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THE RELATIONSHIP BETWEEN SOIL AND AIR TEMPERATURE CONCERNING COTTONSEEDS CULTIVATION AT NORTH DELTA

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ABSTRACT

There are 14 stations under the supervision of Extension Sector, Ministry of Agriculture and Land Reclamation. Those stations are scattered all-round the country and record the entire climate data daily or whatever it is needed. Agricultural climate data were collected along the recorded period (Feb.1st to March 31, 2002). Data of the previous years was not used since the climate was significantly changed) from station located at Sedi Salem, Kafr El-Sheikh Governorate to represent the North Delta region.

It could be conclude that the high temperature decline along the soil layer (0 – 20 cm). This led all the estimated statistics (max high, low high, min high, min low, range high, range low, STDV high and STDV low) to be declined along the soil layer (0 – 20 cm). Consequently, soil temperature change is affected in the upper layer (5cm) and then decline sequentially in the sequential layers.

. The relationship between the lowest, highest and mean temperatures in the upper soil layer (5 cm) and high air temperature is derived and represented by the equations 1- 3 below:

Soil low temperature (at 5-cm depth) =

0.7783x(high. air temperature) - 3.0406 (1)

$R2 = 0.621$

Soil high temperature (at 5-cm depth) =

0.9084x(high. air temperature) + 2.344 (2)

$R2 = 0.6779$

Soil mean temperature (at 5-cm depth) =

0.8433x(high. air temperature) - 0.3483 (3)

$R2 = 0.6726$

These equations provide whom it may be concerned (researchers, extension workers and farmers) by a very simple method to get a quick prediction of soil temperature just by knowing air temperature which is so easy and available to any person. In order to cultivate cotton in the proper time as MALR recommend.

Keywords: cotton seedling, soil and air temperature and climate data.

INTRODUCTION

Egyptian cotton occupy the first rank among all the other crops because of its economic importance as export crop or local use in the Egyptian factories. So, agricultural research gears its concern and interest on increasing cotton productivity and improving its quality.

Roots accommodate to the microclimate of the soil. The temperature of the soil changes within very small distances, being dependent upon the type of ground cover and the heat capacity of the soil. Where vegetation is sparse, the degree to which the soil warms up depends on its color, water and air content, and on its structure. Loose, well-aerated soils warm up superficially, whereas compact, wet soils conduct heat to deeper levels. During the night the soil surface cools down and the heat flow in the soil is reversed. The soil thus buffers the heat balance of the habitat by taking up a considerable quantity of heat during the day, and releasing this at night. In regions with a seasonal climate, a seasonal temperature cycle – measurable even down to greater depths in the soil – is superimposed on the diurnal temperature fluctuations. Under a closed cover of vegetation the soil is protected from strong irradiation and from radiation loss. (Larcher, 1995).

Soil temperature determines the planting date of cotton seeds. Since planting date determine cotton yield. Ministry of agriculture and land reclamation stated that the optimum date of cotton seeds cultivation by whenever the accumulative temperature for 10 days reaches 160 °C with average 16 ° C /day, (AES, 2002). This date allows cotton plants to produce the highest number of flowers and open bolls as well as decreasing the chance of infection by insects as bolls warms and sucking insects. Hence increasing cotton productivity and promote its rank.

Root growth is often limited by low (suboptimal) or high (supraoptimal) soil temperature. At low temperatures root growth is retarded, the roots become shorter and thicker, and particularly lateral root formation is depressed (Gregory, 1983 cited to Marschner, 1997). Low root zone temperatures might also inhibit shoot growth by insufficient uptake and supply of nutrients to the shoot (Al-Ani and Hay, 1983 cited to Marschner, 1997).

Soil temperature is one of factors of the meteorological system (e. g. air temperature, wind speed and direction, relative humidity ...etc) in addition to soil texture, soil structure and moisture (Ray Linsley *et al.*, 1982). So, the soil temperature reacts with all these factors.

Hosny and Eid, (1995) studied the effect of temperature on cotton planting and productivity. They indicated that the optimum planting date for cotton was March 1st at Sakha and Gemmiza (Lower Egypt). They added that cotton should not be planted after the end of March.

Measuring soil temperature is laborious and need specific tools and instruments, which are not available in most conditions and statuses especially at the simple farmer level. So, the current study aims to introduce a simplified method to determine and predict soil temperature just whenever the air temperature is known.

MATERIALS AND METHODS

Data were collected from different climatological stations which are scattered all-round the country, since there are 14 stations under the supervision of Extension Sector, Ministry of Agriculture and Land Reclamation. Those stations record all the climate data daily or whatever it is needed. Data were analyzed using computer software referring to the statistical textbooks (Pindyck and Rubinfeld, 1976).

