

ONION (*Allium cepa*, proprietary Walla Walla Sweet cultivar)  
Pink root; *Setophoma terrestris*  
White rot; *Sclerotium cepivorum*  
Host response; mycorrhizal colonization

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### **Effects of Mykos Gold Granular, an arbuscular mycorrhizal fungi inoculant, on pink root, white rot, and crop growth in spring- and fall-planted sweet onion crops near Walla Walla, WA, 2017-2018.**

Symbiotic arbuscular mycorrhizal fungi (AMF) form associations with most plant species. Under some conditions, AMF can help the host plant mine the soil for immobile nutrients and water, and resist some soilborne diseases. Utilizing AMF inoculants to enhance onion crop performance is of particular interest because of the sparse, unbranched root system of onion plants. In this study, the AMF inoculant Mykos Gold Granular (RTI-Ag, Gilroy, CA) was evaluated alongside a non-inoculated control treatment in each of three commercial, direct-seeded sweet onion crops near Walla Walla, WA, to determine the potential effects of the inoculant on crop growth and soilborne diseases. One trial was set up in a spring-planted bulb crop in 2017 (spring trial), and the other trial was set up in each of two fall-planted, over-wintered crops in 2017-2018 (fall trial). In both trials pink root and white rot were of interest to the grower, although white rot usually is more severe in fall-planted bulb crops in this region. The direct-seeded spring crop was planted on 3 Apr 2017 with non-treated seed of a proprietary Walla Walla sweet cultivar, irrigated by wheel-line, and managed with standard production practices for this region. Mykos Gold Granular was applied at 4 lb/acre, mixed with the granular insecticide Lorsban (40.2% chlorpyrifos, applied at 3 lb/acre), in-furrow at seeding from Gandy boxes mounted on the planter. There were seven replicate plots of the two treatments, arranged in a randomized complete block design. The AMF inoculant was applied to one bed planted with a double-row of onions, extending the length of the field (~500 ft), and the adjacent non-inoculated bed served as the control treatment for that replicate block. All non-inoculated (control) beds were treated with Lorsban at the grower's standard rate of 7 lb/acre. Onion stand counts were measured in a 10-ft section of double row of each plot on 4 May, when seedlings each had one true leaf. On 15 Jun, roots from five onion plants per plot were stained according to Verheilig et al. (1998) to quantify AMF colonization microscopically (5× to 20× magnification) using a modified gridline intersection method (Giovannetti and Mosse 1980). Leaf length (from basal plate to tip of the longest leaf) was measured on the same five plants, following which the bulb and leaves of each plant were dried and weighed for biomass. On 31 Jul, all bulbs from a 10-ft section of double-row per plot were dug manually, the roots washed in buckets of water, and severity of pink root evaluated (percentage of symptomatic roots per plant, averaged for all plants harvested per plot). White rot was not observed in the spring-planted trial. Following removal of the top foliage 2 in. above each bulb, the bulbs were weighed and sized for yield measurement. The fall-planted trial was set up in each of two fields with a history of white rot on 7 Sep 2017, and irrigated with sprinkler hand-lines. Each fall-planted field had the same experimental design and treatment application method as the spring-planted trial, except eight replicate blocks were used for measuring crop variables in each trial instead of seven. Stand counts were measured on 26 Sep in Field 1, and 2 Oct in Field 2. Plants were dug for disease evaluations on 23 May 2018. The field was harvested in Jul 2018 by the grower. Observations were made using the same methods as in the spring-planted trial except that: i) bulbs dug on 23 May were assessed for incidence of white rot (percentage of plants infected out of all plants harvested in each plot) in addition to severity of pink root; ii) following biomass measurement, dried bulbs and leaves were submitted to Soiltest Farm Consultants (Moses Lake, WA) for foliar nutrient analysis; iii) bulb yield and AMF root colonization data were not collected. All data were subjected to analysis of variance (ANOVA) in R version 3.3.1. Visual examination of data distributions and the Shapiro-Wilk test of model residuals were used to check suitability of the data for parametric analyses.

For the 2017 spring-planted trial, AMF colonization of onion roots was significantly greater in plots inoculated with Mykos Gold Granular than in control plots (70 vs. 59%,  $p = 0.014$ ). Using a threshold of  $p = 0.05$ , treatment means were not significantly different for any other variable. However, the trend for greater yield of jumbo bulbs in AMF-inoculated plots than control plots (25 vs. 20 jumbo bulbs per 5 ft of bed) was associated with a  $p = 0.140$ , i.e., this difference is very likely to have been an effect of the Mykos Gold Granular treatment. Pink root was mild in the spring-planted trial (7-8% severity). For the 2017-18 fall-planted trial, onion stand counts were significantly greater in the AMF-inoculated plots (49 vs. 45 plants per 10 ft of double row,  $p = 0.004$ ). The incidence of white rot was very limited (6-7% per plot), as was the severity of pink root (7-8% per bulb), neither of which were affected significantly by the Mykos Gold Granular application. Although foliar nutrient concentrations tended to be slightly greater in the AMF-inoculated plots, the differences were not significant statistically. Based on an increase in number and weight of jumbo bulbs in AMF-treated plots in the spring-planted trial, and an increase in stand counts in the fall-planted trial, results from this study suggest that the AMF inoculant Mykos Gold Granular potentially could add some benefit to onion production under the conditions and practices of the farm where this study was completed. This contrasts with previous research showing limited or no benefit of AMF inoculants in onion crops in the neighboring Columbia Basin. The AMF inoculant may have had more benefit in this Walla Walla study for one or both of the following reasons: i) the grower planted non-treated seed (fungicides in onion seed treatments used widely in the Columbia Basin can affect AMF adversely), and ii) the relatively low soil phosphorus (20-25 ppm) levels in these fields compared to fields in the Columbia Basin (40-80 ppm P). In one study, onion root colonization by AMF dropped 75% when soil P

was increased from 18 to 80 ppm (Henrichs et al. 2017). Disease pressure was insufficient to assess the potential of Mykos Gold Granular for suppressing white rot and pink root in this study.

