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MANIFESTATION OF YIELDING CAPACITY OF SINGLE-CROSS STERILE HYBRIDS OF SUGAR BEETS DEPENDING ON GENOTYPE AND FEEDING AREA

Nenka M.M., postgraduate student
Korneieva M.O., candidate of biological sciences
Boiko I.I., senior research worker
Institute of Bioenergy Crops and Sugar Beets NAAS
Andreieva J.S., candidate of agricultural sciences
Krotiuk L.A., research worker
Verkhniachka research-breeding station

The article describes the research results about variability of combinatorial ability in simple sterile hybrids of sugar beets depending on the feeding area by yield characteristic. Selection of better hybrid combinations stable by manifestation was done.

Crop capacity is an important element of sugar beets productivity, its phenotype manifestation depends on the interaction between genotype and environmental conditions [1]. V.F. Savytskyy wrote: “studying a range of phenotypes that are capable to realize each genotype under different environmental conditions, you can make more accurate selection of the desired forms by quantitative characteristics” [2]. In other words, for studying the norms of reaction it is better together with generally accepted methods of studying this characteristic to use special experiments creating different environmental conditions [3]. On the basis of this approach you can differentiate genotypes which are in normal conditions close between themselves by features display.

Modification variability “disguises” considerably the selection of valuable genotypes by the crop capacity. The coefficient of variation of this characteristic is high — from 30 to 60 %. Thus, a group of plus-variant plants selection contained the plants with an average weight of tubers — 800 g, and a group of minus-variant plants selection — 150 g. Analysis of these groups progeny showed slight differences between young plus- and minus-variants, which was less than 12 g [2]. So, it is important to distinguish the contribution of genotype and environmental share in the phenotype manifestation of the characteristic.

A.L. Mazlumov studied the average mass of selected tubers grown on different feeding areas. On extended feeding area it was 312 g, and the percentage of selection was 46 %. On a feeding area, that was less in twice, the average mass of a tuber was 195 g, the percentage of selection was 34 %. On the basis of the experiment the scientist made a conclusion about greater efficiency of selection at the extended feeding area [4].

By determining the genetic formula of control of crop capacity characteristic some scientists proved the essential role of non-additive genes [5, 6], but the

scientists tended to believe that this characteristic is the result of such actions as additivity, dominance and epistasis [7]. But these authors did not study the effect on phenotype depending on various environmental conditions.

The purpose of our study is to examine the variability of combinatorial ability of simple sterile hybrids of sugar beets depending on the feeding area and to select better hybrid combinations stable by manifestation.

Methods of the research. The experiments were conducted at Verkhniachka experimental breeding station during 2011-2012 years. We used 5 fixers of sterility (FS) and 5 male-sterile lines (MS) to create simple sterile hybrids. Breeding was done on the areas of open transpollination with sufficient insulation by topcross type with a grid of 5×5 [8]. 20 hybrid combinations with sterile pollen were received and they would be used as a maternal component of MS-hybrids of sugar beets.

Strain testing was done on a simple feeding area (SA) of 45×22,5 (cm^2) and extended area (EA) of 45×45 (cm^2) [9].

Combinatorial ability of the components of simple sterile hybrids was estimated by Wolf V.H. and Litun P.P. methods [10] and dispersive analysis was done by Dospekhov B.O. method. [11].

The results of the research. Based on dispersive analysis it was found that there are significant differences between experimental simple hybrids by crop capacity as to SA (F_{fact}=7,38>F_{theory}=2,01) and EA (F_{fact}=21,76>F_{theory}=2,01) that allowed to estimate combinatorial ability of MS-lines and FS (fixers of sterility).

In SA variant the crop capacity of simple sterile hybrids was 41,8-58,3 t/ha, a range of variability was 16.5 t/ha. In EA variant oscillatory amplitude of the crop capacity between hybrids was higher — 22,6 t/ha, the crop capacity was 39,1-61,7 t/ha (table 1).

