Management of Pythium Leak

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Pythium ultimum is the principle causal agent of Pythium leak causing potato tuber rot in the Pacific Northwest (PNW). *P. ultimum* is a soilborne pathogen and is a type of water mold belonging to the Oomycete family. This pathogen is a generalist and is capable of infecting seeds and roots of a large number of crop plants, in addition to tubers. This pathogen is a rapid colonizer and can grow quickly through the soil. Pythium seed, seedling rot and tuber rot is commonly managed by treating seed or plants with products containing the active ingredient of metalaxyl or mefenoxam.

Internal tuber rot symptoms caused by the Pythium leak pathogen are characterized by the presence of black, gray and/or brown infected tuber tissue (Figure 1) that is immediately visible upon cutting open a tuber. The infected tissue normally forms a very distinct boundary between infected and healthy tissue. The infected tuber tissue easily expresses water when pressure is applied to the infected portion of the tuber. Pink rot is often mistaken for Pythium leak. The tissue of tubers infected with the pink rot pathogen, *Phytophthora erythroseptica*, has a boiled texture to it and turns pink after 20 to 30 minutes of exposure to the air after cutting. These two pathogens can often infect the same tubers and cause dual infections (Figure 2).

In the past, it was considered that *P. ultimum* required a wound for the pathogen to infect tubers, but recent evidence suggests that the pathogen is capable of infecting healthy tubers through lenticels (Figure 3). Management of *Pythium* has become more difficult in areas where the pathogen has developed resistance to metalaxyl. Isolates of metalaxyl-resistant *P. ultimum* (Figure 4) have been isolated from potato fields in Idaho, Oregon and Washington. The resistant isolates can grow on metalxyl-amended medium at 250 ppm. Concentrations of metalaxyl in plants is usually below 1 ppm. Approximately 1.4, 42.4, 32.7% of the potato fields surveyed in Idaho, Oregon and Washington, respectively, contain metalaxyl-resistant *P. ultimum*. In the fields where metalaxyl-resistance was detected, on average, the percentage of the *Pythium* population in the soil that was resistant was 5.6, 31.1, and 21% in Idaho, Oregon and Washington, respectively. So, even if metalaxyl-resistant isolates are detected in a grower's field, it doesn't mean the entire *Pythium* population is resistant. In about 85% of the fields in the PNW where resistance is detected, the metalaxyl-sensitive *Pythium* population is still predominant.

Growers often ask what can be done to protect potato tubers from Pythium leak and late blight tuber rot caused by *Phytophthora infestans*. To address this, field trials were conducted in Hermiston, OR and Paterson, WA to assess different products applied as foliar applications on their efficacy to manage Pythium leak and late blight tuber rot.

In the Paterson field trial, products were applied to the foliage two or three times at two week intervals beginning at flowering. The trial was planted in March, 2015. Ten different treatments (non-treated control; Resist57 @ 10 pints/A (2X); Resist57 @ 10 pints/A (3X);Resist @ 10 pints/A (2X); oxathiapiprolin @ 4.8 fl. oz/A (2X); Ranman @ 6.1 fl. oz./A (2X); Omega 500 F @ 8.0 fl. oz./A (2X); HeadsUp @ 3.34 oz wt/A (2X); Ridomil Gold Bravo SC @ 2.5 pints/A (2X) and Phostrol @ 10 pints/A (2X)) were evaluated using the cultivar Ranger Russet. Plots were organized in a randomized complete block design with four replications of each treatment. The tubers of the plants treated with these different products were then harvested. To determine the efficacy of the products in managing Pythium leak, the tubers were wounded and inoculated with *P. ultimum*. Tubers were cut in half longitudinally six days after inoculation and

the percent infected internal tissue was determined. To determine the efficacy of the products in managing tuber late blight, twenty tubers of each treatment were challenged inoculated with a US-24 strain of *P. infestans* and placed in storage at 50°F for one month. Tubers were then cut open and evaluated for the incidence of late blight tuber rot.

