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PECULIARITIES OF THE LEAVES OF THREE WILD SUNFLOWER SPECIES

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Abstract
The study represents the results of the investigation of some peculiarities of the leaves of three wild sunflower species: Helianthus mollis, H. maximilliani, H. nutalli. The leaf width and length, leaf thickness and the thickness of the epidermis, and the peculiarities of the leaf pubescence were studied. The wild sunflower species can be a source of genes of tolerance for many factors, including diseases and drought. We found that the investigated species had statistically significant differences in the leaf blade parameters. The thickness of the leaf was similar. However, the epidermis thickness showed statistically reliable differences between H. maximilliani and H. nutalli. This can be a reason for the different tolerance of this species to drought and high temperatures. Leaf pubescence also showed clear differences between all species. H. mollis has a greater number of hairs on the top and lower epidermis of leaves out of all investigated species. H. nutalli has the lowest number of hairs on its top surface of all these species. However, H. maximilliani has an almost equal number of hairs on both the top and lower epidermis.

Keywords: Helianthus, sunflower, wild species, leaf size, leaf pubescence

1. INTRODUCTION

The sunflower, a pivotal species in the global agricultural landscape, holds particular significance for the Ukrainian economy. Before the War, Ukraine was a leading exporter of sunflowers and their products. Even today, the country exports significant quantities of sunflower seeds and oil. Therefore, the investigation of sunflowers remains a crucial and timely issue.

Our world is changing. Many countries feel the influence of climate change. The weather is not the same. The temperatures of the air and soil are rising very fast. The amount of falls, instead, is falling. The plants suffer from high temperatures and low humidity. And it is clear that in these conditions, harvest is lower, and the quality of the products is worse, too. Modern breeding programs deal with a search for new genes that can help make the species more tolerant to the high temperature and low humidity. Such genes can be found in genomes of wild species that grow in different conditions, including high temperatures and drought. That is why it is not just important, but essential to investigate wild species of the most valuable crops and, after their investigation, decide if they can help improve our crops and make them more tolerant of the environment. This research on wild sunflower species, with its potential to significantly improve crop productivity and environmental adaptation, is of utmost importance.

Many breeders use wild sunflower species in their work. Hristova-Cherbadzi M. obtained several new lines of cultivated sunflowers by crossing them with wild species. She used both annual and

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perennial species, and the rate of cross-breeding was different. However, some of the interspecific hybrids showed resistance to some fungal diseases and had high combining abilities. For some combinations, they first obtained the hybrids (M. Hristova-Cherbadzi, 2009).
Tran V. H. *at al.* (2024) Their overall results support that cultivated H. annuus has less tolerance for drought than wild sunflower species in this drought scenario. This is another proof of the high role of wild sunflower species as a source of valuable genes for drought resistance.
Leaves, being the primary site of photosynthesis, are crucial for plant productivity. The size, shape, and structure of leaves are key determinants of a plant's productivity. It is clear that the more efficient the process of photosynthesis, the higher the yield. Therefore, for agricultural crops, leaves are not just a critical factor, but the critical factor in determining plant productivity. This underscores the significance of our research on the peculiarities of the leaves of three wild sunflower species, as it directly contributes to our understanding of plant productivity and the potential for crop improvement.
Our study aimed to investigate the peculiarities of the leaves of three wild species of sunflower because they are essential for the plant's output. We chose three wild species of sunflower that grow in Ukraine and can be used in breeding programs due to their tolerance for many environmental factors, including drought.

2. MATERIALS AND METHODS

We chose three wild sunflower species as the material: *Helianthus mollis, Helianthus maximiliani*, and *Helianthus nuttallii*. These are the materials from the sunflower species collection of the Chair of Genetics and Plant Resources of Zaporizhzhia National University.
The measurements of leaf traits were taken using rulers, and the thickness measurements were taken under the microscope using the eyepiece micrometre. The photos were taken using a USB 2.0 microscope.

