PLANT EXTRACTS FOR REPLACEMENT OF METHYL BROMIDE: PRE- AND POST-PLANT APPLICATIONS.

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Plants with antifungal, antibacterial and antiparasitic activity have been used in traditional forms of medicine for thousands of years. BioFume™ is an emerging methyl bromide and pesticide alternative product that contains essential oils of Mediterranean plants (*Thymbra spicata* var. *spicata*, *Pinpinella anisum*, *Foeniculum vulgare*, *Thymus* spp., *Origanum* spp.) as its active ingredients. BioFume and similar plant-based agricultural products pose fewer toxicological and environmental hazards than most chemical methyl bromide alternatives, and BioFume in particular may be safely applied to plant foliage when appropriately formulated. BioFume has been tested under greenhouse and field conditions against different fungi, bacteria, and nematodes on a variety of vegetable crops, and was generally found to protect plants to the same extent as methyl bromide, and a greater extent than Dazomet (Basamid) (Figure 1).

Advantages of BioFume use include:

- It has a broad spectrum of activity against a wide variety of fungi, bacteria, nematodes, and insects, and has been shown to be active against organisms that are resistant to pesticides
- The volatile components of the essential oils are active, meaning that they can dissipate through soil or through other material to be fumigated in the same manner as methyl bromide
- The complex composition of these oils, and the fact that the components seem to function synergistically, makes it less likely that pathogens and pests will develop resistance to them
- Even as little as 100 ppm concentrations can be effective as in formulated form.
- BioFume is non-toxic, and will not accumulate in soils, ground or surface waters or in plant or animal tissues
- BioFume can be mixed with irrigation water and applied to soil or to plants this way after planting, or diluted in oil and injected under pressure into soils prior to planting, using standard agricultural equipment
- When BioFume is used to fumigate soil, plants can be put into the ground after 1-2 weeks (immediately after removal of plastic)
- Since the active ingredients are not synthetic or derived from genetically engineered organisms, BioFume could be used in organic farming
- High concentrations (>5%) are phytotoxic in some formulations and can be used to kill weeds, including nutsedges, if necessary. However, when

appropriately diluted, BioFume does not harm vegetables or ornamental plants, and has even been used safely on roses (1000 ppm)

- BioFume appears to cause shifts in the composition of the soil microflora (specifically, increases in fluorescent pseudomonad populations) that may help suppress pathogens and/or induce systemic disease resistance responses in the plants, explaining its long-term effects
- BioFume applications also appear to have direct effects on plant metabolism that result in increased chlorophyll content, growth and the induction of flowering.

Potential problems with BioFume use include:

- BioFume does not usually reside in soils for longer than two weeks, and while long-term protection has been observed with single initial applications, multiple applications of BioFume are usually required for optimal results
- Concentrated forms of BioFume which may be used to control weeds may be prohibitively expensive, unless used for high-value crops

More research is required to fully understand the effects of BioFume on plant metabolism, and on the soil microflora. It is known that BioFume enhances levels of fluorescent pseudomonad bacteria in soil (a 1000-fold increase was observed in soil treated with 1000 ppm BioFume), and that BioFume-metabolizing isolates from soil have demonstrated the ability to promote plant growth and protect plants from disease. The use of BioFume in conjunction with plant-beneficial rhizobacteria generally produces better results than use of BioFume or the rhizobacteria alone, leaving open the possibility of combined treatments of BioFume treatments with applications of known biocontrol or other plant-beneficial organisms. However, the direct effects of BioFume on plants, and its effects on the composition of soil fungal communities, are not yet well understood.

For more information on BioFume, contact Naturale-Agro (naturale@ mindspring.com).

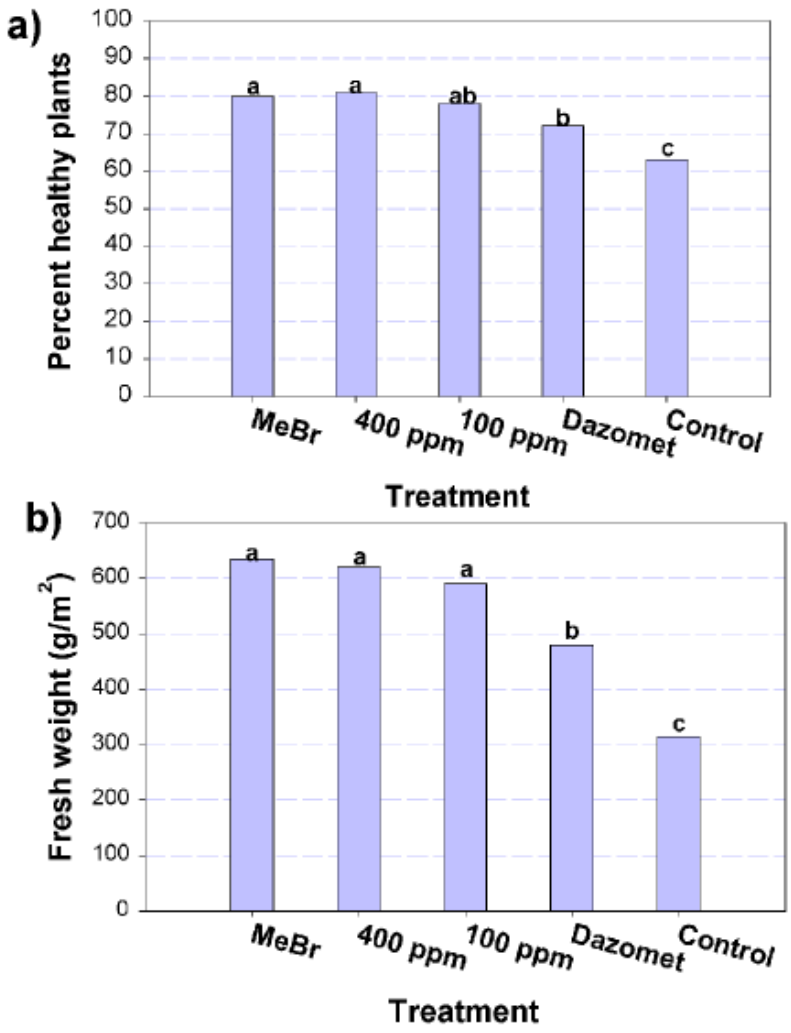

Figure 1: Effect of methyl bromide, BioFume (100 or 400 ppm applied to soil) and Dazomet on (a) suppression of disease and (b) biomass accumulation in pepper plants exposed to a combination of *Phythophthora capsici* and *Meliodogyne incognita* under field conditions