Scientific Papers. Series B, Horticulture. Vol. LXIII, No. 2, 2019
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

DISTRIBUTION AND MORPHOLOGY ASPECTS OF EXTRAFLORAL NECTARIES IN *PRUNUS AVIUM*

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Abstract

Plants secrete nectar to achieve two important mutual interactions with animals, namely pollination and indirect defence. Floral nectar is secreted inside flowers and attracts pollinators. Extrafloral nectar is generally secreted on vegetative parts of plants and attracts members of the third trophic level as a method of indirect protection against herbivores. Extrafloral nectaries are morphologically diverse and include glandular structures that differ in location, size and shape. The purpose of this study was to determine the morphology and position of extrafloral nectarines on petiole and limb in several cherry tree varieties, namely: 'Giorgia', 'Giant Red', 'Ferrovia', 'Kordia', 'Regina', 'Skeena' and 'Lapins'.

Key words*: cherry tree, extrafloral nectaries, morphology.*

INTRODUCTION

Plants secrete nectar to achieve two important mutual interactions with animals, namely pollination and indirect defence. Floral nectar is secreted inside the flowers and attracts pollinators.

Extrafloral nectar is generally secreted on vegetative parts of plants and attract members of the third trophic level as a method of indirect protection against herbivores (Escalante-Pérez et al., 2012).

Extrafloral nectaries are secretory glands that have no connection with the process of pollination. They are morphologically diverse and include glandular structures that differ in location, size and shape. They can be found on almost all plant organs, including leaves, petiole, bracts, cotyledons, fruits and on the exterior of sepals.

Also, extra-floral nectaries are found in varied forms such as unicellular forms, nectar secretion hairs, amorphous glandular tissue, secretory channels, which can be strongly vascularized or completely devoid of vascular system (Rodríguez-Morales et al., 2016).

The presence of extrafloral nectaries in plants has been reported around the world for about 25% of angiosperms. Most plants with such glands belong to the families *Asteraceae, Euphorbiaceae, Fabaceae, Lamiaceae, Melastomataceae, Orchidaceae* and *Rubiaceae* (Weber & Keeler, 2013).

Nectars can be defined as plant secretions, which mediate mutual interactions with a wide variety of animals, which from an ecological point of view can be divided into two main groups: pollinators rewarded with floral nectar and defenders against herbivores rewarded with extrafloral nectar.

It is well established that nectar from the extra-floral nectariferous glands, by mutual association with ants mainly, provides the plant with an indirect defence against herbivores. There is also a wealth of evidence that the ecological effects of these nectar sources are much deeper, knowing that they not only mediate interactions between several species along the food chain but can also be induced by herbivores (Tilney et al., 2018).

A large number of plants exhibit extrafloral nectaries that are not associated with

reproductive functions but are intended to attract ants and other arthropods. Extrafloral nectars are common and widespread in many vascular plants and are generally considered to be a tool used by plants to attract animals for defensive purposes (Grasso et al., 2015).
The defensive action of the ants is so visible that there is a long history of using these animals as biocontrol agents, and there are numerous studies reporting the protection of plants by ants in a wide variety of habitats, from the temperate to the tropical climate (Grasso et al., 2015).
The purpose of this paper was to determine morphology and position of extrafloral nectaries on petiole and limb for 7 varieties of cherry. The results obtained are presented below.

MATERIALS AND METHODS

Materials

The varieties analysed in this study are: 'Giorgia', 'Giant Red', 'Ferrovia', 'Kordia', 'Regina', 'Skeena' and 'Lapins'. For each variety, 9 to 12 leafs were collected on 27th April 2018 from the USAMV experimental fields in Bucharest.

Methods

The dimensions of the biological materials were adapted for the microscopic study.
Microscopic images were acquired using the Leica S8 APO stereomicroscope, which is connected to the LAS Core software that controls the Leica DFC295 camera installed on the microscope.

