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Original Article

Possibilities for production and application of native *Cyclamen neapolitanum* in landscape architecture and horticulture

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***Abstract*:**
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Cyclamen neapolitanum Ten is autochthonous in Montenegro and Serbia in wide range of habitats, from Mediterranean-seaside, to sub Mediterranean and mountain ones, where it grows on fresh, porous soils, rich in humus and carbonates. It is perennial hardy herbaceous plant with underground tuber, which goes in dormancy trough the period of physical drought. *C. neapolitanum* flourishes during the autumn, forming after near ground rosette of leaves, which lasts to the next summer, so it is extraordinary suitable for perennials, especially alpinums, individual green areas and also for vertical greening of buildings (balconies, terraces). Reproduction is generative. Generative reproduction of *C. neapolitanum* was examined with seed collected in Gorica (Podgorica, MNE), Petrovac (MNE), and Palojce (Grdelicka George, Serbia). Two different artificial substrates were used, as well as classical technologies of plant production with single seed sowing in tresset pots, which were later used to transplantation. Seed germination was high (more then 85%), for the seeds originated from all three localities, and also in both of substrates. Further loses in plant production were not evident, and development of seedlings as well as transplanted plants, was good. Based on conducted experiments, here are given the proposals for economical commercial production, and also for cultivation of plants on green areas.

Key words: *Cyclamen neapolitanum*, Serbia, Montenegro, seed germination, commercial production.

Introduction

Cyclamen L. is a genus of 23 species of flowering plants, native in Mediterranean region, along with Krimea, Caucasus, mountains of Middle Europe and Cappadocia.

The most popular among cyclamen is *C. persicum* Miller, originated from Ciprus, Syria and Israel, with their cultivars, which are one of leading flower pot cultures for more then 100 years. During the long period of cultivation, numerous cultivars have been created, differing among each other according to size of entire plant, flower color and size, and petals shape. Natural size of *C. persicum* is about 30 cm in height, and about 18-20 cm in diameter (above ground). According to size of plant, there is a whole group of selected cultivars with "small sizes"- not more then 10 cm in height, and 9-15 cm in diameter, called mini cyclamen, which became very popular pot culture. But those mini cyclamen, as almost all *C. persicum* cultivars do not tolerate low temperatures, so they are appropriate only as a pot culture in interior and exterior.

Cyclamen neapolitanum Ten is autochthonous in Montenegro and Serbia in wide range of habitats, from Mediterranean seaside, to submediterranean and mountain ones, where it grows on fresh, porous soils, rich in humus and carbonates. It is perennial hardy herbaceous plant

with underground tuber, which, as the other Cyclamen species, goes in dormancy trough the period of physical drought. *C. neapolitanum* flourishes during the autumn, forming after near ground rosette of leaves, which lasts to the next summer.

The flowers appear in late summer and autumn before leaves, and are distinguished by the base of the petals flaring outwards into a pentagonal throat with 10 lobe-like teeth (auricles). Tubers are very large, up to 10 cm in diameter, with roots growing from the upper surface only. Leaves are robust and tough, very variable, usually with 5-9 shallow lobes but often rounded or lance shaped, usually toothed but not cartilaginous, blade green with silvery mottling of great variety. Leaf stalks are long, creeping and then upstanding. Flowers are 1-1.5 cm long, with varying shade of rose pink with a dark crimson blotch at the throat, with faint scent. The fruit is five-chambered capsule, containing numerous sticky seeds, about 2 mm in diameter in the base. The capsule is surrounded by sepals until fruit ripening. During the ripening, fruiting stalks are curling up in a clock-spring-like spiral and settle (condescend) to ground level, and 1-2 cm underground, taking the capsule in peat layer in depth optimal for seed germination. That's happened in the end of plant vegetation, when the leaves start drying, i.e. when the more then half leaves are already dry. When is ripe, capsule is about 1, 5 (1-2) cm in diameter. (Papazova-Antonova, 1964; Grunert, 1968; Polunin & Huxley, 1978).

