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SOME PROSPECTS OF GROWING AND USE OF CHINA ASTER FOR SPACE GREENING IN PODILLIA ZONE

Annual aster, also called China aster (*Callistephus chinensis* (L.) Nees) is one of the priority ornamental flower plants for the introduction both in Ukraine and throughout the world. Domestic and foreign scientists are diverse in the study of this plant. Most of the works published during the last decades are devoted to the study and search for the most favorable agrotechnical techniques for aster cultivation under different conditions. The research was being carried out during 2016-2017 on the territory of the Bio-stationary of Vinnytsia National Agrarian University with partial subsequent data processing at Bila Tserkva National Agrarian University. The purpose of the study was to identify the most adapted and resistant samples among the collection cultivars of China aster for their further breeding and greening of various objects of Vinnytsia region. The methods of field and laboratory research were applied in accordance with the basic methodological requirements. The prospects of growing cultivars of China aster (*Callistephus chinensis*) in the green space of Vinnytsia region were analyzed. The demand for new cultivars of different groups of annual aster in ornamental gardening and the need to develop decorative cultivars resistant to diseases and adapted to the environment was proved. For the first time, biomorphological features of Chinese asters (*Callistephus chinensis*), methods of reproduction and the most promising cultivars for their growing under conditions of Vinnytsia region and their further use in landscaping of various objects were investigated. A collection of cultivars of different groups of Chinese aster on the territory of the collection site of Vinnytsia National Agrarian University was produced and unified. Due to high ornamental qualities, economic and biological qualities of the studied cultivars, all of them are evaluated as well adapted to the edaphic and climatic conditions of Podillya and they are recommended as objects intended for the replenishment of the assortment of plants for greening, collection and exhibition funds as well as breeding activities. A diversity of colours and forms of inflorescence, various shapes and height of the bush enable to use China aster widely in the single linear plantations, group plantations, for the arrangement of mixborders and plant beds, on the rocky landscapes and borders, to create groups and flower beds.

Keywords: *Callistephus chinensis*; biomorphological features; introduction; flowering period; decorative qualities; cultivars.

Introduction. Annual aster, also called China aster (*Callistephus chinensis* (L.) Nees) is one of the priority ornamental flower plants for the introduction both in Ukraine and throughout the world (Anonymous, 2014; Bhargav et al., 2016; Chaitra, & Patil, 2007; Chowdhuri et al., 2016; Dilt, Gupta, & Sharma, 2007).

China aster belongs to the Asteraceae family, the subfamily Tubuliflorae, the genus *Callistephus* Cass., which includes over 40 groups or cultivar types. Under natural conditions, *C. chinensis* is common in the Eastern and Northern China, Japan, southern Far East, Russia and the northern part of the Korean Peninsula. It grows in natural conditions, mainly in the mountains on the rocky slopes and stony scatterings. Today, the world collection includes more than 4000 cultivars (Levandovska & Oleshko, 2014).

For the first time, China aster seed was imported to Europe from China in 1728. France is considered to be the

first breeding center for China aster, where a cultivar with the double inflorescence was produced in 1750. Over the past decade, French breeders have produced a magnificent Riviera Garden Group, which belongs to Holchsta variety type, cultivars of Duchess variety type as well as a series of cultivars of Miledi variety type (Syrov, 1991).

In 1752, this plant was brought to England from France. By the end of the XVIII century, English breeders had produced a large number of cultivars with blue, purple and pink calathiums (Tavlinova, 2001).

From the 19th century, China Aster Breeding Center moved to Germany. And it was the German gardeners who played a crucial role in the formation of the world assortment of China aster. It should be noted that among 44 variety types that are known today, 20 of them have been produced by the German breeders, e.g. Straw Pen, Comet, Queen of the Market, Royal Dwarfs, Liliput, Petio and

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others. As an industrial crop, this plant has become widespread only since 1980 (Levandovska & Oleshko, 2014).

In the US, the breeding of China aster was initiated in the late 19th and early 20th centuries. Cultivars of Princess variety type was first produced by the American gardeners in 1949 (Levandovska & Oleshko, 2014).

In 1975, a group of dwarf cultivars of Pinocchio variety type was developed and distributed in Holland. The originators from Sweden have replenished the world's assortment with the new variety type called Madelin. 18 promising cultivars for industrial cultivation were obtained as a result of a thorough and long-term work of Polish breeders. In 1923, for the first time, Russian scholars started breeding of annual aster. Moldova has been engaged in the breeding of China aster since 1967 (Levandovska & Oleshko, 2014).

