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EFFECT OF WATER STRESS ON RHIZOSPHERE MYCOFLORA AND ROOT INFECTION OF SOYBEAN

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Abstract

Of the 29 species of fungi isolated from the rhizosphere of 28 days old soybean seedlings, *Fusarium* spp., *Aspergillus flavus* and *A. niger* were the dominant species. Plants subjected to water stress showed greater number of fungi in the rhizosphere as compared to non-stressed plants. Population of fungi in the rhizosphere of plants growing at 25% MHC was greater as compared to plants growing at 50, 75 and 100% MHCs and showed a decline with increase in soil moisture. Greater number of plants wilted at low moisture level as compared to high moisture level. Infection and or colonization of roots by *Macrophomina phaseolina* and *Fusarium* spp., also showed a decline with increasing soil moisture.

Introduction

Soybean (*Glycine max* (L.) Merr.) an economically important oil seed and food crop is an important source of plant proteins in the human diet. (Shastri, 1956). The seeds contain 20% oil which is composed of 80% unsaturated fatty acids and 7-8% linolenic acid (Neergaard, 1977). Of the various diseases affecting the crop, soilborne diseases produce severe losses to soybean plants. Soil moisture which affects growth of plants, also plays an important role as a determinant of growth of root infecting fungi. Water stress has been reported as an important predisposing factor in increasing the severity of root rot of sorghum (Hsi, 1961; Edmunds, 1964) and cotton (Ghaffar & Erwin, 1969). Infection on black gram, guar, okra and cotton was generally low at high soil moisture whereas more infection was observed in soil at low moisture level of 25% MHC (Sheikh & Ghaffar, 1979). The present report describes the effect of water stress on the rhizosphere mycoflora of soybean and the infection of roots by root infecting fungi.

Materials and Methods

Ten soybean seeds were sown in 12 cm diam., plastic pots containing 250 g sandy clay loam soil, pH 8.15. Soil moisture was adjusted and maintained at 25, 50, 75 and 100% MHC. Water holding capacity of soil was determined using the method of Keen & Rackzkowski (1921). There were 3 replicates of each treatment and the replicates were kept in randomized block design in a screen house. After 18 days of growth, the plants were subjected to water stress by allowing the water content of soil to drop to approximately 10% MHC (on the basis of daily weight). Plants were kept at 10% MHC for 3 days, after which the initial soil moisture was restored. The plants were uprooted after 3 days to determine rhizosphere mycoflora and infection of roots

by soil-borne root infecting fungi. Rhizosphere mycoflora was recorded by volume displacement technique, whereas, for the assessment of root infection and colonization the roots were washed in running tap water, surface disinfected with 1% $Ca(OCl)_2$ and 1 cm root pieces were transferred onto PDA plates containing penicillin @ 100,000 units/l and streptomycin @ 0.2 g/l. The dishes were incubated for 4 days at 28°C. The fungi isolated from rhizosphere and roots were identified after reference to Barnett (1960), Booth (1971), Ellis (1971), Gilman (1957), Nelson *et al.*, (1983) and Raper & Fenell (1965).

Results and Discussion

A total number of 29 species of fungi viz., *Alternaria alternata, A. tenuissima, Ascochyta* sp., *Aspergillus caespitosus, A. candidus, A. flavus, A. niger, A. quadrilineatus, A. sulphureus, A. terreus, A. unguis, A. versicolor, A. wentii, Cladosporium* sp., *Curvularia lunata C. pallescens, Drechslera australiensis, D. halodes, D.* state of *Cochliobolus spicifer, Fusarium* sp., *Macrophomina phaseolina, Monodictys putredinis Myrothecium roridum, Scytalidium* sp., *Stachybotrys atra, Tricothecium roseum*, sterile mycelium (black), sterile mycelium (red) and sterile mycelium (white) were isolated from the rhizosphere of soybean plants. Of these, *Fusarium* spp., *Aspergillus flavus* and *A. niger* were the dominant species. Total population of fungi in rhizosphere was greater in water stressed plants as compared to non-stressed plants. In both the stressed and non-stressed plants, the population of fungi at 25% MHC was more which showed a decline with increase in soil moisture (Fig. 1).

