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e-Xtra*

Measuring Root Disease Suppression in Response to a Compost Water Extract

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ABSTRACT

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Commercial application of compost to prevent plant disease is hindered by variable performance. Here, we describe the use of a growth pouch assay to measure impact of a compost water extract (CWE) on root infection under controlled conditions. Most pea roots (≥95%) inoculated with *Fusarium solani* or *Phoma pinodella* spores rapidly develop a single local lesion in the region of elongation. In the presence of CWE, infection of pea roots grown in pouches was reduced by 93 to 100%. CWE used as a drench on pea seedlings grown in sand also resulted in 100% protection but, in a heavy clay soil, infection was reduced by <50%. CWE filtered to remove microorganisms did not inhibit frequency of *F. solani* infection, and resulted in increased local lesion development on individual roots. CWE inhibited mycelial growth of both pea- and cucumber-infecting isolates of *F. solani* in culture but exerted <40% protection against cucumber root infection. CWE treatment of pea but not cucumber was associated with retention of a sheath of border cells interspersed with bacteria covering the region of elongation. Growth pouch assays may provide a system to monitor effects of specific compost mixtures on root–rhizosphere interactions, and to identify variables influencing disease control.

In recent decades, global interest in sustainable agriculture increasingly has focused on reduced reliance on commercial fertilizers and pesticides (25,26,33). Urgency in developing biological control methods for soilborne diseases has increased as efforts to cease application of methyl bromide have progressed (14,16). Compost in various forms has been used for centuries but concerns about food safety, reproducibility, and phytotoxicity have hampered systematic application of such approaches in agriculture (4,13,29,38). The United States Department of Agriculture has outlined a critical need to define, measure, and determine mechanisms of compost function in plant health and development in diverse climate and soil environments (USDA.gov). Although chemically defined pesticides and fertilizers can predictably influence crop production, composts are heterogeneous mixtures whose intrinsic variability complicates efforts to achieve reproducible results. Defining biological control mechanisms even with specific microbial populations under controlled conditions remains a longstanding challenge (24). Defining mode of action for any given solid compost preparation sufficiently to predict efficacy for a given crop may not be a realistic goal. Water extracts of compost, by contrast, yield a liquid product that is amenable to chemical and biological analysis, and can be applied as a drench to plant surfaces (9,20,34,43). Promising effects of compost treatments on important soilborne pathogens, including species of *Pythium* (5,8,35), *Phytophthora* (31), *Fusarium* (12,23,32), *Rhizoctonia* (35), and *Meloidogyne* (43), reveal the benefits to be gained by a better understanding of how disease is reduced with some crop species in some conditions.

Little is known about physiological effects of compost during early root development. Root tips (≈1 to 2 cm from the apex) of higher plants contain primary sites for the establishment of beneficial and pathogenic root–microbe associations and can influence the architecture of the entire plant (1,10,36). Therefore, understanding how compost influences root tip and rhizosphere structure and function may be critical to designing reliable approaches to crop improvement. Unfortunately, the fact that roots grow underground, out of sight, is an obstacle to evaluating the dynamic cellular and biochemical bases for root tip responses to additives (11). A rapid, cost-effective growth pouch assay has been used for decades to describe mechanisms of root infection and colonization by *Rhizobium* spp. and other bacteria, including species isolated from compost mixtures (2,19). Clapp and coworkers (7) introduced the growth pouch assay as a tool to quantify plant responses to soluble nutritional factors from humic substances commonly used in compost preparations. We have used the pouch assay to document mechanisms by which root border cell populations released from root caps function in defense (17,21,22). In the current study, we report effects of a specific compost water extract (CWE) on susceptibility of roots to fungal infection, using the soilborne pathogen *Fusarium solani* f. sp. *pisi* (*Nectria haematococca* mating population VI) and its host, *Pisum sativum* L., as the primary model system.

MATERIALS AND METHODS

Plant material. Pea (*P. sativum* L.) seed of ‘Little Marvel’ (Meyer Quality Seeds, Baltimore, MD) and ‘Alaska’ (Chesmore Seed Company, St. Joseph MO) were treated as described previously (17,18). After immersion for 10 min in 95% ethanol fol-

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* The *e*-Xtra logo stands for “electronic extra” and indicates that the online version contains two supplemental tables.

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