# UV Light Acclimation Capacity of Leaf Photosynthetic and Photochemical Behaviour in Near-isohydric and Anisohydric Grapevines in Hot and Dry Environments

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**Appendix A**
**Supplementary Data**

TABLE S1
The calculated fluorescence variables.

| Variable description | Equation |
|---|---|
| Variable fluorescence | $F_v = F_m - F_o$ |
| Relative variable fluorescence at J-step (2 ms) | $V_j = (F_{2ms} - F_o)/(F_m - F_o)$ |
| Initial slope (in $ms^{-1}$) of the fluorescence curve with respect to $F_{300}$ | $M_o = 4 \times (F_{300\mu s} - F_o)/(F_m - F_o)$ |
| Absorption of photon flux by antenna chlorophyll molecules of active and inactive reaction centre of PSII per excited cross-section of leaf area | $ABS/CS_m$ |
| Maximum yield of primary photochemistry of PSII | $\varphi_{Po} = F_v/F_m$ |
| Parameter of functional PSII units (*) | $1/F_o - 1/F_m$ |
| Maximum water-splitting efficiency | $F_v/F_o$ |
| Quantum yield for electron transport | $\varphi_{Eo} = (F_v/F_m) \times (1 - V_j)$ |
| Quantum yield for energy dissipation | $\varphi_{DIo} = 1 - \varphi_{Po}$ |
| Density of reaction centres | $RC_{QA} = \varphi_{Po} \times (ABS/CS_m) \times (V_j/M_o)$ |

(*) Flexas *et al*. (2001)

TABLE S2
Calculated fluorescence variables.

| Index description | Equation |
|---|---|
| Chlorophyll index ([a]) | $CHL = [(I_{850}/I_{0,850})/(I_{710}/I_{0,710})] - 1$ |
| Flavonol index | $FLAV = \log (FRF_R/FTF_{UV})$ |
| Anthocyanin index | $ANT = Log (FRF_R/FRF_G)$ |
| Nitrogen balance index | $NBI = [(CHL_{AD} + CHL_{AB})/2]/ [(FLAV_{AD} + FLAV_{AB})]$ |

† The chlorophyll index was calculated from the average of the two leaf sides; the flavonol and anthocyanin indices were calculated from the sum of the abaxial and adaxial sides. I and $I_0$ are light transmission at 710 and 850 nm, with and without the leaf sample inside the leaf clip, respectively.
†† FRF is the far-red chlorophyll fluorescence emission excited by red (650 nm) or UV (375 nm) light.
††† FRF is the far-red chlorophyll fluorescence emission excited by red (650 nm) or green (520 nm) light.

TABLE S3

Effects of leaf level (basal and apical), cultivar (Bovale grande, BG, and Cannonau, CNN) and treatment (UV-screening, –UV, and control exposed to direct solar radiation, C) on maximum yield of primary photochemistry of PSII ($\varphi_{Po}$) water-slitting efficiency ($F_v/F_o$), quantum yield for electron transport ($\varphi_{Eo}$) quantum yield for energy dissipation ($\varphi_{DIo}$), the density of the reaction centres ($RC_{QA}$), and the parameter of the functional PSII units ($1/F_o$ to $1/F_m$) during the season. Means in columns followed by different letters are significantly different within main effects on the basis of LSD performed by two-way ANOVA (analysis of variance) at $p < 0.05$ (n = 6).

