Effects of field bindweed (*Convolvulus arvensis* L.) and powdery mildew [*Leveillula taurica* (Lev.) Arn.] on pepper growth and yield – Short communication

A. Karkanis[1], D. Bilalis[2], A. Efthimiadou[3], N. Katsenios[2]

[1]*Department of Agriculture, Crop Production and Rural Environment, University of Thessaly, Volos, Greece*
[2]*Department of Crop Science, Agricultural University of Athens, Athens, Greece*
[3]*Open University of Cyprus, Nicosia, Cyprus*

Abstract

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Field experiments were conducted to determine the effects of field bindweed and powdery mildew on growth and yield of a pepper crop. This study also evaluated the efficacy of fungicide application programs for controlling powdery mildew. Field bindweed influenced growth and yield of pepper. The greatest dry weight and yield of pepper were recorded with weed-free control treatment. Moreover, powdery mildew was severe. The fungicide application programs positively influenced growth and yield of pepper. The control plots had the lowest yield of pepper. The first symptoms of powdery mildew on pepper plants developed 20–25 days after powdery mildew diagnosis on field bindweed. Two azoxystrobin applications, at 10 and 25 days after infection of field bindweed by powdery mildew, restricted the disease progress. Our results indicate that field bindweed is highly susceptible to powdery mildew infection and could be used as an indicator species of *L. taurica* presence in pepper plants.

Keywords: competition; disease; indicator; pepper with photosynthesis; mildew with strobilurin fungicides; weed

Convolvulus arvensis L. (Convolvulaceae), field bindweed, is a perennial herb. Its deep and extensive root system, together with its long-lasting seed bank, is a key feature to the noxious weed status that it receives worldwide (Gianoli 2001). Crops suffer enormously from field bindweed which competes for nutrients and water (Aneja, Srivinas 1990) and harbours parasitic fungi (Glawe et al. 2003). Powdery mildew caused by *L. taurica* (Lev.) Arn. [anamorphic stage: *Oidiopsis taurica* (Lev.) Salmon] is a serious disease affecting the leaves of pepper grown in greenhouses and in the field. The disease is controlled in pepper crops by means of frequent application of synthetic fungicides and sulphur (Brand et al. 2009; Sudha, Lakshmanan 2009). The strobilurin fungicides (e.g. azoxystrobin, kresoxim-methyl) appear to be the most important new group of fungicides. The main objective of this study was to evaluate the effects of field bindweed and powdery mildew on growth, photosynthesis and yield of pepper crop.

MATERIAL AND METHODS

Field experiments were carried out in central Greece (Domokos, 230 km from Athens). An area naturally heavily infested with field bindweed was

selected. The experiment was set up on an area of 800 m^2 according to the split-plot design with four replicates, two main plots: weed-free control and field bindweed competition and three sub-plots [control, non-sprayed; treatment 1: azoxystrobin application (200 g a.i./ha) at 60, 75, 90 and 116 days after transplanting (DAT); treatment 2: azoxystrobin application (200 g a.i./ha) at 10 and 25 days after infection of field bindweed by powdery mildew]. The sub-plot size was 5 × 6 m. In 2009 and 2010, after hardening, the pepper (*Capsicum annuum* L. Dolmy F1) seedlings were transplanted on the same dates (10/05/2009 and 10/05/2010) in paired-rows. The distances between two rows in a pair and between two consecutive paired-rows were 0.40 and 1.35 m, respectively, and plant-to-plant spacing was 0.40 m. The dry matter (kg/ha) of field bindweed was assessed at 150 DAT. For the determination of dry matter (dry matter of stems + dry matter of leaves, kg/ha) and yield of pepper (kg/ha), five plants were randomly selected in each plot. The yield was estimated by collecting and weighing the green fruits of pepper. Fruits were harvested at five-day intervals at the ripening stage, from the third week of July to the middle of October. Measurements of photosynthetic rate (μmol CO_2/m^2s) were measured on two successive days, between the hours of 10.30 and 14.30, with five measurements per plot. Measurements of photosynthetic rate were made using an LCi Leaf Chamber Analysis System (ADC, Bioscientific, Hoddedson, UK; Measurement range: PAR: 0–3000 μmols/m^2s, CO_2 concentration: 0–2000 ppm, temperature: –5 to 50°C). The adaptation time for the leaf disc in the chamber is 60 s. Photosynthetic rates are calculated approximately every 20 s. The percentage of diseased leaf surface area was assessed visually eight times between 80 and 150 DAT. The data were subjected to statistical analysis according to the split-plot design.