1. The crop capacity of simple sterile hybrids of sugar beets depending on feeding area, 2011-2012

Simple sterile hybrids	Simple area of 45×22,5 ($см^2$)			Extended area of 45×45 ($см^2$)		
	Crop capacity, t/ha	Deviation from average index,%	Deviation from standard, %	Crop capacity, t/ha	Deviation from average index,%	Deviation from standard,%
St	55,6	2,5	0	54,7	1,1	0
MS 1/Ot 2	55,0	1,9	-1,1	61,7	8,1*	12,8
MS 1/Ot 3	51,7	-1,5	-7,1	64,5	10,9*	18,0
MS 1/Ot 4	58,1	5,0*	4,6	54,9	1,3	0,4
MS 1/Ot 5	58,3	5,2*	4,9	58,7	5,1*	7,3
MS 2/Ot 1	54,9	1,8	-1,2	54,9	1,3	0,3
MS 2/Ot 3	46,9	-6,3	-15,7	39,1	-14,5*	-28,5
MS 2/Ot 4	53,5	0,4	-3,7	53,1	-0,5	-2,9
MS 2/Ot 5	47,7	-5,4*	-14,1	40,6	-13,1*	-25,9
MS 3/Ot 1	55,7	2,6	0,2	55,2	1,6	0,9

MS 3/Ot 2	61,5	8,4*	10,6	62,5	8,9*	14,2
MS 3/Ot 4	46,2	-6,9*	-16,9	48,4	-5,2*	-11,5
MS 3/Ot 5	56,8	3,7	2,2	53,9	0,3	-1,5
MS 4/Ot 1	41,8	-11,3*	-24,8	54,7	1,0	-0,1
MS 4/Ot 2	44,3	-8,8*	-20,3	40,6	-13,1*	-25,9
MS 4/Ot 3	46,2	-6,9*	-16,9	57,8	4,1*	15,6
MS 4/Ot 5	57,7	4,6*	3,8	61,1	7,5*	11,7
MS 5/Ot 1	54,4	1,3	-2,1	53,8	0,18	-1,7
MS 5/Ot 2	55,5	2,4	-0,1	51,7	-1,9	-5,6
MS 5/Ot 3	55,3	2,2	-0,5	50,5	-3,1*	-7,6
MS 5/Ot 4	58,2	5,1*	4,7	53,7	0,5	-1,9

* — significant deviations at the 5 % level.

Differential ability of EA factor was expressed more noticeable, because we selected 6 best and 5 worst hybrids with a true difference by deviation from the average population value, against 5 best and 4 worst hybrids on a simple area respectively.

Deviation from standard in the best hybrids in SA variant was lower compared with EA and it was 3,8…4,9 % against 7,3…18,0 %.

Three hybrids of MS 1/Ot 5, MS 3/Ot 2 and MS 4/Ot 5 characterized by true deviation from standard at both feeding areas that indicates the stability of yield in both cases (fig. 1).

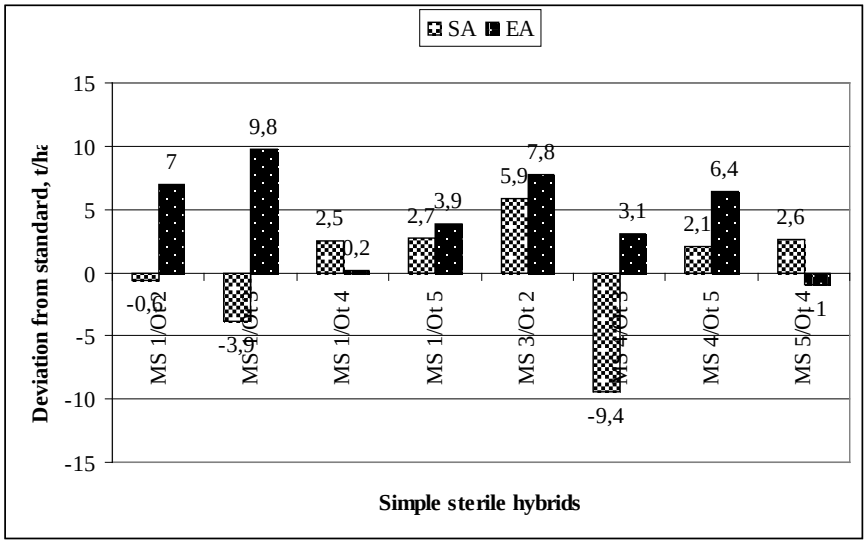

Fig. 1. Deviation from standard of simple sterile hybrids on simple and extended areas

Hybrids of MS 1/Ot 2, MS 1/Ot 3 and MS 4/Ot 3 reacted well on the extended area that indicates their plasticity. In hybrids of MS 1/Ot 4 and MS 5/Ot 4 we noticed decline in the crop capacity in EA variants. Contribution to the total variability of environment by crop capacity characteristic, i.e. EA and SA variants, was lower in EA variant (8,5 %) than in SA variant (21,0 %) (fig. 2, 3). However, components interaction of hybrids was expressed more on the extended area — 53,0 % than in SA — 41,3%. Contribution of maternal and parental components on both variants was close.

