THE INTERACTION PARASITE – HOST PLANT, IN THE SYSTEM *OROBANCHE CUMANA* WALL. (*OROBANCHE CERNUA* LOEFL.) - *HELIANTHUS ANNUUS* L.

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ABSTRACT

Broomrape (*Orobanche cumana* Wallr. syn. *Orobanche cernua* Loefl.) is one of the most important factors limiting sunflower yield in Europe. The use of resistant sunflower varieties is a reliable way to control this parasite. The actual spectrum of broomrape races in Europe has changed. The study of the sunflower differential set for the broomrape races in Romania, under natural and artificial infestation demonstrated the existance of a new spectrum of races. We assigned the new race with F and the corresponding gene for resistance, with Or6. The χ^2 test has shown that the inheritance of resistance is controlled by a single dominant gene. Five *Orobanche* populations were studied, one from Turkey, one from Spain, one from Yugoslavia and two from Romania (Cãlãraºi and Constanþa). The behaviour of the differentials for the race 5 and 6 (race E and F) shows that there are some differences between the races of broomrape in Turkey and Constanþa (Romania). The races of Yugoslavia and Cãlãraºi (Romania) are completely different from the races of Spain, Romania and Turkey.

Key words: broomrape, parasite-host plant interaction, sunflower

INTRODUCTION

The sunflower broomrape (*Orobanche cumana* Wallr./*Orobanche cernua* Loefl.) has become one of the most important parasites of this oleaginous crop in Russia, Ukraine, Moldavia, Romania, Turkey, Bulgaria, Yugoslavia and Spain, but it has been also reported in other countries. Broomrape is an important problem because of the large area sown with sunflowers in infested zones (Joel, 1988). Breeding programmes for the incorporation of resistance genes to broomrape in sunflower have started many years ago in Eastern Europe. At present, the parasite is controlled mainly by the use of resistant cultivars. The appearance of more virulent broomrape types in Ukraine and Russia (Tolmacev, 1991), Bulgaria (Shindrova, 1994), Yugoslavia (Mihaljcevic, 1996; Dozet et al., 1998), Romania (Pãcureanu-Joita et al., 1998), Turkey (Bulbul et al., 1991) and Spain (Alonso et al., 1996) is an indication of the possible danger of an epiphytotic attack of sunflower crops on the whole European countries scale. Much information has been accumulated about the mechanisms and genetic control of sunflower resistance to broomrape. However, there is a need to systematically determine the independence between the virulence of different broomrape biotypes and sunflower resistances. The goal of this work was to present the situation of broomrape races in Romania and to show the interdependence of the virulence of different biotypes and sunflower resistance.

MATERIAL AND METHODS

Orobanche was collected on infested sunflowers in several geographic areas. Two Romanian populations, one Yugoslavian, one Turkish and one Spanish were studied. Seeds of *Orobanche* plants were collected in one field, in the same area on different sunflower genotypes. The differentials set of sunflower for broomrape races in Romania was used. Two sunflower genotypes (the differentials for broomrape races E and F) were used to be infested with *Orobanche* seeds from each region of Europe. For *in vitro* experiment, *Orobanche* seeds were surface sterilized for 5 min in sodium hypochlorite (3.61%) and rinsed five times with distilled water. They were preconditioned at 21ºC for a week on glass fibre filter paper moistened with 5 ml sterile distilled water in a Petri dish. Sunflower seeds were surface sterilized in the same way, before being sown in vials containing balls of glass (2 mm diameter) moistened with sterile distilled water. Preconditioned broomrape seeds were stimulated for germination with GR 24, after that being placed on the roots of 10 days old sunflower seedlings. After infestation, broomrape development was observed weekly, under a binocular microscope. The presence of necrotic broomrapes and their

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number was noted. The mean values of the fixation of *Orobanche* on roots (stage 1), formation of *Orobanche* tubercles (stage 2), tubercles with adventive roots (stage 3) and *Orobanche* with stem (stage 4), were calculated.