By the beginning of the second half of the 20th century, in Ukraine, the cultivars of mainly foreign origin had been cultivated. Although the breeding work with China aster began in the country not so long time ago, Ukrainian breeders have already produced a number of new cultivars that are not inferior to the world standards and are more adapted to the edapho-climatic conditions of Ukraine (Levandovska & Oleshko, 2014).

The first researches on the breeding of this plant were initiated in the National Botanical Garden named after M. M. Hryshko of the National Academy of Sciences of Ukraine, where the largest collection of China aster is gathered and comprised of 164 cultivars ('Aniuotochka', 'Veresneva', 'Zhemchug', 'Leleka', 'Kiev waltz', 'Varia' and many others) belonging to 27 variety types.

Domestic and foreign scientists are diverse in the study of this plant. Most of the works published during the last decades are devoted to the study and search for the most favorable agrotechnical techniques for aster cultivation under different conditions (Khangjarakpam et al., 2014; Munikrishnappa et al., 2013; Navalinskien, Samuitien, Jomantiene, 2005; Pandey & Rao, 2014; Patil, 1990; Pratiksha et al., 2017).

The scientists argue that the data, which presents the features of growth and development of China aster, the level of productivity of various cultivars, their respond to a specific set of weather and climatic conditions, can be rarely found in the literature, and there are no studies on these issues under the conditions of Podillia region. Therefore, they are of great relevance for the effective breeding of cultivars resistant to specific natural conditions of cultivation, preservation of the gene pool and expansion of the assortment of ornamental flower plants in modern landscaping (Doddagoudar, Vyakarnahal & Shekargouda, 2004; Levandovska, 2010; Rai & Chaudhary, 2016; Reddy & Sulladmath, 1983; Vashchenko, Lange & Merkulov, 1982).

Thanks to simplicity of the growing conditions, diversity of colors in cultivars, unusual form and duration of plant flowering, asters are widely grown on the private plots, in the parks, squares, and in pot culture and they are actively used in phyto- and flora interior design (Alekseeva, 2006; Alekseeva, Cherniak & Levandovska, 2008; Kozevnikov, 2002).

The study of the history of origin, assortment of this plant is of great significance for further introduction and replenishment of the collection fund of China aster (*C. chinensis*) in the territory of Vinnytsia region.

Materials and methods. The research was carried out during 2016–2017 on the territory of the Bio-stationary of

Vinnytsia National Agrarian University with partial subsequent data processing at Bila Tserkva National Agrarian University.

The object of the research was the species of China aster with its cultivars that are the most ornamental and resistant to diseases and pests under conditions of Vinnytsia region and the bio-stationary of VNAU.

The aim of the study was to identify the most adapted and resistant samples among the collection cultivars of China aster for their further breeding and greening of various objects of Vinnytsia region.

The methods of field and laboratory research were applied in accordance with the basic methodological requirements by B. A. Dospekhov. The scheme of sowing was small site and drilled, site location was randomized (Vashchenko, Lange & Merkulov, 1982).

Results. The terms and sequence of flowering depend on the biological characteristics of cultivars and climatic conditions (Zosiamliana, Reddy & Rymbai, 2013). Having analyzed the terms of sowing, germination and flowering of the studied cultivars of China aster, a calendar of plant flowering was formed (Figure 1).

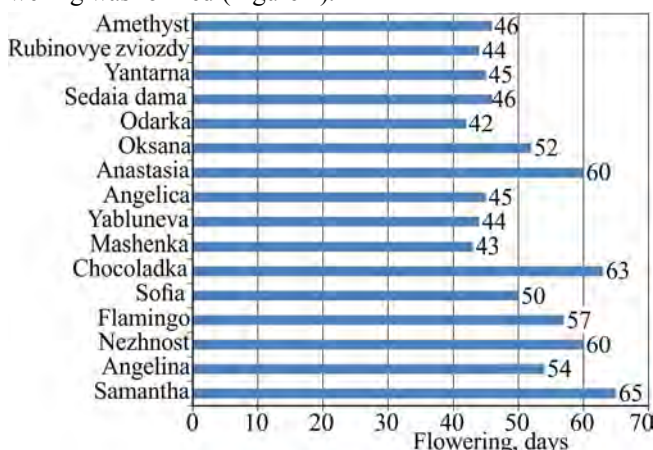


Fig. 1. Duration of flowering of the studied cultivars of China aster

Analysis of duration of flowering have shown that on average in 2016–2017, 'Odarka' cultivar has the minimum index of 42 days, while 'Chocolate' and 'Samantha' had the maximum indices of 63 and 65 days, respectively.

