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BEHAVIOUR OF ORNAMENTAL SPECIES *NIPPONANTHEMUM NIPPONICUM* IN CROPPING CONDITIONS FROM SW AREA OF ROMANIA

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Abstract

Nipponanthemum nipponicum (Franchet ex Maxim.) Kitam., originating in Japan, is part of the hemicryptophyte perennial group. It is a valuable plant and it is noticeable by the fact that it blooms in a period when most of the flowering species end their period of decoration (September-November). In our country N. nipponicum is not known as an ornamental plant and has not been mentioned in any scientific work. As a result, in this paper we have proposed the study of the behavior in culture in order to introduce this species into the assortment. In Craiova city conditions, the flowering was observed at the beginning of October (4.10.) and the decoration duration was between 25 - 36 days. Analyzing the behavior of N. nipponicum plants under different cultivation conditions, it is observed that the plants grown in the sunny exhibition recorded the best results for all the analyzed parameters.

Key words*: assortment, diversification, Nipponanthemum nipponicum, ornamental plant*

INTRODUCTION

Landscapes and urban green space plays a critical role for keeping our cities attractive and healthy (Roy, 2019). Hemicryptophyte perennial plants are characterized by rich flowering and bright colors. They are largely used in the summer-autumn decorations because most plants flower in June - October. The systematic position of *Nipponanthemum* have also been the subjects of much debate (Shen, 2021). *Nipponanthemum* were classified into subtribe *Leucantheminae*, but all were later shown to belong to subtribe Artemisiinae according to molecular phylogenetic data (Sanz, 2008; Shen, 2021).

The genus *Nipponanthemum*, family Asteraceae, consists of only one species, *N. nipponicum* (Franch. ex Maxim.) Kitam, formerly considered part of *Chrysanthemum* (Kitamura, 1978; Koyama, 1995). It is separated from *Chrysanthemum* by morphological characters (Uehara, 2012), and the morphology of chromosomes (Nakata et al., 1995). There is a form with pink flowers, *N. nipponicum* roseum, but the base species is generally preferred, which was used by American horticulturist Luther Burbank to produce *Leucanthemum* x *superbum* (Shasta Daisy).

N. nipponicum (Franchet ex Maximowicz) Kitamura, syn. *Chrysanthemum nipponicum* (Franchet ex Maxim.) Sprenger, *Leucanthemum nipponicum* (Franchet ex Maxim.), Bull. (Garcia et al., 2004), common names "Nippon daisy" or "Montauk daisy"**.** Is a shrubby perennial of 20-60-70 cm tall (-100), native to coastal regions of Japan, and distributed on the rocky slopes near seashores of Pacific side (Gleason & Cronquist, 1991; Hong et al., 2015), but cultivated as an ornamental in other regions (Tosca et al., 1999). The leaves have dimensions of 20-75 (-90) × 12-15 (-20) mm, serrated edges, rarely entire. Unlike other chrysanthemums, the leaves of *N. nipponicum* are dark green, glossy, even leathery, which makes it attractive even before it starts flowering. The flowers are arranged in calatidium inflorescences, white ligulate florets and yellow tubular ones, typical of the *Asteraceae* family. Several authors mention that it blooms between September-November, a period in which most flowering species end their decoration period (Ellis, 2000; Fell, 2007).

The sources consulted show that *N. nipponicum* grows well in full sun, but also tolerates partial shade. Requires fertile, well-drained soil. It is a plant tolerant to drought, frost, salts and has great disease resistance; it blooms in autumn

