Relationships Between Some Physio-Morphological Traits and Cotton (*Gossypium hirsutum* L.) Yield

Sema BASBAG[1] Remzi EKINCI[2] Oktay GENCER[3]

[1] University of Dicle Faculty of Agriculture Department of Field Crops, 21280 Diyarbakir-Turkey

[2] Southeastern Anatolia Research Institute, Post box: 72, Diyarbakir-Turkey

[3]Cotton Research and Application Center, 01330 Adana-Turkey

Abstract: The leaf shape, size, area and number of leaf per plant of cotton are factors which effect seed yield via photosynthetic activity. The experiment, composed of six cotton cultivars, three normal leaf shape and three okra leaf shape were conducted in the University of Dicle, Faculty of Agriculture Experimental Area, in randomized complete block designs, Turkey in 2007. In the study, the single leaf area, leaf chlorophyll content, photosynthetic yield and cotton seed yield were evaluated. The coefficient correlation between cotton seed yield and all characters was analyzed. The normal leaf shape cultivars were the higher than okra leaf shape cultivars for single leaf area, chlorophyll content (SPAD Value), photosynthetic yield and cotton seed yield. Okra leaf cotton varieties were superior than normal leaf shape cotton varieties with regard to fluorescence value, photosynthetically active radiation (PAR), but these genotypes are unable to utilize these advantages for increasing photosynthetic yield and seed cotton yield. it was determined that cotton seed yield has positive and significant correlation with photosynthetic yield, single leaf area, SPAD value.
Key Words: Photosynthesis, photosynthetically active radiation (PAR), yield, cotton, correlation

Introduction

As a common property for all other plants, there is a close relation between plant growth and growing conditions also for cotton plant. Environmental conditions should provide opportunity more photosynthesis activity to completely enhance plant's yield potential. Plant productivity is closely related to measurements of single leaf area and photosynthesis canopy measurements (Zelitch, 1982). This measurement more accurately describes the photosynthetic activity per unit ground area and combines genotype efficiency, leaf morphology and canopy architecture (Peters, et al. 1974).

Net photosynthesis yield measured at cotton leaves may change depending on environmental conditions during the measurement, conditions prevailing in ecological conditions, age and location of the leaf in a plant. Furthermore, impact of temperature on photosynthesis activity in a cotton plant may change depending on water potential, light density and according to time of measurement, etc.

This study was conducted to determine some physiological characteristics affecting photosynthesis and cotton seed yield in cotton plants having okra type and normal leaves, and to determine correlations among the traits.

Materials and Methods

The study was conducted at experimental area of Dicle University Faculty of Agriculture in Diyarbakir, Southeastern Anatolia of Turkey, during 2007 growing season. In this study, three okra leaf (Adana 98, Siokra 1/4 and Fibermax 832) and three normal leaf (DP Opal, Fantom and Berke) cotton varieties were used.

The average of long term temperature is 15.8°C, rainfall is 483.6 mm and the average relative humidity is about 29.9%. climatic data for daily temperature and evoporation and relative humudity were given Figure 1 and 2, respectively. In 2007 cotton growing season, average temperature is 25.62 °C; maximum temperature is 33.66 ºC; minimum temperature is 16.82 ºC; and the average relative humidity is about 42.73% (Reports of Diyarbakir, Turkey, Meteorology Directorate).

Soil of the experimental area has low organic material and phosphorus, has adequate calcium and high clay content (49%-67%) in the 0-150 cm profile. Water permeability of the soil is good and salt levels are suitable for cotton production (Reports of Soil and Water Resources Research Institute, Sanliurfa).

The experimental was arranged a completely randomized block design with four replications. Each plot consisted of 4 rows at 12 m long. The distance intra rows and inter rows were 15 cm and 70 cm, respectively.

In the study, Fluorescence value, Photosynthetically active radiation (PAR), photosynthetic yield, SPAD value traits were evaluated randomly selected over ten plants which top of the fifth node on the

normal sized leaf, at ten days intervals. The observations for single leaf area and seed cotton yield were taken on ten marker plants.

