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THE INFLUENCE OF ECOLOGICAL FACTORS ON TYPICAL RESPONSE OF LILIES

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Lilies have a huge aesthetic impact on a person due to the unique variety of colors and beautiful decorative appearance. They are widely used for cultivation in parks and gardens, both planted separately and in groups near trees, shrubs, lawns, as well as for cutting and forcing. When it comes to color, shape, aroma, or flowering time, lilies are unmatched among bulbous plants. Therefore, the relevance of the topic is to identify the basic requirements for different types of lilies in Poltava region in terms of resistance to adverse environmental factors, taking into account the ability to maintain a high decorative effect. The aim of the study was to determine the influence of environmental factors on the typical response of lilies. To achieve this goal it was imperative to solve the following tasks: 1) Study the influence of sunlight on the typical response of lilies; 2) Determine the effect of low temperatures in winter for the revival of lily vegetation; 3) Show the relationship to moisture of different hybrids of lilies; 4) Identify the decorative quality. The study was conducted in Hlobyne district of Poltava region in Lypove village on the territory of a private farm S=0.1 ha during 2018–2020. In total, 55 varieties of lilies are grown on the site. For the experiment, 17 varieties were taken, which were classified into six groups by nomenclature. They are Oriental hybrids, Asian hybrids, Longiflorum-Asian-Hybrids, Tubular / Orleans hybrids, Oriental-Tubular Hybrids, Longiflorum-Oriental hybrids. The subject of the research is varietal reaction of lilies. Taking into account the influence of such environmental factors as light, low temperatures and moisture on the typical response of lilies on the average during 2018–2020, the best hybrids for cultivation in Poltava region were identified. According to the obtained results for the formation of flower beds, it is recommended to use the following groups of lilies: Asian hybrids Lollypop, Tropical Breeze and Dimension and Oriental-Tubular hybrids Robert Swanson, Altari, Beverly Drems, Pearl Jennifer and African Lady. They are well adapted to environmental conditions and have high decorative qualities in plant height and inflorescences.

Key words: *Hybrids of lilies, sunlight, low temperatures, moisture, typical response, decorativeness.*

ВПЛИВ ЕКОЛОГІЧНИХ ЧИННИКІВ НА СОРТОВУ РЕАКЦІЮ ЛІЛІЙ

М. О. Антонець, О. А. Антонець, О. Г. Міленко, А. А. Суховієнко, М. С. Ворвихвіст
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Лілії мають чудовий декоративний вигляд, тим самим формуючи в людини певні естетичні почуття. Їх широко використовують для вирощування в парках та садах як поодиноко, так і насадже-

ні у групах поблизу дерев, чагарників, на газонах, а також для зрізу і вигонки. За кольором, формою, ароматом, тривалістю цвітіння лілієм немає рівних серед цибулинних рослин. Актуальність теми полягає у вияві основних вимог до сортів лілій на Полтавщині щодо стійкості до несприятливих чинників зовнішнього середовища, зберігаючи при цьому високий декоративний ефект. Метою дослідження було з'ясувати вплив чинників середовища на сортову реакцію лілій. Для досягнення поставленої мети необхідно розв'язати такі завдання: 1) розглянути вплив сонячного світла на сортову реакцію лілій; 2) з'ясувати дію низьких температур у зимовий період у відновленні вегетації лілій; 3) показати відношення до вологи різних гібридів лілій; 4) виявити декоративну якість. Дослідження проводили у с. Липове Глобинського району Полтавської області на території приватного господарства S=0,1 га протягомі 2018–2020 років. Для досліду взято 17 сортів лілій, які класифіковано у шість груп. Це Східні гібриди, азіатські гібриди, Лонгіфлорум-Азіатік-Гібриди, Трубчаті гібриди, Орієнтально-Трубчасті гібриди, Лонгіфлорум-орієнтальні гібриди. Форма квітника – прямокутні клумби. Предметом дослідження є сортова реакція лілій. Посухостійкість і стан рослин після перезимівлі оцінювали за О. Порадою. Декоративність включала висоту рослин, діаметр куща, забарвлення квіток, махровість суцвіття, діаметр суцвіття, оригінальність та загальний стан рослин. Зважаючи на вплив таких екологічних чинників, як світло, низькі температури і волога на сортову реакцію лілій у середньому по роках досліджень, виявлено найкращі гібриди для вирощування на Полтавщині. Згідно з отриманими результатамив для формування квітників рекомендовано використовувати такі групи лілій. Це Азіатські гібриди Lollypop, Tropical Breeze і Dimension та Орієнтально – Трубчасті гібриди Robert Swanson, Altari, Beverly Drems, Pearl Jennifer і African Lady. Вони гарно пристосовуються до умов навколишнього середовища і мають високі декоративні якості.

