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BROOMRAPE (*Orobanche* spp.) PROBLEM IN THE EASTERN MEDITERRANEAN REGION OF TURKEY

Bülbül, F.*[1], Aksoy, E.[1], Uygur, S.[2], Uygur, N.[2]

[1] *Plant Protection Research Institue 01321 Köprüköyü/ADANA*
[2] *Çukurova University, Faculty of Agriculture, Department of Plant Protection 01330 Balcali/ADANA*

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SUMMARY

Broomrapes (*Orobanche* spp.) which belong to the family *Orobanchaceae* are obligate parasitic flowering plants. The main center of distribution is the Mediterranean basin, where large areas are heavily infested. Yield losses due to *Orobanche* range from 5 to 100% depending on the region and the crop.

Orobanche species infesting crops in the eastern Mediterranean region of Turkey are: *O. aegyptiaca*, *O. ramosa* and *O. crenata*. *O. aegyptiaca* / *O. ramosa* were present in 27.72% of the tomato greenhouses and 80% of the tomato fields, *O. crenata* and *O. aegyptiaca* / *O. ramosa* were present in 57.89% of the faba bean fields and 75.51% of the lentil fields.

Sunflower cultivation has gradually increased in the eastern Mediterranean region since 2004. In 2005, sunflower acreage and production in the region were tripled compared with 2004. There has not been any record on broomrapes in sunflower fields in eastern Mediterranean region yet, but broomrapes are considered a possible threat for sunflower fields in this area. *Orobanche cernua* Loef. causes considerable damage in sunflower fields in other regions of Turkey where sunflower has been sown for years and it may spread from those regions to the eastern Mediterranean region. In addition, sunflower is also a host plant of *Orobanche ramosa* L. and *Orobanche aegyptiaca* Pers. which were already found in some crops in the eastern Mediterrean region.

Since the magnitude of the broomrape problem increases each year in Turkey, a "National Broomrape Project" has been organized in collaboration of some govermental institues and universities in 2006. The Project includes extension activities too. Because growers are not carefull about dispersal of broomrape, they should be trained how to apply preventive measures as soon as possible.

Key words: sunflower, broomrape, *Orobanche*

* Corresponding author

INTRODUCTION

Considerable damage is inflicted on food and fodder plants by parasitic flowering plants. Due to the withdrawal of water, minerals and organic compounds by the parasites, the growth of the host is retarted, and crop yields are lowered or reduced to zero under conditions of severe infestation (Sauerborn, 1991).

Over 100 *Orobanche* species are identified in the world, but only a few of them are economically important weeds in cropping systems. They are parasitic on a wide range of plant families (*Asteracea, Fabaceae, Solanaceae, Apiaceae, Cucurbitaceae*) (Linke *et al.*, 1989).

Production of several important crops (lentil, faba bean, tomato, potato, sunflower, etc.) is threatened by broomrapes (*Orobanche* spp.). As a result of this threat, the cultivated crop areas attacted with broomrapes have been declining steadily in some countries as farmers kept abandoning the production of these crops in heavily infested fields.

Some particularly damaging *Orobanche* species occur in the Mediterranean region and in Western Asia. They parasitize important cash and food crops. Although *Orobanche* is distributed worldwide, significant damage is caused only in South and East Europe, North Africa and West Asia. Yield losses range from 5 to 100% depending on the region and crop. In the Mediterranean region and West Asia, around 16 million ha are endangered by *Orobanche* (about 1.2% of the world's arable land) (Sauerborn, 1991).

Control of these parasites is difficult because broomrapes produce hundreds of thousands of minute seeds that are highly persistent in the soil and can easily spread to new areas. Moreover, due to the intimate connection between these holoparasitic weeds and their hosts, no economically viable and effective control system against the parasites could be developed for several cultivated plants. Lack of efective countermeasures against broomrapes contributes to the continuously increasing importance of these weeds in agricultural areas.

