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EFFECT OF ORGANIC MATTERS ADDITION AND WATER STRESS ON SOIL THERMAL PROPERTIES UNDER RAS SUDR CONDITIONS.

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Key Words: Organic matters, Water stress**,** Soil temperature**,** Soil heat content.

ABSTRACT

A field experiment was carried out to study the effect of organic matters addition and water stress on some soil thermal properties. Experimental field, located in the Desert Research Center station in Ras Sudr, South Sinai governorate. Three rates (5, 10 and 15 ton/fed) were used of chicken manure and compost. Three levels of irrigation water (40, 60 and 80% from available water) were applied using drip irrigation system for planted Pearl millet (*Pennisetum Glaucum* L.). The soil temperature was recorded and moisture content was determined for three soil depths at 0-5, 5-10 and 10-15 cm, during July, August and September months. Heat content was calculated in Calories for each soil depth. The results showed that, the addition of organic matters (chicken manure and compost) caused to decrease in the soil temperature during July and August, and they had an opposite reaction during September as they caused to increase the soil temperature. Organic matters act as a buffer to changes in soil temperature. Organic matters (chicken manure and compost) affects the soil temperature and soil heat content. Since organic matter absorb and retain moisture so the soil treated with it has high amounts of moisture. Therefore, the use of organic matters is a source of moisture, and as such, it is recommended that farmers should know how to effectively manipulate organic matters to ensure that moisture is maintained even during dry spells. This is important because it helps farmers manage soil under the influence of climate change.

INTRODUCTION

Soil thermal properties is essential when assessing heat transport in soils. Thermal regime of soils is associated with many other soil processes (water evaporation and diffusion, plant transpiration, contaminants behavior etc.). thermal properties play an important role to ensure optimal emergence

and crop growth **Bradford, (1995)**. The measurement of thermal properties is also necessary for determining mass and energy exchange processes which take place in the soil-plant-atmosphere continuum. Therefore, investigating soil thermal properties helps evaluate optimum conditions for plant growth and development, and is important for controlling soil thermal moisture regime **Usowicz, (1992)**. Soil temperature is one of the important factors that influence soil properties processes involved in plant growth. It governs the soil physical, chemical and biological processes **Buchan, (2001)**. It also influences the interspheric processes of gas exchange between the atmosphere and the soil **Lehnert, (2013)**. The amount of radiation received by the soil affects soil temperature, biological processes such as; seed germination, seedling emergence, plant root growth and the availability of nutrients **Probert, (2000)**. The temperature of the soil alters the rate of organic matter decomposition and the mineralization of different organic materials in the soil **Davidson and Janssens, (2006)**. Soil temperature also affects soil water retention, transmission and availability to plants. The manner in which heat flows through the soil is of considerable importance in plant cultural practices in general. Specifically, it affects plant-root activity with respect to the uptake of nutrients, water, etc., and in engineering uses of the soil. Heat conduction in soils is governed by thermal properties. Thermal properties of soil influence the partition of energy at the ground surface, and are related to the soil temperature and the transfer of heat and water across the ground surface **Nwadibia et al., (2010)**. The knowledge of thermal properties of soil is essential to study the surface energy and radiation budgets, to quantify surface temperature and heat storage required in agriculture, for germination rate, etc. The thermal properties are strongly dependent on the variation with the water content of the soil. Soil water improves the thermal contact between the soil particles, and replaces air, which has 20 times lower thermal conductivity than water **Hanks and Ashcroft, (1986)**. The heat capacity per unit volume of soil is the quantity of heat needed to raise the temperature of a unit volume of soil by one degree Kelvin. Thermal conductivity of soil is the amount of heat transferred through a unit in unit time under a unit temperature gradient. It is a measure of the ability to conduct heat and is dependent upon the bulk density and the soil water content. Increasing soil bulk density increases the thermal conductivity. Soil thermal capacity is rather stable fora wide range of soil moisture content. **Liu et al., (2008)** investigated the variations of the soil thermal parameters with soil moisture using a series of one-year continuous

observation. They noted that the soil thermal conductivity increases as a power function of soil moisture, whereas the heat capacity changes are relatively small. **Guan et al., (2009)** found a relationship between the soil thermal properties and soil moisture.

Soil temperature affects many physical, chemical, and biological soil properties, and the plants growing in it.

- It affects plant and microorganism growth.
- It affects many soil environmental processes such as soil drying by evaporation (therefore, water content).
- It affects water movement and retention in soils.
- It affects soil formation.

