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THE RESPONSE TO STOMATAL CONDUCTANCE AND CHLOROPHYLL VALUE OF GROUNDNUT GROWN UNDER SALT STRESS IN DIFFERENT DEVELOPMENT STAGES

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Abstract

In this study its response to salinity over different development periods (blooming, ginofor formation and fruit formation and maturation) was determined in the Eastern Mediterranean Region. The experimental design was split plot in a randomized complete block with three replications and was conducted in a total of 180 pots. In the irrigaton of groundnut, saline water with electrical conductivity (ECw) 0.19 dS m^{-1} ($T_{0.19}$), 3.54 dS m^{-1} ($T_{3.54}$), 7.12 dS m^{-1} ($T_{7.12}$) and 12.86 dS m^{-1} ($T_{12.86}$) were used. It was determined that Ginof formation stage was the most sensitive stage to salinity than the other developmental stages. Yield parameters were affected at $p < 0.001$ level from development stage, irrigation water salinity and the development stage x irrigation water salinity interaction. Chlorophyll values at different salinity levels of stoma conductivity was show that different. The highest and lowest stomatal conductance were realized in $T_{3.54}$ (356.025 mmol m^2s^{-1}) and $T_{12.86}$ (238.25 mmol m^2s^{-1}) issues. Stomatal conductivity showed differences at different salinity levels. The highest and the lowest stoma conductivity monitored at $T_{3.54}$ (356.025 mmol m^2s^{-1}) and $T_{12.86}$ (238.25 mmol m^2s^{-1}). It was observed that the at the plots where the highest stoma conductivity determined had the higest yield.

Key words: *groundnut, salinity, development periods, stomatal conductance, chlorophyll.*

INTRODUCTION

Drought problems arising in the arid and semi-arid regions makes almost mandatory to use of marginal quality water in irrigation (brackish, reclaimed, drainage and waste water). Salt water usage causes the salinization to about 830 million hectares of worldwide (Martinez-Beltran and Manzur, 2005). This situation becomes necessary to determine in detail to the salt water yield function in salinity field (especially the plants that play an active role in human nutrition). One of the peanut plant species rich in oil, protein, carbohydrates, vitamins and mineral substances (Arıoğlu et al., 2010). Worldwide, about 24.7 million hectares in 100 countries, the production plant grown shelled 34.1 million megagram (Mg/ha), average efficiency 1.38 Mg/ha (FAO, 2002). Yield losses due to drought may vary with time associated with temperature and high stress factors, such as region-specific irradiance. About 3/2 in arid regions where crop production potential limitation of production consists, depending on the seasonal rainfall. In these areas productivity changes between 0.7-0.8 Mg/ha. But even with that limited water efficiency in commercial areas are level of 2.0-4.0 Mg/ha (Smartt, 1994). Lack of soil moisture in peanut farming and irrigation water quality are considered to be the most important factors limiting the yield. Growth period changes from about 120 to 150 days. precipitation of 500-700 mm is sufficient for the cultivation of peanuts during the growth. But this fall should be distributed to the growing period. Peanut maximum daily water consumption that occurs in flowering and pod-linking and maturation. The highest water consumption in July-August, August-September of about 6.0-8.5 mm/day was measured. In starting period (germination) when the peanut requesting adequate soil moisture it must be inserted into a small amount of water stress during the vegetative period. Flowering period is the period in which the most sensitive to water shortages. In general, extreme water shortages in the vegetative period causes to delay of flowering, the product formation, development and

harvest. Water shortages of the flowering period lead to loss of the flowering and poor of the flower pollination.

Studies conducted in response to the saltwater applications of peanuts is almost negligible. Revealing different stages of plant development functions of salt-yield research was not found in a literature search. In this research, during that three different development of peanut aim to determine the different irrigation water salinity effects of yield, vegetative and physiological parameters.

MATERIALS AND METHODS

Research was conducted in greenhouses sheltered from rain, between May and October 2012, NC-7 variant of the Virginia group (leaning early). The plants were grown in 43 cm diameter and 47 cm high plastic pots., each pot filled with sandy-clay loam soil (42.0% sand, 35.3% clay, 22.7% loam) which is volume weight 1.38 gr cm^{-3}, salinity C_1S_1.