RESULTS AND DISCUSSIONS

For each studied variety, a series of images was made to determine the morphology and position of extrafloral nectaries on petiole and limb (Figures 1 to 7).

Figure 1. Extrafloral nectaries for the 'Giorgia' variety

Figure 2. Extrafloral nectaries for the 'Giant Red' variety

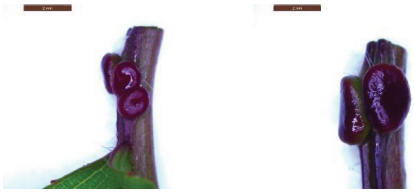

Figure 3. Extrafloral nectaries for the 'Ferrovi'a variety

Figure 4. Extrafloral nectaries for the 'Kordia' variety

Figure 5. Extrafloral nectaries for the 'Regina' variety

Figure 6. Extrafloral nectaries for the 'Skeena' variety

Figure 7. Extrafloral nectaries for the 'Lapins' variety

After the images were acquired, it was observed that the glands are found on both the

petiole and the limb, their number ranging from 2 to 4, for the studied samples. Also, their position on the petiole differs from one variety to another.

The position, number and dimensions of the extrafloral nectaries of the analysed varieties are presented in Tables 1 to 7.

Table 1. Position, number and dimensions of the extrafloral nectaries for the 'Giorgia' variety

No.	Distance to the limb (mm)	Length (mm)	Width (mm)	Number of glands on the limb	Total number of glands
F1	2.488	1.692±0.187	1.062±0.061	0	2
F2	1.577	1.867±0.061	1.139±0.049	0	2
F3	2.255	1.553±0.113	0.948±0.056	0	2
F4	3.717	1.550±0.354	1.056±0.306	1	3
F5	3.155	1.983±0.015	1.250±0.042	0	2
F6	1.796	2.113±0.342	1.032±0.051	0	2
F7	2.377	1.531±0.028	1.072±0.045	0	2
F8	2.418	1.935±0.064	1.184±0.127	0	2
F9	1.614	1.655±0.017	1.050±0.043	0	2
F10	1.770	1.298±0.092	0.932±0.144	0	2

Table 2. Position, number and dimensions of the extrafloral nectaries for the 'Giant Red' variety

No.	Distance to the limb (mm)	Length (mm)	Width (mm)	Number of glands on the limb	Total number of glands
F1	0	1.225±0.400	0.736±0.322	1	2
F2	0	1.316±0.117	0.755±0.0007	0	2
F3	0	1.251±0.088	0.752±0.125	0	2
F4	0	0.650±0.612	0.463±0.361	1	2
F5	0	0.733±0.132	0.592±0.022	1	2
F6	0	1.173±0.519	0.721±0.155	1	2
F7	0	0.645±0.106	0.491±0.132	2	2
F8	0	0.805±0.379	0.604±0.300	2	2
F9	0	1.254±0.158	0.838±0.065	0	2
F10	0.335	1.005±0.197	0.795±0.002	0	2

Table 3. Position, number and dimensions of the extrafloral nectaries for the 'Ferrovia' variety

No.	Distance to the limb (mm)	Length (mm)	Width (mm)	Number of glands on the limb	Total number of glands
F1	0.841	1.538±0.450	1.034±0.364	1	3
F2	0.000	2.346±0.191	1.596±0.176	0	2
F3	3.862	2.936±0.012	1.986±0.090	0	2
F4	1.582	2.079±0.059	1.308±0.116	0	2
F5	2.889	2.559±0.074	1.516±0.061	0	2
F6	0.964	1.610±0.147	1.210±0.140	0	3
F7	3.049	1.546±0.559	1.162±0.483	1	3
F8	2.680	2.174±0.018	1.511±0.023	0	2
F9	3.487	2.307±0.041	1.432±0.018	0	2

Table 4. Position, number and dimensions of the extrafloral nectaries for the 'Kordia' variety

