ADVANCES IN BRASSICA SEED MEAL FORMULATION FOR REPLANT DISEASE CONTROL

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Apple replant disease is incited by a biological consortia of fungal and oomycete pathogens, and plant parasitic nematodes. Effective employment of an individual organic amendment for control of such a diverse biological complex seems improbable. However, on sites lacking significant lesion nematode populations, pre-plant soil applications of *Brassica napus* seed meal (SM) in conjunction with a post-plant mefenoxam application provided fumigant levels of disease control, growth and fruit yield (Mazzola and Mullinix, 2005). Seed meal formulations rather than independent SM meal amendments may yield more broad-spectrum control of the causal pathogen complex (Mazzola and Brown, 2010). Such a formulation would be of value in the management of this disease syndrome in organic production systems. Goals of the current study were to evaluate the effect of apple root stock, seed meal formulation and application date on the control of replant disease at multiple orchard sites in Washington State.

Field trials were established in Chelan, Pullman and Quincy, WA. All three sites were treated with a *Brassica juncea/Sinapis alba* seed meal (SM) formulation in the autumn of 2009 which was tarped using a virtually impermeable film for a two week period post-SM application, and planted with apple on G11 rootstock in May of 2010. Additional treatments at the Quincy site included a *B. juncea/B. napus* SM formulation, a spring 2010 application, and M9 apple planting rootstock.

At all sites, application of either seed meal formulation resulted in significant increases in tree growth relative to the no treatment control, and were as effective as pre-plant soil fumigation with Telone-C17. At the Chelan orchard, *B.juncea/B. napus* SM soil amendment provided a two year increase in growth increment that was significantly greater than pre-plant soil fumigation (Fig. 1). The formulated seed meal treatment significantly ($P = 0.036$) reduced numbers of *Pratylenchus penetrans* recovered from the roots of Jonagold/G11 trees, but pre-plant soil fumigation did not ($P = 0.381$). Suppression of *Pythium* root infection was similar and significant ($P < 0.035$) for both treatments relative to the no treatment control. At this same site, the SM treatment provided significant weed control resulting in a reduction in within row weed density of approximately 85% two months after planting, and weed suppression was evident through October. At the Pullman orchard, *B.juncea/S. alba* SM soil amendment significantly ($P = 0.009$) increased tree growth increment relative to the no treatment control.

All seed meal treatments significantly ($P < 0.001$) improved tree growth at the Quincy orchard relative to the no treatment control, and to a level equivalent to that attained in response to pre-plant Telone-C17 soil fumigation (Fig. 3). Significant differences were observed among seed meal treatments when used in conjunction with Gala/M9 but no differences were observed when used in conjunction with Gala/G11 apple. Increase in growth increment of Gala/M9 was significantly greater in soils amended with the *B. juncea/S. alba* SM formulation in the autumn of 2009 than soils treated with the *B. juncea/B. napus* SM formulation in spring 2010. In general, *Pythium* spp. root infection frequency was higher for trees grown in soils receiving SM applications in the spring rather than the autumn prior to planting, and for Gala/M9 than Gala/G11. All seed meal treatments effectively suppressed root infestation by *P. penetrans* and did so to a level equivalent to that attained in response to Telone-C17 soil fumigation.

Although all seed meal formulations provided a disease control and tree growth response that was equivalent to pre-plant soil fumigation, notable differences were observed among sites. Seed meal amendments conducted in the spring six weeks prior to planting were effective at the Chelan and Pullman orchards but resulted in extensive symptoms of phytotoxicity and tree mortality at the Quincy orchard. Tree mortality was higher in soils treated with the *B. juncea/S. alba* than the *B. juncea/B. napus* SM formulation, and higher for G11 than M9 rootstock. The Chelan and Pullman orchards possessed were sandy loam and silt loam soils, respectively, with high organic matter (3.2-4.2%) while the Quincy orchard soil was a sandy soil possessing an organic matter content of 1.7%.