The experiment was conducted according to the split plot in a randomized complete block design in three different growth period (Flowering, Ginof formation, The formation and maturation of fruits periods), 4 different salinity in irrigation water (ECw) (0.19 dS m^{-1} (T_0), 3.54 dS m^{-1} ($T_{3.5}$), 7.12 dS m^{-1} (T_7) ve 12.86 dS m^{-1} (T_{13})), three replications and In each replications will take place the 5 pots, a total of 180 pots. NaCl salt and pure $CaSO_4$ salt sources were used in the experiment. Na and Ca values take care in the irrigation water must be kept between 0.1 and 0.7 (Grattan ve Grive, 1999). Determining the amount of irrigation water, prior to each watering (everything subject extra 3 pots) the observation of the subject pot is determined by measuring the required amount of irrigation water needed to field capacity. 20% of washing water is applied at each irrigation witness subject to issues outside (T_0). Irrigation water salinity (dS m^{-1}) was measured by portable EC meter (Orion 3 Star, USA), soil moisture content (cm^3 cm^{-3}) and soil salinity was measured by ΔT marka HH-2 moisture meter. Before the experiment starting, calibration equation is determined for the soil salinity y= 0.0127x + 0.91, (r^2=0.96**). Evapotranspiration was determined by in every treatment of the weight of the 3 pot weighing the time between two irrigation and and summing the wanting. Plants in pots removed and collected in the harvest peanuts and eliminating all land in the pot tried to prevent the possible loss of peanut grain. The resulting grain, In every treatment that peanuts were determined to width (mm), length (mm), the average grain weight (gr) and numeral (number m^{-2}). Plant height were measured to determine the vegetative response before each irrigation. In this research, stomatal conductance and chlorophyll content were read a total of 6 times in 2 pots out of every replication before irrigation In order to determine the effects of irrigation water salinity on plant physiology. Stomatal conductance was measured by porometer (Model SC-1. LPS0881) and chlorophyll content was measured by Minolta SPAD 502. Stomatal conductance and chlorophyll content were measured in the middle of parcel, the full-blown fresh leaf which see the sun, In outdoor conditions between times of 12:00-14:00, once a week and before irrigation.

RESULTS AND DISCUSSIONS

Soil Moisture Content, Soil Salinity and Evapotranspiration: In this research, the plants were irrigated by fours in blooming and ginof period and in the during fruit ripening 3 times. Unsalted water for irrigation has been applied to all issues from planting to exit from to soil period. Salt water applications have started blooming period and continued until the harvest period. Soil salinity has increased significantly depending on irrigation practices (outside of T0 issue). 0.19 dS m^{-1} irrigation water is even did not cause a significant reduction in salinity level in the next period of saltwater applications in blooming and ginof periods. This situation is due to Na ions present in the soil is heavily complex and the high hydration diameter not impede the full realization of the washing process (Frenkel ve ark. 1978). Evapotranspiration (Et) decreased overall by increasing salinity (Table 1).

Table 1. The average values of evapotranspiration and soil salinity in the growth period

Issues	Blooming Period		Ginof Formation Period		Fruit Formation and Maturation Period		Seasonal Average	
	Et (mm)	ECe (dS m^{-1})	Et (mm)	ECe (dS m^{-1})	Et (mm)	ECe (dS m^{-1})	Et (mm)	ECe (dS m^{-1})
$T_{0.19}$	813.00	1.15	744.00	1.62	714.33	0.62	757.11 a	1.13
$T_{3.54}$	738.00	3.36	716.67	2.45	757.33	1.67	737.33 a	2.48
$T_{7.12}$	677.67	6.88	704.33	4.38	630.00	2.88	670.67 b	4.69
$T_{12.86}$	628.67	12.61	613.33	8.25	586.67	4.57	609.56 c	8.42

The highest Et was measured in witnesses issue in blooming and ginof formation periods and it also was measured in $T_{3.54}$ issue in during fruit ripening period. Significant relationship was found like that (y=-14.307x+799.15 r^2=0.95**) in blooming period between Et and average Ece, and also in ginof formation periods (y=-10.081x+754.35, r^2=0.93**) and insignificant relationship was found like that (y=-12.357x+745.34 r^2=0.74ns) during fruit ripening. Increased salinity dS m^{-1} of 1 causes a decrease 14.3 mm of BST in blooming period and also in ginof formation period it causes a decrease 12.35 mm.