and is also decorative through its leaves, all positive attributes for plantation in urban locations (Ellis, 2000).
Nipponanthemum can be propagated by seeds, cuttings, or division (Fell, 2007). *N. nipponicum* requires little maintenance. It may be cut back hard in spring to maintain a compact habit. Plants may be divided in spring every three years to maintain the vigor of the plant (Ellis, 2000). *N. nipponicum* can be used for the decoration of green spaces, as isolated plant or in groups, mixed borders, in rock gardens and xeriscaping, but also as cut flowers or as container plants.
In the literature, information on the ecological requirements, multiplication and culture technology of the perennial species *N. nipponicum* is very little or missing. In Romanian literature *N. nipponicum* was mentioned by Vidrașcu (2002). He specifies the plant is part of the decorative collection, unique in Romania, of the "Anastasie Fătu" Botanical Garden from Iaşi. In his study, Vidrașcu highlights the resistance against *Peronospora tanaceti* Gaum of the species.
The data presented in this work refer to the *N. nipponicum* plants behavior in the town of Craiova and it considers two differentiators: the age of the plants and the different cultivation conditions.

MATERIALS AND METHODS

The behavior of the *N. nipponicum* species was analyzed in the 2018-2019 period, in the experimental field of the Floriculture, Faculty of Horticulture of the University of Craiova. This is located in Craiova's "Al. Buia" Botanical Gardens. The sector is placed on a flat field with a clay-sandy soil and is protected by air flows. The temperate climate of Craiova is characterized by very hot, even scorching summers and more gentle winters. The average annual temperature varies between 10.5 and 11.5^0C and the amount of rainfall a year is on average 550 mm. The climate type is forest-steppe with abrupt winter to summer changes and slower summer to autumn transitions. It has Mediterranean influences which are typical in the Romanian fields. The above demonstrate the location poses a favorable environment for cultivating *N. nipponicum*.
In the first stage of the study we followed the behavior of the *N. nipponicum* in different light exposures (V1 - full sun, V2 - half-shade, V3 - shade). The biological material contained of uniform, two years old plants (Figure1).

Figure 1. Two-year-old plants in the experimental field

In the second stage of the study we followed the behavior of the *N. nipponicum* plants of different ages. The biological material was represented by different age plants: N1 - young plants, (obtained from cutting rooting), N2 - two years old plants and N3 - mature plants (> three years), from the Faculty's existing collection. Cuttings were obtained in the greenhouse of the Faculty. The recorded temperatures were between $20\text{-}25^0$C while the soil humidity was maintained by permanent watering. Cuttings were transplanted after rooting in June.
The observations made in the 2018-2019 period focused on: average plant height, average leaf length, average leaf width, average flower diameter, start in vegetation, the appearance of flower buds, the blooming, the maximum flowering and the end of flowering.
The phenophases of the vegetation season, from the start of the vegetation until the end of flowering, were recorded using Biologische Bundesanstalt, Bundessortenamt and CHemical industry (BBCH) scale (Table 1), used by other researchers for various plant species (Meier, 1997; Stratópoulos et al., 2019; Cosmulescu & Scrieciu, 2019; Stanciu et al., 2021), through observations on leafing and flowering in the year 2019.

Table 1. Description of flowering phenophases recorded based on the BBCH code

No. of phenological phase	Phenological phase	BBCH Code	Description of BBCH Code
F0	Bud bursting	09	Buds show green tips
F5	Inflorescence occurrence	59	Separation of floral buds
F6	Beginning of flowering	60	The first flowers have opened
	Full flowering	65	At least 50% of flowers are open, the first petals fall
	End of flowering	69	The end of flowering: all petals have fallen

The following determinations were made: the number of days from the start of vegetation until the appearance of flower buds, the number of days from the start of vegetation until the beginning of flowering, the number of days from the beginning of flowering until the end of flowering, respectively the duration of flowering.

RESULTS AND DISCUSSIONS

Existing studies do not cover or are seldomly discussing ecological requirements, propagation or the culture technologies used for the *N. nipponicum* species. However, from the existing studies we can summarize that *N. nipponicum* develops well in full sun, but tolerates half-shade as well. The soil can have just average in fertility, as long as it is very well-drained.

