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Hydrophobic-Hydrophilic Combination for Sandy Soil Conditioning and Plantation 1-Growth Response and Water and Fertilizers use Efficiency by Casuarina Trees

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Abstract: At two successive years (2006 and 2007) split plant designed field experiment with four replications was conducted on a drip irrigated sandy soil at El-Katta, Giza Governorate, Egypt. One year old nursery plants of Casuarina were chosen as the indicator plants. Examined treatments were a) untreated soil b) soil treated with 150g/m^2 locally prepared bitumen emulsion 50% active material as the hydrophobic coditioner c) 20g acrylamide hydrogel as the hydrophilic one incorporated in the plant pit at a depth of 30 cm d) and e) 10g and 20g hydrogel incorporated in the plant pit before mulching the soil with 150 g bitumen emulsion/m^2 soil. The mulched area for each tree was 2m^2. Four irrigation treatments were examined i.e. 100 (I_1), 80 (I_2), 60 (I_3) and 40% (I_4) of the water requirements by the trees. Growth response for both roots and shoots and dry weight of the trees determined after 12 month from transplantation and water and fertilizers use efficiency by the trees were taken as parameters for evaluation. Incorporating the hydrogel in the plant pit followed by mulching the soil with the locally prepared bitumen emulsion is more effective than using each of them alone. The combined and interacted effects of applying both technologies for sandy soil conditioning together were practically proved. Better plant growth, higher water and fertilizers use efficiency by trees were gained, especially when using lower quantities of irrigation water. Incorporating 20g hydrogel in the plant pit before mulching ~ 2m^2 locally prepared bitumen emulsion at the rate of 150g/m^2 under I_3 irrigation treatment seems to be effective and more economic at the same time. Besides saving nearly 2/3 the quantities of water normally used for irrigation. Cost of the applied conditioners under such condition is about 0.8L.E./tree. Since the required wind break trees for one feddan (4200m^2) ranges between 30 and 60 trees, costs of soil conditioners needed to get the highest growth response and water and fertilizer use efficiency by the trees will not exceed 48 L.E./feddan.

Key words: Acrylamide hydrogel · Sandy soil conditioning · Water and fertilizers use efficiency · Casuarina trees

INTRODUCTION

For the urgent need to meet food and dress demands in Egypt, more desert areas have to be put under cultivation. Such soils are poor with respect to their physico-bio-chemical properties, soil-water-plant relationships as well as their nutritional status.

Previous studies indicated that surface mulching with bitumen emulsions- particularly those locally prepared from Egyptian row materials as hydrophobic materials- is considered as one of the applied techniques that can provide adequate conditions for sandy soil plantation. It protects the soil against wind and water erosion, reduces evaporation, increases the preserved moisture below the mulch layer, modifies soil temperature, increases plant growth and nutrients uptake and stimulates the biological activity of the soil [1].

On the other hand mixing super absorbent materials (hydrogel)-as hydrophilic organic polymeric products- with sandy soil increases the soils capacity to store water. The water stored in this way is available to plants for some considerable time. Due to the bonding effect of the hydrogel molecules with sandy particles and their swellability, an improved and stable structure of the sandy soil is obtained. Besides, beneficial changes in soil porosity, particularly the amount of the water retaining pores, were achieved by soil conditioning. Moreover, germination process, plant growth, nutrients uptake by the plants and both water and fertilizers use efficiency were beneficially

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increased by mixing the plant pits in sandy soil with hydrogels [2-6].

It is expected that incorporating hydrogels in the plant pit followed by mulching the sandy soil with bitumen emulsion may be more effective than using each of them alone. This part of the work aims at studying the combined effect of bitumen emulsion and hydrogel on growth response and water and fertilizer use efficiency by growing plants, as growing wind break trees- particularly those require less water- in newly reclaimed sandy areas is a "must". Casuarina was chosen in this study as the indicator plant. Casuarina is the most commonly grown tree in Egypt. It is planted primary as wind breaks to provide protection to field crops, livestock, roads and residential areas in new desert settlements. However, in a country which is poor in forest resources such as Egypt, Casuarina are also a good source to timber. In rural remote areas, the timber is used for firewood, agricultural implements and in building construction. Further more, the timber is used since few years for wood particle boards to meet the acute needs for wood products [7].