By the duration of the interphase period of vegetation from the beginning of flowering to the complete loss of ornamental, the cultivars of aster were divided into 3 groups, namely early, middle and late. 'Amethyst' cultivar is considered to be early with the duration of the period of "germination – mass flowering" lasting for 120–130 days. Such cultivars as 'Odarka', 'Oksana', 'Anastasia', 'Angelica', 'Yabluneva', 'Sedaia dama', 'Samantha' have a middle interphase period of 131–145 days. Such cultivars as 'Mashenka', 'Chocoladka', 'Sofia', 'Flamingo', 'Nezhnost' and 'Angelina' were attributed to the group of the late interphase period (146–160 days).

The vast majority of the studied cultivars of annual asters had a flowering period similar to the standard one, which indicates favorable weather conditions as well as properly selected and applied cropping practices (seeding, transplanting, nutrition, watering, weed and pest control).

In the course of the conducted research, it was established that under conditions of the bio-stationary of VNAU the introduced cultivars of the annual aster (*C. shenensis*) showed high fruit bearing results. This indicator varies within 2.0–5.0 g/bush. The results are presented in Table 1.

Table 1. Seed productivity of China aster cultivars (2016–2017)

Name of the cultivar	Seed productivity, g/bush	Name of the cultivar	Seed productivity, g/bush
Amethyst	5.0	Yabluneva	3.5
Rubinovyе zviozdy	3.5	Mashenka	2.0
Yantarna	3.0	Chocoladka	3.5
Sedaia dama	3.5	Sofia	3.0
Odarka	4.5	Flamingo	3.5
Oksana	2.5	Nezhnost	3.0
Anastasia	2.0	Angelina	3.0
Angelica	2.5	Samantha	2.0

Cultivars produced by the Institute of Horticulture of NAAN, namely 'Amethyst' and 'Odarka', had relatively high yields, in particular 5.0 g/bush and 4.5 g/bush, respectively. The lowest seed yield was found in such cultivars as 'Mashenka' (2 g/bush), 'Samantha' (2 g/bush), and 'Anastasia' (2 g/bush).

According to these studies, in 2017, seed yield indices were significantly lower than those in 2016, but seed yields appeared to be higher and variation coefficient was lower in 2017. This indicates a weak direct correlation of the level of ornamentality and productivity of China aster plants, since the results of the studies are reliable, and the variation coefficient is rather insignificant.

According to the research results on the effect of mineral fertilizers on the height of annual asters, it was found that all of 16 varieties experienced plant elongation on the background of mineral fertilization, compared to the standard. The highest values were obtained at the rate of mineral fertilizers of 6.0 g/m². The increase in the bush height of the studied cultivars ranged from 4 % ('Angelina' cultivar) to 60 % ('Oksana' cultivar) (Figure 2).

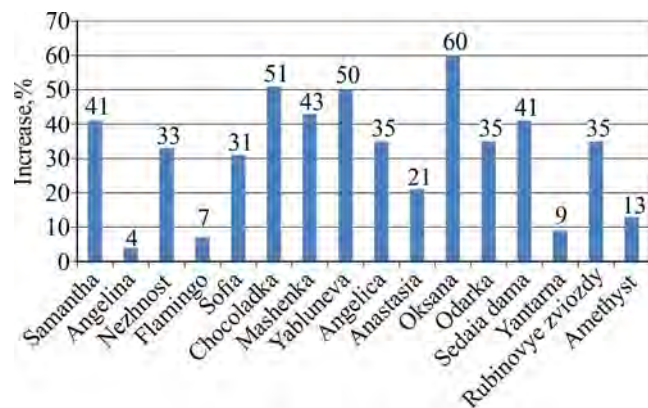


Fig. 2. The effect of mineral fertilizers on the plant height of Chinese aster (*C. shenensis*)

From the point of view of the culture application in the flower design, where variability in height within the cultivar is unacceptable, the established response to the introduction of mineral fertilizers is negative. Early cultivar 'Amethyst' responded to increased rates of fertilizers by 5.1 cm increase in height within the experiment; mid cultivars, in particular 'Odarka', 'Oksana', 'Anastasia', 'Angelica', 'Yabluneva', 'Samantha', on average, responded by 11.1 cm increase in height, and late cultivars 'Chocoladka', 'Sofia', 'Flamingo', 'Nezhnost', 'Angelina', 'Yantarna' responded by 12 cm increase in height, on average. The highest respond to the rate of mineral fertilizers was observed in cultivars 'Oksana', 'Chocoladka' and 'Yabluneva', in which the bush height increased by 60 %, 51 % and 50 %, respectively.