Behavior of the N. nipponicum plants in different growing conditions

The time of phenological stages varies depending on species, on age and on the local climate within a species (Stanciu, 2021). In Table 2 one can observe that *N. nipponicum* behaves differently depending on the growing conditions. The onset of vegetation was the earliest recorded in the plants cultivated in full sun (18.03.2019), followed by the plants cultivated in half-shade (23.03.2019) – five days later. For the plants grown in full shade (07.04.2019), the onset of vegetation was last observed 20 days after the ones grown in full sun.

The first time the buds were noticed was on 19.09.2019, only for the plants cultivated in full sun. The blooming began on 04.10.2019, 15 days after the floral buds were observed. The flowering period was between 4.10.2019 - 7.11.2019 in the autumn season, only for the plants grown outdoors in full sun.

The number of days between the start of vegetation until the buds emergence was 192 days. The number of days between the start of vegetation until blooming started was 207 days. The decorative period, more specifically the number of days from start to end of the blooming period, was 35 days.

Table 2. Blooming phenology of *N. nipponicum* in different cultivation conditions

Cultivation exposure	Bud bursting (09)	Inflorescence occurrence (59)	Beginning of flowering (60)	Full flowering (65)	End of flowering (69)	Number of days 09-59	Number of days 09-60	Duration flowering 60-69 (days)
Full sun (V1)	18.03.2019	19.09.2019	4.10.2019	21.10.2019	7.11.2019	192	207	35
Half-shade (V2)	23.03.2019	-	-		-	-	-	-
Shade (V3)	07.04.2019	-	-		-	-	-	-

Physiologically, light has both direct and indirect effects. It affects on metabolism directly through photosynthesis, whilst indirectly through growth and development (Zhang et al., 2011). According to Kozlowska (2011) light has the strongest effect on the development of inflorescence buds and then on the formation of inflorescences.

Table 3 presents the effects of different light expositions on plants growth and development. The average plant height recorded the highest values (V1-36.5 cm) for the plants cultivated in full sun exposure, whilst the plants cultivated in shaded areas recorded the lowest values of this parameter (V3-18.2 cm) (Table 3).

The average leaf dimensions registered highest values in full sun exposure (V1-6.9 cm length, V1-5.3 cm width), whilst for the plants cultivated in half shade and shade, the recorded values were significantly lower, between 4.6-5.3 cm length and 1.5-1.7 cm width.
The average diameter of the inflorescence for the plants cultivated in full sun was 17.25 cm, while the average length of the floral stem was 15.5 cm.
Plants respond to shading by either acclimation or by avoidance. The process of acclimation is typically achieved by increasing the leaf area (Evans &Poorter, 2001). Avoidance involves a repositioning of leaves (Ballare, 1999). Low light intensity inhibits plant growth and productivity by depressing gas exchange (Gregoriou et al., 2007). For herbaceous perennials like *N. nipponicum*, light is an important factor affecting plant growth, morphology, and developmental changes. Cultivation in half shadow, but especially in full shadow reduced the vegetative growth and in some cases blooming did not happen. In conclusion, *N. nipponicum* for landscaping in full sun exposition presents a good growth habit, flowering and an attractive aspect of foliage.

Table 3. Cultivation conditions influence on the main morphological characteristics of the *N. nipponicum* plants

Cultivation exposure	Height of plants (cm)	Length of leaf (cm)	Width of leaf (cm)	Diameter of heads (cm)	Floral stem length (cm)
Full sun (V1)	36.5	6.9	2.1	7.25	15.5
Half-shade (V2)	30	5.3	1.7	-	-
Shade (V3)	18.2	4,6	1.5	-	-