In the Hermiston field trial, two late season foliar applications of each product were applied, spaced at two week intervals, with the last foliar application applied two weeks prior to vine kill. The trial was planted in May, 2015. Six different treatments (non-treated control; Ridomil Gold Bravo SC @ 2.5 pints/A; Phostrol @ 10 pints/A; Ranman @ 6.1 fl. oz./A (2X); HeadsUp @ 3.34 oz wt/A; and oxathiapiprolin @ 4.8 fl. oz/A were evaluated for each of three cultivars, Ranger Russet, Russet Burbank and Umatilla Russet. Plots were organized in a randomized complete block design with four replications of each treatment. The tubers of the plants treated with these different products were then harvested, and the efficacy of the products in managing Pythium leak and late blight tuber rot were assessed as in the Paterson trial.

Research results: None of the products tested in the Paterson, WA or Hermiston, OR field research trials were effective in reducing the incidence of infection of tubers inoculated with the Pythium leak pathogen under our laboratory conditions, since there was 100% infection of tubers across all treatments. In addition, only one treatment, Ridomil Gold Bravo SC, from the Hermiston, OR field trial, significantly reduced the percentage of infected internal tuber tissue compared to the non-treated control, and this only happened in Russet Burbank tubers (Figures 5 and 6). In contrast, foliar applications of all phosphorous acid-based products (Resist57, Resist, and Phostrol) significantly reduced the incidence of late blight tuber rot infection compared to the non-treated control in the Paterson trial, with three foliar applications of Resist57 being the most effective treatment (Figure 7). The other products tested at the Paterson trial were not effective under the test conditions assessed in significantly reducing late blight tuber rot infection. Of the products tested at the Hermiston field trial, only Ridomil Gold Bravo SC and Phostrol significantly reduced the percent incidence of late blight tuber infection and the percentage of infected internal tuber tissue (Figures 8 and 9). The results from the Hermiston trial indicates that even late season applications of metalaxyl and phosphorous acid have the ability to help protect below ground tubers from infection and that it is effective across all three cultivars assessed, except for Phostrol applications for Ranger Russet. This research supports previous research conducted by Dennis Johnson, Washington State University, on the efficacy of multiple applications of phosphorous acid successfully managing tuber late blight.

Figure 1. Potato tubers infected by *Pythium ultimum* causing Pythium leak.