This report shows the importance of broomrape species in Turkey, more specifically in the eastern Mediterranean region of Turkey, and broomrape problem in the sunflower production in that region. In addition, National Broomrape Project, which was established in Turkey in 2006, will be briefly outlined.

Broomrape (*Orobanche* spp.) species and their host plants in Turkey

In Turkey, 36 species of *Orobanche* have been recorded (Gilli, 1982), but only four of them cause considerable damage to crops (Table 1). In Turkey, *Orobanche ramosa* L. and *O. aegyptiaca* Pers. are harmful to tobacco, tomato (Demirkan and Nemli, 1993) and lentil (Aksoy and Uygur, 2003), *O. cernua* Loefl. is harmful to sunflower (Petzoldt *et al.*, 1994) and *O. crenata* Forks. causes damage to faba bean (Kitiki *et al.*, 1993) and lentil (Aksoy and Uygur, 2003).

Yield losses caused by *Orobanche* spp. in sunflower, tomato and faba bean were observed in Turkey (Table 2). *Orobanche* species caused extensive yield losses (21.64-81.83%) in tomato, tobacco, sunflower and faba bean.

Table 1: Host range of *Orobanche* spp. in Turkey

Orobanche spp.	Host plant	Reference
O. aegyptiaca	Tomato	Aksoy and Uygur (2003)
	Lentil	Uludag and Demir (1997), Aksoy and Uygur (2003)
	Faba bean	Aksoy *et al.* (2001)
O. ramosa	Tobacco	Ekiz (1970)
	Tomato	Aksoy *et al.* (2001)
	Sunflower	Ekiz (1970)
	Lentil	Aksoy and Uygur (2003)
	Eggplant	Demirkan (1993)
O. crenata	Faba bean	Kitiki *et al.* (1993), Aksoy and Uygur (2003),
	Lentil	Uludag and Demir (1997) Aksoy *et al.* (2001)
O. cernua/cumana	Sunflower	Ekiz (1970)

Table 2: Yield losses caused by *Orobanche* spp. in Turkey

Orobanche spp.	Crop	Yield loss (%)	Reference
O. ramosa	Tomato	24.18	Aksoy, 2003
	Tobacco	21.64-35.56	Ekiz, 1970
O. cumana	Sunflower	27-31.87	Ekiz, 1970
O. crenata	Faba bean	81.83	Aksoy, 2003

An estimated 100 thousand tons of sunflower is lost due to broomrape infestation and broomrape management problems in sunflower, which corresponds to an annual loss of 50 million Euro. Economic loss of lentil of about 60 million Euro is estimated annually. It is estimated that 70,000 tons of tobacco leaves are lost annually due to broomrape infestation, which is equivalent to 175 million Euro. The overall annual loss in tomato is estimated at 200 million Euro (Uludag and Demirci, 2005).

Eastern Mediterranean region and crops

The eastern Mediterranean Region of Turkey includes seven provinces - Adana, Mersin, Hatay, Osmaniye, Gaziantep, Kilis and Kahramanmaras (Figure 1).

This region, also called Çukurova (Cilician plain), is a plain between the deltas of the Seyhan and Ceyhan rivers. Because of its fertile soil and Mediterranean climate, different crops can be cultivated year round. Most important crops grown in the area are wheat, lentil, corn, cotton, soybean and citrus; sunflower, canola and olive are increasingly grown in the area; additionally, various vegetables and fruits

are grown in the area. For this reason the eastern Mediterranean area is very important for the agricultural production of Turkey.

Figure 1. Map of east Mediterranean region of Turkey

Distribution of broomrape species in eastern Mediterranean region

Orobanche species infesting crops in the eastern Mediterranean region are *O. aegyptiaca*, *O. ramosa* and *O. crenata*.