Ключові слова: *гібриди лілій, сонячне світло, низькі температури, волога, реакція сорту, декоративність.*

Introduction

Lilies have been cultivated for thousands of years. Jesus Christ, in the Sermon on the Mount, recommended: "Consider the lilies of the field, how they grow" [1]. "Civilization has long known the white lily – images of it are found on Assyrian and ancient Egyptian monuments dating back over 3,500 years" [2]. O. Tymchenko notes that "the image of this flower was minted on Roman coins. In addition, the Greeks and Romans considered the lily a symbol of innocence. Newlyweds used wreaths of lilies and wheat as decorations. In France, the flower was an emblem of royal power. Among the aborigines of Japan, lilies were the main vegetable culture, and even today they are consumed by the peoples of Asia" [3].

Lilies were mentioned by the ancient Greek physician Dioscorides in his work "On Medicinal substances". Today in medicine, they are used as a diuretic and as analgesic for rheumatism, respiratory diseases, and to remove inflammation. White lily (Lilium candidum L.), in the countries of Southern Europe, is among the essential oil cultures. In the Crimea, 50 hundredweight/ha of flowers were harvested, and up to 4 kgs of oil were extracted from them, which were used for high-quality perfumes. This plant is also used in cosmetics; it smoothens out wrinkles on the face when a decoction of lily bulbs is used as facewash.

Lilies have a huge aesthetic impact on a person due to the unique variety of colors and beautiful decorative appearance. E. Olejnikova notes that "both in the garden and in the bouquet it gives the impression of noble dignity and majestic beauty. This is one of the oldest garden plants" [4]. Lilies are widely used for cultivation in parks and gardens, both planted separately and in groups near trees, shrubs, lawns, as well as for cutting and forcing. When it comes to color, shape, aroma, or flowering time, lilies are unmatched among bulbous plants. Kevin Fitzgerald argues that, nonetheless, "most of the public is unaware that lilies can be dangerous to cats, and indeed cannot correctly identify the plants in their own homes. Cats have been shown to be extremely sensitive to the toxic effects of lilies" [5].

These plants are cultivated all over the world. They can have large and small flowers, tall and low stems, and have different blooming periods. In Ukraine, lilies are planted in flower beds. Lilies are perennials. In Ukraine there is only one wild representative of the generation of lilies. This is the forest lily (Lilium martagon L.) This plant is listed in the Red Data Book. According to the international classification, all garden lilies are divided into 8 sections by their origin, flower shape, location and direction in relation to the flowering stem.

L. Ishchuk notes that "about 100 species and more than 3000 types are known. Under certain temperatures and light conditions, which are created in greenhouses in the winter, you can get flowering

plants during the winter-spring period. Asian, Tubular, and Oriental hybrids are suitable to be forced to bloom in greenhouses. The most commonly vertical flower type lilies that are forced are Alyonushka, Veronica, Diana, Zolotinka, [and] Natalia" [6]. The most commonly used for forcing is Lilium regale Wils royal lily [7].

O. Bykov points out that during forcing there may be "physiological disorders on plants such as leaf burn abscission and bud drying" [8]. O. Tkachenko claims that "80 pathogenic microorganisms have been registered on lilies in the world. Among them the most common are fungi that cause gray rot or blue mold and bulb rot or fusarium wilt" [9].

O. Tymchenko notes that "selective work with lilies first began 200 years ago in Japan, but in Europe and America only in the early twentieth century" [3]. "Although most of the bulbs produced for distribution worldwide are grown mainly in the Netherlands, the bulbs are also grown in other countries in the Northern Europe, the United States, Asia, Israel and also the Southern Hemisphere, including Brazil, Australia, New Zealand, Tasmania and Chile. There are series of diseases caused by fungi, viruses, bacteria and nematodes and physiological disorders that affect the production and quality of lily bulbs and cut down healthy flower cultures around the world" [10].

