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SUNFLOWER BREEDING FOR RESISTANCE TO THE NEW BROOMRAPE RACE

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SUMMARY

Broomrape (*Orobanche cumana* Wallr.) is a parasitic plant that feeds on sunflower roots. In recent years, a new, aggressive race designated as race F (called biotype D in Russia) has spread drastically in Spain. The aim of our work was to find donors of resistance to this biotype, to study heredity of this trait and to develop new sunflower inbred lines combining F-race broomrape resistance with other valuable traits. Preliminary resistance tests showed that practically all VNIIMK-released and prospective inbred lines are susceptible to the new broomrape race, with only VK-623 exhibiting resistance. Consequently, we tested all breeding materials obtained from VK-623 as a parental line as well as all F_1 hybrids. All F_1 hybrids were susceptible to the new race, indicating that the resistance was recessive. Among the tested breeding material, resistant plants were encountered with different rates. Fifteen resistant plants were found in the progeny of two F_3 morphologically different plants from a hybrid combination 14B × (VK-623 × VK-616). After testing, all of them were transplanted and self-pollinated. Their progeny proved their resistance in the next year tests. As a result, two new prospective inbred sunflower lines were developed, which exhibited resistance to broomrape races C and D. However, as the recessive character of the obtained resistance creates some difficulties in commercial sunflower hybrid breeding, we shall continue to look for new dominant resistance genes donors among the sunflower samples.

Key words: breeding, broomrape, hybrid, resistance, sunflower

INTRODUCTION

Broomrape (*Orobanche cumana* Wallr. syn. *O. cernua* Loefl.) is a parasitic plant that feeds on sunflower roots. It is widely spread on the territory of the former USSR, in southern Europe, Middle East and China (Parker, 1994). The main method of broomrape control is development of resistant hybrids and/or OP varieties. During more than 100 years of co-evolution of sunflower and broomrape in Russia, biotype A was replaced by biotype B and then by biotype C. Biotype C is

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presently the predominant one on the territory of Russia (Antonova, 1998, 2000). A majority of hybrids and OP varieties released in Russia are resistant to that biotype; still, broomrape continues to produce new races. In recent years, a new, more aggressive race designated as race F (biotype D in Russia) has spread drastically in Spain (Domingues, 1996).

The aims of this work were to find donors of resistance to this biotype, to study heredity of this trait and to develop new sunflower inbred lines combining F-race broomrape resistance with other valuable traits.

MATERIAL AND METHODS

Race C broomrape (*Orobanche cumana* Wallr. syn. *O. cernua* Loefl.) seeds were collected from sunflower fields in Russia (mainly in the Krasnodar territory) and comparatively tested against broomrape race F (designated as biotype D in Russia) obtained from Spain. Race C was used for preliminary testing - only resistant genotypes were tested against race D (the amount the seeds of the Spanish race was limited).

All inbred lines from the working collection of Hybrid Sunflower Breeding Department of All-Russia Research Institute of Oil Crops (VNIIMK) were used as material for this study.

Seeds of the tested sunflower lines were planted into boxes filled with the soil artificially infested with broomrape seeds and cultivated for a month. After that, sunflower plants were uprooted, their root systems carefully washed and amount of broomrape nodules or stalks registered. Plants without any broomrape nodules or stalks were classified as resistant, the others were treated as susceptible.

RESULTS

The preliminary resistance tests showed that all VNIIMK-released inbred lines are susceptible to the new broomrape race. Consequently, all prospective inbred lines had to be tested too. A majority of them proved to be susceptible. However, line VK-455 demonstrated partial resistance and line VK-623 full resistance. The number of broomrape plants on the roots of sunflower plantlets varied in this experiment from 0.0 (VK-623) to 22.9 (SL-1), with 9.7 as the average value (Table 1). All of the tested inbred lines were completely resistant to Russian biotype C.

The entire breeding material obtained from VK-623 used as a parental line (4 hybrid combinations in the pedigree nursery), and its F_1 hybrids were tested during the same season in the greenhouse. All F_1 hybrids were susceptible to the new race, with the number of germinated broomrape plants on the sunflower roots varying from 9.2 to 16.3. This meant that this resistance was recessive (Table 2). It should be mentioned here that both parents in the combination VK-680 A × VK-623 were

resistant to race C. It will be necessary to develop resistant parental lines for production of resistant hybrids if this race becomes dominant in Russia.