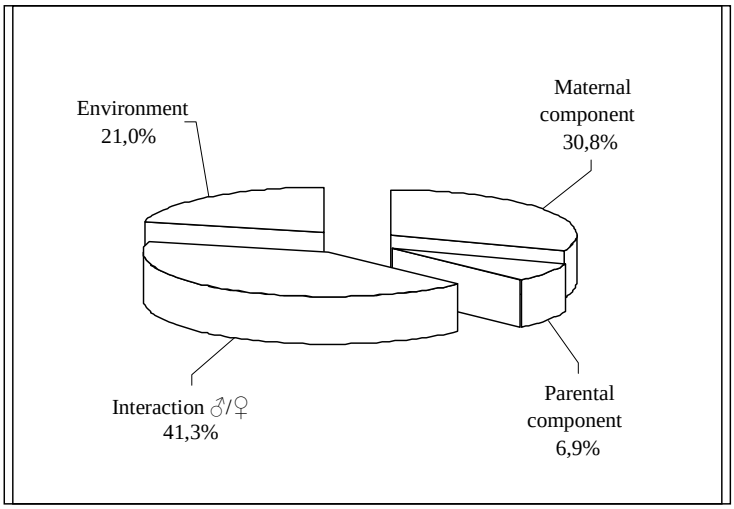

Fig. 2. Contribution of influence factors to variability of crop capacity characteristic of hybrids on simple area

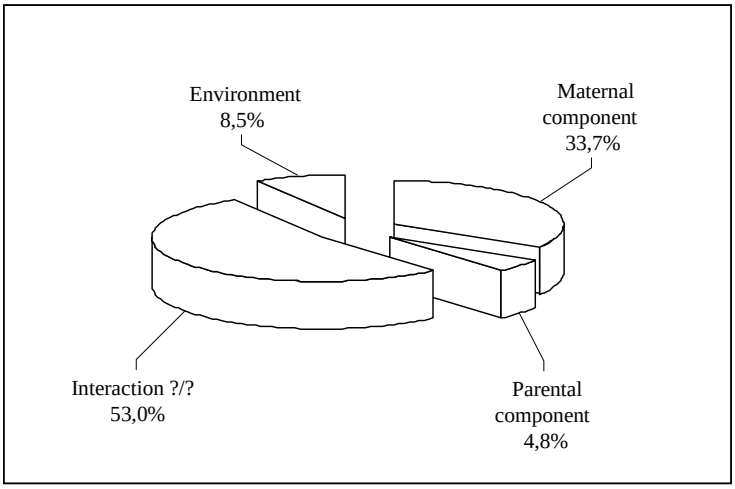

Fig. 3. Contribution of influence factors to variability of crop capacity characteristic of hybrids on extended area

Combinatorial ability of the components of simple sterile hybrids is largely affected by environment that was mentioned by a number of authors [12, 13]. According to our data the general combinatorial ability (GCA) of MS lines which interprets the additive gene action was more stable than SCA (specific combinatorial ability) (table. 2, 3).

2. GCA effects of MS-lines on simple and extended areas

MS lines	Simple area	Extended area
MS 1	2,78*	6,40*
MS 2	-2,23	-6,64
MS 3	2,05*	1,43*
MS 4	-5,49*	-0,04
MS 5	2,89*	-1,15

* — GCA effects, significant at the 5% level

Three MS lines in SA variant were considered genetically valuable and in EA variant there were two MS lines. MS 1 and MS 2 showed high level of GCA in both

variants indicating its stability. SCA effects turned out to be more variable depending on modifying impact of “feeding area” factor (table 3). High positive effects were stable in components of MS 2/Ot 1 hybrids, MS 3/Ot 2 and MS 4/Ot 5 in both conditions.

Expression of this characteristic was found more or less in all other hybrids. We met combinations (MS 3/Ot 4 and MS 2/Ot 5) in which SCA effects changed truly positive sign to negative. There was one more fact which attracted our attention — constants of SCA by MS-lines in all cases were higher in EA variant compared with SA variant testifying the high expression of SCA.

