ESTIMATING EFFECTS ON YIELD AND OTHER AGRONOMIC PARAMETERS IN SUNFLOWER HYBRIDS INFESTED WITH THE NEW RACES OF THE SUNFLOWER BROOMRAPE (*Orobanche cernua* Loelf)

Juan Domínguez

Department of Breeding and Agronomy
Agricultural Research Centre (C.I.D.A.) P.O. Box 4240
14070 Cordoba Spain

Abstract

Estimation of the effects of sunflower broomrape infestations under field conditions is a difficult task, since to asses the extend of the damage caused by the parasite in the plants of the infested plots, on trial non infested control plots are necessary. To avoid such a difficulty, an experiment was carried out in which three sunflower hybrids with known different reactions (resistant, tolerant and suscept) to the new broomrape races currently present in Spain, were grown in containers simulating high potential cropping conditions (approx. 4.000 Kg/Ha).The experiment was designed as a complete factorial (hybrids=3; infections=2) arranged in a RCBD , Yield, total biomass, plant height and other agronomic parameters were measured.

The results obtained show a negative effect of the broomrape infestation on the susceptible hybrid as shown by a significant decrease in capitulum seed weight, number of seed per capitulum and other parameters. Broomrape inoculated resistant hybrid did not present any significant effect on any of the parameter analysed. The tolerant hybrid, broomrape infested, showed a decrease in certain parameters although in most of the cases, non significant.

Results of further experiments, trying to elucidate the consequence of different levels of water availability on the effects of broomrape infestation in susceptible hybrids, have shown that the negative effects on yield and one hundred seeds weight are of a bigger magnitude when the level of water availability is high, and when water stress is severe, there is no significant differences between infested and non infested treatments

Introduction

The sunflower broomrape (*Orobanche cernua* Loelf.) has become one of the most important pests of this oleaginous crop in Spain. New, more aggressive strains of this parasitic angiosperm have appeared, to which traditional sunflower cultivars are not longer resistant (1). Fortunately, new cultivars, carrying resistance genes to these new strains of broomrape, have been recently developed and released by seed companies, making sunflower cropping economically feasible (2).

Assessing broomrape effects on susceptible cultivars is difficult to carry out under standard field conditions, since sunflower cultivars must be evaluated under the same environmental conditions with and without natural broomrape infection. So far, efforts to control broomrape infections by physical and chemical means have been unsuccessful, since not complete control has been achieved (3, 4, 5), so, it has not been possible to compare the

same sunflower genotype affected by broomrape versus the same one free of this weed, under similar field conditions.

The effect of water on sunflower broomrape infections has been a debate topic since the appearance of the new strains attacking oleaginous cultivars in Spain. Farmers, in general, have the belief that irrigated sunflowers are less prone to be infected by broomrape, and if infections do occur, negative effects of *Orobanche* in the sunflower plant are of inferior magnitude as compared with broomrape effects on dryland cropped sunflower.

In order to shade light on these two topics, two experiments were carried out in the Agriresearch Center (C.I.D.A.) of Córdoba (Spain), during the years 1994 and 1995.

The first experiment was focused to estimate the effect of broomrape infections on sunflower yield and other agronomic characteristics, and the second one, was aimed to study the interactions of sunflower broomrape infections with different levels of water availability. In order to carry out the studies under the same environmental conditions, both experiments were laid out using as experimental plots, plant containers, large enough, as to produce sunflower plants analogous to those of a standard field crop.

Experiment 1

Material and Methods

Three sunflower commercial cultivars were used in this study: FLORASOL, CORONIL and ISLA. The first two were selected on basis to their different degree of susceptibility to the new strains of broomrape, and the last one due to its high degree of resistance.

A factorial experiment in a randomised block design was set up, being one factor: cultivars, with three levels, and the other one, presence or absence of broomrape. The experiment was replicated six times and the experimental plot was a container of 100 l. of capacity filled with a mixture of pith, sand and silt (60 %, 20 %, 20 %), adding a fertiliser mix of slow release. *Orobanche* soil infestation was carried out by thoroughly mixing 50 mg. of broomrape seed with the upper 10 cm. of the container soils. After inoculation, seeding was done in both type of containers (March/3/1994), those with broomrpae and those non-inoculated, with three seeds per container, once seedlings were in the two leaves stage, plants were thinned leaving only one plant per container. Each container was irrigated as needed with the same quantity of water all through the sunflower plants growing cycle. Containers were kept in the open during the duration of the experiment. Records were taken on days to flowering, plant height, capitulum diameter, total biomass, number of seeds per capitulum, weight of seed per capitulum and one hundred seeds weight.

