Soil Environment and Respiration As Influenced by Secondary Succession and Chlordane On Three Northeast Indiana Sites

N. David Schmidt[1], Gerald E. Bendixen[2], James D. Haddock
Department of Biology
Indiana University-Purdue University at Fort Wayne
Fort Wayne, Indiana 46805

Abstract

The effects of chlordane and successional development on carbon dioxide evolution were studied on their northeastern Indiana sites during the 1975 growing season. Soil moisture, temperature, and carbon dioxide evolution were sampled every two weeks from mid-May to December on a control plot and a treated plot on each of the three sites. A multiple regression of the data removed the effects of soil moisture and temperature and determined the effect of chlordane on soil respiration. Chlordane reduced the level and natural variability of soil respiration measurements. These effects were more significant on the sites of early successional development.

Introduction

Soil respiration has been studied in a variety of ecosystems from at least as early as Lundegardh (1), (2). In this study the effects of succession and perturbation (chlordane) on soil carbon dioxide evolution were explored. An attempt was made to determine whether the effects are direct or if they are due to an alteration of the physical environment due to succession.

Methods and Materials

The dynamics of temperature, moisture, and carbon dioxide evolution were examined throughout the 1975 growing season in three northeast Indiana plant communities: a woodlot, a blackberry brambles and an old field. All sites were within .5 kilometers of each other. The soil texture on all sites was a silt loam and they all had a silty clay loam texture in their upper horizons. The woodlot and old field were situated on the Morley Series (Morley silt loam, 2-6% slopes, moderately eroded) and the blackberry brambles site belonged to the Martinsville Series (Martinsville silt loam, 0-2% slope).

The complete history of the woodlot is not known. Based on the size of the red oak (*Quercus rubra*) and basswood (*Tilia americana*) root sprout regeneration, the last extensive cutting probably took place some 30 to 40 years ago. Sugar maple (*Acer saccharum*) comprises most of the saplings and will eventually dominate if the site remains undisturbed. The old field site has not been farmed in the last four years and herbaceous perennials are dominant. Important grasses include orchard grass (*Dactylis glomerata*), Kentucky bluegrass (*Poa pratensis*) and timothy (*Phleum pratense*). The dominant forbs are mainly composites belonging to the genera *Erigeron*, *Aster*, and

[1] Present Address: Harley Feed and Fertilizer, Inc., Chambers, NE 68725.
[2] Department of Mathematical Sciences.

Solidago. Species of *Rosa* and *Rubus* are responsible for the character of the blackberry bramble site. Many of the herbaceous species found in the old field are present but the forbs are much more abundant than the grasses.

Sampling was conducted at approximately two week intervals starting in mid-May. The sites were sampled on sequential days with the blackberry site being first and the woodlot last. Three soil cores were taken of the top one inch and three cores of the top three inches for soil moisture determination. Triplicate temperature readings were taken at the soil surface, one inch depth and three inch depth at each sampling time. The soils were dried to constant weight at 105°C and percent moisture on a dry weight basis was determined.

In early May, at each site, one of a pair of 3 by 4.5 meter plots was sprayed with chlordane according to the label instructions. CO_2 evolution was determined by absorption by a base (20 ml of 1.000N KOH) and subsequent titration with HCl. The chambers were one gallon cans painted white. Three determinations were made on each of the treatment and control plots at each site at each sample time.

A preliminary study showed that the soil moisture at the 3 inch depth and the temperature at the 1 inch depth were more closely associated with the changing values of CO_2 evolution. Therefore, only the soil moisture and temperature at these depths were used in the subsequent analysis. To remove the dependence of soil respiration on moisture and temperature, a multiple regression was performed. Treating each of the three sites separately, the logarithm of CO_2 was regressed against soil moisture and the logarithm of temperature.

Results and Discussion

The average seasonal moisture, temperature and CO_2 evolution are shown for the various sites (Table 1).

TABLE 1. *Average values of measured variables at each site.*

	Moisture %		Temperature °C			CO_2 Evolution mg C/hr/m²	
Site	1 inch	3 inch	Surface	1 inch	3 inch	Treated	Control
Oldfield	23.7	21.8	23.1	21.5	20.0	62.9	86.2
Blackberry	24.1	21.9	21.4	19.2	18.0	65.8	81.2
Woodlot	33.8	32.4	19.3	17.0	16.1	45.4	46.9

The results of the data collected at the oldfield site is shown in Figure 1. The horizontal axis indicates the day of the year (number of days since December 31, 1974) the sample was taken. Shown are two lines describing the measured CO_2 evolution on the control and treatment plots. Each of the data points on these curves is an average of the three values of CO_2 evolution observed at that sample time. The other two lines show the predicted values of CO_2 evolution at each sample time in each plot. The predicted values are based upon the

