INFLUENCE OF SUPERPHOSPHATE ON SOIL PROTOZOA

G. KASI VISWANATH AND S. C. PILLAI

(Department of Biochemistry, Indian Institute of Science, Bangalore 560 012)

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ABSTRACT

The protozoa, especially the species of Colpidium *and* Colpoda *developed in large numbers in the soils fertilized with different doses of superphosphate* (40, 80, 160, *and* 320 kg P_2O_5 *per hectare). The numbers of protozoa were highest in the soil* (195,000 *per gram of soil) which received* 320 *kg superphosphate per hectare and yielded the maximum quantities of ragi grain and straw. The bacteria, actinomycetes and fungi were not affected by higher doses of superphosphate.*

Key Words : Superphosphate, soil protozoa.

INTRODUCTION

Experiments have been in progress at the University of Agricultural Sciences, Bangalore, in which the soils under 9–2–7, a high yielding variety of ragi (*Eleusine coracana*), and another variety of ragi, *Purna*, have been continuously fertilized with different quantities of superphosphate, *viz.*, 0, 40, 80, 160 and 320 kg P_2O_5 per hectare (1). The numbers of bacteria, actinomycetes and fungi in these soils have been recorded (2).

Through the courtesy of Prof. B. V. Venkata Rao of the University of Agricultural Sciences, Bangalore, we had an opportunity of studying the protozoa in those soils not only under *Purna* variety of ragi but also under the other variety of ragi, 9–2–7. In this paper we are giving an account of our observations on the protozoa in those soils.

MATERIAL AND METHOD

Material

Samples of the red soil (0–6 inch) from the 30 microplots under fertilizer trials at the University of Agricultural Sciences, Bangalore, with two varieties of ragi (*Purna* and 9–2–7) were collected in January 1969. Those soils were continuously fertilized with superphosphate from 1967. The other details of the soils and the experiments which have been in progress are given by Venkata Rao and Sadasivaiah (1, 3).

Method

Autoclaved sewage and "agricultural medium" (consisting of straw, leaf powder, cowdung, defatted groundnut cake, ammonium sulphate and superphosphate) were used for the cultivation of the protozoa from the soils in the manner as described earlier by Kasi Viswanath and Pillai (4–7) and as indicated below.

RESULTS AND DISCUSSION

The examination of soil samples (over 1,500 in number) has shown that, among the ciliate protozoa, the species of *Colpidium, Colpoda, Vorticella, Lionotus* and *Chylophrya* were found in large numbers, and that, among these protozoa, the species of *Colpidium* and *Colpoda* were relatively more abundant.

The results given in Tables I and II show that the species of *Colpidium* developed in greater numbers compared to the species of *Colpoda*. Among the two media used, the "agricultural medium" generally supported their

TABLE I

Numbers of* Colpidium *sp. and* Colpoda *sp. in the soils under* 9–2–7 *variety of ragi* (Eleusine coracana) *fertilized with different quantities of superphosphate*

Treatment: Quantity of superphosphate added to the soil (kg P_2O_5 per hectare)	Numbers of protozoa ($x\ 10^2$/g soil)			
	Colpidium sp.		*Colpoda* sp.	
	Autoclaved sewage	"Agricultural medium"	Autoclaved sewage	"Agricultural medium"
0 (control)	110	257	70	137
40	147	337	73	190
80	297	343	183	213
160	363	383	183	260
320	573	467	220	333

* Since the species of *Colplidium* and *Colpoda* were the most dominant, their relative number are given. There were other ciliate protozoa also, such as the species of *Vorticella, Lionotus* and *Chylophrya* and the total numbers of protozoa in the soils under 9–2–7 variety of ragi are given in Fig. 1.

TABLE II

Numbers of* Colpidium *sp. and* Colpoda *sp. in the soils under Purna variety of ragi* (Eleusine coracana) *fertilized with different quantities of superphosphate*

Treatment: Quantity of superphosphate added to the soil (kg P_2O_5 per hectare)	Numbers of protozoa ($\times 10^2$/g soil)			
	Colpidium sp.		*Colpoda* sp.	
	Autoclaved sewage	"Agricultural medium"	Autoclaved sewage	"Agricultural medium"
0 (control)	70	187	17	66
40	77	193	60	83
80	80	263	213	190
160	87	290	73	227
320	583	1133	217	730

* Since species of *Colpidium* and *Colpoda* were the most dominant, their relative numbers are given. There were other ciliate protozoa also, such as the species of *Vorticella*, *Lionotus* and *Chylophrya* and the total numbers of protozoa in the soils under Purna variety of ragi are given in Fig. 2.

growth better. The numbers of *Colpidium* sp. and *Colpoda* sp., increased in the soils with increasing dose of superphosphate. The yields of grain and straw of both *Purna* and 9–2–7 varieties of ragi also increased with higher quantities of superphosphate (1).