Sowing of seeds under conditions that are less favorable than those provided by the standard enables to get additional characteristics of seed quality.

Discussion. Considering the environmental aspects of growing annual asters in the green areas of Podillia zone, in particular in the collection site and the entire territory of Vinnytsia National Agrarian University, the following points should be noted:

1. Development of the garden and park compositions requires proper selection of the plant material taking into account the age and seasonal dynamics as well as ecological expediency.
2. Species characteristics are as important as individual morpho-biological and ornamental features of plants, which enhance ornamental expressiveness of other elements of artistic compositions. China aster can be perfectly combined with deciduous and coniferous flower and ornamental plants that represent different life forms (trees, shrubs, herbs).
3. The use of China aster is not limited to the open ground, since this plant is often used for indoor decoration and creation of floral compositions.
4. According to our studies and previous research results, growing of China aster under conditions of large cities, on the territories of industrial buildings are of great relevance. A great share of flower plants badly withstands urban pollution, so, from the environmental point of view, it is rather problematic to choose plants that are resistant to adverse environmental factors. However, such China aster cultivars as 'Nezhnost', 'Angelina', 'Chokoladka', 'Angelica', 'Yantarna', 'Odarka' are resistant to dust and they do not require special growing conditions, which is extremely important when choosing a range of floral products for the greening of urban areas.

Cultivar diversity of the studied species enables to use plants for different purposes, e.g. to design flower beds, edges, China asters can also be planted in the shadow areas, which often remain completely undecorated with flowers or sometimes decorated with unsuitable plants because of our conditions; creation of rocky gardens, where they are planted alone or in groups between stones, they look excellent on their gray background; group plantations of China aster can be intended for gardens and parks; wonderful China asters in border and alley plantations near the walls and foundation of buildings; spectacular in mixborders; like solitaires in the light lawns, bordered by dark leaves of bushes; in hedges, the aster is ornamental both in the front and in the background, and they are also used as houseplants to create a special interior.

Generalized guidelines on the use of different species for space greening taking into account their bio-morphological features are given in Table 2.

From the practical point of view, all the species investigated are of great interest as potentially valuable objects for the replenishment of assortment of ornamental plants in Ukraine and they are considered to be promising for improving the condition of parks, gardens and gardens.

Conclusion. Due to high ornamental qualities, economic and biological qualities of the studied cultivars, all of them are evaluated as well adapted to the edaphic and climatic conditions of Podillia and they are recommended as objects intended for the replenishment of the assortment of plants for greening, collection and exhibition funds as well as breeding activities.

Table 2. Biomorphological features and guidelines on the use of ornamental cultivars of the genus *C. chinensis*

Name of variety	Variety type	Plant size		Duration of flowering, days	Guidelines on the use
		height	width		
Samantha	Tubular	45-50	20-25	65	Borders, flower beds, in vases, rocky gardens
Angelina	Tubular	60-65	20-25	54	Solitaires, plant beds, retaining walls, aster flower beds
Nezhnost	Artistic	60-70	45-50	60	Mixborders, groups, land tracts
Flamingo	Artistic	45-50	20-25	57	Borders, flower beds, in vases, rocky gardens
Sofia	Artistic	60-65	30-35	50	Solitaires, plant beds, retaining walls
Shocoldka	Artistic	65-70	35-40	63	Mixborders, groups, flower arrangement
Mashenka	Triumph	35-40	30-35	43	Borders, flower beds, modular flower beds, rocky gardens
Yabluneva	Similar to peony	45-50	30-35	44	Borders, flower beds, in containers, rocky gardens
Angelica	Similar to peony	70-75	35-40	45	Mixborders, groups, near the walls of buildings
Anastacia	Similar to peony	60-65	30-35	60	Solitaires, plant beds, retaining walls
Oksana	Similar to peony	60-65	30-35	52	Solitaires, plant beds, retaining walls, flower beds
Odarka	Similar to peony	65-70	30-40	42	Mixborders, groups, modular flower beds
Sedaia dama	Duches	65-75	45-55	46	Solitaires, plant beds, retaining walls, flower beds
Yantarna	American bush	75-80	35-40	45	Mixborders, groups, land tracts
Rubinovyv zvizozdy	Unique colon-like	60-65	30-35	44	Solitaires, plant beds, retaining walls, modular flower beds
Amethyst	Valderzes	40-45	35-45	46	Borders, flower beds, for arrangement, stony gardens

A diversity of colors and forms of inflorescence, various shapes and height of the bush enable to use China aster widely in the single linear plantations, group plantations, for the arrangement of mixborders and plant beds, on the rocky landscapes and borders, to create groups and flower beds.

