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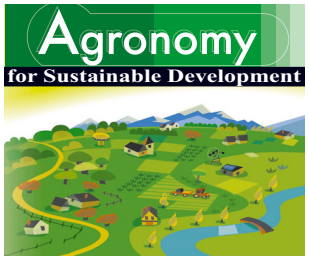

Research article

Yield and arbuscular mycorrhiza of winter rye in a 40-year fertilisation trial

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Abstract – The impact of different fertilisation treatments on soil organic matter, available soil nutrients, mycorrhizal and root properties, as well as on the yield response of winter rye (*Secale cereale*) was studied in a long-term field trial in Austria under dry site conditions. Winter rye has been grown since 1906 in soils treated with easily soluble mineral fertiliser, farmyard manure, and in an unfertilised control. We found the soil organic matter to be 96% higher in the plots fertilised with farmyard manure compared with easily soluble mineral fertiliser. Available soil phosphorous and potassium contents were at least 136% higher in both fertilised treatments than in the unfertilised control. Arbuscular mycorrhizal colonisation (+46%) of winter rye roots by indigenous arbuscular mycorrhizal fungi, arbuscule frequency (+20%), and the length of the extraradical arbuscular mycorrhizal mycelium (+18%) were higher in the unfertilised control and reduced in the NPK treatment compared with the farmyard manure treatment. The average grain yield of winter rye from 1960 to 2000 increased in all treatments. This increase was higher in the fertilised treatments, +41% for farmyard manure and +60% for easily soluble mineral fertiliser, than in the unfertilised control. Two main effects presumably accounted for the continuously increasing average winter rye yield in all fertilisation treatments: (1) the use of modern winter rye varieties with a higher nutrient efficiency; and (2) an ongoing atmospheric nitrogen deposition. We conclude that the preferential application of farmyard manure, typical for low-input farming systems, resulted in increased levels of soil organic matter, arbuscular mycorrhizal colonisation and arbuscule frequency, supporting soil fertility by an enhanced crop nutrient uptake by arbuscular mycorrhizal fungi under dry site conditions, thus promoting crop yield stability and sustainable plant growth.

arbuscular mycorrhizal fungi (AMF) / long-term field trial / continuous rye cropping / farmyard manure (FYM) / easily soluble mineral fertiliser (NPK)

1. INTRODUCTION

Recent adverse environmental effects of high-input agricultural systems, e.g. pollution of groundwater due to the application of easily soluble mineral fertilisers, have increased the public interest in sustainable agricultural systems such as organic farming, where soluble mineral fertilisers are prohibited (Oberson and Frossard, 2005). Symbioses of crop plants with soil micro-organisms are crucial for soil fertility and crop nutrition in low-input farming systems. The effects of low-input management practices such as organic manuring on soil microbial communities need to be understood to increase soil fertility for sustainable crop production (Mäder et al., 2002).

Applying farm yard manure (FYM) has a long-term effect on physical soil properties and soil micro-organisms (Mäder et al., 1995). It usually takes several decades until a dynamic equilibrium in the content and quality of soil organic matter has been reached (Reganold et al., 1987). Therefore, long-term field trials are required to assess the sustainability of organic matter-based management practices on crop yield and soil fertility. Only a few results, however, are available about soil nutrient contents, arbuscular mycorrhizae and crop yield from long-term fertilisation field trials.

In dry soils, the mobility of nutrients in soil solution and the microbial activity that mobilises mineral nutrients from the solid phase are generally reduced. Under such dry conditions, the nutrient availability to crops may be insufficient, especially in low-input agricultural systems.

An arbuscular mycorrhiza is a symbiotic relationship between arbuscular mycorrhizal fungi and plant roots (Smith and Read, 1997). Most crop plants in temperate agricultural systems build an arbuscular mycorrhiza; therefore, arbuscular

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