

THE INHERITANCE OF SOME QUALITATIVE AND QUANTITATIVE TRAITS IN HYBRID PEACH'S PROGENY F₁ AND F₂

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Character of the inheritance of some qualitative and quantitative traits in the peach's hybrid offspring of 20 crossing combinations was analyzed. The resulting actual segregation of hybrids for qualitative peach's traits corresponds to theoretically expected ratio. The inheritance of the peach's "fruit's ripening period" is more complex. There are four types of distribution of hybrids in the F₁ and F₂: normal, asymmetric, bimodal and chaotic. Segregation of hybrids for the fruit's ripening period proves not only polygenic, but oligogenic control of this trait.

Key words: *Prunus persica*, hybrid progeny F₁ and F₂, inheritance of the fruit's ripening period.

Introduction. Peach [*Prunus persica* (L.) Batsch.] - the traditional fruit culture of the South Ukraine, especially Crimea. It has great economic importance in USA, France, Italy and others countries. Not review on its popularity and rather ancient culture, understanding genetic structures and genus organizations of the far lags behind from such beside the other cultures (for instance, corn and other one-year plants). At present molecular genetic approaches in plant breeding have been blended with traditional breeding practices and it is now certain that a solid genetic database for peaches is obtainable in the very near future [1]. The inheritance qualitative characteristics *P. persica* occurs, at first thought, enough simply, on law Mendel i.e. on monofactorial model [3]. To the main qualitative traits *P. persica* pertain: flower's type, "present pile", character of covering colorations, color of the thin skin, consistency and color of the flesh, knitting of the stone, stone's drawing, the forms of the glandules and etc. They are controlled by oligogenes. The greater variety beside peach exists not on qualitative, but on quantitative characteristics: height of the plants, parameters of leaves, stipules, flower and fruit, area and intensity of covering colorations, degree pile, period of the blossom and duration of the vegetation, contents biochemical material and others. In this article is tracked inheritance such characteristic culture as a "fruit's ripening period". This question is important, both in theoretical, and in practical plan. The administrators are necessary to have peach's assortment from ultra-early fruit's repining before very late varieties, providing steady conveyor to fresh product for consumption, as well as cheese for conversion. The endless elongation of this period of the unceasing the fruit's ripening by creation new sorts is limited biological particularities of the culture and climatic factors of the area.

Materials and methods. Research has been carried out in the selection garden of the Steep department Nicitsky Botanical Gardens – National Scientific Center (NBS – NSC), located in south steppe climatic zone of the Ukraine. Object of the research – hybrid families of the first and second generations (F₁, F₂). Work hypothesis – classic genetic theory – Mendel’s laws, according to which, the hybrid generation F₁ are homozygotic, but segregation for qualitative traits exists in F₂. The hybrid progeny is received by crossing peach’s sorts with known qualitative characteristics differs of the fruit ripening period. The hybrid offspring are grown to fruiting age. The whole is analyzed 528 hybrid seedlings 10-15 year’s age: 17 cross combinations generation F₁ and 3 combinations of the population F₂ from self-pollination. The study was conducted on length several years after entering of seedlings in time fruit ripening. The average date of the fruit’s ripening period of seedlings was fixed as described in the Program and methods [4].

Results and discussion. It is known that such characters in peach plants as a flower-type, a fruit flesh’s color, a flesh’s consistency and stone’s knitting are inherited by model monohybrid cross: in the F₁ generation are observed homogeneity of traits, in the F₂ – segregation in 3:1 ratio [3]. Segregation of traits in the F₁ off-spring is demonstrated so initial parents had alleles being in heterozygote state.