I. Bohdanova notes that "lilies are not very common among flower lovers. This is hindered by the difficulties associated with the lack of planting material, as well as insufficient awareness of the biological characteristics of this plant" [11]. A. Otroshko states that "all the difficulties associated with growing lilies can be divided into two groups – disorders caused by extreme conditions and disorders caused by pathogens. The latter group is divided into three classes: 1) fungal diseases; 2) diseases from viral infections; 3) bacterial diseases" [12].

Yeonhwa Jo & Won Kyong Cho note that "most cultivated lily plants are propagated by bulbs. Therefore, numerous lily bulbs are often infected with various viruses that cause viral diseases. To date, no study has investigated plant viruses of the same type with the same genetic background, collected from different geographical regions" [13]. They explored different viromes of the Sorbonne type of lily.

Domestic selection of lilies, unfortunately, is low, but every year the need for planting material increases. M. Kolisnychenko notes that while selecting lilies, he chose Asian hybrids. "These lilies are very undemanding, resistant to diseases and viruses, are not affected of by sub zero weather or frosts, bloom gaudily every year, even when in the shade, and have a wide range of colors. They can grow in one location for 10–15 years without losing their decorativeness" [14].

Modern scientists claim that there are many unresolved issues in the selection of Asian types of lilies. "Asian types of lilies bred by hybridization and / or duplication of chromosomes of Sinomartagon species, are diploid, triploid or tetraploid, but the homology of genomes among Sinomartagon and Asian lily species remains unclear" [15].

Scientists from Korea and Pakistan note that the Asian hybrid Enchantment was bred in the United States by Ian de Graff and was a lily flower famous for its a shape. After 1990, the popularity of Asian types began to decline, and oriental lilies took the bulk of the market for the lily trade due to their fragrant flowers, which had a distinguished shape even in early flowering [16].

Therefore, the relevance of the topic is to identify the basic requirements for different types of lilies in the Poltava region in terms of resistance to adverse environmental factors, taking into account the ability to maintain a high decorative effect. The aim of the study was to determine the influence of environmental factors on the typical response of lilies. To achieve this goal it was imperative to solve the following tasks: 1) Study the influence of sunlight on the typical response of lilies; 2) Determine the effect of low temperatures in the winter for the revival of lily vegetation; 3) Show the relationship to moisture of different hybrids of lilies; 4) Identify the decorative quality.

Materials and methods of research

The study was conducted in Globin district of Poltava region in the Lypove village on the territory of a private farm S=0.1 ha during 2018–2020. In total, 55 varieties of lilies are grown on the site. For the experiment, 17 varieties were taken, which were classified into six groups by nomenclature. The object of research were lilies of the following groups. They are Oriental hybrids – one variety of Willeke Alberti (Fig. 1); Asian hybrids – three varieties of Lollypop (Fig. 2), Tropical Breeze (Fig. 3), Dimension (Fig. 4); Longiflorum-Asian-Hybrids (LA-Hybrids) – three varieties Freya (Fig. 5), Advantage (Fig. 6), Suncrest (Fig. 7); Tubular / Orleans hybrids – two varieties Golden Spledor (Fig. 8), Regale Album (Fig. 9); Oriental-

Tubular Hybrids (OT-Hybrids) – five varieties of Robert Swanson (Fig. 10), Altari (Fig. 11), Beverly Drems (Fig. 12), Pearl Jennifer (Fig. 13), African Lady (Fig. 14); Longiflorum-Oriental hybrids (LO-Hybrids) – three varieties of Pink Perfection (Fig. 15), Deliana (Fig. 16), Polar (Fig. 17). The shape of the flower bed – rectangular flower beds. Subject of research – varietal reaction of lilies.

Drought resistance was defined as "assessment of the reaction in the critical period of development" according to O. Porada [17]. The condition of plants after overwintering was also assessed by O. Porada [17]. N. Syplyva, M. Hnenna, S. Koliadenko and O. Pavlenko recommend to define decorativeness as follows: "The decorative features are taken as a basis, namely the height of the plants, the diameter of the bush, the color of the flowers, the terry of the inflorescence, the diameter of the inflorescence, the originality and general condition of the plants. The calculation is based on a 9-point scale, so a type of lily can receive a maximum score of 54 points for decorativeness. To determine the decorativeness, there is a scale: 1 – weak decorativeness (score less than 14 points); 2 – average decorativeness (score from 15 to 28 points); 3 – high enough decorativeness (score from 29 to 41 points); 4 – high decorativeness (score from 42 to 54 points) [18].