Orobanche aegyptiaca/ramosa were present in 27.72% of the surveyed tomato greenhouses and in 80% of the surveyed tomato fields. In tomato greenhouses, 0.42 *Orobanche aegyptiaca/ramosa* shoots / per tomato root were observed. In tomato fields 3.32 *Orobanche aegyptiaca/ramosa* shoots/m^2 were determined (Aksoy and Uygur, 2003). The tomato parasitism data, by *O. ramosa*, are in accordance with a study conducted by Demirkan and Nemli (1993) in the Aegean region of Turkey.

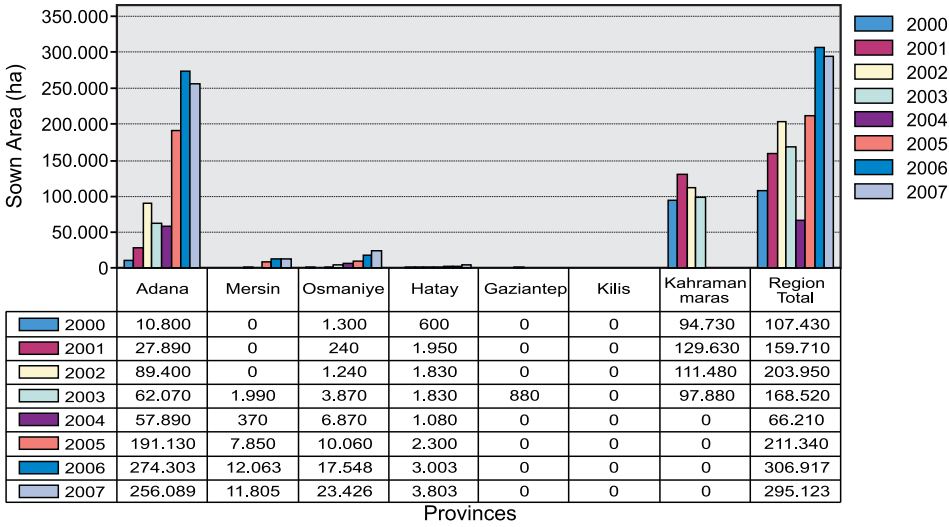
Orobanche spp. were present in 57.89% of the surveyed faba bean fields; 54.54% of them were infested only by *O. crenata* and 9.1% showed infestation by *O. aegyptiaca / ramosa*. In other fields, *O. crenata* occured together with the complex *O. aegyptiaca/ramosa* at approximately 36.36% of the area. In the faba bean fields 6.81 *O. aegyptiaca/ramosa* and *O. crenata* shoots/m^2 were determined (Aksoy and Uygur, 2003). The results for *O. crenata* in faba bean are in accordance with Kitiki *et al.* (1993).

Orobanche spp. were present in 75.51% of the surveyed lentil fields; 5.26 of them were infested by *O. crenata* and 94.74 % showed infestation from *O. crenata* and the complex *O. aegyptiaca/ramosa*. In lentil fields, 6.55 *O. aegyptiaca/ramosa* and *O. crenata* shoots/m^2 were determined (Aksoy and Uygur, 2003). Uludag and Demir (1997) also determined *O. crenata* and *O. aegyptiaca* in lentil fields in southeast Anatolia region of Turkey.

