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DEVELOPMENT OF ORIGINAL MATERIAL FOR SUNFLOWER BREEDING FOR SEED CHARACTERISTICS, OIL AND PROTEIN QUALITY IN THE CONDITIONS OF CENTRAL-CHERNOZEM REGION

N.P. Tavoljanskiy, P.V. Chiryaev, S.V. Scherstyuk, V.I. Altinnikova and V.T. Tikhomirov*

Veidelevka Institute of Sunflower (VIS), Ltd, Centralnaya 43a, Veidelevka, Belgorod region, 309720, Russia

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SUMMARY

In this paper we show the seed characteristics and oil and protein quality parameters used at Veidelevka Institute of Sunflower (VIS) for obtaining the original sunflower material. As a result of the breeding program, a donor of super high oil percentage was selected that has no negative influence on economically valuable characteristics.

Key words: sunflower, line, correlation, donor of super high oil percentage

INTRODUCTION

Oil-type sunflower as a field crop was developed in the middle of the 18th century in the European part of Russia. As a result of the vast and intense work of Academician V.S. Pustovoit's school, practically a new type of cultivated plant was obtained from inadequately cultivated domestic populations of sunflower. There has not been anything comparable to this type of plant in the world with regard to oil content, husk content, economic characteristics and high field resistance to major diseases.

Sunflower breeding at Belgorod experiment station on the seed quality characteristics and high oil percentage was started in 1929 by V.S. Malyarenko and it was continued by K.I. Prokhorov. In the 1970s, a high-oil variety Vostok was obtained, which has taken the first place for high oil content in seed (73%) in an international test of sunflower varieties in Ceylon. The variety Zelenka 368 demonstrated its

* Corresponding author, e-mail: msch@mail.ru

qualities at an international exhibition in Brussels, at Leipzig fair and at All-union Agricultural Exhibition in Moscow.

K.I. Prokhorov's varieties have got a long commercial life. The variety Voskhod is still on the Russian list of sunflower varieties and it has the highest oil content in its group, which exceeds those of all the zonal varieties to 1.0-1.5%.

It is obvious that the potential for hereditary variability of the original material plays an important role in sunflower breeding, but is not completely realized, because it is difficult to foresee the nature, character and direction of external stress factors.

MATERIALS AND METHODS

When developing original material for breeding for quality of seeds, oil and proteins, we analyzed the most significant correlations which were obtained in the study of collections of stable lines from VIS, VIR, VNIIMK, Kazakhstan, Ukraine, USA, Canada, France and Bulgaria. It should be mentioned that the correlation coefficients were calculated for average means of characteristics (N>20) which corresponded to the genotypic variability of the cultivated sunflower (Tavoljanskiy, 2000).

RESULTS AND DISCUSSION

The results that we obtained showed that the achene structure changed slightly (coefficient of oil content variation was 5.6%, protein – 6.5%, husk – 11.4%), but there were rather high correlations between the structure and other factors. The increase in oil percentage in seed occurred simultaneously with the reductions in protein content (r=-0.55) and husk content (r=-0.43). There is obviously a feedback between oil and protein contents in seed, but the kernel to husk ratio is the result of selection. Oil percentage did correlate with these characteristics, but not as intensively, moreover, it depended on shoot growing speed (r=+0.26). Head size correlated positively with the yield of kernels (r=+0.32), oil yield (r=+0.32) and protein yield (r=+0.22). High and fast-growing genotypes were more productive because the correlation is from +0.22 to +0.39. They also had higher oil percentages (r=+0.25) (Tavoljanskiy *et al.,* 2002).

The analysis of variability and correlations of the characteristics under study allowed to separate them into the following groups:

1. Oil percentage in the kernel, husk percent in achenes, length of the growing season and plant height – were "elementary", genotypically strongly determined characteristics. Their correlations were typically high and obviously on the genotypic basis. The relations between oil and husk contents as well as plant height and vegetative period were determined in hybrid offsprings,

mainly by means of the characteristics of the parental forms. The average value of the characteristic itself, as well as the agreement of its changes with the changes of other traits depends on environmental factors. In unfavorable conditions, the range of variability and determination level of these traits increase considerably.

