EXPLORING BIOFUMIGATIONAL POTENTIAL OF MUSTARDS

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The study conducted near Santa Paula, California in 2002 compared the effect of tissue mulching and consequent irrigation on survival of pathogenic fungus sclerotia of *Sclerotinia minor*, citrus nematode (*Tylenchulus semipenetrans*) (an indicator species for root-knot and cyst nematodes - Ole Becker, personal communication) and seed of burclover (*Medicago polymorpha*), annual ryegrass (*Lollium multiflorum*) and pigweed (*Amaranthus retroflexus*). Oriental mustard (*Brassica juncea*), yellow mustard (*Sinapis alba)*, faba/bell bean (*Vicia faba*) and a mixture of cereal crops of rye (*Secale cereale*) and triticale (*Triticum aestivum* x *Secale cereale*) were chopped with mower at late flowering and resulted mulch was sprinkler-irrigated with 30 mm (1.2 inches) of water within 0.5 h after mulching, similar to method employed by Matthiessen and Warton (2002). Bare-ground controls were also included. All pathogens were buried in water-permeable bags at 20 cm soil depth prior to irrigation, recovered 7 days later and analyzed for viability. All plots where split and a half of each plot was covered with black PVC plastic after bag burial. Mulch from all plots was collected and aqueous extracts were used in laboratory for sclerotia growth and weed germination assays. 'Gladiator' romaine lettuce (*Lactuca sativa*) and proprietary variety (DUDA California) of celery (*Apium graveolens*) were planted in all field plots (1 by 6 m) following biofumigation.

Addition of any organic material to the soil caused dramatic reduction in citrus nematode survival (Figure 1), while survival in bare ground control was similar to room temperature stored bags. Nematode suppression was 92% greater after oriental and yellow mustard (with exception of yellow mustard treatment with additional plastic) than after cereal or legume, indicating possible contribution of mustard allelochemicals to nematode suppression. Walker (1997) also reported 25 to 81% reduction in citrus nematode population after soil was amended with 40 to 80 g/kg soil of tissue of several *Brassica* species.

Biofumigation in the field did not affect growth of sclerotia (Figure 2) of *Sclerotinia minor*, except when oriental mustard was used in combination with plastic (75% reduction in growth compared to control). Results from other treatments appear inconsistent and highly variable. The effect of oriental mustard tissue extracts on sclerotia growth was further assessed in the laboratory. No sclerotia grew in aqueous extracts from oriental mustard tissue (Figure 3) and sclerotia growth was reduced about 60% in tissue extracts from treatments: oriental mustard + plastic and cereal. Oriental mustard was superior to other crops in inhibiting sclerotia growth in both field and lab tests. However, the mechanism inhibiting sclerotia growth in the lab may not have been fully employed in the field, resulting in some viable sclerotia. This may indicate that sclerotia in the field were exposed to a lesser concentration of mustard-derived allelochemicals than in lab extracts. Identification of the concentration measurements of allelochemicals thought to be responsible for pathogen suppression is necessary to test this hypothesis.

Abundant presence of *Trichoderma* sp. (the fungi with biocide potential) was observed in plates with sclerotia from both field and lab isolates from oriental mustard plots. This observation is in agreement with results of Smith (2001), which documented prolific growth of *Trichoderma* sp. at ITC concentrations well beyond what killed pathogenic fungi such as *Gaemannomyces graminis* (take-all disease), *Pythium sulcatum* (cavity spot of carrots), and bacteria *Ralstonia solonacearum* (bacterial wilt). This suggests that dynamic changes in microbiological community may be partially responsible for biofumigation effects of *Brassica* sp. on certain soil-borne pathogens.

No inhibition in weed seed emergence was observed in the field (data not shown). However, in the lab aqueous tissue extracts of oriental mustard completely inhibited germination (Figure 4) while burclover and pigweed did not germinate in faba bean tissue extracts. Lack of weed suppression in the field and complete weed germination inhibition in the lab correspond with findings of *Sclerotinia minor* assays. This again indicates the need for identification of allelochemicals and correlation of their concentration with suppression of soil-borne pests and weed germination inhibition.

Infection of romaine lettuce with *Sclerotinia minor* was 91 and 68% lesser after biofumigation with yellow and oriental mustard, respectively, than after faba bean (Figure 5). Lettuce following yellow mustard + plastic was nearly infection-free (7.6 times lesser infection score than control). Yellow mustard + plastic treatment consequently resulted in the largest lettuce heads at the time of harvest (Figure 6). Bare-soil control had more weeds than other treatments (data not shown), likely due to the absence of plant residue, thus, resulting in lightest lettuce heads (Figure 6). Similarly, celery plants were lightest in bare-soil control treatment (Figure 7) but had the greatest weight following biofumigation with mustards (46% more than after faba beans and 73% more than after bare soil control).

