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FEATURES OF FLOWERING AND FERTILIZATION HAZELNUT IN LUGANSK REGION AND DONETSK BASIN OF UKRAINE

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Produced research proof of the flowering characteristics and pollination hazelnut varieties that enable to predict the yield in conditions of Lugansk region.

Keywords: hazelnut, shape, flowering, female and male inflorescences, pollination, length, shoots.

Hazelnut as a cultivated plant has been growing nearly two thousand years. Archaeological research, buried under volcanic dust in 79 AD Pompeii, showed that hazelnuts were widely used by these legendary city residents. Hazelnut has been long cultivating in the Mediterranean coast states: Turkey, Italy, France, Romania and in the Crimea on the Black Sea coast in the Krasnodar region and the Caucasus [1, 2, 7, 10]. However, long before, hundreds or perhaps thousands of years until the bringing into the culture, different countries people gathered and have been gathering now various fruits of wild hazel *Corylus* L kinds. In North and then South America, Australia and some other parts of the world filbert culture has been already recognized in the twentieth century.

It is clear that environmental conditions in Turkey, Italy, the Crimea or the Caucasus are different from Donbass, but experience of botanical institutions and many amateur gardeners shows that filbert culture here is quite possible in the occurrence of varieties and resistant forms to unfavorable factors of local soil and climatic conditions [3, 4, 8, 12].

Selection or creation of such varieties is an urgent task, because *C. avellana* L. (hazel European) grows well in a moderate climate since becoming of this sort.

Fossil hazel species, which is its ancestors grew in Cretaceous period throughout the territory of modern European oak distribution [2, 11], particularly in Ukraine.

Modern hazelnut varieties, for centuries, were formed as a result of deliberate selection from natural hybrids mainly of three hazel kinds - *C. avellana* L., *C. maxima* Mill. and *C. pontica* C. Koch. On the American continent in the selection of hazelnut also were involved other hazel kinds - *C. americana* Mill. (Marsh.), *C. cornuta* Marsh., and in the Far East - *C. heterophylla* Fisch. and *C. sieboldiana* Blume. Periodically, and with varying success to improve hazelnut varieties, were also used tree sorts -*C. colurna* L., *C. chinensis* Franch. and *C. ferox* Wall. [6, 7].

Hazelnut, like its wild species ancestors is a cross-pollination anemophilous plant [5, 9]. This is monoecious diclinous plant in which female flowers develop on the same plant as the male inflorescences (aglets), but in some distance from them. Anemogamous was formed in the evolution process as a mechanism for cross-pollination of plants in winter and early spring period, when hazel blooms, as in the most parts of its areal, as in Ukraine, and conditions for its pollinator insect s are unfavorable. Existence of natural hazelnut clones and varieties of clones in industrial parks reduces effectiveness of diclinous monoecious as a guarantee mechanism of cross pollination, but genetic self-incompatibility system ,which they have, completes diclinous and quenches close pollination both as within the same plant as within the entire clone, even if such pollination occurs [13]. In consequence of self-incompatibility majority hazelnut varieties, as well as wild hazelnut, cannot set fruits from self-pollination [5, 15]. Small exceptions include such partly self-pollination varieties as wide spread in Turkey Tombul. However, these varieties require cross-pollination to realize their full productive potential and getting full quality fruits [5, 6].

Scientists have found that hazelnut plants and wild hazel have sporophyte incompatibility, where pollen germination is determined by genotype of source plant pollen (sporophyte) and tissue genotype style with stigmas (also sporophyte). Hazelnut incompatibility is controlled by S-gene, which could be in many allelic

states. For the time being more than 25 alleles of this gene is identified. There are two allelic forms of interaction determined between them – dominance, incomplete dominance and also hierarchy based on interaction between different alleles S-gene self-incompatibility [5-7, 13-15].

The peculiarities of flower buds hazelnuts are differ from many other monoecious crops (cucumber, corn, etc.) by the flower buds formation, which have bisexuality potency [5, 6]. Future flower buds sex of haselnut and wild hazel plants starts with flowering evocation - the incipient stage of stem apex transition to reproductive morphogenesis. On the generative organs is identified evokator –is a specific chemical substance that acts as an internal stimulus to develop of male and female primordial flowers [6, 15].

