduced, created in the Botanical Gardens of Polissia National University, proves to be a source of considerable importance for further introduction and selective breeding work.

Keywords: Aromatic plants, Asteraceae*,* Efficiency of introduction, Central Polissia of Ukraine.

Introduction

Natural flora bears an enormous anthropogenic burden, so the issue of conservation and enrichment of the plant gene pool is currently relevant and urgent (Cherevchenko et al., 2012; Richardson and Pyek, 2012). In this sense, the introduction and selective breeding of plants play an essential role (Vasilieva et al., 2017). Plant introduction is an important factor in the enrichment of plant resources, in general, as well as in increasing the biotic diversity of phytocenoses from crops, in particular (Cherevchenko et al., 2012; Makhanova and Makhanova, 2016). Therefore, one of the main tasks is to introduce species that have high economic value and are characterized by considerable adaptability together with broad ecological plasticity (Rakhmetov, 2011; Yarmyshko, 2018). Quite promising in this regard are members of the family Asteraceae or Compositae distributed on all continents except Antarctica (The Plant List, 2013). The family includes more than 30,000 species, which belong to almost 2,000 genera. The flora of Ukraine contains 695 of these species that belong to 121 genera. However, the natural reserves in wild plants of the family are limited, so introduction and cultivation of valuable species will enrich the biodiversity of Ukrainian flora. A collection of medicinal and aromatic plants of the Asteraceae family has been created in the Botanical Gardens of Polissia National University where complex introduction and biological and ecological studies are carried out. They focus on seasonal rhythms of plant growth and development, dynamics of production processes, accumulation of secondary metabolites, and an estimation of the general productive potential of plants (Ivashchenko and Rakhmetov, 2016; Ivashchenko, 2017, 2018; Ivashchenko, Kotyuk, and Bakalova, 2020). A growing body of empirical evidence indicates that its use in pharmacy, cosmetology, food industry is highly promising (Wan et al., 2017; Fildan et al., 2019; Manfrinato, Canella, Ardenghi, and Guzzon, 2019; Omer et al., 2016; Kandilarov et al., 2018). To introduce the most promising species under the conditions of a region, it is important to assess how successful the process of introduction has been. The success of introduction is determined by the adaptive capacity of introduced plants, their ability to undergo all stages of individual and seasonal development, to reproduce, to remain stable and hardy under new growing conditions (Klimenko, 2012; Vasilieva, 2016).

The objective of the research is to assess the success of the introduction was and to determine the prospects for the cultivation of the Asteraceae family rare medicinal and aromatic species of the Asteraceae family, under conditions of Central Polissia of Ukraine.

Materials and Methods

The introduction studies of the medicinal and aromatic species of the Asteraceae family were carried out during 2013-2021 in the experimental plots of the Polissia National University Botanical Gardens, which belong to the Central Polissia region of Ukraine. The soil of the botanical gardens is sod-carbonate. The humus content (according to Tyurin) constituted 2.39 ± 0.01%, the pH salt solution of the humus horizon was 7.2 ± 0.10; the P_2O_5 content amounted to 332.67 ± 18.87 mg/kg; K_2O ranged within 128.67 ± 26.9 mg/kg (according to Kirsanov), the Nk content (according to Cornfield) was 63.0 ± 10.1 mg/kg of soil. The ecological conditions of the botanical garden area are typical of Central Polissia of Ukraine, its temperate continental climate being generally favorable for the cultivation of various plant species.

The source of seeds and planting material was a collection from spicy-aromatic plants of the Department of Cultural Flora of the M.M. Gryshko National Botanical Gardens (NBS) of the National Academy of Sciences of Ukraine and the Botanical Gardens of I. Franko Lviv National University and through delectus exchange from other botanical gardens of Eurasia. The subject of the investigation was represented by 8 species of plants in the Asteraceae family plants: annuals-*Helenium aromaticum* (Hook.) Bailey (pineapple sneezeweed); *Glebionis coronaria* (L.) Cass. ex Spach. (crowned chrysanthemum) of 2 varieties: *G. coronaria* var. *discoloration* (d'Urv.) and *G. coronaria* var. *coronaria*; and perennials-*Serratula coronata* L.; *Artemisia dracunculus* L. (tarragon wormwood), 3 forms; *Artemisia austriaca* Jacq. (Austrian wormwood); *Artemisia abrotanum* L. (wormwood), 2 forms; *Artemisia maritima* L. (sea wormwood); *Tanacetum balsamita* L. (large tansy), 2 varieties: *T. balsamita* var. *balsamitoides* (Sch.Bip.) P. D. Sell and *T. balsamita* var. *tanacetoides* Boiss.

