

DETERMINING NEW BROOMRAPE-INFESTED AREAS, RESISTANT LINES AND HYBRIDS IN TRAKYA REGION OF TURKEY

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Received: October 08, 2003

Accepted: January 05, 2004

SUMMARY

New broomrape races have spread quickly year after year to reach 70% of the sunflower acreage in Trakya region of Turkey. These new races were more virulent in Turkey than in other countries such as Spain and at least one more race other than F race was observed in Trakya. Some inbred lines from Trakya Agricultural Research Institute-Edirne (TARI) exhibited resistance in some parts of the region, but the sunflower hybrid PR-64-A-95 exhibited resistance in all locations. This hybrid and other resistant lines will be evaluated again in subsequent years and they will be used as a differential set for determining new broomrape races.

Key words: sunflower, resistance, broomrape, new races

INTRODUCTION

Broomrape (*Orobanche cernua* Loefl.) is the most important parasite reducing seed and oil yield, 1000-seed weight, oil content, plant height and head diameter in sunflower production. Sunflower (*Helianthus annuus* L.) has been severely affected by broomrape in the main crop areas of Turkey (Ozhatay, 1973; Uludere, 1988; Bulbul, 1991) and in some European countries since 1958 (Gagne *et al.*, 1998). A, B, C, D races of broomrape were determined in early times (Aćimović, 1980; Vranceanu, 1980) and E race (Melero-Vara *et al.*, 1989) was determined in 1980s by controlled *Or1-5* genes (Domingez *et al.*, 1996). Resistant hybrids and cultivars were developed against these races and these resistant sunflower cultivars were used widely in different parts of the world until 1995 (Mihaljčević, 1996).

This resistance was subsequently overcome by *Orobanche* race E. Recently, yet another *Orobanche* race, race F, appeared in Turkey (Kaya, 2003), Romania (Pacurianu-Joita *et al.*, 1998) and in some areas of Spain (Alonso, 1996; Ruso *et al.*, 1996; Sukno *et al.*, 1999a, 1999b; Fernandez-Martinez *et al.*, 2000). Pacurianu-

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Joita *et al.* (1998) determined that the new F race, more virulent than the other known races, was differentiated by the sunflower line LC-1093. Based on this knowledge, we could conclude that the broomrape overcomes the sunflower's resistance mechanism each 20 years.

FAO European Sunflower Network started a study to determine the distribution and virulence rate of the new F races in different European countries. Different sunflower lines and hybrids were tested in yield trials and their reactions against *Orobanche* in natural and artificial conditions in laboratory and field in 1996-1997. In that study (Shindrova *et al.*, 1998), the new F race from Turkey was more virulent than those from the other countries and it affected extremely some important yield characters of sunflower.

The new *Orobanche* populations are more virulent in Turkey than in other countries. The areas infested with the new races in Trakya region (the European part of Turkey) are increasing by 50% per year. On the other hand, the BR populations developed by Jan (Jan *et al.*, 2000) resistant to the F race showed different reactions and exhibited susceptibility only in some parts in the region. Preliminary results show that there are at least three different broomrape populations. The aims of this study were to determine the areas infested with new *Orobanche* races and find resistant sunflower lines and hybrids which show resistance in Trakya region of Turkey.

MATERIAL AND METHODS

TARI-Turkey started a new project in 1999, to determine infested areas and find resistant lines and hybrids against these races. A differential set for A, B, C, D, E races were planted in inoculated field conditions in 1999. Six lines were planted in the set and inoculated with broomrape seeds collected by TARI, Sygenta Seed Co. and Pioneer Seed Co. from three different parts of Trakya region. New races first appeared in Malkara at the beginning of 1990s, then spread out to other regions in the following years. Infested areas with new races were determined by inspecting village after village in 1998, 2000 and 2002 with contribution of extension officers, sunflower farmer associations and salesmen of private seed companies. A detailed broomrape infestation map has been prepared.

Sunflower hybrids and lines developed by National Sunflower Research Project at TARI in Edirne and commercial sunflower hybrids that belong to private companies were tested again the new broomrape races under artificial conditions between 1999 and 2002. Broomrape seeds were gathered by threshing plants collected from different infested fields of Trakya region, which covers 75% of Turkey sunflower production. Before planting, a pinch of broomrape seeds was placed in each hole opened in the field. *Orobanche* test plots were 5 m in length, with 14-15 plants in each row, with 35 cm × 1 m plant density in two replicates. The susceptible open pollinated cultivar Vniimik-8931, which was used as control, was planted after each

40 rows. Broomrape observations were evaluated as frequency (F) intensity (I) and attacking rate (AR) based on Pustovoit method (Aydin, 1996). The plants having 0-10% frequency and 0-1 AR values were accepted as resistant (Vranceanu *et al.*, 1980). The plants which had 10-20% frequency were accepted as tolerant in 2002 evaluations.