This study at Santa Paula, CA and reports from reviewed literature show beneficial effects of mustard species on subsequent crop plantings. However, it is unclear which allelochemicals where the most suppressive for pest and pathogens studied at Santa Paula, CA and if lack of suppression was a result of low or low concentrations of those allelochemicals.

RERERENCES

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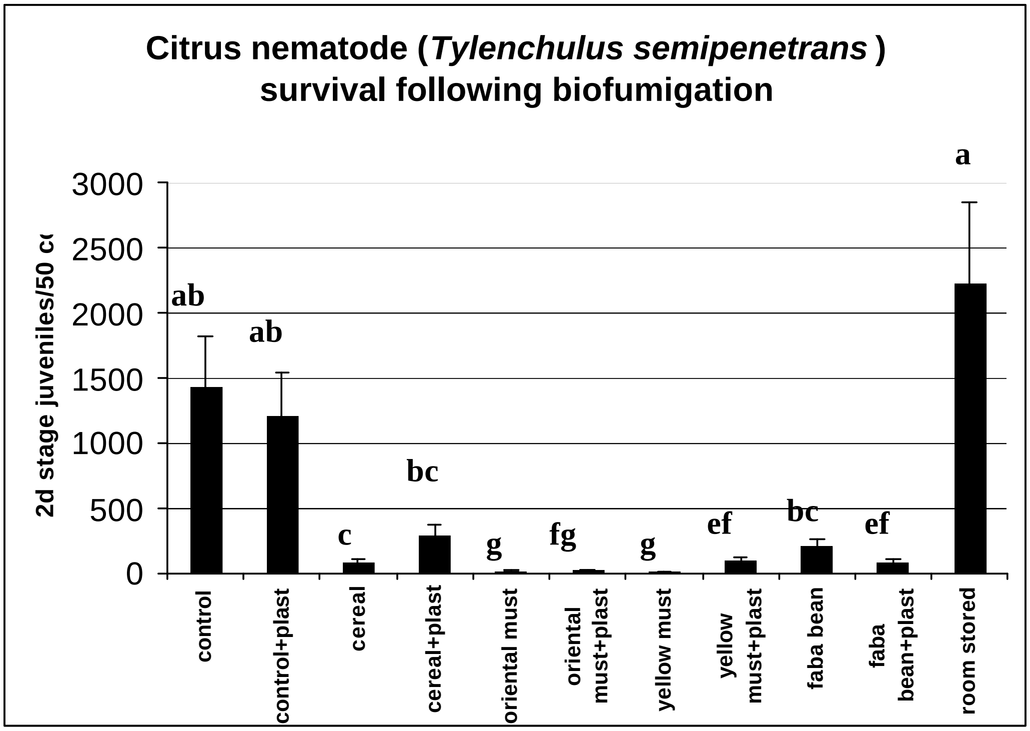

Figure 1. Survival of citrus nematode following biofumigation at Santa Paula, CA in 2002. Treatments are: control (bare ground), faba bean, 'Pacificgold' oriental mustard, 'Idagold' yellow mustard, cereal mixture of rye and triticale; '+ plast' indicate presence of PVC plastic during biofumigation