It is known that flowers of entomophilous plants are with attractive aroma to pollinator insects, bright petals, interesting shape, accumulate nectar etc. However, many entomophilous plants, particularly hazelnut, have unobtrusive, poorly developed female flowers, but they are well adapted to intercept a large pollen mass carried by the wind. [6] Only during the large flowering when colored stigmas move outward, it looks like "rose spots" on the bare bush [7, 15].

Flower buds in the dormant state little differ from vegetative. Each female flower bud germinates female inflorescence, which could number from 4 to 20 pistil flowers, but they are usually formed in eight [15]. Formation of future female hazelnut flower begins in June and July. [6]. After the style formation further differentiation processes in the female flower is suspended and restored in Ukraine in March next year. [7]

Stamen hazelnut flowers and filbert are also form from summer or fall that precedes flowering, but their development is very different from the development of female flowers. Although inflorescence (aglets) appear in July, but in this period they are little differentiated. Each aglet calculated 130-280 flowers. Their development pauses soon after the formation and organic rest comes, its duration depends on the variety. Forced rest comes after the organic rest under Ukraine winter conditions, which ends according to agro-climatic zones due to

meteorological conditions. Most seed plants anthers consist of two longitudinal unicamerate halves connected by ovary, but the hazelnut and filbert halves are separated. Therefore, although each male flower actually has only 4 stamens, but because of bifurcated anther it seems that they are 8. Before flowering aglets elongate and their dense surface becomes friable that promotes pollen an opportunity to pour out, sow and to be spread by wind. In general in March term in Ukraine with frequent frosts are low favorable conditions for flowering, pollination, fertilization and fruits growth for most plants. However, March flowering hazelnut and filbert held in Ukraine with absence of leaves on their plants as well as majority deciduous plants, trees and bushes of other species. It gives pollen the opportunity to get on stigmas pistils without obstacles and not settle on the leaves of trees and bushes [6, 7].

Under ideal temperature conditions after pollination (falling pollen on stigmas pistils) pollen tubes quickly enough (within two to three days) reach base style. In cold or drought, this process could be delayed significantly. After growing pollen tubes to the base of the style their growth stops to differentiation of ovary. Well then, although pollination occurred in leafless period, but fertilization and development of the ovary descends after stable warming when frost intimidation to the ovary is passed. Flowers with pollen stigmas ovaries begin to grow very slowly and only in June and July favorable conditions fast accelerate their growth. Instead ovaries of not pollen stigmas flowers stop growth and never exceed 1-2 mm [7, 15]. Hazelnut and filbert embryo sacs are ripen in a few months after pollination. In Turkey with warm climate it may be in four or six months, and in Ukraine – in a month and a half or in two months. In consideration of fertilization the zygote is formed, which further development begins after repeated division of the primary endosperm nucleus, while increasing the size of the embryo sac [6, 7].

With relatively sufficient quantity of publications devoted to the development of generative organs hazelnuts and filbert [5-7, 9, 13-15] the question of peculiarity location inflorescences on shoots, flowering and fruiting in Lugansk

region and the Donetsk Basin of Ukraine is almost unclear that prompted us to conduct our researches.

The purpose of research - find morphological features of location of the generative organs on shoots; specific formation generative buds and preservation of collective fruits certain hazelnuts forms in Lugansk region.

Research Methodology

In ongoing experiments in 2009-2011 we studied hazelnut forms planted in 1989 biennial seedlings in Yunytsk forestry Bilovodskyy district Lugansk region. In accounting of inflorescences determined their location on shoots, inflorescences quantity, which were formed from 1, 2, 3 ... 10th buds from apical, in a percentage to the total number of inflorescences, which were analyzed in 50-250 pieces for each form. Research from study the optimal shoot length with a maximum concentration of fruit buds in local forms selected for Donbass, took place in 2010-2011 in five forms: 5-9, 20-4, 10-5, 17-9 and 7 - 6. Took into account placing generative organs on the shoots which were not less than 15 cm, 16-30 cm, 31-45 cm and over 45 cm in length.

The results were treated by statistical methods using computer programs.

Research Results

Study characteristics of inflorescences location on shoots showed that the majority of female and male inflorescences in all investigated forms are concentrated in the upper part of the shoot. Then far bud is placed on top of the shoot, then less the likelihood of becoming inflorescences in it. Thus the form of 1-21, 3-11, 10-5, 15-3 and 17-9 aglets mostly formed from the first and second buds on the shoot top. Instead of this, forms 5-9, 7-6, 11-12, 20-4, 22-8 and 25-7 a number of aglets were formed from the second - fourth buds, as well as five or six buds together. These forms make up a large quantity of aglets, distributed along the shot more evenly. The relationship between the place of aglets location shoots and their number were identified.