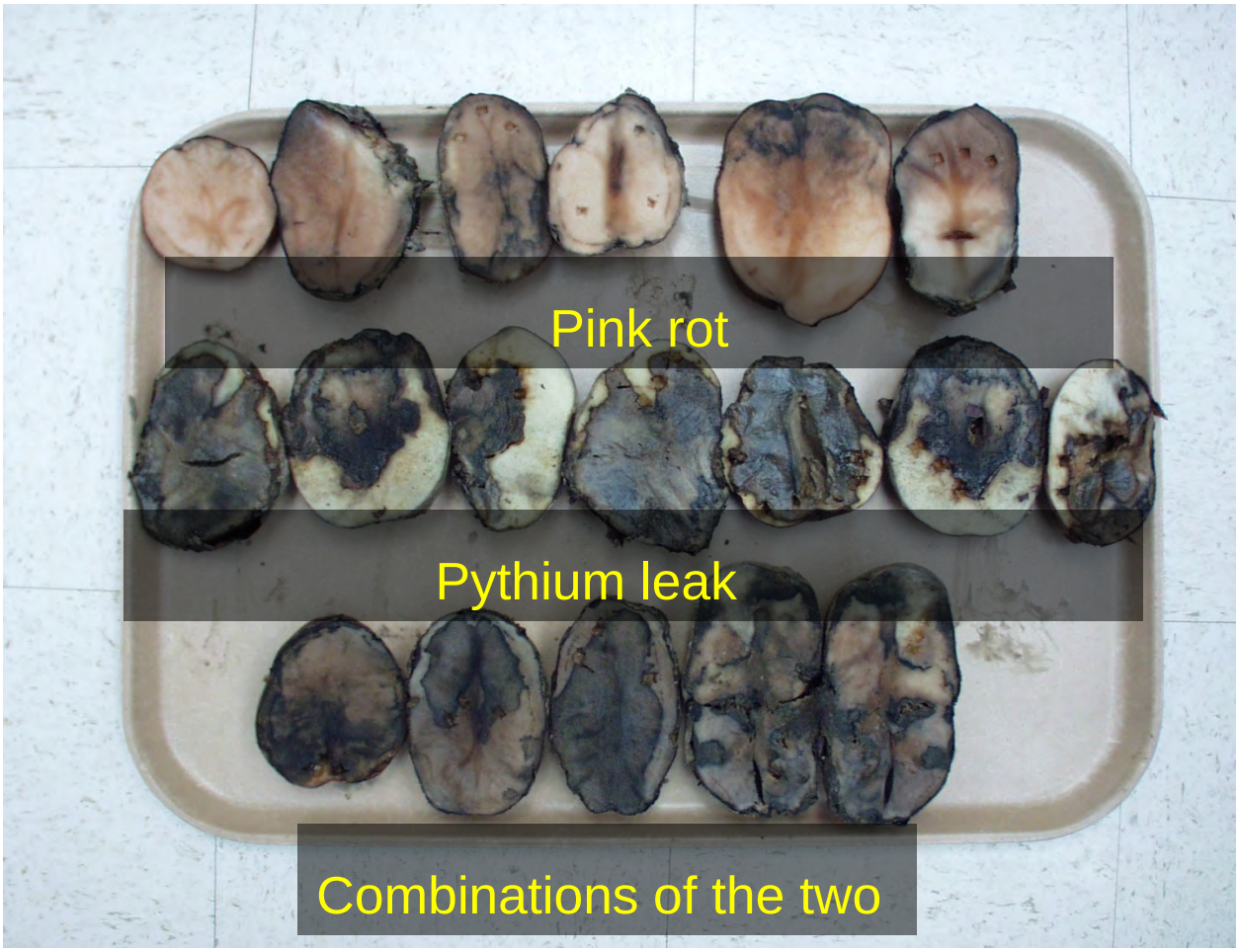

Figure 2. Picture showing infections caused by *Pythium ultimum* and *Phytophthora erythroseptica* causing Pythium leak and pink rot, respectively. Sometimes these pathogens can infect the same tubers, causing dual infections.


Figure 3. Lenticels infected by *Pythium ultimum.*

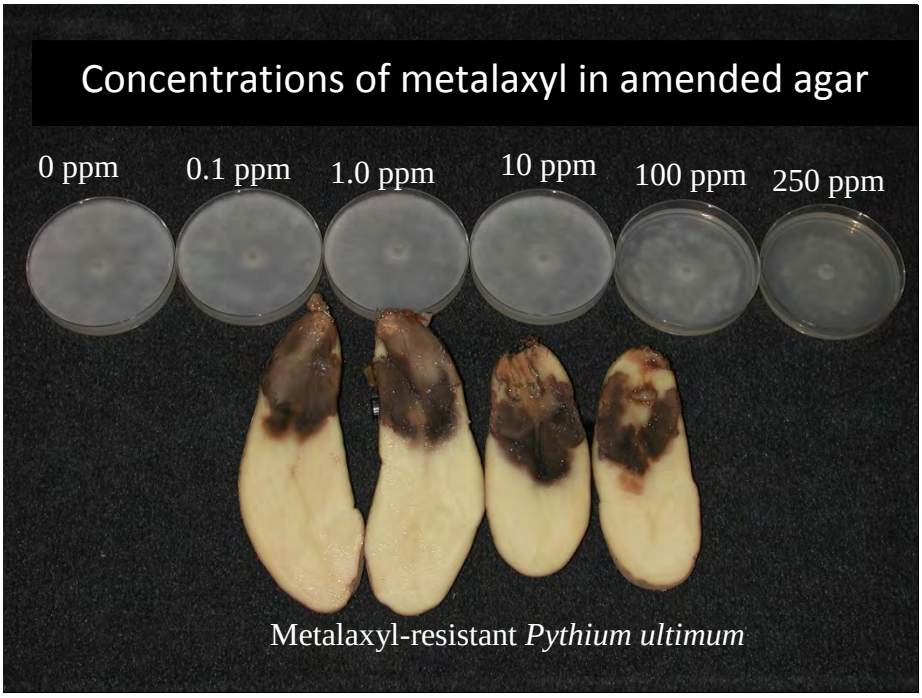

Figure 4. Metalaxyl-resistant *Pythium ultimum* growing on metalaxyl-amended agar up to 250 ppm.