20 hybrid families F₁ have been analyzed. Segregation was appeared for the flower’s type, the color and the consistency of the fruit’s flesh and stone’s knitting. Results are presented in table 1. Segregation for the “pile of the fruit’s skin” wasn’t revealed. There is noted homozygosity for “flower-type” (“showy flowers”) in crossings Veteran x F₃ 137-81, Gurzufskiy x F₁ 26-76, Dvoynik x F₁ 26-76, Gvardeyskiy Jeltiy and Moscvich x Vedetta. Since the rose-type flower (“showy flowers”) is controlled recessive alleles shsh, possible conclude that initial parental forms were homozygote (shsh) on the given trait (allele). There is segregation for “flower-type” follows a 1:1 ratio in 11 populations F₁ from 20 (Tabl.1). Possible expect, that sorts Armgold, Valiant, Gvardeyskiy Jeltiy, Dakota, Moravia, Rubynoviy, Start with “bell-type” flower are heterozygote for given characteristic (Shsh). There isn’t segregation for “fruit flesh’s color” in 14 from 20 hybrid families, as follows fruits they was gold. Parental forms of these families had yellow-fleshed fruits. The yellow flesh’s color - a recessive trait, is controlled allele “yy”. Naturally expect from of yellow-fruit’s parents only the yellow-fleshed progeny. In hybrid families, where one of the initial parents was white-fleshed, in F₁ is noted segregation for “fruit flesh’s color”. So, in the F₁ Tourist x F₁ 26-76, Moravia x Pushistiy Ranniy, Gurzufskiy x F₁ 26-76 the segregation for “fruit flesh’s color” is existed close to 1:1 in ratio (tabl. 1).

Table 1

Segregation some of traits peach's cultivars in F1 generation

	Combination of crossing	Segregation for' flower's type,			Segregation for:		
		real, piece		In theory expected	Fruit's flesh:		Ston's knitting: knitting/ half knitting / absolute knitting
		Bell-type - Non-showy flower,	Rose-type - showy flower		consistency	color	
				fibrous: gristly	white: yellow*		
1	Valiant x Kodru	7	7	1:1	10:0	0:10	5:3:2
2	Valiant x Tovarisch	13	10	1:1	21:0	0:21	19:2:0
3	Dakota x Tovarisch	41	36	1:1	77:0	0:77	50:1:8
4	Moravia x Springold	7	12	1:1	11:0	0:11	5:1:5
5	Moravia x Madeleine Puyet	20	14	1:1	15:0	2:13	7:4:4
6	Moravia x Pushistiy Ranniy	14	14	1:1	10:0	4:6	5:3:1
7	Moskvich x Gvardeiskiy Jeltiy	13	5	1:1	9:0	0:9	7:0:2
8	Rubinoviy x F2 124-78	21	17	1:1	18:0	0:18	16:0:2
9	Rubinoviy x Tovarisch	37	50	1:1	53:0	0:53	48:1:3
10	Start x Madeleine Puyet	7	10	1:1	9:0	0:9	5:2:2
11	Start x Armgold	7	5	1:1	4:0	0:4	0:0:4
12	Turist x F2 26-76	25	19	1:1	39:0	24:15	39:0:0
13	Veteran x F3 137-81	0	54	0:1	33:2	0:35	27:2:6
14	Gurzufskiy x F2 26-76	0	43	0:1	38:3	21:19	28:3:10

Примечание:

- - White – including light green, cream and purely white or with different tints;
- - yellow – including orange, yellow-orange and purely yellow or different tints.

The analysis of 7 hybrid offspring F₂ from self-pollination has shown heterozygote of initial parents: Fergansky Jeltiy, Moravia, Gorniy Hrustale, Nicitskiy Jeltiy and Maot Haor. There is segregation noted for all traits in the F₂ (Turist x Ferganskiy 63-48). In population F₂ Moravia x Gorniy Hrustale homozygosis is aparies for to one's: "present pile", "fruit flesh's color" and "fruit flesh's consistency". In the generation F₂ Nikitskiy Jeltiy x Maot Haor homozygosis exists for the flower's type (shsh), "fruit flesh's color" (yy) and presence skin's pile (GG).