Chlorophyll reflection, photosynthetically active radiation (PAR), photosynthetic yield determined using a portable EARS Photosynthesis-Meter (Environmental Analysis and Remote Sensing, Delft-Netherlands). SPAD value was determined using a handheld portable SPAD 502 Chlorophyll-Meter (Minolta, Osaka, Japan), Single leaf area was determined using the method suggested by Johnson (1967). The statistical results were evaluated with JMP Statistics Packet Program (Copyright © 1989-2002 SAS Institute Inc.) and the means were grouped with LSD (0.05) test.

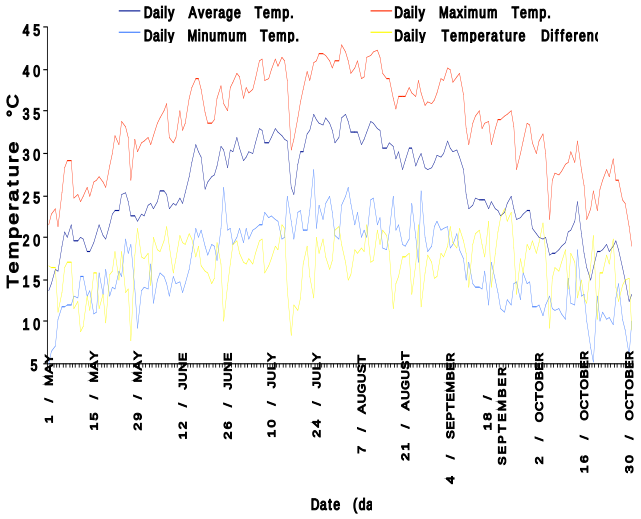

Figure 1. Daily Temperature of Growing Season

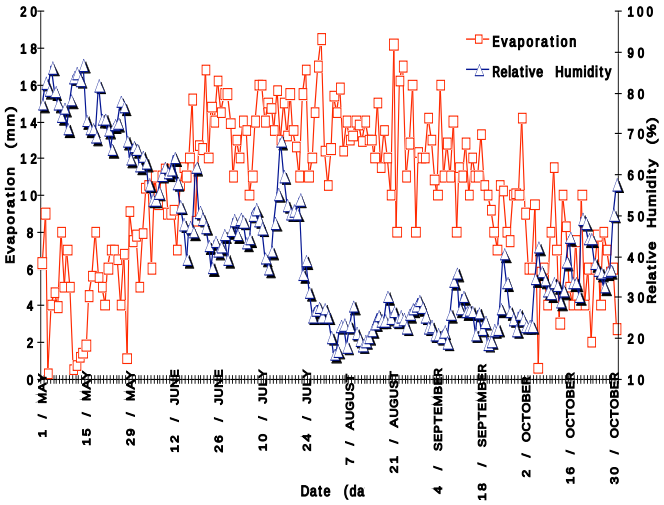

Figure 2. Evaporation and Relative Humidity of Growing Season

Results and Discussion

The results of the variance analysis and correlation coefficients for fluorescence value, photosynthetically active radiation (PAR), photosynthetic yield, seed cotton yield, SPAD value and single leaf area were given in Table 1. Seed Cotton yield with evaluated the other traits of correlation coefficients were given in Figure 3.

Significant variation was observed among genotypes at $p<0.01$ level for fluorescence value, photosynthetically active radiation (PAR), photosynthetic yield, seed cotton yield(kg ha^{-1}), SPAD value and single leaf area.

Fluorescence values varied between 1548.83 (Berke) and 1890.73 (FiberMax 832), and the genotypes with okra shaped leaf have higher values compared to genotypes with normal shaped leaf. Fantom (normal leaf) genotype had higher fluorescence values compared to other normal shape leaf genotypes due to its cluster structure, also Adana 98 genotype had lower values compared to genotypes with okra shaped leaf due to its plant wide canopy structure.

