RESEARCH ABSTRACT

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Study Title: Contributions by lupines to volcanic soils.

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Abstract: The effects of colonization of Lupinus lepidus and L. latifolius on carbon, nitrogen, and microbial activity in volcanically disturbed soils was investigated in several studies. Examination of nitrogen fixation rates showed that both species have diurnal and seasonal fluctuations that appear to be associated with environmental factors. Nitrogen fixation rates are highest during daylight and early in the growing season, and the seasonal pattern is reflected in carbon and nitrogen levels; that is, as nitrogen fixation increases, carbon and nitrogen production increases. First year plants of both species fix similar amounts of nitrogen.

Though lupines do contribute a significant amount of nitrogen to the soils where they colonize, their contribution to the overall system is less than that from other sources. The highest rates of nitrogen fixation by lupines among study sites was found on the pumice plain.

Lupine seedlings make the most important contribution in addition of nutrients to soil. Both species begin to fix significant amounts of nitrogen within two weeks of germination; the rate of nitrogen fixation relative to plant biomass is similar for seedlings and adults of both species. Since seedling mortality is generally high in these disturbed areas, a tremendous amount of carbon and nitrogen is released into the soil and made available to other organisms when seedlings die off each growing season.

Comparisons of soil under lupines to bare soil show more total nitrogen in lupine soil. This was the case at all sites studied but was most pronounced on the pumice plain. Studies of soil carbon show that there is more carbon under lupines than in surrounding soil on the pumice plain. In areas of less volcanic disturbance where there is already a high concentration of carbon in soil, there is less carbon under lupines. This is largely due to the priming effect of lupines. Microbial activity is increased under lupines due to addition of nutrients to the soil; with increased activity, microbial respiration increases and carbon is released from the soil in the form of carbon dioxide.

Investigation of the effects of lupines on soil microbial activity compared soil under L. latifolius, living L.

lepidus, dead L. lepidus, and bare soils at various depths. The highest levels of microbial biomass were found under L. latifolius; second highest under dead L. lepidus; third highest under living L. lepidus; and significantly lower levels were found in bare soil. In all instances, most activity occurs in the top 5 cm of the soil profile and decreases as depth increases.

In an experiment in which leaves of the two species were added to samples of each of these soils, interesting patterns of microbial activity were observed. All four types of soil showed the greatest increase in activity when leaves of L. latifolius were added; after an initial burst of activity, it tapers off to normal levels for these soils. Addition of L. lepidus leaves, by contrast, results in a slower, steady increase in activity that eventually exceeds levels in soils that have been amended with L. latifolius leaves. Bare soil shows increased microbial activity with the addition of lupine leaves but not to the level of soils in which lupines have grown.

Type of Measurement(s): Plant measurements for field adults and greenhouse seedlings: biomass (grams); patch density (#individuals/M^2); seed weights; total organic carbon, total Kjeldahl nitrogen, total Kjeldahl phosphorous, inorganic nitrogen, and total soluble carbon; nitrogen fixation (%); nitrogenase activity (micromoles/gram of nodules/time); in addition to all of the above, greenhouse seedlings were measured for leaf area, relative growth rate, net assimilation rate.

Soil measurements (20 day incubation): estimates of carbon and nitrogen mineralization; nitrification potentials; Ph; buffering capacity; estimation of microbial biomass via substrate induced respiration.

Frequency of Measurement(s): Beginning in 1981, annually on the pumice plain.
Nitrogen fixation data was collected in summer 1986, once per month for 5 months at 5 sites. Soil work conducted in 1987 (4 times in summer), June 1988, and Sept. 1990.

Data Storage: Hard copies in spread sheet format in ASCII Quatropro in personal possession.

Long-term plans: Data available for collaborative efforts: Study ongoing to monitor long-term processes especially soil microbes. Hopes to be able to sample soil annually. Available for collaborative efforts, hopes to actively conduct field work in such a situation.