Sunflower production in eastern Mediterranean region

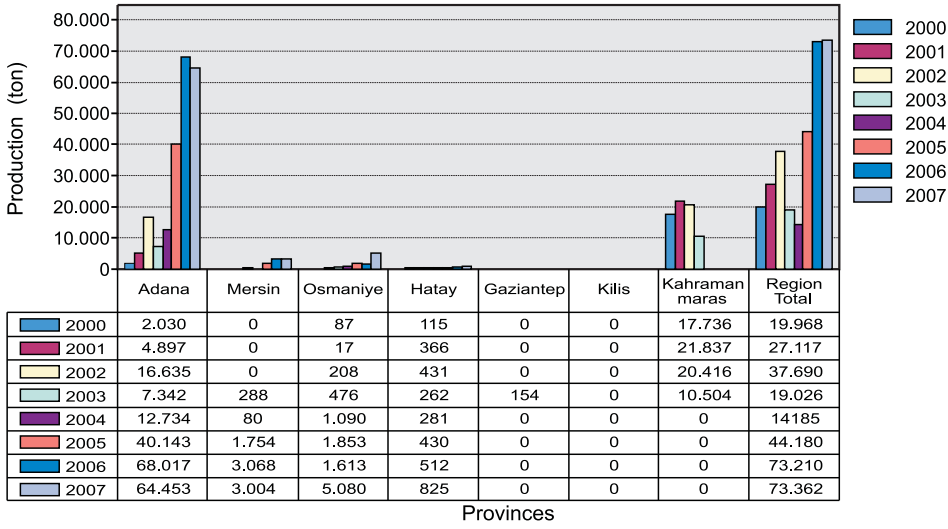
Sunflower is cultivated in eastern Mediterranean region of Turkey from 2004, in four provinces, Adana, Mersin, Hatay and Osmaniye.

The sunflower acreage in this region from 2000 to 2007 is shown in Figure 2 and sunflower production in the same region is shown in Figure 3, according to the data obtained from Turkish Statistical Institute (Anonymous, 2008).



	Adana	Mersin	Osmaniye	Hatay	Gaziantep	Kilis	Kahraman maras	Region Total
2000	10.800	0	1.300	600	0	0	94.730	107.430
2001	27.890	0	240	1.950	0	0	129.630	159.710
2002	89.400	0	1.240	1.830	0	0	111.480	203.950
2003	62.070	1.990	3.870	1.830	880	0	97.880	168.520
2004	57.890	370	6.870	1.080	0	0	0	66.210
2005	191.130	7.850	10.060	2.300	0	0	0	211.340
2006	274.303	12.063	17.548	3.003	0	0	0	306.917
2007	256.089	11.805	23.426	3.803	0	0	0	295.123

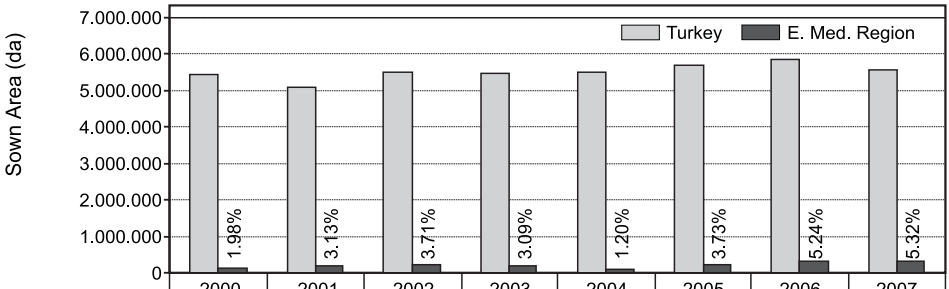
Figure 2: Sunflower acregae in eastern Mediterranean region (2000-2007)



	Adana	Mersin	Osmaniye	Hatay	Gaziantep	Kilis	Kahraman maras	Region Total
2000	2.030	0	87	115	0	0	17.736	19.968
2001	4.897	0	17	366	0	0	21.837	27.117
2002	16.635	0	208	431	0	0	20.416	37.690
2003	7.342	288	476	262	154	0	10.504	19.026
2004	12.734	80	1.090	281	0	0	0	14185
2005	40.143	1.754	1.853	430	0	0	0	44.180
2006	68.017	3.068	1.613	512	0	0	0	73.210
2007	64.453	3.004	5.080	825	0	0	0	73.362

Figure 3: Sunflower production in eastern Mediterranean region (2000-2007)

