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The Potentiality for Improving Plant-Soil-Water Relations in Sandy Soils Using Some Synthesized Am Na (Or K) ATEA Hydrogels

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IN OUR COURSE in preparing and developing effective soil conditioners, four synthesized AmNa (or K) ATEA hydrogels (polyacrylamide Na or K acrylate copolymer cross-linked with tri-ethanol amine) were evaluated for improving plant soil water relations in virgin sandy soils compared with two other natural conditioners, namely farmyard manure and Quasr El Sagha bentonitic caly (Fayoum).

The hydrogels Gl and G2 were Am Na A while the hydrogels G3 and G4 were Am K A. Preparation in each group was either in air or in nitrogen, in sequence. Examined application rates were 0.1 and 0.2 % (w/w) for hydrogels; 2 and 4% (w/w) for farmyard manure and 5 and 10% (w/w) for bentonitic caly.

Synthesized hydrogels were more effective in modifying the pore size distribution towards the increase in water holding pores (28.8 -0,19 μ) on the expense of drainable ones (> 28.8 μ). Water relation implies that the available water for plants increases up to more than two times that of the original sandy soil, while allowing at the same time the soil to remain aeratedl. Soil properties related to water movement *i.e.* infiltration rate, hydraulic conductivity and adjusted evaporation were also improved. Although the application rates of natural conditioners are 20 times for the farmyard manure and 50 times for the hentonitic clay that of the application rate of examined polymer, the effect of hydrogels on improving plant-soil-water relations in sandy soil is very near to that of bentonitic clay and much better than that of farmyard manure. This indicates the importance of applying a such relatively new technique for sandy soils conditioning. With this respect, the hydrogels G3 and G4 are preferred for their high release of the beneficial cation for plant growth, *i.e* K. Costs of synthesis are another of preference.

Keywords: Super absorbent materials, Acrylamide hydrogels, Sandy soils, Pore size distribution, Water retentivity, Water movement.

Sandy soils have two major problems: low fertility and inadequate water retention. Wind erosion, water erosion, drought and loss of irrigation water and plant nutrients are expected. However they could be as productive as any fertile soil if the right soil water management practices are tollowed (Massoud, 1973 and Balba, 1989). Other than adding clays or organic manures and composts to sands, the only obvious way to keep water more available in such soils is frequent water application and / or the use of synthesized soil conditioners (El-Hady and Azzam, 1983). Although clays (100 to 150 m^3/ fed., Abd alla *et al.*, 1970) could be mixed with sand to improve its water reternivity, such treatment is expensive. It is usually justified only when land is very limited The application of organic materials to sandy soils (10 to 20 ton/fed., Ahdou *et al.*, 1969) has quite a similar effect to that of clay with some exceptions that organic matter is usually decomposed too fast that it is difficult to maintain more than 1 or 2 percent without heavy and seasonal manuring (Donahue *et al.*, 1977). Frequent irrigation is the usual solution tor keeping enough water available in sandy soils. The high porosity of sands will allow excessive percolation losses especially if overland flow methods of watering are used (Baudelaire, 1973).

The use of synthesized condtioners to avail suitable environments for planting sandy soils under the severe conditions of our deserts *i.e* the limited water resources; the inadequate water retention and low fertility of the soils-has become an accepted practice. Among these conditioners are hydrogels. Hydrogels (Super absorbent moterials) are hydrophilic polymeric products that associate quickly with irrigation water to form gels. When mixed with sandy soil, they increase its capacity to retain water. Water retained in this way is available to plants for some considerable time, as required. Due to the bending effects of hydrogels molecules with sand particles and their swellablity, an improved structure of the sandy soil is obtained, besides, beneficial changes in soil porosity, particeularly the amount of water retaining pores. Both chemical and biological properties of the conditioned soils are also improved. Moreover, germination, plant growth. nutrients uptake, yield and both water and fertilizers use efficiency by plants were beneficially increased by mixing the plant pits in sandy soil with hydrogels (El-Hady, *et al.*, 1987 a and b and 1993; Tayel and El-Hady 1981, El-Hady, *et al.*, 1981, 1983, 1990, 1991, El-Hady and Azzam 1983 and Azzam and El-Hady1983).

Most of the previous studies on hydrogels were done on imported products. A conclusion was drown that synthesis of hydrogels in Egypt by Egyptain raw materials may reduce their prices and in turn will raise the cost benefit of the conditioning process (Rasheed *et al*., 1997).

Some hydrogels based on copolymer of accylamide sodium or potassium acrylate crosslinked with ethanol amines were synthesized at the Polymers and Pigments Dept., NRC, Egypt, (Rizk *et al.*, 2001). Evaluation of these polymers as conditioners to improve plant-soil-water relations in sandy soils, compared with other traditional conditioners *i.e.* bentonitic clays and farmyard manures, is the aim of the present work.

Material and Experimental Tecniques

Material

1-Soil

A virgin sandy soil (more than 90% of its particles are > 20 μ) located at El-Shabab area, west Sinai, Ismailia governorate was used. The main analytical data of the soil are presented in Table 1.

TABLE 1. Analytical properties of the soil under investigation.

