HELIA, **28**, Nr. 42, p.p. 101-106, (2005) UDC 633.854.78:632.1:631.524.86

SOURCES OF RESISTANCE TO DISEASES IN ORIGINAL MATERIAL OF SUNFLOWER

Tikhomirov, V.T.* and Chiryaev, P.V.

Veidelevka Institute of Sunflower Ltd, Centralnaya 43 a, Veidelevka, Belgorod Region, 309720 Russia

Received: July 10, 2003
Accepted: February 12, 2005

SUMMARY

This paper summarizes the results of infection level evaluation for the most harmful sunflower diseases in Central Chernozem Region of Russia. Using annual and perennial wild sunflower species from collection as sources of resistance to pathogens has shown to be important.

Various forms of cultivated sunflower have been obtained during many years work. Among them, we identified male and female sunflower lines with complex resistance. These lines also possess high general combining ability and agronomically important traits.

A disease causing several extremely located necrotic spots has been registered at the end of the growing season. This kind of disease development may be considered as field resistance index.

Key words: sunflower, line, resistance, disease

INTRODUCTION

Breeding for plant resistance is a continuous process and it requires an active mobilization of material capable of enriching and diversifying the genetic basis of resistance. The annual *Helianthus* species are easily mobilized heritable material for improving the cultivated sunflower genome.

A wild species collection has been established at Veidelevka Institute of Sunflower (VIS) and work started on interspecific hybridization and estimation of resistance to the main pathogens.

MATERIAL AND METHODS

The investigated material comprised the following samples:

- five annual wild sunflower species: *Helianthus argophyllus, H. niveus, H. neglectus, H. debilis, H. petiolaris*;

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

- nine perennial wild sunflower species: *H. tuberosus, H. divaricatus, H. grosseseratus, H. hirsutus, H. maximilliani, H. mollis, H. nuttallii, H. occidentalis, H. rigidus;*
- eight cultivated sunflower forms obtained in VIS from heterosis and population sunflower breeding: VB 354, VB 3090, VB 36, VB 119, VB 127, VB 130, VB 34, VB 368.

The observations and evaluation of disease attack were carried out in a quarantine nursery at the end of the growing season.

RESULTS AND DISCUSSION

Our investigation showed that the main phytopathogenic factors infecting sunflower in Central Chernozem Region (CCR) of Russia are:

1. **White rot** – caused by a phytopathogenic saprophytic fungus. The disease is widespread and losses incurred by it reach up to 70%. The disease has three forms – root, stem and head form. The head form is most harmful.
2. **Grey stem spot**, stem canker or *Phomopsis* –appeared in the region six years ago and is now registered in all CCR districts. The harmfulness of this disease increases each year.
3. **Downy mildew** – this widespread disease was registered for the first time in the 1950s. Losses caused by the disease in individual years come up to 30% or more.
4. **Grey rot** – an extremely harmful disease, especially during seedling stage and during sunflower maturation in wet and cool weather.
5. **Broomrape** – a widespread parasitic angiosperm, most harmful in the dry conditions of the zone.

TheVIS sunflower breeding program uses an extensive material differing in the botanical and geographical origin and ecological and agronomic characters. Emphasis is placed on annual and perennial species as resistance sources to disease casual organisms (Tavoljanski, 2000). The immunity evaluation is performed in a quarantine nursery, using sunflower collection for maintenance of wild species (Table 1).

Table 1: Wild species of sunflower as main sources of resistance diseases. The separate populations of wild sunflower species possessing the complex resistance to the main pathogens

Annual	Perennial
Helianthus argophyllus	*Helianthus divaricatus*
Helianthus niveus	*Helianthus tuberosus*
Helianthus neglectus	*Helianthus grosseserratus*
Helianthus debilis	*Helianthus hirsutus*
Helianthus petiolaris	*Helianthus maximilliani*
	Helianthus mollis
	Helianthus nuttallii
	Helianthus occidentalis
	Helianthus rigidus

Among the annual species, highest resistance to white rot, stem canker (*Phomopsis*), mildew and other diseases was discovered in separate populations of *Helianthus argophyllus*, *Helianthus niveus, Helianthus neglectus, Helianthus debilis* and *Helianthus petiolaris* (Tavoljanski *et al.*, 2001). These species show good crossability with cultivated sunflower forms and exhibit important genetic resistance. At present, the experimental/tested material is in the F_4 generation.

