PROCEEDINGS
OF THE
NINTH SYMPOSIUM
ON THE
NATURAL HISTORY OF THE
BAHAMAS

Edited by:

David L. Smith
Sherilyn Smith

Conference Organizer

Kenneth C. Buchan

Production Editors

David L. Smith
Sherilyn Smith
Vincent J. Voegeli

Gerace Research Center
San Salvador, Bahamas
2003

Cover photograph courtesy of David and Sherilyn Smith

Printed in the USA

ISBN 0-935909-73-7

DETERMINATION OF NUTRIENT CONCENTRATION LEVELS IN SOIL SAMPLES TAKEN FROM SLASHED AND BURNED FIELDS ON SAN SALVADOR ISLAND, BAHAMAS

Joshua R. Meyer
Jason D. Keith
Lawrence J. Stephens

Division of Mathematics and Natural Sciences, Elmira College
Elmira, NY 14901

ABSTRACT

The slash and burn technique has been used in the Bahamas to increase nutrient levels in nutrient-poor soil. The Cornell Method for "Chemical Soil Tests," developed by Thomas Greweling and Michael Peech, is a useful way to determine the concentrations of soil nutrients and to measure the effectiveness of the slash and burn technique.

The specific nutrient levels being tested at Elmira College are ammonia, nitrate, potassium, and phosphorous. Samples are also being analyzed for total organic content. Each year, approximately three sets of soil samples are taken from two different fields treated with the slash and burn technique. In the past year and a half, the two different fields have not been burned, nor have they been used for crops. Nutrient levels are being studied in fields that lie fallow and fields that are being used for growing crops in order to compare any nutrient level changes.

INTRODUCTION

The soil of the Bahamas is characterized as very thin, nutrient-poor, material composed mainly of sand, clay, and ash with a maximum depth of no more than two inches. The slash and burn technique was practiced by the Arawak Indians in pre-Columbian days in what is now the Commonwealth of the Bahamas. This technique also known as "shifting cultivation" helped the Arawaks to grow many starchy and sugar-rich crops, such as manioc, yucca, sweet potatoes, peanuts, lima beans, and squash (Eneas 1998). When planting, the Arawaks located a fairly smooth, gently sloped piece of land for drainage purposes. After a site was chosen, trees and brush were cut and burned while the stumps and smaller trees were left to help protect the cultivated crops as well as the soil. Crops were planted at the end of the dry season, just before the rains of the approaching wet season because this was the only source of water for the crops. Along with the nutrient rich ash, manure was also used by the Arawaks to provide nourishment for the crops (Eneas 1998).

Eneas reported that the Arawaks could maintain a single plot for fifteen to twenty years. This was possible because of the fallow periods lasting up to thirty years, which restored nutrients and decaying plant matter. The plots that are used for our research, presently only last for about three years then are abandoned for new plots. Currently corn, lima beans, pigeon peas, and native okra are grown. Due to the severe degradation and erosion of the island soil from overuse, deforestation and weather, the fields can only be used for this short period of time. The slash and burn technique has been proven to be effective and reliable for the Bahamian agrarian society as well as a fairly efficient method given the socioeconomic conditions of remote island life.

MATERIALS AND METHODS

Samples are collected at approximately three different times each year. The fields under study are either freshly cut and burned, in use, or not recently burned. This range in activity should provide results that have a variance in nutrient level concentrations.

Ten samples were gathered over a twenty-three month period from a field on San Salvador Island, Bahamas with the following coordinates: 24° 06.939', 74° 27.705' for the upper field; and 24° 06.935', 74° 27.703' for the lower field.

The samples were gathered directly from the soil surface and contain a mixture of sand, ash, rock, and dead plant matter. These samples were placed in plastic, zip-lock bags and transported to the laboratory in Elmira, NY, USA.

The soil mixture was then filtered through a Sargent 30-mesh sieve to remove larger components, leaving a fine textured, small granular sample. The Cornell Method was used for analysis of the soil extract. Ten grams of each sample was weighed and placed in fifty milliliters of an acetic acid extracting solution with a small amount of activated decolorizing carbon. The solutions were prepared and mixed for thirty minutes on an automatic mixer and then filtered by gravity through a Whatman 1 filter paper into fifty-milliliter Erlenmeyer flasks (Greweling and Peech 1965). This procedure gave a clear, colorless, soil extract to be used in nutrient tests.

These soil extracts were then tested for concentrations of phosphorous, ammonia, nitrate, and potassium using reagents and standards prepared according to the Cornell Method. Nutrient concentrations were detected by use of either an UV-Vis spectrophotometer, or an atomic absorption spectrophotometer.

In addition to the nutrient tests, the soil was also tested for the presence of organic matter. Two grams of each sample were placed in a small crucible and brought up to 375° C, in increments of 75° C every fifteen minutes. Once 375° C was reached, the samples were kept at that temperature for an hour and then heated to 550° C, and left at this temperature for twenty hours. The samples were then cooled and weighed to determine the percentage of organic matter in the soil (Carter 1993).

RESULTS

Analytical results expressed in pounds per acre for each sample were plotted for each date.

$$\frac{\text{Pounds of nutrient}}{\text{Acre of soil}}$$

The concentration, expressed in parts per million (ppm), for each nutrient was determined. The following equation was then used to convert nutrient concentrations in the soil extract to pounds per acre.

$$\text{ppm} \times \text{soil depth} \times 0.3 = \text{pounds per acre}$$

Because of the great variation in soil depth on San Salvador a specific soil depth cannot be accurately determined. A soil depth of two inches was used in calculations, so that comparisons could be made.

