THE EFFECT OF CLIMATE CONDITIONS ON THE GROWTH AND DEVELOPMENT OF PEANUTS GROWN ON SANDY SOILS FROM SOUTHERN OLTENIA

DIMA Milica, DIACONU Aurelia, DRĂGHICI Reta, CROITORU Mihaela, STURZU Rodica

Abstract. In the area of sandy soils in the south of Oltenia, the air temperature can vary during the vegetation period. The elements of productivity and the production of peanuts differ according to the variety and the conditions of growth and development. The elements of productivity are influenced by air temperature, and high air and soil temperature influence pod production negatively, too. Peanut varieties react differently depending on their tolerance to high temperatures. The cultivation of genotypes of peanuts that tolerate heat stress is becoming more and more important for high yields. Of the studied genotypes, the HYY1, HYY2, Provenance China 2, Henan Province genotypes proved to be tolerant to thermal stress and obtained the highest values for some elements of productivity and yields that exceeded 5000 kg / ha.

Keywords: peanuts, sandy soils, genotype, thermal stress.

Rezumat. Efectul condițiilor climatice asupra creșterii și dezvoltării arahidelor pe solurile nisipoase din sudul Olteniei. În zona solurilor nisipoase din sudul Olteniei temperatura aerului poate fi variată pe parcursul perioadei de vegetație. Elementele de productivitate și producția de arahide variază în funcție de soi și condițiile de creștere și dezvoltare. Elementele de productivitate sunt influențate de temperatura aerului, iar temperatura ridicată a aerului și a solului influențează negativ producția de păstăi. Soiurile de arahide reacționează diferit în funcție de toleranța lor la temperaturile ridicate. Cultivarea genotipurilor de arahide tolerante la stresul termic devine din ce în ce mai importantă pentru obținerea unor producții ridicate. Dintre genotipurile studiate, soiurile HYY1, HYY2, Proveniență China 2, Henan Province s-au dovedit a fi tolerante la stresul termic și au obținut cele mai mari valori la unele elemente de productivitate și producții care au depășit 5000 kg/ha.

Cuvinte cheie: arahide, soluri nisipoase, genotip, stres termic.

INTRODUCTION

Thermal stress, together with water stress, is considered one of the main factors that negatively affect the production of crop plants. Temperature is a critical factor controlling plant growth and development (COX, 1979; PATEL & FRANKLIN, 2009; HATFIELD & PRUEGER, 2015). Each plant species has a specific temperature range for plant growth and development represented by a minimum, maximum and optimal level (IPCC, 2007). In the context of climate change, higher temperatures associated with water deficit will affect plant productivity (MCKEOWN et al., 2005; SØNSTEBY & HEIDE, 2008; DUFAULT et al., 2009) suggested that in case of annual plants temperature is the major environmental factor affecting production, with minimum and maximum daily temperatures having the greatest effect on plant growth, development and productivity.

KETRING et al. (1982) have shown that temperature plays a critical role in the growth and development of peanut plants and it seems that the optimum temperature differs depending on the vegetation phase. AWAL & IKEDA (2002); PRASAD et al. (2006) reported that the minimum temperature for peanut seed germination is about 10^0C, and the optimal temperature for plant emergence is between 25-30^0C. ONO et al. (1974); ONO (1979); DREYER et al. (1981) have shown that air and soil temperature are important factors for the achievement of peanut production, as peanut flowers develop on the soil surface, while pods in the soil. KETRING (1984); PRASAD et al. (1999) indicated that the average optimum air temperature for the vegetative growth of peanut plants appears to be between 25 and 30^0C, while for the formation of pods it was between 20 and 25^0C. The daytime temperatures over 35^0C during the pod formation phase reduce the number of pods, consequently the pod production. PRASAD et al. (2000) showed that peanut plants are susceptible to high air and soil temperatures, due to their aerial flowering and due to the fact that peanut plants form pods in the soil

The research undertaken by ARIOGLU & ERSOY (1987); ONAT et al. (2017) showed that in the next 30-50 years a temperature increase by 2-3^0C is estimated. In most regions, this global warming will have a negative impact on plant growth and development. As a consequence, the production of important plant species will be compromised. The cultivation of genotypes of peanuts that tolerate heat stress is becoming increasingly important for high yields.