| Trial and onion crop attribute                           | Control             | Mykos Gold Granular | Pr > F <sup>y</sup> |
|--|---------------------|---------------------|---------------------|
| 2017 spring-planted trial                                |                     |                     |                     |
| Stand count on 4 May (plants per 10 feet of double-row)  | 88 ± 2 <sup>z</sup> | 89 ± 3              | 0.537               |
| Leaf length (in.)  | 16.96 ± 0.44        | 16.10 ± 0.69        | 0.321               |
| Biomass (oz dry weight)                                  | 0.225 ± 0.019       | 0.208 ± 0.025       | 0.608               |
| AMF root colonization (%)                                | <b>59 ± 2</b>       | <b>70 ± 4</b>       | <b>0.014</b>        |
| Severity of pink root (%)                                | 8 ± 1               | 7 ± 1               | 0.698               |
| Weight of colossal bulbs (lb per 5 feet of double-row)   | 0.5 ± 0.2           | 0.3 ± 0.2           | NA                  |
| Weight of jumbo bulbs (lb per 5 feet of double-row)      | 13.3 ± 1.1          | 15.6 ± 1.0          | 0.273               |
| Weight of medium bulbs (lb per 5 feet of double-row)     | 4.1 ± 0.3           | 4.5 ± 0.8           | 0.731               |
| Weight of pre-pack bulbs (lb per 5 feet of double-row)   | 0.3 ± 0.1           | 0.2 ± 0.1           | 0.390               |
| Weight of rejected bulbs (lb per 5 feet of double-row)   | 1.6 ± 0.4           | 1.5 ± 0.4           | 0.899               |
| Weight of marketable bulbs (lb per 5 feet of double-row) | 18.2 ± 1.1          | 20.8 ± 1.3          | 0.272               |
| Number of colossal bulbs (per 5 feet of double-row)      | 1 ± 0               | 0 ± 0               | NA                  |
| Number of jumbo bulbs (per 5 feet of double-row)         | 20 ± 2              | 25 ± 1              | 0.140               |
| Number of medium bulbs (per 5 feet of double-row)        | 13 ± 1              | 13 ± 2              | 0.773               |
| Number of pre-pack bulbs (per 5 feet of double-row)      | 2 ± 1               | 2 ± 1               | 0.611               |
| Number of rejected bulbs (per 5 feet of double-row)      | 2 ± 1               | 2 ± 1               | 1.000               |
| Number of marketable bulbs (per 5 feet of double-row)    | 35 ± 2              | 40 ± 3              | 0.209               |
| 2017-18 fall-planted trial                               |                     |                     |                     |
| Stand count (plants per 10 ft of double-row)             | <b>45 ± 1</b>       | <b>49 ± 1</b>       | <b>0.004</b>        |
| White rot incidence (% of plants affected)               | 7 ± 3               | 6 ± 3               | 0.837               |
| Pink root severity (% of roots symptomatic/bulb)         | 7 ± 1               | 8 ± 1               | 0.702               |
| Foliar N (%)   | 2.98 ± 0.26         | 3.12 ± 0.27         | 0.235               |
| Foliar P (%)   | 0.51 ± 0.05         | 0.50 ± 0.05         | 0.758               |
| Foliar K (%)   | 3.20 ± 0.20         | 3.32 ± 0.22         | 0.390               |
| Foliar Ca (%)  | 1.16 ± 0.07         | 1.21 ± 0.07         | 0.338               |
| Foliar Mg (%)  | 0.36 ± 0.02         | 0.37 ± 0.02         | 0.579               |
| Foliar Na (ppm)  | 0.06 ± 0.00         | 0.06 ± 0.01         | 0.115               |
| Foliar S (%) <sup>x</sup>                                | 0.20 ± 0.01         | 0.21 ± 0.02         | 0.156               |
| Foliar Zn (ppm)  | 29.3 ± 1.4          | 32.3 ± 2.9          | 0.762               |
| Foliar Fe (ppm)  | 908 ± 240           | 629 ± 114           | 0.151               |
| Foliar Mn (ppm) <sup>x</sup>                             | 61.4 ± 4.6          | 59.2 ± 1.9          | 0.371               |
| Foliar Cu (ppm)  | 21 ± 5              | 20 ± 4              | 0.365               |
| Foliar B (ppm)   | 31.8 ± 1.5          | 31.3 ± 1.8          | 0.760               |

<sup>z</sup> Each value is the mean ± standard error of six to eight replicate plots in the trial. For the spring-planted trial, most attributes were measured in six replicate plots except onion stand count, plant height, and biomass, which were measured in seven replicate plots. For the fall-planted trial, attributes were measured in eight replicate plots except foliar nutrient concentrations, which were measured from six replicate plots.

<sup>y</sup> Probability that the observed difference between treatment means is random. For those variables significant at  $p \leq 0.05$ , treatment means are highlighted in bold font. Variables for which most values were zero are marked “NA”, indicating “not analyzed” statistically.

<sup>x</sup> Square-transformed to meet assumptions for parametric analysis.