1) Mechanical analysis

Course sand 2000 - 200 μ %	Fine sand 200-20 μ %	Silt 20-2 μ %	Clay < 2μ %	Soil texture
43.2	51.6	2.9	2.3	Sandy

2) Chemical analysis

pH 1:2.5	EC $dS\ m^{-1}$	$CaCO_3$ %	OM %	Soluble cations meq /100 g soil				Soluble anions meq /100 g soil			CEC meq/ 100 g soil
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{2-}	
7.8	1.6	1.5	0.1	1.3	0.45	0.39	0.06	0.36	0.55	1.29	6.15

3) Hydro-physical analysis

Bulk density g cm^{-3}	Total porosity %	Water* holding capacity %	Field capacity* %	Wilting percentage* %	Intrinsic permeability	Mean diameter of soil pores (μ)
1.640	38.11	21.73	9.06	2.88	6.35	17

*On weight basis.

2. Soil conditioners and application rates

The following synthiesized and natural conditioners were examined:

2.1. Hydrogels: Four hydrogels (G1, G2, G3 and G4) based on polyacrylamide (Na or K) acrylate copolymer crosslinked with ethanol amines were synthesized

(Rizk *et al.*, 2001). Description of their main constituents, synthesis conditions and properties are presented in Table 2.

TABLE 2. Description of the main constituents and properties of examined hydrogel: a- Main constituents and polymerization conditions.

Active substance	G1	G2	G3	G4
	Am NaA*	Am NaA*	AmKA**	AmKA**
Ionization degree	30mole %			
Cross linker	Tri ethanol amine(TEA)			
Cross linker ratio	1.71%			
Initiater	ammonium peroxy disulphate $(NH_4)_2S_2O_8$			
Initiater ratio	0.14			
Temperature used for polymerization	30 °C			
Time of polymerization (hrs)	1.5	2.0	1.5	2.0
Presence or absence of nitrogen	presence	absent	presence	absent
Monomer content	Not higher than 300 ppm			

b- Properties

	G1	G2	G3	G4
Appearance:	White to slightly yellow grains			
Grain size :	0.25 - 1 mm			
Bulk density (dry):	≈ 600 kg/m^3			
Solubility :	Insoluble in water and organic solvents			
pH 0.1 % in distilled H_2O	7.5	7.6	7.1	7.1
Absorption capacity in g/g hydrogel deionized water :	667.3	602.7	575.4	527.01
NaCl Solution /3000 ppm	84.4	75.5	——	——
Absorption time : Up to 50 %	20 minutes			
Total absorption	60 minutes			

*Acrylamide sodium acrylate copolymer
**Acrylamide potassium acrylate copolymer

2.2. Farmyard manure (OM): The used manure is an organic and animal residues including some soil mineral materials (mineral matter). Aalysis of O.M. used in the present work are given in Table 3.

TABLE 3. Analysis of farmyard manure used as soil conditioner in the current investigation.

Water %	Dry matter % Total	organic	mineral	pH	Organic C %	N %	C/N ratio	P%	K%
15.65	84.35	71.25	13.10	8.60	41.3	1.95	21.2	0.25	0.95
S%	Total dissolved solids %		Ca %	Mg %	Na %	Mn ppm	Fe ppm	Zn ppm	Cu ppm
0.22	1.28		1.01	0.32	0.15	125.7	1215.8	32.7	4.2

2.3. Bentonitic clay: Bentonitic clay of Quasr El-Saagha at El-Fayoum Depression (particles >2μ and > 1 μ in diameter are 11.1 and 76.70%, respectively) was chosen for the present study. Its particle size distribution, chemical and mineralogical composition, main hydrophysical mechanical and chemical properties were presented elsewhere (El-Hady and El- Sherif, 1988).

Experimental

Plant-soil-water relations

Soil conditioners were homogeneously mixed with the air dried sandy soil at different rates, *i.e.* 0.0, 0.1 and 0.2% for hydrogles, 0.0, 2 and 4% for farmyard manure and 0.0, 5 and 10% for Quasr El-Sagha bentonitic clay. Either the untreated or treated soils were uniformity packed in PVC columns (2kg soil in capacity) in a way that a constant bulk density of 1.64 g cm^{-3} was obtained. For soils treated, with hydrogels, a sufficient amount of water was added to complete the gelation reaction and to reach equilibrium. All soils were wetted to saturation and left to evaporate for one week, then they were resaturated weekly for another seven wetting/drying cycles. After two months from the beginring of the experiment undisturbed samples from each treatment were taken for evaluation. Bulk density, soil water, equilibrium values over the range from 0 to 15 atm, infiltration rate, hydraulic conductvity and adjusted evaporation for different wetting and drying cycles were determined. Total porosity, void ratio, pore size distribution and mean diameter of soil pores, soil water characteristics and available water in the soil were calculated (Dewis and Freitas, 1970; Hillel, 1971 and Loveday, 1974).

Released ions from synthesized hydrogels

A certain quantity of hydrogel (0.1g) with grain size (0.25-1.0 mm) was interspersed with l00ml deionized water for 18hr at room temperature. After this period, the contents were poured out into a sieve with a mesh size of 0.25 mm so that the layer of the polymer gel on the sieve should has a thickness of no more than 8 mm. For a further period of 25 min, to allow for dripping, the filtrate was collected (The filtration method described by Pieh and El-Hady, 1990). The hydrogel sample was left on the sieve to evaporate for 7 days, then another 50 ml of deionized water were slowly added by a drip system. The filrate was also collected. Such watering was repeated 6 times at a frequency of 7 days interval. Collected filtrates were analyzd for their pH and soluble Na^+ and K^+ (Dewis and Freites, 1970).