Research results and their discussion

According to N. Zaverukha, V. Serebriakov and Yu. Skyba, abiotic factors "include solar radiation, temperature, humidity" [19]. The effect of sunlight was studied in the experiment. "According to their needs of light, plants are divided into heliophytes, sciophytes and facultative heliophytes" [19]. "Plants that tolerate high temperatures are heat-resistant, and those that can withstand the effects of low temperatures, are cold-resistant" [19]. The impact of this environmental factor has also been studied. The observation of the typical reaction of lilies to moisture took into account the division into groups – "hydrophytes (moisture-loving), mesophytes (moderately moisture-loving) and xerophytes (drought-resistant)" [19].

T. Melnyk and O. Surgan studied the influence of climatic conditions on the decorativeness of Callistephus chinensis (L.) Nees. "According to research, it has been established that there is a certain relationship between the weather conditions of the year and the number of inflorescences. Thus, increases in rainfall during the growing season promote the development of vegetative mass, but have a negative effect on the formation of the number of inflorescences in plants of C. Chinensis" [20].

Over three years of research, observations have shown that members of the six groups have different responses to environmental factors. The eastern hybrid Willeke Alberti had the best result in terms of reaction to light (Fig. 18). It is a heliophyte. Also, this hybrid withstood low temperatures in winter (Fig. 19). According to this environmental factor, it has a score of 9 points according to O. Porada. Regarding water needs, it is a xerophyte (Fig. 20). Drought resistance also has 9 points. The hybrid has high decorative qualities, that is, grows well in groups (Fig. 21). But there is a threat to the reaction of this hybrid to low temperatures. Spring frosts can damage these plants, so they definitely need shelter.

Fig. 1. Oriental hybrid Willeke Alberti

Asian hybrids are heliophytes (Lollypop, Tropical Breeze) and facultative heliophytes (Dimension). This

can be seen from the histogram (Fig. 18). They have high frost resistance (9 points), except for Lollypop (7 points) and do not need cover for the winter (Fig. 19). Also, Asians do not require stable soil moisture, that is, they are xerophytes and not demanding of the soil in their place of planting (Fig. 20). For greater aesthetic effect, they are grown in groups. These lilies have a high decorative value. But Lollypop looks great alone (Fig. 21). These hybrids a decorative quality known as the plant height. It starts from 1 to 1.4 m. It is desirable to plant them with low-growing plants in order to avoid sunburn of the stems. Asian hybrids are recommended to be grown both in the north of Ukraine and in the central regions due to their ecological plasticity. Haiyi Liang and L. Mahadevan studied "the physical process of flowering in the Asian lily Lilium casablanca. Their observations have shown that the edges of the petals shrink when the flower opens, suggesting that differential growth causes the unfolding of these laminar shell-like structures" [21].