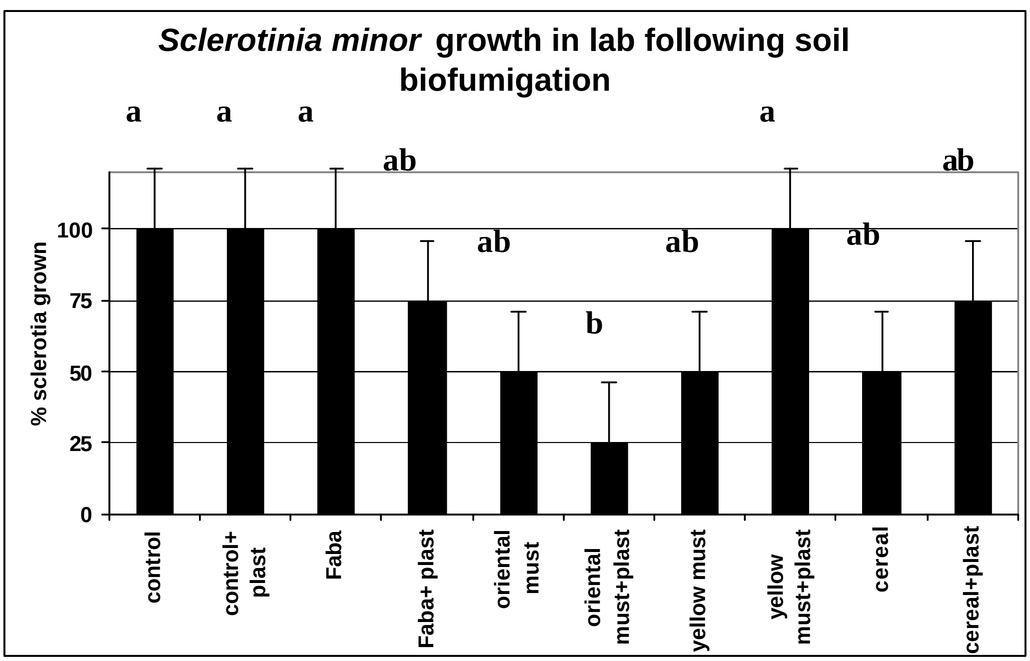

Figure 2. Growth of sclerotia of *Sclerotinia minor* following biofumigation at Santa Paula, CA in 2002. Treatments are: control (bare ground), faba bean, 'Pacificgold' oriental mustard, 'Idagold' yellow mustard, cereal mixture of rye and triticale;'+ plast' indicate presence of PVC plastic during biofumigation

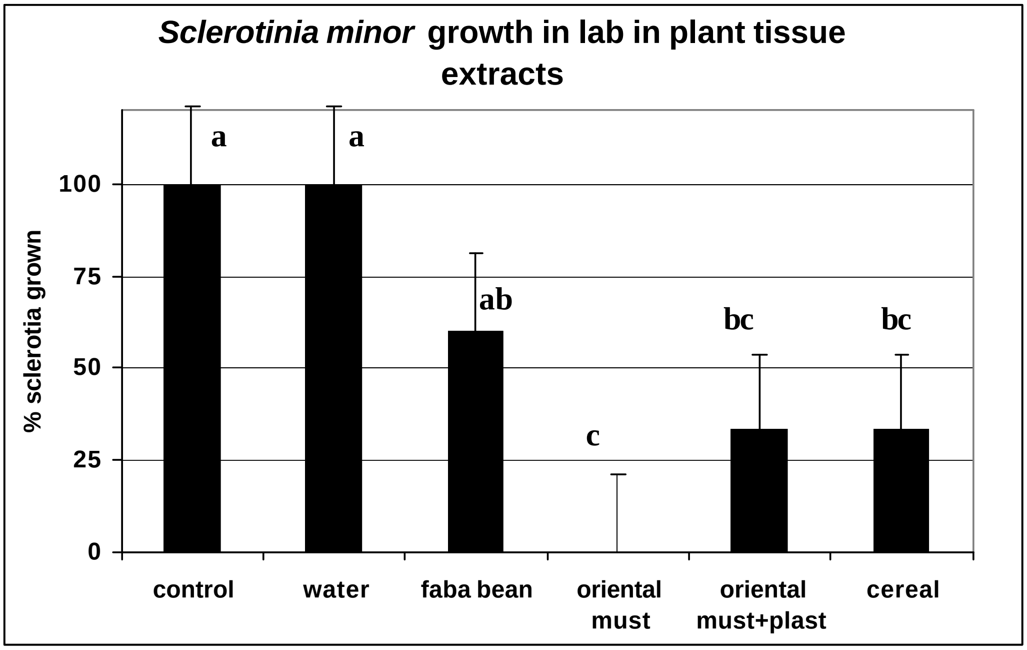

Figure 3. Growth of sclerotia of *Sclerotinia minor* in laboratory in aqueous plant tissue extracts