MATERIAL AND METHODS

The researches were carried out between 2018 and 2019 at the Research and Development Station for Field Crops on Sandy Soils of Dabuleni (RDSFCS Dabuleni), on a sandy soil with a low content of nitrogen (0.06%), with a good supply of extractable phosphorus (79.5 ppm), a low supply of exchangeable potassium (67 ppm), and a low supply of humus (0.55%) with a pH of 6.72, showing a moderately acid reaction.

The purpose of these researches was to study the effect of the high air and soil temperature on some productivity elements and on the production of pods in a few peanut genotypes during the vegetation period.

The biological material used in this study was represented by 10 peanut (*Arachis hypogaea* L.) genotypes (table 3), which were initially studied in the comparative competition culture.

The experience was established using the randomized blocks method in three repetitions.

The climatic data were recorded at the weather station of RDSFCS Dabuleni, determinations were made on the number of pods per plant, weight of pods/plant, production of pods / ha, mass of thousand grains.

The results were processed using the variance analysis method.

RESULTS AND DISCUSSIONS

According to the aspects related to the requirements of peanuts with respect to the heat factor (POP et al., 1986; MILICA DIMA, 2006), it was established that only early varieties of peanuts can be grown in Romania and only in the South of the country where the annual average temperature is over 10°C, an average daily temperature over 12°C is achieved for 140-163 days, and the temperature sum exceeds 2800°C. During the experiment, the average monthly temperatures were higher in 2018 compared to 2019. The peanut plants in the experimental field have undergone the main vegetation phases in different climatic conditions recorded at the RDSFCS Dabuleni meteorological station.

Figure 1 presents the climatic data for the peanut vegetation period (April-September) 2018-2019. For the months of April and May, the temperature amplitudes recorded in the air for the period 2018-2019 are shown (Table 1). The climatic conditions registered at the meteorological station of RDSFCS Dabuleni characterize the studied years as warm ones, with higher values of the average monthly temperature during the vegetation period (April-September), compared to the multiannual data. (Fig. 1).

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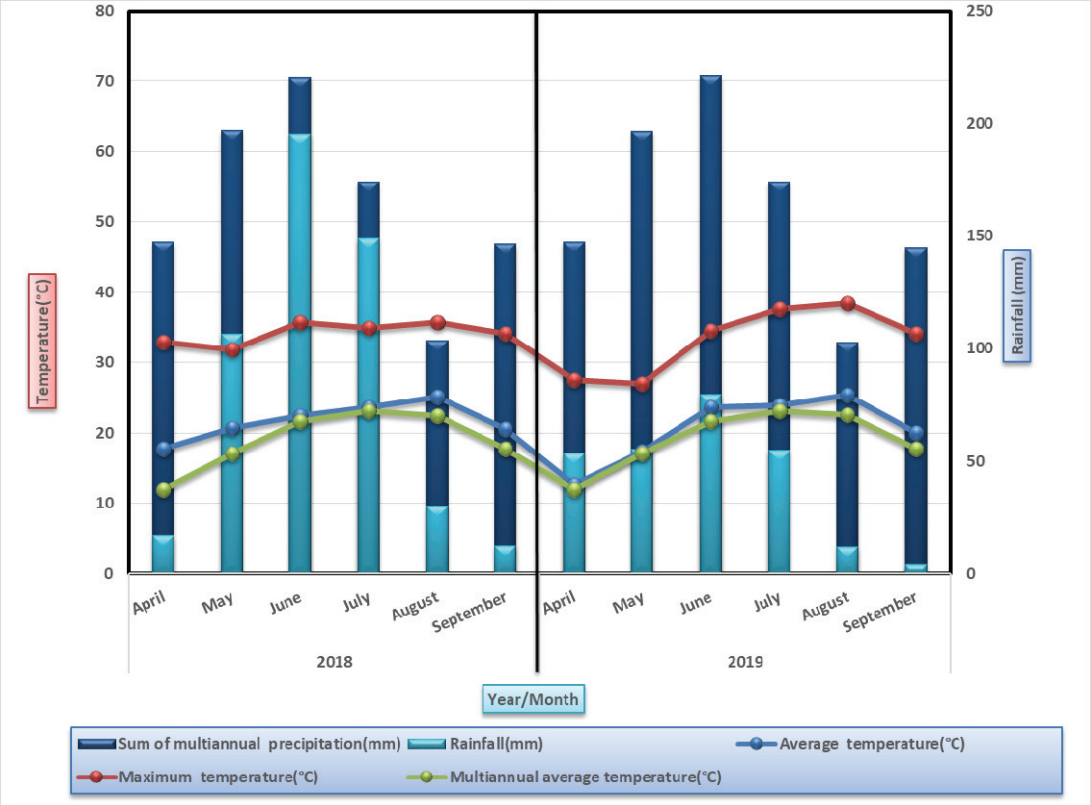

