Contribuţii Botanice, *XLII*, **2007**
Grădina Botanică "Alexandru Borza"
Cluj-Napoca

HETEROSIS MANIFESTATION OF SEVERAL QUANTITATIVE CHARACTERS OF ORNAMENTAL INTEREST IN GILLYFLOWER (*MATTHIOLA* SP.) BREEDING

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Abstract: Six parental patterns (P_1 – P_6) of cultivars of the *Matthiola incana* species and 10 direct and mutual hybrid combinations (obtained through cyclic crossbreedings using P_1 as a tester) were analyzed in 2006, in terms of the main quantitative characters that confer ornamental value to the plants. The results showed that regarding hybrid vigor, in F1 descendants with simple flowers, positive heterosis was found in all or the majority of the studied combinations only in the case of the flower diameter, siliqua length and number of inflorescences per plant, when heterosis was calculated based on the parental mean. When heterosis was calculated in relation to P_{max}, the other combinations had both positive heterosis and negative heterosis regardless of the way of its calculation.

In descendants with plants presenting composite flowers, only the height of plants and the flower diameter had predominantly positive heterosis for both ways of calculation, the other characters having negative values. We assume that negative heterosis in this case, could be rather designated as the result of genetic transgressions.

Keywords: *Matthiola* sp., cyclic hybridization, ornamental characters, heterosis

Introduction

Like in other garden plants, in which the phenomenon of heterosis was evidenced in intervariety crossbreedings more than 100 years ago [2], in the case of gillyflowers, heterosis most frequently manifests in these crossbreedings. This statement is also supported by the fact that the variability analysis of the F_1 generations obtained after intraspecific crossbreedings in the *Matthiola* genus [3, 4] clearly showed that, almost always, the variability of this hybrid generation was significantly different from that of parental patterns, the means of the studied quantitative characters being, in the majority of cases, higher in F_1 hybrids compared to the mean values of the parental population. This paper presents data on the heterosis of the studied quantitative characters, expressed as a difference between the mean of the F_1 population and the mean of the two parental patterns, on the one hand, or as a difference compared to the character value of the best parent, on the other hand.

Material and Methods

Six varieties of gillyflower belonging to the *Matthiola incana* species (P_1 - *white-yellowish flowers*; P_2 – *purple flowers*; P_3 – *light mauve flowers*; P_4 – *dark purple flowers*; P_5 – *pink-purple flowers*; P_6 – *pink flowers*) were used in 2004 and 2005 in a system of direct and mutual cyclic crossbreedings, in which P_1 was used as a tester.

The artificial hybridization was performed using the methodology presented by Pui et al. (2007b), a number of 10 hybrid descendants being obtained (see Table 1 and 2), which included between 60 and 200 F_1 plants. Each descendant was sown in 2006 in separated plots, the measurements and determinations being performed in 50 plants from each combination, for the following characters:

- height of plants with simple flowers/composite flowers (cm);

- number of inflorescences per plant with simple flowers/composite flowers;
- number of simple flowers/composite flowers in inflorescence;
- diameter of simple/composite flowers (cm);
- siliqua length (cm);
- beginning of flowering (days, since 01.06);
- duration of flowering (days).

In the varieties with both simple and composite flowers, two samples of 50 plants each, representing the two fundamental types of flowers, were analyzed. The same number of plants was used for the analysis of the mentioned characters in the parental patterns under study in the *Matthiola* sp. collection of “Babeş-Bolyai” University (UBB).

Based on the obtained results after measurements, the heterosis value (V_h) of the studied characters for each hybrid combination was calculated. The results were expressed by the comparison of the mean of the F_1 hybrids with the parental mean, as well as by the comparison of the F_1 mean with the character mean of the best parent, according to the formulas [1]:

$$V_h = \overline{F_1} - (P_1 + P_2)/2$$
$$V_h = P_{\max} - \overline{F_1}$$

Results and Discussion

The data regarding the hybrid vigor of the characters analyzed in the F_1 descendants of gillyflowers with simple flowers are shown in Table 1.

In can be observed that only in the case of three analyzed characters (number of inflorescences/plant, flower diameter (cm) and siliqua length (cm) the heterosis value is predominantly positive in the majority or in all individuals of the 10 studied combinations, both when heterosis is calculated compared to the parental mean and when it is calculated compared to the best parent. There are a number of characters such as: height of plants, number of flowers in inflorescence, beginning of flowering and its duration, in which, in certain combinations, heterosis is positive, while in others, it is negative. It should be noted that almost always, if heterosis has negative values, it maintains its sign regardless of the way in which it is calculated. Based on the analysis of these results, it can be concluded that hybrids of gillyflowers with simple flowers (extremely important characteristics for the reproduction of plants) have obvious and positive heterosis, which favors the process of seed multiplication of the cultivars of this species.

