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Suitability of Natural Soil Conditioners for Improving Hydrophysical and Chemical Properties of Alkaline Clayey Soil

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THE effect of rice straw and Taflah on some hydrophysical and chemical properties was studied using alkali clayey soil from El-Fayoum Governorate in a pot experiment.

The additions of rice straw or Taflah to the soil showed highly significant positive effect on the organic carbon, extractable humus, total drainable pores, quick drainable pores and aggregation coefficient. Hydraulic conductivity was significantly increased with the addition of rice straw only.

The interaction effect of the additions of these two conditioners to the soil significantly increased total porosity, water stable aggregates > 0.25 mm and fulvic acids. Also these additions increased both total organic carbon and extractable humus which resulted in a pronounced increase of macro pores as well as the aggregate size of 2.0 - 0.84 mm, the aggregation coefficient and hyraulic conductivity were increased.

Keywords: natural conditioner, soil properties.

Under arid and semi-arid conditions, much attention has been drawn on the significance of supplementing organic materials to the soil to improve its physical and chemical properties for plant growth (Kononoba, 1966., Allison, 1973, Van Doren and Allmaras, 1978; Talha *et al.* 1979 and Abdel - Ghaffar, 1982). Crop residues are the main available sources

for increasing organic matter in the soil (Raid, 1982 and Abdel - Samie, 1982).

In Fayoum Governorate (90 km South-West of Cairo), the annual acreage of rice crop ranges between 37000 and 50000 fed. The expected residues of straw accordingly ranges between 100 and 140 thousand tons. Meanwhile natural precipitates known as "Taflah" (usually named as raw bentonite) are found in wide areas of the governorate and is believed to improve soil conditions growing for crops in a manner similar to calcifereous amendements (El-Sherif and El-Hady,(1983).

Clayey soils of Fayoum are characterizing by inefficient drainage due to poor water movement (IFAD, 1979).

Therefore, the present work aims to study the effect of additions of rice straw or and "Taflahores on the hydrophysical and chemical properties of a representive alkali clay soil at Fayoum.

Material and Methods

An alkaline clayey soil sample from the surface layer (0-30 cm) of a farm near to El-Fayoum city was collected air-dried, sieved through a 2mm - sieve and mixed well. The soil characteristics, as determined according to Black *et al.* (1965), were found to be: coarse sand 3.2%, fine sand 21.4%, silt 32.8%, clay 42.6%, electrical conductivity of saturated soil-water extract 2.30 mmhos/cm at 25°, pH of saturated soil water paste 8.6, cation exchange capacity 38.48 m.e./100 g soil,exchangeable Na^+, K^+, Ca^{++} and Mg^{++}: 12.8, 1.72, 13.48 and 10.4 me/100 g soil respectively and calcium carbonates 3.85%.

A sample of rice straw was collected, air dried, ground to pass through a 60 mesh-sieve, analysed according to Jackson (1962) and Cattenie (1980) and found to contain organic carbon 34.4%, total nitrogen 1.34%, phosphorus 0.2%, potassium 2.56% and C/N 27.7.

A sample of "Taflah , El-Sheif and El-Hady (1983) named it as (raw bentonite) was collected from the 0-45 cm surface layer of koom Osheem area (45 km North_East of Fayoum) air dried, sieved through a 1 mm-sieve and mixed well. Its characteristics were found to be: coarse

sand 1.2%, fine sand 7.8% silt, 19.4%, clay 47.1% using HCl, but, 3.2, 8.3, 20.8 and 67.7% respectively using sodium hexametaphosphate, organic matter 1.12%, total nitrogen 0.064%, calcium carbonate 22.88%, gypsum 1.82 me/100 g, electrical conductivity of the saturated Taflah-water extract 3.41 mmhos/cm at 25° and pH of saturated Taflah-water paste 7.8.

The experimental design included soil incubation for 6 months, the soil received treatments of 4 additions of rice straw (0, 1, 2, and 4% wt/wt on oven dry basis) x4 additions of Taflah (0, 1, 2 and 4% wt/wt on oven dry basis).