$$\begin{aligned} \text{\% of plant with } Orobanch\text{e} & \quad F = \frac{\text{The plant number infested by } Orobanch\text{e}}{\text{Total plants in the row}} \times 100 \\ \text{The number of } Orobanch\text{e in} & \quad I = \frac{\text{Total } Orobanch\text{e}}{\text{Total plants infested by } Orobanch\text{e in the row}} \\ \text{one infested plant} & \\ \text{The number of } Orobanch\text{e in} & \quad AR = \frac{F \times I}{100} \\ \text{one plant in the row} & \end{aligned}$$

In 2001, broomrape seeds were collected from different areas and planted in inoculated pots in growth chamber as 6 sets: Malkara, Hayrabolu, Muratli, Edirne, Luleburgaz and all mixed in the winter. Tolerant hybrids S-288, TARSAN-1018, ARDA-2098, TR-3080 (OZDEMIRBEY) and susceptible SANBRO hybrids were planted in this set.

Resistant sunflower hybrids and lines were selected from broomrape observations under conditions of artificial infestation in the field in 1999, 2000 and 2001. These lines and hybrids were planted under natural field conditions in 2002 and 6 sets established and tested in different infested areas in Trakya region. BR-1, resistant Pioneer hybrid PR-64-A95, other resistant and tolerant hybrids were included into a set consisting of 8 sunflower hybrids and 34 lines, which was grown under conditions of artificial infestation in previous years in the locations Pazarli - Vize (the heaviest infestation) and Akcakoy - Corlu (an area heavily infested with new races) (PIONEER Seed Co.), Cesmekolu - Luleburgaz and Muratli (ADVANTA Seed Co.), Arzulu - Muratli and Faras - Hayrabolu (MAY Seed Co.), all in Trakya region.

RESULTS AND DISCUSSION

The layout of infestation with new broomrape races in Trakya sunflower production areas was shown in the map given in Figure 1. Yellow-colored regions are areas infested before 1998, green-colored zones were infested before 2000 and blue-colored zones were infested before 2002. These new races increased each year by 50% in relation to the previous year. The infested areas started with 2% in 1995 to reach 35% of seriously infested area in 2002. In 2002, the new *Orobanch*e races could be observed in more than 60-70% of the total sunflower production areas of Trakya region.

Within the *Orobanch*e project, a differential set for A, B, C, D, E races was planted under conditions of artificial infestation in the field in 1999, to determine whether the races occurring in the infested areas in the region are new or one of the

five known races. Since plants in the set were susceptible, we concluded that we were dealing with new races (Table 1).

Table 1: Observations on the differential set for broomrape planted in 1999

Cultivar name	Race	Plant #	Plant # with <i>Orobanche</i>	<i>Orobanche</i> number	Frequency (%)	Intensity	Attacking rate	
TRAKYA TAE	AD-66	A	32	3	15	9.4	5.0	0.5
	Kruglik A-41	B	28	6	12	21.4	2.0	0.4
	Jdanov 8281	C	40	11	27	27.5	2.5	0.7
	Record	D	33	7	13	21.2	1.9	0.4
	S-1358	E	22	6	13	27.3	2.2	0.6
	P-1380		32	4	7	12.5	1.8	0.2
SYNGENTA	AD-66	A	26	8	13	30.8	1.6	0.5
	Kruglik A-41	B	22	2	7	9.1	3.5	0.3
	Jdanov 8281	C	42	14	43	33.3	3.1	1.0
	Record	D	42	5	16	11.9	3.2	0.4
	S-1358	E	30	4	5	13.3	1.3	0.2
	P-1380		37	2	8	5.4	4.0	0.2
PIONEER	AD-66	A	26	14	27	53.8	1.9	1.0
	Kruglik A-41	B	40	11	21	27.5	1.9	0.5
	Jdanov 8281	C	48	16	40	33.3	2.5	0.8
	Record	D	34	11	22	32.4	2.0	0.6
	S-1358	E	39	5	10	12.8	2.0	0.3
	P-1380		45	5	11	11.1	2.2	0.2