In the process of cultivation of introduced perennials we evaluated their viability and success of introduction according to Bylov and Karpisonova (1978), taking into account their ability to the seed and vegetative propagation, a general condition of plants, winter hardiness, resistance to diseases and pests. Each of the parameters was evaluated on a 3-point scale with a maximum positive score of 3 points.

Ability to seed propagation

1. Point-lack of viable seeds (plants did not bloom; if they bloomed, they did not set fruits; seeds did not ripen)
2. Points-limited seed productivity
3. Points-high seed productivity

Ability to vegetative propagation

1. Point-ineffective or absent
2. Points-satisfactory
3. Points-the plants demonstrated an impressive ability to vegetative propagation

General condition of plants

1. Point-the development of plants was unsatisfactory, with insufficient flowering, flowers did not reach their proper size
2. Points-the plants did not differ from the natural ones in terms of habit and bloomed profusely
3. Points-the habit was superior to natural plants, and the introduced plants bloomed more profusely than their natural counterparts

Resistance of plants to diseases and pests

1. Point-suffered significant damage
2. Points-only partial damage
3. Points-were undamaged

Condition of plants after winter

1. Point-unsatisfactory, there was a significant elimination of individuals
2. Points-on average, the number of individuals decreased
3. Points-excellent, complete preservation

The success of species introduction was determined by an overall assessment of viability, i.e., species that are low promising for cultivation ranged between 5 and 8 points, promising-9-12 points, highly promising -13-15 points (Bylov and Karpisonova, 1978).

To assess the success of annual introduction, we modified the above scale, taking into account the ability of plants to propagate seeds, a general condition of plants, resistance to diseases and pests : 8-9 points-highly promising species, 6-7 points-promising, 3-5 points-unpromising. Due to the biological characteristics of annuals, we did not consider indicators such indicators as the ability to vegetative propagate and winter hardiness, which is consistent with the recommendations of Vasfilova (2016).

Assessment of the introduction stability of plants was carried out according to Trulevich (1991), who distinguishes 4 groups : I-unstable plants; II-weakly stable, III-stable; IV-highly stable. Unstable plants (I) do not go through a full annual cycle of shoot development, their rhythmic processes being disrupted, and vitality deteriorating from year to year; they often die in the early stages of ontogenesis (if obtained from seeds) or within the first years after planting (if transplanted).

Weakly stable plants (II) undergo an irregular annual cycle of shoot development; their vitality being weaker in comparison with plants of natural habitats; their life form often changes significantly; plants do not reproduce on their own; the rate of ontogenesis more often accelerates or, less often, slows down.

Stable plants (III) undergo a full cycle of shoot development; their rhythmic processes are stable and different from the natural ones only by some calendar rescheduling, adapted to the local climatic conditions; the vitality of the plants vitality is high. In terms of productivity and size, introduced plants correspond to the natural ones or even exceed them; their life form remains intact, the

rate of ontogenesis being normal or slightly accelerated; plants do not reproduce on their own not forming self-seeding, but successfully do so "artificially".

Highly stable plants (IV) undergo a full annual cycle of shoot development, and they are characterized by stability of rhythmic processes and adaptation to the local climatic and weather conditions. The vitality of these plants is high; their productivity and size correspond to those of the natural ones and more often essentially exceed them; their life form remains intact, the rate of ontogenesis being natural; plants propagate intensively by self-seeding and are capable of self-renewal and expansion of the occupied area.