The single leaf area was more effective on fluorescence value, and that the fluorescence value was negatively correlated with cotton seed yield. On the other hand, there was a negative correlation coefficient between fluorescence value and single leaf area (r = -0.706**) and cotton seed yield (r = -0.334).

Siokra ¼ genotype had the highest PAR (222.51,) while Berke cotton genotype had the lowest PAR (191.05) leaf form positively effected PAR. On the other hand, PAR was significantly negative correlated with leaf area (r=-0.638**) and seed cotton yield (r= -0.797**).

Photosynthetic Yield changed from 23.86 (Fiber Max 832) to 29.30 (Berke). Photosynthetic yield was affected by leaf form, plant form and single leaf area, and this trait had positive effects on cotton seed yield. Photosynthetic yield was positive correlated with leaf area (r=0.671**) and cotton seed yield (r=0.676**).

Cotton seed yield ranged from 2560.50 kg ha^{-1} (Siokra 1/4) to 4270.26 kg ha^{-1} (Berke). Genotypes with normal shaped leaf had higher yielded compared to genotypes with okra shaped leaf (Monks et al, 1999; Kerby et al., 1980; Andries et al., 1969; Ekinci et al., 2008). However, Heitholt, (1994) stated that okra leaf cotton produced more lint yield than the normal leaf isoline, while normal leaf type had higher seasonal light interception, and Pettigrew et al., (1993) stated that no differences were between both cotton types for yield.

SPAD values varied between 43.34 (Siokra 1/4) and 51.98 (Berke). SPAD values of Normal leaf cotton genotypes were higher than that of okra leaf genotypes. However, Evangelos et al.,(2006) reported that the okra leaf isoline having higher value than the normal leaf isoline for the SPAD values. Positive correlation were found between SPAD value and single leaf area (r=0.774**) and seed cotton yield (r=0.792**).

Single leaf area changed from 22.37 cm^2 (Adana 98) to 34.07 cm^2 (Berke). The highest single leaf area was observed in the normal leaf genotypes. The strong and significant positive correlations were determined between single leaf area and seed cotton yield (r=0.676**), SPAD value (r=0.774**), photosynthetic yield (r=0.671**).

Table 1. Analysis of Variance for Evaluated Properties on Cotton Varieties.

Varieties	Fluorescence Value	Photosynthetically Active Radiation (PAR)	Photosynthetic Yield	SPAD Value	Single Leaf Area (cm^2)	Seed Cotton Yield ($kg.ha^{-1}$)
Berke	1548,83 C	191,05 B	29,30 A	51,98 A	34,07 A	4270,26 A
Deltaopal	1614,32 B C	193,03 B	28,02 A	49,26 B	31,07 A B	4110,86 A B
GW Fantom	1679,72 B	197,40 B	27,79 A	47,71 B	28,54 A B C	3740,33 B
Adana 98	1629,60 B C	219,47 A	25,58 B	43,43 C	22,37 C	3040,73 C
FiberMax 832	1890,73 A	220,26 A	23,86 B	44,70 C	26,04 B C	3250,83 C
Siokra 1/4	1641,61 B	222,51 A	24,55 B	43,34 C	23,55 C	2560,50 D
$LSD_{0.05}$	87,02	13,70	1,98	2,34	6,22	450,93
Prob	0,00	0,00	0,0006	<.0001	0,013	<,0001
Mean	1667,47	207,29	26,52	1,28	27,61	3500,0
CV (%)	2,86	3,63	4,11	2,70	12,39	7,21