MATERIALS AND METHODS

Field experiment was carried out in the Agricultural Field Experiment Station of the Desert Research Center in Ras Sudr, South Sinai Governorate, calcareous loamy sand soil texture, to study the effect of addition different types of organic matters and different levels of water stress on some soil thermal properties. The experimental treatments were, three rates (5, 10 and 15 ton/fed) of chicken manure and compost. These treatments were added to soil two weeks before planting and mixed in 15 cm soil depth. Three levels of irrigation water (40, 60 and 80% from available water). Pearl millet (*Pennisetum Glaucum* L.) was planted in 8th June, 2019 under drip irrigation system. Source of irrigation water used from a well, which has EC, 9.47 dS/m and Sodium adsorption ratio (SAR) 13. All plots received the recommended rates of NPK mineral fertilizers were as follows phosphorus as 100 kg/fed of calcium superphosphate (15.5% P_2O_5) as before cultivation, potassium as 75 kg/fed of potassium sulphate (48-50% K_2O) and nitrogen as 120 kg/fed of ammonium sulphate (20.5%N). Nitrogen and potassium were divided into three equal portions and were applied at seedling, vegetation and yield formation stages to fulfill the needs of plant growth. Each treatment consists of 3 plots, each one was 4 m^2. Data of soil analyses according to **Klute, (1986)** were tabulated in Table (1). Cutting the plants was done in three stages; the first cutting was 35 days after planting, the second and the third cuttings were after 70 and 105 days from the first cutting. After cutting, when plants 10 cm height, soil samples were taken to determined soil moisture content. soil temperature was determined and recorded at

the same time every hour from 6:00 AM until 6:00 PM through July, August and September for 0-5, 5-10 and 10-15 cm soil depth. Digital thermometer was used to record soil temperature **Taylor and Jackson, (1965)**. To calculate soil heat content, air temperature was measured at 1 meter height above soil surface by using thermometer. Heat content was calculated as Calories for each soil layer and the total heat retained was calculated by the following equations

$H = (m_s * c_s) + (m_w * c_w)$

where:

H = heat content of the soil in Calories

c_s = specific heat in Calorie/g/ ºC of dry soil particles

c_w = specific heat in Calorie/g/ ºC of soil water

m_s = mass of dry soil profiles.

m_w = mass of water

$H_T = H_s + H_w$

where:

H_T = total amount of heat retained in each layer

H_s = amount of heat retained by solid particles

H_w = amount of water heat.

Hs is the product of the mass of the oven dry soil particles and heat capacity the soil and H_w was estimated by multiplying the volumetric water content (θ_V) of each soil layer and the heat capacity of water. Afterwards, the of treatments obtained via multiplying (H_T) by the recorded soil temperature at the considered time.

Table (1): Some physical and chemical properties of surface soil sample.

Soil sample (cm)	Course sand %	Fine sand %	Silt %	Clay %	Texture	Bulk density (Mg/m^3)	$CaCO_3$ (%)	EC (dS/m)
0-15	16.78	64.80	10.29	8.13	Loamy Sand	1.49	51.81	8.67

Particle size distribution according to Scheme of International Soil Science Society

RESULTS AND DISCUSSION

Soil temperature, soil moisture content and soil heat content of the studied soil as affected by various treatments are given in Tables (2-10). From Table (2) Soil treated with 5, 10 and 15 ton/fed chicken manure

soil depth 0-5 cm under 40% from available water at 6-9 AM in July causes to change soil temperature from 26.27 ºC in control to 25.63, 25.32 and 25.21 ºC respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change soil temperature from 26.27 ºC in control to 25.18, 25.84 and 25.10 ºC respectively. Soil treated with 5, 10 and 15 ton/fed chicken manure causes to change soil moisture content from 13.38% in control to 17.84, 18.12 and 18.13% respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change soil moisture content from 13.38% in control to 18.22, 18.49 and 19.57% respectively. Soil treated with 5, 10 and 15 ton/fed chicken manure causes to change soil heat content from 388 Cal/g soil in control to 416, 422 and 430 Cal/g soil respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change soil heat content from 388 Cal/g soil in control to 447, 471 and 497 Cal/g soil respectively. The minimum soil temperature was 21.88 ºC at 6-9 AM in 10-15 cm for soil treated with 15 ton/fed compost, soil moisture content was 10.08% at 3-6 PM in 0-5 cm for control and soil heat content was 364 Cal/g soil at 6-9 AM in 10-15 cm for control. The maximum soil temperature was 32.96 ºC at 12-3 PM in 0-5 cm for control, soil moisture content was 20.34% at 6-9 AM in 10-15 cm for soil treated with 15 ton/fed compost and soil heat content was 587 Cal/g soil at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost. The soil heat content under 15 ton/fed compost treatment was higher than that of the other treatments under 40% from available water. This result is in agreement with those of **Gamliel and Stapleton, (1993)** and **Elia (2019)**. This finding may attributed to the presence of high moisture content in the soil layer treated with compost. The results declared that the values of soil heat content for chicken manure treatments was lower than the values of soil heat content for compost treatments. In the same time, it was noticed that the values of the soil heat content in the layers 0-5, 5-10 and 10-15 cm of control was lower than the soil heat content values of each of all chicken manure and compost treatments. As the amount of chicken manure and compost increased, the soil heat content also increased. Therefore, soil treated with high organic matters will have high heat content because organic matters do not easily loss or gain heat and hence increases the heat content and more heat is stored.