Results and Discussion

I. Plant-soil-water relations

a. Effect on soil porosity and pore size distribution

Improvements in soil bulk density, void ratio, soil porosity and micro and macro porosity due to soil conditioning are given in Table 4 and illustrated in Fig.1 . Data reveal that soil conditioning by either the four examined hydrogels or the other two natural conditioners increased the void ratio, total porosity, the micro pores (> 28.8μ) relative to total or the macro ones (< 28.8μ) and the water holding pores (28.8-0.19μ). It decreased soil bulk density and drainable pores (> 28.8 μ). The conditioning effect increases with increasing application rates of the conditioners. Synthesized hydrogels were more effective in modifying the pore size distribution towards the increase in water storage pores. Differences between the four studied hydrogels are statistically insignificant. Water holding pores were increased by 82.3 ± 8.6% and 109.8 ± 5.3% when hydrogels were incorporated into sandy soil at the rates of 0.1 and 0.2%, respectively, compared with 15.3 and 38.0% or 74.3 and 92.9% by incorporating the two rates of either farmyard manure or Fayoum bentonitic clay into sandy soil, respectively. This increase in water holding pores is vital to ensure water reservation in sandy soil under dry farming conditions.

These changes in bulk density, void ratio and pore system due to gel addition could be attributed to the swelling of the gel fine particles. This swells out the soil and so reduces its density. Deswelling or drying the soil diminishes the volume of gel particles leaving voids in the soil. On rewetting the soil, water go through soil voids to get in contact with particles. So, it swells again (El-Hady and Azzam, 1983).

b. Effect on water retention and available water

Improvements in retained water in sandy soil under different tensions-due to soil conditioning are presented in Table 4 and illustrated in Fig. 2 and 3. Data refer to an increase in the percentages of retained water at all suctions under study being higher with increasing the application rate of each conditioner.

At saturation, *i.e.* at pF = 0, the total water holding capacity (WHC) of the soil was increased by 7.6 and 14.1% when incorporating 2 and 4% O.M in the soil, respectively. Relevant values with 5 and 10% Quasr El-Sagha bentonitic clay were 13.4 and 19.0 % in sequence. Applying hydrogels to sandy soil increased also its WHC by 16.3 ± 2.9% and 24.2 ± 40% when added at the rates of 0.1 and 0.2%, respectively.

TABLE 4. Improvements* in soil properties due to conditioning process.

Soil conditioner	Application rate %	Soil porosity and pore size distribution						Water retention in the soil			Water transmitting properties		
		Bulk density g cm^{-3}	Soil voids (ratio)	Drainable pores (macropores %)	Water holding pores %	Air filled porosity at pF=2%	Mean diameter of soil pores (μ)	Water holding capacity % w/w	Field capacity % w/w	Avalible water % w/w	Average infiltration rate cm min^{-1}	Hydraulic conductivity (K) m day^{-1}	Adjusted evaporation E adj.
Untreated (values)	0.0	1.640	0.62	20.78	10.13	23.25	17	21.73	9.06	6.18	4.9	7.57	1.0
% of untreated		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
G1	0.1	95.4	111.3	78.2	193.6	70.8	80.0	119.7	172.6	202.8	63.3	63.7	69.2
	0.2	93.8	116.1	77.8	217.2	64.5	72.4	128.9	193.2	231.1	59.2	52.1	61.5
G2	0.1	94.5	114.5	78.3	183.3	78.5	78.8	117.3	165.6	193.9	65.3	62.2	68.6
	0.2	93.7	117.7	76.2	210.0	68.3	73.5	125.8	188.6	224.1	57.1	54.0	63.3
G3	0.1	94.6	114.5	76.9	179.0	80.3	79.4	114.9	161.8	189.0	69.4	63.3	69.9
	0.2	93.9	116.1	72.9	205.7	69.8	74.1	122.0	184.1	218.9	63.3	54.8	64.1
G4	0.1	94.9	112.9	77.5	173.2	82.1	81.2	113.1	157.1	182.4	71.4	65.5	70.5
	0.2	94.2	116.1	70.4	206.2	69.0	75.3	120.0	193.2	218.8	65.3	56.3	62.8
OM	2.0	94.7	114.5	95.2	115.3	105.5	91.2	107.6	117.4	121.7	79.6	83.0	91.5
	4.0	94.0	116.1	92.5	138.0	97.0	87.1	114.1	136.0	146.8	73.5	76.0	86.2
Bentonitic clay	5.0	97.9	104.8	76.9	174.3	68.2	76.5	113.4	162.0	178.0	49.0	58.3	80.1
	10.0	96.3	109.7	73.3	192.9	63.4	70.0	119.0	179.0	200.2	45.0	48.7	76.5

* calculated as a % of untreated soil.

