NARDI FUNDULEA, ROMANIA ROMANIAN AGRICULTURAL RESEARCH, NO. 42, 2025
www.incda-fundulea.ro; doi.org/10.59665/rar4259 First Online: May, 2025. DII 2067-5720 RAR 2025-167

Results on the Correlation between Flowering and Productivity in Some Peanuts Genotypes Grown On Sandy Soils in Southern Oltenia

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ABSTRACT

Field experiment was conducted to evaluate the vegetative growth, main productivity elements and the production of eight peanuts genotypes grown on sandy soils and to assess relationships among their yield components. The experiments were carried out in the period 2021-2022 at the Research Development Station for Plant Culture on Dăbuleni Sands. The results showed that the percentage of flowers transformed into gynophores and the percentage of gynophores transformed into pods were characteristics that contribute to the increase of production in peanuts grown on sandy soils. The total number of flowers per plant was negatively correlated with the percentage of flowers transformed into gynophores and pods, while the percentage of flowers transformed into gynophores and pods were positively correlated with pod production. The highest pod production was obtained in the Viviana genotype which had the lowest number of flowers per plant and the highest percentage of flowers that developed into pods.

Keywords: peanuts, sandy soils, production, pods.

INTRODUCTION

Peanuts (*Arachis hypogaea* L.) are considered one of the most important oil crops worldwide with 25.2 million hectares and an annual world production of peanuts of 45.2 million tons (FAO, 2013). The groundnut crop is the second most important cultivated food legume and the fourth largest edible oilseed crop in the world (Shilman et al., 2011). The expansion of this culture all over the world was due to the multiple and valuable uses that peanuts have for food, feed and industry.

Peanut seeds are an important source of proteins, lipids and fatty acids for the food industry. It is an important source of edible oil and protein for human consumption (Gulluoglu, 2011; Arioglu et al., 2000; Chamberlin et al., 2014; Chowdhury et al., 2015). Peanut kernels have an oil content of 47-50% (Sanders, 2002). They contain palmitic, oleic and linoleic acids, representing about 90% of the total fatty acids at maturity of the seeds (Young and Waller, 1972). Peanut seeds with high oleic acid provide a lower oxidation rate resulting in greater marketing acceptability (Mozingo et al., 2004).

On sandy soils in the south of Oltenia, peanuts find favorable eco-pedological conditions for growth and fruiting, conditions that allow the cultivation of this species with good results (Mitrea, 1993).

Considering the climate and soil conditions in the area of sandy soils in the south of Romania, in Oltenia it is necessary to use early varieties with high production capacity for economic efficiency.

Peanut genotypes differ in the number of flowers, gynophores and pods. Bell et al. (1991) reported that peanut cultivars showed a wide range of reproductive traits at different developmental stages. Although reproductive development is important for pod production, early vegetative development

Received 23 April 2025; accepted 19 May 2025.

regulates reproductive capacity (Awal and Ikeda, 2003). Gardner and Auma (1989) demonstrated that some peanut cultivars with pods spread outside the parcel influenced pods production compared to cultivars with pods clustered near the parcel, and that cultivars with pods spread higher vegetative and reproductive growth rates significantly higher than varieties with clustered pods. Number of flowers, gynophores and pods are the most important quantitative traits affecting yield potential in peanut (Awal and Ikeda, 2003).

After pollination and fertilization, the corolla closes, the calyx tube bends, the flower withers, and then the gynophore forms. When the gynophore reaches its maximum depth in the soil, it stops growing and the pod begins to develop. The pod continues to grow, reaching maximum size after the gynophore penetrates the soil. It is well known that peanuts produce several flowers, but not all of them produce pods. Ishag (2000), Jordan et al. (2008) and Kaba et al. (2014) reported that peanuts have indeterminate growth type and that the plants produced many flowers during the growing season, but only 15-20% of the flowers produced mature pods. Young et al. (1982) reported that total pod production increased continuously with growing season.

Caliskan et al. (2008) reported that dry matter accumulation in the plant continued until maturity, although the rate of accumulation differed by genotype and plant age. Generally, there are 3 stages of grain development. The first is a rapid growth phase with simultaneous increase in fresh and dry weight. In the second phase, the rate of increase in dry weight is often stable, but the moisture content of the grain begins to decrease. Then, the beans lose their moisture during the ripening phase and the dry weight changes (Coolbear, 1994; Moctezuma, 2003).

The aim of this study was to evaluate the vegetative growth, some reproductive characteristics that can influence the production of several peanut genotypes grown on the sandy soils of southern part of Romania in Oltenia area.