No.	Distance to the limb (mm)	Length (mm)	Width (mm)	Number of glands on the limb	Total number of glands
F1	1.385	1.504±0.090	1.09±0.142	0	2
F2	2.191	1.016±0.648	0.772±0.522	2	4
F3	0.000	1.4385±0.045	1.034±0.002	0	2
F4	0.000	1.2035±0.092	0.709±0.141	0	2
F5	0.946	1.284±0.091	1.117±0.005	0	2
F6	1.301	1.796±0.070	1.414±0.049	0	2
F7	2.423	2.2±0.062	1.486±0.058	0	2
F8	0.000	1.107±0.047	0.824±0.062	0	2
F9	0.000	0.958±0.209	0.804±0.155	0	2

Table 5. Position, number and dimensions of the extrafloral nectaries for the 'Regina' variety

No.	Distance to the limb (mm)	Length (mm)	Width (mm)	Number of glands on the limb	Total number of glands
F1	0.000	2.839±0.420	1.937±0.175	0	2
F2	1.215	1.333±0.089	1.083±0.027	0	2
F3	0.000	2.538±0.326	1.934±0.234	0	2
F4	3.346	2.166±0.314	1.507±0.028	0	2
F5	0.625	1.933±0.058	1.621±0.164	0	2
F6	0.880	2.030±0.145	1.240±0.035	0	2
F7	0.000	1.171±0.092	1.330±0.012	0	2
F8	1.121	2.026±0.041	1.381±0.009	0	2
F9	0.000	1.359±0.376	0.850±0.060	0	2
F10	0.000	1.262±0.113	1.118±0.073	0	2

Table 6. Position, number and dimensions of the extrafloral nectaries for the 'Skeena' variety

No.	Distance to the limb (mm)	Length (mm)	Width (mm)	Number of glands on the limb	Total number of glands
F1	1.456	1.961±0.0071	1.391±0.135	0	2
F2	0.805	2.157±0.013	1.511±0.292	0	2
F3	3.213	2.571±0.057	1.514±0.226	0	2
F4	1.767	1.624±0.301	1.031±0.406	1	3
F5	2.290	2.213±0.092	1.393±0.032	0	2
F6	1.406	1.646±0.259	0.835±0.033	0	2
F7	3.278	2.354±0.245	1.466±0.094	0	2
F8	2.959	1.132±0.050	0.684±0.202	0	2
F9	2.182	1.115±0.135	0.723±0.146	0	2

Table 7. Position, number and dimensions of the extrafloral nectaries for the 'Lapins' variety

No.	Distance to the limb (mm)	Length (mm)	Width (mm)	Number of glands on the limb	Total number of glands
F1	0.723	0.983±0.270	0.759±0.138	0	3
F2	0.000	1.523±0.179	1.096±0.062	0	2
F3	1.64	1.721±0.038	0.964±0.256	0	2
F4	0.87	1.281±0.462	1.391±0.393	0	2
F5	3.044	1.528±0.173	0.783±0.282	0	2
F6	4.287	2.354±0.203	1.701±0.038	0	2
F7	0.891	2.024±0.357	1.291±0.126	0	3
F8	0.000	1.676±0.338	1.312±0.295	0	4
F9	2.848	1.846±0.790	1.204±0.704	1	3
F10	2.226	1.754±0.096	1.245±0.375	0	2

Following microscopic analysis of different cherry varieties, there are some major differences in position, number and size of extrafloral nectaries as follows: the 'Giant Red' variety consistently has a total of 2 glands which are predominantly positioned on the edge of the limb.

At the same time, this variety has the smallest size of the glands (both length and width).

Regarding the 'Regina' variety, it has no more than 2 glands, which are always positioned on the petiole. The variety with the largest extrafloral nectaries is 'Ferrovia'.

Figures 8 to 10 show the distance to the limb, the total number of extrafloral nectaries and the number of glands present on the limb for all studied cherry varieties.