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ПЕРСПЕКТИВНІСТЬ ВИРОЩУВАННЯ ТА ВИКОРИСТАННЯ *CALLISTEPHUS CHINENSIS* В ОЗЕЛЕНЕННІ ЗОНИ ПОДІЛЛЯ

Однією із пріоритетних в інтродукційній роботі квітково-декоративних рослин, як в Україні, так і в усьому світі, є айстра однорічна, або калістефус китайський (*Callistephus chinensis* (L.) Nees). Вітчизняні та зарубіжні вчені різнопланово вивчають цю рослину. Більшість праць, що опубліковані впродовж останніх десятиріч, присвячені вивченню та пошуку найсприятливіших агротехнічних прийомів для вирощування айстри в різних умовах. Проаналізовано перспективність вирощування сортів айстри китайської (*Callistephus chinensis*) на об'єктах озеленення Вінниччини. Зазначено про зростання попиту на нові сорти різних груп айстри однорічної у декоративному садівництві та необхідність створення декоративних сортів цієї культури, стійких до хвороб та адаптованих до умов навколишнього середовища. Вперше досліджено біоморфологічні особливості айстри китайської (*Callistephus chinensis*), способи розмноження та визначено найперспективніші культивари для їх вирощування в умовах Вінниччини та для подальшого їх використання в ландшафтному озелененні різних об'єктів. Створено та уніфіковано колекцію сортів різних груп айстри китайської на території колекційної ділянки Вінницького національного аграрного університету. Враховуючи високі декоративні якості досліджуваних сортів та господарсько-біологічні якості, всі сорти оцінено як добре адаптовані до едафо-кліматичних умов Поділля і рекомендовано як об'єкти для збагачення асортименту рослин для озеленення, колекційних та експозиційних фондів і селекційної діяльності. Різноманітність забарвлення та форм суцвіття, різні форми та висота куща дають змогу широко використовувати калістефус китайський (*Callistephus chinensis*) для створення поодиноких лінійних посадок, групових посадок, для влаштування міксобордерів і рабатов, на кам'янистих ділянках ландшафту і в бордюрах, для створення груп і клумб.

Ключові слова: біоморфологічні особливості; інтродукція; період цвітіння; декоративні якості; культивари.

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ПЕРСПЕКТИВНОСТЬ ВЫРАЩИВАНИЯ И ИСПОЛЬЗОВАНИЯ *CALLISTEPHUS CHINENSIS* В ОЗЕЛЕНЕНИИ ЗОНЫ ПОДОЛЛЯ

Одним из приоритетных в интродукционной работе цветочно-декоративных растений, как в Украине, так и во всем мире, является астра однолетняя, или калистефус китайский (*Callistephus chinensis* (L.) Nees). Отечественные и зарубежные ученые разнопланово занимаются изучением данного растения. Большинство работ, опубликованных в течение последних десятилетий, посвящены изучению и поиску наиболее благоприятных агротехнических приемов для выращивания астры в различных условиях. Проанализирована перспективность выращивания сортов астры китайской (*Callistephus chinensis*) на объектах озеленения Винницкой области. Отмечено о росте спроса на новые сорта различных групп астры однолетней в декоративном садоводстве и необходимости создания декоративных сортов этой культуры, устойчивых к болезням и адаптированных к условиям окружающей среды. Впервые исследованы биоморфологические особенности астры китайской (*Callistephus chinensis*), способы размножения и определены наиболее перспективные культивары для их выращивания в условиях Винниччины для дальнейшего их использования в ландшафтном озеленении различных объектов. Создана и унифицирована коллекция сортов различных групп астры китайской на территории коллекционного участка Винницкого национального аграрного университета. Учитывая высокие декоративные качества исследуемых сортов и хозяйственно-биологические качества, все сорта оценены как хорошо адаптированные к эдафо-климатическим условиям Подолья и рекомендованы в качестве объектов для обогащения ассортимента растений для озеленения, коллекционных и экспозиционных фондов и селекционной деятельности. Разнообразие окраски и форм соцветия, различные формы и высота куста дают возможность широко использовать калистефус китайский (*Callistephus chinensis*) при создании отдельных линейных посадок, групповых посадок, для устройства миксобордеров и рабатов, на каменистых участках ландшафта и в бордюрах, для создания групп и клумб.

Ключевые слова: биоморфологические особенности; интродукция; период цветения; декоративные качества; культивары.