MATERIALS AND METHODS

Two successive years (2006 and2007) split plant designed field experiment with four replications for each treatment was conducted as follows:

Location: At a private farm, El-Katta, Giza governorate.

Soil: Virgin sandy soil of which more than 90% consists of particles >20 μ. The main analytical data of the soil are presented in Table 1 [8, 9].

Soil Conditioners

Polymiric Bitumen Emulsion (Bit.): A cationic slow setting modified bitumen emulsion (50% active material) was prepared by using bitumen penetration grad 100/140 produced by Alexandria Petroleum Company, Redicot EM 76 cationic emulsifier based on polyamine derivatives produced by Akzo Noble Surface Chemistry, and polyvinyl acetate butyl acrylate emulsion (60% active material) produced by Hochest Orient Company, Cairo as the modifier. The main specifications of the used asphalt and emulsifier, and modifier are illustrated in Table 2, 3 and 4. It is noteworthy that mentioning trade and firm names is for the information and convenience of the reader. Such use does not constitute an official endorsement of the products.

To estimate the optimum percentage of the emulsifier to be mixed with the aqua's phase and asphalt to get the best bitumen emulsion, a series of bitumen emulsions were prepared using different percentages of EM 76 i.e. 1, 1.5, 2, 2.5, 3 and 3.5%. Properties of the prepared bitumen emulsions were examined according to ASTM D 244.

Table 1: Main analytical data of El-Katta sandy soil

Mechanical analysis				
Sand				
Coarse> 200μ %	Fine 200-20 μ %	Silt% 20-2 μ	Clay% <2 μ	Soil Texture
50.6	41.4	4.4	3.6	Sandy

Chemichal Analysis										
pH 1:2.5	EC (dS/m^{-1})	$CaCo_3$ %	O.M %	Cations (meq/L) 1:5 extract				Anions (meq/L) 1:5 extract		
7.8	1.1	6.2	0.1	Ca^{++}	Mg^{++}	K^+	Na^+	Cl^-	HCO^{-3}	SO_4^{-2}
				3.0	1.6	0.2	7.2	6.8	1.9	3.3

Hydrophysical Analysis					
Bulk Density (Mg m^{-3})	Total Porosity %	Total Water Holding Capacity*(%)	Field Capacity (%)	Witting Percentage	Hydraulic Conductivity (m day^{-1})
1.61	39.25	19.61	6.27	1.32	11.6

Table 2: Physical properties and chemical constituents of the used bitumen

Property	Value
Physical Properties:	
- Penetration at 25 °C l00 g, 5 sec.	130.0
- Kinematic viscosity at 135°C, C.st.	160.0
- Absolute viscosity at 60°C, poise	377.0
- Flash point, °C (Cleveland open cup).	420.0
- Ductility at 25°C, 5cm/min.	+150.0
- Softening point °C (Ring andBall).	45.0
- Solubility in trichloroethylene, %.	99.8
Chemical Constituents, wt%:	
- Oils	44.0
- Resins	44.8
- Asphaltenes	11.2

Table 3: Properties of the used cationic emulsifier

Properties	Value
- Trade name.	Redicote EM76
- Chemical component.	polyamine derivative
- Physical form at 20 °C.	Pale yellow paste
- Iodine value	> 20 g I/100g
- Flash point, °C.	>100
- Melting range°C	54-55
- Density at 20 °C, kg m^{-3}	850
- Total amine number.	305-325 mg Hcl/g

Table 4: The Main constituents and properties of the used modifier

Main constituents of the modifier	Total solid weight%	Physical appearance	pH	Particle size (u)
Polyvinyle acetate Butyl acrylate emulsion	50%	Milky white	3.5-4	0.5-3

The chosen modified bitumen emulsion was prepared on two steps as follow:

Step One: Water was wormed up to 90°C.The emulsifier (2.5% wt %) was added while stirring. The pH of the aqua's face was adjusted at pH=3.5 using HCl. followed by hot bitumen (140°C).Stirring was continued until the emulsion became completely homogeneous.

Step Two: At room temperature poly vinylacetate butyl acrylate emulsion (1% active material by weight) was added to the prepared asphalt emulsion while stirring until get a completely homogeneous modified bitumen emulsion. The pH of the obtained modified emulsion was similar to the original emulsion. This is because the pH of poly vinylacetate butyl acrylate emulsion is equal to 3.5. The original emulsion and the modified emulsion were examined according to ASTMD 244. Table 5 presents the main constituents and properties of the original and the chosen modified bitumen emulsion that could be applied in this study (Bit).