RESULTS AND DISCUSSION

Starting with 1996 year, the differential for the race E of broomrape in Romania, lost the resistance, in the regions: Constanta, Braila and Tulcea (Table 1). The results given by the mean values in the stage 1 to stage 4 of broomrape infestation (Figure 1) show that the isolates from these regions of Europe display differences. In the case of sunflower differential for the race E, broomrape in Turkey seems to be more virulent than broomrape in Constanta, Romania. These results are presented in the photos from figure 2. The broomrape in Yugoslavia is different from broomrape in Romania, Turkey and Spain (less virulent). Twenty one days after infestation, only the attachment (at stage 1) of broomrape was observed per sunflower differential for the race 6 (race F).

Table 1 . Reaction of sunflower differentials to broomrape attack in Romania (populations of different sources), under artificial infestation (1995-2003)

Differentials	Year	Reaction to broomrape races	Source of broomrape seeds and infestation index (I%)					
			Constanta	Tulcea	Brãila	Vaslui	Ialomita	Teleorman
LC-1093	1995	E-A	0	0	0	0	0	0
P-1380-2		E-A	0	0	0	0	0	0
S-1358		D-A	15.7	9.2	16.8	4.9	9.7	0
Record		C-A	30.1	26.5	37.7	26.4	25.2	0
Jd-01		B-A	51.7	47.7	55.2	44.9	47.1	42.2
K-A41		A	69.1	63.5	62.5	62.4	64.1	62.1
AD-66		suscept. to all races	77.2	72.5	69.5	62.7	69.7	62.9
LC-1093	1996	E-A	0	0	0	0	0	0
P-1380-2		E-A	3.8	2.6	3.9	0	0	0
S-1358		D-A	17.2	10.5	14.7	5.9	12.4	0
Record		C-A	29.4	24.2	41.4	29.2	27.5	7.7
Jd-01		B-A	47.4	50.8	48.3	47.2	38.5	35.5
K-A41		A	57.2	49.4	59.2	67.5	59.5	61.3
AD-66		suscept. to all races	78.5	68.7	71.7	65.4	60.3	60.5
LC-1093	1998	F-A	0	0	0	0	0	0
P-1380-2		E-A	5.4	4.3	5.5	0	4.7	0
S-1358		D-A	18.3	11.2	14.7	11.4	22.3	0
Record		C-A	28.4	14.7	24.5	21.3	29.8	5.2
Jd-01		B-A	48.2	38.5	50.4	55.4	58.3	43.3
K-A41		A	49.1	57.6	61.3	60.7	57.4	62.7
AD-66		suscept. to all races	69.2	77.7	70.9	64.8	78.5	68.7
LC-1093	2001	F-A	0	0	0	0	0	0
P-1380-2		E-A	7.5	9.2	15.7	0	8.7	0
S-1358		D-A	19.1	15.4	18.4	11.0	19.8	5.2
Record		C-A	29.2	17.1	23.2	22.4	33.1	9.4
Jd-01		B-A	46.7	33.2	49.5	57.4	55.1	41.3
K-A41		A	47.2	44.1	59.7	61.4	57.2	66.3
AD-66		suscept. to all races	71.2	69.4	71.8	68.2	75.4	78.7
K-078	2003	F-A	0	0	0	0	0	0
LC-1093		F-A	0	0	0	0	0	0
P-1380-2		E-A	8.1	8.9	15.9	0	9.3	0
S-1358		D-A	18.9	15.0	19.2	10.8	18.5	6.7
Record		C-A	31.0	15.7	25.3	20.8	31.5	8.9
Jd-01		B-A	45.8	34.1	47.7	52.9	56.2	44.5
K-A41		A	47.4	44.3	63.7	58.4	57.0	63.9
AD-66		suscept. to all races	77.2	70.4	68.2	68.0	77.3	75.5

