**Supporting information**

**The Impact of Scoria-Filled Aeration Trenches on the N-cycle and Greenhouse Gases Emissions from a Clayey Soil**

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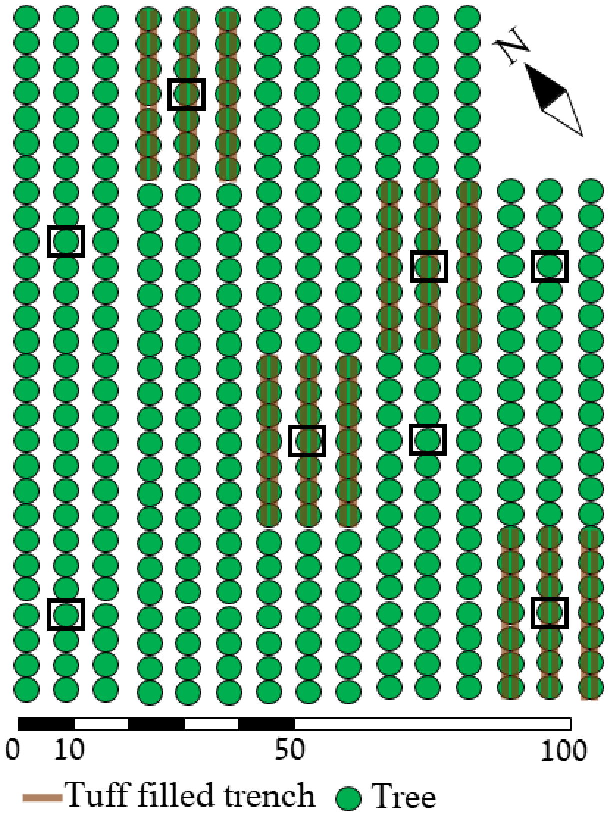


**Fig. SI1.** A schematic representation of the orchard. Gas, water content and porewater measuring sites are presented by rectangles.

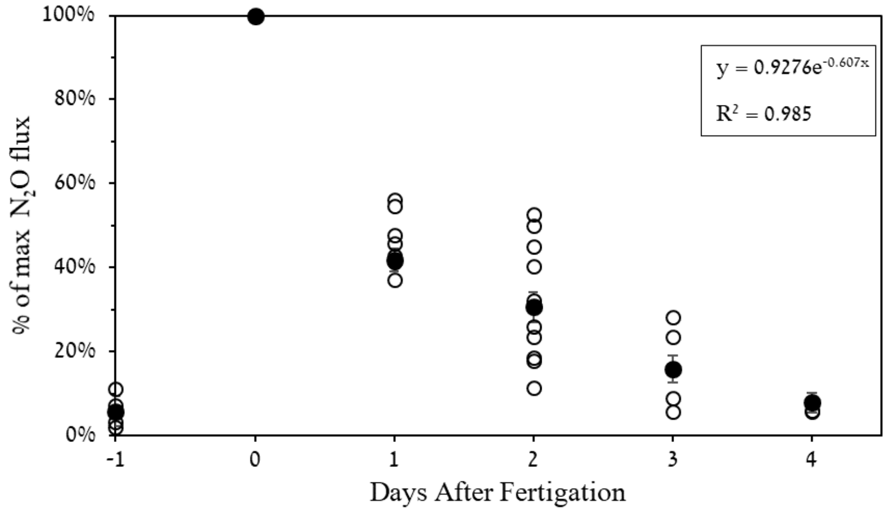


**Fig. SI2.** Trend of $N_2O$ fluxes in the days following N applications (fertigation loads of 225 – 360 kg-N $ha^{-1}$) in drip irrigation, as reported in the literature and measured in this study (hollow circles). Average values are presented by the full circles with vertical lines representing the standard deviations. Zero (0) represents the day of N application. "y," and $R^2$ represents the exponential decay (days 0 – 4), and its coefficient of determination. (Data taken from: Alsina et al., 2013; Baram et al., 2018; Garland et al., 2011; Kennedy et al., 2013; Schellenberg et al., 2012; Wolff et al., 2017; Zhang et al., 2016).