Polyacrylamide Hydrogel (PAMG): The examined hydrogel is a mixture of an anionic (polyacrylaminde K polyacrylate 30% ioncity) and a cationic (polyacrylaminde allylamine hydrochloride 20% ioncity) hydrogrls at the ratio of 2:3. Description and properties of the used hydrogels are presented in Table 6.

Indicator Plant: Six months age nursery plants of Casuarina Gluca Sieber were used as the indicator plants. The transplants were brought from the Horticural Research Institute, Agriculture Reach Center, Ministry of Agriculture and Land Reclamation, Cairo Egypt.

Table 5: Main constituents and specifications of the original and cationic modified bitumen emulsions

Property	Original emulsion	Modified emulsion (Bit.)	Standard method
Constituents:			
Solid content %	50.0	50.0	ASTM D244
EM76 wt%	2.5	2.5	
PVA_{cBA} wt%	-	1	
Hcl, %	1.0	1.0	
Water content %	47.5	46.5	
Properties:			
Color of emulsion	Brown	Brown	
pH of emulsion	3.5	3.5	
Particle charge test	+ve	+ve	
Viscosity, Saybolt Fural at 77°F (25°C), S.	92	120	
Storage stability test, 24h, %.	0	1	
Settlement, wt %(5days).	1.1	1.9	
Resistance to water	Pass	Pass	
Resistance to sea water			
	pass	pass	

Table 6: Description of the main constituents and properties of hydrogels used

	a- Main constituents	
Ionicity	Anionic	Cationic
Active substance	Propeneamide Propionic	
Acid Co-polymer(K-salt)	Propeneamid AllylamineCo-polymer (CL salt)	
Ionization degree	30 mole %	20mole %
Cross linker	Divalent vinyl monomer	
Cross-linking ratio	$1:10^4$ mole/mole	
Percentage of active substance	Greater than 88%	
Monomer content	Not higher than 300ppm	
	b- properties:	
Appearance	White to slightly yellow grains	
Grain size	0.25-1mm	
Bulk density	˜ 600kg/m^3	
Solubility	Insoluble in water and organic solvents	
CEC C mole kg^{-1}	2045	2175
	c- Absorption capacity in g/g hydrogel	
Deionized water	˜525	˜430
0.9% Nacl	˜44	˜35
0.4%$CaCl_2$	˜ 41	˜36
Saline water (1500ppm)	˜ 64	˜54
Absorption time:		
Up to 50%		
Total absorption		
20 minutes		
60 minutes		

Size of the Experimental Plot: 1/ 100 Fed. i.e 10 plant pits.

Soil Treatments

- Untreated soil (the control treatment).
- Soil mulched with 150 g Bit. /m^2 soil.
- Soil treated with 20g PAMG/ plant pit. Gel crystals were incorporated to depth of 30cm.
- Soil treated with 10 g PAMG/plant pit then mulched with 150g Bit. /m^2 soil.
- Soil treated with 10 g PAMG/plant pit then mulched with 150g Bit. /m^2 soil.
  Mulched area for each tree was 2m^2.

Irrigation

- System: Trickle irrigation. Distance between lateral is 2m. Distance between drippers is 1m.Dispersers discharge is 4 l/h.
- Analysis of the irrigation water used is given in Table 7.
- Water requirements for the trees: Water requirement for the trees were computed [10,11].
- Treatments: Four irrigation treatments were examined namely: 100 (I_1), 80 (I_2), 60 (I_3) and 40% (I_4) of the water requirements by the trees. Quantitative of the irrigation water are given in Table 8.

Table 7: Analysis of irrigation water used

		Cations (meq/L)				Anions (meq/L)			
pH	EC(dSm^{-1} at 25 °C)	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	Cl^{-}	Co^{-2} HCO^{-3}	SO_4^{-2}	Adj.SAR
7.05	1.35	9.0	6.5	0.2	8.3	5.9	3.5	14.6	7.33

* Source: well, ** Fe: traces< 3ppm

Table 8: Quantities of irrigation water used* (l/tree)