Figure 1. Climatic conditions between April and September (2018-2019)
recorded at the weather station a RDSFCS Dăbuleni.

Unlike other type of soils, the sands by their nature have the property to warm and cool easily, giving rise to large fluctuations in temperature between day and night. These large temperature fluctuations occur especially during April and May (Table 1), having negative repercussions on seed germination and on the development of young plants.

Precipitation is one of the decisive factors on plant life. These are important in terms of annual quantity, but especially regarding the amount recorded during the vegetation period of the plants and their monthly distribution.

The analysis of the data from Figure 1 shows differences in terms of monthly precipitations, especially during the summer, as 2019 had scarce precipitations. The water deficit during the vegetation period was compensated by irrigation.

Table 1. The amplitude of the temperatures recorded in the air during the sowing – rising period for peanuts.

Specification		Temperature range(^{0}C)	
Month	Decade	2018	2019
April	I	12.0-17.1	9.9-14.7
	II	13.2-20.0	9.1-13.0
	III	17.7-22.4	12.1-17.9
May	I	19.9-23.8	11.4-17.8
	II	16.1-20.7	13.6-22.0
	III	20.3-22.1	16.8-22.7

The number of pods/plant is an element of productivity that varies depending on the genotype and the conditions of growth and development. It can be influenced by air and soil temperature during the vegetation period, and high temperatures negatively affect the productivity elements. Peanut genotypes differ depending on their sensitivity to high temperatures (Table 2).

Table 2. Biometric determinations on productivity elements in the peanut genotypes studied.

Genotype	Number of pods/plant			Weight of the pods/plant(g)			Mass of thousand grains (g)		
	2018	2019	Average (2018-2019)	2018	2019	Average (2018-2019)	2018	2019	Average (2018-2019)
Dăbuleni (Control)	28.7	25.6	27.1	84.1	66.3	75.2	782	702.5	742.2
Viviana	25.7	27.4	26.5	77.3	76.7	77.0	898.0	775.0	863.5
HYY 1	38.2	29.3	33.7 **	107.3	75.9	91.6 ***	980.2	905.8	943.0 ***
HYY 2	37.5	29.0	33.2**	103.5	73.1	88.3 **	935.0	886.0	910.5***
HYY 3	28.7	29.3	29.0	80.6	69.3	74.9	875.3	792.0	833.6**
Viorica	32.0	27.0	29.5	77.1	62.1	69.6	890.6	755.0	822.8*
Prov. China1	28.6	22.6	25.6	80.4	55.9	68.1	870.0	800.0	835.0**
Prov. China2	34.0	28.8	31.4*	95.2	86.0	90.6 ***	910.6	826.4	868.5***
Ning	29.8	25.3	27.5	83.7	80.5	82.1	895.0	780.2	837.6**
Henan Province	39.4	30.3	34.8 ***	98.7	82.3	90.5 ***	920.6	850.0	885.3***
LSD5%=			3.7			7.3			64.8
LSD1%=			5.1			10.1			88.9
LSD0.1%=			7.0			13.7			121.1

Some authors (ISHAG, 2000; KABA et al., 2014) showed that, in the peanut plants, the flowering and the formation of the pods continues for a long time during the vegetation period. The number of flowers that form on a plant is very high, but only 15% of flowers produce mature pods (LIM & HAMDAN, 1984). Temperatures above 34^{0}C affect pollen viability, reduce the number of fertilized flowers, the number of shoots / plant and the mass of 1000 grains (PRASAD et al., 1999).

