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Yield losses caused by powdery mildew on bread wheat cultivars under irrigated Mediterranean conditions in Spain[1]

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Introduction

Powdery mildew, caused by *Blumeria graminis* f. sp. *tritici*, is commonly found throughout the Spanish wheat growing regions every year (Marín *et al*., 1992; RAEA, 2002; Sisquella *et al*., 2004; GENVE, 2006; Anonymous, 2006). This fungus has been considered in Spain a disease of minor importance with not devastating yield losses as they are in some other countries. This is primarily due to the low disease pressure found in the extensive non-irrigated low inputs wheat farming of semi arid areas. This information, however, is changing as disease pressure has been increasing due the continued improvement of cultural practices in cost-effective irrigated farming systems emerging from region to region across Mediterranean areas in Spain.

The aim of the present manuscript was to determine the effects of powdery mildew severity on grain yield reductions in several bread wheat cultivars that varied in resistance to this fungus under irrigated Mediterranean conditions in Spain.

Materials and methods

Field experiment was carried out at Gimenells, province of Lerida, Spain (41°37´ N; 0° 22´ E), during 2005-2006 growing season under natural infections of powdery mildew. Field design was a randomized complete block in a split-plot arrangement of treatments, with three replications. Bread wheat cultivars (Table 1) were allocated to the main plots and fungicide treatment (T1: treated; T2: untreated) to the subplots. Untreated plots were compared with treated plots kept nearly diseased-free with four foliar applications of two alternated fungicides: cyproconazole 10% p/p (800 g/ha) and metal-tiofanato 45% p/v (0.675 l/ha).

Powdery mildew severities were determined by estimating the percentages of leaf area infected on the whole plot and the upper three leaves (flag leaf (F), F-1 and F-2) of each cultivar. Disease assessments were made at Zadoks growth stages (GS): GS-24, GS-32, GS-43, GS-57, GS-61, GS-71 and GS-76. Disease severity assessments were used to calculate the area under the mildew progress curve (AUMPC), as described by Shaner and Finney (1977). No other foliage disease was observed during the study. The estimation of yield loss, based on disease severity was obtained by a linear model of second grade.

Results

Data reported in this document are the first published estimates of yield losses caused by powdery mildew under irrigated Mediterranean conditions in Spain. Bread wheat cultivars showing diverse resistance and susceptibility to powdery mildew are presented in Table 1. Treated plots had significantly ($P < 0.01$) lower values for disease severity and area under the disease progress curve (AUDPC) than untreated plots from the Zadoks GS-43 to GS-76 among cultivars, with the exception of the cv. 'Astral' at the GS-43 (Fig. 1).

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Powdery mildew damage as measured by disease severity on the upper three leaves at Zadoks GS-76 varied from 6.0 to 82.0% on flag leaf, 12.0 to 87.3% on flag-1 and 25.3 to 90.0% on flag-2 among cultivars (Table 1). A regression model constructed to determine the effect of disease severity on yield losses indicated grain yield per ha^{-1} reductions of 3.1%, 6.4%, 7.1%, 20.6%, and 21.6% in '1612-1/11', 'ID-2192', 'ID-2151', 'Anza', and 'Adalid' bread wheat cultivars respectively (Table 1). Thus, the relationship between disease severity and grain yield indicates that in susceptible bread wheat cultivars, powdery mildew can be an important yield constrain under irrigated Mediterranean conditions in Spain.

Table 1. Severity of powdery mildew and its effect on grain yield at the milk-grain stage in seven bread wheat cultivars during 2005-2006 growing season at Gimenells, Lerida, Spain

Cultivar	Fungicide treatment	Disease height†	Disease severity (%)††	AUDPC†††	Powdery mildew severity (%) on††††			Yield (kg/ha)	Predicted yield loss†††††
					F	F-1	F-2		
1612-1/9	Treated	0	0.0 a	0 a	0.0	0.0	0.0	6777.7	0.6
1612-1/9	Untreated	0	0.0 a	0 a	0.0 a	0.0 a	0.0 a	6738.7	
1612-1/11	Treated	2	24.7 a	965 a	0.0	0.0	0.0	7800.0	3.1
1612-1/11	Untreated	5	55.3 b	1991 b	9.0 c	16.0 c	36.7 c	7533.3	
ASTRAL	Treated	2	22.0 a	1164 a	0.0	0.0	0.0	6694.7	1.7
ASTRAL	Untreated	5	51.3 b	1842 b	6.0 b	12.0 b	25.3 b	6588.7	
ID-2192	Treated	3	32.7 a	1306 a	0.0	0.0	0.0	6500.0	6.4
ID-2192	Untreated	6	63.3 b	2409 b	21.3 d	32.0 d	44.0 d	6061.0	
ID-2151	Treated	3	30.7 a	1430 a	0.0	0.0	0.0	7716.7	7.1
ID-2151	Untreated	6	64.7 b	2463 b	24.0 d	33.3 d	48.7 e	7216.3	
ANZA	Treated	3	37.3 a	1553 a	0.0	0.0	0.0	6015.7	20.6
ANZA	Untreated	8	86.7 b	3322 b	76.7 e	86.7 e	88.7 f	4725.7	
ADALID	Treated	3	38.0 a	1782 a	0.0	0.0	0.0	5916.7	21.6
ADALID	Untreated	8	88.0 b	3489 b	82.0 f	87.3 e	90.0 f	4683.3	