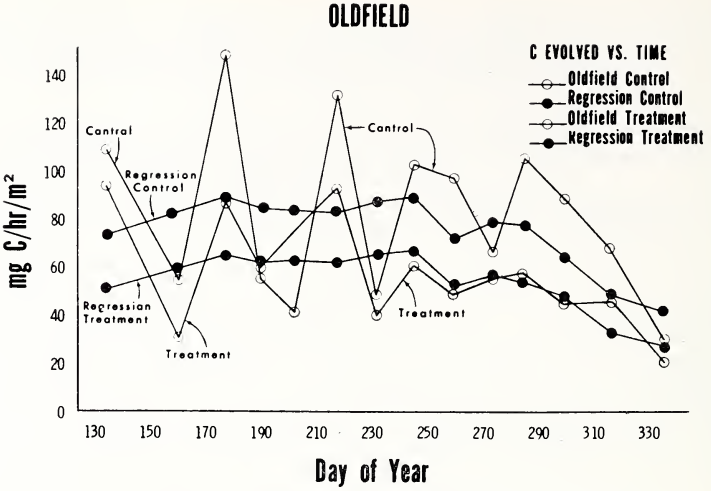

FIGURE 1. *CO_2 Evolution at Oldfield Site vs Day of Year.*

results of the multiple regression and vary according to the soil moisture and temperature at the sample time. The regression curve of the treatment plot is 27% lower ($p = .003$) than the regression curve of the control plot. One also can observe that the measured values of CO_2 evolution on the treated plot have lower peaks than the values from the control plot. Chlordane had the effect of reducing the natural variability in soil respiration.

Figure 2 shows the CO_2 measurements and the regression curves for the blackberry site. There was a 16% reduction ($p = .06$) in the

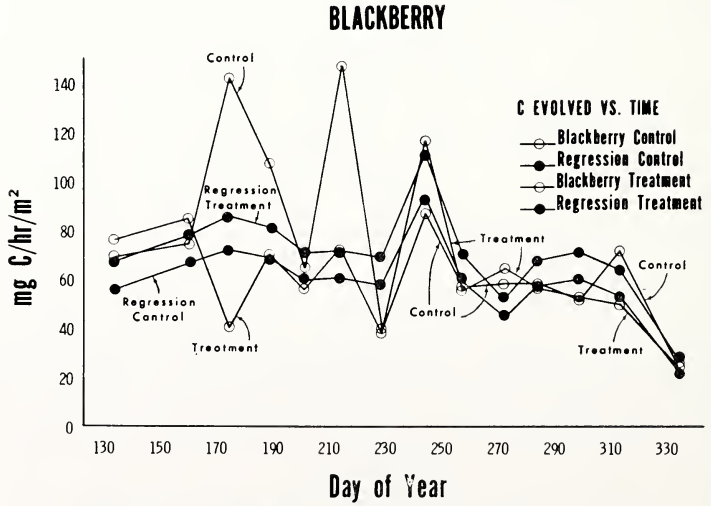

FIGURE 2. *CO_2 Evolution at Blackberry Site vs Day of Year.*

regression curve at the treated plot compared to the control plot. The natural swings in CO_2 evolution measurements appear to be reduced in the treated plot.

Figure 3 describes the observations on the woodlot site. The multiple regression indicated that there was no significant difference in the CO_2 evolution values at the two plots and therefore only one regression curve is shown. The CO_2 evolution measurements after correction for soil moisture and temperature are lower on the woodlot site than either of the other two sites. With respect to this observation, it may be mentioned that no attempt was made to equalize soil nutrients at the three sites.

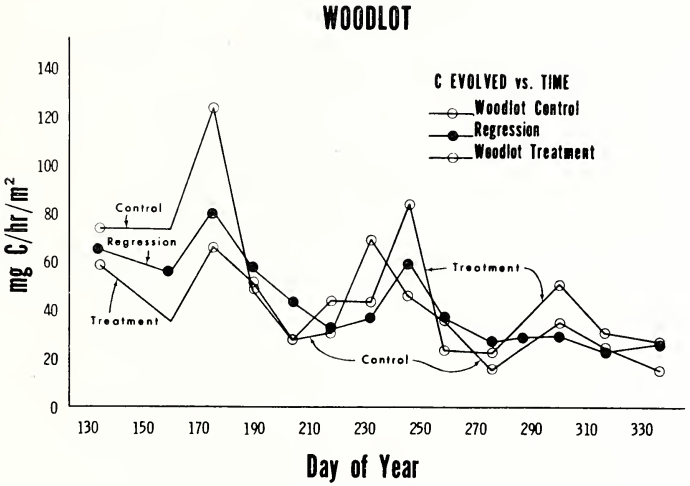

FIGURE 3. *CO_2 Evolution at Woodlot Site vs Day of Year.*

Summary

Significant differences in carbon dioxide evolution due to both successional development and treatment were found to exist during the 1975 growing season. The effect of chlordane was to reduce the level of carbon dioxide evolution and to reduce the natural variability of the measurements. In this study, both of these effects were more significant in sites of early successional development.

Acknowledgments

The authors appreciate the technical assistance provided by Bruce Keller and Ann Creselius.

Literature Cited

1. KUCERA, C. L. and D. R. KIRKHAM. 1971. Soil Respiration Studies in Tallgrass Prairie in Missouri. *Ecology* 52:912-915.

2. LUNDEGARDH, H. 1927. Carbon Dioxide Evolution of Soil and Crop Growth. *Soil Science* 23:253-335.