Stomatal conductance, Chlorophyll Fluorescence: Irrigation water salinity increased, decreased stomatal conductance (Figure 2). Average of stomatal conductance was measured respectively in T_0, $T_{3.5}$, T_7 and T_{13} like that 307.476, 356.025, 268.187, 223.056 mmol m^{-2} s^{-1} . Stomatal conductance values of $T_{3.5}$ and T_{13} were took place separate groups and also T_0 ve T_7 were same group of statistical analysis. The stomatal conductance of $T_{3.5}$ was determined higher than the T0 (witness). It evaluated as a result of salinity given a final effort to recover from the stress of the plant itself has become stressed. Between stomatal conductance and soil salinity the regression coefficient is obtained different linear relationships in the blooming period as (y=-2.43x+340.163 r^2=0.12 ns), in ginof formation period (*y=-34.484x+418.56 r^2=0.96***), also in fruit formation and maturation period (y =-18.417x+310.3 r^2=0.37ns). Ginofor formation of stomatal conductance to be effective during the land 96% salinity be considered as an indication that more important than other periods of water movement and photosynthesis from the leaves in this period. The highest and lowest stomatal conductance in growth period were measured in blooming (326.053 mmol m^{-2} s^{-1}) and fruit formation periods (265.440 mmol m^{-2} s^{-1}). ECe average values were measured between 5.99 dS m^{-1} and 2.43 dS m^{-1} in the same period. Despite the increased stomatal conductance reduction of soil salinity may be a result to cause aging of salinity stress in plants during the growth period.

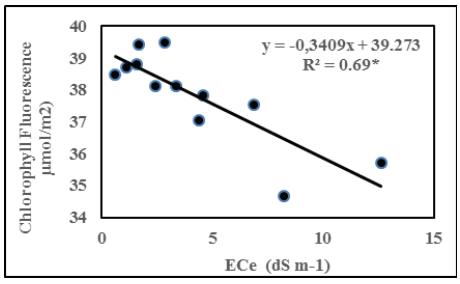

Figure 1. The relationship between chlorophyll content and soil salinity

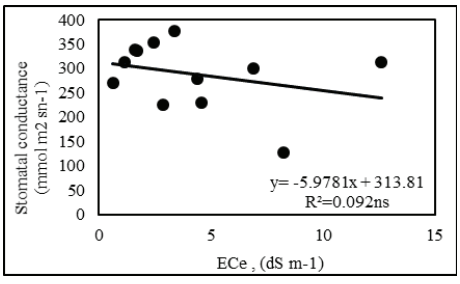

Figure 2. The relationship between stomatal conductance and soil salinity

The effects of soil salinity on stomata conductance ($p<0.01$) is the more efficient than growth periods has been determined in statistical analysis (Table 2). But from 8 August to 10 October (Harvest time) before watering measurements, the highest regression coefficients were determined in the ginof formation period regression analysis between stomatal conductance and ECw ($p<0.05$).

Table 2. Variance analysis of the efficiency parameter

Variation Source	Stomatal conductance (mmol m^{-2} s^{-1})			Chlorophyll Fluorescence (µmol m^{-2})		
	dF	MS	F	dF	MS	F
ECe	3	260406.817	3.357*	3	151.341	7.469**
Growth stages (Gs)	2	125428004	1.617ns	2	111.210	5.489**
ECe* Gs	6	58409.788	0.753ns	6	22.327	1.102ns
Error	344					

Gs: Growth stages, ECe: electrical conductivity of soil paste (dS m^{-1}), dF:Degree of Freedom, MS: Mean Square