Table (3) Soil treated with 5, 10 and 15 ton/fed chicken manure at soil depth 0-5 cm under 60% from available water at 6-9 AM in July causes to change soil temperature from 26.20 ºC in control to 26.03, 25.77 and 25.39 ºC respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change soil temperature from 26.20 ºC in control to 25.26, 25.22 and 25.12 ºC respectively. Soil treated with 5, 10 and 15 ton/fed chicken manure causes to change soil moisture content from 11.64% in control to 16.77, 17.02 and 17.15% respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change soil moisture content from 11.64% in control to 17.40, 17.76 and 18.96% respectively. Soil treated with 5, 10 and 15 ton/fed chicken manure causes to change soil heat content from 386 Cal/g soil in control to 412, 418 and 426 Cal/g soil respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change soil heat content from 386 Cal/g soil in control to 441, 464 and 490 Cal/g soil respectively. The minimum soil temperature was 22.28 ºC at 9-12 AM in 10-15 cm for soil treated with 15 ton/fed compost, soil moisture content was 8.34% at 3-6 PM in 0-5 cm for control and soil heat content was 363 Cal/g soil at 6-9 AM in 10-15 cm for control. The maximum soil temperature was 33.15 ºC at 12-3 PM in 0-5 cm for control, soil moisture content was 19.84% at 6-9 AM in 10-15 cm for soil treated with 15 ton/fed compost and soil heat content was 576 Cal/g soil at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost. Data reveal that there is considerable variation of heat content along with water content. Also, there was an increment in heat content with increasing the rate of water applied to the soil. This may be due to the amount of heat needed to increase the temperature of soil is strongly related to water content. It takes only 0.2 calories of heat energy to increase the temperature of 1 gram of dry soil 1 °C; compared with 1.0 calories per gram per degree for water **Kohnke, (1982)**. The obvious effect of adding 15 ton/fed compost on increasing the soil heat content could be attributed to its black color and keep the higher water holding capacity. This is because the high absorptivity of dark colors to incidence of solar radiation.

Table (2): Effect of different types and rates of organic matters on soil temperature and heat content under 40% from available water in July.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 30.65 ºC														
Control		0-5	26.27	28.16	32.96	31.44	13.38	11.24	10.72	10.08	388	402	476	418
		5-10	24.10	27.37	31.84	29.32	14.40	12.29	11.54	11.11	378	389	441	392
		10-15	23.75	24.20	29.71	28.94	14.43	12.57	11.81	11.49	364	375	373	387
Chicken manure	5	0-5	25.63	27.84	32.81	31.28	17.84	16.28	13.49	12.66	416	419	497	442
		5-10	24.05	26.98	31.67	29.17	18.65	17.12	16.07	14.25	388	414	468	415
		10-15	23.64	24.46	29.48	28.72	19.03	17.09	15.45	13.81	393	402	393	410
	10	0-5	25.32	27.61	32.75	31.07	18.12	16.51	13.75	12.83	422	438	509	457
		5-10	23.86	26.73	31.36	28.73	19.07	17.30	16.28	14.32	398	426	475	428
		10-15	22.97	24.12	29.29	28.16	19.15	17.38	15.83	14.09	413	410	402	418
	15	0-5	25.21	27.18	32.34	30.91	18.13	16.78	14.02	13.07	430	442	525	464
		5-10	23.80	26.46	31.18	28.54	19.14	17.42	16.42	14.48	416	446	486	440
		10-15	22.71	23.89	29.78	28.05	19.25	17.54	15.91	14.14	426	427	420	435
Compost	5	0-5	25.18	27.04	32.17	30.78	18.22	16.83	14.13	13.28	447	470	537	485
		5-10	24.79	26.15	31.04	28.48	19.35	17.57	16.64	14.70	428	458	503	468
		10-15	22.49	23.45	29.63	27.84	19.40	17.69	16.08	14.31	436	419	446	460
	10	0-5	25.84	26.93	32.08	30.53	18.49	17.26	14.62	13.54	471	486	552	512
		5-10	24.73	26.28	30.90	28.64	19.68	17.83	16.81	14.82	448	473	518	487
		10-15	22.43	23.12	29.68	27.56	19.85	17.90	16.54	14.67	463	449	470	474
	15	0-5	25.10	26.27	31.59	29.71	19.57	18.48	14.83	13.83	497	520	587	545
		5-10	23.74	25.74	30.04	28.56	20.15	18.59	17.67	15.57	472	508	552	526
		10-15	21.88	23.10	28.65	27.39	20.34	18.73	16.92	15.24	487	481	504	509