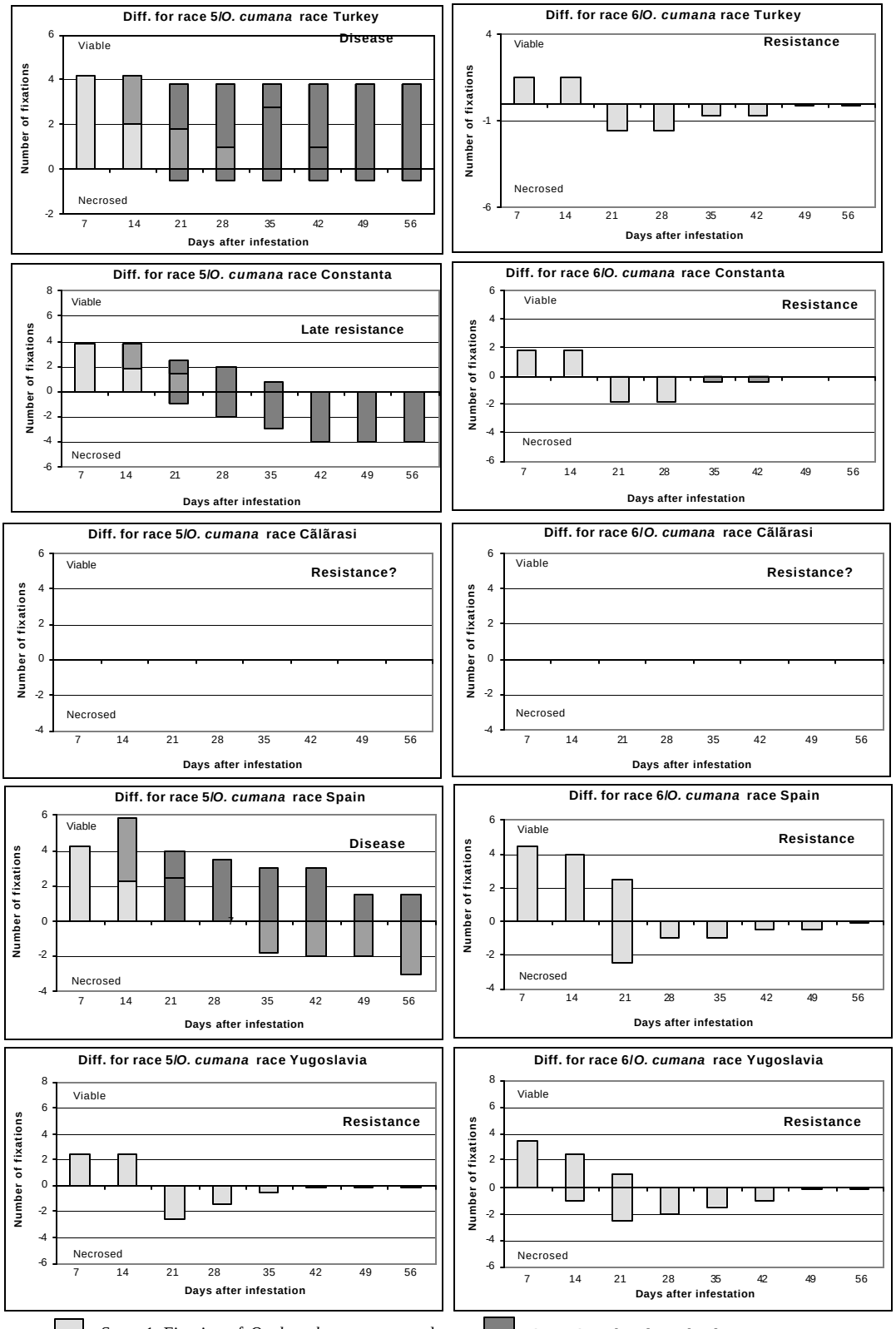

Figure 1 . Results of *in vitro* experiments

and roots of sunflower plant is very small in case of differential for race E infested with broomrape in Turkey. The results of *in vivo* experiment (Table 3) show differences from the virulence of broomrape on sunflower differential for the race E