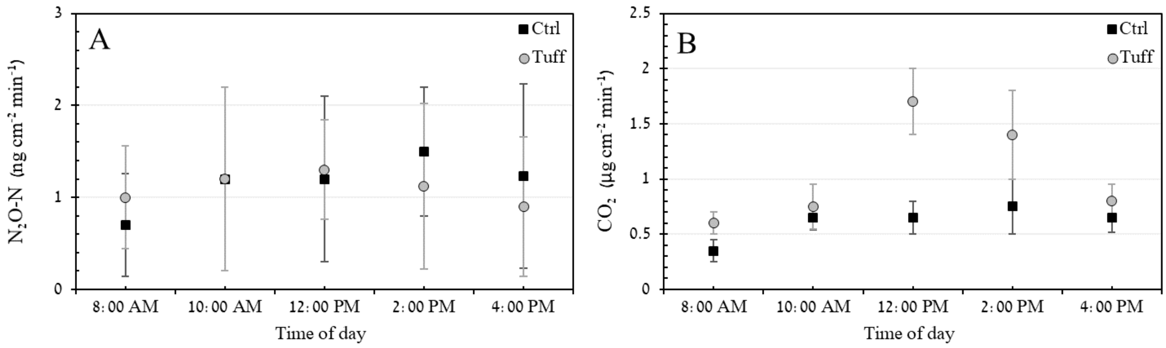


**Fig SI3.** Daily trend of (a) nitrous oxide ($N_2O$) and (B) carbon dioxide ($CO_2$) fluxes during the fertigation season. Each point represents an average of four readings, where vertical lines represent the standard deviation.

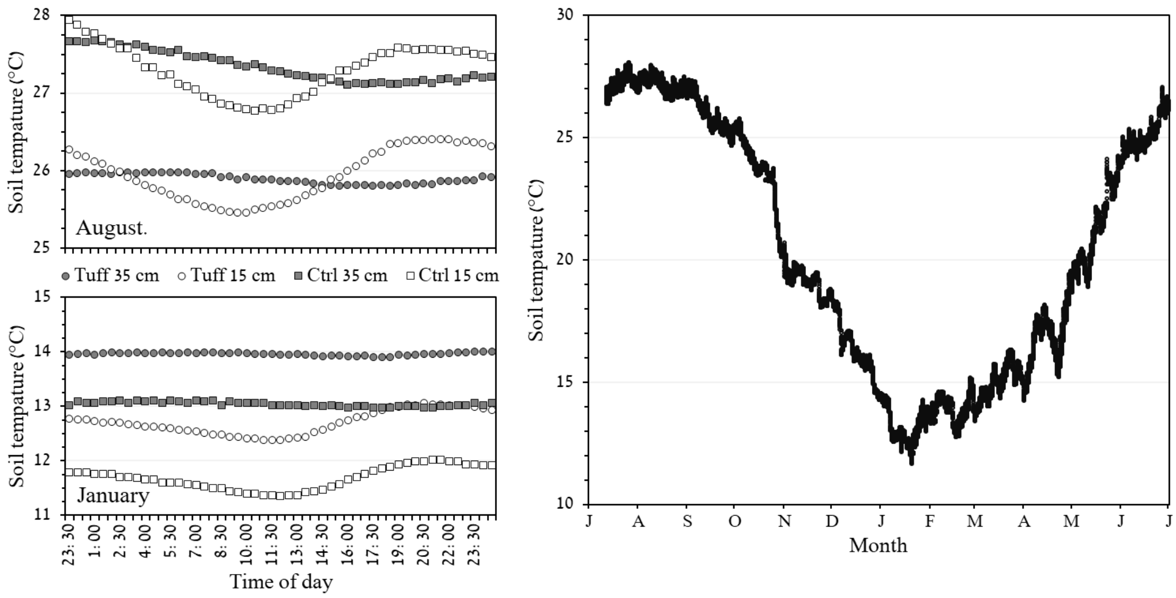


**Fig. SI4.** (Left) Daily dynamics of soil temperatures measured at depths of 15 and 35 cm during the summer (top) and winter (bottom). (Right) Seasonal dynamics of average hourly measurements of soil temperatures (15 – 35 cm depth).

**Table SI1.** Chemical composition of the TWW used for irrigation

| pH | EC | TSS | COD | BOD | $Cl^-$ | $NO_3^-$-N | $NH_4^+$-N |
|---|---|---|---|---|---|---|---|
| | mS $cm^{-1}$ | ------------------------------- mg $L^{-1}$------------------------------- | | | | | |
| 8.4±0.3 | 1.5±0.3 | 12±3 | 37±8 | 7.2±2 | 210±10 | ±14 | 6.1±2 |

**Table SI2.** Physicochemical characteristics of the clay soil at the study site

| Sand | Silt | Clay | Lime | TOC[a] | CEC[b] | EC[c] | pH |
|---|---|---|---|---|---|---|---|
| -------------------(kg $kg^{-1}$)-------------------- | | | | | (meq/100g) | dS $m^{-1}$ | |
| 0.23 | 0.19 | 0.58 | 0.1 – 0.24 | 0.025 | 30 - 35 | 0.40 | 7.5 |