Table (3): Effect of different types and rates of organic matters on soil temperature and heat content under 60% from available water in July.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 30.65 ºC														
Control		0-5	26.20	28.58	33.15	31.71	11.64	9.68	9.08	8.34	386	398	470	414
		5-10	24.65	27.68	32.07	29.47	12.71	10.63	9.92	9.53	376	387	436	389
		10-15	23.71	24.33	29.70	29.03	12.84	10.96	10.23	9.96	363	373	371	385
Chicken manure	5	0-5	26.03	28.22	32.98	31.57	16.77	15.27	12.41	11.61	412	415	490	437
		5-10	23.92	26.42	31.87	29.30	17.70	16.14	15.08	13.29	386	410	461	411
		10-15	23.52	24.03	29.62	28.78	18.08	16.10	14.42	12.78	390	398	390	407
	10	0-5	25.77	27.95	32.91	31.48	17.02	15.54	12.77	11.80	418	433	501	451
		5-10	24.80	27.23	31.51	28.79	18.18	16.45	15.43	13.52	395	421	469	423
		10-15	23.47	23.94	29.58	28.13	18.27	16.54	15.00	13.25	409	407	398	414
	15	0-5	25.39	27.46	32.64	31.30	17.15	15.85	13.07	12.13	426	437	516	458
		5-10	24.15	26.94	31.31	28.69	18.31	16.58	15.57	13.65	412	440	479	435
		10-15	23.44	23.67	29.52	28.01	18.44	16.72	15.07	13.30	421	422	416	430
Compost	5	0-5	25.26	27.30	32.45	31.00	17.40	16.00	13.30	12.47	441	463	527	478
		5-10	24.10	26.63	31.15	28.59	18.70	16.96	16.01	14.08	423	452	495	461
		10-15	23.09	23.17	29.35	27.77	18.76	17.09	15.49	13.73	431	415	440	454
	10	0-5	25.22	27.17	32.34	30.86	17.76	16.55	13.91	12.85	464	479	542	503
		5-10	23.96	26.27	30.99	28.57	19.08	17.25	16.23	14.32	442	467	510	480
		10-15	22.84	22.77	29.13	27.44	19.28	17.34	16.03	14.15	457	443	463	468
	15	0-5	25.12	26.41	31.78	29.92	18.96	17.90	14.25	13.18	490	512	576	535
		5-10	23.87	25.80	30.08	28.50	19.62	18.03	17.12	15.18	465	500	542	517
		10-15	22.64	22.28	28.85	26.10	19.84	18.19	16.46	14.80	480	474	496	501

Table (4) Soil treated with 5, 10 and 15 ton/fed chicken manure at soil depth 0-5 cm under 80% from available water at 6-9 AM in July causes to change soil temperature from 26.09 ºC in control to 25.98, 25.82 and 25.42 ºC respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change soil temperature from 26.09 ºC in control to 25.27, 25.23 and 25.13 ºC respectively. Soil treated with 5, 10 and 15 ton/fed chicken manure causes to change soil moisture content from 9.89% in control to 15.69, 16.03 and 16.17% respectively. Soil treated with 5, 10 and 15 ton/fed compost causes to change on soil moisture content from 9.89% in control to 16.59, 17.04 and 18.34% respectively. Soil treated with 5, 10 and 15 ton/fed chicken manure causes to change soil heat content from 383 Cal/g soil in control to 408, 414 and 421 Cal/g soil respectively, this result agreed with **Elia (2019)** and **Chishala et al., (2019)**. Soil treated with 5, 10 and 15 ton/fed compost effects on soil heat content from 383 Cal/g soil in control to 436, 458 and 482 Cal/g soil respectively. The minimum soil temperature was 22.43 ºC at 9-12 AM in 10-15 cm for soil treated with 15 ton/fed compost, soil moisture content was 6.60% at 3-6 PM in 0-5 cm for control and soil heat content was 361 Cal/g soil at 6-9 AM in 10-15 cm for control. The maximum soil temperature was 33.35 ºC at 12-3 PM in 0-5 cm for control, soil moisture content was 19.34% at 6-9 AM in 10-15 cm for soil treated with 15 ton/fed compost and soil heat content was 564 Cal/g soil at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost. The higher moisture content lowers soil temperature due to the higher of below heat vaporization of water molecules ≈ 585 Cal/g. Therefore, the temperature of the lower layer was always less than the upper one. According **Edem (2015)** organic matters inclusion at any rate dampen heat transfer in the soil.

Data in Tables (5-7) reveal that the same trend, in August but the total soil heat content was higher in August than the total heat content in July this due to increased air and soil temperatures through August.

Table (4): Effect of different types and rates of organic matters on soil temperature and heat content under 80% from available water in July.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 30.65 ºC														
Control		0-5	26.09	29.01	33.35	31.97	9.89	8.11	7.44	6.60	383	395	463	410
		5-10	24.84	27.98	32.29	29.62	11.02	8.98	8.30	7.94	374	384	431	386
		10-15	23.95	24.20	29.61	29.12	11.26	9.34	8.65	8.44	361	371	369	382
Chicken manure	5	0-5	25.98	28.59	33.15	31.89	15.69	14.26	11.34	10.56	408	411	482	432
		5-10	24.67	27.47	32.07	29.42	16.75	15.16	14.09	12.33	383	406	455	407
		10-15	23.79	23.86	29.52	28.84	17.14	15.12	13.39	11.75	387	395	387	403
	10	0-5	25.82	28.29	33.08	31.86	16.03	14.56	11.79	10.78	414	428	493	445
		5-10	24.31	27.15	31.67	28.85	17.29	15.59	14.58	12.72	392	417	462	419
		10-15	23.55	23.76	29.48	28.11	17.40	15.69	14.17	12.42	405	403	395	410
	15	0-5	25.42	27.73	32.94	31.68	16.17	14.91	12.13	11.19	421	432	507	452
		5-10	24.27	26.8	31.43	28.73	17.48	15.75	14.73	12.82	408	435	472	430
		10-15	23.44	23.46	29.42	27.97	17.63	15.90	14.23	12.45	417	418	412	425
Compost	5	0-5	25.27	27.55	32.72	31.21	16.59	15.18	12.47	11.66	436	457	518	471
		5-10	24.12	26.56	31.25	28.63	18.06	16.34	15.38	13.46	419	446	487	455
		10-15	23.38	22.89	29.22	27.69	18.12	16.50	14.90	13.15	426	411	435	448
	10	0-5	25.23	27.41	32.60	31.19	17.04	15.84	13.21	12.15	458	472	532	495
		5-10	24.08	26.40	31.07	28.60	18.48	16.68	15.65	13.82	437	460	501	473
		10-15	23.24	22.68	29.04	27.33	18.71	16.77	15.52	13.62	451	438	457	461
	15	0-5	25.13	26.55	31.97	30.12	18.34	17.32	13.68	12.53	482	503	564	525
		5-10	24.03	25.86	30.11	28.52	19.10	17.47	16.57	14.79	459	492	532	508
		10-15	23.07	22.43	28.98	25.81	19.34	17.65	16.01	14.36	473	467	488	493