A similar regularity in female inflorescences was not observed. Well, most of them from the first and second buds from the top shoot were in the forms 10-5

and 11-12. However, the form 10-5 on five model branches showed 53 fruit buds (the second parameter in the experiment), whereas form 11-12 - only 15, which had the lowest significance (Tab. 1).

Table 1

Location fruit buds and earrings for 5 model branches hazelnut seedlings (2009-2010)

Form	Number of fruit buds, pc	Number of aglets, pc	Proportion of fruit buds on shoots with earrings,%
1-21	20	37	33,1
3-11	17	63	58,0
5-9	28	129	90,7
7-6	60	72	72,4
10-5	53	53	58,8
11-12	15	125	82,0
15-3	25	136	54,8
17-9	33	13	9,5
20-4	31	126	72,8
22-8	32	138	84,5
23-2	25	13	16,6
25-7	26	116	72,3
HIP_{05}	3,7	5,7	2,8

It should be noted that in most cases, women inflorescences, as well as male are close on the same shoot. In addition, some female inflorescences are located directly on aglets pedicels. It is clear that cases of aglets placement and female inflorescences on the same shoots are more common in forms that make up a lot of aglets. Thus, in the forms 5-9, 11-12 and 22-08 over 80% of fruit buds are located

on the same shoot, as aglets. In forms, forming little aglets, such as forms 17-9 and 23-2, less than 20% of fruit buds are placed on the shoots with aglets.

Correlation of quantity female inflorescences and aglets forms that have been studied are often different. Most of them have dominated male inflorescences, as it usually happens in all anemophilous kinds. Forms 17-9 and 23-2 are exception where female inflorescence are dominated (Table 2).

Table 2

Ratio of earrings and female inflorescences in the studied forms of hazelnuts

form	Ratio of male inflorescences to the number of women			Type flowering
	2010	2011	Середнє	
1-21	1,37	4,04	2,71	mixed
3-11	6,32	4,46	5,39	male
5-9	4,15	7,76	5,97	mixed
7-6	3,13	3,01	3,07	mixed
10-5	1,04	1,49	1,26	mixed
11-12	9,37	7,97	8,67	male
15-3	3,99	7,30	5,64	male
17-9	0,23	0,38	0,30	female
20-4	5,26	3,01	4,13	male
22-8	4,82	3,88	4,35	male
23-2	0,56	0,29	0,43	female
25-7	6,46	3,41	4,93	male
HIP_{05}	2,37	2,38	3,73	

In most studied forms of hazelnuts is identified stable, for years,correlation number of aglets and female inflorescences. But in 2010 in the form of 1-21 it was almost three times lower than in 2011, that indicates to the complex inheritance reaction of this form on fluctuations growth conditions and its development. Instead of this, the forms 17-9 and 23-2 annually prevailed number of fruit buds

which developed female inflorescence. These forms have high productive potential in proper selection of pollinator varieties.

Besides buds location on the shoots also on the probability of forming fruit buds the shoot length affects. Typically, the largest number of female inflorescences are set on annual shoots 15-40 cm in length. Shorter shoots often slow in growing and die, but the buds, which are formed on shoots longer than 40 cm tends to vegetative growth.

In our experiments on the shoots shorter then 15 cm, were formed only 10-15 female inflorescences. In some forms more their quantity were formed on short shoots, for example in the form 10-5 they were 19-21 pieces. Most fruit buds in average were located on the shoots longer than 45 cm in the form 5-9 – 42,5, 10.5 - 56.5, 7-6 – 24,5, 20-4 - 39.0 units. Unlike other forms 17-9 the highest number of fruit buds (35,5 pieces) were indicated on the shoots 31-45 cm in length (Table 3).

