Interaction of northern root-knot nematode with *Fusarium oxysporum* f. sp. *fragariae* race 1

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Fusarium wilt of strawberry is a widespread disease across all strawberry growing districts of California. *Fw1* major gene resistance has been integrated into many strawberry cultivars and is an important disease management tool for growers. Northern root-knot nematode (*Meloidogyne hapla;* N-RKN) has been detected in Cal Poly Strawberry Center's diagnostic service since 2022 (n = 4, 8, 6, 10, and 8 in 2022, 2023, 2024, 2025, and 2026, respectively) and in our district-wide root disease surveys. In other crops, soilborne pathogens have shown to interact with *Meloidogyne* spp. and exacerbate the disease or break resistance to fungal pathogens including *Fusarium* and *Verticillium.* The objective of this study was to assess the interaction between *Fusarium oxysporum* f. sp. *fragariae* race 1 (*Fof*) and *M. hapla* in a resistant (San Andreas) and a susceptible (Monterey) cultivar to *Fof* in a greenhouse experiment. For three months, N-RKN was reared on 'Large Red' cherry tomato planted in infested soil collected from strawberry ranches in the Santa Maria district. N-RKN eggs were extracted from infected tomato plants. *Fof* inoculum was prepared in Kerr's broth and adjusted to 5×10^6/spores mL^{-1}. The experiment was set up as a randomized complete block design with four treatments: (1) an untreated control (UTC), (2) soil inoculated with 20 N-RKN eggs/g soil (N-RKN), (3) inoculated soil with 5×10^6 spores/ml of *Fof* race 1 (*Fof*; root-dip inoculation), and (4) co-inoculated soil with 5×10^6/spores mL^{-1} *Fof* spores and 20 N-RKN eggs/g soil (N-RKN+ *Fof*) with six replicates. After three months of plant growth, the experiment was harvested, plant weight, *Fof* DNA quantity in crown tissue, and N-RKN eggs in root tissue were assessed.

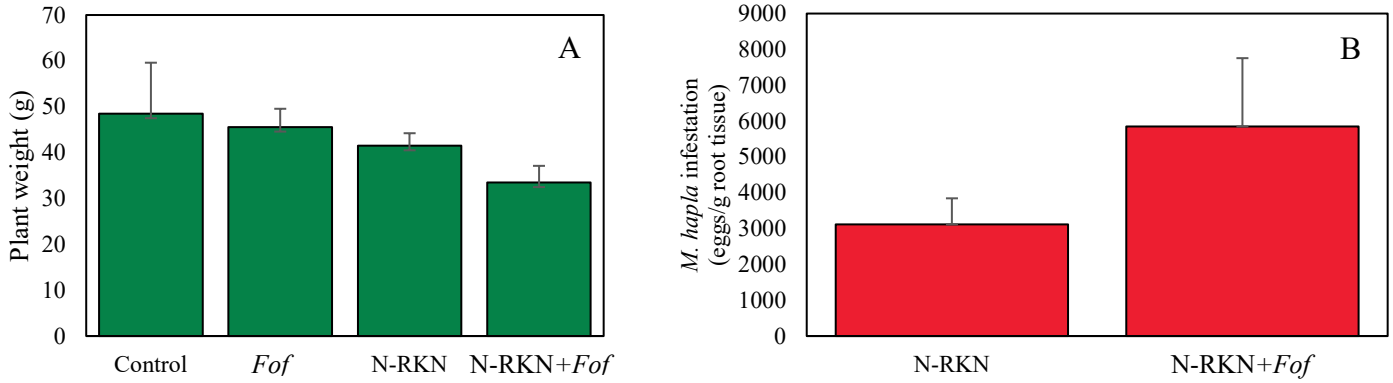


Figure 1. A) Mean plant weight of 'San Andreas' strawberry plants three months after inoculation in trial 1. Mean plant weight of treatments did not differ significantly based one-way ANOVA ($P = 0.5947$). **B)** Mean N-RKN eggs/g root tissue three months after inoculation in trial 1. Mean *M. hapla* eggs/g root tissue between treatments did not differ significantly based on one-way ANOVA ($P = 0.1061$). Control = non-inoculated control; *Fof* = *Fusarium oxysporum* f. sp. *fragariae* race 1 (*Fof*) spores root dip; N-RKN = northern root-knot nematode inoculation at 20 eggs/g soil; N-RKN+*Fof* = combined treatments (N-RKN+*Fof*). Error bars represent ± SE with n = 6.

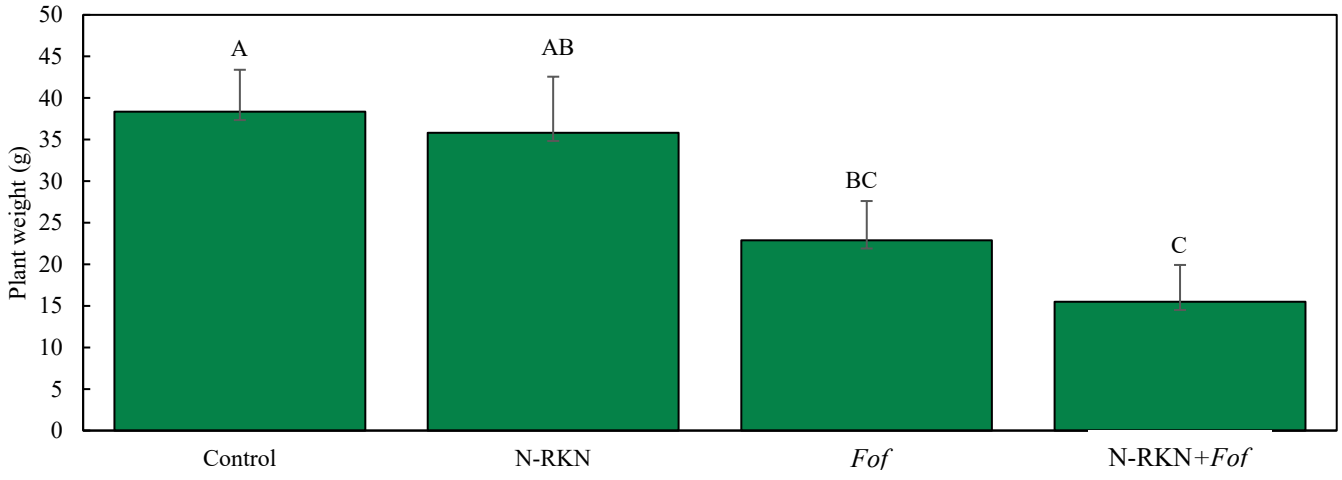


Figure 2. Mean plant weight three months after inoculation in trial 2 across 'Monterey and 'San Andreas' (no significant interaction between cultivar and treatment ($P = 0.418$). Treatment had a significant effect on plant weight based on two-away ANOVA performed on log-transformed data ($P = 0.0005$). Different letters indicate significant differences among treatments based on Tukey HSD post hoc test. Control = non-inoculated control; *Fof* = *Fusarium oxysporum* f. sp. *fragariae* race 1 (*Fof*) spores root dip; N-RKN = northern root-knot nematode inoculation at 20 eggs/g soil; N-RKN+*Fof* = combined treatments (N-RKN+*Fof*). Error bars represent ± SE with n = 6.