Table (5): Effect of different types and rates of organic matters on soil temperature and heat content under 40% from available water in August.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 33.12 ºC														
Control		0-5	27.54	27.88	34.35	31.77	12.75	10.56	10.03	9.38	427	442	524	460
		5-10	25.92	26.26	33.20	30.55	13.79	11.64	10.87	10.43	416	428	485	431
		10-15	24.99	25.29	31.07	28.32	13.82	11.92	11.15	10.82	401	413	411	426
Chicken manure	5	0-5	27.08	27.29	34.19	31.6	17.30	15.71	12.86	12.01	458	461	547	486
		5-10	25.88	26.08	33.02	30.37	18.12	16.56	15.49	13.64	427	456	515	457
		10-15	24.87	25.20	31.01	28.23	18.51	16.53	14.86	13.19	433	442	433	451
	10	0-5	26.76	27.05	34.13	31.52	17.48	15.94	13.13	12.19	464	482	560	503
		5-10	25.30	25.57	32.70	30.02	18.55	16.75	15.71	13.71	438	469	523	471
		10-15	24.25	24.68	30.97	28.21	18.63	16.83	15.25	13.47	455	451	442	460
	15	0-5	26.39	26.80	33.71	31.1	17.59	16.22	13.40	12.43	473	486	578	511
		5-10	25.16	25.45	32.52	29.81	18.62	16.87	15.85	13.87	458	491	535	484
		10-15	24.18	24.53	30.92	28.16	18.74	16.99	15.33	13.52	469	470	462	479
Compost	5	0-5	26.32	26.74	33.54	30.91	17.68	16.27	13.51	12.65	492	517	591	534
		5-10	25.10	25.32	32.37	29.64	18.84	17.02	16.07	14.09	471	504	554	515
		10-15	24.02	24.38	30.76	28	18.89	17.14	15.50	13.70	480	461	491	506
	10	0-5	26.31	26.52	33.44	30.81	17.96	16.71	14.01	12.91	518	535	607	563
		5-10	24.85	25.19	32.23	29.54	19.17	17.29	16.25	14.22	493	521	570	536
		10-15	23.80	24.19	30.57	27.8	19.35	17.36	15.97	14.06	510	494	517	522
	15	0-5	26.11	26.33	32.94	30.28	19.06	17.95	14.23	13.21	547	572	646	600
		5-10	24.78	25.09	31.34	28.61	19.65	18.06	17.12	14.98	519	559	607	579
		10-15	23.67	23.88	29.91	27.11	19.85	18.20	16.36	14.64	536	529	555	560

Table (6): Effect of different types and rates of organic matters on soil temperature and heat content under 60% from available water in August.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 33.12 ºC														
Control		0-5	27.56	27.84	34.57	32.00	11.93	9.68	9.14	8.46	421	436	519	454
		5-10	26.09	26.31	33.45	30.82	13.00	10.78	10.00	9.55	410	422	480	425
		10-15	24.95	25.26	31.00	28.27	13.03	11.08	10.28	9.94	394	406	404	420
Chicken manure	5	0-5	27.38	27.79	34.37	31.79	16.62	14.98	12.05	11.17	447	450	538	476
		5-10	25.93	26.24	33.23	30.59	17.47	15.86	14.76	12.84	416	445	505	446
		10-15	24.74	25.08	30.92	28.17	17.87	15.83	14.10	12.38	421	431	421	440
	10	0-5	27.11	27.43	34.30	31.71	16.80	15.22	12.32	11.35	454	472	551	493
		5-10	25.41	25.76	32.86	30.2	17.91	16.05	14.98	12.92	427	458	513	460
		10-15	24.69	25.04	30.89	28.14	17.99	16.13	14.50	12.68	444	440	431	449
	15	0-5	26.71	27.01	34.02	31.42	16.92	15.50	12.60	11.60	463	476	569	501
		5-10	25.36	25.71	32.67	30.00	17.98	16.17	15.12	13.09	447	481	525	474
		10-15	24.66	24.93	30.82	28.06	18.10	16.30	14.59	12.73	458	459	451	468
Compost	5	0-5	26.57	26.90	33.84	31.23	17.01	15.55	12.72	11.82	477	503	578	519
		5-10	25.21	25.54	32.49	29.81	18.20	16.33	15.35	13.32	455	489	540	500
		10-15	24.29	24.71	30.65	27.89	18.25	16.46	14.77	12.91	464	445	476	491
	10	0-5	26.53	26.77	33.71	31.1	17.30	16.01	13.23	12.10	504	520	595	550
		5-10	25.17	25.54	32.34	29.66	18.55	16.61	15.53	13.44	478	506	556	522
		10-15	24.04	24.53	30.41	27.63	18.73	16.68	15.25	13.29	495	479	503	507
	15	0-5	26.43	26.75	33.17	30.53	18.43	17.29	13.45	12.40	533	559	634	587
		5-10	25.12	25.48	31.40	28.66	19.04	17.40	16.44	14.23	505	545	595	565
		10-15	23.82	24.20	30.13	27.34	19.24	17.55	15.65	13.88	522	515	541	546