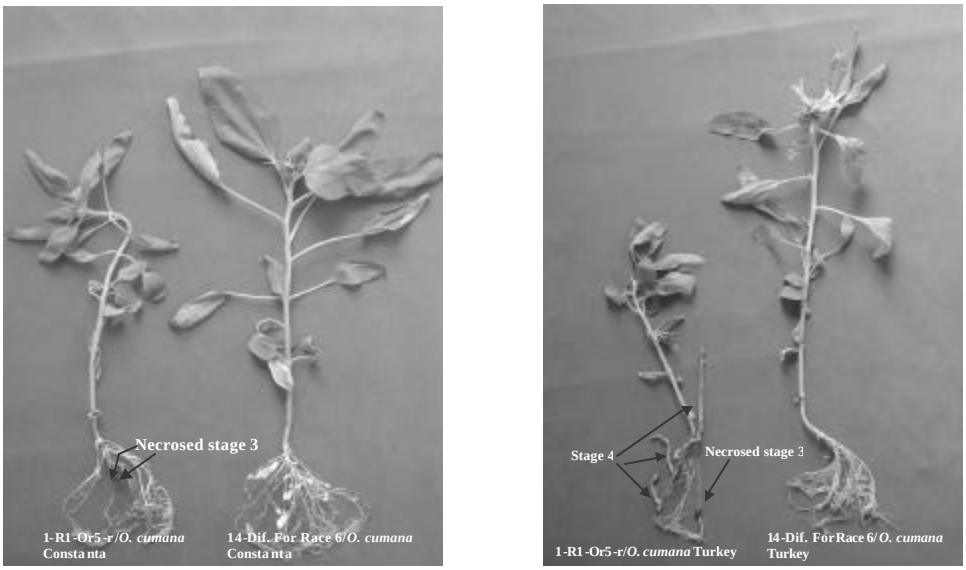

Figure 2. Broomrape attachments on sunflower roots of the differential for race E

Number of the fixations is bigger for the broomrape populations from Spain and Yugoslavia. The behaviour of the broomrape in Turkey and Constanta – Romania, is similar in this case. There are no attachments of broomrape on sunflower, in both situations. There is no infestation with broomrape from Calarasi – Romania, on the differential for race E and the differential for race F. The results after 56 days of *in vitro* infestation (Table 2) confirm the differences between the isolates of broomrape, especially on sunflower differential for the race E. The weight of aerial part (androsterile line A and the maintainer, B), especially for the broomrape from Constanta – Romania (number of emergences) on the maintainer.

A new race of the parasite *Orobanche cumana* Wallr. has appeared in Romania, starting with 1996 year. This new race has spread in recent years very much, on a large area cultivated with sunflower in Constanta, Braila, Tulcea and Ialomita regions. The populations of broomrape attacking sunflower crop in Europe are very different. The most virulent population is in Turkey, comparing with broomrape in Romania, Spain and

Table 2. Dry weight of aerial parts and roots of sunflower cultivars, 56 days after *in vitro* infestation by different *Orobanche cumana* populations

Races	Constanta (Romania)			Turkey			Spain			Călărasi (Romania)			Yugoslavia		
Sunflower cultivars	AP	R	*O*	AP	R	*O*	AP	R	*O*	AP	R	*O*	AP	R	*O*
Diff. for race 5 (E)	1306	196	79	540	112	405	1042	147	112	1105	170	0	1290	212	0
Diff. for race 6 (F)	1705	282	0	1310	295	0	1110	303	0	1450	230	0	1256	276	0

AP = aerial parts; R = roots; O = *Orobanche*

Table 3. Number of *Orobanche cumana* emergences on different sunflower hosts, 70 days after infestation

	Orobanche cumana races				
Sunflower genotypes	Yugoslavia	Romania (Călărasi)	Romania (Constanta)	Turkey	Spain
10A-Diff. for race 5 (E) line A	0	0	1.3±0.6	0.7±0.6	2.1±0.6
10B-Diff. for race 5 (E) line B	0	0	6.7±0.6	2.3±0.6	4.4±0.6
Diff. for race 5 (E) line R	0	0	2.7±0.6	4±1	3.7±0.6

Yugoslavia.

The results of this experiment are not too clear regarding broomrape from Călărasi – Romania.

CONCLUSIONS

The population of broomrape, attacking sunflower crop in Europe are very different.

Comparing with broomrape in Romania, Spain and Yugoslavia, the population in Turkey is the most virulent.

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Table 1

Average yield of experiments with winter wheat cultivars, under irrigation and dry-land in six localities from the South of Romania (2002)

Locality	Average yield under:		Yield percentage diminution
	irrigation (kg/ha)	dry-land (kg/ha)	
Caracal	8560	5601	34.6
Marculesti	4716	3075	34.8
Teleorman	5963	3594	39.8
V. Traian	6941	3794	45.3
Fundulea	4858	1918	60.5
Simnic	(8560)	380	95.6

Table 2

Percentage diminution of some plant features under water stress conditions as compared to irrigation