	Irrigation treatments			
Month	I_1	I_2	I_3	I_4
January	240	192	144	96
February	240	192	144	96
March	360	288	216	144
April	360	288	216	144
May	480	384	288	192
June	600	480	360	240
July	600	480	360	240
August	600	480	360	240
September	480	384	288	192
October	480	384	288	192
November	360	288	216	144
December	240	192	144	96
Total	5040	4032	3024	2016

* 100, 80, 60 and40% of irrigation requirements for I_1, I_2, I_3, and I_4, respectively

Fertilization: 100g ammonium sulphate (20.5%N), 50 ml orthophosphoric acid 85% P_2O_5 and specific gravity 1.75g/cm^{-3} and 25g potassium sulphate (48-52% K_2O) were applied /tree through the irrigation system (fertigation). These quantities assemble 0.0205, 0.0244 and 0.0125 units of N, P_2O_5 and K_2O/tree, respectively.

Examined Parameters: Growth response which includes:

- Average length of the main roots (cm), Average length of the secondary roots (cm), and fresh and dry weights of the roots (g).
- Stem length (cm), Stem diameter (mm), number of branchlets on the stem, fresh and dry weights of the stem and the leaves (g).
- Water use efficiency (WUE) by the trees calculated as gram of the dry weight of the tree produced by each m^3 of irrigation water used.
- Fertilizers use efficiency (FUE) by the trees calculated as Kg of the dry weight of the tree produced by each unit of fertilizer materials unit.

Statistical Analysis: Data were statistically analyzed according to Gomez and Gomez [12].

RESULTS AND DISCUSSION

As the obtained results of both successive years were not significantly different, their average was taken into consideration.

Growth parameters of the roots of Casuarina Gluca Sieber trees after 12 months from transplanting (assembled with the average length of the main root in cm, average length of all secondary roots in cm and fresh weight of the roots in g) as affected by sandy soil conditioning and irrigation treatments are shown in Table 9.

Growth parameters of the shoots of Casuarina Gluca Sieber trees after one year from transplantation assembled with the length of the stem in cm, the stem diameter in mm, the average branchlest number of the stem, and the fresh weight of both the stem and the leaves in g. as affected by conditioning and irrigation treatments are presented in Table 10.

Dry weight of the roots, stem and leaves of Casuarina Gluca Sieber trees after the second period from transplantation as affected by examined treatments are shown in Fig. 1. Total dry weight of the trees is shown in Table 11.

Table 9: Growth parameters* of the roots of Casuarina Gluca Sieber trees after 12 months from transplantation as affected by sandy soil conditioning and irrigation treatments

Conditioning Treatment** (C)	Irrigation treatments I1 Value	%of control	I2 Value	% of control	I3 Value	% of control	I4 Value	% of control	Mean
			Average length of the main root(cm)						
a	28.2	100.0	21.4	75.9	19.6	69.5	18.2	64.5	21.9
b	35.3	125.2	32.3	114.5	29.1	103.2	27.9	98.9	31.2
c	51.2	181.6	54.6	193.6	56.2	199.3	49.6	175.9	52.5
d	55.3	196.1	61.4	217.7	59.9	212.4	52.4	185.8	75.3
E	81.0	287.2	85.7	303.9	77.3	274.1	61.9	219.5	76.5
Mean	50.2	178.0	51.1	181.1	48.4	171.7	42.0	148.9	47.9
L.S.D. 0.05	I=.091		C =5.0			I x C = 1.2			
			Average length of all secondary roots(cm)						
a	234.2	100.0	196.6	83.9	167.3	71.4	146.2	62.4	186.1
b	299.6	127.9	250.4	106.9	232.6	99.3	221.4	94.5	251.0
c	414.4	176.9	436.4	186.3	433.1	184.9	355.9	152.0	410.0
d	421.7	180.1	446.4	190.6	436.1	180.7	381.9	163.1	421.5
E	548.1	234.0	571.3	243.9	501.6	214.2	396.4	169.3	504.4
Mean	383.6	163.8	380.2	162.3	354.1	150.1	300.4	128.3	354.6
L.S.D. 0.05	I= 3.8		C =11.5			I x C = 13.4			
			Fresh weight of the roots(g)						
a	53.51	100.0	39.74	74.3	35.78	66.90	30.70	57.4	39.9
b	68.34	127.7	59.16	110.6	56.32	105.30	52.13	97.4	59.0
c	106.86	199.7	124.96	233.5	127.61	238.50	96.72	180.7	114.0
d	125.75	235.0	143.57	268.3	139.94	261.52	110.76	206.9	130.0
E	185.75	347.1	198.88	371.7	165.73	309.70	128.11	239.4	169.6
Mean	108.00	201.9	113.30	211.7	105.10	196.30	83.70	156.4	102.5