One of those scattered climatological stations is located at Sedi Salem, Kafr El-Sheikh Governorate to represent the North Delta region. The soil texture in this area is clay and its properties are given in Table (1). Soil analyses were done according to Page (1982). Central Laboratory for Agricultural climate (CLAC) in co-operation with Extension Sector publishes monthly tertiary publication. Data of about 59 days from Feb.1[st] to March 31, 2002 were used in the derivation. Data of the previous years were not used since the climate measurements and conditions were significantly changed, so that including it may make the prediction unrealistic.

Measurements and statistics:

High: the high temperature along the day (24 hours).

Low: the low temperature along the day (24 hours).

Mean: the arithmetic mean of the high and low temperature along the day (24 hours). (i.e. mean = (high + low) / 2).

Max: the maximum temperature along the period of 58 days.

Min: the minimum temperature along the period of 58 days.

Range: the deference between the max and the min temperature along the day (24 hours). (i. e. range = max – min).

STDV: the standard deviation i. e. (STDV = sum of squares of deviations of the values about its arithmetic mean divided by number of degrees of freedom).

Average: the arithmetic mean of the values along the period of 58 days

Table (1): Some physical and chemical properties of the investigated soil.

Soil property	Soil depth (cm)	
	0-15	**15 - 30**
EC , dS/m	0.73	0.90
PH	7.6	7.6
Soluble cations (meq/l)		
Na^+	6.7	10.0
Ca^{++}	1.8	1.2
Mg^{++}	0.8	2.2
K^+	0.07	0.06
Soluble anions (meq/l)		
Cl^-	5.1	6.1
HCO_3^-	4.2	3.1
CO_3^{--}	-	-
SO_4^{--}	1.0	4.3
Total Nitrogen (%)	0.15	0.14
Organic matter (%)	1.67	0.45
Total phosphorus (%)	0.021	0.001
Physical properties		
Textural class	Clay	Clay
Bulk density(gm/cm^3)	1.26	1.29
Hydraulic conductivity(cm/h)	0.21	0.21

RESULTS AND DISCUSSION

1 – fluctuation of soil temperature:

Data in Table (2) show some measurements and statistics of the climatological data along the recorded period (Jan.1[st] to Feb., 28 2002). It is noticed that the high temperature decline along the soil layer (0.0 – 20 cm), while low temperature increase. This led all the estimated statistics (max high, low high, min high, min low, range high, range low, STDV high and

STDV low) to be declined along the soil layer (0.0 – 20 cm). As it is shown in Figs: 1-5. For example the maximum value of the highest temperature at the upper surface layer (5 cm) was 31°C, while it was 23.6°C at 20 cm. Also, the highest value of the lowest temperature at the upper surface layer (5 cm) was 21.4°C, while it was 18.6°C. Moreover, the average value of the highest temperature at the upper surface layer (5 cm) was 21.5°C, while it was 17°C at 20 cm and it was 13.4°C at 5 and 20 cm for the lowest temperature. Lastly, the standard deviation (STDV) of the highest temperature at the upper surface layer (5 cm) was 5.1°C, while it was 2.82°C at 20 cm and it was 4.56°C and 2.31°C at 5 and 20 cm respectively for the lowest temperature. It could be conclude that the soil temperature changes are significantly affected at the upper layer (5cm) and then these changes decline sequentially in the sequential layers. These results are in good agreement with that obtained by Larcher, 1995.

Table 2: measurements and statistics of the climatological data along the recorded period
(Jan.1st to Feb., 28 2002)

Statistic	Air temperature		Soil temperature					
			5 cm		10 cm		20 cm	
	High	Low	high	low	high	low	high	low
Max.	35	15.4	31	21.4	27.2	20.2	23.6	18.6
Min.	13	2	12.2	7	13	10.8	13.7	10.6
Range	22	13.4	18.8	14.4	14.2	9.4	9.9	8
Average	21.1	7.4	21.5	13.4	18.3	13.8	17	13.4
STDV	4.62	3.15	5.1	4.56	4.22	2.77	2.82	2.31

2 - derived relation between air and soil temperature:

As mentioned above the upper soil layer is the mostly responsible to the changes the climate effect. But the sequent layers are less affected. So the linear relationship will be derived between air temperature and soil temperature in the upper layer (5 cm) which is more closed to cotton seeds and sequentially influence on cotton seedling. The relationship between the low temperature in the upper soil layer (5 cm) and high air temperature is derived and represented by the equation 1 and Fig. 6 below:

Soil low temperature (at 5-cm depth) =
0.7783x(high air temperature) - 3.0406 (1)
$R2 = 0.621$

The relationship between the high temperature in the upper soil layer (5 cm) and high air temperature is derived and represented by the equation 2 and Fig. 6 below:

Soil high temperature (at 5-cm depth) =
0.9084x(high air temperature) + 2.344 (2)
$R2 = 0.6779$

The relationship between the mean temperature in the upper soil layer (5 cm) and high air temperature is derived and represented by the equation 3 and Fig. 6 below:

Soil mean temperature (at 5-cm depth) =
0.8433x(high air temperature) - 0.3483 (3)
$R2 = 0.6726$

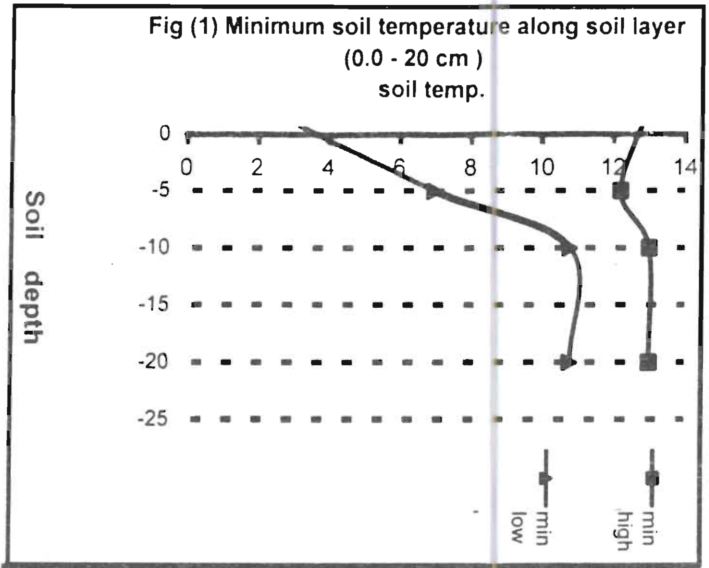


Fig (1) Minimum soil temperature along soil layer
(0.0 - 20 cm)
soil temp.
0
0
2
4
6
8
10
12
14
-5
-10
-15
-20
-25
Soil depth
min low
min high

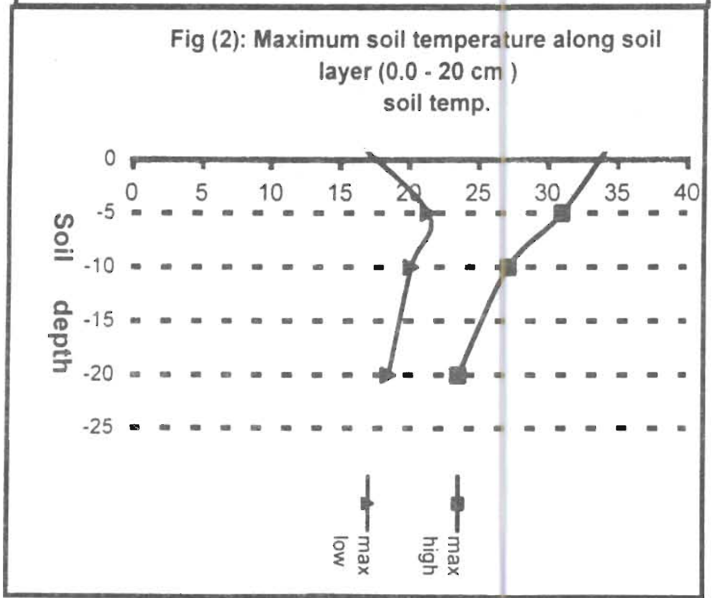


Fig (2): Maximum soil temperature along soil layer (0.0 - 20 cm)
soil temp.
0
0
5
10
15
20
25
30
35
40
-5
-10
-15
-20
-25
Soil depth
max low
max high

Fig (3) Average soil temperature along soil layer (0.0 - 20 cm)