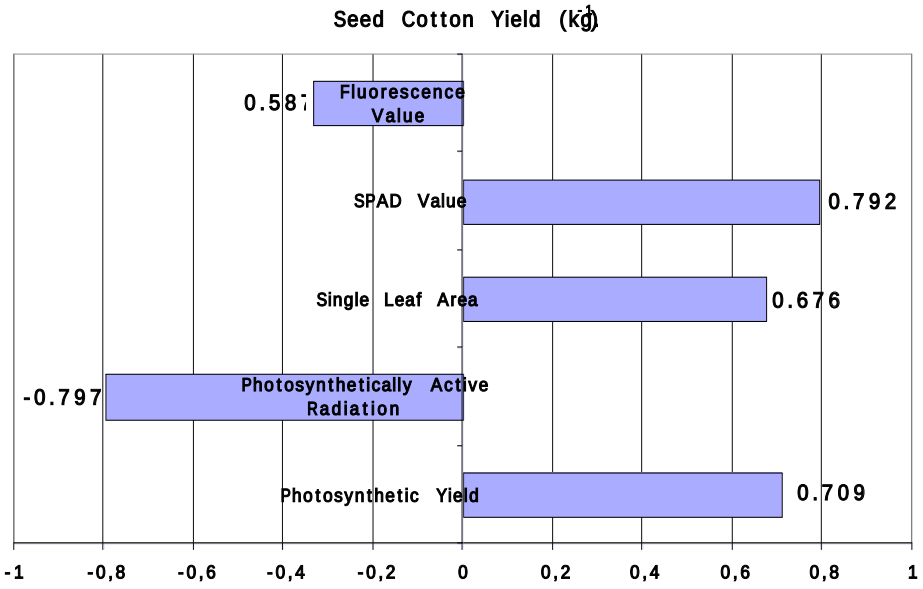

Figure 3. Correlation Coefficients of Seed Cotton Yield with determined the other traits.

Conclusion

It was aimed to determine the effects of some physiological characteristics of cotton genotypes with okra and normal shaped leaves on photosynthetic yield and seed cotton yield, and correlations among these characteristics. it was observed that the genotypes with normal shaped leaf exhibited higher performance compared to the genotypes with okra shaped leaf for photosynthetic yield, seed cotton yield, single leaf area and lower performance for fluorescence value and photosynthetically active radiation.

Although fluorescence value, photosynthetically active radiation were superior in genotypes with okra shaped leaf, it was determined that these genotypes were unable to utilize these advantages for increasing photosynthetic yield and seed cotton yield as Pedigrew, (2004) reported. However, it was determined that cotton seed yield had positive and significant correlation with photosynthetic yield, single leaf area and SPAD value.

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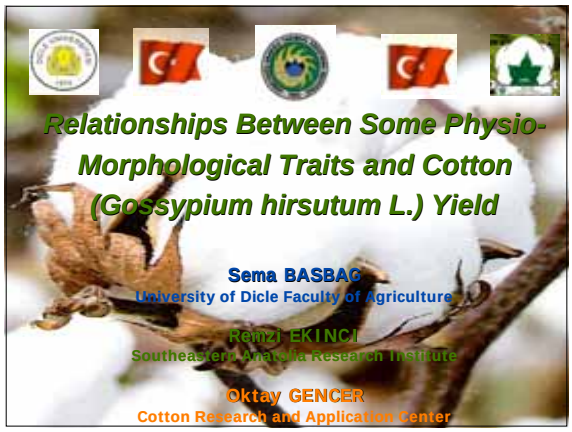


Relationships Between Some Physio-Morphological Traits and Cotton (Gossypium hirsutum L.) Yield

Sema BASBAG
University of Dicle Faculty of Agriculture

Remzi EKINCI
Southeastern Anatolia Research Institute

Oktay GENCER
Cotton Research and Application Center

Introduction

Cotton is the most important crop in the irrigated area of the Southeastern Anatolia region covering about 85% of the cropped land in the region.

The Turkish seed cotton production averaged 697,000 tons from 697,000 ha, of which 46% was from 300,000 ha in this region.

Introduction

As a common property for all other plants, there is a close relation between plant growth and growing conditions also for cotton plant.

Environmental conditions should provide opportunity more photosynthesis activity to completely enhance plant's yield potential.

Introduction

Plant productivity is closely related to measurements of single leaf area and photosynthesis canopy measurements.