2. Yield and oil content per hectare are complex characteristics, derived and mutually determined, with a largely variable system of dependences. Particularly, it is important to mention a high variability of the system of harvest correlations under a more or less stable average level of its general determination and variation. Obviously, genotypic characteristics of parent forms as well as seasonal conditions influence this system. In this connection for motivated collation of such estimates it is necessary to take into account the differences of "contributions" of different components into general productivity of hybrids under different conditions.

It is also necessary to note that oil concentrations in the kernel and in seed increase in different ways in the course of sunflower seed maturation process. The increase in oil concentration in seeds proceeds together with the changes in its qualitative composition. In the course of seed maturation, the iodine number in oil increased by 10-17 units in all the samples.

Table 1: Seed oil increase in sunflower hybrids F_1, F_2 and F_a (%) (VIS, 2001-2002)

Name	Female form				F_1				F_2				F_a			
	1*	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
VB 57 A	88	69.6	84	123	89	68.4	0	155	90	68.1	67	141	88	72.1	67	132
VB 471 A	83	63.2	100	128	86	63.5	0	135	88	63.0	94	129	83	62.4	88	128
VB 246 A	94	64.3	94	139	90	65.0	0	150	90	64.0	88	139	92	63.7	88	138
VB 132 A	87	67.2	94	127	88	66.7	0	140	89	66.0	88	132	87	66.9	67	132
VB 4703 A	93	53.5	100	119	90	55.8	0	155	91	54.1	88	145	91	53.8	88	147
VB 157 A	89	47.4	94	113	90	50.1	0	160	90	47.0	88	153	90	48.9	67	149
VB 178 A	88	50.5	94	118	90	52.4	0	160	90	50.4	67	154	89	50.7	67	150
VB 2 A	95	53.6	100	112	90	54.6	0	155	92	53.0	88	149	93	54.1	88	142
VB 101 A	95	55.5	94	111	90	56.4	0	160	92	55.1	88	151	93	54.8	67	145
VB 102 A	95	50.2	88	119	90	52.8	0	156	93	50.1	67	150	93	50.0	67	140
VB 700 A	94	53.0	88	122	90	54.1	0	156	92	54.0	67	149	92	52.7	67	149
VB 701 A	94	67.2	67	125	90	67.0	0	135	92	67.1	50	131	92	68.1	33	130
VB 3090 (male form)	91	65.3	0	119												

*1 – length of vegetative period, 2 – mass of 1000 seeds (%),
3 – false mildew infection (%), 4 – plant height (cm)

The estimate of general combining ability of male lines showed that line VB 3090 is a super high oil donor (Table 1). Inheritance of super high oil in F_1, F_2 and F_a hybrids occurs on heterosis effect basis, which is determined by superdominance. The estimate of economically valuable characteristics showed that the line

VB 3090 had no negative effect on any of these characteristics (Table 2). The line was registered (Tavoljanskiy *et al.*, 2002).

Table 2: Development of some economically valuable characteristics of hybrid generations F_1, F_2 and F_a (VIS, 2001-2002)

Name	Female form of hybrid	F_1*	F_2	F_a
VB 57 A	46.1	54.0	53.8	53.9
VB 471 A	51.9	55.8	54.1	53.9
VB 246 A	45.1	53.9	52.9	51.8
VB 132 A	49.7	52.6	51.7	52.1
VB 4703 A	52.1	53.4	53.4	52.3
VB 157 A	53.0	53.9	53.1	52.9
VB 178 A	52.4	53.7	52.8	52.3
VB 2 A	47.6	53.8	52.1	51.9
VB 101 A	50.7	54.9	53.7	51.6
VB 102 A	43.2	53.8	50.8	51.2
VB 700 A	50.1	55.4	53.7	51.1
VB 701 A	54.5	54.2	54.8	54.1

*-oil percentage in the male form of hybrid VB 3090 – 52.7%

This line was used in the development of Veidelevsky 18, an early-ripening sunflower hybrid with the oil content of 53.2-55.4% (Table 3). The hybrid corresponds to the middle-Russian ecotype.