Wilting of plants in water stressed treatments showed strong negative correlation (r = -0.8) with soil moisture as at 25% MHC, 86% plants showed wilting as compared to 56, 13 and 36%, respectively, at 50, 75 and 100% MHC. Conversely the number of plants recovered from wilting after regaining the original soil moisture

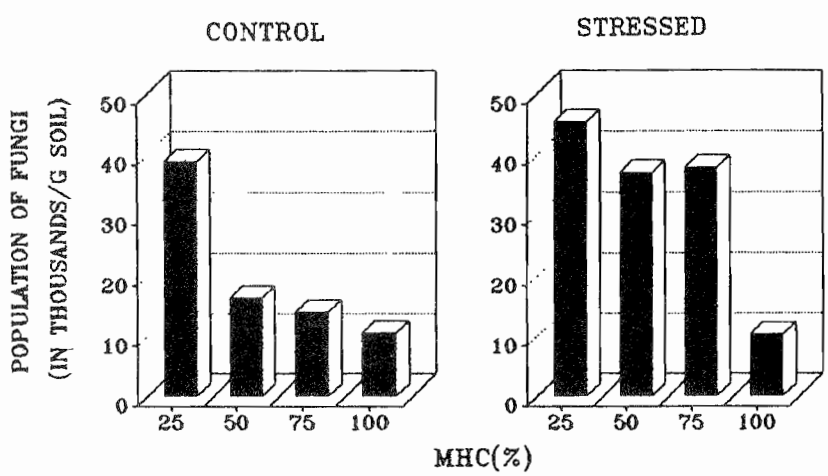

Fig.1. Effect of water stress on rhizosphere mycoflora of soybean at different moisture levels.