This measurement more accurately describes the photosynthetic activity per unit ground area and combines genotype efficiency, leaf morphology and canopy architecture.

Aim of the Research

This study was conducted to determine some morpho-physiological traits affecting photosynthesis and cotton seed yield in cotton plants having okra and normal leaves, and to determine correlations among the traits.

Experimental Area

The study was conducted at experimental area of Dicle University Faculty of Agriculture in Diyarbakir, Southeastern Anatolia of Turkey, during 2007 growing season.

Materials

Three okra leaf shape cotton varieties

- ✓Adana 98,
- ✓Siokra 1/4 and
- ✓Fibermax 832

Three normal leaf shape cotton varieties

- ✓DP Opal (Deltaopal),
- ✓Fantom and
- ✓Berke

Materials

- ✓**Portable EARS Photosynthesis-Meter** (Environmental Analysis and Remote Sensing, Delft-Netherlands).
- ✓**A handheld portable SPAD** (Soil Plant Analysis Development) **502 Chlorophyll-Meter** (Minolta, Osaka, Japan),
- ✓**JMP Statistics Packet Program** (Copyright © 1989-2002 SAS Institute Inc.)

Soil of the Experimental Area

Soil of the experimental area has low organic material and phosphorus, has adequate calcium and high clay content (49%-67%) in the 0-150 cm profile.

Water permeability of the soil is good and salt levels are suitable for cotton production (Reports of Soil and Water Resources Research Institute, Sanliurfa).

Climatic Condations in Diyarbakir

The average of long term temperature is **15.8°C,** rainfall is **483.6** mm and the average relative humidity is about **29.9%.**

In 2007 cotton growing season,

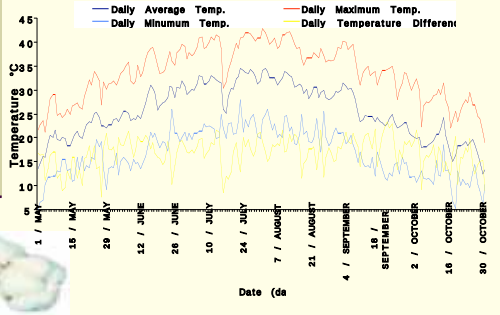
average temperature is **25.62 °C;**

maximum temperature is **42.73 °C;**

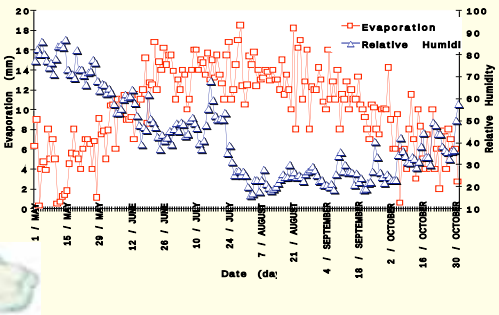
minimum temperature is **16.82 °C;**

and the average relative humidity is **33.66 %.**

Climatic Condations in Diyarbakir



Climatic Condations in Diyarbakir



Method

The experiment was carried out a completely randomized block design with four replications. Each plot consisted of 4 rows at 12 m long.

The distance intra rows and inter rows were 15 cm and 70 cm, respectively.

Method

In the study, fluorescence value, photosynthetically active radiation (PAR), photosynthetic yield, SPAD value traits were evaluated randomly selected over ten plants which top of the fifth node on the normal sized leaf, at ten days intervals.

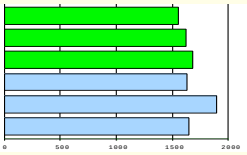
The observations for single leaf area (SLA), and seed cotton yield were done from the marked ten plants.

Results and Discussion

Significant variation was observed among genotypes at $p<0.01$ level for fluorescence value, photosynthetically active radiation (PAR), photosynthetic yield, seed cotton yield, SPAD value and single leaf area.