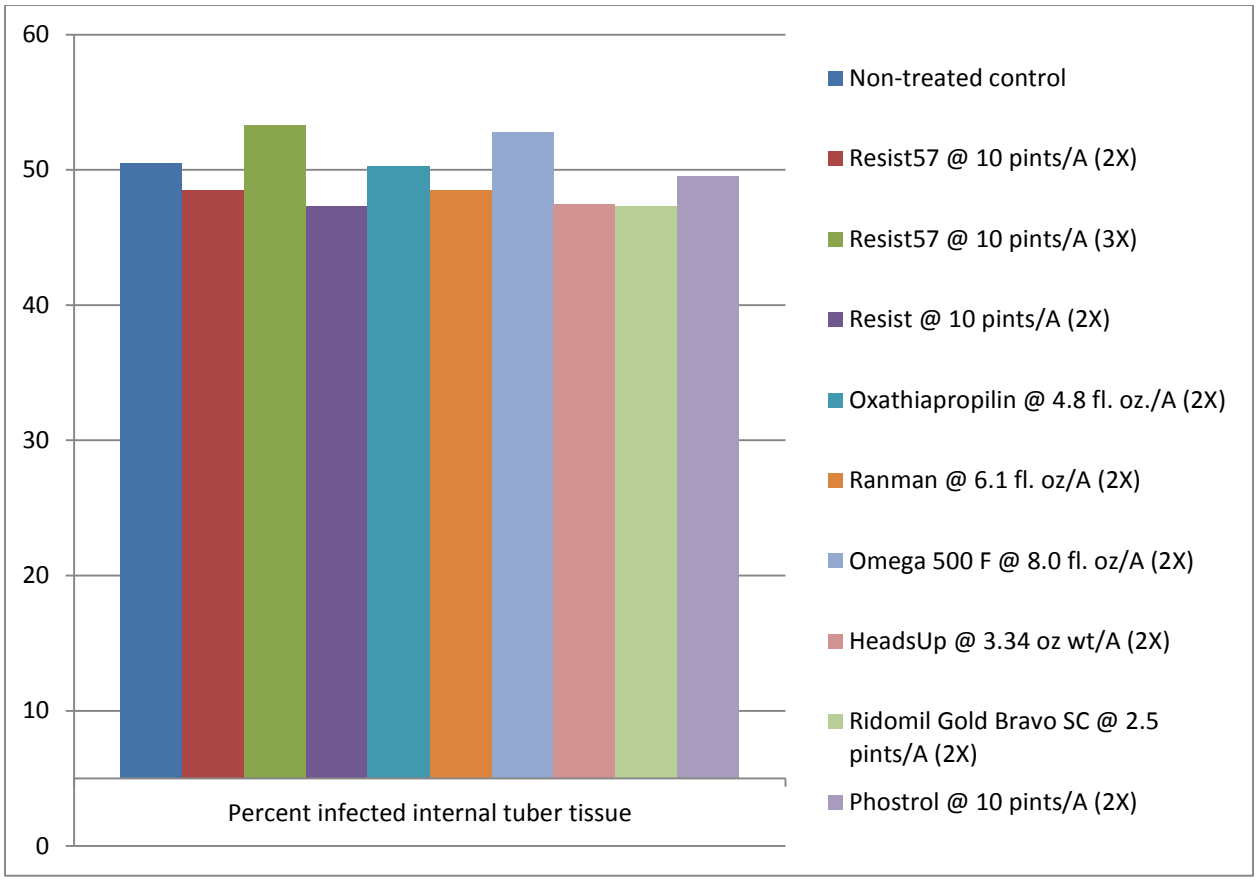

Figure 5. Percent infected internal tuber tissue of Ranger Russet potatoes when foliar applications of fungicides or natural plant defense-inducing compounds were applied at flowering as foliar applications, and tubers of treated plants were harvested and challenge inoculated with *Pythium* using a tuber wounding inoculation technique. Twenty tubers of each treatment were assessed in a 2014 field trial in Paterson, WA. None of the treatments were significantly different from each other at $P \leq 0.05$ using a Fisher LSD.