Table 3

Number of male and female inflorescences, depending on the length of the escape (2010-2011 years)

form	Number of female inflorescences on shoots length (cm)				Number of earrings on shoots length (cm)			
	less 15	16–30	31–45	more 45	less 15	16–30	31–45	more 45
5-9	4	12	34,5	42,5	7,5	39,5	36,5	31
7-6	4	20,5	19,5	24,5	0	26	36	22
10-5	20	31	50,5	56,5	2,5	28,5	28	18,5
17-9	5	27,5	35,5	32,5	3,5	33,0	36,5	38,0
20-4	3	25	32,5	39	–	–	–	–
HIP_{05}	0,6	1,5	1,9	2,4	2,1	2,3	2,7	2,9

In most studied forms (except 5-9) on the shoots up to 15 cm were formed significantly less aglets than female inflorescences, and form 7-6 on the such length shoots did not have them at all. In forms 5.9 and 10-5 the largest number of aglets were counted on shoots in 16-30 cm length, which was on average 39,5 and 28,5 units. The form17-9 had most of (38 pcs.) on the shoots longer than 45 cm.

The form 20-4 was formed regardless of the shoot length very little aglets number. Only some shoots formed from one to four aglets that are not allowed to include these results in the calculations. General regularity shows that female and male inflorescences are better formed on shoots from 16 to 45 cm length.

After the collective fruits formation nuts harvest depends on their development and preservation from casting from the shoots. In this regard, the question about the possible effect of shoot length on preservation and thus on the yield arose. Completed in two years account of available collective fruits for the term on July 25 according to the total number of female inflorescences showed that the observations in 2010 and 2011were significantly different. The largest percentage of preservation collective fruits in the same form in different years was observed on the different lengths shoots. Comparison of average collective fruits for two years also does not give the opportunity to affirm the coherence of number collective fruits hazelnut with shoot length on where these collective fruits were formed (Table 4).

Table 4

Preservation suplid as of 25.07 on the number of female inflorescences of hazelnut studied forms depending on the length of the escape

Форма	Number suplid (%), preserved at 25.07 on the number of female inflorescences on shoots length (cm) *								
	16–30			31–45			більше 45		
	2010	2011	Average	2010	2011	Average	2010	2011	Average
5-9	73,3	42,9	58,1	63,6	44,0	53,8	47,7	24,7	36,0
7-6	57,7	0	28,8	85,0	42,1	63,6	61,5	30,4	46,0
10-5	21,1	45,8	33,5	29,1	8,7	18,9	54,8	29,6	42,9
17-9	54,5	22,7	38,6	77,1	13,9	45,5	76,0	17,5	46,8
20-4	78,3	33,3	55,8	45,5	26,9	36,2	30,0	35,4	32,7
$НІР_{05}$	3,7	5,8	4,8	3,1	4,3	3,7	3,8	4,4	4,1

In shoots of less than 15 cm in length most studied forms had few inflorescences, and formed collective fruits were mostly crumbled, which does not allow us to make any generalizations. The exception was the form 10-5, on shoots up to 15 cm where more than half collective fruits were saved. This short shoot form formed more fruit buds than other forms (see Table 3).

Conclusions

1. In the agro-climatic conditions Yunytsk Forestry Bilovodskyy district Luhansk region the majority female and male inflorescences in all investigated hazelnut forms are concentrated in the upper part of the shoot.

2. Defined that aglets placed along the shoot more evenly in forms which have a large aglets number.

3. This information could be used for formation correct crown and affects the plantations productivity.

4. We can suggest that with proper selection of pollinator varieties of the female flowering type form we may have high productivity potential.

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ОСОБЛИВОСТІ ЦВІТІННЯ І ЗАПЛІДНЕННЯ ФУНДУКА В УМОВАХ ЛУГАНСЬКОЇ ОБЛАСТІ І ДОНЕЦЬКОГО БАСЕЙНА УКРАЇНИ

ЛОАЙ САХИБ РАДИ АЛЬРМАШДІ

Наведено результати вивчення особливостей цвітіння і запліднення сортів фундука, що дають можливість прогнозувати їх урожайність в умовах Луганської області..

***Ключові слова**: фундук, форма, цвітіння, жіночі і чоловічі суцвіття, запліднення, довжина, пагони.*

ОСОБЕННОСТИ ЦВЕТЕНИЯ И ОПЛОДОТВОРЕНИЯ ФУНДУКА

ЛОАЙ САХИБ РАДИ АЛЬРМАШДИ

Приведены результаты изучения особенностей цветения и оплодотворения, позволяющие прогнозировать урожайность сортов фундука для условий Луганской области.

***Ключевые слова:** фундук, форма, цветения, женские и мужские соцветия, оплодотворения, длина, пагоны.*