PLANT RESPONSE TO SOME EDAPHIC FACTORS

BY

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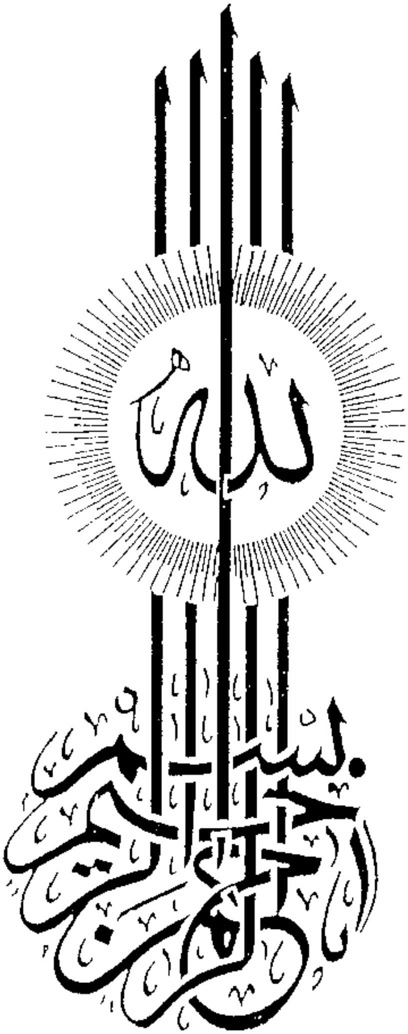

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INTRODUCTION

I. INTRODUCTION

There is a critical balance between water supply and water consumption specially in arid and semi arid regions. The problem now is in finding various ways by which the efficiency of plant roots to uptake water and inorganic nutrients could be increased.

Mycorrhizal fungi occurs in soils in close association with plant roots. The hyphae of these fungus penetrate the cells of the root cortex forming on internal hyphae network.. External hyphae also extend into the soil. The host plant supply the fungus with organic compounds and the fungus assist the roots in exploiting the soil for water and inorganic nutrients. The network of hyphae extending from plant root into growth medium enlarges the contact area between soil and fungus-host root association, and hence facilitates a greater uptake rate of nutrients particularly phosphate and water.

The prevalence of mycorrhizal associations on plants is so common under natural soil conditions so that a non-mycorrhizal plant is the exception. Few plants such as sedes, crucifers and certain aquatics are hardly infected by mycorrhizae. Other plants, specially those of major economic crops form abundant mycorrhizae on their roots.

Their is evidence that mycorrhizal infection may effect plant/water relationship and may lead to healthier plants, capable of tolerating adverse conditions which non-infected plants can not withstand such as drought, salinity and elevated temperature. Also, maximum mycorrhizal nutritional responses have been obtained in relatively low fertile soils.

The purpose of this study was to evaluate the effect of some edaphic factors (Soil water regimes, phosphorus status and soil compaction) on growth of mycorrhizal and non-mycorrhizal plants.

II. REVIEW OF LITERATURE

II.1. Biology and Function of Mycorrhizas :

There are two major classes of mycorrhizal fungi, the ectatrophic (ECM) and the vesicular-arbuscular (VAM). The ericaceous mycorrhizas are a much smaller group, and the orchidaceous fungi have little practical importance despite the attention they have received in early work. Only the two major groups will be discussed here, general descriptions of wich can be found in Harley (1969). Marks and Kozlowski (1973). Sanders et al. (1977) and Mosse, et al. (1981).

ECM form a thick (40μm) sheath of mycelia around root and mycellia penetrats between the cortical cells, so that its total mass may be comparable to that of the roots themselves. The external mycelia extending into the soil have received relatively less attention, but forms single hyphae, rhizomorphs, and hyphal strands on which fruiting bodies may develop. The form of these meycelia depends very much upon the precise host-fungus combination. Ectomycorrhizas occur exclusively on tree species, including all our major forest trees.

The vesicular-arbuscular mycorrhizas (VAM) are not abvious on inspection, but consist of internal and external mycelia without sheaths. The internal mycelia includes intracellular branched structures called arbuscules, and intercellular vesicles and hyphae. The external mycelia carry spores of differing size and may extend several centimeters into the surrounding soil. They are found on most plant species except those with other forms of mycorrhizas, though some species, mostly in the chenopodiaceae and Cruciferae, are not infected.

II.2. The Physiology of vesicular -Arbuscular Mycorrhizal Roots :

Vesicular-arbuscular mycorrhizae colonize considerable portions of the root system and, in spite of the carbon drain they impose on the host plant, their presence within the root tissues can positively influence several aspects of the host plant's physiology. In the majority of cases improved phosphate uptake is the primary cause of growth and yield enhancements in mycorrhizal infected plants. Mycorrhizal roots have different phosphate absorption kinetics and lower threshold values than non-mycorrhizal roots. The external hyphae developing around mycorrhizae explore a large volume of soil and adsrob available phosphate beyond the depletion zone of non-mycorrhizal roots. Phosphate accumulting in external fungal hyphae is translocated to the internal mycelium by a well-developed transport system and transferred to the host tissue mainly across intracellular arbuscules. Specific enzymes are associated with this alternative pathway of phosphate nutrition in mycorrhizal plants. Improved phosphate nutrition is not always sufficinet to explain the observed effects of vesicular-arbuscular mycorrhizae on host plant's physiology (Gianinazzi-Person and Gianinazzi, 1983).