Three Kilograms of soil was mixed well with the assigned weight of straw and Taflah. The mixture was packed in a plastic pot and wetted with distilled water to 60% of the water holding capacity. To avoid moisture loss the soil was covered with polyethylene sheet. However, moisture content was maintained constant by weighing the pot weekly and bringing it to its initial weight by adding distilled water. The prevailing ambient room temperature during incubation period ranged from 27±3°.

After six months of incubation, the following determinations were carried out on the treated soil: total porosity, bulk density and calcium carbonates according to Black *et al.* (1965), field capacity and wilting point according to Baver (1965) hydraulic conductivity according to Tafha *et al.* (1979), stable wet sieving aggregates according to Richards (1954), thus, the aggregation coefficient was calculated according to Gomah and El-Essawi (1975), drainable pores according to De Leenheer and De Boodt (1965) and Black *et al.* (1965), total organic carbon, total extractable carbon, humic acids carbon and fulvic acids carbon according to Knonova (1966). Statistical analysis was conducted according to Steel and Torrie (1960).

Results and Discussion

The obtained data as seen in Table1 indicate that bulk density of the soil was significantly decreased with the additions of rice straw and consequently total porosity was significanlty increased, while increase in bulk density and was observed accordingly a decrease in total porosity with the addition of Taflah. Rice straw decreased bulk density of soils

through its light weight/volume beside its effect on the formation of organic acids during decomposition which decreased soil pH and consequently soil alkalinity that caused dispersion of soil particles. This interpretation may be a good indicator of soil aggregation status with adding rice straw to the soil.

Water stable aggregates >. 25mm in diameter were taken as an indicator of soil aggregates stability (Baver *et al.*, 1972). The data of Table 1 shows that water stable aggregates >0.25 mm were increased significantly with the additions of Taflah or rice straw to the soil. Also, aggregation coefficient was significantly increased at 5% level as a result of the additions of Taflah and rice straw. The aggregation coefficient of the soil was calculated to find out a net comparison between the different treatments.

Also, the data indicate that the most stable structural units of >0.84 mm in diameter were increased significantly (5% level) with the addition of either rice straw or Taflah to the soil. These units are used as criteria to evaluate soil mechanical stabiltiy and the resistance of the structural units of soil against breakdown by tillage or by wind erosion (El-Hady, 1984).

High $CaCO_3$ contents in the Taflah acted as cementing agent between clay particles and as a source of Ca^{++} cation that needed to replace Na^{+} throughout the process of reclaiming alkali soil and relatively reduce dispersion of particles. In addition, Taflah contains high percent of clay minerals, which play important role in soil aggregation by the means of electrostatic action, but the presence of alkalinity in the soil inhibit this role.

In regard to the total drainable pores it was significantly increased with the addition of rice straw and scarcely significant with the addition of Taflah to the soil. This influence could be also observed with quick drainable pores and slow drainable pores, except that of slow drainable pores which were decreased with the addition of Taflah to the soil. Previous investigations showed that the addition of organic materials held soil aggregates apart keeping pore spaces or channels when decomposed (Abdel-Ghaffar, 1982) and Blot and Koengs (1972).

Soil chemical analysis as shown in Table 1 indicate that total and ex-

TABLE 1. The main effect of rice straw and "Taflah" additions as soil conditioners on soil properties.

