

APPLE (*Malus domestica* 'Rome')
Powdery Mildew; *Podosphaera leucotricha*
Scab; *Venturia inaequalis*

J. W. Pscheidt, B. Warneke, N. DiManno
and J. A. Whitney
Dept. of Botany and Plant Pathology
Oregon State University
Corvallis, OR 97331

Evaluation of soil injected fungicide for management of apple diseases, 2022-2023.

This trial was conducted at the Botany and Plant Pathology Field Laboratory in an apple orchard planted on a Camas gravelly sandy loam soil type. Fungicide treatments were arranged in a randomized complete block design in a block of 'Rome' apples on M-7 rootstock planted in 1979 on 20 x 20 ft spacing. Each treatment consisted of 5 single tree replicates. The diameter of trees 8 inches above ground was determined 25 Oct 2022. The fungicide RTSA 505 was injected into the soil around trees using an HTI 2000 Soil Injector connected to a Maruyama MS75 backpack power sprayer. The nozzle end of the injector was inserted 4 inches into the soil prior to horizontal injection of the fungicide solution. The amount of fungicide solution injected was based on the diameter of each tree where 250 ml of solution was injected per inch diameter. For example, 11 separate injection sites were evenly distributed within the drip zone of a tree 11 inches in diameter. Fall injections occurred on 8 Nov 2022 (leaves still on tree) and spring injections occurred 27 Apr 2023 (green tip) and 11 May 2023 (full bloom). The fungicide solution emerged from about half the injection sites (through cracks and earthworm middens) during application and puddled on the ground before subsequently absorbing. Due to dry conditions, a supplemental irrigation of between 0.25 and 0.5 inches water was applied on 16 May with low angle sprinkler heads that do not wet the canopy. The fungicide Banner Maxx II was foliar applied using a hydraulic handgun sprayer at 100 psi, such that 4.5 to 6 gal of a spray suspension was applied per 5 trees (122 to 163 gal water/A), depending on the amount of foliage present. Foliar sprays were applied on 27 Apr (green tip), 11 May (full bloom), 25 May (fruit set), 8 Jun (2nd cover) and 23 Jun (3rd cover). Trees were pruned late Feb 2023. No fertilizer was spread within tree rows. A delayed dormant oil spray of Omni supreme-oil (2.0 gal/A) was applied on 12 Apr for aphid management. Insecticide sprays were applied to the entire block using a Rear's air blast sprayer. Glystar Plus (5.23 oz/gal) and Galligan 2e (2 pts/A) were applied on 1 Mar for weed control using a Rear's 100g boom sprayer. Apple scab infection periods were monitored using a Meter ATMOS 41 All-In-One weather station equipped with standard sensors and a ZL6 data logger. Using a modified primary infection model for apple scab (wet periods start with rain and end with 8 hr drying time), a total of 4 infection periods were detected from Apr through Jun: 2 high risk infection periods (5 and 20 Apr), 1 moderate risk infection period (9 Apr) and 1 low risk infection period (31 Mar). The incidence of scab and powdery mildew on leaves was determined on 10 Jul, by examining all leaves from 20 arbitrarily selected vegetative shoots (190 to 240 leaves for an average of 223) from each tree. Incidence of fruit russet and scab was determined on 28 Aug by examining 100 fruit arbitrarily selected from each tree. To evaluate possible plant growth regulation effects, the height and width of fruit was determined on 29 Aug by examining 50 fruit arbitrarily selected from each tree.

Rainfall during the dormant season (Oct 2022 to March 2023) was 3.18 inches below normal. Spring weather conditions were normal to dry in April and first week of May but then became very dry with little rainfall for the remainder of the season. Soil moisture was measured at 30% water content (29-32%) during both the fall and spring injections. Conditions throughout the spring were considered low risk for apple scab development but high risk for powdery mildew. Apple scab was first found on crabapple pollenizers in a nearby block on 17 Apr but not until June in this block.

