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CELLULASE EFFECTS ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF SOILS.

Sekina A. Mohamed; M.M. Abdel-Ghany and M.H. Mostafa
Soils, Water and Environment Res. Ins., Agric. Res. Center, Giza , Egypt.

ABSTRACT

Some physical and chemical effects of cellulase on soils (sandy, calcareous and clay soil) are investigated in this study. Pots filled with 5 kg soil were treated with Novozym 188 cellulase prepared (10 % solution) at 0.5 and 1.5 % addition rates .Treatments resulted increasing of organic matter (OM), total and available nitrogen, cation exchange capacity (CEC) and total porosity (TP) of the studied soils. The soil properties increased with increasing the application rate of enzyme. Hydraulic conductivity (HC) was increased in clay and calcareous soils but, it was decreased in sandy soil . Electric conductivity (EC) and pH values were not affected by the enzyme addition .

Keywords: Cellulase, soils physical and chemical properties.

INTRODUCTION

Microbiological breakdown of cellulose material in soil as influenced by the soil environment is of interest to both agriculture and industry (Ruschmeyer and Schmidt , 1958). Soils that differed in physical and chemical properties were found to differ in their ability to degrade cellulose (Schmidt and Ruschmeyer , 1958) . The experimental studies on the land change proved to have decreased the activities of the soil enzymes (Salam *et al.*, 1998). The cellulase of microorganisms is known to be multienzyme complexes and cellulose is hydrolyzed with the participation of at least four different enzymes including exo-B-1,4- glucanase (C_1) , endo-B-1,4- glucanase (C_x) , B-glucosidase (A_v) and xylanase (X) (Skladnev and Kalunyants 1982 and Messener and Kabicek , 1991).

The current study was carried out in pots using sandy, calcareous and clay soils, to elucidate the effect of cellulase addition on some soil physical and chemical properties.

MATERIALS AND METHODS

Enzyme : liquid cellulolytic enzyme known by the trade name of Novozym 188 was obtained from Novo Co. in Denmark .

Enzyme assay:Activity and composition of Novozym cellulase complex was estimated according to the method of Galas *et al.* (1981)

C_X ;(endo-glucanase,saccharified CMC) ; enzyme activity = mg sugar / ml enzyme/h .

C_1 ; (exo-glucanase, degrades Solka floc SW – 40) ; enzyme activity = mg sugar / ml enzyme / 24h .

A_V ; (B – glucosidase , saccharified Avice SF) ; enzyme activity = mg sugar / ml enzyme / 24h.

X ; (xylanase , hydrolyzed xylan) ; enzyme activity = mg sugar / ml enzyme /h.

Reducing sugars as glucose was determined by a submicrodetermination method described by James and Marvin (1949).

One ml. Of Novozym cellulase contained 558.4 and 663.1 mg sugar/ml. enzyme/h.of C_X and X enzymes, and 343.6 and 312.8 mg sugar/ml. enzyme/24h of C_1 and A_V enzymes, respectively.

Soil samples :- Pot experiments were conducted on three different textured soils : Sandy soil from South Tahrir (No.1) , calcareous soil from Nobaria region (No.2) and clay soil from Menofiya Governorate (No.3) .

Each pot filled with 5kg of soil sample and mixed with one of the different application rates (0.5 and 1.5 %) of prepared enzyme (10% solution). After 15 days of enzyme addition, pots were irrigated four times. The soils were analyzed for the physical and chemical properties to study the effect of cellulase on soil properties according to the method of Page, *et al.* (1982). Some properties of the studied soils are presented in Table (1)

Table 1. Some characteristics of the studied soils .

Sample No	Particle size distribution			Texture	EC ds/m	pH	CEC meq/100g	C_aCO_3 %	OM %
	Sand %	Silt %	Clay %						
1	91.74	2.63	5.60	Sand	3.10	8.40	3.65	4.30	0.27
2	73.68	12.69	13.63	Sandy loam	18.62	8.90	8.40	27.40	0.23
3	37.5	19.50	42.4	Clay	1.8	7.90	35. 0	4.30	1.90

values of sand % , silt % and clay % were calculated as 100%

RESULTS AND DISCUSSION

Data presented in Table (2) show the increasing of OM, N (total and available) and CEC due to cellulase. Increasing the enzyme addition from 0.0% to 1.5% increased OM from 0.27 to 0.63, from 0.23 to 0.72 and from 1.90 to 2.41% for sandy , calcareous and clay soils , respectively . Also , the total nitrogen content increased from 250 to 361,from 280 to 422 and from 490 to 643 (ppm) due to the addition of 1.5% cellulase for sandy , calcareous and clay soils , respectively . while, maximum content of available nitrogen was 53 , 65 and 113 ppm for sandy , calcareous and clay soils , respectively.