*Each value is the mean of two growing seasons. ** a = untreated soil (control). b= 300 g Bit. / plant pit. c= 20 g PAMG/plant pit. d = 300 g Bit. + 10g PAMG /plant pit. e = 300 g Bit. =20g PAMG /plant pit

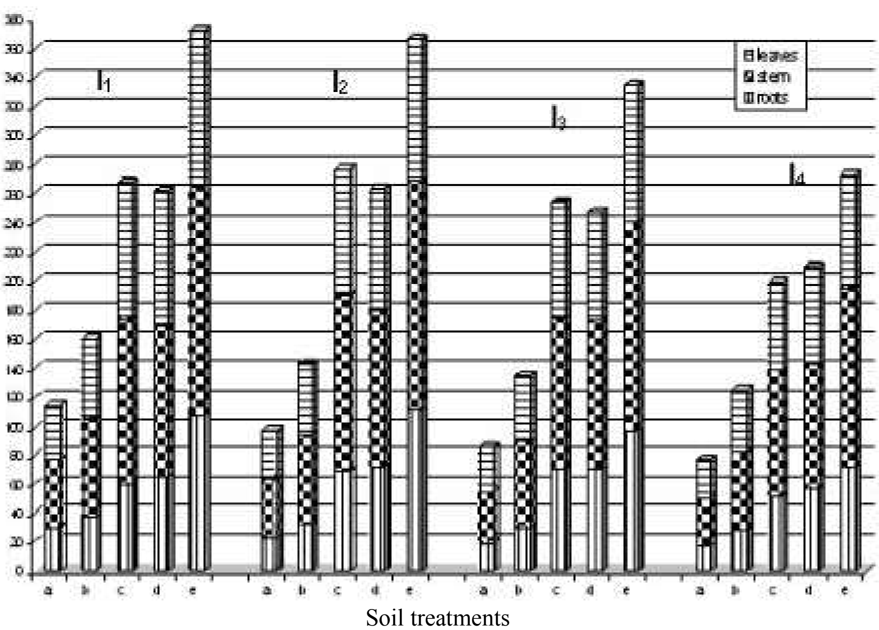

Fig. 1: Dry weight of Casuarina Gluca Sieber trees after 12 months from transplantation as affected by sandy soil conditioning and irrigation treatments

Values of water or fertilizer use efficiency which reflect the relation between the produced dry weight of the trees and the total seasonal water or fertilizers used are presented in Table 12 and 13, respectively.

Table 10: Growth parameters* of the shoots of Casuarina Gluca Sieber trees after 12 months from transplantation as affected by sandy soil conditioning and irrigation treatments