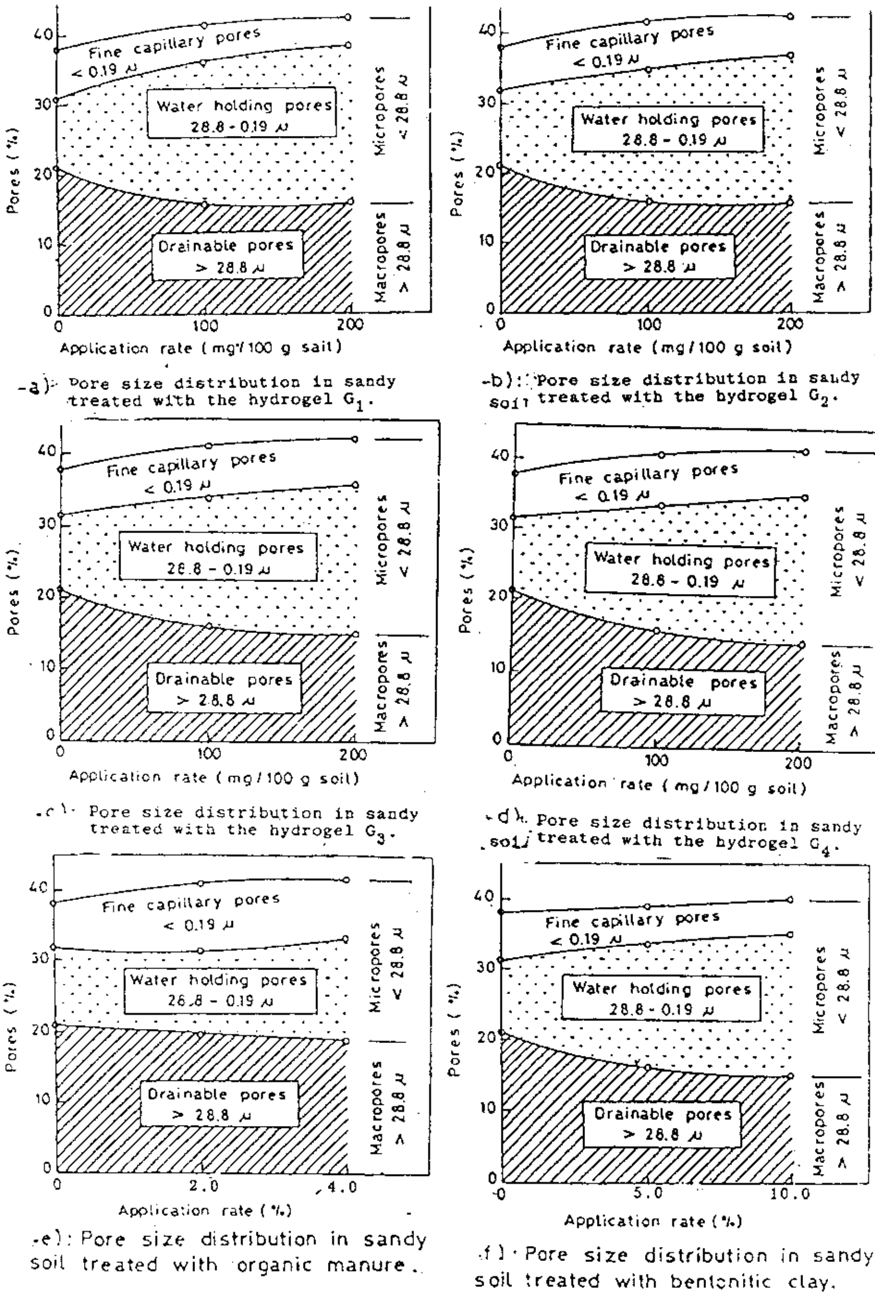


Fig. 1. Pore size distribution in sandy soil treated with soil conditioners.

