Soil Respiration Rates under Different Land Uses in Northeastern Mexico

Israel Cantú, Humberto González and Marco V. Gómez

Universidad Autónoma de Nuevo León, Facultad de Ciencias Forestales

Apartado Postal 41. Linares, Nuevo Leon 67700 Mexico. E-mail: icantu@fcf.uanl.mx

Introduction.

Soil respiration is an important component of the terrestrial carbon budget and is considered the second-largest factor in the flux of carbon between the earth's ecosystems and the atmosphere (Bohn 1982, Eswaran *et al*., 1993, 1995). Soil respiration is widely accepted as the most representative manifestation of the biological activity in the soil, and a good understanding of the variation occurring in the CO_2 fluxes due to land use changes, could help interpret the soil fluxes of other biogenic gases such as N_2O, NO, CO, CH_4. Identifying the environmental factors that control soil CO_2 emissions and their effects on emission rates, is a fundamental aspect in assessing the potential impacts of environmental change. Soil respiration rates vary significantly among major biome type, suggesting that vegetation type influences the rate of soil respiration, soil microclimate and structure, the quantity and quality of detritus supplied to the soil, and the overall rate of root respiration (Raich and Tufekcioglu, 2000). According to the above mentioned and focusing on the importance of the increasing anthropogenic emissions of greenhouse gases in northeastern Mexico.

Objetive.

To assess the contribution of different land uses in CO_2 efflux in predominant vertisols type soils in northeastern Mexico.

Materials and Methods.

Research site

Sampling procedures

Determinations of CO2 efflux in each plot were made twice a week between July 3, 2001 and January 29, 2002. At each sampling date, two daily measurements (at 08:00 and 14:00 h local time, named herein as morning and afternoon sampling time, respectively) were carried out. At each sampling time, four (replications) randomly measurements of soil CO_2 efflux (mmol CO_2 m^{-2} s^{-1}) were taken. Simultaneously, soil temperature (^oC) and soil water content (%, dry mass basis) were registered. It is important to mention that soil respiration in *Sorghum* and *Leucaena* plots, was measured between plant rows.

Soil Respiration Measurement

The closed chamber method for measuring soil respiration was described by Parkinson (1981), where a chamber of known volume is placed on the soil and the rate of increase in CO_2 within the chamber is monitored. Thus, soil CO_2 efflux in each plot was obtained by means of a dynamic closed chamber which is a portable system EGM (PP-Systems, U.K.), employing infrared gas analyzer (IRGA) and a soil chamber (SRC-1), equipped with a fan. With this system, the air is continuously sampled in a closed circuit through the EGM, and the soil respiration rate is calculated, displayed and recorded by the analyzer.

Land Uses Experimental Plots

Five experimental plots with different land uses were selected at the research site to evaluate the contribution of CO_2 efflux: Pasture (*Dichanthium annulatum*), *Leucaena leucocephala* in an alley cropping system, a native and undisturbed shrubland plot, *Eucalyptus microtheca* plantation, and a *Sorghum bicolor* field. L

Environmental data

Air temperature (^oC) and precipitation data (mm) were obtained from a meteorological station located 100 m from the study site. Gravimetric soil water content on each sampling date was determined in soil cores at depths of 0-20 cm by using a soil sampling tube (Soil Moisture Equipment Corp.). Soil water content was determined by drying soil samples in an oven at 105ºC for 72 h, and was expressed on a dry mass soil basis. Soil temperature was measured by means of a geothermometer (Fisher Scientific) at 10-15 cm soil depth.

Results.

Seasonal variation in soil respiration

The seasonal variation in morning and afternoon soil respiration rate at each land uses is shown in Figs. 1 (a) and (b), respectively. During the studied period, average morning soil respiration rates ranged from 0.01 (Shrubland and *Sorghum*) to 8.46 (*Leucaena*) μmol CO_2 m^{-2} s^{-1}. With respect to afternoon soil respiration rates values ranged from 0.01 (Pasture, *Eucalyptus* and *Sorghum*) to 14.4 (*Leucaena*) μmol CO_2 m^{-2} s^{-1} throughout the experimental period. In general, average morning and afternoon soil respiration rates showed the following decreasing CO_2 efflux order among the five investigated land uses Pasture>Shrubland>*Leucaena*>*Eucalyptus*>*Sorghum.*

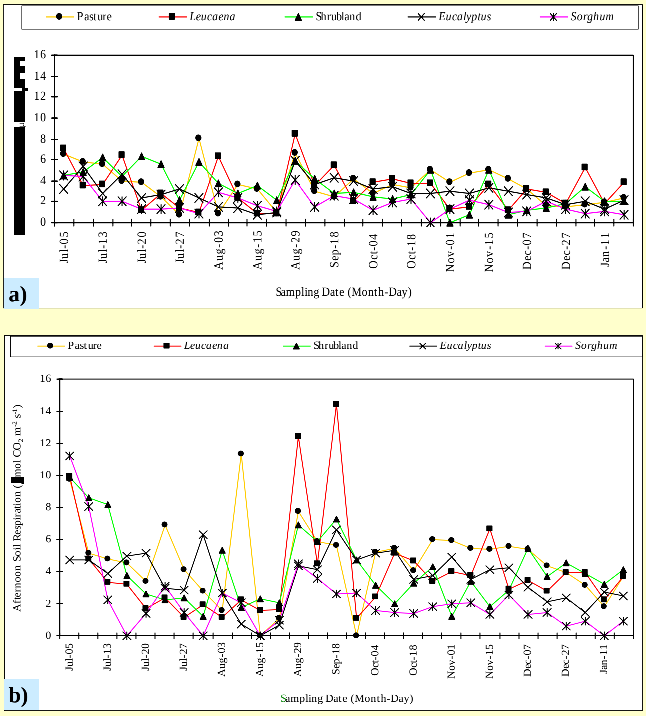

Figure 1. **Seasonal variation in morning (a) and afternoon (b) soil respiration rate at five different land uses. Pasture (•); Leucaena (■); Shrubland (▲); Eucalyptus (×) and Sorghum (∗).**

Soil temperature and soil respiration relationships

The relationship between soil respiration rate and soil temperature for all land uses at each sampling time is illustrated in Fig. 2 Morning soil respiration rates during the studied period ranged from 0.7 to 8.4 μmol CO_2 m^{-2} s^{-1}, while in the afternoon increased the range from 0.6 to 14.4 μmol CO_2 m^{-2} s^{-1}, showing the *Leucaena* and Pasture the absolute maximum CO_2 efflux rates. Higher afternoon soil temperatures were observed during the studied period in Sorghum and Pasture plots, such results may be related to the low vegetative density of these land uses, due the lack of radiation interception, compared with others land uses involving trees (i.e. *Leucaena* and Eucalyptus) that showed lower soil temperatures. However the trend of morning soil temperature during the studied period was similar in the five land uses. Although Pasture and Sorghum showed higher afternoon soil temperatures, only Pasture showed higher soil respiration rate, while Sorghum presented the lowest soil respiration rates.

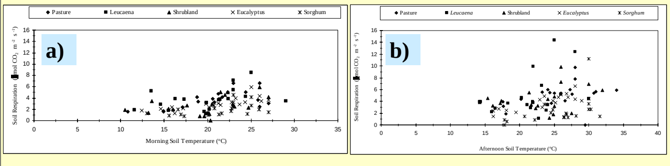

Figure 2. **Relationship between soil respiration and soil temperature in morning sampling (a) and afternoon (b). Data are from all land uses and selected sampling dates (SWC>15%) during the studied period.**