Table 3: Characteristics of sunflower hybrid Veidelevsky 18 (VIS, 2000-2002)

Factor	Hybrid Veidelevsky 18	Hybrid Veidelevsky 80	Hybrid Veidelevsky 99
Achene yield (t/ha)	2.82	2.61	2.89
$NSR_{0.5}$ (t/ha)		0.17	
Length of vegetative period (days)	90	91	94
Plant height (cm)	150	150	165
Oil percentage (%)	54.2	52.7	51.8
Husk content (%)	21.7	23.2	22.8
Hectoliter weight (g/l)	380	350	385
Infection (%) (on the infectious background)			
Broomrape	0	0	0
False mildew	0	0	0
Infection (%) (on natural background)			
Rust	7.7	5.8	6.9
Sclerotinia	0.9	0.9	0.5
Verticilliosis	2.7	2.2	1.1
Phomopsis	5.7	7.2	10.1

At shoots appearance it has weak anthocyanin coloration of the hypocotyl. The stem of the plant is straight, non-branching, with average tomentum in the upper part, of an average height of 150-170 cm (depending on the year), ending with a

rather large head, 18-20 cm in diameter, semi-bent. The average number of seeds per head is 900-1000. The seeds are dark-striped, oval-elongated. The mass of 1000 achenes is 65-75 g, hectoliter weight is 380-410 g/l.

The hybrid matures in 88-92 days, thus belonging to the group of early hybrids. It has a rather high achene yield (2.9-3.1 t/ha), mainly because of high mass of 1000 achenes and well pollinated central part of the head. It is characterized by high degree of adaptation because it was derived from a highly adaptable line obtained from a local interspecific hybrid population. It it tolerant to drought, possesses genetic resistance to broomrape and downy mildew, sunflower moth and low copper content in the soil and it also has tolerance to *Phomopsis*.

Thus, obtaining of the original material with high and super high oil percentage is the main strategy of Veidelevka Institute of Sunflower. Seed, oil and protein quality characteristics interesting for breeding were found in a large part of the breeding material. As a result, a donor of super high oil percentage was selected and used in the development of the sunflower hybrid Veidelevsky 18.

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MATERIAL ORIGINAL DE GIRASOL PARA EL MEJORAMIENTO EN PROPIEDADES DE SEMILLA Y CALIDAD DEL ACEITE Y PROTEÍNAS EN LAS CONDICIONES DE LA ZONA CENTRAL DE CHERNOZEM

RESUMEN

En ese trabajo están demostradas las relaciones correlativas entre las propiedades de la semilla y la calidad del aceite y proteínas que se utilizan en VIS en ocasión de formación del material original de girasol. Como resultado de realización del programa de mejoramiento, se seleccionó el donador del súper alto porcentaje de aceite que no tiene influencia negativa en las características económicamente válidas.

LE DÉVELOPPEMENT DU MATÉRIEL ORIGINAL DU TOURNESOL CULTIVÉ CONCERNANT LES CARACTÉRISTIQUES DE GRAINE ET LA QUALITÉ D'HUILE ET DE PROTÉINE DANS LES CONDITIONS DE LA RÉGION CENTRALE TCHERNOZEM

RÉSUMÉ

Dans cet article les paramètres des caractéristiques de graine et la qualité d'huile et de protéine, utilisés à Veidelevka Institute of Sunflower (VIS) ont été mis en corrélation afin d'obtenir le matériel original de tournesol. Comme résultat de cette recherche, c'est la sélection du donneur d'un pourcentage d'huile très élevé qui n'a pas d'influence négative sur les caractéristiques de valeur économique.