Conditioning Treatment** (C)	Irrigation treatments I_1 Value	I_1 %of control	I_2 Value	I_2 % of control	I_3 Value	I_3 % of control	I_4 Value	I_4 % of control	Mean
				Stem length (cm)					
A	169.7	100.0	131.2	77.3	125.7	74.1	115.6	68.1	135.6
b	197.8	116.6	190.4	112.2	185.4	109.3	173.8	102.4	186.9
c	226.9	133.7	239.6	141.2	214.3	126.3	189.3	111.5	217.5
d	209.3	123.3	215.4	126.9	206.4	121.6	176.1	103.8	201.8
E	251.0	147.9	262.4	154.6	254.6	150.0	221.6	130.6	247.4
Mean	210.9	124.3	207.8	122.4	197.3	89.3	175.3	103.3	197.8
L.S.D 0.05		I = 3.6	C = 20.3				I x C =17.6		
				Stem diameter (mm)					
A	4.9	100.0	3.7	75.5	3.6	71.4	3.3	67.3	3.8
b	5.8	118.4	5.5	112.2	5.3	108.2	5.0	102.0	5.4
c	7.4	151.0	7.6	155.1	7.0	142.9	6.2	126.5	7.1
d	7.2	146.9	7.5	153.1	7.1	144.0	6.3	128.6	7.0
E	9.3	202.0	9.5	193.9	9.1	185.7	8.3	169.4	9.1
Mean	6.9	143.7	6.8	138.0	6.4	130.4	5.8		6.5
L.S.D 0.05		I = 0.2	C = 0.2				I x C =0.4		
				Average branchlets number of the stem					
A	27.9	100.0	22.4	80.3	19.9	71.3	16.5	66.3	21.7
b	32.9	117.9	31.6	113.3	29.2	104.7	27.1	97.1	30.2
c	44.4	159.1	46.1	165.2	42.4	152.0	35.3	126.5	42.1
d	46.5	166.7	48.3	173.1	41.2	147.7	36.4	130.5	43.1
E	56.2	201.4	58.4	209.3	51.3	83.9	44.9	160.9	52.7
Mean	41.6	149	41.4	148.2	36.8	112.0	32.0	116.3	38.0
L.S.D 0.05		I= 0.5	C = 1.8				I x C = 2.6		
				Fresh weight of the stem(g)					
A	66.53	100.0	54.32	81.6	49.46	74.3	42.89	64.5	53.3
b	94.6	142.2	89.46	134.5	65.13	127.9	74.12	111.4	80.8
c	167.2	251.3	170.93	256.9	156.76	235.6	132.67	199.4	156.9
d	155.4	233.6	161.66	242.9	144.26	216.8	133.15	200.1	148.6
E	208.33	313.1	212.71	319.7	183.41	275.7	165.11	248.2	192.4
Mean	138.4	208	137.8	207.1	119.8	186.1	109.6	164.7	126.4
L.S.D 0.05		I= 3.4	C = 9.6				I x C = 12.3		
				Fresh weight of the leaves(g)					
A	70.46	100.0	60.57	85.9	55.260	78.4	48.59	69.9	58.7
b	99.27	140.9	89.17	126.6	85.350	121.1	76.62	108.7	87.6
c	177.29	251.6	165.29	234.6	141.49	200.8	102.88	146.0	146.7
d	165.30	234.6	151.93	215.6	136.16	193.2	101.76	144.4	138.8
E	203.80	289.2	191.70	272.1	172.01	244.1	138.11	196.0	176.4
Mean	143.20	203.3	131.70	187.0	118.10	167.5	93.60	133.0	121.7
L.S.D 0.05		I= 12.2	C = 10.6				I x C =18.30		

*Each value is the mean of two growing seasons.

** a= untreated soil (control) b= 300 g Bit./ plant pit c= 20 g PAMG/plant pit

d= 300g Bit. + 10g PAMG /plant pit e= 300g Bit+20g PAMG /plant pit

Table 11: Total dry weight of the whole plants (g) as affected by sandy soil conditioning and irrigation treatments

Conditioning treatments	Irrigation treatments I_1	I_2	I_3	I_4	Mean
a	114.62	96.54	85.79	76.26	93.3
b	161.05	143.42	134.11	124.69	140.8
c	267.53	277.35	253.62	198.82	249.3
d	261.18	263.89	246.96	208.76	245.2
e	372.18	366.52	334.96	273.50	336.8
Mean	235.30	229.50	211.10	176.40	213.1
L.S.D 0.05	I= 7.3		C = 6.2	I x C = 8.4	

Table 12: Water use efficiency (WUE) (gm^{-3}) by Casuarina Gluca Sieber trees as affected by sandy soil conditioning and irrigation treatments

Conditioning treatments	Irrigation treatments I_1		I_2		I_3		I_4	
	WUE*	%of control	WUE*	%of control	WUE*	%of control	%of control	WUE*
a	22.8	100.0	23.9	104.8	28.3	124.1	37.8	37.8
b	32.0	140.4	35.6	136.1	44.4	194.7	61.9	61.9
c	53.0	232.5	68.8	301.7	83.9	368.0	78.6	98.6
d	51.8	277.2	65.5	287.3	81.7	358.3	103.6	103.6
e	73.8	327.7	90.9	398.7	110.8	486.0	135.7	135.7

In all tables, percentages relative to the control treatment i.e. untreated sandy soil normally irrigated are also inserted.

Concerning the untreated sandy soil (treatment a), lowering the quantities of irrigation water normally used (I_1 treatment) to its 0.8, 0.6 and 0.4 i.e. I_2, I_3 and I_4 treatments significantly decreased all studied growth parameters and consequently the dry weights of trees and both water and fertilizer use efficiency to be 75-85, 60-75 and 55-65% that of the plants of I_1 treatment, respectively.