RESULTS AND DISCUSSION

Field bindweed emergence started 10–15 DAT and was completed within 120 DAT. Field bindweed influenced growth and yield of pepper. The highest dry matter and yield of pepper was recorded with the weed-free control treatment (Table 1). Crops suffer enormously from field bindweed which competes for nutrients and water (Aneja, Srivinas 1990). Powdery mildew was observed on

Table 1. Effects of field bindweed (FB) and fungicides (control, treatment 1 and treatment 2) on dry matter, photosynthetic rate and yield of pepper crop

Fungicide treatments	2009		2010	
	weed-free control	with FB	weed-free control	with FB
Dry matter of pepper (kg/ha)				
Control	7,510	5,430	7,850	5,780
Treatment 1	9,030	6,260	8,670	6,540
Treatment 2	8,780	6,140	8,560	6,340
$LSD_{bindweed}$ (P = 0.05)	467		271	
$LSD_{fungicides}$ (P = 0.05)	362		158	
Photosynthetic rate (μmol CO_2/m^2s) of pepper at 140 days after transplanting				
Control	8.31	8.78	8.93	9.44
Treatment 1	14.43	12.34	15.47	12.56
Treatment 2	15.02	12.09	15.21	12.61
$LSD_{bindweed}$ (P = 0.05)	1.04		0.69	
$LSD_{fungicides}$ (P = 0.05)	0.72		1.17	
Yield of pepper (kg/ha)				
Control	28,400	21,240	27,320	20,500
Treatment 1	40,310	31,400	36,450	29,840
Treatment 2	39,850	31,030	35,700	30,650
$LSD_{bindweed}$ (P = 0.05)	1,217		753	
$LSD_{fungicides}$ (P = 0.05)	764		1,024	

Table 2. Effects of field bindweed (FB) and fungicides (control, treatment 1 and treatment 2) on severity of powdery mildew on pepper crop at 140 days after transplanting

Fungicide treatments	2009		2010	
	weed-free control	with FB	weed-free control	with FB
Control	41.4	43.4	45.6	47.2
Treatment 1	24.2	26.1	26.5	27.8
Treatment 2	24.8	26.5	26.9	28.5
$LSD_{bindweed}$ ($P = 0.05$)	2.1		4.5	
$LSD_{fungicides}$ ($P = 0.05$)	3.4		6.7	

field bindweed plants. In field bindweed, the first symptoms of powdery mildew developed between 85–95 DAT. White powdery colonies covered both leaf surfaces within 30–40 days. Two powdery mildew fungi occur in field bindweed: *Erysiphe convolvuli* DC var. *convolvuli* and *L. taurica* (Lev.) Arn. (Glawe et al. 2003).

Moreover, powdery mildew (*L. taurica*) was observed on pepper plants. Irrespective of year, in pepper plants, the first symptoms of powdery mildew developed 20–25 days after powdery mildew diagnosis on field bindweed plants. White powdery colonies covered the lower surface of leaves within 20–35 days after powdery mildew diagnosis on pepper plants. The fungicide application programs positively influenced growth and yield of pepper. Sudha and Lakshmanan (2007) also reported that a severe outbreak of powdery mildew disease induced by *L. taurica* was observed on *Capsicum annuum* and caused yield loss by up to 80%. There was field bindweed × fungicide interaction for yield of pepper. Moreover, fungicide treatment positively influenced the photosynthetic rate of pepper (Table 1). Akhkha (2008) observed that barley infection by powdery mildew induced stomatal closure and limited CO_2 diffusion to carboxylation sites, causing a decline in the rates of photosynthesis. Two azoxystrobin applications restricted the disease progress on field bindweed and pepper plants (Tables 2 and 3). In contrast, Elad et al. (2007) reported that the current recommendation for powdery mildew control is frequent fungicide applications beginning early in the season. Concerning the disease severity in the prevent study, there were no significant differences between the weed-free control and field bindweed treatment. In addition, Sudha and Lakshmanan (2007) found that the ability of *L. taurica* to infect the native host *Solanum nigrum*

Table 3. Dry matter and severity of powdery mildew of field bindweed treated with fungicides to control powdery mildew of pepper (DAT – days after transplanting)

Fungicide treatments	2009			2010		
	30 DAT	90 DAT	150 DAT	30 DAT	90 DAT	150 DAT
Dry matter (kg/ha)						
Control	38.3	655	830	39.5	560	755
Treatment 1	42.7	618	920	43.4	545	893
Treatment 2	43.9	635	890	44.8	489	794
$LSD_{fungicides}$ ($P = 0.05$)	7.8	25	44	5.9	63	21
	90 DAT	110 DAT	140 DAT	90 DAT	110 DAT	140 DAT
Severity (%) of powdery mildew						
Control	4.5	19.2	67.8	8.4	25.3	77.8
Treatment 1	1.8	5.6	20.4	2.4	7.8	24.3
Treatment 2	5.1	17.8	50.2	9.1	27.6	63.1
$LSD_{fungicides}$ ($P = 0.05$)	0.6	4.8	9.4	0.8	5.1	7.1

is particularly important because this host plant might serve as an inoculum reservoir for adjacently cultivated *Capsicum annuum*.

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Corresponding author:

Dr. D. Bilalis, Agricultural University of Athens, Department of Crop Science,
Iera Odos 75, 11855 Athens, Greece
phone/fax: + 302 105 294 494, e-mail: bilalisdimitrios@yahoo.gr