The Effect of Gamma Radiation on Soil Nitrogen, Phosphorus and Organic Matter

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Introduction

It is a well known fact that gamma radiation causes changes in different biological and natural bodies. Since the soil is considered as a natural body containing many forms of life, the study of radiation on soil can be of importance in determining what changes result from its use. The object of this study was to determine the effects of gamma radiation on the nitrogen, phosphorus and organic matter content of three sandy soils.

Experimental Procedure

Three virgin soils (6" depth) were used in this study, each with a different organic matter content. The soils used were: Blanton (low organic matter content), Arredondo (medium organic matter content) and Rutledge (high organic matter content). All of them are *fine* sands.

Five different treatments (0 kr, 4 kr, 64 kr, 1024 kr and 2048 kr) and three replications were used in the experiment. The chemical determinations were made on two different dates; the first set of determinations was run as soon as possible following irradiation. The second set of determinations was run after the second week following irradiation.

The soil samples were obtained from the vicinities of Gainesville, Florida during the last week of september, 1960. After air drying, the soil samples were sieved through a 2 mm sieve. One hundred grams of soil were put into polyethylene bags; the moisture content was adjusted for Blanton and Arredondo to 10%, and for Rutledge at 40% by adding distilled water to each individual bag. The soil samples were irradiated in a cobalt 60 Irradiator at the Agricultural Experiment Station, University of Florida.

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Chemical Methods

Nitrate was determined by the phenoldisulfonic acid method (2).

The soils were leached with 300 ml. 1N KCl and the nitrogen determined in the leachate according to Jackson (3).

Phosphorus was determined by using the Bray and Kurtz method (1). The organic carbon content was determined by the Walkley-Black method modified by Walkley (4).

Results and Discussion

The results of this study are shown in Tables 1 to 4.

Nitrates (Table 1) show a variation in results but these results are always less than the 0 kr level except for Arredondo at 4 kr and at 64 kr where the value is larger than the value at 0 kr level of radiation.

Table 1.—The effect of various levels of gamma radiation on the average (ppm) nitrate-nitrogen of Blanton, Arredondo and Rutledge fine sands.

Soil Type	Dates[a]	Gamma Radiation in (kr) 0	4	64	1024	2048
Blanton	I	2.9	1.7	2.0	1.8	1.6
	II	4.8	3.2	1.8	3.0	1.6
Arredondo	I	18.7	20.0	17.7	13.5	13.8
	II	25.7	25.9	28.7	17.8	12.1
Rutledge	I	9.4	7.8	5.9	4.3	4.4
	II	32.1	30.6	7.0	6.2	5.1

a Determinations were made: (I) within twenty four hours after irradiation. (II) sixteen days after irradiation.

The KCl extractable nitrogen (Table 2) shows a wide variation in results. It should be noticed that the lowest treatment which gives the lowest nitrogen value for a given soil also gives a high nitrate value. For example: The value for the treatment of 64 kr in Arredondo fine sand has a value of 0.0 for nitrogen but the same soil sample had a value of 28.7 for nitrate which represents the highest value among Arredondo treatments. Another example is found in Rutledge fine sand at 4 kr. However, Blanton does not show such a relation.

Data in Table 3 indicate an increase in extractable phosphorus with changes in levels of radiation with the exception of the 4 kr treatment on Blanton fine sand. An explanation for the exception is not obvious from the data obtained.

No difference was obtained among treatments for organic matter (Table 4). This is due to the limitation of the method, which determines only total carbon.

SUMMARY

The top 6" layers of three virgin soils (Blanton, Arredondo and Rutledge) were exposed to different levels of radiation.

The chemical analysis of these soils was made.

Phosphorus showed an increase with radiation as a general rule except in the case of Blanton fine sand at 4 kr dose.

Though nitrate showed a variation in results, the values obtained at different levels of radiation were in almost every case less than the value of the control.

Nitrogen was closely related with the nitrate content, when nitrogen was high, the corresponding value for nitrates was low and vice versa.

TABLE 2.—The effects of various levels of gamma radiation on the average (ppm) nitrogen of Blanton, Arredondo and Rutledge fine sands.

Soil Type	Dates[a]	Gamma Radiation in (kr) 0	4	64	1024	2048
Blanton	I	0.0	7.8	9.9	7.6	15.9
Arredondo	I	4.0	11.0	0.0	8.5	18.9
Rutledge	I	6.9	4.1	49.5	76.8	87.4

[a] Determinations were made: (I) sixteen days after irradiation.

TABLE 3.—The effects of various levels of gamma radiation on the average (ppm) phosphorus of Blanton, Arredondo and Rutledge fine sands.

Soil Type	Dates[a]	Gamma Radiation in (kr) 0	4	64	1024	2048
Blanton	I	13.3	12.0	14.1	16.5	180.
Arredondo	I	386.6	424.9	420.0	434.0	424.9
Rutledge	I	3.7	4.4	10.3	13.9	15.4

[a] Determinations were made: (1) thirty days after irradiation.

TABLE 4.—The effect of various levels of gamma radiation on the average percent organic matter of Blanton, Arredondo and Rutledge fine sands.

Soil Type	Dates[a]	Gamma Radiation in (kr) 0	4	64	1024	2048
Blanton	I	1.1	1.2	1.2	1.1	1.0
	II	1.1	1.1	1.0	1.0	1.2
Arredondo	I	2.9	3.1	3.0	2.9	2.8
	II	2.9	2.8	2.8	2.9	3.0
Rutledge	I	9.2	9.3	9.3	9.3	9.2
	II	9.3	9.3	9.2	9.3	9.3

a Determinations were made: (I) ten days after irradiation.
(II) twenty seven days after irradiation.

Organic matter remained constant through all the different treatments.

CONCLUSIONS

Nitrates, nitrogen and phisphorus showed differences with increasing levels of radiation.

From the data we can conclude that the increasing levels of radiation probably destroyed the living microflora of the soil; and thereby releasing nitrogen and phosphorus. Further studies are needed to test this presumption.

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