[a]Total organic carbon; [b]Cation exchange capacity; [c]Electrical conductivity based on Baram et al. (Baram et al., 2021)

**Table SI3.** Average carbon dioxide ($CO_2$) and nitrous oxide ($N_2O$) fluxes, measured for the two treatments during the fertigation seasons and winters, and the corresponding t-tests p-values.

| | | Fert. 2018 | Winter 2018-2019 | Fert. 2019 | Winter 2019-2020 | Fert. 2020 |
|---|---|---|---|---|---|---|
| $CO_2$ flux ($\mu g\ cm^{-2}\ min^{-1}$) | Tuff | 1.9±1.6 | 2.3±1.1 | 8.1±2.6 | 1.5±0.2 | 2.8±2.0 |
| | Ctrl | 0.5±0.4 | 5.2±3.0 | 5.2±1.7 | 2.2±3.4 | 2.1±1.5 |
| p | | 0.017 | 0.065 | 0.003 | 0.690 | 0.415 |
| $N_2O$-N flux ($ng\ cm^{-2}\ min^{-1}$) | Tuff | 0.8±0.5 | 1.3±2.2 | 3.5±2.1 | 2.4±2.3 | 3.3±1.3 |
| | Ctrl | 0.5±0.2 | 0.4±0.4 | 4.6±4.2 | 0.5±0.4 | 2.1±2.6 |
| p | | 0.071 | 0.351 | 0.397 | 0.102 | 0.288 |

**Table SI4.** Nitrogen mass balance and $N_2O$ emission factors for each fertigation and winter season.

| | Tuff | | | Control | | |
|---|---|---|---|---|---|---|
| | Applied N load ($kg\ ha^{-1}$) | $N_2O$-N emission ($kg\ ha^{-1}$) | Emission factor | Applied N load ($kg\ ha^{-1}$) | $N_2O$-N emission ($kg\ ha^{-1}$) | Emission factor |
| Fertigation 2018[a] | 300 | 0.68 | 0.23% | 257 | 0.38 | 0.15% |
| Winter 2018-2019 | 0 | 0.84 | 0.28%[c] | 0 | 0.49 | 0.19%[c] |
| Total 2018 | 300 | 1.51 | 0.50% | 257 | 0.87 | 0.34% |
| Fertigation 2019 | 300 | 4.12 | 1.37% | 300 | 3.51 | 1.17% |
| winter 2019-2020 | 0 | 1.42 | 0.47%[c] | 0 | 0.85 | 0.28%[c] |
| Total 2018 | 300 | 5.54 | 1.85% | 300 | 4.36 | 1.45% |
| Fertigation 2020[b] | 120 | 1.84 | 1.53% | 120 | 1.81 | 1.51% |

[a] June – November 2018; [b] April – June 2020; [c] relative to the N application load during the preceding fertigation season.

**Table SI5.** Cumulative carbon dioxide ($CO_2$) emission for each fertigation and winter season.

| Treatment | Fertigation 2018 | winter 2018 - 2019 | Fertigation 2019 | winter 2019 - 2020 | Fertigation 2020 |
|---|---|---|---|---|---|
| | | | Ton-$CO_2$ $ha^{-1}$ | | |
| Control | 2.36 | 1.72 | 8.25 | 0.42 | 1.63 |
| Tuff | 4.32 | 0.71 | 13.4 | 0.57 | 2.56 |

**Table SI6.** Coefficients of determination ($R^2$) of the linear correlation between all the field-measured parameters under the Tuff and the control treatments.

| | Tuff | | | | Control | | | |
|---|---|---|---|---|---|---|---|---|
| | $NH_4^+$-N | $NO_3^-$-N | $NO_2^-$-N | $N_2O$-N | $NH_4^+$-N | $NO_3^-$-N | $NO_2^-$-N | $N_2O$-N |
| $NO_3^-$-N | 0.03 | | | | $0.56^{**}$ | | | |
| $NO_2^-$-N | 0.02 | 0.01 | | | 0.01 | 0.05 | | |
| $N_2O$-N | 0.03 | $0.15^{*}$ | 0.06 | | 0.05 | 0.09 | 0.008 | |
| $CO_2$ | 0.01 | $0.19^{*}$ | 0.04 | $0.4^{**}$ | $0.18^{*}$ | $0.21^{*}$ | 0.034 | 0.1 |

$^{*}$ $p < 0.05$, $^{**}$ $p < 0.01$

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