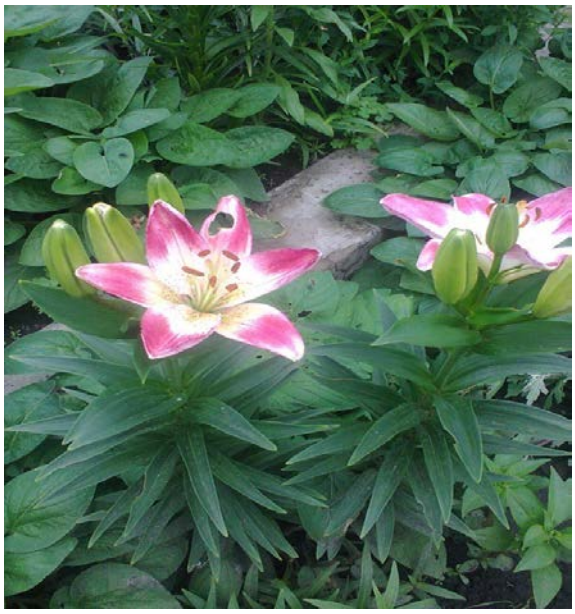


Fig. 2. Asian hybrid Lollypop

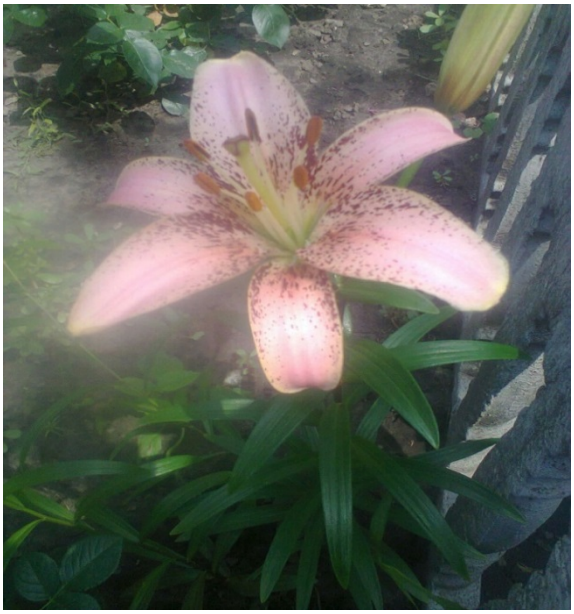


Fig. 3. Asian hybrid Tropical Breeze

Fig. 4. Asian hybrid Dimension

Longiflorum-Asian-Hybrids have a decorative feature known as a large inflorescence, with up to 10–15 flowers on one plant. Therefore, two of them – Freya and Suncrest – are grown in groups for greater decorative effect, and Advantage feels better alone (Fig. 21). These hybrids are optional heliophytes

(Fig. 18). They need cover, even though they are frost-resistant (9 points). This can be seen from the histogram (Fig. 9). In relation to moisture, these hybrids are hydrophytes (Fig. 20). According to O. Porada, lilies have a weak reaction to drought (3 points).

Fig. 5. LA-Hybrids Freya

Fig. 6. LA-Hybrids Advantage

Fig. 7. LA-Hybrids Suncrest

Orleans hybrids look good because of the tubular flowers that are dropped to the bottom. But in the flower garden it is better to plant them alone (Fig. 21). In relation to light, they are opposite, namely Golden Spledor is a sciophyte, and Regale Album is a heliophyte (Fig. 18). These hybrids do not tolerate low temperatures, that is, according to O. Porada they have a reaction of 3 and 5 points, respectively (Fig. 19). In winter, these ilies need cover. As for the reaction to moisture, they again have opposite indicators, namely Golden Spledor is a hydrophyte (3 points). Regale Album is a xerophyte. In terms of drought resistance, the latter has 9 points (Fig. 20).