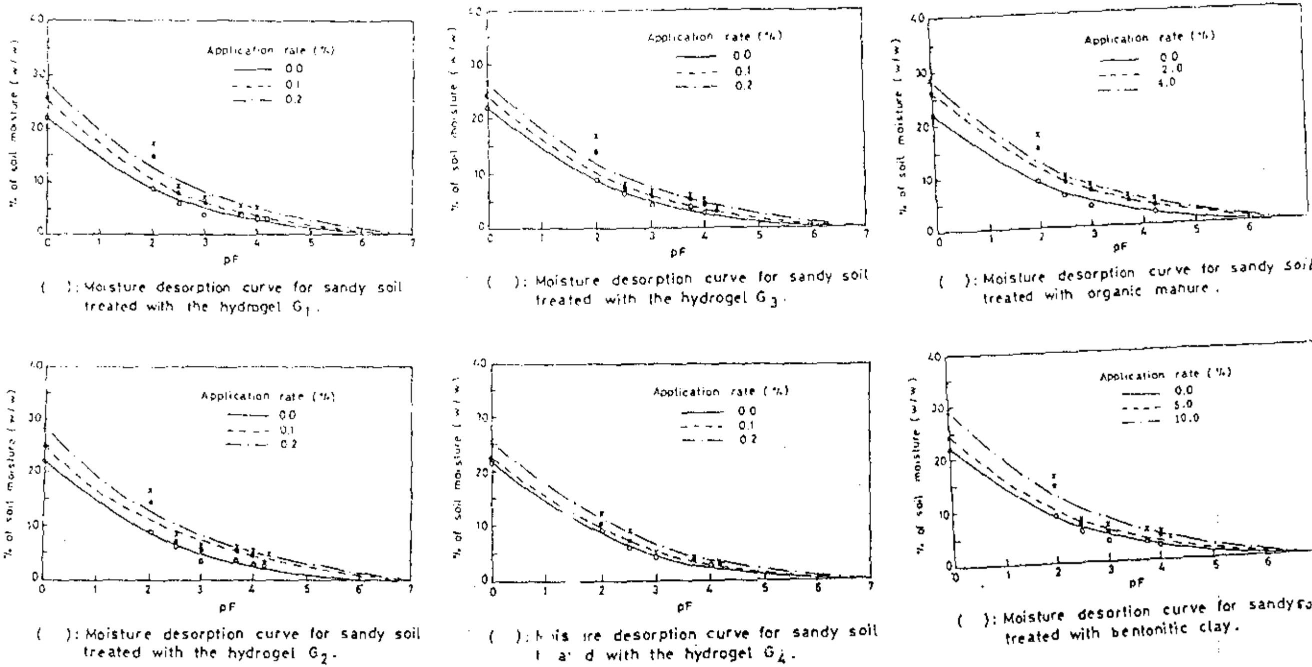
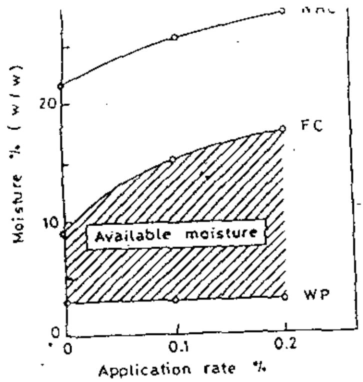
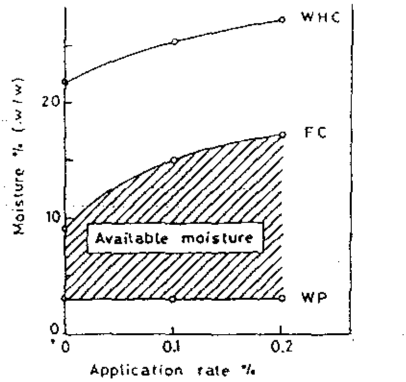


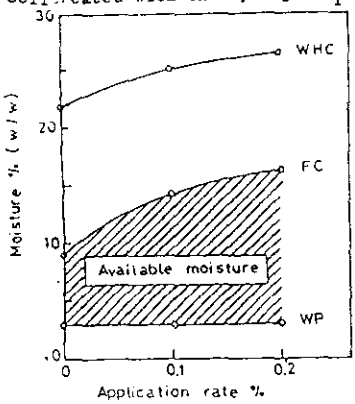
Fig. 2. Moisture desorption curves for sandy soil treated with soil conditioners.



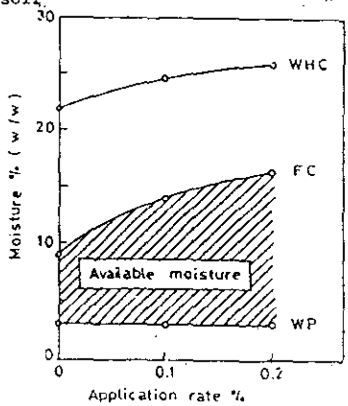
-a): Moisture characteristics of sandy soil treated with the hydrogel G_1.



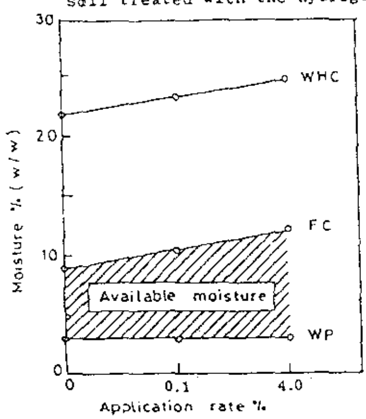
-b): Moisture characteristics of sandy soil treated with the hydrogel G_2.



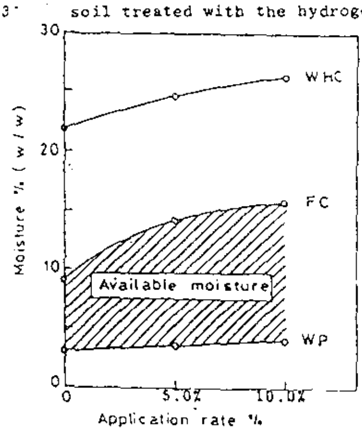
-c). Moisture characteristics of sandy soil treated with the hydrogel G_3.



-d) Moisture characteristics of sandy soil treated with the hydrogel G_4



-e) Moisture characteristics of sandy soil treated with organic manure.



-f) Moisture characteristics of sandy soil treated with bentonitic clay

Fig. 3. Moisture characteristics of sandy soil treated with soil conditioners.

