The Influence of Synthetic Soil Conditioners on the Size of Soil Microbial Biomass in a Loamy Sand Soil

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Abstract: The effect of polyacrylamide (PAM) (synthetic soil conditioners) application on soil microbial biomass C ($C_{\text{mic}}$) and N ($N_{\text{mic}}$) were examined under laboratory conditions. Two types of polymers Acqua-Kept (P1) and Super-Hydro (P2) were mixed separately with a loamy sand soil in various concentrations of 25, 50 and 100 µg g$^{-1}$ soil. After 1, 7, 14 and 28 days of incubation, the soils were analyzed for $C_{\text{mic}}$ and $N_{\text{mic}}$. The two PAMs have shown almost similar effects on the soil microbial biomass C and N. The amount of soil microbial biomass ($C_{\text{mic}}$ and $N_{\text{mic}}$) was increased with the lower polymer applications of 25 and 50 µg g$^{-1}$ soil addition. The response exhibited a parabolic curve. The response was found more pronounced with P2 than P1 application. A slight increase in $C_{\text{mic}}$ and $N_{\text{mic}}$ was observed with the advancement of incubation stages. The results indicate unpredictable changes in soil microbial biomass due to the application of different synthetic soil conditioners.

Key words: Loamy sand soil, soil microbial biomass, polyacrylamides, soil conditioners

Introduction

During the past few decades it was suggested that synthetic soil conditioners, serving as cementing and stabilizing agents, may be applied in cases where natural causes and anthropogenic practices result in deterioration of the soil structure (Wallace and Nelson, 1986). New, longer-lasting polyacrylamides (PAM) are currently under investigation and are sold commercially as promising compounds for improving soil structure and water infiltration.

PAM is a long-chain polymer organic compound, which is prepared under investigation and are sold commercially as promising result in deterioration of the soil structure (Wallace and Nelson, 1986; Wallace et al., 1986). However, reports on the effects of synthetic conditioners on soil biota components are limited. The scarcity of available information on possible interactions between PAMs and soil microorganisms is somewhat surprising, considering their important role in biological processes occurring in the soil, including structure, formation, and stability (Molope et al., 1987; Griffiths, 1965), nutrient cycling and availability to plants.

Keeping in view the above stated work conducted by different workers it is hypothesized that these soil conditioners may help to increase soil microbial population through better soil conditions and hence, will improve soil fertility. Therefore, the present study was undertaken to investigate the response of the soil microbial biomass to the addition of two PAM compounds (P1 and P2) in a loamy sand soil.

Materials and Methods

Soil samples: A laboratory incubation experiment was conducted using the loamy sand soil having 1.76% total organic-C, 0.1585% total-N, 22.4% soil moisture at 33 kPa, with pH 6.27. The soil was collected from the surface layer (0-20 cm) from Hangzhou, Zhejiang province, China.

Soil conditioners: Two soil conditioners (polymers) used were; Acqua-Kept (P1): it was introduced by Chemil S.R.L. Milano Italy Company, its absorption capacity with deionized water is 500-600 g/g, and Super-Hydro (P2) was introduce for Al-Dohasa Rue Ceard Genev Company, its absorption capacity is 500-700 (distilled water cm$^{-2}$ g of product) and it also contain 2%0 N.

Experimental study: After sampling and preparation of soil, both the polymers i.e. Acqua-Kept (P1) and Super-Hydro (P2) were separately mixed with the soil to maintain the concentrations of: 0 (control), 25 (L1), 50 (L2) and 100-(L3) µg g$^{-1}$ soil. All the treatments were replicated thrice.

Soil moisture was adjusted to 60% water content at 33 kPa and incubated in the dark at 25°C ± 1. The beakers were removed from the incubator every day and brought to the original weight by adding the required amount of distilled water. Three beakers each for control and treated soils were removed and submitted to analysis for soil microbial biomass C and N at 1, 7, 14 and 28 days after polymers application.

Soil analyses: Soil samples for the determination of microbial...
bacterial biomass were extracted by a fumigation-extraction (FE) method (Vance et al., 1987) and the organic carbon in the soil extracts was measured using an automated total organic carbon analyzer (Wu et al., 1990). Soil samples for the determination of microbial biomass C were extracted by a fumigation-extraction (FE) method and the organic carbon in the soil extracts was measured after Kjeldahl digestion (Brookes et al., 1985). Water contents at an applied pressure of 33 kPa (0.33 bar) were determined using a pressure membrane system similar to that described by Reining (1963). The pH (in water, 1:2.5) of the soils was measured with a pH meter. Total nitrogen was determined by the Kjeldahl method and total organic carbon by Walkley-Black procedure (Jackson, 1958).