The appearance of “negative heterosis” in some combinations and for some characters does not affect the reproductive function of the gillyflowers with simple flowers, these characters being only indirectly involved in the production of seeds (e.g. height of plants, beginning of flowering).

Table 2 shows the experimental results regarding the heterosis value in the 10 studied combinations, in plants with composite flowers.

Our data show the fact that in F_1 hybrid plants with composite flowers, only the height of plants and the duration of flowering has predominantly positive heterosis values in all the studied combinations. It should be noted that these heterosis values are positive regardless of the way of calculation of hybrid vigor.

Two characters (number of flowers in inflorescence and beginning of flowering) show predominantly positive values of heterosis expressed as a difference of F_1 compared to the parental mean, but when expressed as a difference of the F_1 mean compared to the best parent, heterosis is predominantly negative.

Table 1: Heterozis value of some quantitative characters at intervarieties hybrids of *Matthiola incana* with simple flowers

Parents/Hybrids	Height of plants with simple flowers (cm)	Number of inflorescence/ plant	Number of flowers in inflorescence	Flowers diameter (cm)	Siliqua length (cm)	Beginning of flowering (in days, from 01.06.)	Persistence of flowering (in days)
P_1	75,6	25,1	17,6	2,9	11,7	32,9	105,6
P_2	74,1	16,9	16,9	2,9	10,3	22,0	112,2
P_3	80,3	18,4	20,3	2,7	13,0	23,2	108,3
P_4	70,7	23,6	20,6	2,3	10,6	34,8	103,8
P_5	76,2	21,4	15,8	3,2	14,8	29,1	105,2
P_6	76,9	24,2	16,4	2,9	14,2	24,2	109,1
$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$
P_1 x P_2	5,4 / 4,6	3,5 / -0,6	2,3 / 1,9	0,3 / 0,3	1,7 / 1,0	2,5 / -3,0	-0,5 / -2,8
P_2 x P_1	4,7 / 3,9	3,9 / -0,2	2,9 / 2,5	0,2 / 0,2	1,5 / 0,8	3,7 / -1,8	-1,2 / -2,1
P_1 x P_3	-4,6 / -7,0	3,1 / -0,3	-3,1 / -4,4	0,6 / 0,5	1,9 / 1,2	-0,7 / -4,2	4,3 / 2,9
P_3 x P_1	4,3 / 1,9	3,0 / -0,4	-0,8 / -2,1	0,7 / 0,6	2,4 / 1,7	-2,1 / -2,8	3,2 / 1,8
P_1 x P_4	-1,5 / -3,9	2,6 / 1,8	-0,7 / -0,8	0,9 / 0,6	1,1 / 0,5	0,8 / -0,2	4,8 / 3,9
P_4 x P_1	1,3 / -1,1	2,4 / 1,6	-0,9 / -0,6	1,0 / 0,7	1,7 / 1,1	1,1 / 0,1	2,4 / 1,5
P_1 x P_5	2,1 / 1,8	4,3 / 2,4	2,4 / 1,5	0,3 / 0,1	0,3 / -1,3	2,1 / 0,2	0,6 / 0,4
P_5 x P_1	1,6 / 1,3	3,5 / 1,6	1,5 / 0,6	0,4 / 0,2	0,6 / -1,0	1,0 / -0,9	1,0 / 0,8
P_1x P_6	-1,2 / -1,8	2,6 / 2,1	0,9 / 0,3	0,2 / 0,2	1,9 / 0,6	1,4 / -3,0	-7,1 / -8,8
P_6 x P_1	4,1 / 3,4	1,6 / 1,1	2,6 / 2,0	0,3 / 0,3	1,6 / 0,3	0,0 / -4,4	-0,7 / -1,1

Table 2: Heterozis value of some quantitative characters at intervarieties hybrids of *Matthiola incana* with composite flowers