Locality	Plant number	Plant height	Grain filling period	Spike number	Grain/ear	TKW	Test weight
Caracal	0	14,9	15,0	7,9	10,2	14,1	0,9
Teleorman	0	10,0	19,2	12,0	12,0	11,9	1,0
V.Traian	34,9	21,0	16,9	42,5	12,2	2,9	8,1
Fundulea	4,9	28,8	24,9	6,9	28,9	29,5	3,9
Simnic	27,6	61,7	30,0	65,0	64,5	53,1	10,7
Media	13,5	27,3	21,2	26,9	25,6	22,3	4,9

Table 3

Minimum, maximum and average yields registered at Fundulea in 2002 in international trials WWEERYT with genotypes grouped depending on the originating country

Source	Average yield of the tested genotypes (kg/ha)	Maximum yield of the tested genotypes (kg/ha)	Minimum yield of the tested genotypes (kg/ha)
Romania	2368	2953	2073
Russia	2327	2453	1980
Ukraina-Odessa	2224	3013	1287
Hungary	2181	2780	1320
Ukraina-Mironovka	2108	2753	1500
Moldova	1927	2560	1293
Bulgaria	1898	2873	1313
Turkey	1893	2420	1487
Azerbaidjan	1460	1553	1367
Kazahstan	1422	1833	853
LSD 5%	243	275	

Table 4

Correlations between yield under water stress conditions and different traits

Locality	Average yield diminution because of water stress (%)	Correlation coefficients between yield under water stress conditions and:						
		yield under irrigation	plant height under stress conditions	plant height under irrigation	heading time	spike/ m^2	grain/ear	TKW
Caracal	34,6	**0,48**	0,29	-0,31	-0,12	0,20	0,11	-0,30
Teleorman	39,8	**0,80**	0,35	0,31	**-0,85**	**0,58**	-	-
Valu Traian	45,3	0,04	0,33	0,20	**-0,40**	**0,42**	**0,40**	0,22
Fundulea	60,5	0,00	**0,46**	-0,31	**-0,46**	**0,52**	0,30	-0,17
Simnic	95,6	-0,01	**0,41**	**-0,62**	-0,04	**0,40**	**0,50**	0,15

The bold characters are significant at the probability level of 0.05

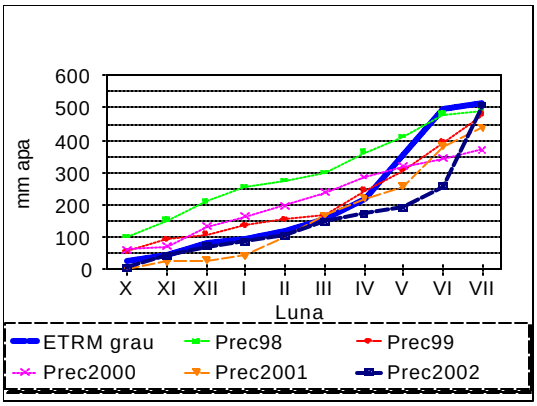

Figure 1. Average evapotranspiration and rainfall during 1999-2002 at Fundulea (mm water; month; wheat evapotranspiration; rainfall)

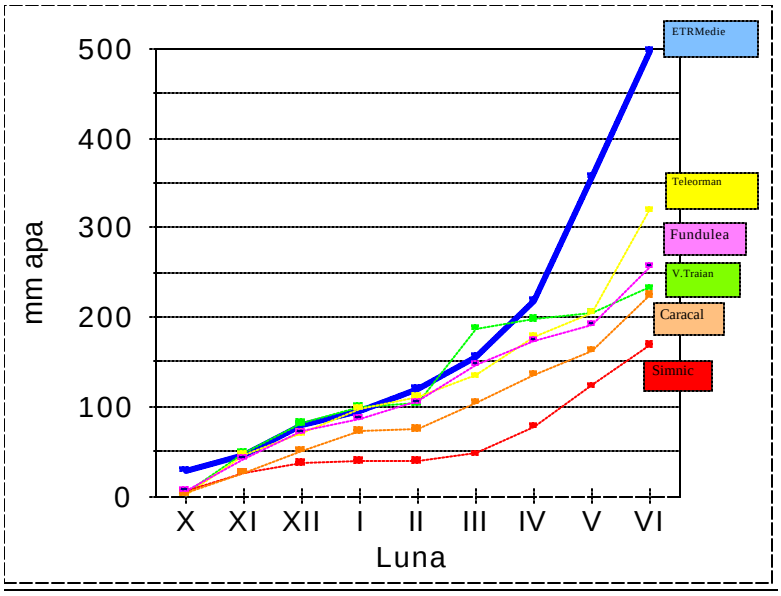

Figure 2. Average evapotranspiration and rainfall during the vegetation period in six locations of Southern of Romania in 2001-2002 year (mm water; month).