Table (7): Effect of different types and rates of organic matters on soil temperature and heat content under 80% from available water in August.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 33.12 ºC														
Control		0-5	27.75	28.21	34.75	32.19	10.13	7.77	7.19	6.49	415	431	515	449
		5-10	26.33	26.75	33.66	31.04	10.95	8.92	8.10	7.62	403	416	475	419
		10-15	25.23	25.65	30.92	28.20	11.08	9.23	8.39	8.04	388	400	398	414
Chicken manure	5	0-5	27.33	27.67	34.57	32.00	15.45	13.73	10.65	9.73	438	441	529	467
		5-10	26.05	26.66	33.47	30.85	16.34	14.65	13.49	11.49	406	435	496	436
		10-15	25.20	25.61	30.84	28.08	16.76	14.62	12.81	11.00	411	422	411	431
	10	0-5	27.06	27.47	34.48	31.90	15.65	13.98	10.93	9.92	444	462	543	484
		5-10	25.63	25.98	33.03	30.38	16.80	14.85	13.73	11.56	417	449	504	451
		10-15	24.98	25.19	30.77	28.06	16.89	14.94	13.23	11.31	434	431	422	440
	15	0-5	26.86	27.35	34.33	31.75	15.77	14.28	11.23	10.18	453	467	561	492
		5-10	25.58	25.95	32.79	30.13	16.88	14.98	13.88	11.74	438	472	517	465
		10-15	24.66	25.06	30.70	27.97	17.00	15.12	13.32	11.36	449	450	442	459
Compost	5	0-5	26.84	27.27	34.10	31.51	16.17	14.63	11.85	10.92	473	499	575	516
		5-10	25.48	25.89	32.60	29.93	17.41	15.45	14.42	12.48	451	485	536	496
		10-15	24.61	24.97	30.53	27.78	17.47	15.58	13.80	12.05	460	441	472	487
	10	0-5	26.75	27.19	33.98	31.38	16.46	15.11	12.39	11.20	500	517	592	546
		5-10	25.43	25.80	32.42	29.75	17.78	15.74	14.61	12.62	474	502	553	518
		10-15	24.45	24.86	30.31	27.53	17.96	15.81	14.31	12.45	491	475	499	503
	15	0-5	26.74	27.18	33.37	30.73	17.65	16.45	12.63	11.52	529	555	631	584
		5-10	25.38	25.79	31.64	28.93	18.29	16.57	15.56	13.44	501	542	592	562
		10-15	24.27	24.62	30.27	27.48	18.50	16.73	14.73	13.08	518	511	537	543

In September the soil temperature, soil moisture content and soil heat content of the studied soil as affected by various treatments are given in Tables (8-10). From Table (8) the minimum soil temperature was 22.14 ºC at 6-9 AM in 10-15 cm for control, soil moisture content was 10.27% at 3-6 PM in 0-5 cm for control and soil heat content was 348 Cal/g soil at 6-9 AM in 10-15 cm for control. The maximum soil temperature was 27.38 ºC at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost, soil moisture content was 20.63% at 6-9 AM in 10-15 cm for soil treated with 15 ton/fed compost and soil heat content was 584 Cal/g soil at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost. From Table (9) the minimum soil temperature was 22.27 ºC at 6-9 AM in 10-15 cm for control, soil moisture content was 8.98% at 3-6 PM in 0-5 cm for control and soil heat content was 342 Cal/g soil at 6-9 AM in 10-15 cm for control. The maximum soil temperature was 27.34 ºC at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost, soil moisture content was 19.76% at 6-9 AM in 10-15 cm for soil treated with 15 ton/fed compost and soil heat content was 576 Cal/g soil at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost. From Table (10) the minimum soil temperature was 22.66 ºC at 6-9 AM in 10-15 cm for control, soil moisture content was 7.38% at 3-6 PM in 0-5 cm for control and soil heat content was 336 Cal/g soil at 6-9 AM in 10-15 cm for control. The maximum soil temperature was 27.20 ºC at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost, soil moisture content was 19.25% at 6-9 AM in 10-15 cm for soil treated with 15 ton/fed compost and soil heat content was 583 Cal/g soil at 12-3 PM in 0-5 cm for soil treated with 15 ton/fed compost.