Considerable increase in growth parameters of the trees grown in sandy soil mulched with 150 g Bit/m^2 soil was obtained under the four studied irrigation treatments. Under normal irrigation (I_1 treatment), mulching the soil with Bit. Increased growth parameters and dry weights of the trees by ~ 20-40%, consequently both water and fertilizer use efficiencies were increased. Moreover, growth parameters of plants grown in the mulched sandy soil exceeded that of the non mulched soil normally irrigated by ~ 10-25%, 8.15% and 5-10% by applying the irrigation treatments I_2, I3 and I_4, in sequence.

When 20 g hydrogel were incorporated into the plant pits and under the studied four irrigation treatments I_1, I2, I3 and I_4 higher growth measurements were recorded compared to those obtained from either the untreated sandy soil (treatment a) or the soil mulched with Bit. (treatment b). Reducing the irrigation water to its 4% caused an increase in the studied parameters that reached 7%. Although the studied growth parameters were greatly reduced underI_4 treatment, they still higher than those of untreated soil normally irrigated by 15-60%.

By increasing 15-20g hydrogel in the plant pits before mulching the soil with 15 g Bit /m^2 soil i.e. treatments d or e, the studied growth parameters were significantly increased. With this respect, dry weight of plants and consequently water and fertilizer use efficiency by the plants reached more than two and three times that of untreated soil by applying the treatments d and e, respectively. Surface mulching with hydrophobic materials such as bitumen emulsions, polymeric bitumen emulsions and rubberized bitumen emulsions is considered as one of the applied techniques that can provide adequate conditions for sandy soil plantation. Presented data on the effects of such treatment on growth of Casuarina trees grown on the sandy soil from one hand and on both water and fertilizers use efficiencies by the trees on the other hand indicate the beneficial effects of mulching the soil with emulsified bitumen especially when using lower quantities of irrigation water. These effects could be explained on the bases of the following phenomena:

Table 13: Fertilizers use efficiency (kg unit^{-1}) by CasuarinaGluca Sieber trees as affected by sandy soil conditioning and irrigation treatments

Conditioning treatments	Irrigation treatments I_1	I_2	I_3	I_4
		N		
a	5.60	4.71	4.18	3.72
b	7.86	7.00	6.54	6.08
c	13.04	13.53	12.37	9.70
d	12.74	12.87	12.05	10.18
e	18.16	17.88	16.34	13.34
		P2O5		
a	4.71	3.96	3.52	3.13
b	6.60	5.88	5.50	5.11
c	10.95	11.37	10.39	8.15
d	10.70	10.82	10.12	8.56
e	15.25	15.02	13.73	11.21
		K2O		
a	9.19	7.72	6.86	6.10
b	12.88	11.47	10.73	9.98
c	21.38	22.19	20.29	15.91
d	20.89	21.11	19.76	16.70
e	29.77	29.32	26.80	21.88
% of control				
a	100.00	84.1	74.60	66.40
b	140.40	125.0	116.80	108.60
c	232.90	241.6	220.90	173.30
d	227.50	229.8	212.20	181.80
e	324.30	319.3	291.80	238.30

a) increasing soil resistance to wind or water erosion by creating favorable soil surface conditions. The formation of rough cloddy soil surface with large and stable aggregate –their remover require higher velocity on one hand and prevent rust formation and reduce soil detachability and subsequently the splash erosion on the other hand [13-17]. b) reducing water loss through evaporation process. The presence of coarse stable aggregates on soil surface breaks the capillary continuity of the soil. This leads to the formation of dry diffusion layer on the top of the soil which acts as a self mulching barrier that hinders water movement from deep layers to the site of evaporation. The increase in the preserved moisture below the mulch layer, during the whole growth season indicates the efficiency of the mulch layer for conserving adequate moisture for plant growth [18]. Therefore, ion mobility and in turn the availability of nutrients to plants increase [19] and c) the increments in the temperature at soil surface treated with bitumen emulsions due to its dark color (~ 25C°) may be one of the reasons that beneficially affect plant growth, microbial activity, chemical and physical reactions in the soil, water, and air movement in the soil and consequently nutrients availability to plants especially in the cold season [17, 18].