Chlorophyll Fluorescence: Chlorophyll values decreased due to the increase in salt concentration (Figure 3). However, this reduction was not statistically significant ($r^2=0.89$ns, $p<0.05$). Chlorophyll values of witness issue ($T_{0.19}$) was measured 38.674 µmol/m^2, and also in $T_{13.86}$ 36.080 µmol/m^2. Chlorophyll values of $T_{3.5}$, T_7 were determined respectively, 38.569 µmol/m^2 and 38.038 µmol/m^2. $T_{0.19}$, $T_{3.5}$, T_7 issues were included in the same group, $T_{12.86}$ was icluded in the different group. Chlorophyll lowest value during the period was measured in $T_{12.86}$ by 35.193 µmol/m^2 and also the highest value was measured in $T_{0.19}$ by 39.491 µmol/m^2. The effect of soil salinity to chlorophyll value of each development cycle has been different. In regression analysis between soil salinity and chlorophyll content is obtained equations as $y=-0.2588x+39.084$, $R^2=0.99^{**}$ in blooming period, $y=-0.61x+39.721$ $R^2 = 0.99^{**}$ in ginof formation period and $y=-0.1948x+39.29$ $R^2=0.17^{ns}$ in fruit formation and maturation period. As it is seen from equation plants closer to the time of harvest chlorophyll values became more erratic than the other periods. In addition to weakening towards the end of the synthesis of chlorophyll in the plant's life cycle and entering senescence salinity stress is a major cause of this condition. Statistically chlorophyll value is significantly affected by developments periods and soil salinity (*$p<0.01$*, Table 2). While chlorophyll measured values in blooming an ginof formation periods located in the same group (37.531 µmol/m^2 ve 37.174 µmol/m^2), fruit formation and maturation period has been involved in a different group (38.815 µmol/m^2).

The Relationship Between Physiological Characteristics and Yield: Peanut of the efficiency parameters response to the irrigation water salinity analysis of variance are given in Table 3. The analysis of variance shows that efficiency parameters are affected at the level of *$p<0.001$* of *their growth period, irrigation water salinity and interaction of growth period x irrigation water salinity.* When the average value of the yield parameter in the development period analyzed, highest values were obtained from fruit formation and maturation periods. This situation shows that if the saline water implemented closer to harvest in the growth period, it would be relatively lower average yield reduction.Stomatal conductance and chlorophyll values at each growth period were not effective at the same level. When regression relationships are examined, both physiological properties were determined to be most effective in ginof formation (Table 3).

The relationship between the efficiency of both features **(**stomatal conductance and chlorophyll) were more important than other periods as both linear and polynominal. Chlorophyll values were effective on a greater number of yield parameters according to the stomatal conductance.

Table 3. The stomatal conductance and Chlorophyll fluorescence parameters relationships with yield (Regression Equations)

