EFFECTS OF ETHREL ON THE FORMATION AND RESPONSES TO VA MYCORRHIZA IN MEDICAGO AND TRITICUM

by C. AZCON-AGUILAR, D. N. RODRIGUEZ-NAVARRO
and J. M. BAREA

Microbiology Department, Estación Experimental del Zaidín. C.S.I.C. Granada, Spain

KEY WORDS

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SUMMARY

Ethrel, a compound which readily releases ethylene, depressed VA mycorrhiza formation in Medicago sativa and Triticum vulgare when it was either applied to the rooting medium or sprayed to the foliage. The axenie germination of Glomus mosseae spores was found to be sensitive to ethrel suggesting that at least part of the effect of ethrel on mycorrhization could come from its effect on fungal development. The possible ecological significance of these findings is discussed.

INTRODUCTION

Mutualistic symbiosis involving plants and microorganisms such as vesicular-arbuscular mycorrhiza (VAM) and legume root nodules depend, both for their formation and function, on a series of interactions between the constituent partners. The implication of plant hormones, either synthesized by the host or by the endophytes, on the establishment and development of these biotrophic associations has been demonstrated or suggested. The synthesis of these substances by microorganisms in the rhizosphere introduces an extra supply which could affect the hormonal balance inherent with the maintenance of the mutualism.

Ethylene, a plant hormone, could play a dual role in the establishment of these microbe-plant associations because of its known activity on root formation and promotion and its suggested, but discussed implications on soil microbial activity.

The evolution of ethylene by soils has been described by several authors and, in some instances, the quantities released are far in excess
of those known to cause root inhibition in cereals. Soil ethylene is of microbial origin being synthesized by most species of soil bacteria and fungi.

Although some investigations refute this (see), ethylene has been described to be one of the causes of soil fungistasis, but as far as we know there is no information about fungistasis towards VAM fungi in soil. The aim of this paper is to study the effects of ethrel (2-chloroethane phosphonic acid), a substance which readily releases ethylene on the formation of and responses to VAM and also its influence on the VAM spore germination. Ethrel is used for some agricultural (horticultural) purposes.

MATERIALS AND METHODS

Two types of experiments were designed, both of them using ethrel as ethylene source. Two points are important, 2-chloroethane phosphonic acid (ethrel) is stable at pH values below 4.0 and begins to be hydrolyzed, releasing ethylene, as the pH rises. It is also known that at pH = 7.1, a 45.4% of ethrel is hydrolyzed in 18 h at 25 ± 1°C. Consequently, at such temperature and pH conditions, the 91.1% of ethrel is lost in 72 h.

 Experiment 1. – Effect of ethrel on VA mycorrhization

This experiment was carried out in open pots of soil as was that previously described (soil no. 8, 18.2 ppm Olsen P, pH = 7.4). This soil was steam-sterilized and then mixed with sterile sand (5:2 mixture).

Two VA mycorrhizal host plants were tested: Medicago sativa L. cv. Aragón and Triticum vulgare L. cv. Mara. Seeds were germinated on moistened filter paper and two-day-old seedlings were transplanted into pots (seven per pot) containing 300 g of the soil/sand mixture. The VA mycorrhizal endophyte assayed was the yellow-vacuolate spore type (YV), a form of Glomus mosseae that was collected from a stock plant culture. The mycorrhizal inoculum was applied to the planting hole and it consisted of spores, hyphae and infected root fragments thoroughly homogenized and divided into equal aliquots. The alfalfa seedlings were also inoculated with the strain 203 of Rhizobium meliloti isolated in this laboratory. Plants were grown in a glasshouse at 19–25°C. They were watered from below and given Long Ashton nutrient solution (5 ml week−1) without phosphate for the wheat and also without nitrogen for the alfalfa.

Three ethrel concentrations were tested (0.01, 0.1 and 1 mg per pot) which were prepared in freshly diluted aqueous solutions and 10 ml per pot were either injected into the rhizosphere by using a syringe (‘root application’) or sprayed to the foliage with a hand sprayer (‘foliar application’). In the later case the soil in the pots was covered with cotton wool during spraying. There is evidence that foliar-applied ethrel will move to the root.

Ethrel treatments were applied for the first time after 10 days of plant growth, being repeated twice more at weekly intervals since ethylene is evolved after its release from ethrel. There was also an untreated control. Ten replicate pots for each of the different experimental situations (ethrel concentrations, ways of application, untreated control and plants) were prepared. Five of these replicate pots were harvested after 5 weeks of plant growth (‘first harvest’) and the remain 5 pots were harvested after a further five weeks (‘second harvest’).

Fresh weight of shoots and roots were recorded and the number of sporocarps and nodules was assessed visually at each harvest and after carefully washing the roots. Mycorrhizal infection was also estimated by microscopically examining stained root samples (more than 100 root segments per pot), and is given as ‘Total (%) infection’. This was calculated from data of incidence (percent of root