| BBCH stage | Main effect | | $\varphi_{Po}$ | $F_v/F_o$ | $\varphi_{Eo}$ | $\varphi_{DIo}$ | $RC_{QA}$ | $1/F_o - 1/F_m$ |
|---|---|---|---|---|---|---|---|---|
| 75 | Leaf level | Basal | 2.29 | 0.23 | 0.35 | 385.9 | 385.9 | $1.04E^{-3}$ |
| | | Apical | - | - | - | - | - | |
| | Cultivar | BG | 2.17 | 0.20 | 0.37 | 307 | 307 | $1.03E^{-3}$ |
| | | CNN | 2.40 | 0.25 | 0.34 | 465 | 465 | $1.05E^{-3}$ |
| | Treatment | –UV | 1.99 | 0.19 b | 0.38 | 314 | 314 | $8.79E^{-4}$ b |
| | | C | 2.59 | 0.27 a | 0.32 | 458 | 458 | $1.20E^{-3}$ a |
| p-value [a] | $P_{(level)}$ | | - | - | - | - | - | - |
| | $P_{(cv)}$ | | 0.547 | 0.250 | 0.531 | 0.068 | 0.068 | 0.872 |
| | $P_{(treatment)}$ | | 0.126 | 0.047 | 0.178 | 0.094 | 0.094 | 0.050 |
| | $P_{(level\ x\ cv)}$ | | - | - | - | - | - | - |
| | $P_{(level\ x\ treatment)}$ | | - | - | - | - | - | - |
| | $P_{(cv\ x\ treatment)}$ | | 0.506 | 0.490 | 0.250 | 0.507 | 0.051 | 0.809 |
| | $P_{(level\ x\ cv\ x\ treatment)}$ | | - | - | - | - | - | - |
| 80 | Leaf level | Basal | 1.95 b | 0.19 | 0.39 a | 403 b | 403 b | $1.01E^{-3}$ |
| | | Apical | 2.67 a | 0.25 | 0.30 b | 568 a | 568 a | $1.22E^{-3}$ |
| | Variety | BG | 1.99 | 0.21 | 0.37 | 453 | 453 | $1.00E^{-3}$ |
| | | CNN | 2.63 | 0.23 | 0.32 | 518 | 518 | $1.23E^{-3}$ |
| | Treatment | –UV | 1.63 b | 0.16 b | 0.43 a | 375 b | 375 b | $8.71E^{-4}$ b |
| | | C | 2.99 a | 0.28 a | 0.27 b | 596 a | 596 a | $1.36E^{-3}$ a |
| p-value [a] | $P_{(level)}$ | | 0.016 | 0.094 | 0.011 | 0.008 | 0.008 | 0.074 |
| | $P_{(cv)}$ | | 0.029 | 0.634 | 0.155 | 0.261 | 0.261 | 0.057 |
| | $P_{(treatment)}$ | | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | $P_{(level\ x\ cv)}$ | | 0.186 | 0.419 | 0.532 | 0.308 | 0.308 | 0.770 |
| | $P_{(level\ x\ treatment)}$ | | 0.117 | 0.022 | 0.019 | 0.153 | 0.153 | 0.035 |
| | $P_{(cv\ x\ treatment)}$ | | 0.295 | 0.062 | 0.322 | 0.701 | 0.701 | 0.346 |
| | $P_{(level\ x\ cv\ x\ treatment)}$ | | 0.967 | 0.974 | 0.528 | 0.962 | 0.518 | 0.870 |
| 83 | Leaf level | Basal | 2.32 | 0.35 | 0.33 | 698 | 698 | $1.04E^{-3}$ |
| | | Apical | 2.47 | 0.34 | 0.32 | 682 | 682 | $1.13E^{-3}$ |
| | Cultivar | BG | 2.24 | 0.37 | 0.34 | 722 | 722 | $1.02E^{-3}$ |
| | | CNN | 2.55 | 0.31 | 0.31 | 658 | 658 | $1.15E^{-3}$ |
| | Treatment | –UV | 2.07 b | 0.41 a | 0.36 a | 749 a | 749 a | $9.27E^{-4}$ b |
| | | C | 2.73 a | 0.28 b | 0.28 b | 631 b | 631 b | $1.25E^{-3}$ a |
| p-value [a] | $P_{(level)}$ | | 0.628 | 0.707 | 0.767 | 0.775 | 0.775 | 0.430 |
| | $P_{(cv)}$ | | 0.316 | 0.136 | 0.284 | 0.268 | 0.268 | 0.244 |
| | $P_{(treatment)}$ | | 0.042 | 0.001 | 0.006 | 0.046 | 0.046 | 0.006 |
| | $P_{(level\ x\ cv)}$ | | 0.635 | 0.229 | 0.420 | 0.619 | 0.619 | 0.503 |

