SILICON DIFFERENTIALLY MODULATES PHENOLIC METABOLISM AND ANTIOXIDANT CAPACITY OF BARLEY CULTIVARS SUBJECTED TO PHOSPHORUS DEFICIENCY

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INTRODUCTION

Current evidence shows that silicon (Si) can alleviate multiple plant stresses by inducing the antioxidant defense and phenolic metabolism of plants (Vega et al. 2019; 2020). Nevertheless, the mechanisms underlying these responses remains unclear. We investigated the Si effect on the phenolic metabolism of two barley cultivars differing in their tolerance to phosphorus (P) deficiency (cv. Sebastian, P-deficiency tolerant and cv. Traveler, P-deficiency sensitive).

MATERIALS AND METHODS

Plants were hydroponically grown with P (0, 0.01 or 0.1 mM P; applied as Na_2HPO_4) in combination with Si (0, 1 or 2 mM Si; applied as Na_2SiO_3). At harvest, total phenols, antioxidant capacity, individual phenolics and the gene expression of enzymes involved in the synthesis of soluble phenolic compounds including phenylalanine ammonia lyase (*HvPAL*) and chalcone synthase (*HvCHS*) were analyzed in shoots.

RESULTS AND DISCUSSION

In cv. Sebastian grown without P, Si reduced both total phenols and antioxidant capacity to levels comparable to plants supplied with an optimal P dose (Figure 1). In contrast, increasing Si doses triggered an enhancement of total phenols and antioxidant ability in cv. Traveler cultivated in absence of P.

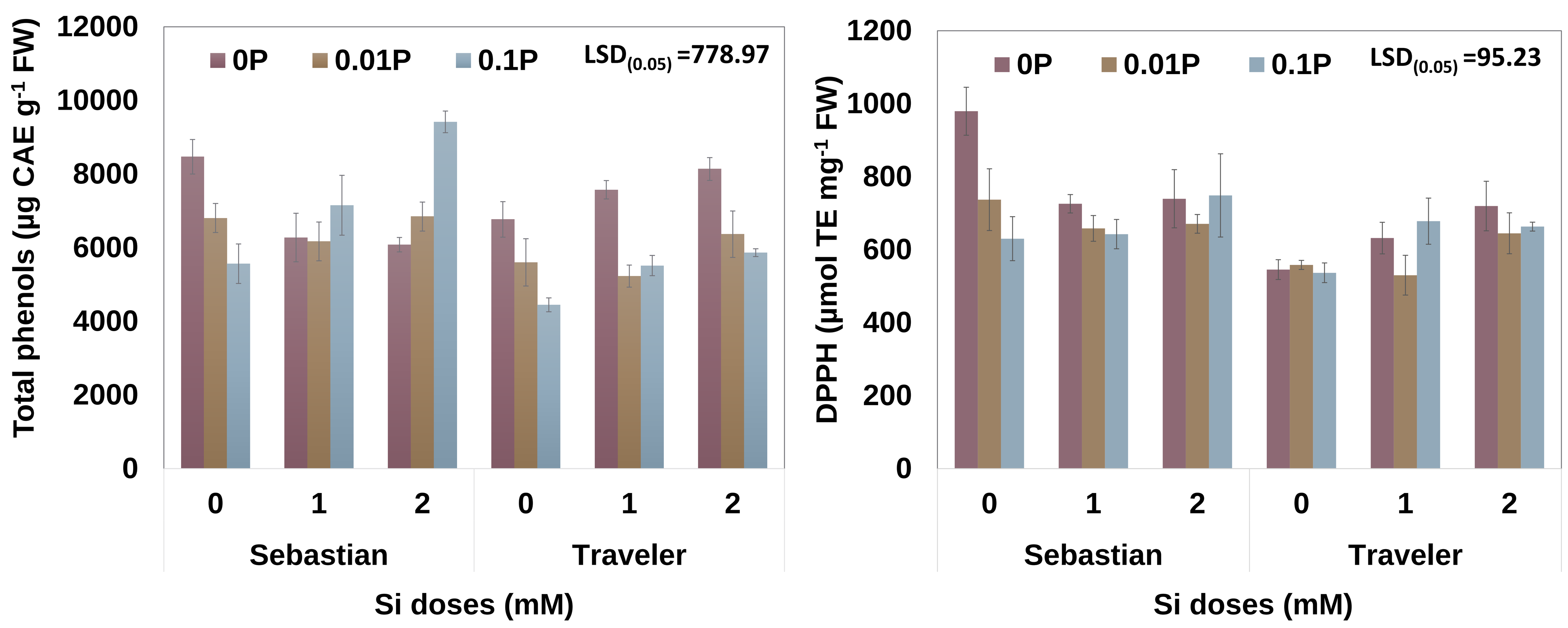

Figure 1. Total phenol concentration and radical scavenging activity in shoots of barley cultivars grown with different P and Si doses during 21 days. Data are means of three replicates ± SD.