3. SCA expression of MS-lines and fixers of sterility on different feeding areas

MS lines	Feeding area	Ot 1	Ot 2	Ot 3	Ot 4	Ot 5	Constant of SCA
MS 1	SA	#	-0,15	-3,09	3,47	-0,23	3,9
	EA		-0,75	6,45*	4,41*	-1,29	10,6
MS 2	SA	4,79*	#	-2,88	3,88	5,79*	10,7
	EA	5,49*		-5,91*	6,49*	-6,38*	32,7
MS 3	SA	1,28	7,45*	#	7,73*	-1,00	20,1
	EA	-2,29	9,39*		-5,98*	-1,12	27,4
MS 4	SA	-5,09*	2,15	0,19	#	7,43*	12,1
	EA	-1,35	-11,07*	4,86		7,55*	46,1
MS 5	SA	-0,83	0,67	0,56	-0,41	#	3,4
	EA	-1,10	1,14	-1,26	1,23		3,8

Note: 1) SA is a simple feeding area of 45×22,5 (cm^2), EA is for extended feeding area of 45×45 (cm^2);

2) * — reliable effects at the 5% level of significance.

Conclusions. Therefore, based on the analysis of experimental data we can state that the extended area is a modifying factor of the crop capacity which leads to the expression of combinatorial ability of MS-lines and fixers of sterility, as well as simple sterile hybrids created with their participation. Components interaction of hybridization is more evident on extended area (53 %) compared with the simple area (41,3 %). We selected three hybrids (MS 1/Ot 2, MS 1/Ot 3, MS 4/Ot 3) with high level of plasticity by crop capacity characteristic. General combinatorial ability of MS lines is more stable compared with specific combinatorial ability in variable conditions of environment.

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Nenka M.M., Korneieva M.O., Boiko I.I., Andreieva J.S., Krotiuk L.A.

Manifestation of yielding capacity of single-cross sterile hybrids of sugar beets depending on genotype and feeding area

The study of stability of genetic parameters of sugar beets in different growing conditions is of certain interest. ***The purpose of the research.*** *To study the variability of combining ability of single-cross sterile hybrids of sugar beets depending on feeding area.* ***Methods of research.*** *20 single-cross sterile hybrids received from top-cross breeding, 5 MS-lines and 5 sterility fixers were tested in two different growing conditions – with the feeding area 45×22,5 and 45×45(cm^2).* ***Research results.*** *On the basis of dispersive analysis it was established that there are considerable differences between experimental single-cross hybrids according to their yielding capacity both on UFA (usual feeding area) ($F_{fact.}=7,38>F_{theor}=2,01$) and on EFA*

(extended feeding area ($F_{fact.}$=21,76>$F_{theor.}$=2,01) which made it possible to estimate the combining ability of MS lines and SF (sterility fixers). The genetic structure of variability of yielding capacity features, GCA (general combining ability) and SCA (specific combining ability) effects were defined. ***Conclusions.*** *Feeding area is a modifying factor which influences the expression of combining ability. Three hybrids (MS 1/Ot 5, MS 3/Ot 2, MS 4/Ot 5) with stable display of reliably high effect of heterosis as well as three hybrids (MS 1/Ot 2, MS 1/Ot 3, MS 4/Ot 3) with high flexibility by the index of yield were singled out.*

Keywords: *combining ability, hybrids, yielding capacity, feeding area, heterosis.*

Ненька М.Н., Корнеев М.А., Бойко И.И., Андреева Л.С., Кротюк Л.А.,

Проявление урожайности простых стерильных гибридов сахарной свеклы в зависимости от генотипа и площади питания

Представляет интерес изучение стабильности генетических параметров сахарной свеклы в различных условиях среды. ***Цель и задачи****. Изучение изменчивости комбинационной способности простых стерильных гибридов сахарной свеклы в зависимости от площади питания и отбор стабильных за проявлением лучших гибридных комбинаций.* ***Методы исследований****. 20 простых стерильных гибридов от топкросных скрещиваний 5 МС-линий и 5 закрепителей стерильности испытывали в двух средах — с площадями питания 45×22,5 и 45×45 (см2).* ***Результаты исследований****. На основе дисперсионного анализа было установлено, что между экспериментальными простыми гибридами по урожайности существуют существенные различия, как на обычной площади питания (Fфакт=7,38>Fтеор=2,01), так и на расширенной площади питания (Fфакт=21,76>Fтеор=2,01), что позволило оценить комбинационную способность МС-линий и ЗС (закрепителей стерильности). Определена генетическая структура изменчивости признака урожайности, эффекты ОКС (общей комбинационной способности) и СКС (специфической комбинационной способности).* ***Выводы****. Выделены три гибрида (МС 1/От 2, МС 1/От 3 и МС 4/От 3) с высокой пластичностью по признаку урожайности. Общая комбинационная способность МС-линий является более стабильной по сравнению со специфической комбинационной способностью, в меняющихся условиях среды.*

Ключевые слова*: комбинационная способность, гибриды, урожайность, площадь питания, гетерозис.*