Results and Discussion

Table 1 provides an assessment of vitality that characterizes the success of the introduction of perennials from the Asteraceae family perennials. The group of highly promising species (13-15 points) includes *S. coronata*, *A. austriaca, and A. abrotanum* (form 1). These species outnumbered natural plants, bloomed more actively than the latter, recovered well after overwintering, suffered only slight damage from diseases and pests, effectively propagated vegetatively by rhizome division and rooting of shoots (*A. abrotanum* (form 1). *S. coronata* demonstrated the best ability to propagate seeds (3 points). According to this criterion, *A. austriaca* and *A. abrotanum* (form 1) were evaluated with 1 and 2 points, respectively (Table 1). *S. coronata* and *A. abrotanum* (form 1) were replanted by self-seeding, while *A. austriaca* was able to expand the area it occupied by vegetative propagation.

A. dracunculus (forms 1, 2, 3), *A. abrotanum* (form 2), *A. maritima*, *T. balsamita* var. *balsamitoides*, *T. balsamita* var. *Tanacetoides* were evaluated as promising species (9-12 points). They did not reach the highest level of introduction success for several reasons: unsatisfactory generative reproduction (*T. balsamita* var. *tanacetoides*, *A. maritima*, *A. abrotanum* (form 2), *A. dracunculus*), inadequate resistance to diseases (*T. balsamita* var. *tanacetoides*, *T. balsamita* var*. balsamitoides*). Two introduced species of *T. balsamita* var. *balsamitoides* and *T. balsamita* var. *Tanacetoides* differed in seed propagation, general condition of plants, and resistance to diseases due to their biochemical composition (I. Ivashchenko, O. Ivashchenko, and Rakhmetov, 2015). The success of *T. balsamita* var. *balsamitoides* rated 12 points; *T. balsamita* var*. tanacetoides*-9 points.

Table 1. Evaluation of the success of the asteraceae family under conditions of central Polissya of Ukraine.

	Assessment, points						
Species, variety, and form of the plant	**Seed propagation**	**Vegetative propagation**	**General plants condition**	**Resistance to diseases, pests**	**Condition after overwintering**	**Overall viability assessment**	**Introduction success***
Serratula coronata	3	3	3	2	2	13	HP
Artemisia dracunculus (form 1)	1	3	3	2	3	12	P
Artemisia dracunculus (form 2)	1	3	3	2	3	12	P
Artemisia dracunculus (f orm 3)	1	3	3	2	3	12	P
Artemisia austriaca	1	3	3	3	3	13	HP
Artemisia abrotanum (form 1)	2	3	3	3	3	14	HP
Artemisia abrotanum (form 2)	1	3	3	2	3	12	P
Artemisia mari tima	1	2	3	3	3	12	P
Tanacetum balsamita var. *balsamitoides*	2	3	3	1	3	12	P
Tanacetum balsamita var. *tanacetoi des*	1	3	1	1	3	9	P

*HP-Highly Promising Species, P-Promising, UP-Unpromising.

The introduced annuals (*H. aromaticum, G. coronaria* var. *discoloration* and *G. coronaria* var*. coronaria*) were evaluated as highly promising (8-9 points) (Table 2) due to their properties: high seed productivity, self-seeding ability, natural plants that are excellent in habit, active blooming, and strong resistance to pathogens.

Table 2. Evaluation of the success of the asteraceae family under conditions of central Polissya of Ukraine.

Species, variety, and form of the plant	**Assessment, points**			**Overall vitality assessment**	**Introduction success***
	Seed propagation	**General plants condition**	**Resistance to diseases, pests**		
Glebionis coronaria var. *discolor*	3	3	2	8	HP
Glebionis coronaria var*. coronaria*	3	3	2	8	HP
Helenium aromaticum	3	3	3	9	HP

*HP-Highly Promising Species, P-Promising, UP-Unpromising.

Trulevich (1991) suggested determining the introduced plants stability under new agroclimatic conditions according to the following criteria: invariance of natural rhythmic processes; ability to go through a full cycle of shoot development; ability to reproduce; ability to maintain natural life form, high vitality, and ability to maintain natural rate of ontogenesis (Trulevich, 1991). Based on these criteria, Trulevich (1991) developed a scale of introduction stability, which is an integral indicator of biological adaptation of plants to new living conditions. Causes of plant instability are diverse and numerous; it is often impossible to determine their individual impacts, so the concept of biological stability allows us to give them an integrated assessment (Trulevich, 1991). Assessment of the introduction stability of perennials from the Asteraceae family perennials shows that two species are highly stable. *S. coronata, A. abrotanum* (form 1). Eight species are estimated as stable: *A. dracunculus* (form 1, 2, 3), *A. abrotanum* (form 2), *A. maritima*, *T. balsamita* var. *balsamitoides*, *T. balsamita* var. *tanacetoides*, *A. austriaca* (Table 3). Among annuals, *H. aromaticum, G. coronaria* var. *discoloration, G. coronaria* var. *coronaria* are classified as highly stable.