Table (8): Effect of different types and rates of organic matters on soil temperature and heat content under 40% from available water in September.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 29.78 ºC														
Control		0-5	24.39	24.73	26.14	24.90	13.60	11.44	10.92	10.27	374	389	464	406
		5-10	23.27	23.57	24.93	23.63	14.63	12.50	11.75	11.31	363	375	426	378
		10-15	22.14	22.41	23.74	22.36	14.66	12.79	12.02	11.69	348	360	353	373
Chicken manure	5	0-5	24.46	24.80	26.21	24.99	18.11	16.53	13.71	12.88	404	408	487	432
		5-10	23.27	23.57	24.94	23.63	18.93	17.38	16.32	14.48	374	402	455	403
		10-15	22.34	22.62	23.94	22.55	19.31	17.35	15.69	14.04	379	389	374	398
	10	0-5	24.59	24.93	26.32	25.07	18.29	16.77	13.98	13.05	411	428	500	449
		5-10	23.32	23.63	24.97	23.63	19.35	17.56	16.53	14.55	385	415	463	417
		10-15	22.57	22.86	24.19	22.84	19.43	17.64	16.08	14.32	401	398	384	406
	15	0-5	24.69	25.03	26.45	25.26	18.40	17.04	14.25	13.29	419	432	517	456
		5-10	23.45	23.75	25.12	23.83	19.42	17.68	16.67	14.71	404	437	475	430
		10-15	22.70	22.99	24.33	22.99	19.53	17.81	16.16	14.37	415	416	404	425
Compost	5	0-5	24.97	25.32	26.75	25.58	18.49	17.09	14.36	13.50	438	463	530	479
		5-10	23.59	23.91	25.26	23.95	19.63	17.84	16.90	14.94	417	450	493	460
		10-15	22.98	23.28	24.63	23.30	19.68	17.96	16.33	14.54	426	408	432	452
	10	0-5	25.16	25.52	26.96	25.77	18.76	17.52	14.86	13.77	464	480	546	508
		5-10	24.16	24.49	25.89	24.64	19.97	18.10	17.07	15.06	439	466	509	481
		10-15	23.17	23.47	24.81	23.52	20.14	18.17	16.80	14.91	455	440	458	467
	15	0-5	25.55	25.92	27.38	26.22	19.86	18.75	15.07	14.06	492	517	584	544
		5-10	24.18	24.51	25.90	24.66	20.44	18.87	17.94	15.82	465	504	546	523
		10-15	23.28	23.58	24.94	23.61	20.63	19.01	17.18	15.48	481	474	494	505

Table (9): Effect of different types and rates of organic matters on soil temperature and heat content under 60% from available water in September.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 29.78 ºC														
Control		0-5	24.51	24.87	26.29	25.06	12.45	10.20	9.65	8.98	368	384	461	402
		5-10	23.39	23.71	25.08	23.79	13.52	11.30	10.52	10.06	357	369	422	373
		10-15	22.27	22.58	23.91	22.54	13.55	11.60	10.80	10.46	342	354	346	367
Chicken manure	5	0-5	24.60	24.95	26.37	25.15	17.13	15.49	12.56	11.69	395	398	481	424
		5-10	23.41	23.74	25.11	23.81	17.98	16.38	15.27	13.36	364	393	448	394
		10-15	22.46	22.74	24.07	22.71	18.38	16.34	14.62	12.90	369	379	364	388
	10	0-5	24.63	24.99	26.40	25.19	17.32	15.74	12.84	11.87	402	420	494	441
		5-10	23.43	23.74	25.11	23.81	18.42	16.57	15.49	13.44	375	406	456	408
		10-15	22.68	22.98	24.31	22.97	18.51	16.65	15.02	13.19	392	388	374	397
	15	0-5	24.75	25.14	26.57	25.36	17.44	16.02	13.12	12.12	410	423	509	448
		5-10	23.60	23.92	25.29	24.01	18.50	16.69	15.64	13.60	394	428	467	421
		10-15	23.00	23.28	24.63	23.31	18.61	16.82	15.11	13.25	405	406	393	415
Compost	5	0-5	25.09	25.45	26.89	25.70	17.53	16.07	13.24	12.34	424	450	520	466
		5-10	23.64	23.97	25.35	24.05	18.72	16.85	15.87	13.83	402	436	481	447
		10-15	23.02	23.33	24.68	23.36	18.77	16.98	15.28	13.42	411	392	417	438
	10	0-5	25.33	25.69	27.14	25.97	17.82	16.52	13.75	12.62	451	468	537	497
		5-10	24.08	24.45	25.89	24.68	19.07	17.12	16.05	13.96	425	453	498	469
		10-15	23.07	23.36	24.72	23.40	19.24	17.20	15.77	13.80	442	426	444	454
	15	0-5	25.48	25.88	27.34	26.18	18.95	17.80	13.97	12.92	480	506	576	534
		5-10	24.22	24.58	25.98	24.74	19.56	17.92	16.95	14.75	452	492	537	513
		10-15	23.24	23.56	24.93	23.62	19.76	18.07	16.17	14.40	469	462	483	493

Table (10): Effect of different types and rates of organic matters on soil temperature and heat content under 80% from available water in September.