The underground organs of a large number of plants growing under natural conditions do not exist simply as roots but as complex vesciular-arbuescular (VA) endomycorrhizal associations. In these plants mycorrhizal fungi invade the host cells and the host root tolerates and maintains the presence of what can be a large volume of fungal tissue. Despite the repercussions that this infection may have on root metabolism and the carbohydrate drain on the plant, the formation of VA mycorrhizae can positively influence several aspects of plant physiology: phosphate nutrition, trace element and water uptake, hormone production, nitrogen fixation and resistance to root disease.

II.2.1. Carbohydrate physiology :

The carbohydrate physiology of VA mycorrhizae has not been studied in great detail in the past, but reports of reduced growth and yield in mycorrhizal plants (Bertheau et al., 1980) are now stimulating interest in this field. There is clear evidence from experiments in which mycorrhizal plants are allowed to photosynthosize in the presence of CO_2 that the carbon requirements of VA mycorrhizal fungi are supplied by the host plant (Bevege et al., 1975). The form of carbon and its mode of transfer from plant to fungns are as yet unknown, but because the host cell always outlive the fungus, transfer must be biotrophic and take place across the living interface between the two organisms. Low irradiation, short day lengths, and defoliation, which all decrease photosynthesis, reduce the spread of VA mycorrhizal fungi in roots (Daft and El-Giahmi, 1978) and the development of mycorrhizal infection has been correlated with the exudation of both sugars and organic acids (Graham et al., 1981). It is possible therefore, that not only sugar levels, but also other major components, such as organic acids, may be important in controlling the development of VA mycorrhizal infections in roots.

According to Bevege et al., (1975) and Cooper and Lösel (1978), VA mycorrhizal fungi rapidly convert and Paul, 1980). This latter effect may partly result from the carbon demand of the fangus itself [(about 10% of the mycorrhizal biomass (Tinker, 1978)] and partly from the increased metabolic activity of root, cells following infection (Cox and Tinker, 1976; Gianinazzi-Pearson et al., 1981; Marx et al., 1982). However, mycorrhizal plants can compensate for this enhanced carbon demand of the infected roots by increased photosynthesis (Allen et al., 1981a&b). For example, in legumes plant growth is greatly improved when both Rhizobia and VA mycorrhizal fungi invade root tissues despite the high carbon demand of both microbial partners (Asimi et al., 1980; Crush 1974; Smith and Smith 1981; and Smith and Daft, 1977). Whilst the use of photosynthate by actively developing mycorrhizal fungi may adequately explain temporary grwoth reductions in young plants (Buwalda and Goh, 1982, Cooper 1975 ; Smith and Smith, 1981), this alone does not appear sufficient need to be examined further in the case of ageing infections and the physiological basis of prelonged negative mycorrhizal effects (Bertheau et al., 1980, Hall et al., 1977 and sparling and Tinker, 1978).

II.2.2. Phosphate physiology :

In the majority of cases, improved phosphate uptake is the primary cause of grwoth and yield enhancement in VA mycorrhizal plants and most phosiological studies have, therefore, focussed on this aspect.

Mycorrhizae infected roots can absorb several times more phosphate than uninfected roots from soils (Gianinazzi-Person et al., 1981; Mosse et al., 1973; Sanders and Tinker, 1971) and solutions (Bowen et al., 1975; Gray and Gerdemann, 1969; Morrison and English, 1967). Differences in phosphate absorption are most striking when soluble phosphate in the rooting medium becomes limiting for growth of the plant species involved. Mosse (1973 a), suggested that mycorrhizal roots can absorb phosphate from soils that are so phosphate deficient that none is taken up by non-mycorrhizal roots. This greater phosphate absorption by VA mycorrhizae arises because of a superior efficiency of uptake from Labile forms of soil phosphate and is not attributable to a capacity to mobilize phosphate sources unavailable to non-mycorrhizal roots (Gioninazzi-Pearson et al., 1981; Mosse et al., 1973; Pichot and Bink, 1976; Powell, 1975). Under certain conditions the mycorrhizae may, however, be able to absrob from fixed phospahte sources (Swaminathan, 1979) or stimulate root phytase activites (Allen et al., 1981; and Gianinazzi-Pearson et al., 1981). Under normal conditions where phosphate concentrations in the soil solution are low (10^{-5}M to 10^{-6}M), mycorrhizal roots have