Hybrid progenies are segregate for the “fruit flesh’s consistency”, stone’s knitting, the form of the glandules and stipules. The cross F₂ 17-115 Veterans x Moldavian Jeltiy shows same the segregation. The off-spring F₂ Laureate x Zlatogor is homogenous for all observed characteristics except “stone’s knitting”: segregation is about 3:1 ratio. Thus you can see from table 1 that segregation for “flower’s type” in F₁ is about to 1:1 ratio. This tests about heterozygote state of suitable alleles of initial parents forms. Segregation for fruit flesh’s consistency is revealed in F₁-families Veteran x F₃ 137-81 and Gurzufskiy x F₁ 26-76.

For appearance of the feature “gristly flesh’s consistency” necessary to alleles, controlled to for it, was in the homozygote state. Signifies, initial parental forms contains given allele, at least once, in single count. The appearance in the F₁ individuals with knitting stone is indicative of heterozygote one’s of the parents for the given trait. Assumed theoretic genetic characteristic of some peach’s traits as the result of analyses offspring F₁ is presented table 2.

Table 2

The hypothetical genetic characteristic of peach’s varieties for some traits

№ N/n	Varieties	The qualitative peach’s traits		
		“flower’s type”	“flesh’s color”	“stone’s knitting”
1	Armgold	Shsh	yy	kk
2	Valiant	Shsh	yy	Nk
3	Gvardeyskiy Jeltiy	Shsh	yy	kk
4	Dakota	Shsh	yy	Nk
5	Kodru	shsh	Wy	kk
6	Madeleine Puyet	shsh	Wy	kk
7	Moravia	Shsh	yy	Nk
8	Moskvich	shsh	yy	Nk
9	Rubinoviy	Shsh	yy	Nk
10	Pushistiy Ranniy	shsh	Wy	kk
11	Start	Shsh	yy	Nk
12	Springold	shsh	yy	kk
13	Tovarcsh	shsh	yy	Nk
14	Turist	shsh	Wy	NN
15	F1 26-76 Nectadiane	shsh	yy	Nk
16	F1 124-78	shsh	yy	Nk

Foot-note: Dominant traits:

Sh – not show flower or bell-type

Y – white flesh’s fruit

N – “Non stone’s knitting”

Recessive traits:

sh – show flower or pose-type

y – yellow flesh’s fruit

k – “stone’s knitting”

The analysis of hybrid seedlings for “fruit ripening period” was realized by breakdown it on groups of fruit ripening with 10-day’s interval: the first, the second and the third ten of the month. The whole was got 12 groups. The analysis progeny has shown that the population F₁ had a more uniform for qualitative traits (the “fruit flesh’s color”, the “flower-type” and i. e.) then F₂. Differences exist for quantitative sign: variation on the form of the fruit, on degree of the covering colorations (% area), on terms of the blossom and fruit’s repining, the resistance to

diseases. Off-springs F₂ from self-pollination were more varied for qualitative and quantitative characteristics. The distribution peach hybrid's seedlings F₁ and F₂ on fruit ripening period are presented in table 3.

Table 3

Distribution hybrid peach's seedling F₁ and F₂ on the "fruit repining period"

№ п/ п	The crossing combination	Amount seedling of the fruit repining period: knead/ ten													
		06			07			08			09			10	
		III	I	II	III	I	II	III	I	II	III	I	I		
Hybrids F₁															
1	Moravia x Madeleine Puyet	†		1	5	4	3		□						
2	Start x Madeleine Puyet	†			4	1	2	□	2						
3	Start x Stark Red Gold		†		1	1	1	□		1					
4	Moravia x Stark Red Gold		4 †	11	3	3	0	0	1						
5	Start x Arnold			† 1	2	1		□							
6	Rot Front x Gvardeyskiy Jeltiy			†	2	10	8	3		□					
7	Moskvich x Gvardeyskiy Jeltiy			†		6	4			□					
8	Rubinoviy x Nektamira F ₂ 124-78				†			2	10	7					
9	Valiant x Codru				5 †	1	0	3	1						
10	Elegy x F ₁ 140-75					7 †	3	6	4	2					
11	Zolotaya Moskva x Vedetta						1	□†	1						
12	Tourist x F ₁ 26-76		1			1	2	8	21	8					
13	Gurzufskiy x F ₁ 26-76					4	0	9	16	11	0	1			
14	Spartak x F ₁ 26-76					1	9	□	14	8	3	1			
15	Rubinoviy x Tovarisch							1	31	11	7	1			
16	Dakota x Tovarisch							5	37	26	3				
17	Valiant x Tovarisch						10	□	5	9					
Hybrids F₂ sejf-pollination															
18	(Touris x Ferganskiy) 63-48 self.						1	0	4	31	9	0	1		
19	(Laureate x Zlatogor) 73-2 self.					□		†	3	10	11	1	1		
20	Gorniy Hrustale self.						1	3	3	1					

□ - the mother's (female) form; † - the father's (male) form.