These studies, in concert with previous field trials (Mazzola and Mullinix, 2005; Mazzola and Brown, 2010) demonstrate that brassicaceae seed meal formulations can be an effective tool for the management of apple replant disease in both organic and conventional production systems. Although site to site variability was observed in tree performance, this was predominantly the result of phytotoxic effects which were alleviated by extending the plant back period when employing the practice in an orchard with a low organic matter sandy soil. These studies also suggest that a prescription-based management system could elevate the utility of this approach for replant disease control. For instance, at the Quincy orchard, the *B. juncea/B. napus* SM formulation resulted no tree mortality as a result of phytotoxicity (overall mortality lower than pre-plant fumigation) but yielded superior growth response when used in conjunction with 'Gala'/G11 than 'Gala'/M9. The consistent achievement of disease control and growth and yield response in Washington State at levels equivalent to pre-plant soil fumigation demonstrate the utility of formulated brassicaceae SM soil amendments as an effective means to manage apple replant disease.

References:

Mazzola, M., and Mullinix, K. 2005. Plant Disease 89:1207-1213.

Mazzola, M., and Brown, J. Plant Dis. 94:835-842.

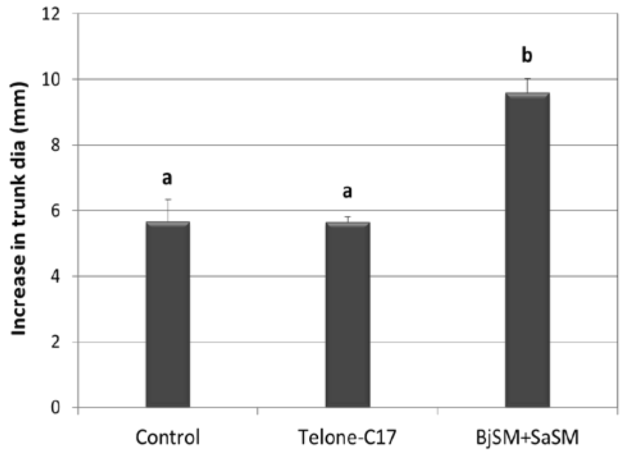

Figure 1. Effect of soil treatment on increase in trunk diameter of Jonagold/G11 apple at the RF organic orchard, Chelan, WA. Seed meal and fumigation treatments were applied March 2010, the site was planted May 10, 2009 and growth data are current as of July 7, 2011. BjSM+SaSM = *Brassica juncea* + *Sinapis alba* seed meal. Bars designated with the same letter are not significantly ($P \geq 0.05$) different.

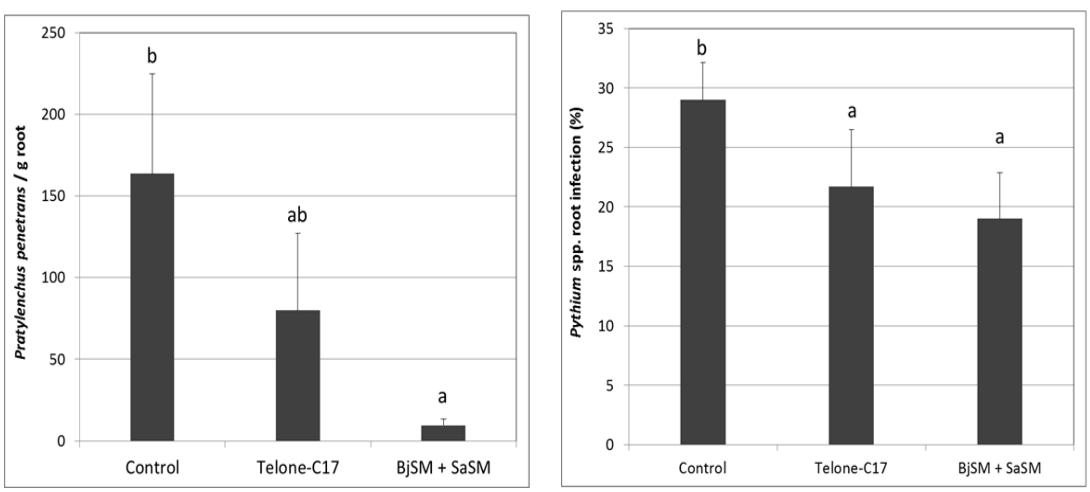

Figure 2. Effect of soil treatments on relative recovery of *Pratylenchus penetrans* (left panel) and *Pythium* spp. (right panel) from roots of Jonagold/G11 at the RF orchard, Chelan, WA. . BjSM+SaSM = *Brassica juncea* + *Sinapis alba* seed meal. Bars designated with the same letter are not significantly ($P \geq 0.05$) different.

