EFFECT OF SOIL MOISTURE STRESS ON LEGUME-RHIZOBIUM SYMBIOSIS IN SOYBEANS

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SUMMARY
In a pot culture experiment, the influence of soil moisture stress at different physiological stages of soybean, cv. Hark, on nodulation, symbiosis and nitrogen accumulation was studied. Moisture stress reduced leghemoglobin content of root nodules and nitrogen uptake by plants. It had no effect on number of bacteroids. Stress at mid bloom and rapid pod filling stages reduced yield and seed protein content. However, these parameters were not affected by stress at nodule initiation and early flowering stages, though, flower initiation and maturity of the plant were delayed. Moisture stress at any stage did not alter nitrogen status of roots.

INTRODUCTION
There have been numerous studies on the relationship between soil moisture and activities of soil micro-organisms. It is also known that moisture stress affects various physiological processes in plants. However, not much is known of the possible influence of moisture stress on the legume-Rhizobium symbiosis. A disturbed water metabolism of the macrosymbiont may cause an impairment of the soil-plant-water balance which may lead to reduce nitrogen fixation and uptake. The present study, therefore, was designed to investigate the influence of soil moisture stress at various stages of the physiological development of soybeans (Glycine max L. Merr.) on nodulation, bacteroids and leghemoglobin content of the root nodules and the subsequent nitrogen accumulation in the plants. Grain yield contributing characters were also taken into account.

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MATERIALS AND METHODS

A pot culture experiment was conducted in randomized block design with four replications using soybean cultivar Hark. Four kilograms of a mollisol soil passed through an 80-mesh sieve was placed in each of the polythene lined pots. The soil had 27.98% sand, 42.27% silt and 29.75% clay. It had slightly acidic reaction (pH 6.3) and high organic C content (1.98%). The exchangeable Ca, Mg, Na and K were 11.3, 5.6, 0.10 and 0.27 meq/100 g air dry soil respectively and the cation exchange capacity was 20 meq/100 g. Single superphosphate (400 mg), zinc sulphate (10 mg), ammonium molybdate (10 mg), borax (10 mg) and manganese sulphate (5 mg) were thoroughly mixed in the soil of each pot so as to make provision for ample supply of nutrients.

Seeds, soaked overnight in sterile distilled water, were treated with soybean rhizobial inoculant (Nitragin Co., Milwaukee, Wis., U.S.A.) uniformly. Eight to ten inoculated seeds were sown in each pot and thinly covered with soil to facilitate germination. After thinning, a uniform population of two plants was maintained in each pot.

The moisture stress treatments were given in quadruplicate to pots selected at random at each of the nodule initiation stage (NIS), early flowering stage (EFS), mid bloom stage (MBS), EFS and MBS in combination (EFS + MBS), rapid pod lolling stage (RPS) and MBS and RPS in combination (MBS + RPS). Control pots did not receive any stress treatment. Since the plants in control, NIS and EFS pots were also to be harvested for nodulation studies after the termination of EFS treatment, four extra pots of each of these treatments were planted simultaneously. Thus, there were 8 pots under each of these three treatments in the beginning. The stress was applied by withholding water supply until a temporary wilting of the plants occurred. Water deficit in the leaves was determined by the method of Weatherley and per cent water saturation deficit (WSD) computed. The stress was given for three consecutive days maintaining a constant water deficit by making up the water lost by evapotranspiration at each four hourly interval. The per cent WSD in the leaves was determined at regular intervals throughout the period of moisture stress. The measurement of per cent WSD in the control plants was also carried out.

Plants from four pots out of eight pots from each of control, NIS and EFS stress treatments were separated from soil after six weeks growth and the root system examined for nodulation. After recording fresh weight, nodules were cut off from the root system and transferred to ice cold M/15 phosphate buffer (pH 7.0). Leghemoglobin was estimated by the method of Procter using Ox-blood hemoglobin as standard and expressed as µg/g of nodule tissue (fresh weight). Bacteroids were counted by the method as outlined by Bergersen.

Plant tops were dried at 60°C. The nitrogen content was determined by the micro-Kjeldahl method of Piper and expressed as mg N/pot. Observations on various yield contributing characters like number of pods, number of grains per pod, were also recorded. Protein content of grain was computed from the nitrogen estimated by the method of Piper.

RESULTS

The stress treatment was particularly severe in its effect at EFS causing nearly 50 per cent reduction in growth (Table 1). However, little or no significant effect of moisture stress at NIS, on dry matter accumulation of root and shoot, indicated more loss of water from plants by moisture stress at EFS than at NIS.

Moisture stress at EFS significantly reduced total number of nodules. The reduction in the number of nodules by stress treatment at both EFS and NIS was more apparent on the secondary roots than on main root. A significant reduction