Table 1: Resistance of sunflower inbred lines to Spanish race of broomrape (VNIIMK, Krasnodar, 2001)

Line	Infected plants, %	Degree of attack*
VK-455	67	1.2
VK-461	92	3.6
VK-467	95	7.9
VK-694	100	6.3
VK-746	100	10.1
VK-761	100	17.0
VK-623	0	0.0
VK-763	100	9.6
VK-604	100	5.8
SL-1	100	22.9
SL-2	100	13.3
SL-3	92	13.8
SL-4	100	21.3
SL-5	90	2.2

* - Degree of attack - average number of broomrape nodules or stalks per sunflower plant

Table 2: Resistance of F_1 sunflower hybrids to Spanish race of broomrape (VNIIMK, Krasnodar, 2001)

Hybrid	Infected plants, %	Degree of attack*
VK-623 A × VK-777	100	9.2
VK-623 A × VK-788	100	11.5
VK-680 A × VK-623	100	16.3

* - Degree of attack - average number of broomrape nodules or stalks per sunflower plant

Resistant plants were encountered with different rates among the tested breeding material. Hybrid combination 14B × (VK-623 × VK-616) gave resistant plants with the maximum frequency (Table 3).

Table 3: Resistance of sunflower breeding material to Spanish race of broomrape (VNIIMK, Krasnodar, 2001)

Origin	Infected plants, %	Degree of attack*
F4 [14B × (VK-623 × VK-616)]-55-1	90	2.9
F4 [14B × (VK-623 × VK-616)]-55-2	100	7.3
F4 [14B × (VK-623 × VK-616)]-55-3	80	4.1
F4 [14B × (VK-623 × VK-616)]-55-4	100	11.6
F4 [14B × (VK-623 × VK-616)]-55-5	100	20.1
F4 [14B × (VK-623 × VK-616)]-55-6	100	10.8
F4 [14B × (VK-623 × VK-616)]-56-1	30	0.6
F4 [14B × (VK-623 × VK-616)]-56-2	55	1.7

* - Degree of attack - average number of broomrape nodules or stalks per sunflower plant

Fifteen resistant plants were found in the progeny of two F_3 morphologically different plants from this combination. All of them were transplanted and self-pollinated. The obtained seeds were planted in the field the next season and the selected promising plants were self-pollinated. Their progenies proved their resistance in the next year of testing.

As a result, two new prospective inbred sunflower lines were developed which were resistant to both broomrape races, C and D. Next year they will be tested for combining ability. Furthermore, the line VK-623 confirmed to be a good donor of this trait. However, the recessive character of the obtained resistance creates some difficulties in commercial sunflower hybrid breeding so we shall continue to search for new dominant resistance genes donors among the sunflower samples.

CONCLUSIONS

Among the elite and promising VNIIMK inbred lines, only one (VK-623) proved to be resistant to the Spanish race of broomrape. All three F_1 hybrid combinations produced from this line were susceptible to the new race with the number of germinated broomrape plants on sunflower roots ranging from 9.2 to 16.3, showing that this resistance was recessive. The entire breeding material obtained from VK-623 used as a parental line (4 hybrid combinations in the pedigree nursery) was tested the same season in the greenhouse. Among the tested breeding material, resistant plants were encountered with different rates. Hybrid combination 14B × (VK-623 × VK-616) gave resistant plants with the maximum frequency. Fifteen resistant plants were found in the progeny of two F_3 morphologically different plants from this combination. All of them were transplanted and self-pollinated. The obtained seeds were planted in the field the next season and the selected promising plants were self-pollinated. Their progenies proved their resistance in the next year of testing. As a result, two new prospective inbred sunflower lines were developed which exhibited resistance to both broomrape races, C and D. Additionally, the line VK-623 confirmed to be a good donor of this trait. However, the recessive character of the obtained resistance creates some difficulties in commercial sunflower hybrid breeding. Therefore, we shall continue to search for new dominant resistance genes donors among the sunflower samples.

