The case for chitin.

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"Chitin is highly biodegradable, breaking down into simple organic acids like acetate and propionate. As shown by its molecular formula (C8H13NO5), it contains 6-7% nitrogen, giving it a carbon:nitrogen ratio ideally suited for bacterial growth. In addition, as a porous solid, chitin provides both a support for bacterial colonization and a long-term source of organic acids (and ultimately hydrogen) that can be utilized by halorespiring bacteria. Therefore it has the potential to fill an important niche as a low-cost slow-release source of hydrogen in bioremediation applications for chlorinated aliphatics".

Chitin-mediated changes in bacterial communities of the soil, rhizosphere and within roots of cotton in relation to nematode control

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"The bacterial communities of soil, rhizosphere and endorhiza were assessed by examining the taxonomic diversity of recoverable bacteria /…/ of 35 soil and rhizosphere bacteria and 25 endophytic bacteria. All major bacterial species which formed at least 2% of the total population in non amended soils and rhizospheres also occurred with chitin amendment"

"Chitin amendment exhibited a further specific influence on the endophytic bacterial community/…/ Burkholderia cepacia, found in similar numbers in the soil of both treatments, was the dominant endophyte in plants grown in chitin-amended soil but rarely colonized cotton roots grown in non-amended soil. These results indicate that application of an organic amendment can lead to modifications of the bacterial communities of the soil, rhizosphere and endorhiza".

Endophytic bacteria have been found in virtually every plant studied, where they colonize the internal tissues of their host plant and can form a range of different relationships including symbiotic, mutualistic, commensalistic and trophobiotic. Most endophytes appear to originate from the rhizosphere or phyllosphere; however, some may be transmitted through the seed. Endophytic bacteria can promote plant growth and yield and can act as biocontrol agents. Endophytes can also be beneficial to their host by producing a range of natural products that could be harnessed for potential use in medicine, agriculture or industry. In addition, it has been shown that they have the potential to remove soil contaminants by enhancing phytoremediation and may play a role in soil fertility through phosphate solubilization and nitrogen fixation. There is increasing interest in developing the potential biotechnological applications of endophytes for improving phytoremediation and the sustainable production of nonfood crops for biomass and biofuel production.

Response of the chitinolytic microbial community to chitin amendments of dune soils.

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"more than half of the chitin had already been decomposed after 4 weeks of incubation./…/ The mean recovery of chitin N as extractable mineral N was 51% after 8 weeks of incubation and 57% after 16 weeks. /…/ a rapid increase in fast-growing fungi and unicellular bacteria followed by an increase in actinomycetes and slow-growing fungi. /…/ This observation seemed also to apply for the chitinolytic bacteria that had become dominant in the chitin-amended dune soils, since they were found to be much slower in degrading chitin than fungi and actinomycetes./…/Unicellular bacteria, therefore, probably only play a minor role in chitin degradation in dune soils./…/ this study indicated that changes in the composition of the chitinolytic CFU differed strongly between chitin-amended dune soils .The variation was not related to differences in organic matter, pH or initial microbial composition. Hence, prediction of the dynamics within the chitinolytic microbial dune community on the basis of general soil characteristics remains difficult.

Suppression of root pathogens by chitin amendments has been attributed to a large increase in antagonistic Streptomycetes. /…/ In this study, stimulation of streptomycetes by chitin amendments differed strongly between soils, even though they had a comparable texture. In addition, those soils which supported a strong stimulation of streptomycetes at 5% moisture did not tend to do so at the higher moisture level. Therefore, the success of disease reduction by chitin-amendments may be unpredictable if it depends on the stimulation of streptomycetes. If this variable development of the chitinolytic community also occurs in agricultural soils, it may help explain the inconsistency of chitin amendments in disease reduction"

Effect of chitin on biological control activity of *Bacillus* spp. and *Trichoderma harzianum* against root rot disease in pepper (*Capsicum annuum*) plants

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European Journal of Plant Pathology **109:** 633–637, 2003.