On the other hand, incorporating super absorbent materials (hydrogel) in sandy soils is considered as one of the new techniques in sandy soil conditioning. Presented data on the effects of the hydrogel on growth of Casuarina trees from one side and water fertilizers use efficiency by the plants from the other side show that the hydrogel has a three fold effect. It works physically, chemically and biologically. The combination of these effects on the properties of sandy soils has resulted in an integrated influence on the afro mentioned plant parameters. These effects could be attributed to: a) improving the stability of the soil structure under both dry and wet conditions and increasing the resistance of the soil against the breakdown by tillage. The formed structure maintains several cycles of complete destruction and reformation without significant changes in the erosion index. b) improving the dynamic soil-water characteristics i.e. decreasing the downward movement of

Table 14: Conditioners needed for plantation of Casuarina Gluca Sieber trees to protect one feddan of El-Katta sandy soil and their costs

Treatments	Conditioners needed for Plant pit		Costs of needed Conditioners For the plant pit (L.E.)			Costs needed for one feddan (30-60 plant pit)L.E.
	Bit (g)	PAMG	Bit	PAMG	Total	
a	-	-	-	-	-	-
b	300	-	0.3	-	0.30	9.0-18.0
c	-	20	-	0.50	0.50	10.0-30.0
d	300	10	0.3	0.25	0.55	16.5-33.0
e	300	20	0.3	0.50	0.80	24.0-48.0

*one feddan 4200 m^2. ** Mulched area for each tree is2 m^2

water through infiltration and the upward movement of it via evaporation. Water loss via evaporation was constant over cycles of wetting and dry revealing that the gel remains fully effective in the soil during this period. c) increasing the ability of the soil to retain water due to the swellability of the hydrogel particles from one hand and its effect on pore size distribution towards fine one i.e. water holding pores on the other hand. d) the contribution of hydrogels to the chemical properties and the nutritional status of sandy soil. This includes: 1) increasing the low exchange capacity of sandy soil. it is essentially due to the high cation exchange capacity of the hydrogel that reached 750 meq / 100g. 2) hydrogels can retain fertilizer's nutrients. Therefore, the loss of added nutrients -by leaching or deep percolation- from soils treated with hydrogels is low. Hence they remain in soil within the reach of the plant root system for along period. 3) improving the nutritional status of sandy soil. With this respect, either the nutrients constituting the gel molecule such as K that adsorbed by the hydrogel could be easily used by growing plants. Hydrogels also affect nutrients uptake indirectly by increasing the moisture in the soil and subsequently ion mobility. Therefore, the availability of some nutrients either present in the soil or added in the form of relatively insoluble fertilizers will be increased. Moreover, the partial retardation of gas exchange between soil and atmosphere as a result of increasing soil moisture and decreasing soil macro porosity may favor transformation of micro nutrients to the available form [20,21]. e) the increase in the microbial counts (bacteria, fungi) and the activity of the enzymes in sandy soils such as dehydrogenase, urease and phosphatase indicate the improvement in the biological activity of such soils [4]. Combinations of these effects leads to an increase in plant growth and dry matter production. A considerable reduction in the water consumption was obtained. Therefore, a significant improvement in the water use efficiency by plants was gained. The produced yield by a unit of added nutrients referred to the beneficial effects of hydrogels for increasing the fertilizers use efficiency by the plants.

As expected, incorporating the hydrogel in the plant pit followed by mulching the soil with the locally prepared bitumen emulsion will be more effective than using each of them alone. The combined and interacted effects of applying both technologies for sandy soil conditioning together were practically proved. Better plant growth, higher water and fertilizers use efficiency by the trees were gained especially when using lower quantities of irrigation water. Besides, the improvement in the hydrophysical and consequently the chemical and biological characteristics of the soil [22]. (part 2 of this reach work.).

Taking into consideration that preparation of one toe of bitumen emulsion (50% active material) in the field costs about 1000 L.E. (Egyptian pounds) and the price of the used hydrogel is about 25 L.E/Kg, costs of conditioners need for the tree will be 0.30, 0.50, 0.55 and 0.80 L.E. when applying the treatments b, c, d and e respectively (Table 14). Since the required wind break trees for one feddan (4200 m^2) ranges between 30 and 60 trees according to the area of the farm, distance between trees and number of roes of trees needed to protect the farm against sever winds besides velocity itself. Therefore, costs of soil conditioners needed to get the highest growth response and water and fertilizer use efficiency by Casuarina Gluca Sieber trees will not exceed 48 L.E. for feddan.

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