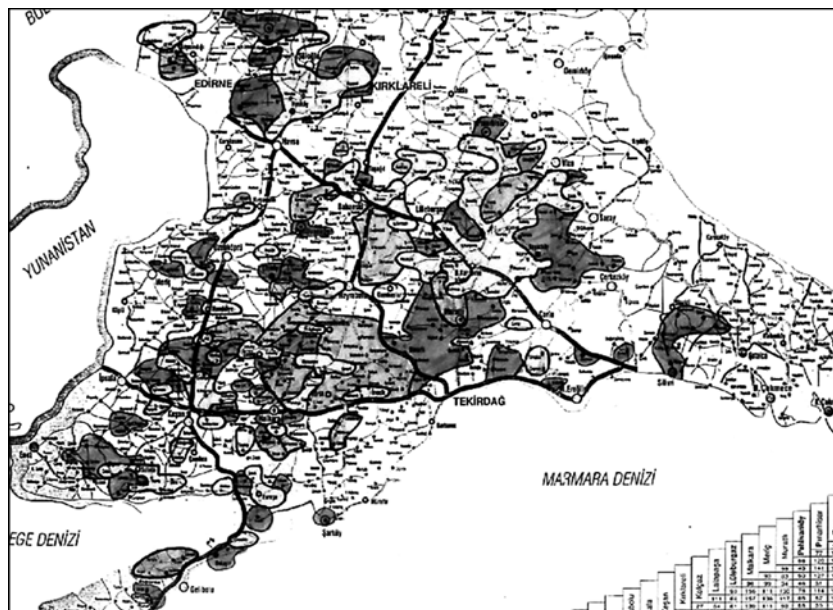


Figure 1: Broomrape infested areas in Trakya region in 1998, 2000 and 2002

Table 2: Broomrape observations in different parts of Trakya region in 2002

No.	Name of line or cultivar	Location					
		May Seed		Pioneer		Advanta	
		Arzulu	Faras	Pazarli	Akcakoy	Muratli	Cesmekolu
1	0043-A	TOL	SUS	SUS	SUS	TOL	TOL
2	0046-A	RES	SUS	SUS	SUS	RES	SUS
3	0046-A/0043-B	SUS	SUS	SUS	SUS	TOL	TOL
4	0195-A	SUS	SUS	SUS	SUS	TOL	TOL
5	0583-A	NONP	SUS	SUS	SUS	TOL	TOL
6	0583-A/0704-B	TOL	SUS	SUS	SUS	TOL	SUS
7	0704-A	SUS	SUS	SUS	SUS	SUS	SUS
8	0821-A	TOL	SUS	SUS	SUS	SUS	SUS
9	1159-A	TOL	TOL	SUS	SUS	SUS	SUS
10	1492-A	TOL	SUS	SUS	SUS	SUS	SUS
11	1599-A	TOL	TOL	SUS	SUS	SUS	SUS
12	2453-A	SUS	SUS	SUS	SUS	TOL	TOL
13	2478-A	RES	TOL	SUS	SUS	TOL	SUS
14	2517-A	RES	TOL	SUS	SUS	RES	TOL
15	3002-A	RES	SUS	SUS	SUS	TOL	SUS
16	3009-A	RES	SUS	SUS	SUS	TOL	SUS
17	4155-A	TOL	SUS	SUS	SUS	TOL	SUS
18	6163-A	TOL	TOL	SUS	SUS	SUS	SUS
19	62001-A	RES	RES	SUS	RES	TOL	TOL
20	62003-A	RES	RES	SUS	RES	RES	TOL
21	646-A	TOL	SUS	SUS	SUS	SUS	SUS
22	6522-A	RES	RES	SUS	SUS	RES	SUS
23	6626-A	SUS	SUS	SUS	SUS	SUS	SUS
24	67372-A	TOL	SUS	SUS	SUS	SUS	SUS
25	67375-A	TOL	SUS	SUS	SUS	SUS	SUS
26	BAH-4-A	SUS	SUS	SUS	SUS	SUS	SUS
27	BAH-5-A	RES	SUS	SUS	SUS	SUS	SUS
28	BAH-7-A	RES	SUS	SUS	SUS	SUS	SUS
29	BAH-8-A	SUS	SUS	SUS	SUS	SUS	SUS
30	BAH-9-A	TOL	SUS	SUS	SUS	SUS	SUS
31	BR-1	TOL	SUS	SUS	SUS	SUS	SUS
32	HA-852-A	SUS	SUS	SUS	SUS	SUS	SUS
33	HA-853-A	TOL	SUS	SUS	SUS	SUS	SUS
34	HA-89-A/0704-B	TOL	SUS	SUS	SUS	SUS	SUS
35	S-288	TOL	SUS	SUS	SUS	SUS	SUS
36	TR-3079	SUS	SUS	SUS	SUS	SUS	SUS
37	TR-3080	SUS	SUS	SUS	SUS	SUS	SUS
38	TR-4098	SUS	RES	SUS	SUS	SUS	SUS
39	TR-6149-SA	SUS	TOL	SUS	SUS	TOL	SUS
40	TR-6189	TOL	TOL	SUS	SUS	TOL	SUS
41	TR-9432	SUS	SUS	SUS	SUS	SUS	SUS
42	XF 64-A-95	TOL	RES	RES	RES	RES	RES

RES: Resistant, TOL: Tolerant, SUS: Susceptible, NONP: No plants.