The number of pods/plant differed between genotypes in 2018 and 2019, the Chinese genotype HYY1 and Henan Province recorded a very significant number of pods/plant, respectively significantly different from the control (Dabuleni). The average number of pods/plant in the 10 genotypes studied was higher in 2018 and decreased in 2019. Higher temperatures from July-August 2019 had a negative effect on the number of pods/plant, for this reason, the number of pods/plant was lower in 2019.

Regarding the weight of the pods/plant, the average weight of pods/plant was lower in 2019.

Analysing the interaction of genotype x year on the weight of pods, HYY1, origin China 2 and Henan Province genotypes showed very significant differences, and the HYY2 genotype registered a distinct significant difference compared to the control Dabuleni.

The high temperature of the air and soil had negative effects on the weight of the pods/plant.

The mass of thousand grains is another element of productivity. The highest value of thousands of grains was recorded by the HYY1 variety in both 2018 and 2019 (Table 2).

All the studied genotypes were affected by high temperatures during the development period of the pods. The genotype x year interaction on the mass of thousand grains shows that almost all varieties recorded very significant and distinctly significant differences from the control.

Regarding to the average production of pods / ha there were differences, but statistically insignificant, except for the HYY1 variety which registered a significant increase in production, of 984 kg/ha compared to the control (Table 3).

The yield of production was affected by the temperature higher than 35°C recorded in July-August. The maximum air temperature of 37.6°C and 38.4°C from July and, respectively, August 2019 (Table 1) significantly reduced the number of mature seeds and the production of pods.

Table 3. The producetion of pods in the studied peanut genotypes.

Genotype	Production of pods(kg/ha)			Relative production (%)	The difference from the witness (kg/ha)	Significance
	2018	2019	The average production (kg/ha)			
Dăbuleni (Control)	5046	3978	4512	93.0	Control	
Viviana	4638	4602	4620	95.2	+108	
HYY 1	6438	4554	5496	113.3	+984	*
HYY 2	6210	4386	5298	109.2	+786	
HYY 3	4836	4158	4497	92.7	-15	
Viorica	4626	3726	4176	86.1	-336	
Prov.China1	4824	3354	4091	84.3	-421	
Prov.China2	5712	5160	5436	112.1	+924	
Ning	5022	4830	4926	101.6	+414	
Henan Province	5922	4938	5430	112.0	+918	
LSD5%=					960 kg/ha	
LSD1%=					1310 kg/ha	
LSD0,1%=					1790 kg/ha	

Our results support the observations of other authors (KETRING, 1984; PRASAD et al., 1999) which indicated that the average optimum temperature for the vegetative growth of peanut plants is between 25 and 30°C, while for the growth and development of the pods it is between 20 and 25°C.

CONCLUSIONS

The cultivation of peanut genotypes tolerant to heat stress is becoming increasingly important for high yields.

The maximum air temperature of 37.6°C and 38.4°C from July and, respectively, August 2019 significantly reduced the number of mature seeds and the production of pods.

Among the studied genotypes, HYY1, HYY2, Provenance China 2, Henan Province genotypes proved to be tolerant to thermal stress and obtained the highest values for some elements of productivity and yields that exceeded 5000 kg/ha.

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Dima Milica, Diaconu Aurelia, Drăghici Reta, Croitoru Mihaela
Research and Development Station for Field Crops on Sandy Soils Dăbuleni
217 Petre Banita street, 207220, Dolj County, Romania.
E-mails: milicadima@yahoo.com, aureliadiaconu@yahoo.com, retadraghici@yahoo.com, mhlcroitoru@yahoo.com

Sturzu Rodica
Agricultural Research and Development Station Teleorman
110 Alexandria street, 147135, Teleorman County, Drăgăneşti Vlaşca, Romania.
E-mail: rodicasturzu@yahoo.com

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