Soil property	Amendements			L.S.D. 0.05
	Control	Rice* straw	Taflah **	
Hydraulic conductivity, mm/hr	2.27	4.63	2.28	0.60
Field capacity, %	40.84	43.14	40.98	0.72
Wilting point, %	20.44	20.75	20.38	0.48
Available water, %	20.40	22.39	20.60	1.00
Total porosity (V/V), %	52.28	56.58	53.14	1.44
Total drainable pores > 9 μ %	32.79	43.87	35.85	2.80
Quick, drainable pores > 30 μ %	26.36	36.73	30.45	2.04
Slow drainable pores 9-30 μ %	6.43	7.04	5.40	1.28
Bulk density,g/cc	1.25	1.15	1.26	0.06
Water stable aggregates:				
5.0 - 2.0 mm, %	8.21	9.87	9.76	0.56
2.0 - 0.84 mm, %	6.40	9.84	9.78	0.72
0.84 - 0.42 mm, %	21.99	19.07	23.48	1.26
0.42 - 0.25 mm, %	9.26	8.98	9.40	0.86
Total > 0.25 mm, %	45.86	47.76	52.52	2.02
Aggregation coefficient, %	84.70	91.50	112.53	2.48
Total organic carbon, % ***	0.812	1.581	0.842	0.012
Total extractable carbon	24.100	31.400	28.800	0.640
Humic acids carbon ***	8.300	12.500	10.400	0.420
Fulvic acids carbon ***	15.800	18.900	18.400	0.660
Hu/Fu	0.525	0.659	0.563	0.022
calcium carbonates %	3.850	3.190	4.850	0.36

* Easch value in this column is the mean of the treatments of 1,.2 and 4% rice straw.

** Each value in this column is the mean of the treatments of 1.2 and 4% Taflah.

*** As percent of the total organic carbon in soil.

tractable organic carbon humic and fulvic acids were significantly increased with the addition of either rice straw or Taflah to the soil $CaCO_3$ ontent in the soil was significantly increased with addition of Taflah but it ends to decrease with the additions of rice straw. Evans and Russell (1959) found that the adsorption from suspensions of the humic and fulvic acid components of a soil organic matter extract by bentonite (as a clay mineral) was extremely rapid. They also stated that the interaction of organic colloids with the clay fraction probably takes place in many soils and may affect the structural conditions, the extractability of the humus and the rate of decomposition of the organic matter in soil

Hydraulic conductivity was increased significantly (at 5% level) with the addition of rice straw to the soil (Table 1). On the other hand the additions of Taflah did not affect soil hydraulic conductivity. Field capacity was increased with the additions of rice straw and wilting point showed very slight increase which consequently increased the available water. Addition of Taflah slightly increased soil field capacity and available water and it showed little decrease in soil moisture at the wilting point.

The interaction effect of the addition of rice straw and Taflah to this alkali clay soil is illustrated in Fig. 1 and 2. Examining the curves of the figures we can easily noticed that the highest interaction effects could be seen with the properties of: hydraulic conductivity > total organic carbon > aggregation coefficient > humic acids (Fig.1and 2). This means that the additions of rice straw + Taflah with a rates up to 4% resulted in highest magnitude of improvement of these hydrophysical properties. This is recommended to reclaim the alkaline clayey soils.

It can be concluded that in reclaiming clayey alkaline soils which are abundant at El-Fayoum Governorate as a result of irrigation and drainage problems, it is recommended to add rice straw with Taflah to this soil to improve soil hydrophysical characteristics which is the main problem in such soils.

1 - Total organic carbon.
2 - Aggregate coefficient.
3 - Humic acids carbon.
4 - Aggregates of 2.0 - 0.84 mm.
5 - Total extractable carbon.
6 - Hu/Fu.
7 - Total aggreagates (> 0.25 mm).
8 - Fulvic acids carbon.
9 - Aggregates of 0.42 - 0.25 mm.