Sorts of medium, med-late and late groups of the fruit ripening period has been used as maternal forms. Early and early-middle sorts weren't taken as mother's forms since its seeds, as a rule, aren't germinating. As father's forms were involved sorts of the very early ripening period (the second ten of July) before late term (the first ten of September). There was hybrid progenies an intermediate type with prevalence early-middle repining season (the end of the July - begin August) in combinations of early (Madeleine Puyet, Stark Red Gold) and med-late varieties (Moravia and Start). There are forms such as heterosis, i.e. else later than parent repining, in populations.

Such a picture exists when crossing early-middle (Gvardeyskiy Jeltiy, Armgold) with late or med-late sorts (Moscvitch, Rot Front and Start). In the population Rubynoviy x Nektamira F₂ 124-78 is tracked greater influence of the maternal sort towards more late ripening, but in the combination Moravia x Stark Red Gold - a father's sort, towards more early ripening. In families Valiant x Kodru, Valiant x Tovarisch and Elegy x F₁ 140-75 two groups stand out amongst posterity: one closer to maternal type, the other - father. Five pairs parent's sorts have same or very close to ripening season (combinations 12-16 in Table 3). Their hybrid progeny is distributed for the ripening date in broad diapason, 50-80 days. Meet the seedlings with early, early-middle, meddle, med-late, late and very late ripening period. Hybrids with maternal type of the fruit's ripening time and later in contrast with it prevail among its (Gurzufskiy x F₁ 26-76, Tourist x F₁ 26-76, Spartak x F₁ 26-76, Rubynoviy x Tovarisch and Dakota x Tovarisch).

There are different peculiarities revealed in the hybrid family F₂. Offspring of late ripening parents in one event are only late, very late and rare - middle forms ((the Tourist x Ferganskiy) 63-48 self.), in the other - late, med-late and middle fruit's ripening hybrids (the Gorniy Hrustale self.). The crossing middle and med-late ripening sorts has given hybrids F₂ with only the late and very late fruit's ripening period (combination 19).

Thereby, the distribution progeny for the fruit's ripening period is much heterogeneous in our study. As a whole it is tracked four type segregations or regularities of the distribution: normal (1, 5, 6, 13, 14, 18 and 20 combinations), bimodal (9, 10 and 17), asymmetrical (4, 8, 12, 15, 16, and 19) and chaotic (2, 3, 7, and 11). Normal, asymmetrical or bimodal distribution peach's progeny was noted by French.

The normal distribution offspring proves of usual quantitative inheritance of the traits [5]. Existed in the some crossing asymmetrical and bimodal distribution seedling testify to of presence the main gene (oligogene) determining early ripeness, both in progeny of the sort Stark Red Gold, and later repining, as in progeny of the 'Tovarisch'. Such distribution offspring will with studies Weinbeger, Bailey and other [2]. Authors have presented the theoretical scheme for the explanation like results. It includes nine "main or dominate" genes and 10 - gene-modifiers. Each of parents and offspring were prefixed preliminary genotypes with these 19 locuses, which it is enough for usual polygenic explanations such quantitative traits. And it is enough to correspond to the polygenic theory of the

French with influence several main genes [5]. Beyli and Hauf prefix the effect of dominance, epistasis, interactions and linkage to specific genes their model [2].