Table 3. Stability of the introduction of the asteraceae family species in central Polissia of Ukraine (according to Trulevich (1991).

Stability Group			
I	**II**	**III**	**IV**
Unstable	**Weakly Stable**	**Stable**	**Highly Stable**
		Annual species	
			Helenium aromaticum
			Glebionis coronaria var. *discolor*
			Glebionis coronaria var*. coronaria*
		Perennial species	
		Artemisia dracunculus	*Serratula coronata*
		Artemisiaabrotanum (form 2)	*Artemisia abrotanum* (form 1)
		Artemisia maritima	
		Tanacetumbalsamita var. *balsamitoides*	
		Tanacetum balsamita var. *tanacetoides*	
		Artemisia austriaca	

Conclusion

According to a comprehensive assessment of the success of the introduction success of the Asteracae family in Central Polissia, highly promising perennial and annual species belong: *S. coronata, A. austriaca*, *A. abrotanum* (form 1), *H. aromaticum, G. coronaria* var. *discoloration*, *G. coronaria* var*. coronaria.* The following species are evaluated as promising: *A. dracunculus* (forms 1, 2, 3), *A. abrotanum* (form 2), *A. maritima*, *T. balsamita* var. *balsamitoides*, *T. balsamita* var. *tanacetoides.*

Assessment of the plant introduction stability showed that the following introduced species proved highly stable: *S. coronata, A. abrotanum* (form 1), *H. aromaticum, G. coronaria* var. *discoloration, G. coronaria* var*. coronaria* and *A. dracunculus* (forms 1, 2, 3), *A. abrotanum* (form 2), *A. maritima, T. balsamita* var. *balsamitoides, T. balsamita* var. *tanacetoides and A. austriaca* were evaluated as stable.

Thus, under the conditions of the Central Polissia of Ukraine, all the investigated species, varieties, forms of plants are estimated to be promising and highly promising, stable and highly stable. Their ability to grow, to develop, to go through the generative phase of development, and to reproduce, indicates that a complex interaction of biotic and abiotic factors appears quite favourable.

The collection of medicinal and aromatic plants introduced, created in the Botanical Gardens of Polissia National University, proves to be a source of considerable importance for further introduction and selective breeding work to enrich the regional phytodiversity of cultural flora with valuable and useful plants.

References

Bylov, V.N., Karpisonova, A.A. (1978). Methods of studying the biological and economic properties of promising species. Bulletin Main Botanical Garden, 107:77-82 (in Russian).

Cherevchenko, T.M., Rahmetov, D.B., Gaponenko, M.V., Andrukh, N.A., Buyun, L.I. (2012). Conservation and enrichment of plant resources through introduction, selective plant breeding and biotechnology. Kyiv: Fitosotsiosentr (in Ukrainian).

Fildan, A.P., Pet, I., Stoin, D., Bujanca, G., Lukinich-Gruia, A.T., Jianu, C., Tofolean, D.E. (2019). Artemisia dracunculus essential oil chemical composition and antioxidant properties. Revista de Chimie, 70:59-62.

Ivashchenko, I.V., Ivashchenko, O.A., Rakhmetov, D.B. (2015). The essential oils composition of Tanacetum balsamita var. tanacetoides Boiss. and Tanacetum balsamita var. balsamitoides (Sch. Bip) P.D. Sell under the Condition of their introduction in the Ukrainian Polissya. Agrobiodiversity for improving nutrition, health and life quality Part I. Nitra: Slovak University of Agriculture in Nitra, pp:293-297.

Ivashchenko, I.V., Rakhmetov, D.B. (2016). Biomorphological features of Serratula coronata L. (Asteraceae) under conditions of introduction in the botanical gardens of ZhNAEU. Modern Phytomorphology, 10:71-82.