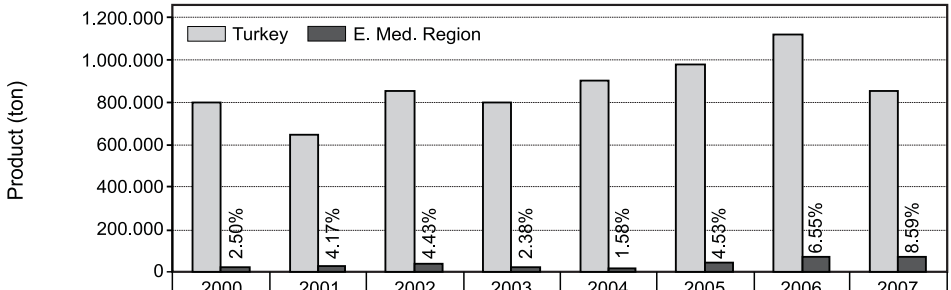
As seen in Figure 2, the sunflower cultivated area increased almost three (2.74) times. Figure 3 shows the that sunflower production in the region increased 3.67



	2000	2001	2002	2003	2004	2005	2006	2007
Turkey	5.420.000	5.100.000	5.500.000	5.450.000	5.500.000	5.660.000	5.854.000	5.546.778
E. Med. Region	107.430	159.710	203.950	168.520	66.210	211.340	306.917	295.123

Year

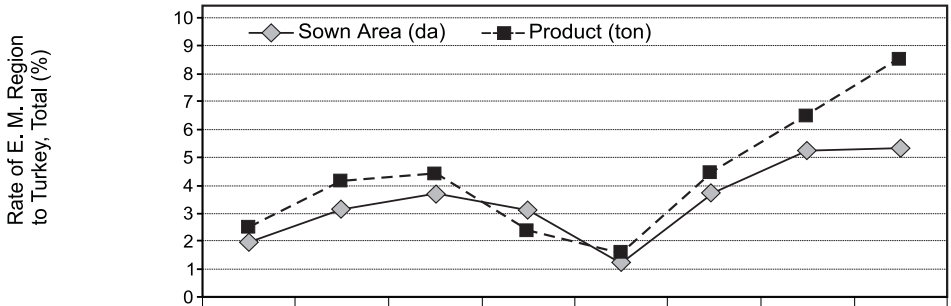
Figure 4: Rate of the sunflower acreage in eastern Mediterranean region in relation to the total sunflower acreage in Turkey (2000-2007) Sown area = Acreage



	2000	2001	2002	2003	2004	2005	2006	2007
Turkey	800.000	650.000	850.000	800.000	900.000	975.000	1.118.000	854.407
E. Med. Region	19.968	27.117	37.690	19.026	14.185	44.180	73.210	73.362

Year

Figure 5: The rate of sunflower production in eastern Mediterranean region in relation to the total sunflower production in Turkey (2000-2007)



	2000	2001	2002	2003	2004	2005	2006	2007
Sown Area (da)	1.98	3.13	3.71	3.09	1.20	3.73	5.24	5.32
Product (ton)	2.50	4.17	4.43	2.38	1.58	4.53	6.55	8.59

Year

Figure 6: The rate of sunflower acregae and production in eastern Mediterranean region compared with the total sunflower production in Turkey (2000-2007)

times in the seven years. The sunflower acreage and production were increased in 2005 more than three times (3.19 and 3.11, respectively) compared with 2004. Among the crops cultivated in the east ernMediterrean region, sunflower acreage and production have recordes largest increases since 2004.

The rate of sunflower acreage in eastern Mediterranean region in relation to the total sunflower acreage of Turkey (2000-2007) is given in Figure 4; the rate of sunflower production in the region is compared with the total sunflower production in Turkey (2000-2007) in Figure 5. Both parameters are given in Figure 6.

As can be seen in Figure 6, the sunflower acregae and production in the region / decreased in the period 2000-2004 and increased gradually in the period 2004-2007. The 2007 rate on increase of sunflower acreage was 5.32 and of production 8.59.