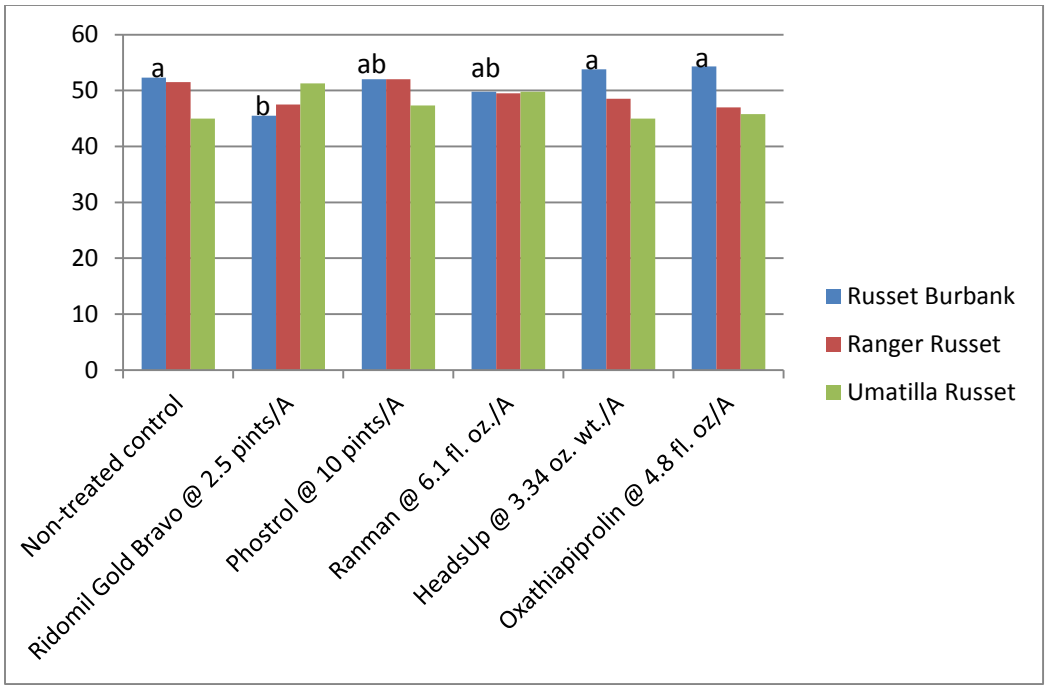

Figure 6. Pecentage of internal tuber tissue infected with *Pythium ultimum*, causal agent of Pythium Leak, of three potato cultivars, when the cultivars were treated with two, late season, foliar applications of each product, spaced at two week intervals between applications with the last application applied two weeks prior to vine kill. Bars with different letters within a cultivar are significantly different from each other at $P \leq 0.05$ based on a Fisher's LSD. If no letters are present, the bars within a cultivar are not significantly different.