TABLE S3 (CONTINUED)

| BBCH stage | Main effect | | $\varphi_{Po}$ | $F_v/F_o$ | $\varphi_{Eo}$ | $\varphi_{DIo}$ | $RC_{QA}$ | $1/F_o - 1/F_m$ |
|---|---|---|---|---|---|---|---|---|
| | $P_{(level\ x\ treatment)}$ | | 0.416 | 0.358 | 0.457 | 0.413 | 0.789 | 0.544 |
| | $P_{(cv\ x\ treatment)}$ | | 0.105 | 0.152 | 0.583 | 0.105 | 0.200 | 0.026 |
| | $P_{(level\ x\ cv\ x\ treatment)}$ | | 0.169 | 0.227 | 0.314 | 0.170 | 0.272 | 0.295 |
| 85 | Leaf level | Basal | 2.30 | 0.19 | 0.32 | 455 | 455 | $1.18E^{-3}$ |
| | | Apical | 2.09 | 0.18 | 0.37 | 452 | 452 | $1.06E^{-3}$ |
| | Cultivar | BG | 2.32 | 0.20 | 0.32 | 477 | 477 | $1.23E^{-3}$ |
| | | CNN | 1.99 | 0.17 | 0.37 | 430 | 430 | $1.01E^{-3}$ |
| | Treatment | –UV | 2.24 | 0.19 | 0.33 | 480 | 480 | $1.11E^{-3}$ |
| | | C | 2.07 | 0.18 | 0.36 | 428 | 428 | $1.13E^{-3}$ |
| p-value [a] | $P_{(level)}$ | | 0.680 | 0.718 | 0.234 | 0.958 | 0.958 | 0.289 |
| | $P_{(cv)}$ | | 0.296 | 0.263 | 0.211 | 0.421 | 0.421 | 0.062 |
| | $P_{(treatment)}$ | | 0.570 | 0.812 | 0.412 | 0.370 | 0.370 | 0.883 |
| | $P_{(level\ x\ cv)}$ | | 0.456 | 0.359 | 0.876 | 0.530 | 0.530 | 0.891 |
| | $P_{(level\ x\ treatment)}$ | | 0.530 | 0.274 | 0.259 | 0.530 | 0.322 | 0.277 |
| | $P_{(cv\ x\ treatment)}$ | | 0.348 | 0.354 | 0.044 | 0.349 | 0.482 | 0.052 |
| | $P_{(level\ x\ cv\ x\ treatment)}$ | | 0.304 | 0.170 | 0.090 | 0.304 | 0.150 | 0.222 |

[a] p-value of main and interactive effects of two-way ANOVA

TABLE S4
Orthogonal partial least squares discriminant analysis (OPLS-DA) of treatment x variety groups, predicting variables that maximally separate groups, and related canonical discriminant function scores and significance.

| | Canonical correlation | | | | |
|---|---|---|---|---|---|
| Variables | Function 1 | Function 2 | Function 3 | Wilks's lambda | Sig. |
| Ψstem | 0.989 | | | 0.002 | 0.025 |
| FuncPSII | | | | | |
| CHL | | | | | |
| NBI | | 0.881 | | 0.090 | 0.050 |
| gs | | | | | |
| T | | | | | |
| Tleaf | | | | | |
| WSE | | | | | |
| QDIo | | | | | |
| RCQA | | | | | |
| FLA | | | 0.771 | 0.405 | 0.735 |
| ANT | | | | | |
| Pn | | | | | |
| QEo | | | | | |
| WUEi | | | | | |

TABLE S5
Matrix scores of multi-factor analysis structure of the whole dataset and of the treatments and cultivars in separated groups. Correlations lower than 0.100 were not considered in the matrix.