C. napolitanum in Serbia was recorded and described by Pančić (1974). It belongs to Mediterranean floral element, and its native areal is widespread to middle and eastern parts of South Europe, South Italy and Greece. In Montenegro it grows in maquia, with *Erica arborea*, *Spartum junceum* near the Adriatic coast, but also in sub Mediterranean and mountain region in primarily oak forests or pine cultures, in deciduous and evergreen shrubberies and woods on fresh, porous soils, rich in humus and carbonates. In Serbia is widespread in mountain regions around Južna Morava, in shrubberies and deciduous forests around Bujanovac, Predejane, Lebane, Vučje (Leskovac), Stalać, Kruševac, Niška Banja, Jelašnica (Niš) and Koritnik (Prizren), on warm, but shaded places, on fresh, porous soils, rich in humus and carbonates (Nikolić, 1972). *C. neapolitanum* is according to size of underground spring very close to mini cyclamen, but it withstand low temperatures, so there is a possibility for its application in exterior. It is extraordinary suitable for perennials, especially alpinums, individual green areas and also for vertical greening of buildings (balconies, terraces).

During the October and November, in phase of flowering, in flower markets in Vranje, Leskovac, Niš and Podgorica, one can find *C. neapolitanum* planted in pots. For that purpose, tubers have been being taken directly from the native habitats. This way of popularization and cultivation of cyclamen can not be accepted from the standpoint of biodiversity protection. Besides, their cultivation and plant production by generative reproduction is possible, easy and economical.

We investigated the possibility of production of *C. neapolitanum* for commercial purposes, and first of all we were interesting in production of cyclamen as perennial plant, and for tuber production. We would like to underline that fact, because the mostly produced *C. persicum* cultivars are produced because of flowers, and their decorative values: as pot plants, or even as cut flowers. In that case, in regime of forced plant production, production cycles last about 12-13 months, or even 8-9 months in greenhouses, with strong fertilization and also phytohormone application. (Bacham, 1985; Boodley, 1981). Period of production of plant with aim to get tuber, which could support plant development on open, in gardens or green areas, and during the number of years, lasts much longer.

Material and methods

Seed collection

Generative reproduction of *C. neapolitanum* was examined with seed collected from 3 localities. Collecting of seeds was done during the last decade of May. About 25 fruits of *C. neapolitanum* were collected per locality.

The fruits were in ripening (5 days). The seeds are cleaned, counted and measured on 0.0001g accuracy.

Table 1. The main characteristics of chosen localities, according to geological base and climate

Locality	N	E	Altitude	Geological base	Climate
Petrovac (MNE)	42˚15'	18˚56'	0 m	limestone	Mediterranean
Podgorica(MNE)	42˚26'	19˚17'	54 m	limestone	Submediterranean
Predejane (Serbia)	42˚50'	22˚08'	276 m	limestone and metamorphic rocks	moderate continental

Experiment design

Two different artificial substrates were used in the experiment: Floradur B and Floradur B: vermiculite 7:3.

Floradur B fine is substrate made of peat (70% of white peat and 30 % of black peat) with addition of sand and perlite, with super fine structure and with pH 5.2-6.0. It contain 70-150 mg/l N, 80-180 mg/l P_2O_5, 140-220 mg/l K_2O and 0.5-1,1 mg/l salts.

Floradur B with addition of vermiculite (7:3) was also used, and vermiculite added in order to perform substrate porosity.

120 seeds per locality were separated and treated by Benlate WP 50 (0.05%) and used for sowing.

Seed sowing and entire testing were carried out in open, with environmental conditions modified by shading: 80% during the plant dormancy (summer), and 20% during the period of plant development (autumn to spring). Moderation of environmental condition was influenced by sand layer 0.03 m^3/m^2, placed on the bottom of bad. This sand layer contributes to fine regulation of air humidity, and consequently moderate temperature. Besides, it assures good drain off substrate, and also protection against ground insects, worms and snails.