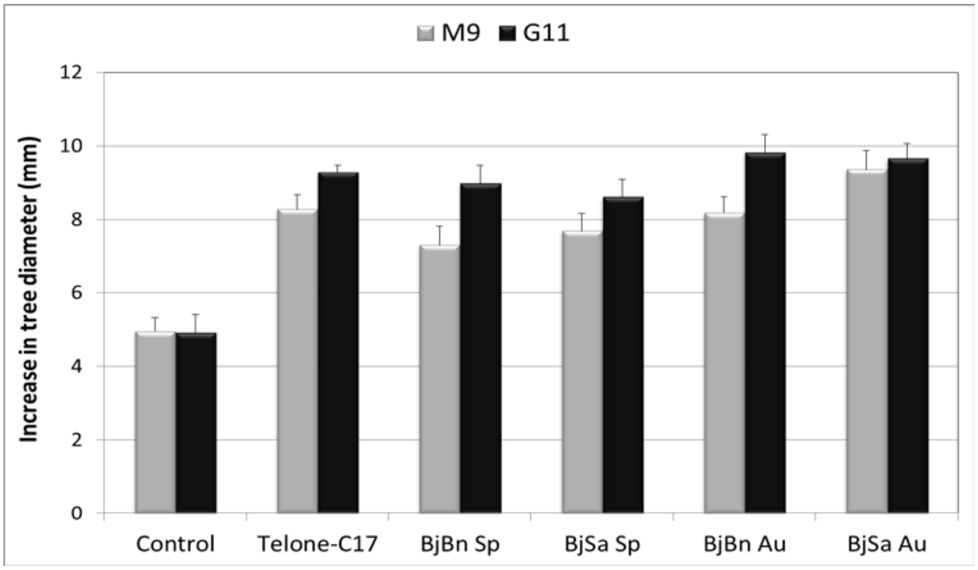

Figure 3. Effect of soil treatment on increase in trunk diameter of Gala/M9 and Gala/G11 at the Sunrise orchard, Quincy, WA. Seed meal was applied 9/29/09 (Au) or 4/6/10 (Sp), fumigation conducted on 10/10/09, the site was planted on 5/12/10 and growth data are current as of July 7, 2011. BjBn = *Brassica juncea* + *B. napus* seed meal; BjSa = *B. juncea* + *Sinapis alba* seed meal. Error bars represented one standard deviation of the mean.

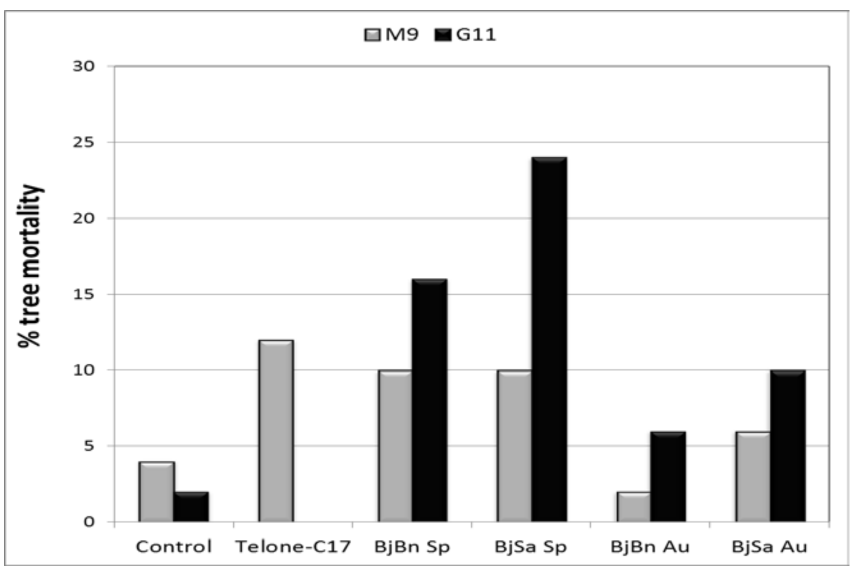

Figure 4. Effect of soil treatment on survival of Gala/M9 and Gala/G11 trees at Sunrise orchard, Quincy, WA as of 7.7.11. Treatments and abbreviations are as in figure 3 legend.