| | Whole dataset | | Control | | -UV | | Bovale grande | | Cannonau | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variables | Factor 1 | Factor 2 | Factor 1 | Factor 2 | Factor 1 | Factor 2 | Factor 1 | Factor 2 | Factor 1 | Factor 2 |
| QPo | 0.970 | | -0.920 | 0.104 | 0.967 | 0.302 | 0.975 | 0.192 | 0.945 | |
| QDIo | -0.970 | | 0.919 | -0.105 | -0.967 | -0.302 | -0.975 | -0.193 | -0.945 | |
| WSE | 0.931 | | -0.894 | | 0.954 | 0.176 | 0.934 | 0.138 | 0.949 | -0.137 |
| FuncPSII | 0.856 | -0.177 | -0.841 | | 0.898 | | 0.862 | | 0.889 | -0.296 |
| RCQA | 0.714 | 0.140 | -0.656 | 0.324 | 0.645 | 0.379 | 0.607 | 0.255 | 0.878 | |
| QEo | 0.657 | 0.269 | -0.655 | 0.547 | 0.585 | 0.456 | 0.490 | 0.325 | 0.857 | 0.139 |
| NBI | -0.631 | | | -0.892 | -0.847 | | -0.854 | -0.114 | -0.477 | -0.118 |
| Stem | 0.425 | 0.251 | 0.257 | 0.832 | | 0.431 | 0.800 | 0.379 | 0.387 | 0.299 |
| ANT | 0.418 | | 0.238 | 0.958 | 0.735 | -0.294 | 0.664 | -0.120 | 0.381 | 0.326 |
| Pn | 0.116 | 0.965 | 0.765 | 0.263 | 0.255 | 0.931 | 0.188 | 0.960 | | 0.920 |
| T | 0.125 | 0.920 | 0.776 | 0.558 | 0.212 | 0.962 | 0.291 | 0.840 | | 0.948 |
| gs | | 0.912 | 0.845 | 0.269 | 0.133 | 0.948 | 0.172 | 0.875 | | 0.957 |
| Tleaf | | -0.755 | -0.657 | -0.387 | | -0.720 | | -0.835 | | -0.827 |
| WUEi | 0.177 | 0.711 | 0.524 | 0.162 | 0.314 | 0.749 | 0.235 | 0.809 | | 0.761 |
| FLA | 0.450 | 0.605 | | 0.722 | 0.581 | 0.671 | 0.709 | 0.615 | | 0.835 |
| CHL | -0.251 | 0.336 | | -0.685 | -0.296 | 0.849 | | 0.922 | -0.478 | 0.376 |

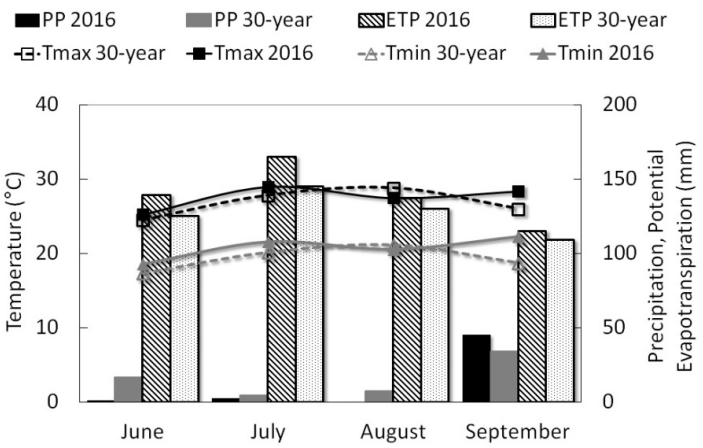


FIGURE S1
Monthly average meteorological conditions over the 2016 experimental season and average climatic conditions (1971 to 2000) in Capo Frasca, Sardinia, Italy (Aeronautica Militare, 2017).