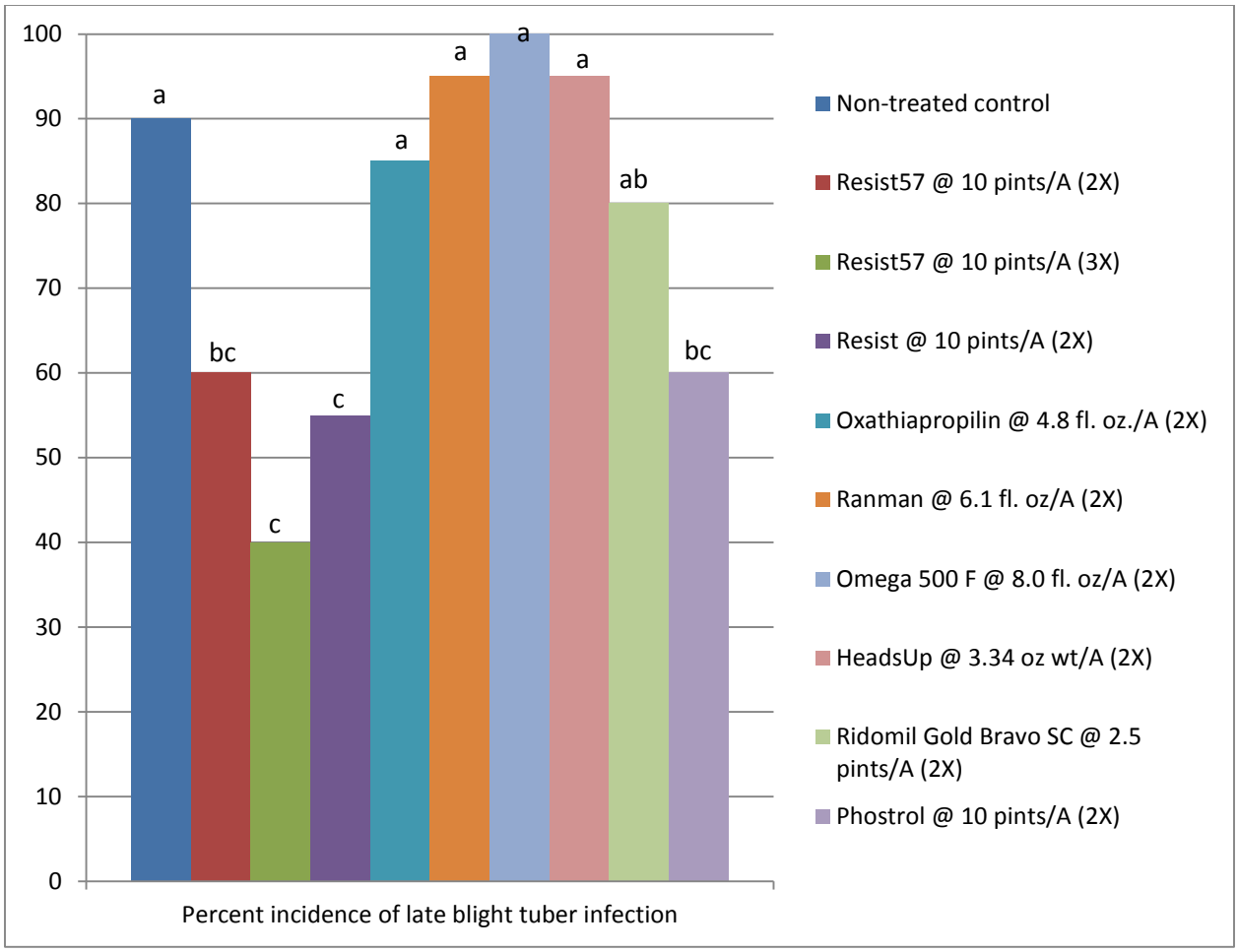

Figure 7. Incidence of late blight tuber rot in Ranger Russet potatoes when foliar applications of fungicides or natural plant defense-inducing compounds were applied at flowering as foliar applications, and tubers of treated plants were harvested and assessed for resistance to late blight tuber rot. Twenty tubers of each treatment were assessed in a 2014 field trial in Paterson, WA.