Table 1. Identification of phenolic compounds from barley shoots by using High-performance liquid chromatography-diode array detector/tandem electrospray ionization mass spectrometry (HPLC–DAD–ESI-MS/MS).

Tr (min)	Tentative identification	λ max (nm)	[M-H]-	Products-ions
10.8	Lutonarin	349	609	447,0; 377,0
18.1	apigenin-pent-hex	336	593.3	502,8; 472,8; 430,8; 310,9
21.4	n.i.	337	776.1	739.1
22.9	apigenin-pent-hex	338	563.9	544,8; 472,9; 442,9; 383
30.3	Isoorientin-7-O-[6-sinapoyl]-glucoside	342	815.6	446,9; 327,2; 299,1
31.1	Isoorientin-7-O-[6-feruloyl]-glucoside	338	785.6	446,9; 327,1
34.5	Isovitexin-7-O-[6-sinapoyl]-glucoside	319	799.6	430,4; 311,0; 283
35.8	Isovitexin-7-O-[6-feruloyl]-glucoside	333	769.6	430,8; 311,0

Seven flavonoids were identified, being the most relevant the derivatives of apigenin and lutonarin (Table 1). Although we did not observe clear effect of Si on the content of individual phenolics in cv. Sebastian exposed to P stress, an increment in the concentration of apigenin-pentoxide-hexoside was detected in cv. Traveler as a consequence of Si application to P-deficient plants (Figure 2).

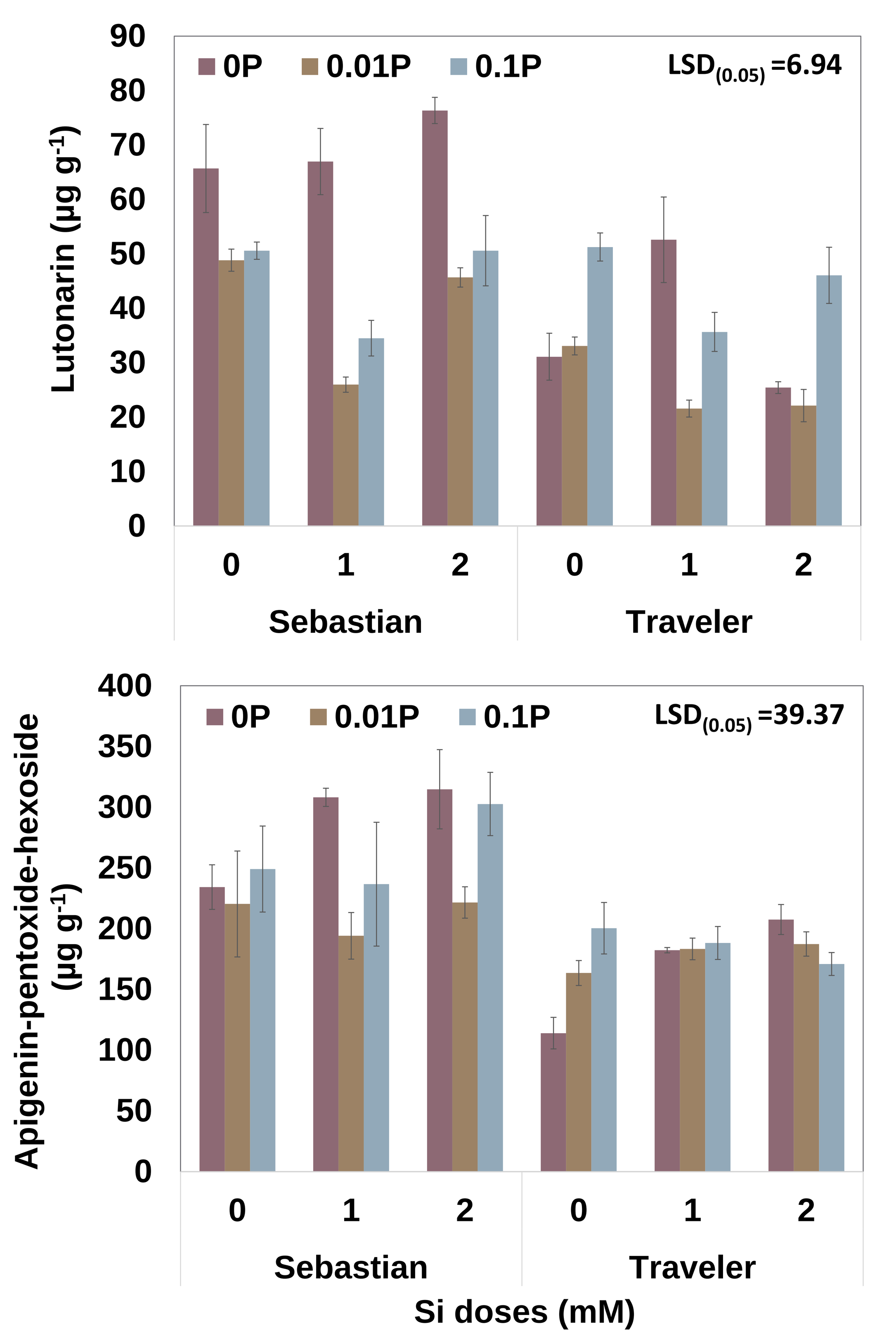

Figure 2. Phenolic compounds in shoots of barley cultivars grown with different P and Si doses during 21 days. Data are means of three replicates ± SD.