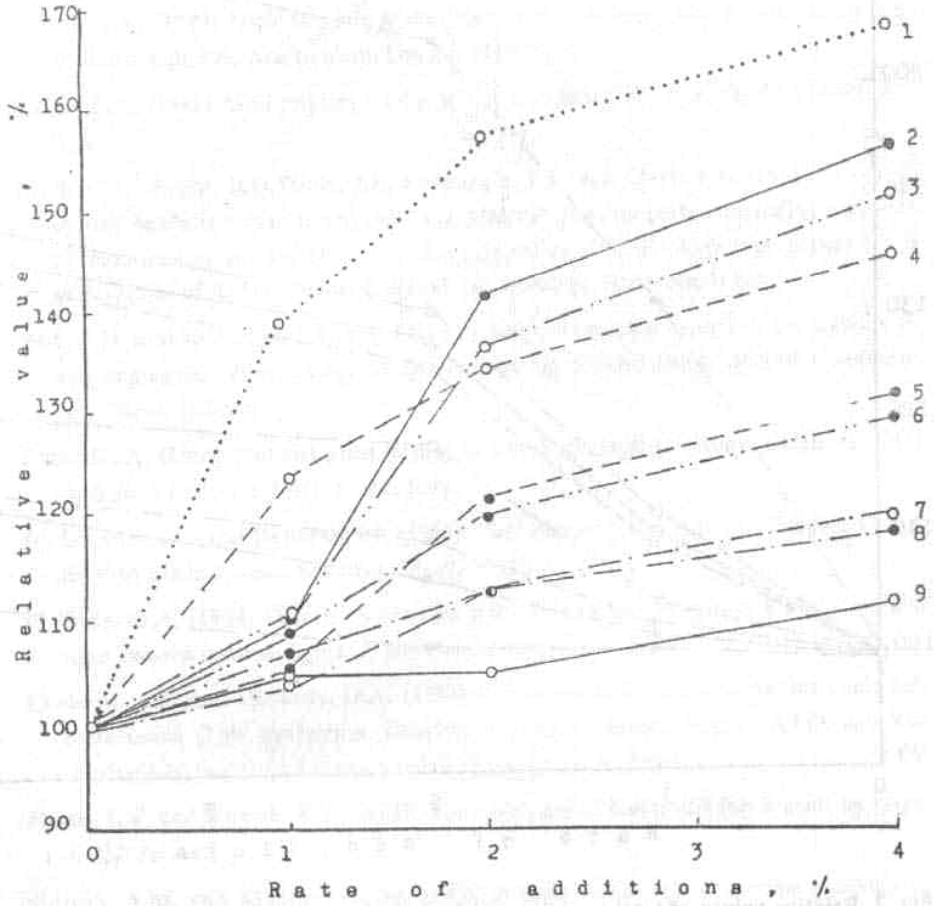

Fig. 1. Relative values of aggregate size of 2.0 - 0.84 and 0.42 0.25 mm, total aggregates, aggregate coefficient, total organic carbon, total extractable carbon, humic acids carbon, fulvic acids carbon and Hu/Fu as affected by the interaction of the additions of rice straw + Taflah.