Highest amount of apple scab on leaves was found on non-treated trees and was significantly higher than all fungicide treated trees (Table 1). Lowest amount of apple scab on leaves was found on trees treated with Banner Maxx II and was significantly lower than all other fungicide treated trees. Highest amount of apple scab on fruit was found on non-treated trees, however, it was not significantly different from scab found on trees treated with 10 ml RTSA 505 in the fall. Lowest amount of apple scab on fruit was found on trees treated with Banner Maxx II, however, it was not significantly different from fruit scab found on trees treated with 5 ml RTSA 505 at bud break. Shoots covered with powdery mildew due to infection the previous year were first observed on 15 May. Highest amount of powdery mildew was found on non-treated trees and was significantly higher than all fungicide treated trees (Table 2). Lowest amount of

powdery mildew was found on trees treated with Banner Maxx II and was significantly lower than all other fungicide treated trees. Highest amount of fruit russet was found on non-treated trees, however, it was not significantly different from that found on trees treated with 10 ml RTSA 505 in the fall. Lowest amount of fruit russet was found on trees treated with Banner Maxx II and was significantly lower than all other fungicide treated trees. Highest fruit diameter to height ratio was found on trees treated with Banner Maxx II, which was not significantly different from non-treated trees. Lowest fruit diameter to height ratio was found on trees treated with 5 ml RTSA 505 in the fall and at bud break, however, it was not significantly different from that found on trees treated with just 5 ml RTSA 505 at bud break or at bud break and 2 weeks later. Phytotoxicity was not observed on any treated trees.

Table 1. Leaves and fruit with apple scab.

Treatment & Rate/injection or /100 gal as indicated below	Time of Application*	Ave. Tree Diameter (inches)**	Apple Scab	
			Leaves (%)**	Fruit (%)**
Non-treated.....	None.....	11.0	18.3 a	5.6 a
RTSA 505 at 10 ml/injection.....	Fall.....	10.7	8.6 bc	4.6 a
RTSA 505 at 5 ml/injection.....	Fall and Bud Break	10.2	7.5 c	2.0 b
RTSA 505 at 5 ml/injection.....	Bud Break...	11.2	10.6 b	1.2 bc
RTSA 505 at 10 ml/injection.....	Bud Break...	10.8	8.1 bc	2.6 b
RTSA 505 at 5 ml/injection.....	Bud Break and 2 weeks later	11.8	9.1 bc	2.4 b
Banner Maxx II at 4 fl oz/100 gal.	All foliar apps	10.9	2.6 d	0.4 c

* Fall injections occurred on 8 Nov 2022 and spring injections occurred 27 Apr 2023 (green tip) and 11 May 2023 (full bloom). The fungicide Banner Maxx II was foliar applied on 27 Apr (green tip), 11 May (full bloom), 25 May (fruit set), 8 Jun (2nd cover) and 23 Jun (3rd cover).

**Means followed by the same letter do not differ significantly based on Fisher's protected LSD ($P \leq 0.05$). Means without letters were not significantly different.

Table 2. Leaves with powdery mildew, fruit russet and fruit diameter to height ratio.

Treatment & Rate/injection or /100 gal as indicated below	Time of Application ^X	Powdery Mildew Leaves (%) ^Y	Fruit Russet (%) ^Y	Fruit Diameter to Height Ratio ^{YZ}
Non-treated.....	None.....	85.7 a	47.8 a	1.11 ab
RTSA 505 at 10 ml/injection.....	Fall.....	70.0 c	45.0 a	---
RTSA 505 at 5 ml/injection.....	Fall and Bud Break	78.1 b	26.4 b	1.05 c
RTSA 505 at 5 ml/injection.....	Bud Break...	75.3 bc	21.6 c	1.09 bc
RTSA 505 at 10 ml/injection.....	Bud Break...	70.5 c	28.6 b	1.11 ab
RTSA 505 at 5 ml/injection.....	Bud Break and 2 weeks later	71.6 c	26.4 b	1.11 abc
Banner Maxx II at 4 fl oz/100 gal.	All foliar apps	32.4 d	15.0 d	1.16 a

^X Fall injections occurred on 8 Nov 2022 and spring injections occurred 27 Apr 2023 (green tip) and 11 May 2023 (full bloom). The fungicide Banner Maxx II was foliar applied on 27 Apr (green tip), 11 May (full bloom), 25 May (fruit set), 8 Jun (2nd cover) and 23 Jun (3rd cover).

^YMeans followed by the same letter do not differ significantly based on Fisher's protected LSD ($P \leq 0.05$). Means without letters were not significantly different.

^Z Data for fall injection with 10 ml RTSA 505 not included in analysis due to significantly smaller fruit.