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INCIDENCE OF *HETERODERA AVENAE* ON THE GROWTH AND YIELD OF CEREALS IN SPAIN

by
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Summary. Microplot experiments have been carried out in *Heterodera avenae* infested and uninfested (control) soils with 97 cereals cultivars (wheat, barley, oats, rye and triticale), in order to assess host efficiency, and effect of nematode's attack. All cereals tested were hosts of the nematode except oat cvs. Barley and wheat cvs. were the most severely damaged, followed by triticale and oat cvs., which, though resistant, showed the effects of nematode attack. Losses in grain yield were mainly due to the reduction of head number/m^2 in wheat and barley cvs., and to number of grains/head in rye, triticale and oats.

Parasitism by the cereal cyst nematode *Heterodera avenae* Woll., causes reduced tillering, early yellowing of leaves, premature maturation and smaller seed heads of infested cereal crops (Kastner and Germerhausen, 1978). The effect of nematode attack on cereal growth and yield has been reported by Kübler (1980), Schönrock-Fischer and Sachse (1980), Gonet and Gonet (1982), Sabova *et al.* (1981 and 1985), Rivoal and Sarr (1987), Romero *et al.* (1988 and 1989).

The present work reports the results of a field experiment with 97 cereal cultivars to evaluate their host status and to quantify crop response to nematode attack.

Materials and methods

The experiment was undertaken in 1987-88 at «La Higueruela» Experimental Farm in Santa Olalla (Toledo). The cultivars of barley (*Hordeum vulgare* L.), oats (*Avena sativa* L.), rye (*Secale cereale* L.), triticale, wheat (*Triticum aestivum* L.) and durum wheat (*Triticum durum* Desf.) were sown in microplots, 1x1 m at the begining of November and at seeding rate of 350 seeds/m^2. Two replicates of each cultivar were sown in plots containing homogenized soil with a population of 25 eggs + J2 of *H. avena*/g soil. A plot of uninfested soil served as control. The soil was a sandy loam, pH 6.5 with low nitrogen and organic matter; fertilizers and weedkillers were applied as necessary to all plots.

In early May, all the plants were harvested from one infested plot for each cultivar. The roots were examined with a stereoscopic miscroscope and plant suscetibility to nematode attack was assessed on the basis of an estimation of the number of females present on the roots and damage to the roots; the plants were rated 0-3, were 0 = non host and 3 = very good host, with numerous females and considerable root damage.

In mid-July, plants were harvested from the remaining infested and uninfested control plots and the following measurements taken: number of heads/m^2, grain yield (g/m^2), straw yield (g/m^2), plant height (cm), 1000 grains weight and number of grains/head. The data were statistically analyzed by Student's t- test.

Results and discussion

«La Higuerela» is in a semi-arid continental climate with cool winters and hot summers (Oliver *et al.*, 1985). Mean temperatures at 20 cm soil depth fluctuated from 7.4°C in January to 23.8°C in June. Rainfall followed the usual pattern of two periods *viz*, autumn-winter and spring, and was exceptionally abundant in June (142 l/m^2).

Root examination showed that all of the wheat and barley cultivars were good hosts for *H. avenae* (3 or 2 rating), durum wheat, rye and triticale cultivars were moderate hosts (2 or 1) and all oat cultivars were non hosts (no females observed on the roots).

Based on the estimated loss of grain due to nematode attack, the various cultivars may be subdivided into three groups:

GROUP A (more than 70% loss of grain)

Barley cvs.: Alpha, Alsekal, Angelica, Arabella, Barbarossa, Cameo, Carla, Cobra, Dobla, Flavia, Flika, Gabriela, Hatif de Grignon, Igri, Iranis, Kym, Klaxon, Marta, Mogador, Ofelia, Osa, Patrick, Plaisant, Polka, Priver, Sonja, Tabaiba, Tatiana and Tipper.

Wheat cvs.: Aboukir, Aldeano (durum wheat), Alud, Arcole, Arganda, Artal, Betres, Cárdeno, Esquilache (durum wheat), Nivelo, Rinconada, Roqueño (durum wheat), Sevillano and Tauro.

GROUP B (40-70% loss grain)

Barley cvs.: Ababella, Aramir, Criter, Fitamara, Hassan, Reinette, Trait d'Union and Zaida.

Wheat cvs.: Alcalá, Alejo, Anza, Aranda, Astral, Ca-

TABLE I - *Mean values (Infested and Control), Student's t-test (t) and losses % for each parameter in cereals.*

BARLEY

	GROUP A				GROUP B				GROUP C			
Variables	Inf.	Cont.	t	%L	Inf.	Cont.	t	%L	Inf.	Cont.	t	%L
		n = 29				n = 8				n = 3		
Grain yield	108.03	535.21	***	79.96	168.62	425.00	***	59.57	262.33	388.00	NS	32.26
Straw yield	200.34	655.52	***	68.61	266.37	622.62	***	51.11	384.66	585.66	*	33.93
N° heads/M^2	206.34	551.24	***	62.09	323.00	507.00	**	44.73	383.33	498.66	NS	14.55
Plant height	48.55	75.89	***	35.56	49.37	75.12	***	33.12	56.00	77.33	NS	27.79
1000 grains	34.68	43.41	***	24.33	35.37	41.75	*	17.27	39.66	41.33	NS	2.86
N° grains/head	15.20	24.38	***	32.57	15.27	21.70	*	30.15	17.26	20.66	NS	9.27