"Two bacterial isolates and one strain of Trichoderma harzianum were tested alone and in combination with chitin for efficacy in control of root rot disease caused by Phytophthora capsici and Rhizoctonia solanis./…/ Seed treatment and root drenching with bacterial suspensions of HS93 with 0.5% chitin was more effective against Phytophthora and Rhizoctonia root rot than addition of the organisms without chitin. /…/ In two greenhouse tests, seed treatment and root drenching with HS93 amended with chitin enhanced its biocontrol activity against P. capsici but not on R. solani. /…/. In both greenhouse experiments, the use of 0.5% chitin alone for root drenching reduced Rhizoctonia root rot. Reduction of root rot disease was accompanied by increased yield. These results show that the antagonistic activity of HS93, LS674 and T. harzianum may be stimulated by chitin resulting in significant improvements in their effectiveness against pathogens".

Chitin-supplemented formulations improve biocontrol and plant growth promoting efficiency of *Bacillus subtilis* AF 1

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"Formulations of a chitinolytic biocontrol and a plant growth promoting Bacillus subtilis AF 1 were prepared in peat supplemented with either 0.5% chitin or Aspergillus niger mycelium, or in spent compost obtained from Agaricus bisporus cultivation and were evaluated for biocontrol of two fungal pathogens and plant growth promoting activities on pigeon pea and groundnut. /…/ The presence of chitin or A. niger (in peat) or A. bisporus (in spent compost) as supplement in the carrier material improved the multiplication of B. subtilis AF 1. When used as seed treatments, formulations of AF 1 in peat supplemented with chitin or chitin-containing materials showed better control of A. niger (causing crown rot of groundnut) and Fusarium udum (causing wilt of pigeon pea) than AF 1 culture alone, in both groundnut and pigeon pea"

Evaluation of amended transplant mixes for fruit and vegetable production

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"Research at Auburn previously established that the organic amendment chitin reduced disease caused by root-knot nematodes and that certain gram + bacteria isolated from soil increased plant growth and reduced the incidence of several diseases. Mechanisms for the beneficial effects attributed to PGPR indicated that increased plant growth can be attributed to shifts in the microbial ecology of the rhizosphere, production of iron chelating siderophores, antibiotics, and hydrogen cyanide. While some PGPR strains exhibit antibiosis and affect pathogens directly, other strains control disease by mechanisms that do not involve production of toxic compounds. These mechanisms include substrate or site competition, and induced resistance in the host which results in increases in defense related compounds referred to as PGPR-mediated induced systemic resistance".

Plant root-bacterial interactions in biological control of soilborne diseases and potential extension to systemic and foliar diseases

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"Plant-associated bacteria reside in the rhizosphere, phyllosphere, and inside tissues of healthy plants./…/ bacteria which have demonstrated biological control activity against soilborne pathogenic fungi and nematodes include rhizobacteria (root-colonising bacteria) and endophytic bacteria (bacteria isolated from within healthy plant tissues)./…/ some rhizobacteria have been found to enhance plant defences, leading to systemic protection against foliar pathogens upon seed or root-treatments with the rhizobacteria. In these cases, introduction of the rhizobacteria results in

reduced damage to multiple pathogens, including viruses, fungi and bacteria. An alternative strategy to the introduction of specific antagonists is the augmentation of existing antagonists in the root environment. This augmentation may result from the use of specific organic amendments, such as chitin, which stimulate populations of antagonists, thereby inducing suppressiveness".

Effect of chitin compost and broth on biological control of *Meloidogyne incognita* on tomato.

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"Chitinolytic bacteria were evaluated as potential biological control agents of the root-knot nematode, Meloidogyne incognita, on tomato. /…../ The gall index was lower in the plants grown in the chitin-amended soil at each time point. Activities of soil chitinase and β-1,3-glucanase were greater in those soils amended with chitin compost and chitin broth. Gall index of tomato root was negatively correlated with soil chitinase activity. Activities of tomato root chitinase and β-1,3-glucanase were higher in plants growing in non-chitin-amended soil at 6 and 8 weeks after nematode infestation. Chitinase activity in tomato root was positively correlated with the gall index of tomato root. The results indicate the potential of chitinase producing bacteria to alleviate nematode parasitism in important vegetable crops".