There is an average date of the fruit ripening of parents correlates with average value of progeny [5]. Was revealed rather high the coefficient of the heritability for the fruit ripening period, equal 0,84. On this theory the characteristic “date of the fruit ripening” is found under the additive genes action. The similar results were got in 1, 6 and 7 crossing combinations our studies. Parents these hybrid forms the most remote friend from friend on the fruit ripening period (for 50-70 days), and posterity is distributed, mainly, within the fruit ripening period of the parents. At reduction of this difference, as from 12-th combination (tabl. 3), such regularity isn't kept. Many hybrids are appears, overstepping limits of the ripening periods of the parents. There are most hybrids since later of the ripening period of parents among of all progeny. The same particularity is revealed in F₂ from self-pollination (18 and 19 combinations).

Amongst hybrid progeny noted variants with darting out means: very early or very late the ripening date. This will also with some authors, who explain such events by point mutations. Thereby, got results allow doing the following findings.

Conclusion.

1. When crossing peach's varieties different in the fruit ripening period is noted segregation progeny for this trait in the first and second generations. Several types of the distribution offspring noted for “the ripening period”: normal, asymmetric, bimodal and chaotic, that is indicative not only the polygenic, but also oligogenic control of this trait.

2. When crossing sorts, very different in the fruit ripening date (50-70 days), the most hybrid offspring F₁ is distributed values within the ripening period of the parental forms. At reduction difference on ripening dates of the parents (before 10-20 days) a shift reveals in the hybrid progeny's distribution towards the later ripening term, outgoing for limits of the parents.

3. The sorts Armgold, Valiant, Gvardeyskiy Jeltiy, Dakota, Moravia, Rubinoviy, Start are heterozygote for trait “flower's type”; the sorts Madeleine Puyet, Pushistiy Ranniy and Turist are heterozygote for “fruit pulp's color”; Valiant, Dakota, Kodru, Moravia, Moskvich, Rubinoviy, Start, F₁ 26-76 Nectadiane, F₁ 124-78 – heterozygote for “stone's knitting”.

4. Yellow-fleshed individuals predominate among studied cultivars and among them the offspring's F₁ and F₂. Elimination “white-fleshed” peach's sorts in spite of dominating character of this trait is caused by artificial selection, by rejection of spoilage these forms as not popular or economic not desirable. The appearance of the trait not connected with economically valuable characteristics as “flower's type” is more evenly, because it has casual nature.

5. Traits “flower's type”, fibrous “fruit flesh's consistency”, “fruit flesh's color” and “stone's knitting” are inherited independently, i.e. alleles controlling given characteristics belong to different linkage groups.

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Лацко Т.А. Спадковість деяких кількісних та якісних ознак в гібридному потомстві персика F1 і F2

Зроблен аналіз гібридного потомства персика першого та другого покоління 20 комбінацій схрещування за деякими кількісними та якісними ознаками. Фактичне розщеплення гібридів за якісними ознаками відповідає теоретично очікуваному співвідношенню. Спадковість «періоду дозрівання плодів» у персика більш складна. Встановлені чотири типи розподілення гібридів у першому та другому поколінні: нормальне, бімодальне, асиметричне і хаотичне. Розщеплення гібридів по «терміну дозрівання плодів» свідчить про те, що ця ознака у персика контролюється не тільки полігенами, а й олігогенами.

Ключові слова: Prunus Persica, гібридне потомство F1 і F2, спадкування період дозрівання плоду.

Лацко Т.А. Наследование некоторых качественных и количественных признаков в гибридном потомстве персика F1 и F2

Проанализирован характер наследования некоторых качественных и количественных признаков в гибридном потомстве F1 и F2 персика 20 комбинаций скрещивания. Полученное фактическое расщепление гибридов по качественным признакам персика соответствует теоретически ожидаемому отношению. Наследование «периода созревания плодов» у персика более сложное. Установлено четыре типа распределения гибридов первом и втором поколении: нормальное, бимодальное, асимметричное и хаотическое. Расщепление гибридов по «сроку созревания плодов» свидетельствует о том, что этот признак у персика контролируется не только полигенами, но и олигогенами.

Ключевые слова: Prunus Persica, гибридное потомство F1 и F2, наследование период созревания плода.