Performance and Adoptability
Biodegradable Mulch
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Report No. FA 2106-01 **April, 2016**

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Summary

Endophytes are organisms that exist in association with plant hosts, in foliage and/or roots. These relationships range from symbiotic to pathogenic. This fact sheet describes what endophytes are and how they contribute to overall plant health. Future research will explore the role of endophytes in cropping systems that use biodegradable mulch.

This material is based upon work that is supported by the National Institute of Food and Agriculture, under award number 2014-51181-22382. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

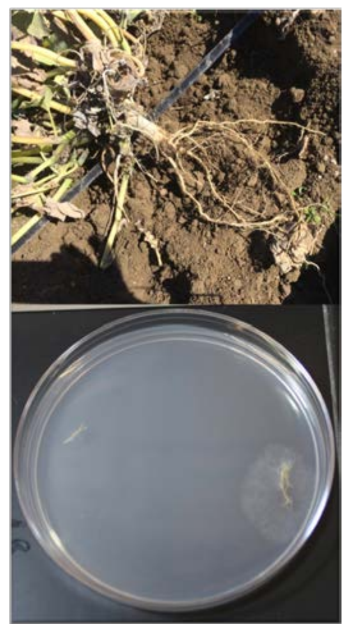
USDA United States Department of Agriculture National Institute of Food and Agriculture

What Is an Endophyte?

Plants host a number of fungi and bacteria within their tissues much like the gut in humans. In plants, microorganisms that are present, but do not cause disease symptoms, are called endophytes (Wilson 1995). Endophytic associations can either be (i) commensal (there is no effect on the host by the organism), (ii) parasitic (the fungi or bacteria benefit, but there is no benefit to the host), or (iii) mutualistic (the host receives some benefit by having the organism present). Some of the benefits to a host include tolerance to heat, salt, or resistance to plant pathogens or animal foraging (Rodriguez and Redman 2008).

Variation in endophyte associations

As examples of endophyte associations, American dunegrass is a grass that grows in the Puget Sound area of western Washington. Colonization by the fungus *Fusarium culmorum* confers tolerance of the grass to salt (Rodriguez and Redman 2008); hence, dunegrass plants not colonized by *F. culmorum* are incapable of living in the region's saline environment. The presence of endophytes can also increase resistance to plant pathogens. Infection by the blight/rot fungus, *Phytophthora palmivora*, is greatly reduced in cocoa seedlings due to the presence of foliar endophytes (Arnold et al. 2003). Many endophytes exhibit a range of symbiotic lifestyles, depending on the host that is colonized. (*continued, next page*)



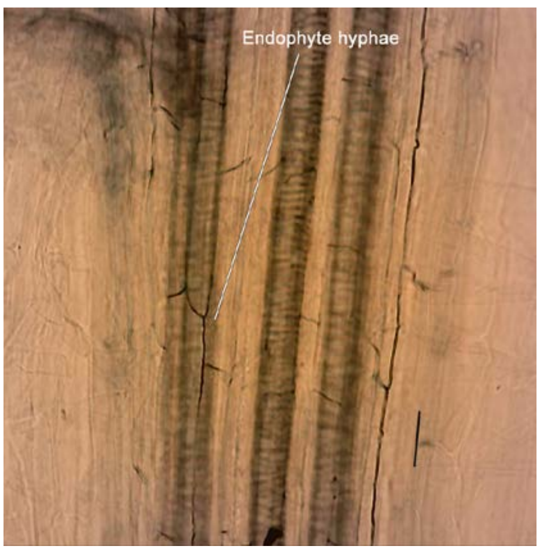
Fungal endophytes are isolated from excavated pumpkin roots by surface disinfecting roots in 70% ethanol and plating root segments onto media.

Strawberry is host to *Colletotrichum gleosporiodes* the cause of anthracnose and crown rot, but tomatoes colonized by this strawberry pathogen exhibit increased drought tolerance and plant biomass (Rodriguez and Redman 2008).

Endophyte colonization of plants

Fungal endophytes are highly diverse and their presence in plants is dependent upon the host, the availability of nutrients, the environment, and the community composition of other microorganisms (Porras-Alfaro and Bayman 2011). Some endophytes exhibit specificity to one tissue type, yet others can be found within multiple locations of the plant (Herrera et al. 2010). For example, endophytes isolated from coffee grown in Hawaii, Puerto Rico, Colombia, and Mexico (Vega et al. 2010) differed in their colonization patterns. While the greatest number was isolated from leaves in Hawaii and Columbia, more were isolated from crown tissues in Puerto Rico and Mexico. However, at all four locations, fungal endophytes were isolated from all plant parts, including roots, berries, and leaf stems (Vega et al. 2010).

Infection of plant foliage by fungal endophytes is thought to occur when airborne spores land on the surface of a leaf. If environmental conditions are conducive to spore penetration, the spores germinate and fungal hyphae enter the plant through the cuticle to colonize the leaf's intercellular spaces (Herre et al. 2007). Eventually, the entire leaf becomes colonized with different endophytes. Interestingly, as leaves age the number of endophyte species colonizing the leaves decreases while the density of endophyte colonization increases (Herre et al. 2007). Infection of roots often occurs in the soil through root hairs. Once root penetration has occurred, the fungus continues to colonize root tissues (Waller et al. 2005). Antagonism to common root pathogens, such as *Rhizoctonia* or *Pythium*, by fungal and bacterial endophytes can result from the endophyte's production of toxic metabolites, direct parasitism of the root pathogen, or outcompeting the pathogen for nutrient sources within the root.



Endophyte hyphae (Scale bar = 100 µM) form the vegetative body of the fungus, through which the endophyte acquires nutrients.

Endophytes in vegetable cropping systems

In vegetable cropping systems, endophytes have been observed to minimize diseases caused by a number of pathogens. Eggplant seedlings first inoculated with *Penicillium* and then with a pathogenic isolate of *Verticillium dahliae* resulted in no symptoms of Verticillium wilt whereas control plants exhibited significant vascular discoloration and wilting (Narisawa et al. 2002). In cucumber, when bacteria called actinomycetes were inoculated into seedlings, damping-off disease caused by *Pythium aphanidermatum* was as effectively managed as with a metalaxyl fungicide application (El-Tarabily et al. 2009).

The absolute impact that endophytes have on plant biology and ecology is unknown. While their role in boosting host tolerance to harsh environments and pathogen or insect invasion has been well documented, endophytes now are being investigated as sources for new secondary metabolites and as playing functional roles in phytoremediation and adaptation to climate and other agricultural changes (Porras-Alfaro and Bayman 2011)

Endophytes and biodegradation

Endophytes have been shown to have the ability to degrade plastics (Russell et al. 2011; Abdel-Motaal et al. 2014). Potential roles of endophytes in the biodegradation of agricultural films in pumpkin cropping systems and for the management of pumpkin root diseases in the Pacific Northwest are being investigated as part of this SCRI project. Research that is currently underway includes:(i) a survey of the endophytic community isolated from pumpkin roots, (ii) assessment of antagonism of endophytes isolated from pumpkin roots towards *Verticillium dahliae*, and (iii) an investigation on how differences in biodegradable agricultural mulch materials impact the endophyte community in a pumpkin cropping system.

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