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MEJORAMIENTO DE GIRASOL A LA RESISTENCIA A NUEVAS RAZAS DE JOPO DE GIRASOL

RESUMEN

El jopo de girasol (*Orobanche cumana* Wallr.) es una planta parásita que se alimenta de la raíz de girasol. En los últimos anos, en Espana hubo una drástica divulgación de una raza nueva, más agresiva de este patógeno, denominada la raza F (o, en Rusia, como biotipo D). El objetivo de este trabajo fue buscar donadores de resistencia a este biotipo, estudiar la herencia de esta característica, y crear nuevas líneas consanguíneas de girasol, que poseyeran resistencia a la raza F en combinación con otras características valiosas. La prueba de resistencia preliminar demostró que prácticamente todas las líneas consanguíneas, registradas y con perspectiva, creadas en VNIIMK, eran sensibles a esta nueva raza de jopo de girasol, y que únicamente la línea VK-623 ha tenido resistencia a ella. Convenientemente, se llevó a cabo una prueba del completo material mejorador, en el cual la línea VK-623 fue utilizada como una de las líneas parentales, tanto como F_1 del híbrido con ella. Todos los híbridos F_1 sometidos a la prueba, se demostraron sensibles a la raza F, lo que significa que se trata de resistencia recesiva. El número de las plantas resistentes en el material mejorador sometido a la prueba, varía. En la descendencia de dos, morfológicamente diferentes plantas F_3 de la combinación híbrida 14B × (VK-623 × VK-616) se encontraron 15 plantas resistentes, que una vez terminada la prueba, fueron transplantadas y sometidas a autofecundación. La descendencia de estas plantas confirmó su resistencia en las pruebas realizadas en el ano siguiente. Como resultado de ello, se formaron dos líneas consanguíneas con perspectiva, resistentes a ambas razas de jopo de girasol (C y D). Pero, el carácter recesivo de la resistencia obtenida, causa ciertos problemas en la formación de los híbridos comerciales de girasol, así que nosotros seguiremos buscando nuevos donadores de genes de resistencia dominantes, entre las muestras.

TRAITEMENT DU TOURNESOL CULTIVÉ SUR LA RÉSISTANCE AUX NOUVELLES RACES DE L'OROBANCHE

RÉSUMÉ

L'orobanche (*Orobanche cumuna* Wallr.) c'est un parasite qui se nourrit par la racine de tournesol. Dans les dernières années en Espagne, il y a eu une expansion drastique d'une nouvelle race de ce pathogène désigné comme race F (ou en Russie, comme biotype D). Le but de cette recherche est de trouver les donneurs résistants à ce biotype afin d'examiner l'hérédité de ce trait et de créer de nouvelles lignes de tournesol cultivé, résistantes à la race et possédant d'autres traits de valeur. Les tests préliminaires ont montré que pratiquement toutes les lignes enregistrées et perspectives obtenues à All-Russia Research Institute of Oil Crops (VNIIMK), sont sensibles à cette nouvelle race de l'orobanche, seulement la ligne VK-623 est résistante à l'orobanche. Par conséquent, tout le matériel obtenu par la ligne VK-623 a été testé et cette ligne est utilisée comme une ligne parentale et aussi bien tous les hybrides F_1. Tous les hybrides testés F_1 se sont montrés sensibles à la race F, ce qui indique qu'il s'agit d'une résistance récessive. Le nombre des plantes résistantes du matériel testé a varié. Chez les descendants de deux plantes morphologiquement dif-

férentes F_3 de la combinaison hybride 14B × (VK-623 × VK-616), quinze différentes plantes résistantes ont été trouvées, ensuite elles sont transplantées et subies une auto pollinisation. Les descendants de ces plantes ont confirmé la résistance dans les testes faits l'année suivante. Le résultat de cette recherche a apporté deus lignes de tournesol cultivé, résistantes à deux races d'orobanche (C et D). Cependant le caractère récessif de la résistance obtenue présente les problèmes particuliers dans la création d'hybrides commerciaux de tournesol cultivé, ce qui nous oblige à continuer la recherche de nouveau gènes donneurs parmi les échantillons de tournesol.