Behavior of the N. nipponicum depending on the age of the plants

Table 4 presents the data on vegetation starting and blooming phenology based on the plant age. For mature plants aged more than three years old and for two years old plants, the vegetation start was recorded on 18.03.2019. For the young plants, obtained from rooted cuttings was recorded on 26.06.2019.
For both mature and two years old plants the buds appeared between 17.09.2019 - 19.09.2019. For the young plants the buds appeared 8-10 days later, on 27.09.2019. The blooming started between 01.10.2019 - 4.10.2019 for mature and two years old plants and on 16.10.2019 for young plants (with a 12-15 days difference).
The blooming period was between 1.10.2019 - 5.11.2019 for mature plants, and between 4.10.2019 - 7.11.2019 for two-year-old plants. The young plants, bloomed in the first year of cultivation between 16.10.2019 - 7.11.2019.
The number of days between the beginning of the vegetation and the buds' appearance was between 94 (for young plants) and 195 days (for mature plants). The number of days between the vegetation start and the blooming start was between 107 days (for mature plants) and 200 days (for two years old plants). The decorative period and the number of days from the start until the end of the blooming was between 22 days for the young plants (N1) and 35 days for the mature plants (N3).

Table 4. Blooming phenology for *N. nipponicum* depending on the age

Plant age	Bud bursting/ plantig (09)	Inflorescence occurrence (59)	Beginning of flowering (60)	Full flowering (65)	End of flowering (69)	Number of days 09-59	Number of days 09-60	Number of days 60-69 (duration flowering)
N1	25.06.2019	27.09.2019	16.10.2019	28.10.2019	07.11.2019	94	113	22
N2	18.03.2019	19.09.2019	04.10.2019	21.10.2019	07.11.2019	185	200	34
N3	18.03.2019	17.09.2019	01.10.2019	23.10.2019	05.11.2019	183	197	35

N1 - young plants; N2 - 2 years old plants; N3 - mature plants (> 3 years)

As we observe in Table 5, the average height of the plants, recorded the highest values at N2 (2 years old plants - 46.5 cm) followed by the N3 (mature plants> three years - 40.6 cm).
The young plants recorded the lowest average height (N3-32 cm). Regarding the average size of the leaves recorded the lowest value at N1 (6.5 cm, 2.1 cm, respectively), and the highest value was recorded at N2 (7.3 cm and 2.5 cm, respectively).
The average diameter of heads was between 5.7 cm (N3 - mature plants (> 3 years) and 7.25 cm (N2 - 2 years old plants). The average length of the flower stalk also recorded the highest value in plants at the age of 2 years (N2-16.3 cm).
The lowest value of this parameter, in correlation with the average plant height, was recorded in young plants (N1-12.7 cm).
In conclusion, the two-year-old *N. nipponicum* plants performed best in the cultivation conditions in the city of Craiova.
It is also worth mentioning that the young plants, resulting from rooted cuttings, bloomed in the first year of cultivation.

Table 5. The main morphological characteristics of *N. nipponicum* plants depending on the age of the plants

Plant age	Height of plants (cm)	Length of leaf (cm)	Width of leaf (cm)	Diameter of heads (cm)	Floral stem length (cm)
N1 - young plants (from cutting rooting)	32	6.5	2.1	6.8	12.7
N2 - 2 years old plants	46.5	7.3	2.5	7.25	16.3
N3 - mature plants (> 3 years)	40.6	6.8	2.3	5.7	15.5

CONCLUSIONS

N. nipponicum excel for the late blooms and general hardiness, it is ideal for combination planting and can enrich the assortment of perennial flowering plants.
The *N. nipponicum* is suitable for sunny places and can be introduced to the ornamental plant design patterns in places similar to Craiova ecological conditions.
The flowering was observed at the beginning of October (2.10-4.10) and the decoration duration was between 25-36 days.
N. nipponicum did not bloom in shade and semi-shade conditions, but stood out through its beautiful foliage throughout the vegetation period.
Analyzing the behavior of *N. nipponicum* plants, it is observed that the plants grown in the sunny exhibition recorded the best results for the analyzed parameters.
The 2-year-old plants performed best in the cultivation conditions in the city of Craiova. In the technology of growing montauk daisy, spring cutting to regenerate plants and dividing the plants every three years can influence inflorescence height and decorative capacity.
It is also worth mentioning that the young plants, resulting from rooted cuttings, bloomed in the first year of cultivation.

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