MATERIAL AND METHODS

The experiment was layed out in the field at RDSPCS Dăbuleni, located in the south of Romania (Oltenia), on a sandy soil low in nitrogen (0.02-0.06%), medium to well supplied with phosphorus (24-107 ppm) and poorly supplied with exchangeable potassium (15-38 ppm). The organic carbon content was low (0.07-0.49%), characteristic of sandy soils, and the soil reaction was moderately acidic to neutral (pHH_2O=6.36-7.10) ha^{-1}.

Eight genotypes of groundnut in the field were studied in three replications on a randomized block design trail.

The size of each plot was 6.3 m^2 (2.1 x 3.0 m). Row spacing was 0.7 m and plant spacing per row was 0.18 m, giving a seeding density of 7.9 plants/m^2.

Fertilization was done with 500 kg/ha of complex fertilizers (15% N, 15% P, 15% K) before sowing and in vegetation at the beginning of flowering with 200 kg/ha of ammonium nitrate. Weed control was done with pendimetalin - 4 l/ha applied pre-emergence (immediately after sowing), in the vegetation through two mechanical harrows and post-emergence herbicides with *fluazifop-P-butil* - 2 l/ha + imazamox / bentazon - 0.25 l/ha. In order to supplement the water deficit in the soil during the growing season, the culture was irrigated by sprinkling. During the vegetation period observations and determinations were made on emergence, flowering and the number of flowers, gynophores and pods per plant were counted and recorded. The percentage of flowers transformed into gynophores, the percentage of flowers transformed into pods and the percentage of gynophores transformed into pods were calculated for each genotype. At harvest, the biometric determinations were made on the number of pods per plant and the production of pods/ha was determined at a humidity of 9%.

Monthly air temperature and precipitation were recorded for studied years at the weather station at the Research Development Station for Plant Culture on Dăbuleni.

The experimental data were processed statistically by the analysis of variance (ANOVA) method.

Probability level P<0.05 was taken to indicate statistically significant differences. Correlation coefficients between pod production and some productivity elements were calculated.

RESULTS AND DISCUSSION

The growth and development of productivity elements in peanuts is influenced by environmental factors. High air temperature from the beginning of flowering or pod formation to maturity significantly reduces pod number and consequently pod production (Ketring, 1984; Prasad et al., 1999, 2000, 2001).

High temperature and low humidity can severely impact the flowering response, limiting the number of flowers produced and reducing flower pollination (Beasley, 1990). Also, temperatures above 38°C that persist for a longer period of time lead to the inactivity of nitrogen fixing bacteria or their non-existence, a fact that is reflected in the reduction of the number of nodules per plant, and finally in the reduction of the production yield.

The climatic elements recorded to the meteorological station of RDSPCS Dăbuleni that had an influence on the peanut culture during their vegetation period are presented in Table 1.

In 2021 the average monthly air temperatures during the growing season were close to the multiannual average temperatures of the respective months during the growing season. In 2022 the average temperature during the growing season exceeded the multiannual average temperature of the growing season by 1.3°C. Regarding the precipitation during the growing season, in both years the amount of precipitation was lower than the multiannual amount. The insufficient amount of precipitation in the summer months was supplemented by irrigation.

Table 1. Climatic elements recorded at the Meteorological Station of RDSPCS Dăbuleni during the peanut vegetation period (2021-2022)

Years/ Months		Apr	May	Jun	July	Aug	Sept	Oct	Total/ Average/ Sum
Average monthly temperature (°C)	2021	9.72	17.6	21.7	25.7	24.6	18.3	10.0	18.2
	2022	11.7	18.3	22.9	25.2	25.1	17.9	13.3	19.2
Multiannual average temperature (1956-2022)		11.88	16.95	21.55	23.29	22.66	17.9	11.5	17.9**
Sum monthly precipitations (mm)	2021	30.6	55.0	53.0	16.8	9.0	9.2	133.0	306.6
	2022	73.6	38.4	67.4	15.0	49.4	56.4	18.6	318.8
Multiannual sum precipitations (1956-2022)		46.97	62.39	69.83	54.00	36.76	44.9	43.52	358.37*

Source of dates: RDSPCS Dăbuleni weather station; *sum; **mean.

According to biological properties, the first flowers appear depending on the date of sowing and the climatic conditions of the period after sowing. Flowering began 22-25 days after the plants emerged and then continued throughout the summer until mid-August.

The transition period from one phenological stage to another was different between genotypes. Time from emergence to flowering also varied between genotypes. Flowering started 27-30 days after emergence and continued until the end of growing season in both years of experimentation (Table 2).

After the appearance of the first flowers, the number of flowers gradually increased, then flower production decreased steadily with time and continued until maturity due to the indeterminate growth type of peanut plants.