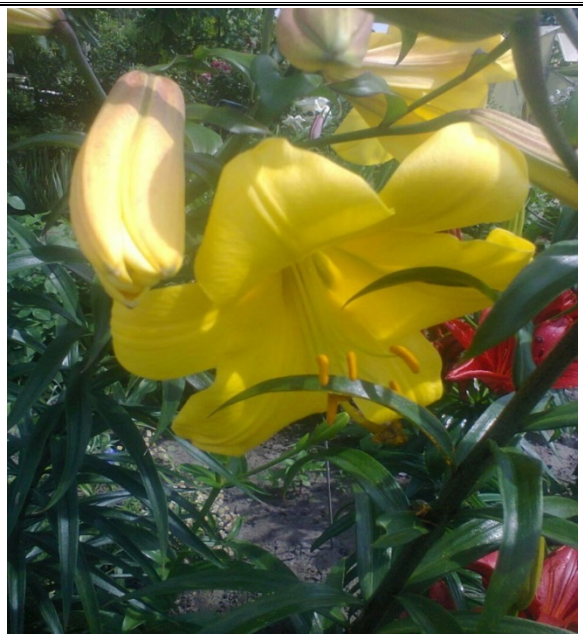


Fig. 8.The Trumpet Hybrid Golden Splendor

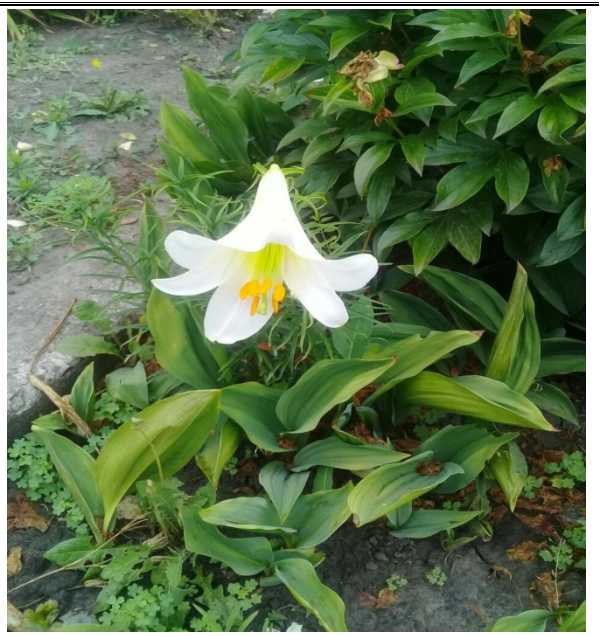


Fig.9. The Trumpet Hybrid Regale Album

Oriental-tubular hybrids are lilies that are adapted for cultivation throughout Ukraine. Their decorativeness is high. The plants have large inflorescences of up to 15 flowers. Because of this, they are recommended to be planted alone in flower beds, with the exception of Robert Swanson (Fig. 21). They are both heliophytes and can grow in the shade (Fig. 18). Altari, Beverly Drems and Pearl Jennifer are frost-resistant (9 points). This can be seen from the histogram (Fig. 19). Robert Swanson and Altari are drought-resistant hybrids, and Beverly Drems, Pearl Jennifer, and African Lady are hydrophytes. This is demonstrated by the histogram (Fig. 20).