Classical technologies of plant production with single seed sowing in peat strips were used. Strips were filled with substrate and marked. Sowed strips were placed on bed previously filled with sand in 3 cm layer. Seed sowing was done on Jiffi strips 4x5, (product No. 30051590) (750 plants per m^2), first transplanting in Jiffy strips 6x6 was done in the September of next (second) growing year, and the second transplantation in Jiffy pots 10x 8, in next September (third year of cultivation)

Soil moisture, and consequently air humidity, was maintained manually.

Phases of plant development under the examination were: from sowing to germination and plant development during the vegetation period.

Cultivation from sowing to germination

Cultivation of sowed seed have taken place in modified climate conditions, with 80-100% shading, with even watering and on temperature of 20-22° C.

Cultivation of seedlings and young plants

Seedlings were watered, and preventive phytopathological and entomological protection was made. In first half of September shading was reduced to 20%, and in those conditions plants have stayed until the end of vegetation period. In second half of May next year, when the 50% of assimilation leaf mass were dry, shading of 80% was established, and the watering was stopped. From the beginning of June, plants were, practically, in dormancy.

First transplantation has been done during the September, second year from seed sowing. Transplantation was done on Jiffi strips 6x6 cm (300 plants per m^2) (Product No. 30052200).

Second transplantation was done in next September, third year from seed sowing. Jiffi pots 10x8 (single-100 plants per m^2) (Product No. 30033500) were used.

As a measure of plant development, the total number of developed leaves, also as general appearance and condition of plant was estimated.

Statistical analysis

The data were analyzed by one- way analysis of variance (ANOVA) and significant differences among treatments were separated by Duncan's test ($P<0.05$) for diameters of collected fruits, number of seeds per fruit and seed mass. Number of days from sowing to germinations, and also all other later comparing of numbers of leaves formed per plant, also as tuber diameters, were compared on the base of mean value. We consider that those parameters, though varying in some manner, are not needed to be analyzed statistically, because they do not contribute to technological process of *C. neapolitanum* commercial production in frame postulated with this investigation.

Results and discussion

Average number of seeds per fruit, mass of seed and characteristics of seed germination are shown in the **Table 2**.

Statistical analyses ANOVA with Duncan Test (sig 0.05) showed that there were no significant differences among material collected at different localities according to diameter of fruits, number of seed per fruit, and mass of seed.

Seeds were sown on 10th of June. Germination started on 5th of July and lasted to July 12th, i.e. germination lasted 25-32 days. Seed germination was high (more then 80%), for the seeds originated from all three localities, and also in both of substrates.

There were no differences according to germination in substrate 1 and substrate 2, but germination lasts shorter in substrate 2, which was more porous.

As important characteristic, we would like to emphasize that the percent of technical germination was quite high according to *C. persicum* (Papazova-Antonova, 1964).

Table 2. Number per fruit and mass of *C. neapolitanum* seed divided from different localities, and characteristics of seed germination

Seed origin	F diam	Nmb of seeds	Mass of 10 seeds	S	GS	GD	% G
Petrovac (MNE)	1.170 a	19.6 a	0.1701 a	1	25	7	82
				2	27	4	84
Podgorica (MNE)	1.289 a	20.8 a	0.1803 a	1	26	4	84
				2	26	3	86
Predejane (Serbia)	1.298 a	20.4 a	0.1753 a	1	25	6	80
				2	27	5	85

F diam –diameter of collected fruits , **S N-** number of seed per fruit, **M-** average mass of 10 seeds (g), **S-** sowing substrate, **GS-** starting of germination (nmb. of days after sowing), **DG-** duration of germination (nmb. of days), **%**-percent of germinated seeds

Table 3. Number of leaves per plant, developed during the four year of investigation