		Lineer regression					Polynomial regression				
		Number of peanut (number/m^2)	Grain W.(gr)	Width (mm)	Length (mm)	Plant Height (cm)	Number of peanut (number/m^2)	Grain W.(gr)	Width (mm)	Length (mm)	Plant Height (cm)
Sc (mmol m^{-2} s^{-1})	Blo	y=-0.0144x +84.31 R^2 = 0.001	y=0.1009x+60.706 R^2 = 0.16	y=0.0606x +76.164 R^2=0.24	y=0.0446x+82.675 R^2=0.37	y=0.1797x +31.156 R^2=0.23	y=-0.023x^2 +15.9x-2615 R^2=0.60	y=0.0083x^2- 5.5449x+1015.6 R^2=0.36	y=0.0066x^2- 4.44x+837.36 R^2=0.77	y=0.0035x^2- 2.32x+483.06 R^2=0.80	y=0,0068x^2- 4.447x+813.7 R^2 = 0.29
	GNF	y=0.369x -27.985 R^2=0.81	**y=0.2955x-1.3599 R^2=0.99****	**y=0.1385x +52.67 R^2=0.97****	**y=0.0997x+65.818 R^2=0.99***	y=-0.0097x +100.86 R^2=0.53	**y=-0.0034x^2 +1.9957x-187.08l R^2=0.99**	**y=-0.0006x^2 +0.5752x- 28.714 R^2 = 0.99****	**y=-0.0005x^2 +0.37x +29.817 R^2=0.99****	**y=-0.0002x^2 +0.1776x+58.20 R^2=0.99****	y=0.0002x^2- 0.0845x + 108.18 R^2 = 0.89
	FFM	y=0.0668x +76.202 R^2=0.14	y=0.0918x +68.836 R^2=0.37	y=0.0289x +90.638 R^2=0.33	y=0.0132x+95.051 R^2=0.15	y=-0.0312x +104.54 R^2 = 0.27	y=-0.0013x^2 +0.7786x-20.952 R^2=0.17	y=0.0005x^2- 0.1909x+107.42 R^2=0.38	y=-0.0006x^2 +0.364x+45.382 R^2=0.43	y=8x$10^{-5}$$x^2$- 0.033x + 101.39 R^2=0.15	**y=-0.0018x^2+ 0.9642x-31.325 R^2 = 0.93***
Chll Fluor. (µmol m^{-2})	Blo	y=5.054x -110.07 R^2=0.20	**y=6.489x -149.93 R^2 = 0.90***	y=2.4099x +5.49 R^2=0.52	y=1.4074x+4.384 R^2=0.51	**y=9.910x -282.1 R^2= 0.95****	**y=12.278x^2 -906.9x+16806 R^2 = 0.99****	**y=-2.5579x^2 +196.47x-3673.9 R^2=0.99****	**y=-2.6925x^2 +202.39x- 3704 R^2 = 0.94***	y=-1.4382x^2 +108.2x – 1937 R^2=0.86	**y=-1.3126x^2+ 107.4x-2090.5 R^2 = 0.96***
	GNF	y=21.055x-709.35 R^2 = 0.74	**y=16.742x - 542.58 R^2 = 0.96***	**y=7.6992x -195.51 R^2 = 0.90***	**y=5.646x-116.7 R^2=0.96****	y=-0.595x +120.31 R^2=0.59	**y=-8.3659x^2 +634.34x-11927 R^2 = 0.94***	**y=-3.2268x^2 +253.3x-4869.2 R^2 = 0.99****	**y=-2.3225x^2 +177.9x-3309.6 R^2 =0.99****	**y=-1.037x^2 +81.6x - 1507.1 R^2 = 0.99****	y=0.2266x^2 -17.21x + 424.19 R^2 = 0.69
	FFM	y=9.671x -281.45 R^2 = 0.69	y=9.0227x -257.02 R^2=0.87	y=2.394x +5.3736 R^2=0.54	**y=2.1102x+16.652 R^2=0.90**	**y=-1.1442x +140.68 R^2=0.09**	**y=-15.516x^2 +1210.7x-23516 R^2=0.97**	**y=-7.7912x^2 +612.13x-11925 R^2=0.98**	**y=-5.5544x^2 +432.3x-8312.4 R^2=0.99**	**y=-1.6864x^2 +132.6x-2508.8 R^2= 0.99****	y=-6.1588x^2 +475.6x-9082.3 R^2 = 0.48

** Blo: Blooming stage, GNF: Ginofor Formation Stage, FFM: Fruit Formation and Maturation Stage

In particular, grain weight, grain width, grain size were an important relationship with stomatal conductance and chlorophyll levels as both of poynomial and linear regression. The effect of stomatal conductance only creating important relationships with plant height has been shown to influence more output parameter values of chlorophyll. The effect of stomatal conductance fruit formation and maturation period creating important relationships with plant height It has been shown to influence more output parameter values of chlorophyll.

CONCLUSIONS

Accurate detection of plant water sensitive and tolerant period is crucial. The information obtained from research done before show that determining the mentioned period for many plants. As with drought stress, salinity stress is caused the low yield by the approximately same mechanism in plant. In areas where water is scarce, in plant physiology is an important option to use saline water for irrigation is causing serious problems. This information we have are showed that plants are more tolerant or more sensitive approximately in the same period of the plant drought-salinity stress. It is important to know the response of the estimated yield physiologically plant occurred during periods of stress. The findings from this study, indicates that the most sensitive period to salinity is ginof formation period among the blooming, ginof formation and fruit formation periods. Increased salinity stress caused a decrease evapotranspiration. It was determined that the stomatal conductance significantly reduced, depending on the salinity and chlorophyll content. The yield on the changes in chlorophyll content rather than changes in stomatal conductance is determined to play a more important role. The plant get older, impact of changes in stomatal conductance yield was insignificant. However, the chlorophyll content was determined to be of a more significant impact on the plant's final stage.

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