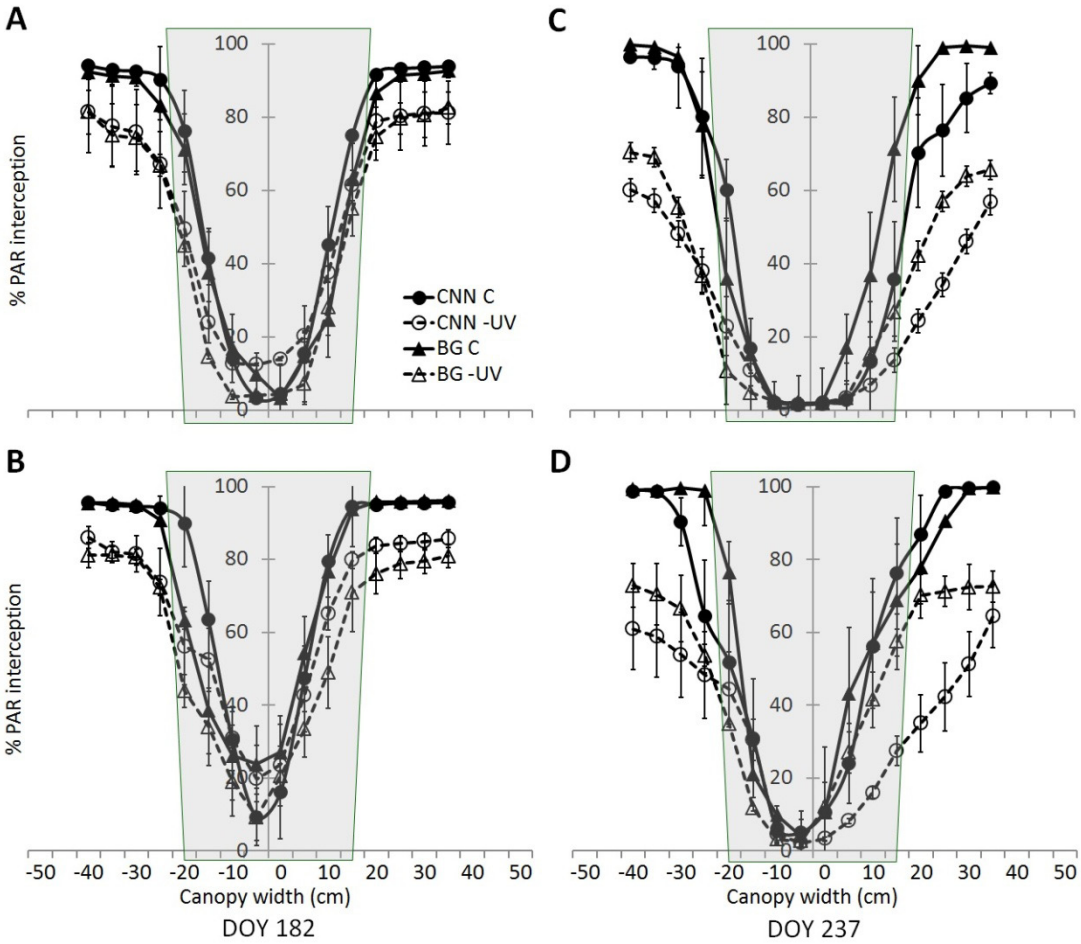


FIGURE S2
Transversal profiles of photosynthetically active radiation (PAR) intercepted by the canopy (% reference PAR), at cluster level (A and C) and in the mid-vegetation layer (B and D), in Bovale grande (BG) and Cannonau (CNN) plants outside (Control, C) and inside the UV-screening filter (−UV) at midday, on days with clear skies (BBCH stages 75 and 85) in the experimental season. Results are the means of seven replicates ± SE.