It was interesting to note that while the numbers of ciliate protozoa increased with increasing dose of superphosphate, the numbers of bacteria, actinomycetes and fungi did not increase with the increase of superphosphate.

The total ciliate protozoa were greater in numbers (Figs. 1 and 2) than those reported in the literature. For example, Bamforth (8) reported "under deciduous vegetation", where the genus *Colpoda* dominated, "ciliates approached, equalled, or exceeded testacea, and numbered 1,000–5,000/g in litters".

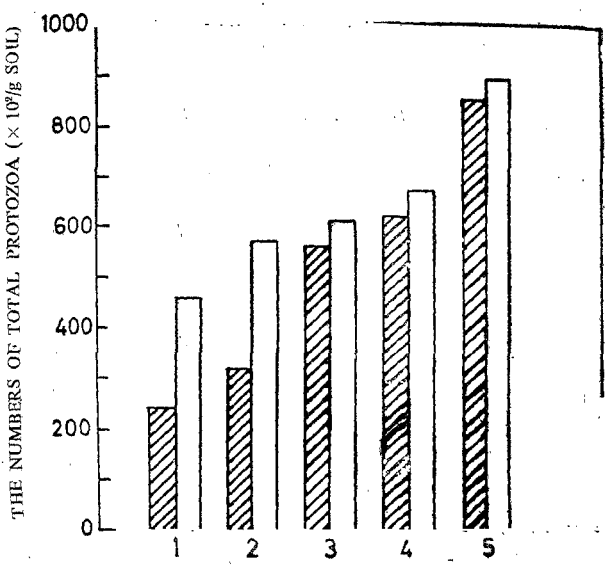

FIG. 1. The numbers of total protozoa (the species of *Colpidium*, *Colpoda*, *Vorticella*, *Lionotus* and *Chylophrya*) in the soils under ragi (*Eleusine coracana*) 9–2–7 variety, fertilized with different quantities of super phosphate.

▨ Autoclaved Sewage

▭ "Agricultural Medium"

1. Control soil which did not receive any superphosphate.
2. Soil receiving 40 kg P_2O_5 superphosphate/hectare.
3. Soil receiving 80 kg P_2O_5 superphosphate/hectare.
4. Soil receiving 160 kg P_2O_5 superphosphate/hectare.
5. Soil receiving 320 kg P_2O_5 superphosphate/hectare.

Dixon (9) observed that soils producing the richest vegetation had the highest number of species of protozoa and that an unusually large number of species of testaceous rhizopods occurred in peaty soils. Singh (10) also recorded that the population of amoebae in the soils correlated with the

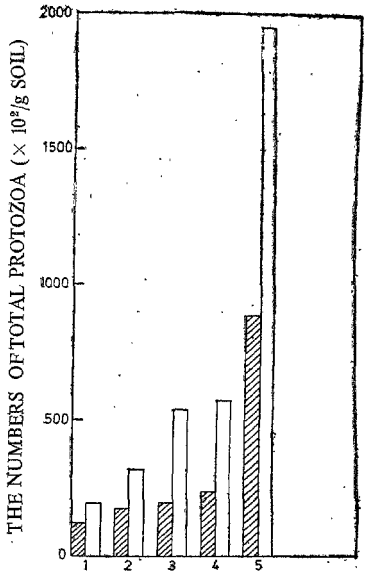

FIG. 2. The numbers of total protozoa (the species of *Colpidium*, *Golpoda*, *Vorticella*, *Lionotus* and *Chylophrya*) in the soils under ragi (*Eleusine Coracana*) *Purna* variety fertilized with different quantities of superphosphate.

Autoclaved sewage

"Agricultural Medium"

1. Control soil which did not receive any superphosphate
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yields of mangolds and wheat grown on Rothamsted (U.K.) soils fertilized with sulphate of ammonia and under dung. According to him, "the treatment of soils with artificial fertilizers for a very long time (over 70 years) had no detrimental effect on amoebae, but had in fact much increased their numbers in comparison with those in untreated plots."