At field capacity (FC) *i.e.* at pF = 2.0, values of retained water show also an increase of 17.4 and 36% or 62.0 and 79% relative to that of the control by applying the same rates of O.M or Quasr El-Sagha bentonitic clay mentioned above, respectively. Conditioning the soil with hydrogels also raised the amount of water retained into the soil at its field capacity over that of the untreated soil by 64.3 ± 6.5% and 87.3 ± 4.6% when incorporated into the soil at the rates of 0.1 and 0.2%, respectively. Moreover, the decrease in air filled porosity in the soil at its field capacity-as a result of increasing water retentivity of the soil - is not likely to become limiting to plant growth, since the air filled porosity is > 10% (Hillel, 1971).

Because the increase in water retained at field capacity *i.e*, at pF = 2.0 is far beyoned that at wilting percentage (WP) *i.e.* at pF =4.2, the available water (FC-WP) increased. Incorporating 2 and 4% O.M., in the soil raised its available water to be 1.22 and 1.47 times that of the untreated soil, respectively. Applying Quasr El-Sagha bentonitic clay to sandy soil also increased its available water to be 1.78 and 2.0 times that of the control for 5 and 10% to treatments, respectively. Regarding hydrogels, available water were 1.92 ± 0.09 and 2.23 ± 0.06 times that of untreated sandy soil when 0.1 and 0.2% of the hydrogels were respectively incorporated into the soil.

Obtained results could be explained on the basis of increasing the smaller pores having the diameters of 28.8-0.19μ on the expense of the large ones, *i.e.* drainable pores having the diameters of > 28.8 μ with soil conditioning. It is well known that increasing available water for plants elongates irrigation frequencies and in trun decrease the quantities of irrigation water needed and costs of irrigation process.

c. Effect on water transmitting properties of the soil

Sandy soil conditioning improves the dynamic soil water characteristics *i.e.* decreasing the downward movement of water through infiltration and the upward movement of it via evaporation. Values of water transmitting properties of sandy soil namely average infiltration rate (I av.) in cm min^{-1} and saturated hydraulic conductivity (K) in m. day^{-1} reached 67.4 ± 3.7 % and 61.2 ± 3.7% and for I av., 63.7 ± 1.4% and 54.3 ± 1.7% for K^- of that of untreated soil by applying 0.1 and 0.2 % hydrogels, respectively. Relevant values for other conditioners are 79.6 and 73.5% for I. av. and 83.0 and 76.0 for K^- with 2 and 4% O.M. and 49.0

and 45.0% for I av. and 58.3 and 48.7 for K^- with 5 and 10% bentonitic clay in sequence. Moreover, reduction in adjusted evaporation (E .adj.) ranged between 29.5 and 31.4%, and 35.9 and 38.5% that of untreated soil for 0.1 and 0.2% hydrogel, respectively. Relevent values for O.M and bentonitic calys were 8.5 and 19.6% for the lower application rates of the conditioners *i.e* 2% O.M and 5% clays and 13.8 and 23.5% for the higher ones *i.e* 4% O.M and 10% clays, respectively, (Table 4). As expected, the improvement in the dynamic soil water characteristics mentioned above, will lead to a considerable decrease in the loss of plant rutrients from sandy soil by leaching or deep precolation (El-Hady *et al.*, 1991 and 2001).

II. Released ions from synthesized hydrogels

When anionic hydrogels are equilibrated with water, a considerable part of the associated cations (Na^+ or K^+) were desorbed from the polymer molecules to the water (El-Hady and Abd El-Hady, 1991 and 1997). After 8 leachates with deionized water about 100 mg Na^+ /g hydrogel were released from each of the anionic hydrogels sodium salt (G1 or G2). As known, pH of the filtrates coincides with its sodium content. This is why the highest pH was recorded in the filtrates of the anionic hydrogels sodium salts. Such increase in the pH of the filtrate may adversely affect soil properties and availability of great number of nutrients needed for the plant. On the other hand the anionic hydrogels potassiun salt (G3 or G4) released K^+ by varying degrees being higher with G3 (196 mg/g gel). (Table 5).

TABLE 5. pH values and released sodium and potassium from different hydrogels after equilibrium with deionized water.

a) pH values

Examined hydrogel	No. of filtrate								
	1	2	3	4	5	6	7	8	mean
G1	7.5	7.5	7.5	7.4	7.4	7.4	7.3	7.3	7.41± 0.08
G2	7.6	7.5	7.5	7.5	7.4	7.4	7.3	7.3	7.44± 0.11
G3	7.1	7.1	7.0	7.0	7.1	7.1	7.0	7.0	7.05± 0.05
G4	7.1	7.1	7.1	7.0	7.0	7.1	7.0	7.0	7.05 ± 0.05

b) released sodium (mg/g gel)

Examined hydrogel	No. of filtrate								
	1	2	3	4	5	6	7	8	Total
G1	20	20	14	12	11	9	8	6	100
G2	20	19	13	13	13	11	6	6	101
G3	2	2	3	2	1	1	0	0	11
G4	3	2	1	1	1	1	0	0	9

c) released potassium, (mg/g gel)

Examined hydrogel	No. of filtrate								
	1	2	3	4	5	6	7	8	Total
G1	0	1	3	3	3	4	6	4	24
G2	0	1	2	3	3	3	4	6	22
G3	31	29	29	25	23	21	21	17	196
G4	25	25	25	21	21	19	19	17	172

Although the anionic polymers Na salt have relatively high swell-abllity, substitution of Na^+ by K^+, *i.e.* producing K salt hydrogels will be of great value. In this case, plants grown in the treated sandy soils-especially in their early stages of growth-can get benefit from such available nontoxic cations (El-Hady and Abd El-Hady, 1991). With this respect the hydrogels G3 and G4 are preferred. Costs of synthesis are another of preference.

