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Competition of wild oat with wheat in comparison to the wheat itself

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Abstract

In a glasshouse experiment, an increase of the number of wheat plants per pot caused the plants to became taller, have more ears and a greater grain yield per pot, while the number of tillers decreased and the straw mass did not change. The N and P contents in straw and N in grain also trended to decrease, while the translocation of these nutrients to the grain increased.

The increase of wild oat plants (*Avena sterilis* spp. *macrocarpa* Mo.) per pot, produced a decrease of the growth attributes, grain yield and N accumulation in grain of wheat per pot. Wild oat competition with wheat was higher than the wheat competition with itself. Such competition affected the height, number of tillers and ears, the fertility index of the shoots, the straw and grain mass, and the total accumulation of N, P and K nutrients per wheat plant.

Introduction

The effects of increasing infestations of wild oats species on cereal crops has been studied widely. Thus, in wheat, it causes reduction of the straw yield (Catizone and Toderi 1974, Gonzalez Ponce 1988), the number of tillers per plant (Bowden and Friesen 1967), and as consequence the grain yield (Bowden and Friesen 1967, Catizone and Toderi 1974, Gonzalez Ponce 1988). In semi-arid conditions, this effect occurs especially in rainy springs (Gonzalez Ponce 1982); this is possibly due to the fact that wild oats uses water more efficiently than wheat (Bowler 1975).

Also, the presence of wild oats, causes a decrease in the N and NO_3^- contents in wheat plant during its growing (Gonzalez Ponce *et al.*1984, Gonzalez Ponce and Lamela 1987), thus the N total accumulation in wheat plant decreases (Gonzalez Ponce 1988). The protein content in wheat grain as a result of the weed infestation did not vary (Bowden and Friesen 1967, Gonzalez Ponce *et al.* 1984, Gonzalez Ponce and Lamela 1987) or decreased (Wimschneider *et al.* 1990).

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On the other hand, the increase of the wheat plant density caused, increase of the number of tillers per area, while did not affect the straw yield (Sorour and El-Sharkawy 1976), and varying the grain yield, depending of climate, cultivars, cultural practices, *etc.* (Evans 1978); however it cause decrease of the number of tillers, straw mass and grain yield per wheat plant (Puckridge and Donald 1967). This increase of plant density, produced a decrease in the N content in grain (Kurten *et al.* 1982, Read and Warder 1982) and also that of P (Read and Warder 1982).

The aim of this paper is the study of the competition of a mediterranean wild oat species (*Avena sterilis* spp. *macrocarpa* Mo.) with wheat, in comparison to the wheat with itself. Effects of this competition were studied on nutrition, growth and yield of wheat.

Materials and methods

The experiments were carried out under glasshouse conditions in pots containing 6 kg of soil. In each pot, a different number of plants were grown, either 6, 8, 10 or 12 wheat plants (*i.e.* the densities 6T, 8T, 10T and 12T), or 6 wheat plants in the company of 2, 4 or 6 wild oat plants per pot (i.e., the densities 6T+2A, 6T+4A and 6T+6A): thus seven different densities were tested.

The wheat seeds (*Triticum aestivum* L., cv. Pané 247) were sown directly in the pots. However, for the emergence of their seedlings to coincide with that of wild oat, the seeds of the weed (*Avena sterilis* spp. *macrocarpa* Mo.) were germinated else where and introduced in the pots following a technique used earlier (Gonzalez Ponce and De Andrés 1984).

Each pot, prior to planting the species, was fertilized with 0.420 g ammonium sulphate, 0.048 g calcium superphosphate and 0.080 g potasium chloride. Also, 0.300 g ammonium nitrate, was added divided in two times, in the 22 and 32 growth stages of wheat (Zadoks *et al.* 1974). Water was applied by irrigation in the same manner for all the pots, and soil was never left to dry out.

The seven different densities were distributed in the glasshouse following a randomized blocks design with four replicates or pots for each one.

At the end of biological cycle of the two species, several attributes of wheat and wild oat plants were measured per pot. Also, due to a lack of grain mass obtained in some replicates of 6T+2A, 6T+4A and 6T+6A densities, for analysis, only was possible to analyze the N, P and K contents in a mean sample of straw and grain of both species for each density. For the analysis, the samples were dried at 60 °C, triturated, and mineralized by the Kjeldahl method for N, and by a mixture of nitric and perchloric acid for P and K elements. Afterwards, the N and P were determined by colorimetric method in autoanalyzer and K by flame emission spectrophotometry.