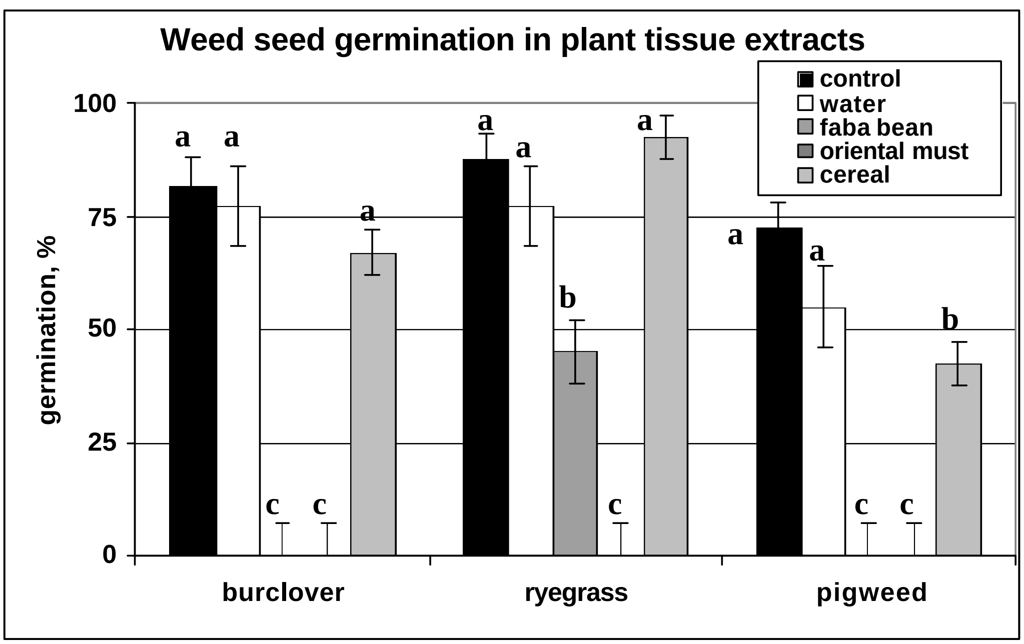

Figure 4. Germination of burclover (*Medicago polymorpha*), annual ryegrass (*Lollium multiflorum* and pigweed (*Amaranthus retroflexus*) in laboratory in aqueous plant tissue extracts

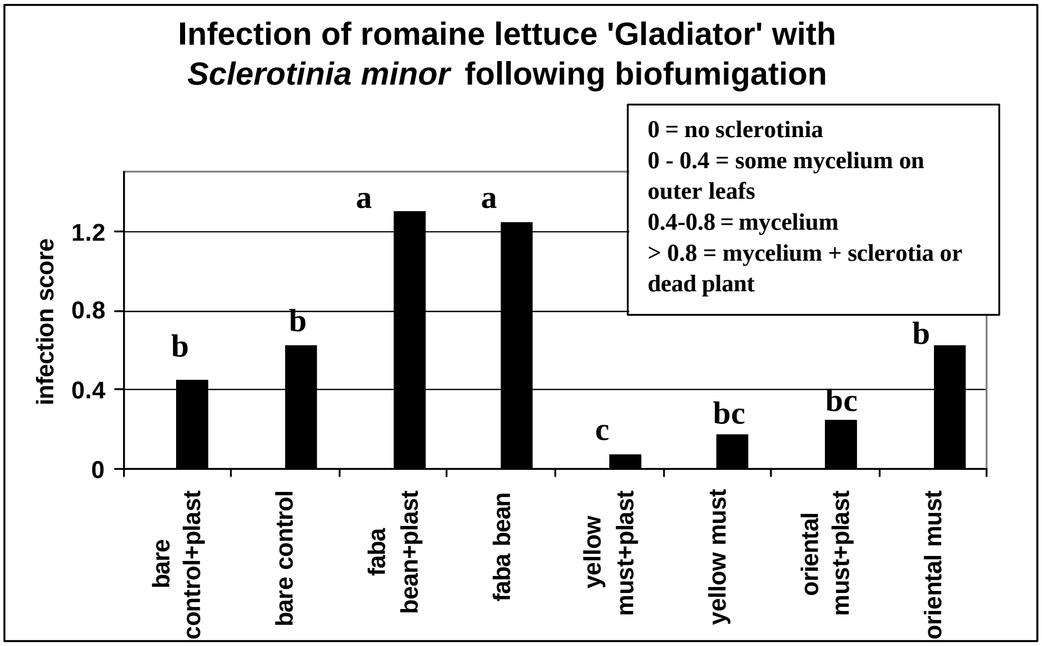

Figure 5. Infection of romaine lettuce ‘Gladiator' with *Sclerotinia minor* following biofumigation at Santa Paula, CA in 2002.Treatments are: control (bare ground), faba bean, ‘Pacificgold' oriental mustard, ‘Idagold' yellow mustard, cereal mixture of rye and triticale;‘+ plast' indicate presence of PVC plastic during biofumigation