WHEAT

	GROUP A				GROUP B				GROUP C			
Variables	Inf.	Cont.	t	%L	Inf.	Cont.	t	%L	Inf.	Cont.	t	%L
		n = 14				n = 24				n = 3		
Grain yield	122.71	575.92	***	78.73	220.00	522.37	***	56.82	223.66	331.00	NS	31.41
Straw yield	214.00	734.07	***	66.83	396.25	779.29	***	44.35	423.00	782.33	**	44.42
N° heads/M^2	169.57	364.57	***	52.12	222.83	355.41	***	30.65	234.00	276.67	NS	11.42
Plant height	57.21	75.07	***	22.98	59.54	82.04	***	25.91	70.67	85.66	NS	11.35
1000 grains	32.00	40.71	***	22.14	32.95	37.79	**	14.31	38.33	41.67	NS	5.48
N° grains/head	23.98	39.74	***	37.48	31.15	38.24	**	16.66	27.93	31.23	NS	8.40

	TRITICALE				OATS				RYE			
Variables	Inf.	Cont.	t	%L	Inf.	Cont.	t	%L	Inf.	Cont.	t	%L
		n = 7				n = 8				n = 1		
Grain yield	266.57	438.42	***	38.12	193.50	301.75	***?	34.13	219.00	419.00	—	47.75
Straw yield	563.00	960.14	*	35.14	594.00	990.75	*	31.90	881.00	1531.00	—	42.47
N° heads/M^2	252.57	220.57	NS	0.33	230.50	256.50	NS	8.70	256.00	304.00	—	15.80
Plant height	87.00	102.42	NS	14.75	99.62	120.00	***?	10.47	113.00	125.00	—	9.61
1000 grains	37.28	37.00	NS	0.00	24.00	25.25	NS	2.84	23.00	22.00	—	0.00
N° grains/head	29.20	57.70	***	27.78	35.68	53.66	*	20.14	37.10	64.10	—	42.14

*** $p<0,001$; ** $p<0,005$; * $p<0,01$; NS Non significant.

macho (durum wheat), Cargifaro, Castan, Castronuevo (durum wheat), Costal, Escualo, Frandoc, Lachish, Maestro, Marius, Novissant-7000, Oscar, Oscar (durum wheat), Pané-247, pesudo, Recital, Sureño 2 and Vitron.

GROUP C (less than 40% loss grain)

Barley cvs.: Beka, Logra and Monlon.

Wheat cvs.: Festin, Jiloca (durum wheat) and Mustan.

Rye cv:: Petkus.

Triticale cvs.: Aseret, Camarna, Fascal, Juanillo, Manigero, Tajuña and Torote.

Oat cvs.: Cartuja, Cometa, Condor, Grata, PA-101, PA-105, Prevision and Roja d'Algeria.

Most of the barley cultivars were included in group A indicating that this crop is the most affected from *H. avenae*, rye and triticale were only moderately affected and although oat cultivars were all non hosts, invasion of the roots by the juveniles caused some loss of grain yield as observed in Australia (Meagher, 1972; Brown, 1982). Our data on oat are somewhat tentative because many of the microplots suffered from lodging of the crop with subsequent loss of grain.

Table I shows the mean values, Student's t-test and losses percentages for each parameter in the three groups; data were transformed using $X = \text{arc. sin. } \sqrt{Y}$ (%/100) according Sokal and Rohlf (1979).

All growth and yield parameters were affected by nematode attack; significative differences were found between infested and control plants in all cultivars belonging to groups A or B in which grain was yield the most affected parameters; this agrees with Romero *et al.* (1988) for experiments made in the same area with wheat cv. Anza. However straw yield was similarly or even more affected than grain yield in cultivars from group C, which means that the nature of crop response is influenced by the intensity of damage.

From the components of grain yield (number of heads/m^2, number of grains/head and 1000 grains weight), number of heads/m^2 was the most affected fot wheat and barley cvs., which agrees with Schönrock-Fisher and Sachse (1980), but in triticale, rye and oats the most affected parameter was the number of grains/head. This is probably, because damages for barley and wheat cvs. were first noticeable by a reducing level of tilleting, resulting in a reduction of the number of heads; in rye, triticale and oat, damages appeared later, when heads are in formation and resulted in a reduced number of seeds. In all cases the 1000 grains weight was the less affected component as reported by Schönrock-Fisher and Sachse (1980) and Rivoal and Sarr (1987).

The results presented here, represent the begining of further research, already in progress, on the use of the barley, wheat and triticale cvs., which proved to be rather tolerant to nematode attack, and of oat cvs. which may be efficient in the reduction of nematode populations, as alternative crops in areas traditionally dedicated to cereal growing.

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