Tolerant hybrids S-288, TARSAN-1018, ARDA-2098, TR-3080 (ÖZDEMİRBEY) and the susceptible hybrid SANBRO were tested for broomrape reaction in growth chamber in winter 2001 as 6 set: Malkara, Hayrabolu, Muratli, Edirne, Luleburgaz and all mixed in the pots. Based on the observation results, new broomrape races infested all cultivars, but TARSAN-1018 was more tolerant than the other hybrids.

Based on the results obtained under conditions of natural infestation in the field, Pioneer hybrid PR-64-A95 was resistant in all locations and BR-1 showed different reactions in the six different locations in the region in 2002 (Table 2). Some inbred lines (62003-A, 62001-A, 6522-A) showed different tolerance in dependence of location. In some areas, a few broomrape plants were observed on resistant Pioneer hybrid PR-64-A95. Differential reactions were also observed in BR-1 and in some inbred lines.

Based on these research results obtained under natural conditions; S-288, TARSAN-1018 and PR-64 A 91 showed resistance in some locations until 1998. BR-1, which is resistant to F race, was susceptible in all locations, so there is at least one more new race in the region in addition to F race. However, they could be sub races or new races. The new races kept spreading in different parts of the region year after year so that in 2002 these new *Orobanche* races appeared everywhere.

Some female inbred lines such as 24788-A, 3002-A, 3009-A, BAH-5-A, BAH-7-A showed resistance in one location (Arzulu), 0046-A and 2517-A in two locations; 62001-A and 6522-A in three locations and 62003-A in four locations (Table 2). TR-4098 showed resistance in Faras location only. The population BR-1 developed by Jan, declared as resistant to F race, did not show the expected resistance in any region. It appears that 2517-A could be used for Muratli (Arzulu, Muratli) region, TR-4098 for Hayrabolu (Faras), 62001-A and 6522-A for both of these regions, 62003-A for Corlu and Luleburgaz (Akacakoy) regions and XF 64-A-95 could be used as broomrape differential for all regions. However, these lines should be tested again in subsequent years prior to their use in differential sets.

CONCLUSION

Areas infested with new broomrape races are increasing year after year in Trakya region. However, we still do not know whether these different broomrape populations are new races or sub populations. Development of sunflower lines and hybrids resistant to these new races continues in Trakya Agricultural Research Institute and private company breeding programs. Some hybrids and lines have showed resistance in some regions. Pioneer hybrid XF 64-A-95 was resistant in all regions and it will be used as differential line against these new broomrape populations in coming years.

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IDENTIFICACIÓN DE NUEVAS RAZAS DE JOPO DE GIRASOL, ZONAS INFECTADAS Y LÍNEAS RESISTENTES E HÍBRIDOS EN LA REGIÓN TRAKYA EN TURQUÍA

RESUMEN

Las nuevas razas de jopo de girasol, rápidamente se divulgaban del año en año, y ahora están presentes en 70% de superficie bajo girasol en la región Trakya en Turquía. Estas razas eran más virulentas que en otros países, como España, y en la región se notó por lo menos una raza más, aparte de la raza F. Algunas líneas consanguíneas que pertenecen a Trakya Agricultural Research Institute-Edirne (TARI), mostraron resistencia en algunas partes de la región, pero, solamente el híbrido PR-64-A-95 era resistente en todas las ubicaciones. Este híbrido, tanto como otras líneas resistentes, serán evaluados de nuevo el año siguiente, y luego se utilizarán como conjuntos diferenciales para la identificación de las nuevas razas de jopo de girasol.

DÉTERMINATION DES RÉGIONS INFECTÉES PAR OROBANCHE ET DES LIGNES ET HYBRIDES RÉSISTANTS DANS LA RÉGION DE THRACE EN TURQUIE

RÉSUMÉ

Les nouvelles races de l'orobanche ont une expansion très rapide en dernières années et sont présentes sur 70% de surfaces cultivées en tournesols dans la région de Thrace en Turquie. Ces races étaient plus virulentes en Turquie que dans d'autres pays, comme en Espagne, alors que dans la région de Thrace il en existe au moins une à côté de la race F. Quelques lignes cultivées appartenant à Trakya Agricultural Research Institute-Edirne, (TARI) ont montré une résistance dans certains endroits de la région, mais seulement l'hybride de tournesol PR-64-A-95 était résistant sur tous les lieux. Cet hybride et d'autres lignes résistantes seraient évalués encore une fois dans les années suivantes, et ensuite utilisés comme groupes différentiels pour l'identification de nouvelles races de l'orobanche.