†Represent the relative height of the disease founded on the plant from the ground in term of 0-9 scale at its maximum average disease expression (Eyal *et al*., 1987).
††Percent foliage diseased observed on the whole plot at the Zadoks GS-76 (milk grain).
†††Area Under the Disease Progress Curve at the Zadoks GS- 76 (milk grain).
††††F= Percent foliage diseased on flag leaf, F-1= the first leaf below the flag leaf, F-2= the second leaf below the flag leaf at the Zadoks GS-76 (milk grain).
†††††The estimation of yield loss, based on disease severity was obtained by a linear model of second grade. $R^2 = 0.999$. ($P<0.0001$).

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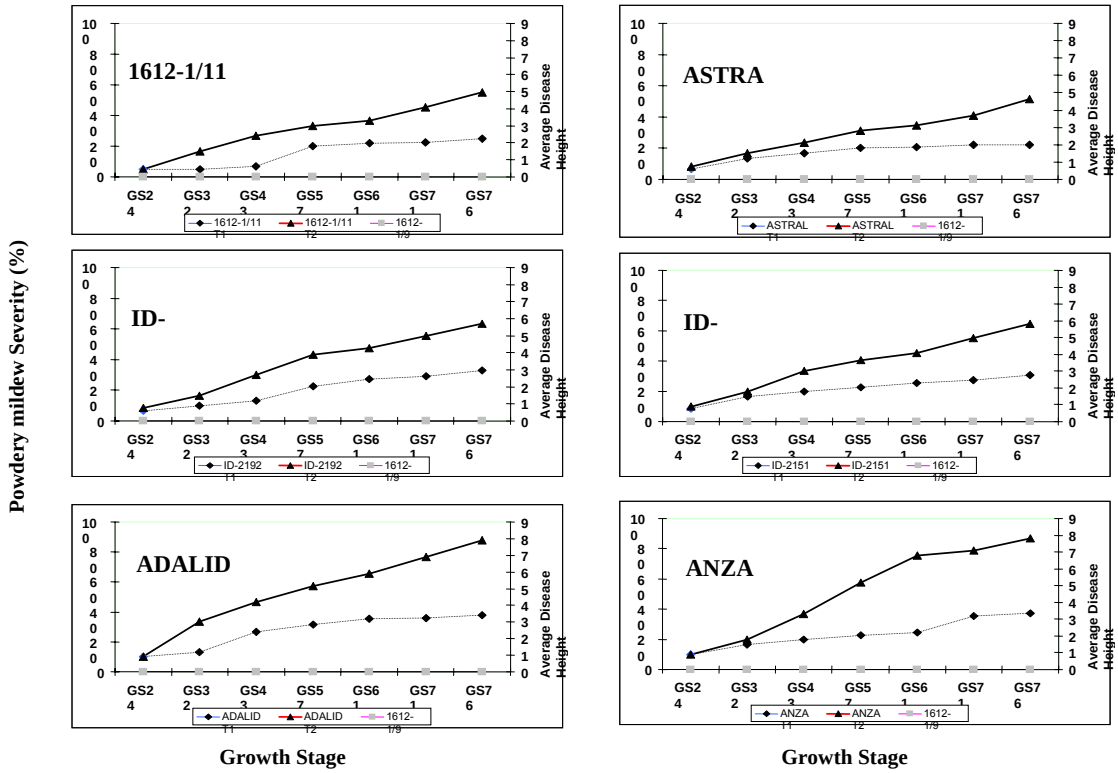

Fig. 1. Disease severity progress curves illustrating the development of powdery mildew on treated (T1: ⋯◆⋯) and untreated (T2: –▲–) plots through different Zadoks growth stages on six bread wheat cultivars during 2005-2006 growing season at Gimenells, Lerida, Spain.