https://en.wikipedia.org/wiki/Helianthus_mollis

Helianthus mollis

https://en.wikipedia.org/wiki/Helianthus_maximiliani

Helianthus maximiliani

https://en.wikipedia.org/wiki/Helianthus_nuttallii

Helianthus nuttallii

Figure 1. Helianthus species

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Hellianthus mollis – perennial wild species of sunflower. It originated in North America and is widespread across much of the United States and Canada. The plant is upright, 0.5 to 1.2 m high. The stem is thin (1.0-1.2 cm in diameter in the lower part and 3-4 mm in the upper part). The stem is green in colour, the waxy bloom is absent, and it is covered with numerous soft hairs and highly branched. The plant tends to grow in nests (clusters). The pedicel reaches 2-3 mm in diameter, green in colour. The leaves are almost always opposite, sessile, with small denticles along the edges, covered with soft hairs on both sides. In the upper part of the stem, the leaves become alternate, and the middle vein weakly protrudes on the underside of the leaf. The leaves are green or grey-green. The base of the leaf is rounded, sometimes pointed, especially in the lower leaves. The apices are rounded. The upper leaves are often asymmetrical, with the top turned right or left.
Helianthus maximiliani is a central North American perennial species and is naturalised in the eastern and western parts of the continent. The plant is upright, 1.5 to 2 meters high. It tends to grow in clusters. The stem is light green on one side and light purple on the other. It has a fragile, light waxy coating. The stem is covered with short, stiff white hairs. The stem does not branch. Pedicels are green, 0.2 - 0.3 cm in diameter, short 1 - 2 cm. The stem reaches 5 - 6 mm in the lower part and 2 - 3 mm in the upper part. Pedicels bear many baskets. The leaves are alternate, dying off in the lower part of the stem as the plant develops. Anthocyanin spots are noted at the point of leaf attachment to the stem. The leaves are sessile, linear-lanceolate, with smooth edges. The leaves are covered with short, stiff hairs on both sides. The leaves have one central vein, which is clearly visible on the lower surface; the edges of the leaf blade are bent upward. Leaves are green-grey or green in colour. The base of the leaves is rounded, and the tops are pointed.
Helianthus nutalii is a perennial species native to northern, central, and western North America. The plant is upright, up to 4 meters high. The stem has few hairs, a faint white waxy coating, and branches. Its diameter reaches 1.2-1.5 cm in the lower part and 0.5-0.7 cm in the upper part. The stem is green in colour. The leaves are mainly alternate to opposite, from lanceolate to almost oval on individual plants. The edges are slightly toothed, and the leaf's surface is wavy, especially at the edges. The base is pointed, and the tips are pointed or rounded. Leaves can have petioles from 1.5 to 2.5 cm in length. The top of the leaves has tiny soft hairs, and the lower part is almost hairless.

3. RESULTS AND DISCUSSIONS

The leaves of three species of wild sunflower were investigated. Firstly, we measured the leaf blade parameters – length and width. The results are presented in Table 1. As we can see from the table, all three species have elongated shape of the leaves. The width of the leaves is smaller than the length. The ratio width/length that can characterise the shape in all these species is different. *H. maximilliani* has the smallest ratio – 0,1, and that is why its leaves are almost linear. The ratio for the *H. nuttallii* is 0,2 and its leaves are very elongated. The last one – *H. mollis* – has the ratio 0,5, so its leaves are lanceolate, almost oval.
However, not only the shape in 2D sizes is essential. The thickness of the leaves also plays a crucial role in productivity and can influence tolerance to drought and high temperatures. The thickness of the leaves tells us how many rows of cells are inside, how many chloroplasts can potentially be there, and how much glucose can be synthesised by this leaf. As shown in Table 2, the thickness of the leaves in all these three species is almost equal.
The epidermis plays an essential role in the life of plants. It is not only a barrier separating living tissues from the environment but also a means of communication with this environment. The epidermis's thickness can be one of the factors that characterise resistance to drought and high

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temperatures. It is the epidermis that is the location and attachment of pubescence. Pubescence also plays a vital role in the resistance of plants to abiotic factors. As is shown in Table 3, the thickness of the epidermis of all three species is almost equal.
Figure 2 presents the surface of all investigated species and their hairs. Table 4 shows the number of hairs on top and lower epidermis.