Obviously, sunflower cultivation was accepted by the growers from the region. The reasons of the increases sunflower production in eastern Mediterranean region are: low production input, below those for the other alternative crops, no problem about sale of produced grain, increase in goverment subsidy forsunflower production and the fact that the sunflower crop can be grown in arid regions. It is estimated that if there there were no important threats such as broomrapes, the sunflower production would increased year after year in this region.

Unfortunately, cultivation of some crops in eastern Mediterranean region is risky because of a possibility of broomrape infestation. The major reason for it are growers who are not carefull about broomrape dispersal in the area. The growers are not acquainted with the parasite; on one side, some growers believe that pulling broompapes out causes and increased infestation in the fields so generally they do nothing; on the other, growers that do weed broomrapes in their fields leave them in the fields or at the side of the fields. S growers throw the weeded broompares in irrigation channels. In addition in this region, broomrape seed transfer can occur by animal manure. Sheeps or cows that graze in broomrape-infested fields cause further broomrape spread in the area. It has been agreed that without drastic measures to stop the spread of *Orobanche* species, they will become more widespread and more numerous in eastern Mediterranean region. The sunflower industry in the area will soon be under a serious threat.

Broomrape species attacking sunflower and their importance

Sunflower is an important host plant for broomrapes, especially for *Orobanche cernua*. In the past decades, sunflower cultivation had to be considerably reduced or the crop production had to be discontinued because of high *Orobanche* infestation. In the 1950, the area of sunflower cultivation was reduced by 37% in the former Yugoslavia following an *O. cumana* infestation. The parasite was suppressed only through the import of resistant species (Mijatović and Stojanović, 1973). In Spain, sunflower fields had to be taken out of production because of high

Orobanche infestation (Sauerborn, 1991). *Orobanche* species that parasitize sunflowers in different parts of the world are given in Table 3.

Table 3: *Orobanche* species that parasitize sunflower in the world

Orobanche species	Frequency	Reference
O. ramosa	x	Parker and Riches, 1993
O. aegyptiaca	xx	Sauerborn, 1991*
	xx	Parker and Riches, 1993
O. mutelii	xx	Sauerborn, 1991*
O. crenata	x	Sauerborn, 1991*
	x	Parker and Riches, 1993
O. cernua	xxx	Sauerborn, 1991*
	xxx	Parker and Riches, 1993
O. minor	xx	Sauerborn, 1991*

* =expanded after Foy *et al.*, 1989, (Sauerborn, 1991)
x =light attack, rare
xx =moderate attack, common
xxx=serious attack, very common, severe crop damage

As can be seen in Table 3, six species of *Orobanche* have been recorded in sunflowers (Sauerborn, 1991; Parker and Riches, 1993). Among these species, *O. cernua* is commonly found and it causes serious attacks; *O. aegyptiaca, O. mutelii* and *O. minor* cause moderate attacks; *O. ramosa* and *O. crenata* cause attacks of low intensity.

In Turkey, *O. cernua* was very common and it caused severe crop damage while *O. ramosa* were found to cause light attacks. Seven *Orobanche cumana* races have already been recorded. Only 22% of the sunflower fields are broomrape free in the Trace region, which is the main sunflower growing area with 70% share of the total production. High and heavy infestation is foudn at 45% of the sunflower fields in that region. Broomrape resistant and Clearfield sunflower varieties are sown at 60% of this area, which reduce potential loss due to intensive broomrape infestation. However, these sunflower cultivars have a lower yield potential compared with broomrape-sensitive cultivars. In the other sunflower-growing areas, 35% of the fields are infested with broomrapes. Altogether, an estimated 100 thousand tons of the crop are lost due to broomrape infestation and broomrape management problems in sunflowers, which corresponds to an annual loss of 50 million Euro (Uludag and Demirci, 2005).

According the other literature sources (Ozge *et al.*, 1997), all sunflower fields, 50% of the tomato acreage and 10% of the tobacco fields are infested with *Orobanche* spp. in Thrace region.