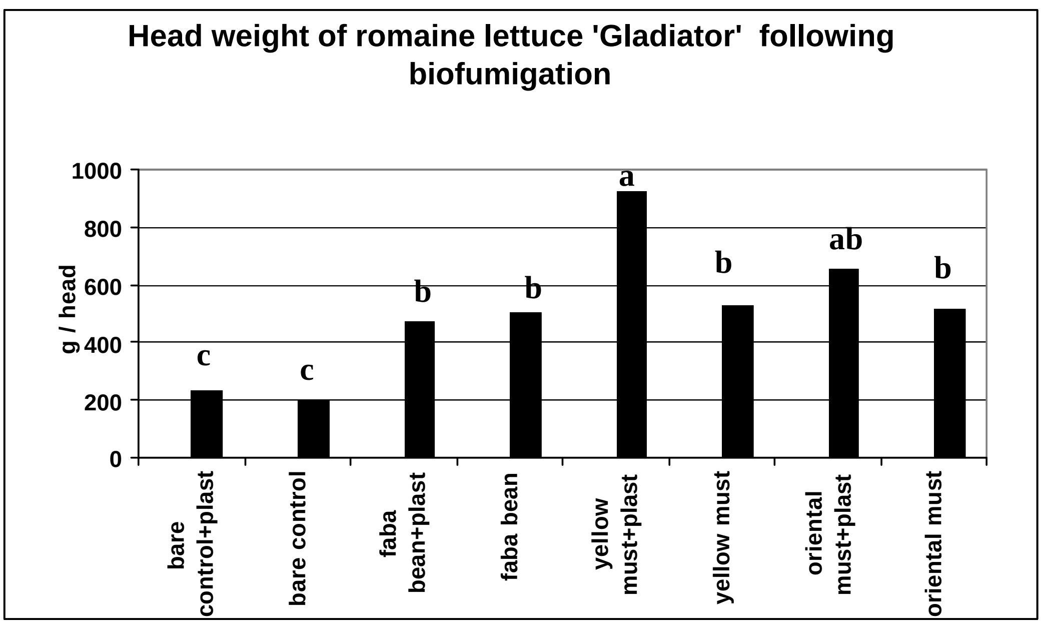

Figure 6. Individual head weight of romaine lettuce ‘Gladiator' following biofumigation at Santa Paula, CA in 2002.Treatments are: control (bare ground), faba bean, ‘Pacificgold' oriental mustard, ‘Idagold' yellow mustard, cereal mixture of rye and triticale;‘+ plast' indicate presence of PVC plastic during biofumigation

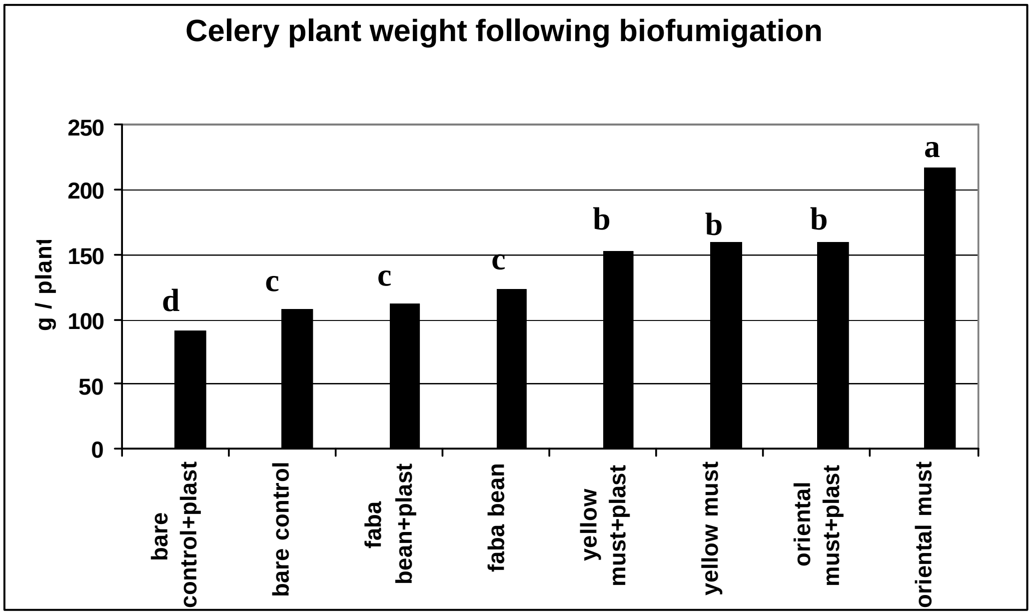

Figure 7. Individual plant weight of celery following biofumigation at Santa Paula, CA in 2002. Treatments are: control (bare ground), faba bean, ‘Pacificgold' oriental mustard, ‘Idagold' yellow mustard, cereal mixture of rye and triticale;‘+ plast' indicate presence of PVC plastic during biofumigation.