Table 1 – Size of the leaves of three wild species of sunflower

№	Species	Leaf width, sm	Leaf length, sm
1	*Helianthus mollis*	4,8±0,02[2, 3]	9,50±0,01[2, 3]
2	*Helianthus maximiliani*	1,7±0,01[1, 3]	15,8±0,05[1]
3	*Helianthus nuttallii*	3,3±0,03[1, 2]	13,9±1,43[1]

Superscripts are the sign that differences are statistically valuable (0.05 level)

Table 2 – The thickness of the leaves of three wild species of sunflower

№	Species	Leaf thickness, mm
1	*Helianthus mollis*	0,050±0,096
2	*Helianthus maximiliani*	0,057±0,0350
3	*Helianthus nuttallii*	0,052±0,0340

Superscripts are the sign that differences are statistically valuable (0.05 level)

Table 3 – The thickness of the epidermis of the leaves of three wild species of sunflower

№	Species	The thickness of the epidermis, mm
1	*Helianthus mollis*	0,018±0,0043
2	*Helianthus maximiliani*	0,022±0,0002[3]
3	*Helianthus nuttallii*	0,010±0,0015[2]

Superscripts are the sign that differences are statistically valuable (0.05 level)

Helianthus mollis *Helianthus maximilliani* *Helianthus nuttallii*

Figure 2. Surface of the leaves

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Table 4 – The number of hairs on the leaf surface

№	Species	The number of hairs on the top epidermis	The number of hairs on the lower epidermis
1	*H. mollis*	88.4±1.40[2, 3]	too much[a]
2	*H. maximilianii*	21.0±0.68[1, 3]	26.2±0.76[1, a]
3	*H. nuttallii*	9.8±0.04[1, 2]	28.1±0.80[1, a]

Superscripts are the sign that differences are statistically valuable (0.05 level). [a] an index sign about differences between top and lower epidermis.

Clearly, all investigated species differ in the number of hairs. The most intensive pubescent has *H. mollis*. The number of hairs on the lower epidermis cannot even be counted. Interestingly, *H. maximilianii* has an almost equal number of hairs on both sides of the leaf. However, the differences between the sides are statistically significant. All investigated species have more hairs on the lower epidermis. The peculiarity of the leaf pubescent of *H. nuttallii* lies in the fact that the number of hairs on the lower epidermis is three times more than on the top epidermis. In field conditions, all species showed high resistance to prolonged high temperatures. The most heat-resistant species was *H. nuttallii* (Dubova O., Boika O., 2024). However, *H. nuttallii* does not have the greatest number of hairs on the leaf surface, so the number of hairs is not the main factor of the high-temperature resistance.

4. CONCLUSIONS

Sunflower is the main oil crop of Ukraine. The southwestern part of North America is considered the birthplace of the sunflower. This is indicated by the wide variety of wild species of the Helianthus family distributed here, which are practically not found in other places. We can see that all investigated wild perennial species have many hairs, mainly on the leaf's lower side (on the lower epidermis). The most pubescent was *Helianthus mollis*. The shape, sizes and thickness of the leaves in these species are different. However, the thickness of the epidermis is equal.

5. REFERENCES

Dubova O. ., Boika O. (2024) PECULIARITIES OF LEAF PUBESCENCE OF WILD SUNFLOWER SPECIES. Book of Abstracts International Scientific Symposium Current Trends in Natural Sciences, May 16-18, 2024 Pitesti: POLITEHNICA Bucharest.

M. Hristova-Cherbadzi (2009) Characterization of Hybrids, forms and Lines, Obtained from Interspecific Hybridization of Cultivated Sunflower Helianthus Annuus L. with Wild Species of Genus Helianthus, Biotechnology & Biotechnological Equipment, 23:sup1, 112-116, DOI: 10.1080/13102818.2009.10818378

Tran, V. H., Nolting, K. M., Donovan, L. A., & Temme, A. A. (2024). Cultivated sunflower (Helianthus annuus L.) has lower tolerance of moderate drought stress than its con-specific wild relative, but the underlying traits remain elusive. Plant Direct, 8(4), e581. https://doi.org/10.1002/pld3.581

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