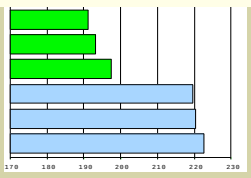
Fluorescence Value

Berke	1548,83	C
Deltaopal	1614,32	B C
Fantom	1679,72	B
Adana 98	1629,60	B C
FiberMax 832	1890,73	A
Siokra 1/4	1641,61	B
LSD 0.05	87,02	
Prob	0,0001	
Mean	1667,47	
CV (%)	2,86	



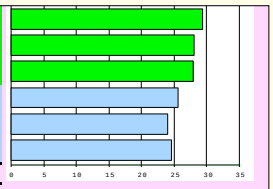
Photosynthetically Active Radiation (PAR)

Berke	191,05	B
Deltaopal	193,03	B
Fantom	197,40	B
Adana 98	219,47	A
FiberMax 832	220,26	A
Siokra 1/4	222,51	A
LSD 0.05	13,7	
Prob	0,0006	
Mean	207,29	
CV (%)	3,63	



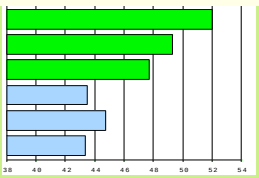
Photosynthetic Yield

Berke	29,30	A
Deltaopal	28,02	A
Fantom	27,79	A
Adana 98	25,58	B
FiberMax 832	23,86	B
Siokra 1/4	24,55	B
LSD 0.05	1,98	
Prob	0,0006	
Mean	26,52	
CV (%)	4,11	



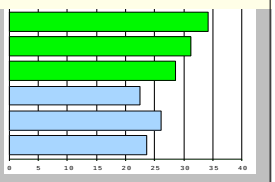
SPAD Value

Berke	51,98	A
Deltaopal	49,26	B
Fantom	47,71	B
Adana 98	43,43	C
FiberMax 832	44,70	C
Siokra 1/4	43,34	C
LSD 0.05	2,34	
Prob	<.0001	
Mean	1,28	
CV (%)	2,7	



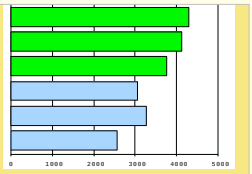
Single Leaf Area (cm^2)

Berke	34,07	A
Deltaopal	31,07	A B
Fantom	28,54	A B C
Adana 98	22,37	C
FiberMax 832	26,04	B C
Siokra 1/4	23,55	C
LSD 0.05	6,22	
Prob	0,013	
Mean	27,61	
CV (%)	12,39	

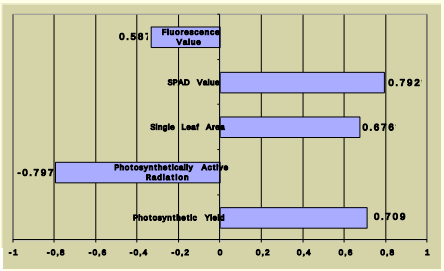


Cotton Seed Yield (kg ha^{-1})

Berke	4270,26	A
Deltaopal	4110,86	A B
Fantom	3740,33	B
Adana 98	3040,73	C
FiberMax 832	3250,83	C
Siokra 1/4	2560,50	D
LSD 0.05	450,93	
Prob	<.0001	
Mean	3500,08	
CV (%)	7,21	



Correlation Coefficients of Seed Cotton Yield with Evoluated the other Traits



Conclusion

Normal shaped leaf varieties resulted in higher performance compared to the genotypes with okra shaped leaf for photosynthetic yield, seed cotton yield, single leaf area, and lower performance for fluorescence value and photosynthetically active radiation.

Conclusion

Although fluorescence value, photosynthetically active radiation were higher for genotypes with okra leaf, these genotypes were unable to utilize these advantages for increasing photosynthetic yield and seed cotton yield.

Conclusion

However, while cotton seed yield had positive and significant correlation with photosynthetic yield, single leaf area and SPAD value, photosynthetically active radiation (PAR) and fluorescence value resulted in negative and significant correlation.