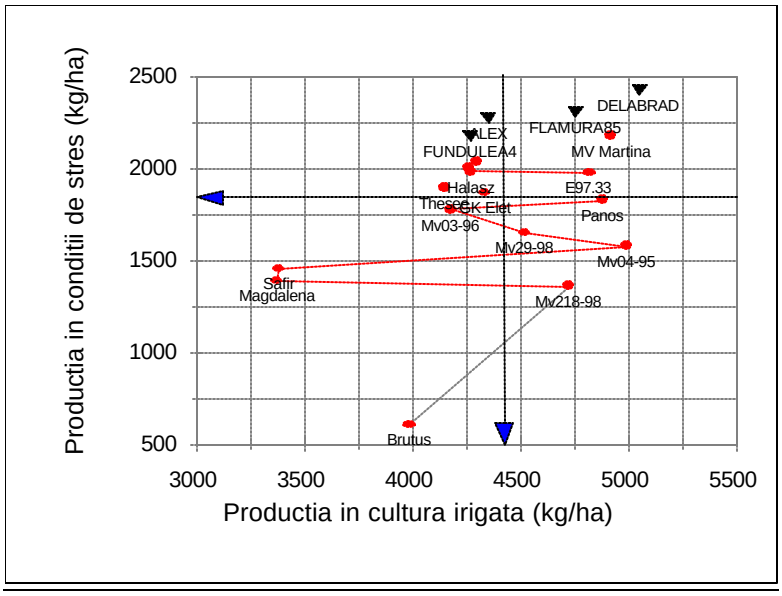

Figure 3. Yield obtained by some Romanian and foreign cultivars under irrigation and non-irrigation, in 2002 at Fundulea (arrows indicate the experiments average yield)(Yield under stress conditions; yield under irrigation).

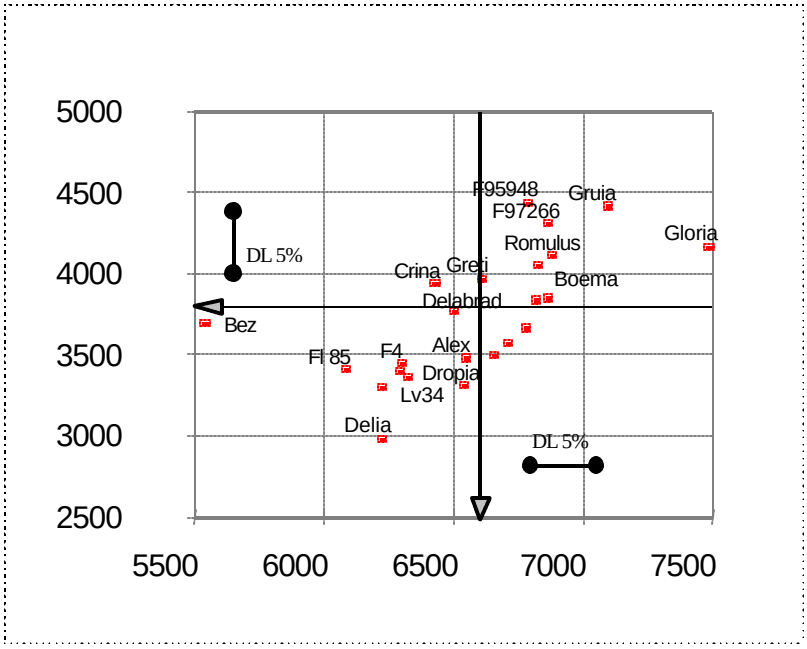

Figure 4. Average yields in four locations, obtained in 2002 by Romanian new lines and cultivars under irrigation and non-irrigation (arrows indicate experiments average yield)(Yield under non-irrigation; Yield under irrigation; LSD).