Addition of enzyme (1.5%) increased the CEC from 3.65 to 8.81, from 8.40 to 10.10 and from 35.0 to 42.0 m. eq . / 100g for sandy, calcareous and clay soils, respectively . From the above mentioned effects of cellulase on increasing some soil chemical properties. It could be concluded that the clay soil was respond more to enzyme application . Also, these results suggested the raising OM content had a good effect on increasing adsorption of surface

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as well as increasing CEC for the studied soils. These results confirmed with Schnitzer (1991) and Salam, *et al*. (1998) who found that the activities of all enzymes in soil were closely related to the soil organic matter (SOM) and total nitrogen . A normal agricultural soil may contain 1--5 % OM. From the stand point of soil organic matter(SOM), it influence plant growth through its effect on the physical, chemical and biological properties of soils . Also, it promotes good soil texture, thereby improving soil tilth, aeration and moisture movement and retention.

The values of some physical properties are shown in Table (3) Total porosity (TP %) values were increased in all soils under study. Maximum of TP was 42.11 % in calcareous soil but, the level of TP in clay and sandy soils were nearly the same, 37.4 % and 37.02 % respectively. While, hydraulic conductivity (HC) was increased in clay (from 5.61 to 8.01 cm /h) and calcareous (from 5.66 to 7.91/ cm/h) soils but, decreased (from 12.2 to 9.62 cm/h) in sandy soil . These changes in treated soils could be attributed to the modification of pore size distribution as a result of increasing OM content which caused aggregate formation.

According to the data presented in Table (3) the values of electric conductivity (EC) was nearly constant . There was slight increase in electric conductivity (EC) in all soils . Also, pH values did not affected by enzyme addition and nearly constant . White *et al.* (1934) and (1949) found that soil acidity had a definite controlling influence on the rate of cellulose decomposition. pH 7.2 is the optimum soil reaction for cellulose decomposition. While , Ruschmeye and Schmidt (1958) found that soil reaction and N relationships varied most consistently together with the cellulose decomposition ability of a soil . Soil reaction and N relationship of soil are most important factors influencing the activity of the cellulolytic-soil microorganisms.

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تأثير إنزيم السليوليز على بعض الخواص الطبيعية والكيمائية للأراضي

سكينة أنور محمد - محمد محمد عبد الغنى - محمود حلمي مصطفى

معهد بحوث الأراضي والمياه والبيئة - مركز البحوث الزراعية– جيزة – مصر

استخدم فى هذه الدراسة ثلاثة أنواع من الأراضي (الرملية ، الجيرية ، الطينية) لدراسة تأثير إضافة أنزيم السليوليز على بعض الخواص الطبيعية والكيمائية للأراضي ، وقد تم ذلك باستخدام الأصص (5 كيلوجرام تربة / أص) ، وأضيف الأنزيم بمعدل (½ ، 1½ %) (من وزن عينة التربة) ، وقد أوضحت النتائج ما يلي : I

إضافة الأنزيم أدى إلى زيادة كل من المادة العضوية ، النيتروجين (الكلى،الصالح)، والسعة التبادلية الكاتيونية ، والمسامية الكلية فى جميع الأراضى المستخدمة خصوصاً مع معدل الإضافة 1½ % .

وقد اختلف تأثير الأنزيم من حيث تأثيره على التوصيل الهيدروليكى على حسب نوع التربة ، فقد لوحظ أن التوصيل الهيدروليكى يزداد فى الأراضى الطينية والجيرية ويقل فى الأراضى الرملية.

أما بالنسبة للتوصيل الألكتروليتى ورقم الحموضة (pH) فلا يوجد تأثير واضح على أى من الأراضى المستخدمة .

Table (2): Effect of different rates of cellulase on some chemical properties of soils.

0.0 , 0.5 and 1.5 % enzyme rates												
Sample No	**OM %**			**TN ppm**			**Available N ppm**			**CEC Meq / 100g**		
1	0.27	0.46	0.63	250	341	361	30	49	53	3.65	6.91	8.81
2	0.23	0.51	0.72	280	396	422	34	54	65	8.40	9.61	10.10
3	1.90	2.23	2.41	490	554	643	95	101	113	35.0	40.1	42.0

Table (3): Effect of different rates of cellulase on some physical properties and soil pH.

0.0 , 0.5 and 1.5 % enzyme rates										pH		
Sample No	TP %			HC cm/h			EC cm / sec					
1	33.25	35.52	37.02	12.2	10.12	9.62	3.10	3.39	3.85	8.4	8.2	8.32
2	39.75	40.90	42.11	5.66	6.81	7.91	18.62	18.7	18.9	8.9	8.7	8.32
3	36.92	37.03	37.4	5.61	6.93	8.01	1.8	1.85	1.82	7.9	7.71	7.6