**Statistical analysis:** Data were examined by analysis of variance completely randomized and Duncan’s multiple range tests using statrix software (CoStat Statistical Software, 1990).

**Results**

**Effect of polymers on soil microbial biomass-C (Cmic):** The data regarding the effect of two polymers on soil microbial biomass C is presented in Table 1. The results showed that when the polymers were applied at lower concentrations of 25 and 50 g g⁻¹ soil, they showed a positive response on Cmic and increased it, while the highest concentration (100 g g⁻¹ soil) used has decreased it, as compared with the control. The data further revealed that the soil microbial biomass has not reacted much differently against the two polymers used. Increasing the concentrations of P1 resulted in a gradual increase, except L3 where it was decreased, in the soil microbial biomass although it was not effected significantly (p<0.05) in almost all the incubated stages at all levels (except L2 level after 1 d incubation), as compared with the nontreated control soil. The data obtained after the application of P2 also showed a similar pattern like P1 i.e., a parabolic pattern, where 50 g g⁻¹ soil showed the maximum increase in Cmic at all the incubation stages (1, 7, 14 and 28 d) studied, as against the control. After 1 and 28 d of incubation, only the L2 level was found significantly different than the control while all other treatments, though they showed some increase/decrease, were found at par with the control. The increase in Cmic content was more in P2 as compared to P1 and a slight increase was noticed with the passage of time.

**Effect of polymers on soil microbial biomass-N (Nmic):** The additions of two polymers (P1 and P2), applied at different levels, have produced different effects on Nmic contents at different incubation stages, as compared with the control (Fig. 1 and 2). The P1 polymer was found to be increased the Nmic contents at L1 and L2 levels, while L3 level has decreased it. The maximum Nmic contents (46.86 g g⁻¹ soil) were found at 28th day of incubation with 50 g g⁻¹ soil of P1 addition which was found significant than control. The addition of P2 significantly increased the Nmic at two lower levels (L1 and L2) while the higher level (L3) non-significantly decreased it, as compared with the control. When % increase/decrease in Nmic with P1 and P2 application was calculated, it was noticed that the maximum % increase of 12.3 was found with 50 g g⁻¹ soil of P1 addition at 28th day of incubation and it was 31.9% with P2 addition with the same level and at same incubation periods as P1. The higher concentration of 100 g g⁻¹ soil of both the polymers were found to have a depressing effect on the Nmic contents, as compared with the control.

![Fig. 1: Effect of Aqua-Kept (P1) polymers on microbial biomass N (µg g⁻¹ soil)](image1.png)

![Fig. 2: Effect of Super-Hydro (P2) polymers on soil microbial biomass N (µg g⁻¹ soil)](image2.png)

Table 1: Effect of polymers (P1 and P2) on soil microbial biomass C (µg g⁻¹ soil)

<table>
<thead>
<tr>
<th>Polymers application (µg g⁻¹ soil)</th>
<th>Time after application (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control (check)</td>
<td>162.9 bc</td>
</tr>
<tr>
<td>P1 25 (L1)</td>
<td>180.3 ab</td>
</tr>
<tr>
<td>P1 50 (L2)</td>
<td>183.2 a</td>
</tr>
<tr>
<td>P1 100 (L3)</td>
<td>154.5 c</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>17.91</td>
</tr>
<tr>
<td>Control (check)</td>
<td>162.9 b</td>
</tr>
<tr>
<td>P2 25 (L1)</td>
<td>186.2 a</td>
</tr>
<tr>
<td>P2 50 (L2)</td>
<td>190.4 a</td>
</tr>
<tr>
<td>P2 100 (L3)</td>
<td>158.5 b</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>21.49</td>
</tr>
</tbody>
</table>
control. With the advancement of incubation periods, an increase in Nw contents were observed. The increase in Nw was more in P2 than P1, might be due to 20% N contents of P2.

**Discussion**

Our results indicated that the addition of two polymers (Acqua-Kept (P1) and Super-Hydro (P2)) at 25 and 50 μg g⁻¹ soil have shown positive effect on soil microbial biomass. However, the higher concentration of 100 μg g⁻¹ soil has depressing effect on microbial biomass.

In the loamy soil, Steinberger et al. (1993), also found that the soil microbial biomass reacted differently to the two PAMs. Increasing the concentrations of 2J resulted in a gradual decrease in the microbial biomass, although the microbial biomass was found to be increased in the oil industry support the notion that polyacrylamides can somehow stimulate the growth of microorganisms. Growth of some sulfate-reducing bacteria is also stimulated by polyacrylamides, and microbial biomass nitrogen in soil. Soil Biol. Biochem., 12: 405-411.


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