Although the application rates of natural conditioners are 20 times for the farmyard manure and 50 times tor the bentonitic clay that of the application rates of examined polymers, the effect of hydrogels on improving plant-soil-water relations in sandy soil is very near to that of bentonitic clay and much better than that of farmyard manure. This indicates the importance of applying such relatively new technique for sandy soils conditioning. It is worth mentioning that applying both types of soil conditioners (natural and synthesized) together *i.e.* incorporating mixtures of organic materials and the proper hydrogels-if possible-in the soil may be more effective and economic than using each of them solely (Abd El-hameed *et al.*, 1995; El-sherheiny *et al.*, 1995; El-Hady *et al.*, 1995 a and b, 2000 a, b and c and 2001 a and b; El-Hady & Hefiny, 2001 and Arafat & El-Hady, 2000).

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بلمرات فائقة الامتصاص للماء من نوع الاكريلاميد صوديوم (أو البوتاسيوم) أكريلات هيدروجل كمحسنات لعلاقات الأراضى الرملية بالماء والنبات

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طبقا لبرنامجنا فى تحضير وتطوير محسنات للتربة ذات قدرة فائقة على امتصاص الماء فقد حضرت أربعة بلمرات من الأكريلاميد وبعض مشتقات أملاح حمض الأكريليك فى وجود التراى إيثانول أمين كمادة رابطة بين سلاسل الهيدروجل واستخدام الأمونيوم بيرسلفات كمنشط لعملية البلمرة. مركبى ج١ وج٢ من البولى أكريلاميد صوديوم أكريلات بينما مركب الهيدروجل ج٣ وج٤ فمن نوع البولى أكريلاميد بوتاسيوم أكريلات. المركب الأول من كل مجموعة حضر فى وجود النيتروجين (وسط خامل) بينما المركب الثانى حضر فى غيابه.

قيمت البلمرات المحضرة كمحسنات لأرض رملية من غرب سيناء ومعدن طين البنتونيت (الطفلة) الناتج من مناجم قصر الصاغة بالفيوم وكانت معدلات الإضافة للتربة الرملية كنسب وزنية هى: صفر و١. ٠ و٢. ٠٪ بالنسبة لمركبات الهيدروجل. صفر و٢ و٤٪ بالنسبة للسماد البلدى صفر و٥ و١٠٪ بالنسبة للطفلة.

الناتج المتحصل عليها يمكن تلخيصها فى الأتى:
كفاءة المواد المختبرة على تحسين علاقات الأرض والماء والنبات فى الأراضى الرملية:
أ) تؤدى عملية تحسين الأراضى الرملية إلى زيادة كل من المسامية الكلية للتربة ونسبة المسام الدقيقة (المسام ذات الأقطار أقل من ٨. ٢٨ ميكرون) منسوبة إلى أى من المسام الكلية أو المسام الواسعة(المسام ذات الأقطار أكبر من ٨. ٢٨ ميكرون) ونسبة المسام الحافظة للماء. (المسام ذات الأقطار من ٨. ٢٨ إلى ٠. ١٩ ميكرون).

كما أن عملية التحسين تؤدى إلى خفض كل من الكثافة الظاهرية للتربة والمسام المسئولة عن صرف الماء (المسام ذات

الأقطار أكبر من ٨ . ٢٨ ميكرون) ويزداد التأثير التحسينى للمواد المختبرة بزيادة معدل إضافتها للتربة.

كانت المحسنات المصنعة (مركبات الهيدوجل) أكثر كفاءة على تعديل التوزيع الحجمى للمسام فى التربة ناحية زيادة نسبة المسام الحافظة للماء حيث قدرت الزيادة فى هذه المسام عن مثيلاتها فى التربة الغير المعاملة ب ١ . ٦٠-٢ . ٨٠٪ و٢ . ٨٧-٤ . ٩٧٪ عند خلط مركبات الهيدروجل فى التربة الرملية بمعدل الاضافة ١ . ٠ و ٢ . ٠٪ على الترتيب مقارنة ب١ . ٧٪ و ٦ . ٢٦٪ عند استعمال السماد البلدى و٥ . ٦٨٪ و١ . ٨٢٪ عند استعمال الطفلة بمعدلى الإضافة المختبرين لكل منهما على الترتيب. من المعروف أن الزيادة فى المسام الحافظة للماء فى التربة يعد أمراً حيوياً حيث يؤكد قدرة التربة الرملية على الاحتفاظ بالماء تحت الظروف القاسية للزراعة الجافة.