Nutrient concentrations displayed in Figure 1 for ammonia, Figure 2 for nitrate, Figure 3 for phosphorus, and Figure 4 for potassium show some trends in the twenty-three month observation period. It was observed that the nutrient concentrations in the lower field were lowest in samples collected during February and April, 2000. This occurred in all cases, except for ammonia. Trends in the upper field were not as easily observed. Although nutrient concentrations in the upper field followed a similar pattern, concentrations were not as low as in the lower field. The data from total organic followed a pattern similar to that found in soil nutrients.

It can be observed from the graphs that nutrient concentration levels at the end of the study period had returned to their approximate initial levels observed 23 months earlier. The initial point and ending point were the peaks for all samples, except ammonia.

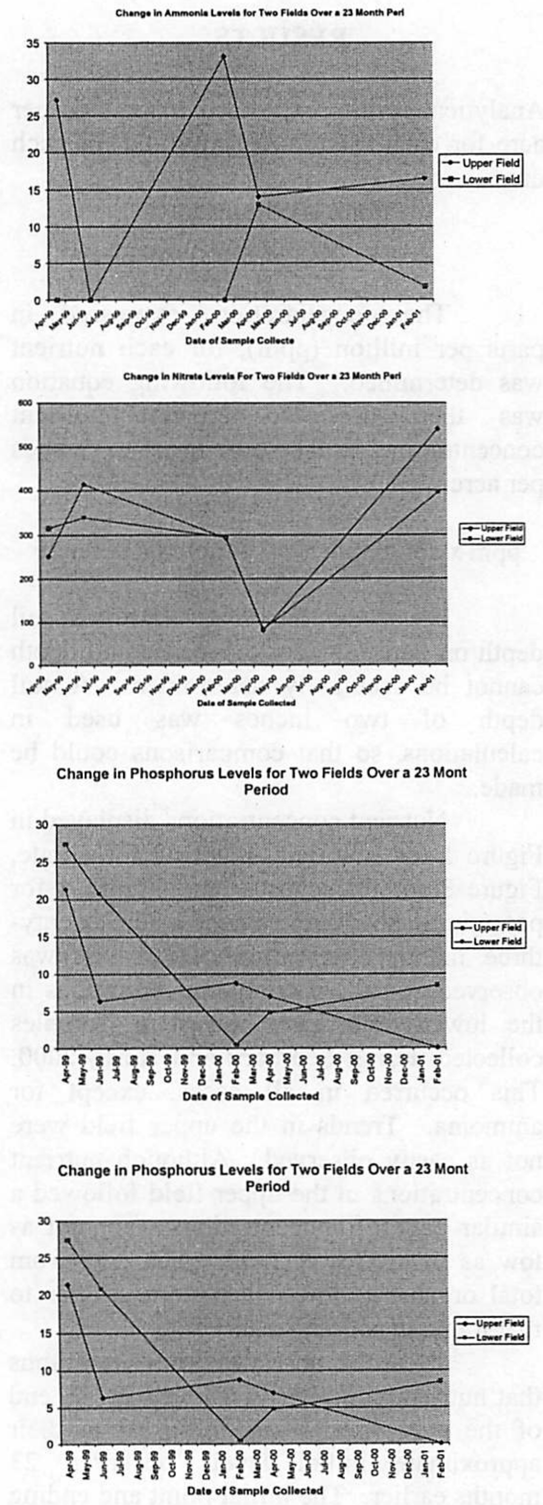

Figure1,2,3 and 4. Changes in nutrient concentration over a 24 month period.

DISCUSSION

As discussed in the results section, both fields followed similar patterns of nutrient concentrations over the 23-month cycle. This is undoubtedly due to the close proximity of the fields.

The similarity between the initial and final measurement can be explained by observing the slash and burn pattern along with field use patterns. The fields were just burned prior to the initial measurement. This would cause the nutrient level concentrations to be high. With continued use of the fields, nutrient levels dropped to a low between the months of February and April, 2000. There was no visible use of the field from October 1999, when the crops were harvested, through the final measurement in February 2001. The graphs show that the nutrient level concentrations continued to drop after the field was no longer in use. Nutrient concentration levels started to increase with no apparent burning, which could be due to naturally occurring vegetation. Ideally, a field would be used for a long enough period of time to establish a trend for the nutrient concentration levels, but the short length of time that a field is used makes it difficult to notice these developing trends.

In an effort to more completely understand the slash and burn technique and its effect on nutrient concentration levels on San Salvador Island, other test sites will need to be added. Along with more locations, a control site should be added to determine whether the slash and burn technique is completely responsible for the results.

LITERATURE CITED

Carter, Martin E. 1993. *Soil Sampling and Methods of Analysis.* Lewis Publishers. Boca Raton, FL. Pp. 460-464.

Eneas, William and J. Godfrey. 1998. *Agriculture in the Bahamas: Historical Development.* Media

Publishing. Nassau, Bahamas. Pp.8-13.

Greweling, T. and M. Peech. 1965. *Chemical Soil Tests.* Cornell University Agricultural Experimental Station