Results and discussion

The infested treatments corresponding to both susceptible cultivars, flowered 3 days later than their homologous non infested. The resistant cultivar flowered at the same time in both infested and not infested treatments.

In table I the values of different agronomic parameters of the three sunflower cultivars are depicted. ISLA, the resistant cultivar, as expected, did not show any significant differences for the parameters studied. However CORONIL and in a lesser extent FLORASOL, both susceptible to broomrape did show significant differences for parameters as number of seed per capitulum and weight of seed per capitulum. In most of the other studied characters, there were no significant differences, although a tendency for the culti-

vars free of broomrape to present the higher values was observed, these differences were clearly significant when the cultivars were averaged. In general, infested susceptible plants were negatively and significantly affected by broomrape.

The most important effect, under a practical point of view, was the significant decrease in seed weight per capitulum in the plants infested with *Orobanche*, which in the case of the most susceptible cultivar, CORONIL, amounted a 25 %, which means that even in the most favourable environmental conditions (no water stress and enough nutrients availability), broomrape does negatively and significantly affect yield in susceptible sunflower cultivars. Previous evaluations in a large field scale carried out by sampling affected and not affected dryland sunflower cropped areas, had estimated yield losses, due to broomrape infection, in a 30 % (7).

Experiment 2

Material and methods

Using only one broomrape susceptible cultivar: CORONIL, a factorial experiment with two factors, in a randomised block design, was set up, being the first factor the presence and absence of *Orobanche*, and the second factor, four different levels of water availability. This experiment was replicated six times. Containers, type of soil, broomrape inoculation, seeding (March/1/1995) and experiment husbandry were done as in experiment 1, except irrigation. From seeding up to star stage (R1), all treatments were irrigated the same and as needed; once star stage (R1) was achieved, four treatments of irrigation were applied to both, infested and non infested plants, according with the factorial design adopted:

1) Maintaining the container soil at field capacity,
2) Irrigating with half of the water quantity given in treatment 1,
3) Irrigating with one fourth of water of treatment 1
4) Irrigating with one eighth of water of treatment 1.

In this experiment, records were taken on days to flowering, plant height, capitulum diameter, number of seeds per capitulum, weight of seed per capitulum and one hundred seeds weight.

Results and discussion

Date of flowering was affected the same in all the broomrape infested water treatments, these delaying flowering 3 days in comparison with the non infested water treatments..

In Table II the values of the different agronomic characters studied are presented. When all the water treatments were averaged, the plants infested with broomrape did always show lower values and significantly different to those of the plants free of *Orobanche*, for the parameters studied, which agrees with the results obtained in the first experiment. The interaction: water availability x broomrape status, was only significant for seed weight per capitulum and one hundred seeds weight, since the fall of the values of these characters when affected by a lower water availability, were at a higher rate in the treatments free of *Orobanche* as compared with the infested treatments This might be caused by the fact that water treatments with high levels of water availability (FC and ½ FC) when free of broomrape, showed higher and quite different values for both parameters, than their infested counterparts. Since the number of seeds per capitulum was not signifi-

cantly affected, the difference in weight of seed per capitulum should be due to the difference in one hundred seed weight. It is clear that, in this experiment, yield was affected significantly by broomrape and in a major extend when plants were a high level of water availability. This effect became almost negligible when water stress was severe as in the 1/8 FC treatment. Therefore when growing cycles are characterised by periods of intensive water stress, as the two last seasons in southern Spain, yield losses of sunflower caused by broomrape infections are of less importance than in well watered crops. These results contrasts clearly with the farmers general thinking of a non destructive role of broomrape in irrigated sunflower crops.

REFERENCES

1 Garcia Ruiz, R. and J. Domínguez. 1994. Resultados de los ensayos de girasol. RAEA. D.G.I.A. Consejería de Agricultura y Pesca. J.A.

2 García Ruiz and J. Domínguez. 1995. Resistencia del girasol al jopo (*Orobanche cernua* Loelf.). Ensayo 1995. RAEA. D.G.I.A. Consejería de Agricultura y Pesca. J.A.

3 Garcia-Torres, L., Mesa-García, J. and Romero-Muñoz, F. 1987. Agronomic problems and chemical control of broomrapes (*Orobanche* spp.) in Spain: a studies review. In: H. Chr. Weber and W. Forstreuter (eds.), Parasitic flowering plants, Proceedings of the 4th International Symposium on Parasitic Flowering Plants. Marburg, Germany, Phillipps University, pp.241-248.

4 Jacobson, R., Greenberger. I., Katan, M. and Alon, H.. 1980. Control of broomrape in carrot by means of solar heating. Weed Sci. 28: 312-315.