Among the perennial species, resistance to the most harmful disease complex was registered in populations of *H. tuberosus*, *H. divaricatus*, *H. hirsutus*, *H. maximilliani*, *H. mollis*, *H. nuttalli*, *H. occidentalis*, *H. rigidus*, etc. Because of low crossability or total cross-incompatibility of wild perennial species and cultivated sunflower, crossing techniques and methods need to be developed for further mobilization of these species in programs of breeding for disease resistance.

Among the various cultivated sunflower forms obtained from heterosis and population breeding, female and male lines were indicated as being the least infected by diseases (Table 2).

A disease displaying several extremely located necrotic spots was registered at the end of the growing season. This kind of disease development may be considered as field resistance index.

Lines – sources of resistance were obtained by self-pollination and laboratory and field screening to eliminate undesired genotypes. These sources were derived from original material by the following breeding and genetic methods: convergence crossing, cumulative breeding, gamete selection, second cycle, recurrent selection and interspecific hybridization.

The majority of the lines possessing high combine ability have been included in the development of commercial heterotic hybrids. Some of these hybrids, such as Veidelevski 11 and Veidelevski 18, are currently being examined by the State Commission for Variety Testing. The line VB 36 with low general combining ability (GCA) is an exception.

The donors of agronomically valuable characters are of special interest. For example, the line VB 354 is resistant to *Sclerotinia* and the infections by mildew and *Phomopsis* do not exceed 10 and 7%, respectively. Moreover, this line possesses recessive top branching which is favorable for duration of flowering in seed production of commercial hybrids. It is typical particularly for the hybrid Veidelevski 11, which has VB 354 as a parent. It possesses high GCA, lemon coloration of ray flowers - the marker character which facilitates the elimination of undesired phenotypes and stay-green steam - the indirect index of *Phomopsis* resistance. The four-time repeated verification in F_1, F_2 and backcrosses indicated that the line VB 354 was a reliable donor of ultra-early maturity without negative effects on agronomic characters of the hybrids. As this line is a dwarf type, it is necessary to increase the stand density up to 25%, *i.e.*, to 63-65000 plants/ha in CCR conditions.

Table 2: Sunflower lines resistant to harmful factors and their breeding characters

Self pollinated lines	The displaying of diseases and broomrape (%)				Vegetation period (days)	Number of leaves on main stem	Plant height (cm)	Technological coefficient	GCA mark	Mass of 1000 seeds	Oil content (%)	Achene harvestness (c/ha)
	Broomrape	Downy mildew	*Phomopsis*	White rot								
VB 119	0	-	0	13.0	97	39	140	0.93	4	61.2	51.0	15.7
VB 127	0	-	15.0	0	96	32	130	0.92	5	57.6	51.9	11.9
VB 24	0	-	8.0	12.0	92	26	120	0.89	4	59.2	50.7	10.9
VB 368	0	30.0	9.0	0	95	30	130	0.93	3	55.4	50.9	12.7
VB 354	21.5/10[a]	10.0	7.0	0	85	21	100	-	4	24.9	50.1	-
VB 3090	0	0	8.0	10.0	89	25	115	0.90	4	54.2	51.7	10.2
VIR 130	0	72.6	1.5	2.0	99	38	170	0.76	5	57.6	46.2	14.1

a: intensity of lodging;
-: no final data;
VB 354: possesses recessive branching and marker characters of lemon coloration of ray florets and “green stem”, the donor of ultra-early maturity;
VB 3090: the donor of super-high oil content (>52%);
VIR 130: possesses 27 marker characters.

The line VB 3090 is single headed, completely resistant to broomrape and downy mildew, with *Phomopsis* and *Sclerotinia* infection rates of 8 and 10%, respectively. This line possesses high GCA and is a reliable donor of super-high oil content. It is a parent of the registered hybrid Veidelevski 18.