Results

An increase of density of wheat plants per pot, from 6T to 10T, produced an increase in height and number of ears per pot, with a decrease in number of tillers per pot, but

caused no effect in going from 10T to 12T. As a result, the straw mass remained unaffected and the grain mass grew up to 10T density (Table 1).

Table 1. Average attributes of wheat plant per pot [± S.E.].

Densities	Height [cm]	Number of tillers	Number of ears	Straw mass [g]	Grain mass [g]
6T	85.8 ± 1.2	20.3 ± 1.1	13.3 ± 1.6	19.2 ± 0.4	5.0 ± 0.9
8T	93.5 ± 2.0	19.3 ± 0.9	15.0 ± 0.7	19.4 ± 0.8	5.2 ± 0.3
10T	98.5 ± 1.0	17.3 ± 0.4	17.0 ± 0.4	18.8 ± 0.3	7.0 ± 0.2
12T	95.9 ± 1.0	16.8 ± 0.7	16.8 ± 0.7	19.4 ± 0.6	6.6 ± 0.2
6T + 2A	89.0 ± 0.9	9.5 ± 0.4	6.3 ± 0.2	9.2 ± 0.2	3.3 ± 0.1
6T + 4A	80.5 ± 0.9	7.5 ± 0.9	6.0 ± 0.1	6.6 ± 0.7	2.8 ± 0.2
6T + 6A	78.0 ± 2.3	6.3 ± 0.2	5.3 ± 0.4	5.3 ± 0.3	1.6 ± 0.3

Table 2. N, P and K contents in straw and grain at ripening of wheat plant [% of dry mass].

Densities	Straw			Grain		
	N	P	K	N	P	K
6T	0.52	0.15	3.8	3.6	0.58	0.6
8T	0.36	0.14	3.6	3.4	0.65	0.5
10T	0.27	0.11	3.5	3.1	0.62	0.6
12T	0.27	0.10	3.6	3.1	0.64	0.6
6T + 2A	0.40	0.17	3.9	4.3	0.67	0.7
6T + 4A	0.40	0.18	3.9	4.2	0.56	0.6
6T + 6A	0.42	0.22	3.8	3.9	0.65	0.7

Table 3. N, P and K accumulations in straw and grain of wheat per pot [mg].

Densities	Straw			Grain		
	N	P	K	N	P	K
6T	100	29	730	180	29	30
8T	70	27	698	177	34	26
10T	51	21	658	217	43	42
12T	52	19	698	211	42	40
6T + 2A	37	16	359	142	22	23
6T + 4A	26	12	257	118	16	17
6T + 6A	23	12	201	62	11	11

As the number of wheat plants increased from 6T to 10T, there was a trend towards decrease of the N and P contents in straw and N in grain in wheat plant, but not going from 10T to 12T densities (Table 2). Also, from 6T to 10T densities N and P accumulations in straw per pot decreased, but both in grain increased (Table 3),

while their total accumulation per pot did not varied substantially nor that of K at different wheat densities (Table 4).