National Broomrape Project in Turkey

Since the magnitude of the broomrape problem is increasing each year in Turkey, a National Broomrape Project has been established in collaboration of some

govermental institues and universities. The National Project is managed by Minister of Agriculture and supported by TUBITAK (The Scientific and Technological Research Council of Turkey). The Project is planned for 4 year (2006-2010) and is currently is in its third year.

A total of 37 researchers and 17 different organisations (including 6 research institutes, 9 universities and 1 agrochemical company), cooperate in an attempt to solve the problem of broomrape control in potato, tomato and lentil crops. The project program involves a research and education parts.

Although the broomrape presence has been confirmed for some regions of the country, the true dimension of the broomrape problem remains yet unknown for many regions of Turkey. For this reason, the dimension of the broomrape problem was primarily addressed at the national level, by identifing the broomrape species attacking susceptible host crops (lentil, tomato, potato, sunflower, tobacco), as well as their distribution and abundance. Furthermore, the fact that yet no satisfactory solution could be offered to the steadily increasing questions and complaints directed at provincial and county authorities and research institutes by producers of broomrape host crops, particularly tomato, plays a major role in the planning of this project. During four years, intensive efforts will be invested in a wide array of investigations (identification of insect pests and diseases of the weed, studies on germination biology, use of natural fertilizers and several plants with allelopathic properties in broomrape control, trap cropping, determination of optimum sowing dates and varieties, tests on solarization and some mulch materials in under-glass tomato production, studies on biological and chemical control).

The National Broomrape Project includes extension activities as well. One of extension activities is education of producers on preventive measures about dispersal of broomrape seeds. With poll studies of farmers' responses at the beginning and end of the project, impact analyses of this project which has both a research and an extension component will be done. In that way, the rate of realization of project objectives will be established scientifically.

CONCLUSIONS

Eastern Mediterranean region of Turkey has very fertile soils and in this area sunflower acreage and production have gradually increased because of economic interest of farmers. No *Orobanche* has been detected in sunflower fields in the region so far, but it is possible because the *Orobanche* species that attack sunflowers are present in the region. *O. ramosa, O. aegyptiaca* and *O. crenata* were determined in tomato, lentil and faba bean fields in this region. It is an important objective to train growers to prevent the broomrape problem increasing gradually in sunflower fields in eastern Mediterranean region.

Six *Orobanche* species, *Orobanche cernua, O. aegyptiaca, O. mutelii, O. minor, O. ramosa* and *O. Crenata*, have been recorded in sunflower fields. Out of

these species, *O. cernua* is found very common and it causes serious attacks in some countries including Turkey. Only 22% of the sunflower fields are broomrape free in Trace region, which is the main sunflower-growing area of Turkey with 70% share of the total national acreage. High and heavy infestations are present in 45% of these sunflower fields.

Since growers are not carefull about broomrape dispersal o, both eastern Mediterranean region and Turkey on the whole are at high risk of large-scale infestation with broomrape. To prevent further broomrape spread in Turkey, extension workers and farmers must be trained on preventive measures for dispersal of broomrape seeds and all preventation practices must be taken immeditally.

Since the magnitude of the broomrape problem kept increasing in Turkey year after year, a National Broomrape Project has been organized in collaboration of some govermental institutes and universities. The objective of the project is to educate producers how to preventithe dispersal of broomrape seeds.