Fig. 10. OT-Hybrid Robert Swanson

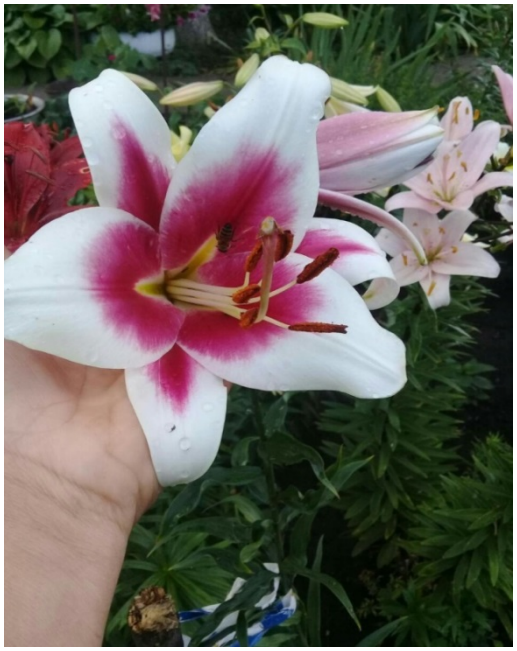


Fig. 11. OT-Hybrid Altari

Fig. 12. OT-Hybrid Beverly Drems

Fig. 13. OT-Hybrid Pearl Jennifer

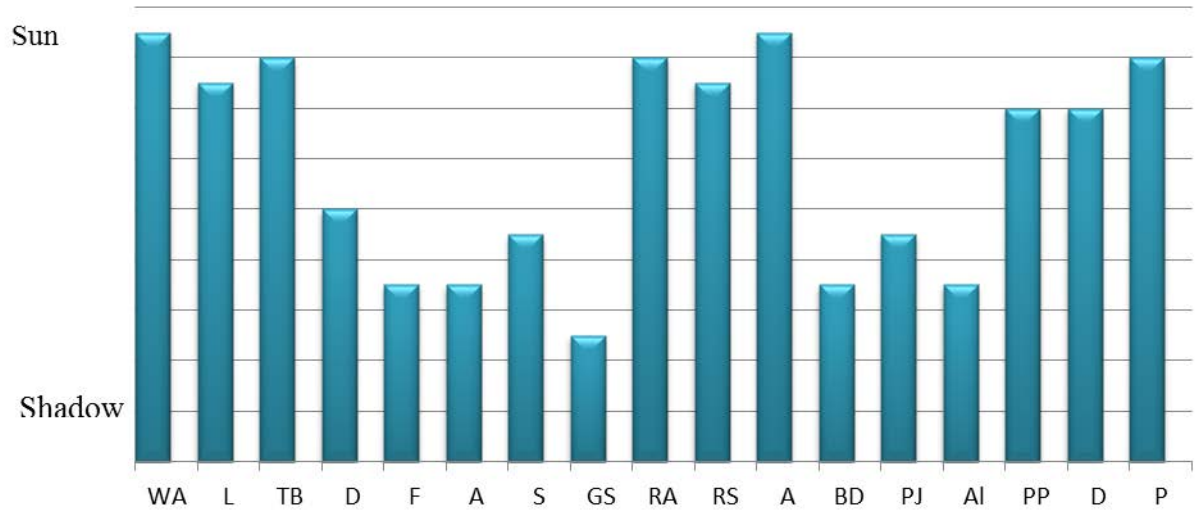
Fig. 14. OT-Hybrid African Lady

The last group of hybrids Longiflorum-oriental have a high decorative value. Because of this, they are recommended to be cultivated in groups (Fig. 21). Pink Perfection, Deliana and Polar are heliophytes (Fig. 18). According to O. Porada Perfection, Deliana and Polar have a reaction to low temperatures of 3 points (Fig. 19). All members of the group need cover in the winter. These lilies are xerophytes (Fig. 20), that is with high drought resistance according to O. Porada (9 points).