Ivashchenko, I.V. (2017). Chemical composition of essential oil and antimicrobial properties of Chrysantemum coronarium (Asteraceae). Biosistems Diversity, 25:119-123.

Ivashchenko, I.V. (2018). Biomorphological peculiarities of Glebionis coronaria (Asteraceae) introduced in Ukrainian Polissya. Modern Phytomorphology, 12:59-71.

Ivashchenko, I., Kotyuk, L., Bakalova, A. (2020). Morphology and productivity of tarragon (Artemisia dracunculus L.) in Central Polissya (Ukraine). Ukrainian Journal of Ecology, 10:48-55.

Kandilarov, I.K, Zlatanova, H.I, Georgieva-Kotetarova, M.T, Kostadinova, I.I, Katsarova, M.N, Dimitrova, S.Z, Lukanov, L.K, Sadakov, F. (2018). Antidepressant effect and recognition memory improvement of two novel plant extract combinations-antistress I and antistress II on rats subjected to a model of mild chronic stress. Folia Med (Plovdiv), 60:110-116.

Klimenko, O.L. (2012). Introduction studies of species of the genus Grindelia Willd. under conditions of Forest-Steppe of Ukraine. Bulletin of the Biosphere Reserve Askania-Nova, 14:147-151 (in Ukrainian).

Makhanova, G.S., Makhanova, R.S. (2016). Questions of introduction of essential oil plants. Scientific Almanac, 1:42-48 (in Russian).

Manfrinato, C., Canella, M., Ardenghi, N.M.G., Guzzon, F. (2019). Traditional use of tarragon/pèrschtròmm (Artemisia dracunculus L., Asteraceae) in the linguistic island of Sappada/Plodn (European Alps, northern Italy). Ethnobotany Research and Applications, [S. l.], 18:1-9.

Yarmishko, V.T. (2018). Modern problems of plant introduction. Collection of Scientific Works of State Nikitsky Botanical Garden, 147:89-91 (in Russian).

Omer, E.A., Hendawy, S.F., Abou Hussein, E.A., El Gendy, A.G., Ezz El-din, Azza A. (2016). Introduction of Artemisia species into the Egyptian cultivation. Journal of Essential Oil Bearing Plants, 19:793-805.

Rakhmetov, D.B. (2011). Theoretical and applied aspects of plant introduction in Ukraine. Kyiv: Agrar Media Group. (in Ukrainian).

Richardson, D.M., Pyŝek, P. (2012). Naturalization of introduced plants: ecological drivers of biogeographical patterns. Phytologist, 196:383-396.

Plant List. (2013). Version 1.1. Published on the Internet; http://www.theplantlist.org/

Trulevich, N.V. (1991). Ecological and phytocenotic bases of plant introduction. Moscow: Nauka (in Russian).

Wan, C., Li, S., Liu, L., Chen, C., Fan, S. (2017). Caffeoylquinic acids from the aerial parts of Chrysanthemum coronarium L. Plants, 6:1-7.

Vasfilova, E.S. (2016). Introduction prospects of medicinal plants species in connection with accumulation of biologically active compounds. VSU Bulletin Ser Chemistry Biology Pharmacy, 4:42-48 (in Russian).

Vasilieva, O.Yu. (2016). Study of ontomorphogenesis and reproductive biology of introduced plants. Biological Diversity. Introduction of plants. Proceedings, pp:315-316 (in Russian).

Vasilieva, O.Yu., Zuyeva, G.A., Buglova, L.V., Sarlayeva, I.Ya., Ak-Lama, T.A., Lezin, M.S., Cheremysina, A.V. (2017). The role of biomorphological studies in the introduction of economically useful plants in the continental climate. Bulletin of the Botanical Garden-Institute of the Far Eastern Branch of the Russian Academy of Sciences, 18:73-79 (in Russian).

Citation:

Ivashchenko, I.V., Rakhmetov, D.B., Kotyuk, L.A., Sayuk, O.A. (2021). Evaluation of the success and prospects of introduction for cultivation of medicinal aromatic Asteraceae plants in central Pollysia (Ukraine). *Ukrainian Journal of Ecology* 11 (9), 1-5.