Effect of silicates and electrical conductivity on Fusarium wilt of hydroponically grown lettuce

EFFECT OF SILICATES AND ELECTRICAL CONDUCTIVITY ON FUSARIUM WILT OF HYDROPONICALLY GROWN LETTUCE

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SUMMARY

Silicon can stimulate natural defense mechanisms in plants, reducing foliar diseases like powdery and downy mildew on several crops, including lettuce. The effect of silicate on fusarium wilt, caused by *Fusarium oxysporum* f. sp. *lactucae* was evaluated under greenhouse conditions on lettuce grown in soilless systems. Silicon, as potassium silicate, was added at 100 mg L^{-1} of nutrient solution at three levels of electrical conductivity; 1.5–1.6 mS cm^{-1} (E.C.1), 3.0–3.2 mS cm^{-1} (E.C.2) and 4–4.2 mS cm^{-1} (E.C.3). Pots containing lettuce plants were first inoculated with *F. oxysporum* f. sp. *lactucae* ($3x10^5$ clamidospores ml^{-1}) 15–20 days before transplanting. Disease severity and physiological parameters, including chlorophyll content, were analyzed weekly after transplanting. The addition of potassium silicate slightly reduced *Fusarium* wilt, at all levels of electrical conductivity under study, compared to the control. On the contrary, the increase of electrical conductivity of the nutrient solution showed no effect on the disease. The use of silicon was previously demonstrated to significantly reduce downy mildew on lettuce in soilless systems, and in this trial it demonstrated to slightly reduce disease severity of an important soil-borne pathogen like *F. oxysporum* f. sp. *lactucae,* suggesting the possibility to apply it successfully in soilless crops.

Key words: silicon, *Fusarium oxysporum* f. sp. *lactucae*, *Lactuca sativa,* soilless systems.

INTRODUCTION

Silicon (Si) is an abundant element in soil and is also important in the nutrition of many plant species, with beneficial effects on plant tissues (Epstein, 2009). Silicon can stimulate natural defense mechanisms in plants, reducing foliar diseases like powdery and downy mildew on several crops. Increased electrical conductivity (E. C.) of the nutrient solution in soilless system can also influence positively or negatively plant diseases and previously showed to reduce powdery mildew on tomato and downy mildew on lettuce (Garibaldi *et al.*, 2011 and 2012),

Fusarium oxysporum f. sp. *lactucae* (FOL) is a pathogen causing lettuce wilt worldwide (Matheron and Gullino, 2012). Considerable effort has been done in the search for resistance cultivars. Despite this, methods to control the disease, particularly in soilless systems, are necessary.

The objective of the present work was to evaluate the effect of increased potassium silicate in the nutrient solution at varying levels of electrical conductivity (E.

C.) on *F. oxysporum* f. sp. *lactucae* incidence and severity in tomato grown in soilless system.

MATERIALS AND METHODS

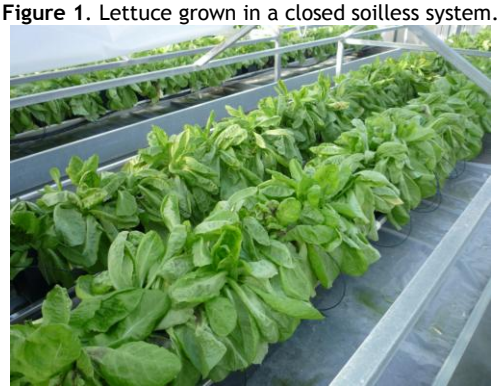
Growth of plants and experimental conditions

Three trials were carried out at Grugliasco (Torino), in glasshouses. Lettuce plants were maintained on benches in a glasshouse (20–28°C), at a density of five plants m^{-2} (Fig.1). Fifteen-day-old lettuce plants were planted in 18 cm diameter plastic pots (one plant per pot). The pots were placed over six channels of 6 m in length and 25 cm in width. Each hydroponic unit consisted of one channel connected to a storage tank (300 L) filled with the nutrient solution, automatically delivered to the plants with the aid of an electronic control unit program.
Silicon, as potassium silicate (KSi), was added at 100 mg L^{-1} of nutrient solution at three levels of electrical conductivity; 1.5–1.6 mS cm^{-1} (E.C.1), 3.0–3.2 mS cm^{-1} (E.C.2) and 4–4.2 mS cm^{-1} (E.C.3). Pots containing lettuce plants were first inoculated with *F. oxysporum* f. sp. *lactucae* ($3x10^5$ clamidospores ml^{-1}) 15–20 days before transplanting. Plants were checked weekly for disease development, noting the number of infected plants and severity of symptoms.

Statistical analysis

Analyses of variance were carried out with the statistical programme SPSS 17.0. After ANOVA, Tukey's "Honestly Significantly Different" was used as post-hoc analysis, with a significance defined at the $P < 0.05$ level.

Figure 1. Lettuce grown in a closed soilless system.



RESULTS AND DISCUSSION

The addition of potassium silicate to all the three nutrient solutions with different electrical conductivities slightly reduced *Fusarium* wilt of lettuce, at all levels of electrical conductivity under study, compared to the control, with results varying according to E. C. (Tab. 1).

On the contrary, the increase of electrical conductivity of the nutrient solution showed no significant effects on the disease (Tab. 1).
The best results were achieved with the combination of high E.C. and KSi, with a disease reduction, compared to control, of 49 and 42%, respectively, in trial 1 and 3.

Table 1. Effect of potassium silicate and electrical conductivity against *Fusarium oxysporum* f. sp. *lactucae* on lettuce grown soilless.

E.C. (mS cm^{-1})	KSi (ppm)	Disease index (0-100)		
		Trial 1	Trial 2	Trial 3
1.5-1.6	0	42.5 c*	16.4 ab	16.5 ab
3.0-3.2		41.0 c	20.2 bc	20.4 ab
4-4.2		34.0 bc	24.2 bc	22.5 b
1.5-1.6	100	38.8 bc	13.2 ab	12.0 ab
3.0-3.2		36.0 bc	14.8 ab	10.6 ab
4-4.2		21.0 b	14.9 ab	7.0 ab
Healthy control		0 a	0 a	0 a

* Tukey's HSD test ($P < 0.05$)

CONCLUSIONS

The effect of potassium silicate applied at different levels of electrical conductivity of the nutrient solution was evaluated against *F. oxysporum* f. sp. *lactucae* on lettuce grown in a soilless closed system. The E.C. level alone not influenced Fusarium wilt, while after the addition of silicates it reduced the disease.
In accordance with previous research, the positive role of silicon in plant nutrition and increased resistance to plant pathogens has been demonstrated. Recently, the positive effects of silicon application to reduce powdery mildew on tomato, downy mildew on lettuce and black spot on basil grown soilless, in experiments carried out in the same environment, were observed (Garibaldi *et al.*, 2011 and 2012; Cogliati *et al.,* 2012). In this trial it demonstrated to slightly reduce disease severity of an important soil-borne pathogen like *F. oxysporum* f. sp. *lactucae,* suggesting the possibility to apply it successfully in soilless crops.

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