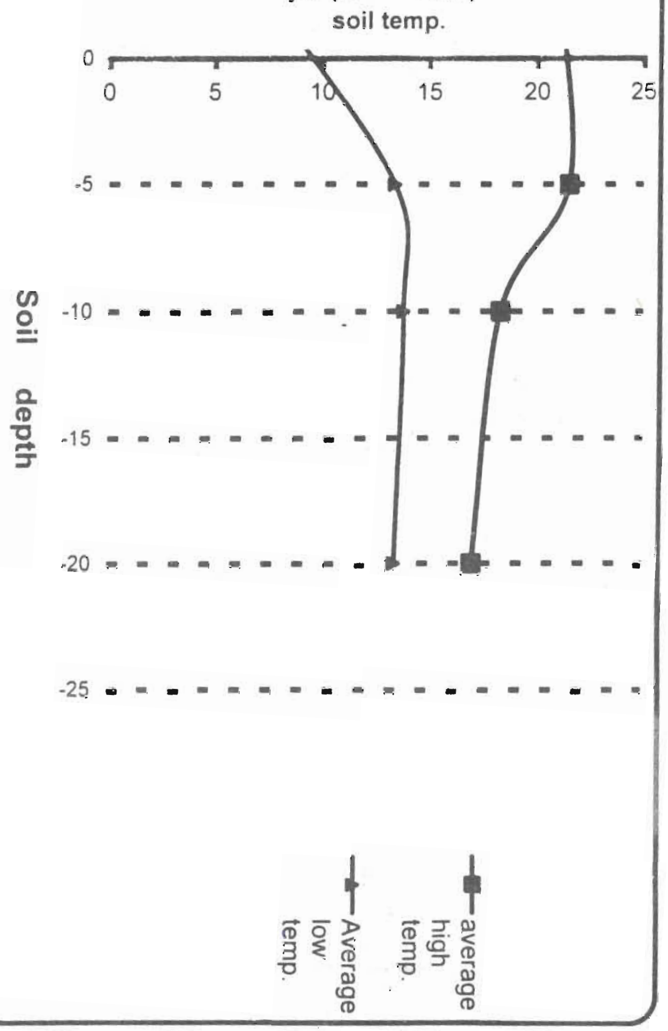


Fig (4): Range of soil temperature along soil layer (0.0 - 20 cm)

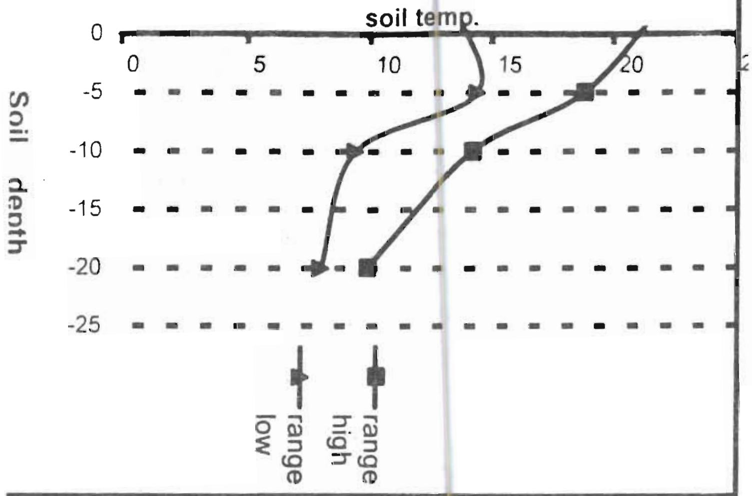


Fig (5): STDV of soil temperature along soil layer (0.0 - 20 cm)

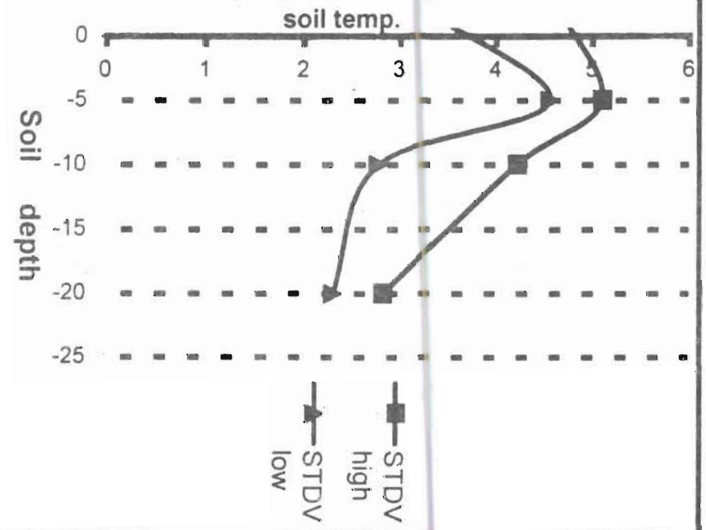
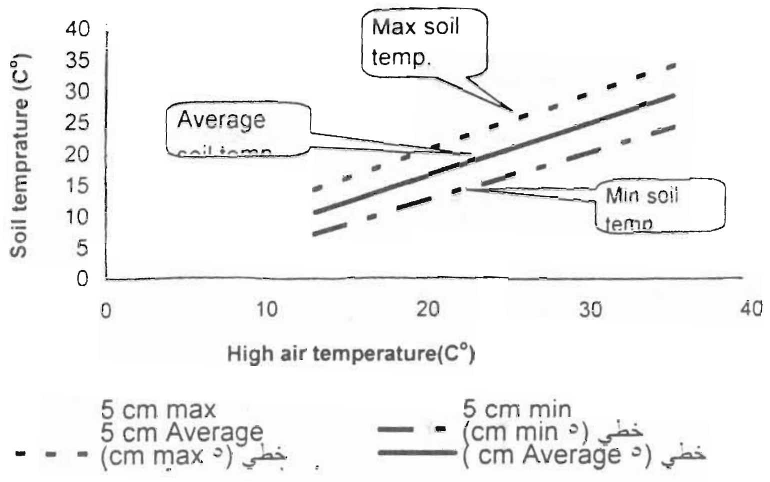