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EL PROBLEMA DEL JOPO (*Orobanche* spp.) EN LA REGIÓN MEDITERRÁNEA ORIENTAL DE TURQUÍA

RESUMEN

El jopo (*Orobanche* spp.) que pertenece a la familia *Orobanchaceae* son plantas parásitas obligadas con flores. El principal centro de distribución es la cuenca del Mediterráneo, donde grandes áreas están fuertemente infestadas. Las pérdidas de rinde debidas a *Orobanche* oscilan entre 5-100% dependiendo de la región y el cultivo. Las especies de *Orobanche* que infectan los cultivos en la región mediterránea oriental de Turquía son: *O. aegyptiaca*, *O. ramosa* y *O.crenata*. Las especies *O. aegyptiaca* y *O. ramosa* estaban presentes en el 27.72% de los invernaderos donde se producía tomate y el 80% de los tomatales; *O. crenata* y *O. aegyptiaca* / *O. ramosa* estaban presentes en el 57.89% de los judiares y el 75.51% de los lentejares. El cultivo de girasol ha aumentado gradualmente en la región del Mediterráneo oriental desde 2004. En 2005, el área sembrada y la producción de girasol en la región aumentaron más de tres veces respecto de 2004. No ha habido ningún registro de presencia jopo en cultivos de girasol en la región del Mediterráneo oriental, todavía. Pero al jopo se lo considera una posible amenaza para el girasol en esta área. *Orobanche cernua* Loef. provoca daños considerables en el girasol en otras regiones de Turquía donde dicha oleaginosa ha sido sembrada durante mucho tiempo y puede extenderse desde allí hacia a la región del Mediterráneo oriental. Además, el girasol es también un hospedero de *Orobanche ramosa* L. y *Orobanche aegyptiaca* Pers ya señalados en algunos cultivos en la región del mediterráneo del este. Dado que el problema del jopo se incrementa anualmente en Turquía, un "Proyecto Nacional del Jopo" se realiza en colaboración con algunos institutos gubernamentales y universidades desde 2006. El proyecto incluye también actividades de extensión. Puesto que los productores no son cuidadosos de sobre la dispersión del jopo, ellos deben ser instruidos inmediatamente sobre medidas preventivas.

PROBLÈME DÛ À L'OROBANCHE (*Orobanche* spp.) DANS LA RÉGION MÉDITERRANÉENNE ORIENTALE DE LA TURQUIE

RESUME

L'Orobanche (*Orobanche* spp), appartenant à la famille des *Orobanchaceae*, est un parasite commun des plantes à fleurs. Le centre principal de dissémination est le bassin méditerranéen, où des vastes zones sont fortement infestées. Les pertes de rendement dues à l'Orobanche vont de 5 à 100% selon la région et la culture. Les espèces d'Orobanche attaquant les récoltes dans la région méditerranéenne orientale de la Turquie sont : *O. aegyptiaca, O. ramosa et O.crenata.*

O. aegyptiaca / *O. ramosa* étaient présents dans 27.72% des serres et 80% des champs de tomate. *O. crenata* et *O. aegyptiaca* / *O. ramosa* étaient présents dans 57.89% des champs de fève et 75.51% des champs de lentille.

Depuis 2004, la culture de tournesol a régulièrement augmenté dans la zone est-méditerranéenne. En 2005, les surfaces cultivées et la production représentaient plus du triple de 2004. A ce jour, il n'y a eu aucune observation d'Orobanche dans les parcelles de tournesol du secteur, mais ce parasite est considéré comme une menace potentielle.

Orobanche cernua Loef. a causé des dommages considérables dans des champs de tournesol d'autres régions de la Turquie où le tournesol était cultivé depuis de nombreuses années et il pourrait se disperser de celles-ci vers la zone est-méditerranéenne. En outre, le tournesol est également un hôte pour *Orobanche ramosa* L. et *Orobanche aegyptiaca* Pers. qui ont été déjà repérées dans quelques cultures de la Méditerranée orientale.

Puisque l'importance du problème *Orobanche* augmente chaque année en Turquie, un "Projet National *Orobanche*" a conduit à la collaboration entre les instituts gouvernementaux et les universités depuis 2006. Ce projet inclut aussi des extensions d'activité. Comme les agriculteurs ne sont pas forcément précautionneux avec la dispersion possible de l'*Orobanche*, ils doivent être dès à présent formés grâce à des mesures préventives.

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