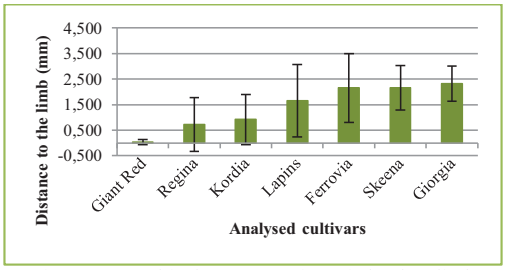

Figure 8. Graphical representation of gland-to-limb distance (mm) for analysed cherry varieties

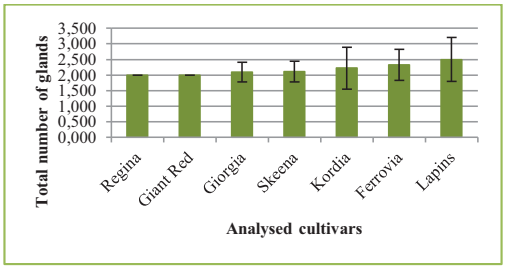

Figure 9. Graphic representation of the total number of glands for the analysed cherry varieties

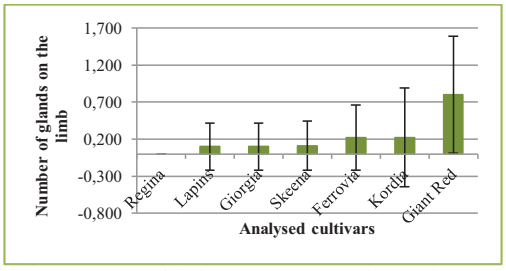

Figure 10. Graphical representation of the number of glands placed on the limb for the analysed cherry varieties

CONCLUSIONS

The largest distance between the glands and the limb was recorded on the 'Giorgia' variety leaves, while the smallest distance was recorded for the 'Giant Red' variety. As for the total number of extrafloral nectaries, it was between 2 and 4 per leaf for the analysed varieties. Thus, the largest number of leaf glands was recorded for the 'Lapins' variety, and the lowest number of leaf glands was recorded for 'Regina' and 'Giant Red' varieties. The presence of extrafloral nectaries on the limb was predominantly observed on the analysed leaves of the 'Giant Red' variety, while for the 'Regina' variety these glands were present only on the petiole.

Overall, the present study is unique, as no literature data was found on the correlations among cherry tree variety and extrafloral nectaries morphology and further attention has to be paid on research related to the influences of these on the pathology and pest resistances as well as on productivity of the same cultivars.

REFERENCES

Escalante-Pére, M., Jaborsky, M., Lautne,r S., Fromm, J., Müller, T., Dittrich, M., Kunert, M., Boland, W., Hedrich, R., Ache, P. (2012). Poplar Extrafloral Nectaries: Two Types, Two Strategies of Indirect Defenses against Herbivores, *Plant Physiology*, 159, 1176-1191.

Grasso, D.A., Pandolfi, C., Bazihizina, N., Nocentini, D., Nepi, M., Mancuso, S. (2015). Extrafloral-nectar-based partner manipulation in plantant relationships, *AoB PLANTS*, 1-15.

Rodríguez-Morales, D., Aguirre, A., Coates, R., Díaz-Castelazo, C., Angeles, G. (2016). Structure and histology of extrafloral nectaries of tropical species in a mexican rain forest, *Biosci. J., Uberlândia*, 32(3), 730-739.

Tilney, P.M., Nel, M., van Wyk, A.E. (2018). Foliar secretory structures in *Ekebergia capensis* (*Meliaceae*), *Heliyon*, 4, e00541.

Weber, M.G.; Keeler K.H. 2113. The phylogenetic distribution of extrafloral nectaries in plants, *Annals of Botany*, 111, 1251-1261.