Fig. (6): Relationship between high air and soil temperatures



RECOMMENDATION

The current study provide whom it may be concerned (researchers, extension workers and farmers) with a very simple tool to get a quick prediction of soil temperature just by knowing air temperature which is so easy and available to any person, in order to cultivate cotton in the proper time as Ministry of Agriculture and Land reclamation recommend.

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العلاقة بين حرارة الجو وحرارة التربة في خدمة إنبات بذور القطن

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تنتشر محطات الأرصاد الجوية الزراعية تحت إشراف قطاع الإرشاد الزراعي بوزارة الزراعة في أربعة عشر موقعا لتغطي مختلف أنحاء الجمهورية وتمد الباحثين والمهتمين ببيانات الأرصاد الجوية الزراعية.

وقد جمعت بيانات الأرصاد الجوية الزراعية من محطة سيدي سالم التي تمثل منطقة شمال الدلتا , وذلك علي مدي ٥٩ يوما (أول فبراير إلى ٣١ مارس٢٠٠٢) ولم تستخدم بيانات الأعوام السابقة نظرا لتغير المناخ عما هو عليه الآن) تلك الفترة التي تسبق زراعة القطن وذلك لاستخدام هذه البيانات في اشتقاق علاقة بين درجتي الحرارة في الجو والتربة , حتى يمكن التنبؤ بما يمكن أن تكون عليه درجة حرارة التربة خلال شهر مارس كي يتسنى زراعة القطن في أنسب درجة حرارة لإنبات بذور القطن طبقا لتوجيهات وزارة الزراعة.

وقد وجد أن الطبقة السطحية (٥ سم) هي أكثر الطبقات الأرضية تأثرا وتغيرا في درجات الحرارة ثم ينخفض هذا التغير والتأثر كلما تعمقنا في القطاع الأرضي , وهذه الطبقة السطحية هي الطبقة الأكثر تلامسا وتأثيرا في إنبات بادرات القطن. لذلك تم اشتقاق العلاقة الخطية بين درجة حرارة الجو ودرجة حرارة التربة للطبقة السطحية علي عمق ٥ سم . وتمثل المعادلات التالية ١ – ٣ العلاقة بين درجة حرارة الجو العظمي والدرجة الصغرى والكبري ومتوسط درجة حرارة التربة لعمق ٥ سم .

درجة الحرارة الصغرى للتربة علي عمق ٥ سم =
٠,٧٧٨٣ (درجة حرارة الجو العظمي) – ٣,٠٤٠٦ (١)
ر^2 = ٠,٦٢١

درجة الحرارة العظمي للتربة علي عمق ٥ سم =
٠,٩٠٨٤ (درجة حرارة الجو العظمي) +٢,٣٤٤ (٢)
ر^2 = ٠,٦٧٧٩

متوسط درجة حرارة التربة علي عمق ٥ سم =
٠,٨٤٣٣ (درجة حرارة الجو العظمي) –٠,٣٤٨٣ (٣)
ر^2 = ٠,٦٧٢٦

وبهذا فإنه يمكن استخلاص أن هذه الدراسة تمد المختصين والمهتمين بزراعة القطن من باحثين ورجال الإرشاد الزراعي والمزارعين بطريقة سهلة وبسيطة للتنبؤ بدرجات حرارة التربة بمجرد معرفة حرارة الجو التي يمكن قياسها ببساطة وسهولة دون الحاجة إلى أجهزة معقدة وغير متوفرة في كثير من الأحيان, حتى يتمكن المزارع من زراعة القطن في الوقت وتحت ظروف درجات الحرارة المناسبة التي توصي بها وزارة الزراعة.