There has been considerable evidence on the occurrence of large numbers of rhizopods in the cultivated soils. But the results given in the present paper show that the ciliates are by far the most numerous. One reason for this difference seems to be the use of relatively more suitable media with adequate aeration of the media.

According to Brodskii (11), soils may be classified as to "activity" by the relative numbers of protozoa in them as follows :

	Number of protozoa/g of soil
Very low activity	= "no" more than 1,000.
Low activity	= between 1,000 and 20,000.
Moderate activity	= between 20,000 and 100,000.
Active	= between 100,000 and 500,000
Very active	= more than 500,000.

In the present study, the ciliates alone accounted for as many as 195,000 under *Purna* and 89,000 under 9–2–7 varieties of ragi, where the yields of ragi grain and straw were also the highest. It is thus understandable that Sandon (12) who, as a result of detailed examination of 148 soils from different parts of the world, concluded: "It appears that on the whole the conditions most favourable for the growth of crops are the ones most favourable to the development of flagellates, ciliates and amoebae, while the testaceous rhizopods flourish best in peaty soils."

Prasad and Jha (13), who examined 20 soils representing different agro-climatic zones in Bihar (North India) for the protozoa, found that the protozoan population was large and ranged from 157,000 to 8,873,000 per gram of soil. According to them, "this number is considerably higher than usually reported in the literature largely for non-tropical soils". They noticed that the stimulatory effect of organic manure (574,000 to 834,000 protozoa per gram of soil) was of higher order than that of fertilizers (431,000 to 527,000 protozoa per gram of soil). They further found that relatively high density of protozoa (3,958,000 per gram of soil) in the soil under berseem (*Trifolium alexandrinum*) as well as in the soils that were manured (431,000 to 834,000 per gram), where bacterial populations are known to be high, is indicative of a close relationship between the two groups of organisms, which is, "consistent with the findings of others (Alexander, M. 1961, p. 111)" (14).

Datta and Mangat (15) found the largest numbers of amoebae (1,430,000) and flagellates (192,000) per gram of the soil under groundnut (*Arachis hypogea*), whereas the ciliate population was maximum (64,500 per gram of soil) in rice (*Oryza sativa*) fields. They also reported that the oxygen diffusion rate of the soil had a definite correlation with the number of different protozoa found in the soil.

The large numbers of ciliate protozoa observed in the experimental soils under the two varieties of ragi which received various doses of superphosphate might be as a result of general stimulation of all the microorganisms, including protozoa. But, Shetty and Rangaswami [16] who studied the changes in the populations of bacteria, actinomycetes, fungi and phosphobacteria in the soils under discussion and in the rhizosphere of sunnhemp (*Crotalaria juncea L.*) in response to heavy doses of phosphate fertilizer application to the soil, made the following observation: "Superphosphate along with the usual doses of ammonium sulphate and potash in the ratio of 60: 40: 40 gave the maximum increase in the soil and rhizosphere microflora. More than 80 kg of phosphate fertilizer had a decreasing effect on bacterial population in the rhizosphere of sunnhemp crop. Actinomycete and fungal populations were not much affected by the higher doses of phosphate fertilizer. Application of phosphate fertilizer greatly inhibited the phosphobacterial population both in soil and in the plant rhizosphere."

With regard to the numbers of bacteria, actinomycetes and fungi in these soils under *Purna* variety, Shetty and Rangaswami [2] reported the following: "In general, the microbial population was maximum during flowering stage (55 days) of the crop, and thereafter got reduced significantly up to harvest, at all levels of phosphate fertilizer application. P_3 treatment (160 kg P_2O_5) recorded the maximum increase in microbial population during flowering stage of growth. Bacterial population was significantly increased at all levels of treatment and plant growth, compared to uncropped control. Actinomycete population decreased from vegetative to harvesting stage. There was no significant effect on fungal population due to different doses of phosphate fertilizer treatment." Phosphobacteria were not found in the soils treated with 80, 160 and 320 kg P_2O_5 per hectare.

Thus the increase in the soil protozoa by superphosphate seems to be due to selective stimulation and the protozoa could have favourably influenced the soil processes leading to higher yields of both the varieties of ragi in the field trials referred to in this paper.

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