The lines VB 119 and VB 127 are used for developing heterotic hybrids, such as the hybrid VIS 2000, which has the yield potential of 125% in comparison with the control, Veidelevski 99. These lines are promising sources of resistance to broomrape and *Sclerotinia*. Their high seed yield potentials (15.7 and 11.9 q/ha, respectively) are positively reflected on economic characters of commercial hybrids, *i.e.*, the economy of seed production. These lines are classified in the early maturity group, which is the most productive group in CCR. Their vegetation period is 96-97 days; they have from 32 to 39 light-green cordate-elongated leaves; their plant height is 130-140 cm and the technological coefficient is 0.92-0.93. Their 1000-seed weight is within the limits of 57.6-61.2 g, with high oil content (51.0-51.9%).

The line VIR 130 is unique for a large number of marker characters (27), from the dominant anthocyanine-colored hypocotyls to white seed color. The infection rates of downy mildew, *Phomopsis* and *Sclerotinia* are in this line 72.6, 1.5 and 2.0%, respectively, while it shows a complete resistance to broomrape. The line VIR 130 possesses high combining ability (GCA marked as 5) and high productivity (seed yield potential of 1.41 q/ha) in seed production. It should be noted that all hybrids developed from this line are tall and always inhibiting the hybrids and lines growing nearby (*i.e.*, they possess high competition ability during testing and harvest). Unfortunately, the line VIR 130 bears significant losses during mechanized harvest, as indicated by the low technological coefficient (0.76) and significant head declivity.

The lines VB 24 and VB 368 are completely resistant to the new races of broomrape and they have tolerable *Phomopsis* infection rates of 8 and 9%, respectively. Furthermore, the line VB 368 is resistant to the head form of *Sclerotinia*. These lines have high oil contents (50.7 and 50.9%, respectively), with 1000-seed weights of 59.2 and 55.4, respectively, and are considered as high-technology lines.

This collection of self-pollinated lines is a good source for developing sunflower hybrids resistant to the most widespread and most harmful diseases of the region.

REFERENCES

Tavoljanski, N. and Anaschenko, A., 2001. Progress report of the interspecific hybridization laboratory of Veidelevka Sunflower Institute (VIS) for 1999. *In*: FAO Progress Report 1999-2000, Working Group: Evaluation of wild *Helianthus* species. Udine, Italy, November 2-4, 2001.

Tavoljanski, N., 2000. In: Theory and Practice of Development of Modern Sunflower Hybrids. Belgorod, 451 (in Russian).

Tavoljanski, N., Yesaev, A., Yakutin, V., Akhtulova, A. and Tikhomirov, V., 2001. Using the collection of wild species in sunflower breeding. Sunbio 2001: Fifth European Conference on Sunflower Biotechnology. Italy, November 4-8, 2001.

FUENTES DE RESISTENCIA A LAS ENFERMEDADES EN EL MATERIAL ORIGINAL DE GIRASOL

RESUMEN

En el elaborado es dado el cuadro de calificación del nivel de infección con las plagas de girasol más peligrosas en la zona central Chernozem de Rusia. Se mostró importante la utilización de las especies anuales y perennes de girasol salvaje de la colección como fuente de resistencia a patógenos.

A lo largo del trabajo de muchos años, se han creado diferentes formas de girasol cultivado. Entre ellas, la menor infección la tenían las líneas masculinas y femeninas con la resistencia compleja. La necrosis muy estrechamente localizada, registrada en el final de la temporada, puede aceptarse como el índice de la resistencia campestre. Las líneas susodichas poseen también altos valores de capacidad general de combinación y las características importantes agronómicamente.

LES SOURCES DE RÉSISTANCE AUX MALADIES DANS LE MATÉRIEL D'ORIGINE DU TOURNESOL

RÉSUMÉ

Cet article résume les résultats de l'évaluation du niveau d'infection des maladies du tournesol les plus nocives dans la région centrale de chernozem de Russie. L'utilisation de sortes de tournesol sauvage annuelles et vivaces de la collection comme sources de résistance aux pathogènes s'est montrée d'une grande valeur.

Les diverses formes de tournesol cultivé ont été obtenues après plusieurs années de travail. Parmi celles-ci, les moins infectées par les maladies étaient les lignées mâles et femelles à résistance complexe. Des nécroses exceptionnellement localisées enregistrées à la fin de la saison peuvent être considérées comme un indice de résistance. Les lignées mentionnées plus haut possèdent aussi une grande aptitude générale combinatoire et d'importantes caractéristiques agronomiques.