ب) تؤدى عملية تحسين الأرض الرملية إلى زيادة الماء الذى تحتفظ به التربة تحت قوى الشد المختلفة وتزداد قدرة التربة على الاحتفاظ بالماء بزيادة معدل إضافة المحسنات. تراوحت الزيادة فى كمية الماء القابل للاستفادة بواسطة النبات بمعاملة التربة بمركبات الهيدروجل (مقارنة بالتربة غير المعاملة) بين ٤ . ١٨٢ و ٨ . ٢٠٢٪ أو بين ٨ . ٢١٨ و ١ . ٢٣١٪ عند استخدام معدلى إضافة ١ . ٠٪ أو ٢ . ٠٪ من هذة المركبات بينما كانت هذه الزيادة ٧ . ١٢١٪ ٨ . ١٤٦٪ فقط باستخدام ٢ . ٤٪ سماد عضوى و١٧٨٪ و ٢ . ٢٠٠٪ عند استخدام ٥و ١٠٪ طفلة على التوالى.

النتائج المتحصل عليها تؤكد القدرة الفائقة لمركبات الهيدروجل المختبرة على زيادة الماء القابل للاستفادة بواسطة النباتات المنزرعة فى الأراضى الرملية والذى يؤدى بالتالى إلى إطالة الفترات بين الريات وتقليل الاحتياجات المائية للنباتات وخفض تكلفة عمليات الرى.

ج) لا تؤدى استخدام مركبات الهيدروجل المختبرة إلى التأثير العكسى على أى من تهوية التربة والتفاعلات الحيوية فيها أو على تنفس الجذور واستخدام هذه المركبات كمحسنات للتربة الرملية يجعل نسبة مسام التهوية فى مجال الجذور عند السعة الحقلية للتربة مناسبة، أى أعلى من ١٠٪ حتى ولو خلطت التربة بالمعدلات المرتفعة من هذه المحسنات.

د) تؤدى عملية تحسين التربة إلى تقليل حركة الماء فى التربة لأسفل (النفاذية) أو لأعلى (التبخير). بلغت قيم متوسط النفاذية ٤ . ٦٧٪، ٢ . ٦١٪ من قيم الأرض غير المعاملة باستخدام معدلى إضافة الهيدروجل ١ . ٠و ٢ . ٠٪ على التوالى مقارنة ب ٦ . ٧٩٪ بمعاملة ٤٪

سماد عضوى و٤٥٪ لمعاملة ١٠٪ طفلة كما بلغ الانخفاض فى معدل البخر من سطح التربة ٥ . ٣٨٪ و٨ . ١٣٪ و ٥ . ٢٣٪ للمعاملات ٢ . ٠٪ هيدروجل ٤٪ سماد عضوى و ١٠٪ طفلة على التوالى.

الأيونات المناسبة من جزيئات الهيدروجل فى الماء:

عند اتزان مركبات الهيدروجل المختبرة مع الماء ينساب جزءمعتبر من أيونات الصوديوم أو البوتاسيوم من جزيئاتها إلى الماء بعد ٨ غسلات لجزيئات البوليمر بالماء الخالى من الأيونات انساب حوالى ١٠٠ ملليجرام من أيونات الصوديوم / جرام من الهيدروجل بولى أكريلاميد صوديوم اكريلات (ج١، ج٢). الصوديوم المنساب يؤدى إلى رفع قيمة رقم الأس الهيدروجينى للراشح والذى قد يؤدى بالتالى إلى التأثير العكسى على كل من خواص التربة وقابلة النبات للاستفادة بعدد كبير من العناصر المغذية له. من ناحية أخرى فان مركبات الهيدروجل بولى أكريلاميد بوتاسوم أكريلات (ج٣، ج٤) ينساب منها أيونات بوتاسيوم بدرجات مختلفة يتفوق فيها المركب ج٣ على المركب ج٤ حيث ينساب منه ١٩٦ملليجرام من أيونات البوتاسيوم / جرام من الهيدروجل.

بالرغم من أن مبلمرات البولى أكريلاميد صوديوم أكريلات هيدروجل تمتاز بارتفاع قدرتها على امتصاص الماء إلا أن استبدال أيونات الصوديوم بأيونات البوتاسيوم أى إنتاج مبلمرات بوتاسيومية سوف يكون لة فائدة عظمى حيث أن النباتات النامية (خاصة فى مراحل نموها الأولى) يمكنها امتصاص أيونات البوتاسيوم المناسبة من جزيئات البوليمر إلى الماء والتى تعد من العناصر المغذية الضرورية لها لذا يفضل إنتاج مبلمرات الهيدروجل بحيث لا يكون الكاتيون المرافق لها ساما للنباتات النامية ولا يؤدى إلى تأثيرات ضارة على خواص التربة وفى نفس الوقت يحسن أن يكون ذلك الكاتيون من بين العناصر المغذية الضرورية للنباتات النامية.

بالرغم من أن معدلات إضافة المحسنات الطبيعية للتربة الرملية تبلغ ٢٠ مرة بالنسبة للسماد البلدى، و٥٠ مرة بالنسبة للطفلة قدر معدلات إضافة الهيدروجل إلا أن الفعل المحسن لمركبات الهيدروجل المحضرة على علاقات التربة و الماء والنبات تقترب جدا من الفعل المحسن للطفلة ويزداد كثيرا عن الفعل المحسن للسماد البلدى مما يؤكد اهمية استخدام مثل هذه التكنولوجيا الحديثة نسبيا فى تحسين خواص الأراضى الرملية. وفى هذا المجال يمكن اعتبار مركبى الهيدروجل ج٣ وج٤ مقبولين كمحسنات للأراضى الرملية.