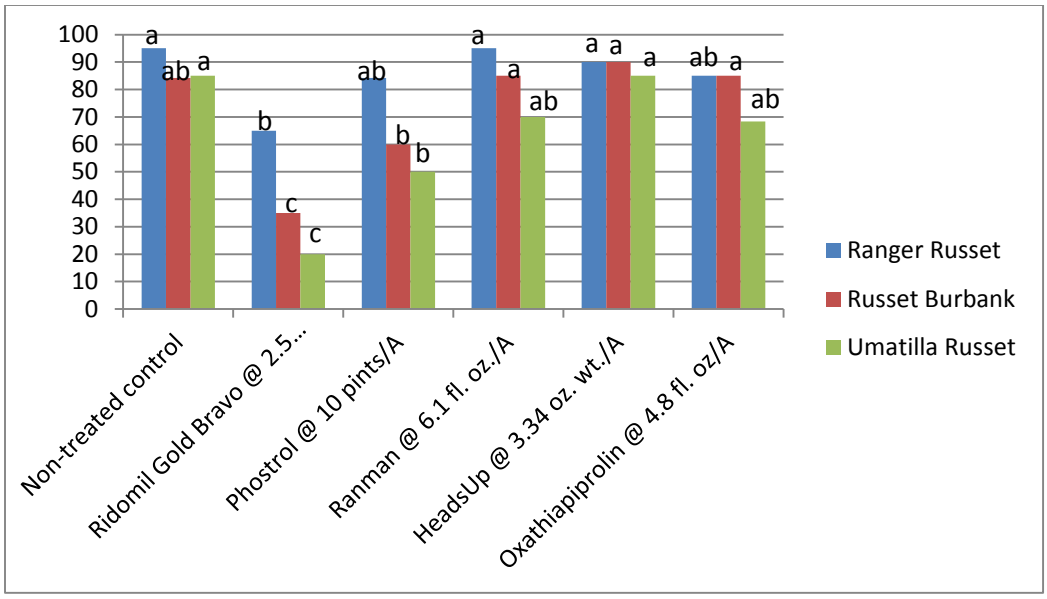

Figure 8. Pecentage incidence of tubers infected with *Phytophthora infestans*, causal agent of potato late blight, of three potato cultivars, when the cultivars were treated with two, late season, foliar applications of each product, with applications spaced at two week intervals, and the last application applied two weeks prior to vine kill. Bars with different letters within a cultivar are significantly different from each other at $P \leq 0.05$ based on a Fisher's LSD.

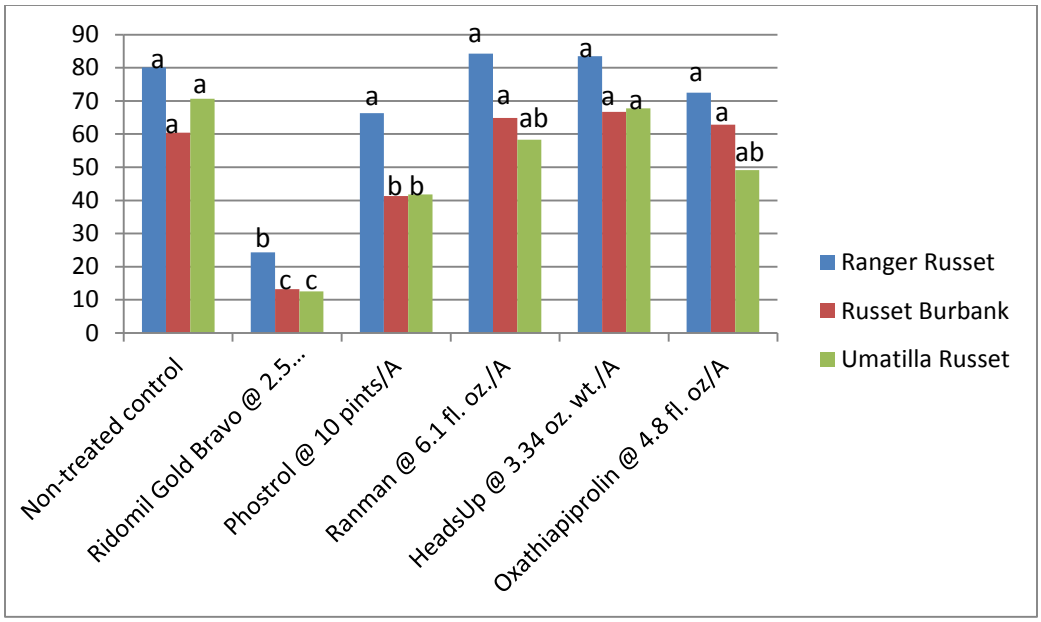

Figure 9. Percentage of internal tuber tissue infected with *Phytophthora infestans*, causal agent of potato late blight, of three potato cultivars, when the cultivars were treated with two late season, foliar applications of each product, with applications spaced at two week intervals, and the last application applied two weeks prior to vine kill. Bars with different letters within a cultivar are significantly different from each other at $P \leq 0.05$ based on a Fisher's LSD.