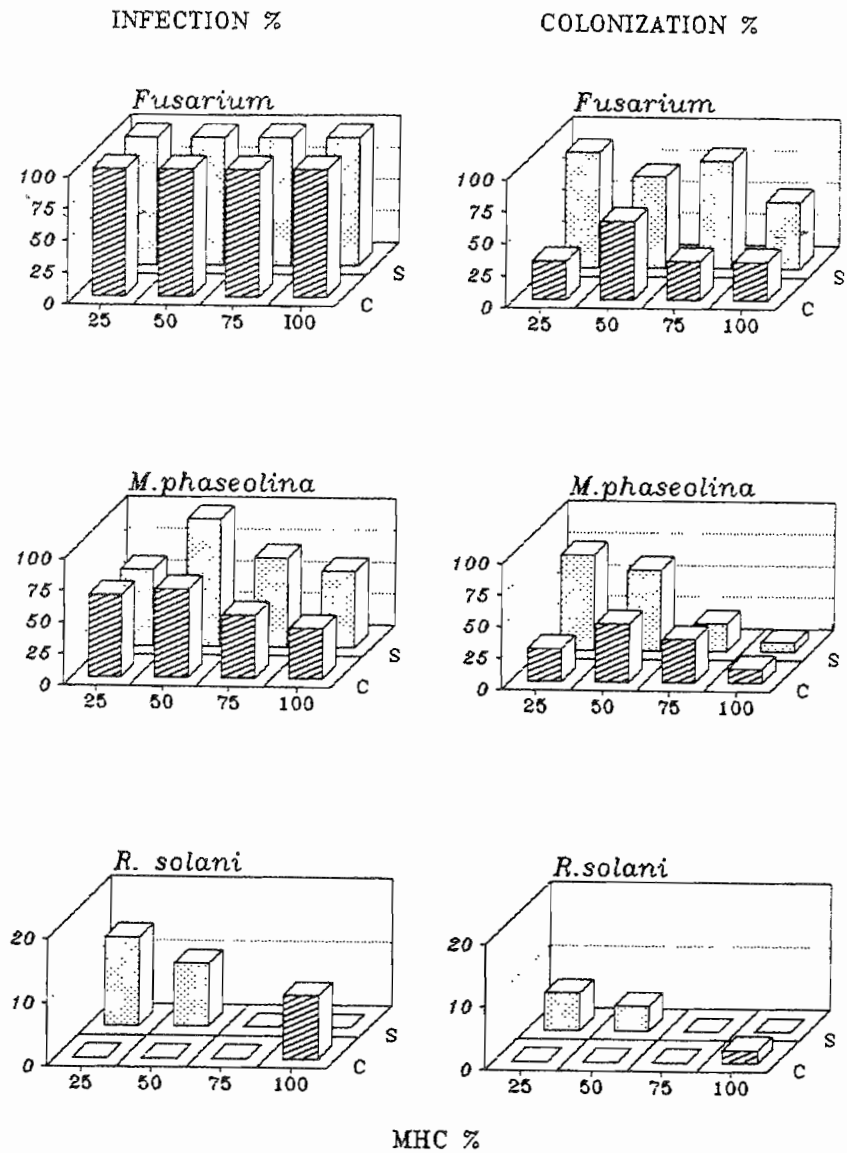

Fig.2. Effect of water stress on infection and colonization of soybean roots by *Macrophomina phaseolina*, *R. solani* and *Fusarium* spp., at different moisture levels.

C - Control; S = Stressed.

showed a strong positive correlation (r = 0.8) with increase in soil moisture as at 25% MHC only 15% of plants recovered as compared to 40, 88 and 64% recovery, respectively, at 50, 75 and 100% MHC. No wilting of plants was observed in regularly watered treatments. Moisture stress presumably predisposes the roots to infection by soil-borne pathogens resulting in wilting and or death of plants.

Infection and or colonization of roots by root infecting fungi viz., *M. phaseolina* and *Fusarium* spp., also showed a negative correlation with soil moisture. Infection of roots by *Fusarium* spp., was 100% in all treatments, however, the frequency of root colonization in water stressed plants was greater (92%) at 25% MHC as compared to 52% colonization at 100% MHC. Similarly, *M. phaseolina* infection was greater in water stressed plants as compared to control plants (Fig. 2). In both the stressed and non-stressed plants, infection and colonization of roots by *M. phaseolina* decreased with increase in soil moisture indicating that soil moisture has a direct effect on the predisposition of plants to infection of roots by root infecting fungi.

These results support the observation of Sheikh & Ghaffar (1979) who found that root infection by *M. phaseolina* on black gram, guar, okra and cotton was greater at 25% MHC than at high soil moisture. Similarly, moisture stress in addition to high temperature has been reported to favour charcoal rot of sorghum (Edmunds, 1964) and cotton (Ghaffar & Erwin, 1969) whereas Vasudeva (1941) reported that the incidence of *M. phaseolina* infection on cotton reduced at low soil temperature. Reduction in charcoal rot in cotton (Ghaffar & Erwin, 1969), soybean (Meyer *et al.*, 1974) and pine seedlings (Hodges, 1962) was observed by frequent irrigation or during rainy season. Similar results have also been reported for *Fusarium roseum* (Cook & Papendick, 1970) and *Thielaviopsis basicola* (Papavizas & Lewis, 1971). Greenhouse experiments showed that soybean plants infected with *M. phaseolina* grow vigorously in moist soil without any sign of infection, whereas the plants grown under low moisture were stunted and showed typical symptoms of charcoal rot (Dhingra & Sinclair, 1978). Radha (1960) reported increased infection and decreased cotton seed germination with decreasing soil moisture.

Presumably, plants subjected to water stress released extra nutrients from the roots which stimulated the population of fungi in the rhizosphere resulting in greater infection as compared to regularly watered plants. These results would suggest a practical cultural method of control of soybean soil-borne root infecting fungi by keeping the soil moisture at sufficiently higher level.

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