Seed origin	substrate	Number of leaves per plant					
		Sept II	May II	TRANSPLANT.	May III	TRANSPLANT.	May IV
Petrovac (MNE)	1	2-3 (2.5)	4-5 (4.7)		8-9 (8.2)		13-18 (15.5)
	2	2-3 (2.8)	5 (5.0)		8-9 (8.9)		15-18 (16.5)
Podgorica (MNE)	1	2-3 (2.8)	4.5 (4.5)		8-9 (8.9)		12-17 (14.5)
	2	3 (3.0)	5 (5.0)		10 (10.0)		14-18 (16,0)
Predejane (Serbia)	1	2-3 (2.9)	4-5 (4.8)		9-10 (9.6)		14-18 (16)
	2	3 (3.0)	5 (5.0)		10 (10.0)		16-17 (16.5)

Average number of leaves per plant developed during the four years of investigation was shown in **Table 3**.

Differences in number of leaves formed in September of first year of cultivation and May of second year of cultivation were not evident. Number of leaves is mostly equal independently of locality, with lightly decreased number of leaves on substrate 2.

In September of second year of cultivation, there were no differences in number of formed leaves. Mostly because of needs for developing above-ground spring, transplanting in single pots was done in September third year of cultivation. In that moment, the tubers were about 2 cm in diameter, independently on treatments. During the September and October the flowers were formed, 1-3 per plant. In regard to small number of flowers per plant, plants have not proved commercial yet.

At the end of that vegetation period, in May in fourth year of cultivation, number of leaves per plant was 12-18. The diameter of tubers was about 4 cm in that moment. For following growing season (in fourth year of cultivation) the plants were fit for market: as tubers, as plantlet in peat pots, or as pot plants, transplanted in earthenware.

The experiments show that the flowering starts at the same time, independently of seed origin or substrate used, in third year of cultivation, and also without differences according to developed leaf mass. Average number of leaves was bigger on substrate 2.

The tubers were equal independently of seed origin and substrate also in the end of vegetation season in fourth year of plant cultivation.

On the manner previously described, *C. neapolitanum* could be generatively reproduced economically. Cultivation was done under the natural environmental conditions with shading. Sterile conditions of substratum and pots deplete the possibility of pests and diseases appearances. In whole cycle of plant production only 2 transplantings exist, without damaging of root system. Humidity, attained by watering is applied only in first 4 months in continuum, and after that only when necessary.

Plants obtained this way could be used on individual and public green areas, especially in perennials because of late flowering of *C. neapolitanum* and retaining of leaves during the whole winter, until the end of May. Cultivation measures which could be applied are the same as for the other perennes with tubers or bulbs resistant on low temperatures.

By supplying market with plants produced this way, one could not only actualize it in application, but also protect their natural genofund and habitats, meaning stoppage of taking tubers from native habitats, and without harm to the wild plants and populations.

Conclusion

C. hederifolium has a great value as a herbaceous perennial plant for use on individual or public green areas because of its late flowering and retaining of leaves during the whole winter, especially because of its withstanding on low winter temperatures.

Characteristics of seeds, and consequently developed plants, collecting from native populations of *C. neapolitanum* in Montenegro (Petrovac and Podgorica) and Serbia (Predejane) were investigated on two artificial substrates (Floradur B and Floradur B: vermiculite 7:3).

Seeds collected from all tree localities have practically the same value, and can be used in generative plant reproduction. Seed germination was high (more then 80%), for the seeds originated from all three localities, and also in both of substrates. Further loses in plant production were not evident, and development of seedlings as well as transplanted plants, was good.

Plant development is better on substrate 2 in phase of plant sowing and first transplanting, so we suggest it (Floradur B: vermiculite 7:3) for sowing and first transplanting, and substrate 1 (Floradur B) for second transplanting.

Usage of jiffy strips and jiffy pots during cultivation assures good aeration of soil, which, as we believe, contributes to good results.

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