Does Organic Farming Favour Arbuscular Mycorrhizal Fungi?

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ABSTRACT
Arbuscular mycorrhizal fungi (AMF) are important contributors to plant health and yield in low input systems. We investigated the relative size of the AM fungus community in paired organic and conventional fields from 12 farms in England on a range of soil types. It was found that AMF spore numbers and root colonization potential were significantly higher under organic relative to conventional management, and, for spore numbers, the difference between organic and conventional management increased significantly with time since conversion. There were no overall differences in total C, N, P, available P, Ca, Mg and K between conventional and organic management. AMF spore numbers and root colonization potential were not related to any of the soil chemical parameters.

INTRODUCTION
Arbuscular mycorrhiza (AM) are symbiotic structures formed between plant roots and fungi in the phylum Glomeromycota. Arbuscular mycorrhizal fungi (AMF) play an important role in plant health by improving nutrient (especially inorganic P) and water uptake by their host plant, and providing protection against soil-borne pathogens (Kurle and Pfleger, 1994). However, many management practices typical of conventional high input systems, particularly P fertilizer application and the use of biocides, are known to be deleterious to AM fungus communities (Kabir *et al*., 1998; Thingstrup *et al*., 1998). This study was conducted to determine the relative impact of organic and conventional management on the size of AM fungus communities.

MATERIALS AND METHODS
Soil was collected from paired organic and conventional fields on twelve English farms on a range of soil types (Table 1). All but one of the samples were from arable/field vegetable systems; Redesdale is an upland grassland system.

Within each field five 10x10 m areas were marked out and from within each area 20 soil cores (0-30 cm depth) were collected and pooled to provide a 5 kg sample. Each sample was analysed for total C, N and P, extractable (Olsen) P, and extractable Mg and K. AMF spores were extracted from a sub-sample using sucrose density gradient centrifugation and counted by microscopy. To determine root colonization potential by AM fungi, onion (*Allium cepa*) was grown in pots containing 100 g fresh weight of soil at 60 % water holding capacity for 14 weeks in the glasshouse; roots were stained with aniline blue (Grace and Stribley, 1991) and the percentage root colonized by AM fungi determined by microscopy. For statistical purposes each farm was considered as a block.

Table 1. Characteristics of the 12 sites examined for AMF population

Site	Soil type	Enterprise
Ryton, Warks.	Sandy loam	Vegetable
Wellesbourne, Warks.	Sandy loam	Vegetable/Arable
Terrington, Norfolk	Silt clay loam	Vegetable/Arable
Kirton, S. Lincs.	Silty loam	Vegetable
Sutterton, S. Lincs.	Silty loam	Vegetable
Epworth, N. Lincs.	Sandy loam/peat	Vegetable
Duggleby, N. Yorks.	Clay loam over chalk	Arable
Great Coxwell, Oxon.	Sandy silt loam over limestone	Arable
Cirencester, Gloucs.	Silty loam over limestone	Arable
Tarleton, Lancs.	Peat	Vegetable
Ormskirk, Lancs.	Peat	Vegetable
Redesdale, Northumberland	Fine sandy loam	Grassland

Table 2. AMF spores (per 100 g of soil) and percentage of onion root length colonized by AMF in soil from paired organic and conventional sites. Values shown are the means of 5 replicates (standard errors are shown in brackets).

Site	Years since conversion	Number of spores (per 100 g of soil)		Percentage of roots colonized	
		Con	Org	Con	Org
Ryton	15	45 (12)	116 (20)	25 (9)	43 (7)
Wellesbourne	4	162 (33)	143 (19)	34 (11)	39 (10)
Terrington	7	259 (36)	819 (125)	4 (2)	52 (8)
Kirton	4	832 (86)	1164 (228)	20 (7)	53 (11)
Sutterton	3	882 (209)	1746 (194)	35 (12)	58 (8)
Epworth	2	410 (100)	530 (82)	52 (17)	55 (5)
Duggleby	2	898 (195)	606 (85)	12 (3)	65 (10)
Great Coxwell	10	643 (31)	824 (138)	43 (2)	84 (4)
Cirencester	18	308 (53)	1955 (386)	20 (5)	72 (6)
Tarleton	4	396 (37)	504 (135)	16 (7)	34 (7)
Ormskirk	1	186 (28)	749 (112)	33 (4)	36 (7)
Redesdale	12	509 (107)	1250 (200)	50 (4)	62 (6)

RESULTS

There was no consistent effect of organic rather than conventional management on any of the soil chemical parameters (data not presented). However, both AMF spore numbers and root colonization potential were significantly higher ($P<0.01$) under organic than under conventional management (Table 2). The ratio of spores in organic: conventional management was significantly correlated with length of time following conversion ($r=0.6$, $P<0.05$).

DISCUSSION

There was no significant relationship between AMF spore numbers or root colonization potential and any of the soil chemical parameters. Some researchers (Jensen and Jacobsen, 1980; Kahiluoto *et al*., 2001) have found a negative correlation between available P and AMF population. This was not the case here.

In a number of studies, organic management has been shown to stimulate AMF communities, with the effect attributed to reduced soil P under organic management (Ryan *et al*., 1994; Mader *et al*., 2000). However, differences in AMF inoculum between the organic and conventional farms included in our study cannot be ascribed to differences in soil chemistry. This suggests that other practices such as the use of fertility building crops, a greater variety of cash crops, non-chemical weed control, and non-use of fungicides may be important; all these factors are known to influence AMF populations (Kurle and Pfleger, 1994).

A wide variety of AMF spores were observed in this study. Over 150 species of AMF have been described, and both functional diversity and niche differentiation in AMF have been demonstrated (Newsham *et al*., 1995). Work is ongoing to determine the impact of organic and conventional management on AMF diversity.

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