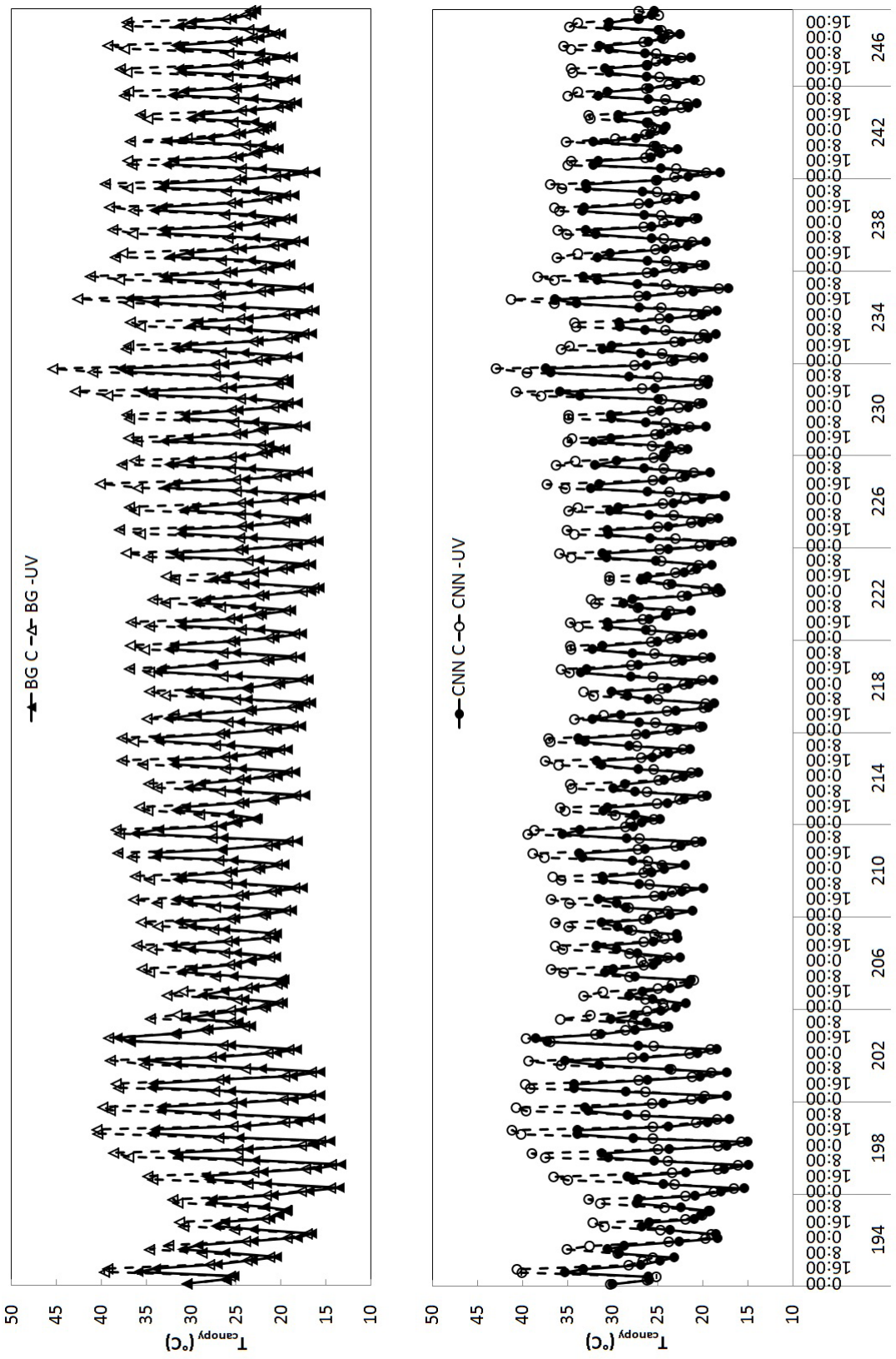


FIGURE S3
Canopy temperature (°C) during the experimental season in Bovale grande (BG) and Cannonau (CNN) plants outside (Control, C) and inside the UV-screening filter (–UV). Results are the mean of three replicates ± SE.