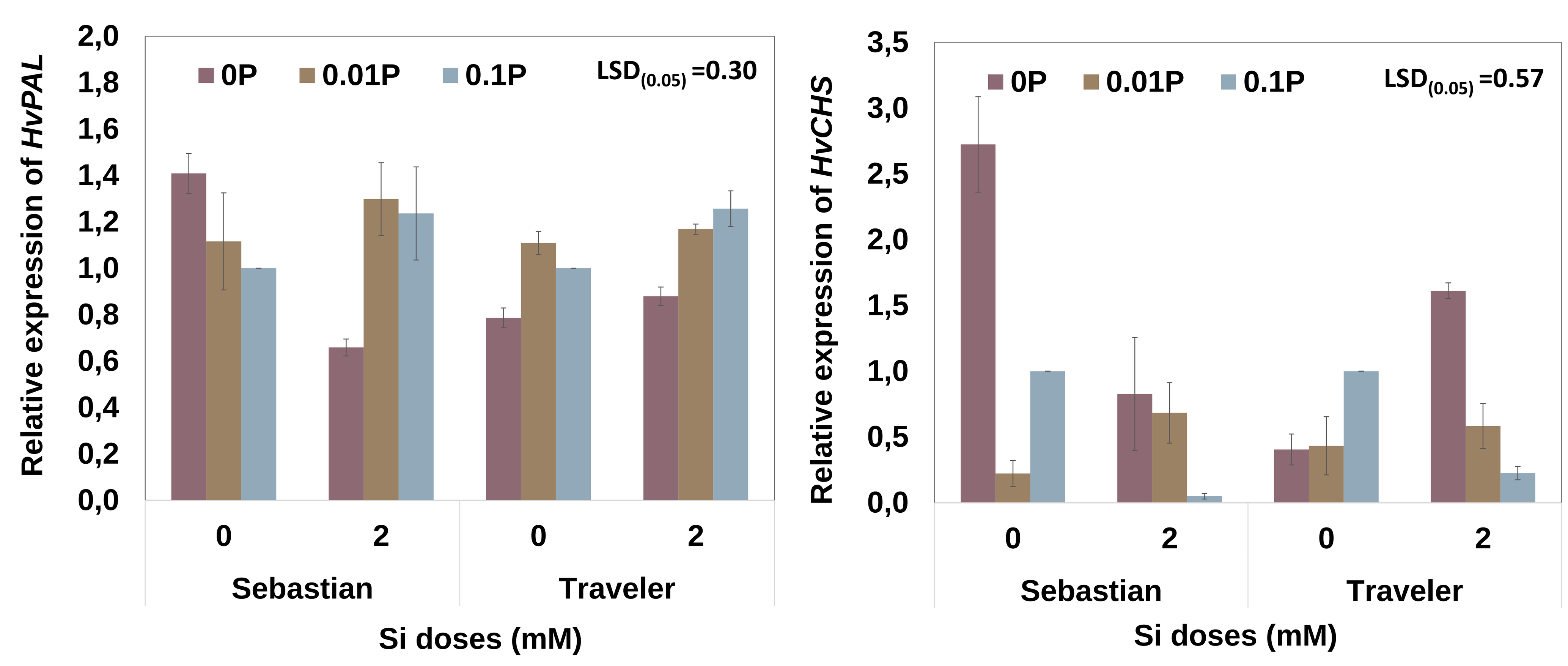

Figure 3. Gene expression analysis of *HvPAL* and *HvCHS* by qRT-PCR in shoots of barley cultivars grown with different P and Si doses during 21 days. The expression levels were normalized in relation to *Actin* or *ADP* gene expression. Data are means of three replicates ± standard error.

Differential expression of genes associated with the synthesis of phenolics was also induced by Si under P-stress. The transcript level of *HvPAL* diminished in cv. Sebastian and augmented in cv. Traveler due to Si supply under P limitation (Figure 3). Likewise, Si decreased *HvCHS* expression in cv. Sebastian grown without P, whereas an up-regulation of *HvCHS* was observed when Si was applied to cv. Traveler grown with low P.

References. Vega et al. 2019, Agronomy 9, 388; Vega et al. 2020, Agronomy 10, 1138.

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