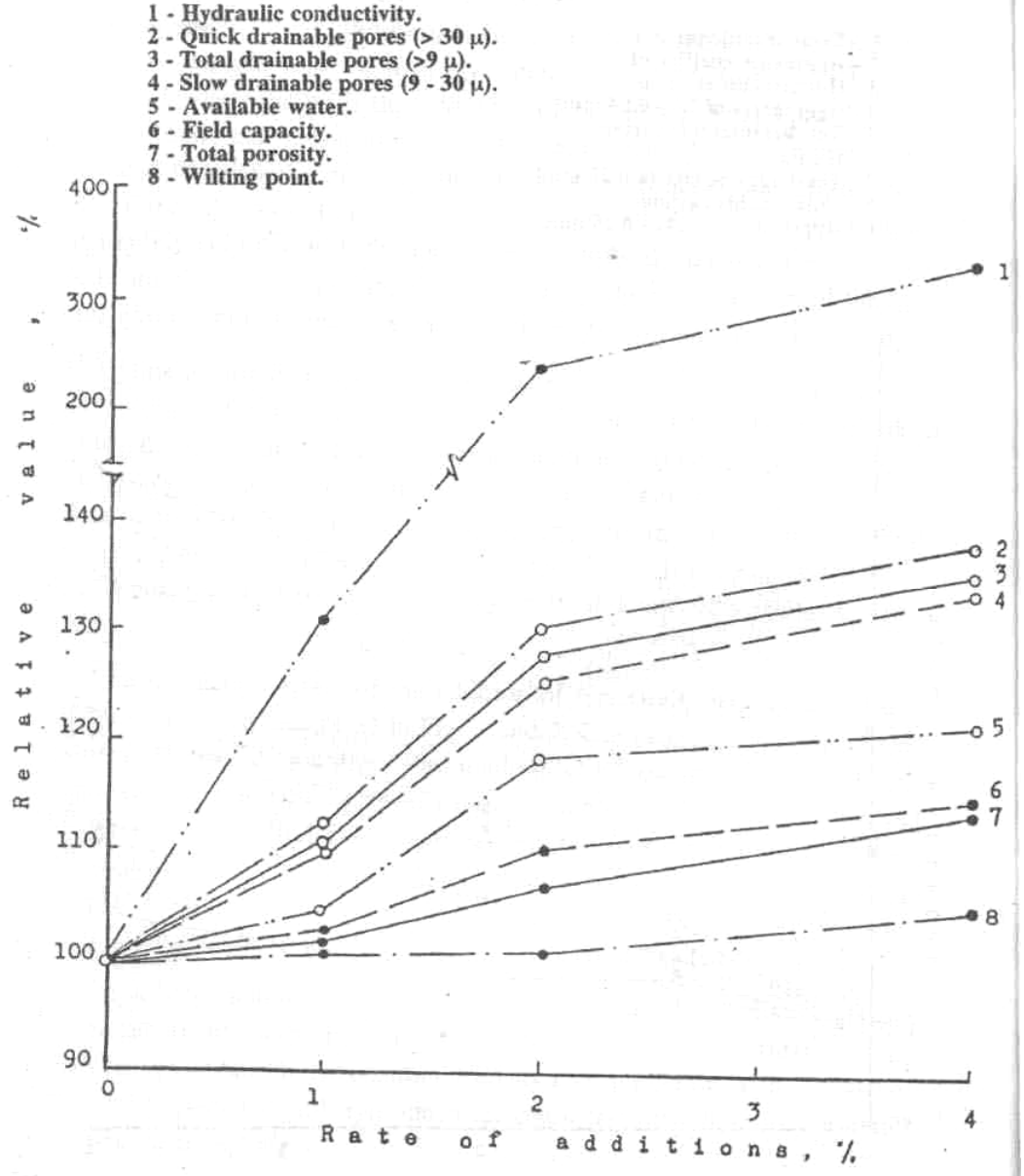

Fig. 2. Relative values of total porosity, quick drainable pores, slow drainable pores, total drainable pores, hydraulic conductivity, field capacity, wilting point and available water as affected by the interaction of the additions of rice straw + Taflah.

References

Abdel-Ghaffar, A.S. (1982) The significance of organic materials to Egyptian agriculture and maintainance of soil productivity. Paper presented at the FAO/SIDA Workshop on the use of organic materials for improving soil productivity in the Neat East, *FAO Soils Bull.* No. 45 Rome, Italy.

Abdel-Samie, M. (1982) Resources of organic wastes in Egypt. Paper presented at the FAO/SIDA Workshop on the use of organic materials for improving soil productivity in the Neast East. *FAO Soils Bull.* No. 45, Rome, Italy.

Allison, F.E. (1973) *"Soil Organic Matter and its Role in Crop Production,"* El-Sevier Scientific Pub. Co., Amesterdam, London, New York.

Baver, L.D. (1965) *"Soil Physics,"* John Willey and Sons Pub., London, New York and Paris.

Black, C.A., Evans, D.D.White, J.L. Ensminger, L.E. and Clark, F.E. (1965) *"Methods of Soil Analysis,"* Part 1: Physical and Mineralogical properties including statistics of measurement and sampling. Part 2. Chemical and Microbiological properties No. 9 in the Series of Agron., Am. Soc. Agron. Inc. Madison, Wisconsin, U.S.A.

Blot, G.H. and Koenings, F.F.R. (1972) Physical and chemical aspects of the stability of soil aggregater. *Proceedings Symposium on the Fundamentals of Soil Conditioners,* Ghent, Belgium.

Cattenie, A. (1980) Soil and plant testing as a basis of fertilizer recommendations. *FAO Soils Bull.* No. 38/2, FAO, Rome, Italy.

De Leenheer, L. and DeBoodt, M. (1965) *"Soil Physics"*; International Training Center for Post-graduate. Soil Scientist. Ghent, Belgium.