Fig. 15. LO-Hybrid Pink Perfection

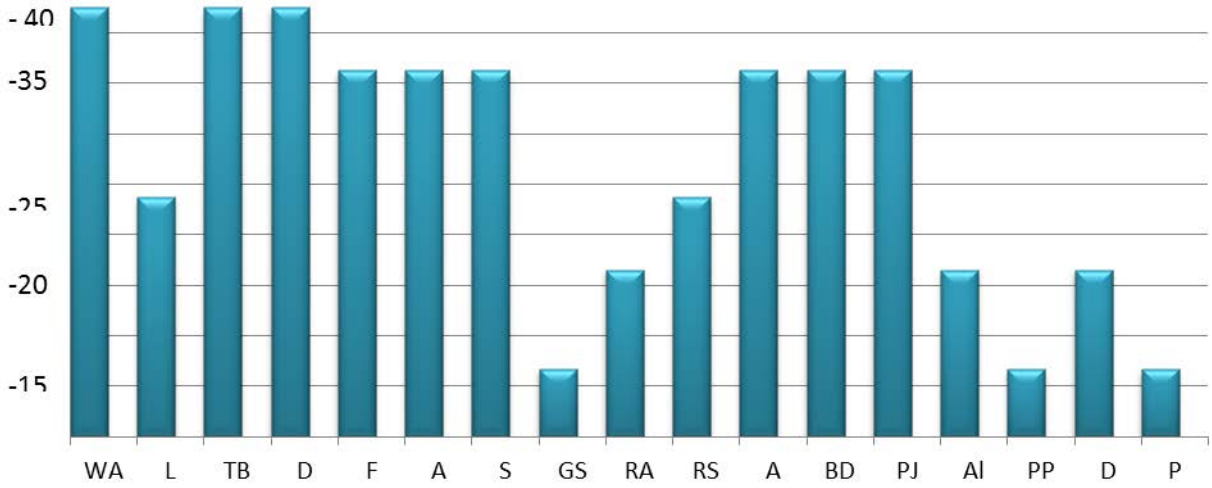
Fig. 16. LO-Hybrid Deliana

Fig. 17. LO-Hybrid Polar



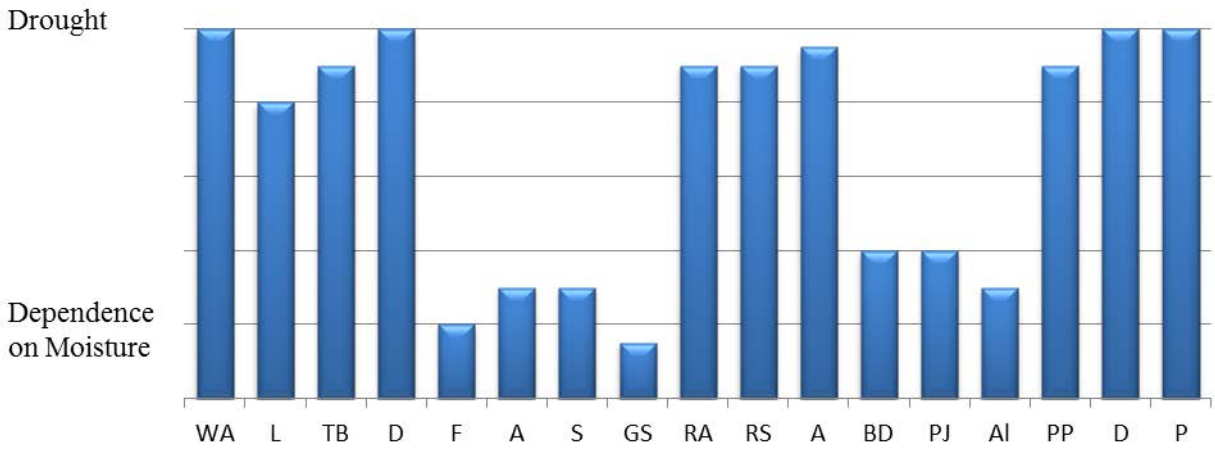
Note: WA – Willeke Alberti; L – Lollypop; TB – Tropical Breeze; D – Dimension; F – Freya; A – Advantage; S – Suncrest; GS – Golden Spledor; RA – Regale Album; RS – Robert Swanson; A – Altari; BD – Beverly Drems; PJ – Pearl Jennifer; AL – African Lady; PP – Pink Perfection; D – Deliana; P – Polar.

Fig. 18. Typical response of lilies to sunlight



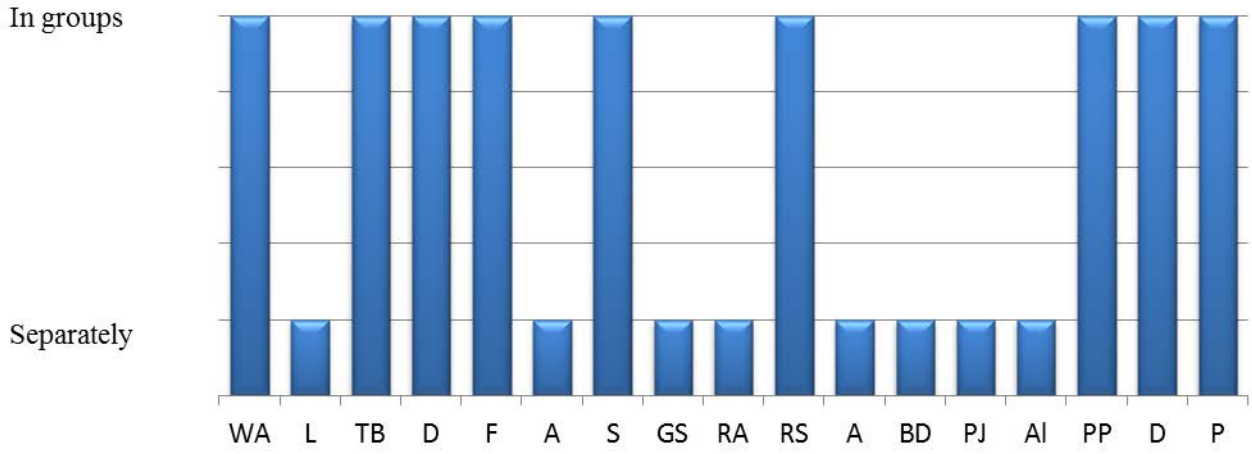
Note: see Fig. 18.

Fig. 19. Typical response of lilies to low temperature



Note: see Fig. 18.

Fig. 20. Typical response of lilies to moisture



Note: see Fig. 18.

Fig. 21. Decorative quality of lilies in the structure of the flower garden

Conclusiones

Thus, taking into account the influence of such environmental factors as light, low temperatures and moisture on the typical response of lilies on average for 2018–2020, the best hybrids for cultivation in Poltava region were identified. According to the obtained results for the formation of flower beds it is recommended to use the following groups of lilies: Asian hybrids Lollypop, Tropical Breeze and Dimension and Oriental-Tubular hybrids Robert Swanson, Altari, Beverly Drems, Pearl Jennifer and African Lady. They are well adapted to the environmental conditions and have high decorative qualities in plant height and inflorescences. Oriental hybrid Willeke Alberti also showed a positive response to the above environmental factors, along with an excellent aesthetic appearance. But it is in danger of death from possible cold spells in spring.

Prospects for future research. In 2021, the study of the impact of environmental factors on all the 55 types of lilies grown on a private farm in Hlobyne district is planned. Preparations are also underway to initiate a similar experiment on tulips.

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