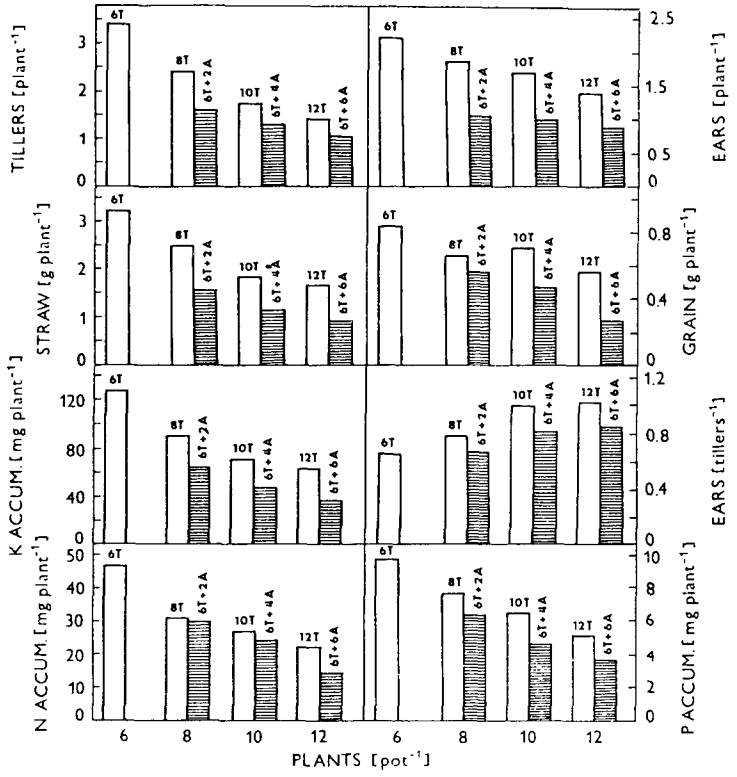

Fig. 1. Growth characteristics and accumulation of N, P and K in wheat plants grown alone (density 6, 8, 10 or 12 plants per pot) or in company with 2, 4 or 6 wild oat plants (density 6+2, 6+4 or 6+6)

Table 4. N, P and K accumulations in wheat, wild oat plants and total per pot [mg].

Densities	Wheat			Wild oat			Total		
	N	P	K	N	P	K	N	P	K
6T	280	58	760	-	-	-	280	58	760
8T	247	61	724	-	-	-	247	61	724
10T	268	64	700	-	-	-	268	64	700
12T	264	62	738	-	-	-	264	62	731
6T + 2A	179	38	382	119	26	753	298	64	1135
6T + 4A	144	28	274	135	32	941	279	60	1215
6T + 6A	65	22	213	157	37	1091	242	69	1304

The above-ground mass of wild oats per pot grew with the increase of its infestation, 13.3 ± 0.9, 15.7 ± 1.3 and 18.1 ± 1.0 g of dry matter for 6T+2A, 6T+4A and 6T+6A densities respectively. But due that N, P and K contents in straw and grain were alike, that is why their are not shown, the N, P and K accumulations were in the same sense that the values of above-ground mass (Table 4).

The competing capacity of wild oats with wheat increased with its rate of infestation, being affected the wheat plant in its height, number of tillers and ears, and straw and grain mass per pot (Table 1, Fig. 1) decreasing the N, P and K accumulations in the straw, grain and total plant per pot and per plant (Tables 3, 4). There was a trend that the N grain content in wheat decreased as a result of increasing wild oat densities (Table 2).

Discussion

The increase of the number of wheat plants per pot, causes an increase in their height, probably due to a light competition among them, but due to the decrease of the number of tillers, the straw mass remain unaffected. However, Sorour and El-Sharkawy (1976) found an increase of tillers and a decrease in plant height as consequence of an increase wheat seed rates. The increase of grain mass per pot is a result of the increase of number of ears.

An increase of the number of wheat plants caused the decrease in the N content in wheat grain, which was in agreement with other researchers (Kurten *et al.* 1982, Read and Warder 1982), but here also increased the N and P translocation from straw to grain.

As Tables 2 and Fig. 1 show, the attributes and N, P and K accumulations in wheat per plant were more affected due to wild oat competition than due to wheat competition. This was found previously for some attributes and N nutrient in other cultivars and conditions (Gonzalez Ponce 1988), but P and K nutrients were not studied. As a consequence when both species lives together, after tillering, when crown roots were well grown, wild oat may have acquired superiority in competition for nutrients with regard to wheat (Chancellor 1976).

It is noticeable, that both, an increase of wheat and wild oat plants produced an increase of fertility index of the wheat shoots (number of ears/number of tillers), perhaps a defense of wheat plant in face of the competition for light. However, this index was lower in interspecific competition.

The practical significance of the results consists in showing the need of the control of wild oat plants in wheat fields, not only by its because of damages on the growth, yield and grain protein yield of wheat, but also because its presence decreases the efficiency of the fertilizatin on wheat crop. On the other hand, a control of wild oats, allows to increase the wheat seed rates with the purpose to increase the grain yield and grain protein yield up to the limits imposed by the cultivars, soil and climatic conditions of the location.

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