El-Hady, O.A. (1984) Criteria to evaluate soil conditioners for aggregate formation and wind erosion control. *Egypt. J. Soil Sci.* **24** (2) 137.

El-sherif, A.F. and El-Hady, O.A. (1983) The use of Egyptian bentonite for sandy soil reclamation (Lab. evaluation. Conclusive report. bentonite Project A.I.D. and The Academy of Scientific Research and Technology, A.R. Egypt.

Evans, L.T. and Russell, E.W. (1959) The adsorption of humic and fulvic acids by clays. *J. Soil Sci.* **10** (1) 119.

Gomah, A.M. and El-Essawi, T.M. (1975) A study on the role of organic materials in stabilizing soil aggregates. *Alex. J. Agric.* Res. **23** (3) 631.

Ifad (1979) Fayoum Agricultural Development Project. Report of the Project Identification Mission to the Arab Republic of Egypt, International Fund for Agriculutral De-

velopment, Rome, Italy.

Jackson, M.L. (1962) *"Soil Chemical Analysis"*, 4th Ed., Prentice Hall Inc., Englewood Cliffs, N.J.

Knonova, M.M. (1966) *"Soil Organic Matter, Its Nature, Its Role in Soil Formation and in Soil Fertility"*, 2nd English Ed., Pergamon Press Ltd., Headington Hill Hall, Oxford, England.

Raid, A. (1982) Potential sources of organic matter in Egypt. Paper presented at the FAO/ SIDA Workshop on the use of organic materials for improving soil productivity in the Near East. FAO Soils Bull. No. 45, Rome, Italy.

Richards, L.A. (Ed.) (1954) *"Diagnosis and Improvement of Saline and Alkali,"* U.S.D.A. Hand Book No. 60, U.S.A.

Steel, R.G.D. and Torrie, T.H. (1960) *"Principles and Procedures of Statistics"*, Mc Graw Hill, New York, U.S.A.

Talha, M., Abd El-Samie, A.G. and Omar, M.S. (1979) Factors affecting water movement in alluvial soils. *Egypt. J. Soil Sci.* **19** (1), 55.

Van Doren, D.M. Jr. and Allmaras, R.R. (1978) Residue management practice on soil physical environment, microclimate and plant growth. In *"Crop Residue Management System," ASA special Pub.* No.31, Am. Soc. Am. Inc., Madison, Wisconsin, U.S.A.

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استخدام المحسنات الطبعية لتحسين الخواص الفيزيائية والكيماوية بالاراضى الطينية الصوديه

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اجريت تجربه معمليه باستخدام الاصص لدراسة تأثير اضافه كلا من الطفلة (خام البنتونيت) وقش الارز للاراضى الطينيه القلوية فى محافظةالفيوم.

وقد اظهرت النتائج ان لاضافة قش الارز أو الطفلة الى التربه القلويه تأثير معنوى موجب على زيادة الكربون العضوى ، الدبال ، ومسام الصرف والمسام السريعة الصرف ومعامل التحبب. ومن ناحيه أخرى فأن اضافة قش الارز ادى الى زيادة قيمة التوصيل الهيدروليكى.

وقد تبين من دراسه التأثير المتبادل لكل من اضافة الطفلة وقش الارز الى التربة القلوية زياده معنوية موجبه فى كل من المسام الكليه ، التجمعات الثابتة ضد الماء ذات القطر اكبر من ٠,٢٥ مم. أو حمض الفولفيك ، وكذلك تبين انه نتيجه الاضافة لكل من قش الارز والطفلة ظهرت زياده كلا من الكربون العضوى الكلى والدبال المستخلص مما يؤدى الى زياده معنوية فى المسام الكبيرة الحجم والمجمعات الارضية ذات قطر ٠,٨٤ - ٢,٠ مم وبالتالى زياده معامل التحبب للتجمعات الثابتة ضد الماء والتوصيل الهيدوليكى ، وكان افضل تأثير عند اضافة (لطفله + قش الارز) بنسبه ٤٪ لهذه الارض.