Parents/Hybrids	Height of plants with composite flowers (cm)	Number of inflorescence/plant	Number of flowers in inflorescence	Flowers diameter (cm)	Beginning of flowering (in days, from 01.06.)	Persistence of flowering (in days)
P_1	54,3	8,9	16,3	3,6	32,9	105,6
P_2	50,1	7,3	18,2	3,6	22,0	112,2
P_3	49,0	6,7	13,7	4,3	23,2	108,3
P_4	49,8	5,2	13,2	4,4	34,8	103,8
P_5	44,9	3,2	14,4	4,6	29,1	105,2
P_6	57,4	5,8	11,9	3,7	24,2	109,1
$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$	$\pm d_{\bar{P}} / \pm d_{PM}$
P_1 x P_2	5,6 / 3,5	1,2 / 0,4	0,6 / 1,5	0,2 / 0,2	2,5 / -3,0	-0,5 / -2,8
P_2 x P_1	5,2 / 3,1	1,0 / 0,2	0,3 / -0,7	0,8 / 0,8	3,7 / -1,8	-1,2 / -2,1
P_1 x P_3	4,0 / 1,3	0,1 / -0,1	2,1 / 0,8	-0,6 / 0,2	-0,7 / -4,2	4,3 / 2,9
P_3 x P_1	5,2 / 2,5	-0,3 / -1,4	0,7 / -0,6	0,3 / -0,1	-2,1 / -2,8	3,2 / 1,8
P_1 x P_4	6,2 / 3,9	0,9 / -1,0	1,4 / -0,2	-0,3 / -0,1	0,8 / -0,2	4,8 / 3,9
P_4 x P_1	3,4 / 1,1	-0,9 / -1,0	1,2 / -0,4	0,1 / -0,3	1,1 / 0,1	2,4 / 1,5
P_1 x P_5	7,0 / 2,3	1,5 / -1,4	0,4 / -0,5	-0,1 / -0,6	2,1 / 0,2	0,6 / 0,4
P_5 x P_1	6,3 / 1,6	1,3 / -1,6	0,8 / -0,2	-0,2 / -0,7	1,0 / -0,9	1,0 / 0,8
P_1x P_6	2,4 / 0,8	2,7 / 1,1	-1,8 / -0,4	0,1 / 0,1	1,4 / -3,0	-7,1 / -8,8
P_6 x P_1	0,9 / -0,7	-0,4 / -1,2	1,2 / -1,0	0,6 / 0,5	0,0 / -4,4	-0,7 / -1,1

It is obvious that, for such characters, the creation of commercial hybrids is not a favorable solution. However, the following remark should be made regarding the sign of heterosis in the different characters analyzed in certain hybrid combinations. As shown in the data of Table 2, these values frequently have the minus sign, which would define "negative heterosis". Because all the analyzed characters directly or indirectly increase the value of the plants, when these characters have high positive numerical values, we consider that in these cases we cannot speak of negative heterosis that might have a sense and value in gillyflower breeding. This term should be probably replaced by the expression "negative transgressions", which illustrates much more correctly the genetic bases of this phenomenon.

Conclusions

1. Hybrids of gillyflowers with simple flowers show obvious and positive heterosis, which is favorable for the seed multiplication process of the cultivars of this species;
2. The appearance of "negative heterosis" in some combinations and for some characters does not affect the reproductive function of gillyflowers with simple flowers, these characters being indirectly involved in the production of seeds (e.g. height of plants, beginning of flowering);
3. In F_1 hybrid plants with composite flowers, only the height of plants and the duration of flowering had predominantly positive heterosis values in all the analyzed combinations;
4. It can be appreciated that for important characters that are directly involved in the ornamental function of gillyflowers (height of plants, number of composite flowers in inflorescence), the creation of commercial hybrids can be a solution for the launching of some cultivars with superior characteristics. On the contrary, for characters such as the flower diameter (cm), number of flowers in inflorescence and beginning of flowering, in which heterosis calculated by comparison with the best parent has predominantly negative values, the creation of commercial hybrids does not seem to be an efficient solution;
5. In the case of plants with composite flowers, for some characters, the expression "negative heterosis" should be replaced by "negative transgression", an aspect that will be detailed in future studies.

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MANIFESTAREA HETEROZISULUI UNOR CARACTERE CANTITATIVE DE INTERES ORNAMENTAL ÎN AMELIORAREA MICSANDRELOR (*MATTHIOLA INCANA*)

(Rezumat)

Din analiza variabilităţii generaţiilor F_1, obţinute din încrucişări intervarietale la specia *Matthiola incana*, a reieşit că mediile caracterelor cantitative studiate, în majoritatea cazurilor, sunt superioare la hibrizii F_1 faţă de

valorile medii ale populației parentale, manifestându-se, şi în cazul acestei plante horticole ornamentale, fenomenul de heterozis. Deoarece specia *Matthiola incana* prezintă atât varietăți cu flori simple, cât şi varietăți cu flori involte, au fost analizate probe a câte 50 de plante pentru fiecare tip de flori. Măsurătorile şi determinările au fost efectuate pentru următoarele caractere cantitative: înălțimea plantelor cu flori simple/involte (cm); numărul de inflorescențe pe plantă cu flori simple/involte; numărul de flori simple în inflorescență/flori involte în inflorescență; diametrul florilor simple/involte (cm); lungimea silicvei (cm); începutul înfloritului (zile de la 01.06); durata înfloritului (zile).

Exprimarea rezultatelor s-a făcut prin compararea mediei hibrizilor F_1 cu media parentală, după formula: $V_h = \overline{F_1} - (P_1 + P_2)/2$, cât şi prin compararea mediei F_1 cu media caracterului la cel mai bun părinte, după formula: $V_h = P_{\max} - \overline{F_1}$

Received: 4.07.2007; Accepted: 16.10.2007