5 Jacobson, R., Uriely, E. and Dagan, J. 1987. Preliminary experiments on broomrape control with vapam. In: H.C. Weber and W. Forstreuter (eds.), Parasitic flowering plants, Proc. 4th Int Symp.on Parasitic Flowering Plants. Marburg, Germany, Phillipps University, pp.241-248.

6 Saavedra del Rio, M.; Fernandez-Martinez, J.M. and Melero-Vara, J.M. 1994. Virulence of populations of *Orobanche cernua* Loefl. attacking sunflower in Spain, pages 139-141, in: Biology and Management of Orobanche. A.H. Pieterse, J.A.C.Verkleij ad S.J. ter Borg, (eds.) Amsterdam. The Netherlands, Royal Tropical Institute.

Table I. Values of different agronomic characteristics of 3 sunflower cultivars as affected or not by broomrape.

CULTIVAR	Plant height (cm)		l.s.d. (5%)	$\bar{X}$	Capitulum diameter (cm)		l.s.d. (5%)	$\bar{X}$	Total dry biomass (gr)		l.s.d. (5%)	$\bar{X}$
	Or+ (*)	Or- (*)			Or+	Or-			Or+	Or-		
ISLA	154	142	n.s.	148	18.2	17.5	n.s.	17.8	228.6	223.7	n.s.	226.1
FLORASO	120	111	n.s.	115	17.7	18.2	n.s.	17.9	198.9	229.7	n.s.	214.3
CORONIL	150	150	n.s.	150	18.5	20.0	n.s.	19.3	217.3	262.7	n.s.	240.0
$\bar{X}$	141	134			18.1	18.6			214.9	238.7		
l.s.d. (5%)	5			7	n.s.			1.2	20.9			n.s.

CULTIVAR	Seed weight per capitulum (gr)		l.s.d. (5%)	$\bar{X}$	Number of seeds per capitulum		l.s.d. (5%)	$\bar{X}$	Two hundred seeds weight (gr)		l.s.d. (5%)	$\bar{X}$
	Or+ (*)	Or- (*)			Or+	Or-			Or+	Or-		
ISLA	85.4	81.9	16.5	83.6	1097	1032	218	1064	16.2	16.3	n.s.	16.2
FLORASO	74.1	87.3	16.5	80.7	1395	1322	218	1358	10.8	13.7	n.s.	12.3
CORONIL	74.6	100.4	16.5	87.5	1479	1765	218	1622	10.3	11.6	n.s.	10.9
$\bar{X}$	78.0	89.9			1324	1373			12.4	13.8		
l.s.d. (5%)	9.3				n.s.			154	0.9			1.1

(*) Or+ = Orobanche infested

Or- = Free of Orobanche

Table II. Values of different agronomic characteristics of a sunflower cultivar (Coronil) as affected by broomrape or/and different leves of water availability.

WATER AVAILABILITY	Plant height (cm)		l.s.d. (5%)	$\bar{X}$	Capitulum diameter (cm)		l.s.d. (5%)	$\bar{X}$	Seed weight per capitulum (gr)		l.s.d. (5%)	$\bar{X}$
	Or+ (*)	Or- (*)			Or+	Or-			Or+	Or-		
FC	147	149	n.s.	148	18.3	21.0	n.s.	19.7	45.3	77.1	12.7	61.2
½ FC	109	120	n.s.	115	14.8	19.0	n.s.	16.9	35.3	71.6	12.7	53.5
¼ FC	83	89	n.s.	86	10.7	14.3	n.s.	12.5	12.0	28.1	12.7.	20.1
⅛ FC	60	67	n.s.	63	7.5	9.7	n.s.	8.6	3.0	5.2	12.7	4.1
$\bar{X}$	100	106			12.8	16.0			23.9	45.5		
l.s.d (5%)	3.7			5.3	1.0.			1.4	6.3			8.9

WATER AVAILABILITY	Number of seeds per capitulum		l.s.d. (5%)	$\bar{X}$	One hund. seeds weight (gr)		l.s.d. (5%)	$\bar{X}$
	Or+ (*)	Or- (*)			Or+	Or-		
FC	1270	1704	n.s.	1487	3.7	4.6	0.6	4.1
½ FC	1193	1500	n.s.	1347	3.2	5.1	0.6	4.1
¼ FC	578	945	n.s.	761	2.2	2.9	0.6	2.6
⅛ FC	279	426	n.s.	352	1.1	1.3	0.6	1.2
$\bar{X}$	830	1144			2.6	3.5		
l.s.d. (5%)	87.8			124	0.3			0.4

(*) Or+ = Orobanche infested

Or- = Free of Orobanche