Treatment	Rate (ton/fed)	Soil depth (cm)	Soil temperature (ºC)				Soil moisture content (%)				Soil heat content (Cal/g soil)			
			6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM	6-9 AM	9-12 AM	12-3 PM	3-6 PM
Average air temperature 29.78 ºC														
Control		0-5	24.55	24.90	26.31	25.11	11.02	8.66	8.09	7.38	363	379	457	397
		5-10	23.53	23.84	25.21	23.93	12.15	9.82	8.99	8.52	351	364	418	367
		10-15	22.66	22.95	24.29	22.94	12.18	10.13	9.29	8.94	336	348	340	362
Chicken manure	5	0-5	24.69	25.06	26.48	25.27	16.09	14.37	11.29	10.38	394	398	481	424
		5-10	23.57	23.88	25.26	23.97	16.98	15.30	14.14	12.13	363	392	448	393
		10-15	22.82	23.11	24.45	23.12	17.40	15.26	13.45	11.64	368	379	363	388
	10	0-5	24.69	25.07	26.50	25.29	16.29	14.62	11.58	10.56	401	419	495	441
		5-10	23.61	23.95	25.33	24.05	17.45	15.49	14.37	12.21	374	406	456	408
		10-15	22.94	23.23	24.61	23.31	17.53	15.58	13.87	11.95	391	388	373	397
	15	0-5	24.79	25.19	26.65	25.45	16.41	14.92	11.88	10.83	410	424	513	449
		5-10	23.74	24.08	25.49	24.22	17.52	15.63	14.52	12.38	394	429	469	422
		10-15	23.00	23.30	24.65	23.33	17.64	15.76	13.96	12.01	406	407	394	416
Compost	5	0-5	25.24	25.61	27.07	25.90	16.91	15.38	12.40	11.46	430	456	526	473
		5-10	23.78	24.12	25.54	24.26	18.15	16.19	15.17	13.03	408	442	488	453
		10-15	23.10	23.39	24.75	23.45	18.21	16.32	14.55	12.60	417	398	423	444
	10	0-5	25.28	25.65	27.09	25.94	17.21	15.85	12.94	11.75	457	474	543	503
		5-10	24.15	24.49	25.91	24.70	18.52	16.48	15.35	13.16	431	459	505	475
		10-15	23.31	23.65	25.02	23.72	18.71	16.56	15.06	12.99	448	432	450	460
	15	0-5	25.38	25.75	27.20	26.07	18.40	17.20	13.17	12.07	486	512	583	541
		5-10	24.29	24.66	26.07	24.87	19.04	17.32	16.30	13.99	458	499	543	519
		10-15	23.46	23.78	25.15	23.88	19.25	17.47	15.47	13.62	475	468	489	500

CONCLUSION

The addition of organic matters (chicken manure and compost) caused to decrease in the soil temperature during July and August, and they had an opposite reaction during September as they caused to increase the soil temperature. Organic matters act as a buffer to changes in soil temperature. Organic matters (chicken manure and compost) affects soil temperature and soil heat content. Since organic matter absorb and retain moisture so the soil treated with it has high amounts of moisture. Therefore, the use of organic matters is a source of moisture, and as such, it is recommended that farmers should know how to effectively manipulate organic matters to ensure that moisture is maintained even during dry spells. This is important because it helps farmers manage soil under the influence of climate change.

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تأثير اضافة المواد العضوية والاجهاد المائى على الخواص الحرارية للتربة تحت ظروف رأس سدر.

ضياء سعيد منير بولس

قسم كيمياء وطبيعة الأراضي – مركز بحوث الصحراء

أجريت تجربة حقلية لدراسة تأثير اضافة المواد العضوية والاجهاد المائى على الخواص الحرارية للتربة. تم اجراء التجربة الحقلية بمحطة بحوث رأس سدر التابعة لمركز بحوث الصحراء بمحافظة جنوب سيناء. استخدم نوعين من المواد العضوية وهما سماد الدواجن والكمبوست بمعدلات اضافة ٥، ١٠، ١٥ طن/فدان لكل منهما. استخدم ثلاث مستويات من الاجهاد المائى ٤٠، ٦٠، ٨٠ % من ماء الميسر وذلك بأستخدام نظام الرى بالتنقيط وزراعة محصول الدخن اللؤلؤى. تم قياس وتسجيل كلاً من حرارة ورطوبة التربة عند ثلاث اعماق من التربة وهى ٠-٥، ٥-١٠، ١٠-١٥ سم خلال شهور يوليو واغسطس وسبتمبر. تم حساب المحتوى الحرارى بالكلورى لكل طبقة من طبقات التربة الثلاثة. اظهرت النتائج ان اضافة المواد العضوية (سماد الدواجن والكمبوست) أدت الى خفض درجة حرارة التربة خلال شهرى يوليو واغسطس. وكان لهما تأثير عكسى خلال شهر سبتمبر حيث أدت الى زيادة درجة حرارة التربة. المواد العضوية تعمل على تقليل التغيرات فى حرارة التربة خلال شهور السنة. المواد العضوية (سماد الدواجن والكمبوست) يؤثران على كلاً من درجة حرارة التربة والمحتوى الحرارى للتربة. المواد العضوية لها القدرة على امتصاص الرطوبة والاحتفاظ بها و لذلك فإن التربة المعالجة بها تحتوى على نسب عالية من الرطوبة. لذلك يعد أستخدام المواد العضوية وسيلة لحفظ الماء بالتربة. وعلى هذا النحو فمن الافضل ان يعرف المزارعون كيفية التعامل بفاعلية مع المواد العضوية لضمان الحفاظ على الرطوبة حتى اثناء فترات الجفاف. وهذا مهم لانه يساعد المزارعين على كيفية أدارة التربة تحت تأثير تغير المناخ.