

Acetylene Reduction and Fertilization Responses in Lotus purshianus

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Native legumes are an important forage component in the annual grass rangelands of the central California Sierran foothills. Of the management practices tested for increasing growth of legumes at the San Joaquin Experimental Range, sulfur fertilization has been the most successful. Plant dry weight, legume density and nodulation were all higher in S-fertilized field plots sampled at the end of the winter growing season (Bentley, et al., 1958; Green, 1959).

We tested the effects of S-fertilization on growth and nitrogen fixation rates (acetylene reduction activity) of five SJER forage legumes: Lotus purshianus, Lupinus bicolor, Trifolium microcephalum, L. ciliolatum and L. variegatum. Only the results for Lotus purshianus will be discussed here.

The plants were grown in pot culture in native soil and were incubated in a growth chamber with day length and temperature controlled to approximate natural growth conditions. Treatments were applied at 28 d post-seeding, at which time the plants had formed the first true leaves. Fertilization levels were S (65 kg ha⁻¹), N (35 kg ha⁻¹) and unfertilized. Three pots at each fertilization level were uninoculated; three received 10¹⁰ cell of a known effective Rhizobium lupini strain isolated from a nodule collected from L. purshianus in the field. Unplanted pots of soil were also treated and were incubated with the plants to ensure that the acetylene reduction activity (ARA) measured was due to growth of the legumes. All pots were watered as required for plant growth, but were allowed to dry until the plants had reached the wilting point at 83 d post-inoculation.

Although L. purshianus was slow to germinate in the growth chamber and is the last legume to bloom in the field, it was the first of the species to bloom in the growth chamber and was still blooming at the end of the experiment. Inoculated plants of this species bloomed earlier than uninoculated plants, and N-fertilization speeded blooming.

Acetylene reduction activity was determined by enclosing the pots (including plant shoots) in Nalgene polycarbonate jars. Ethylene concentration was determined using gas chromatography. Activity was linear between 60 and 120 min; three samples taken during this period were used for rate calculation. No ARA was detected in unplanted pots of soil. Of the species tested, only L. purshianus showed a positive response to S-fertilization. Sulfur fertilization increased the rate at which ARA developed in inoculated plants, but had little effect on the maximum activity attained. Inoculation increased ARA of unfertilized and S-fertilized plants, while combined inoculation and N-fertilization decreased and delayed the development of ARA. Acetylene reduction activity ceased after plants were dried to the wilting point, even though most plants appeared to recover completely from water stress after being rewatered.

Shoot biomass was determined by oven dry weight. Total N content of the plant shoots was determined by the Kjeldahl method. Of the legumes tested, only L. purshianus showed increased growth or N content in response to fertilization with N or S. Sulfur increased shoot weight only when combined with inoculation.