Table 2. Phenological observations of the studied genotypes

Genotype	The sowing-emergence interval (days)	The emergence-flowering interval (days)	The emergence- occurrence gynophore interval (days)
Dăbuleni	20	22	27
Viviana	19	22	27
Brâncoveana	18	22	27
Tâmburești	19	25	30
Velican	19	24	29
L3/15	20	22	27
L5/18	20	22	27
HYY 1	19	24	29

Genotype L3/15, which has a decumbent growth type, produced the highest number of flowers per plant, while Viviana produced the lowest number of flowers per plant. Genotype L3/15 produced an average of 890 flowers per plant, while Viviana produced only 348 flowers per plant (Table 3). Depending on the genotype, gynophore formation began approximately 27 to 30 days after emergence. The number of gynophores increased steadily throughout the growing season and slowed near harvest. The L3/15 genotype produced the highest number of gynophores per plant, while the lowest number of gynophores was obtained in Viviana genotype (Table 3). Pod formation for all genotypes started about 42-45 days after emergence, then increased until 120 days after emergence, after which it decreased near harvest. Depending on the genotype, the number of pods per plant is different. The L3/15 genotype produced more pods per plant than the other genotypes (Table 3).

Table 3. Some productivity characteristics of the studied genotypes (average of experimental years)

Genotype	Total number of flowers/plant	Total number of gynophores/plant	Total number of pods/plant
Dăbuleni	680	216	58
Viviana	348	145	45
Brâncoveana	593	140	50
Tâmburești	750	208	54
Velican	860	205	60
L3/15	890	265	63
L5/18	810	200	54
HYY 1	737	180	46
Average	708.5	194.8	53.75
LSD 5%	14.1	4.9	4.3

Regarding pod production and some productivity elements, there were significant differences (Table 4). The total number of gynophores and pods of genotype L3/15 was higher than that of the other genotypes due to higher flower production. The high number of flowers produced by genotype L3/15 is a consequence of the type of branching. Although Viviana produced the least amount of flowers, gynophores and pods, the percentage of flowers transformed to gynophores and the percentage of flowers transformed to pods was higher than the other genotypes. Viviana genotype, which had the lowest number of flowers, gynophores and pods, had the highest pod production. Peanut genotypes produce more flowers than the plants can support and turn into pods. The average results obtained show that 26.2% of the flowers formed only gynophores and 7.5% produced pods. The average production of pods was 4680 kg/ha, the variety Viviana obtaining the highest production of pods of 5900 kg/ha (Table 4).

Table 4. Some elements of productivity and pod production in the studied genotypes

Genotype	Percentage of flowers transformed into gynophores (%)	Percentage of flowers converted into pods (%)	Percentage of gynophores transformed into pods (%)	Yield of pods (kg/ha)		
				2021	2022	Average "21-22"
Dăbuleni	30.5	8.5	27.5	3435	4005	3720
Viviana	41.8	12.8	29.2	5788	6012	5900
Brâncoveana	24.1	9.0	35.2	4447	4953	4700
Tâmburești	28.7	7.5	26.0	4362	4638	4500
Velican	23.5	7.5	30,2	3817	4183	4000
L3/15	18.5	4.5	23.5	4723	4657	4690
L5/18	18.0	4.2	26.3	5320	5880	5600
HYY 1	24.8	6.0	25.6	4131	4525	4328
Average	26.2	7.5	27.9	4503	4857	4680
LSD 5%	1.2	1.0	2.6	395	366	381

The percentage of flowers transformed into gynophores was negatively correlated with the total number of flowers, gynophores and pods and this was positively correlated with pod production (r=0.345) but insignificantly. According to the results, the percentage of flowers transformed into pods was negatively correlated with the number of flowers, gynophores and pods. The total number of pods was positively but insignificantly correlated with the percentage of gynophores transformed into pods. In addition, pod production was positively correlated with the percentage of flowers converted to pods (Table 5).

Table 5. Correlation coefficients between production and some productivity traits in the peanut genotypes studied (average of experimental years)

Productivity elements	Total number of flowers	Total number of gynophores	Total number of pods	Yield of pods (kg/ha)
Percentage of flowers transformed into gynophores	-720**	-0,512*	-0,452	0,345
Percentage of flowers converted into pods	-0,835**	-0,672**	-0,300	0,335
Percentage of gynophores transformed into pods	-0,421	-0,548**	0,252	0,032

*P≤0.05; **P≤0.01.

Total flower number of peanut genotypes was not an indicator of higher pod yield. The significant and negative correlations between number of flowers and the ratio of flowers to gynophores and the ratio of flowers to pods confirmed this finding. The peanut plant has an indeterminate growth type, the flowering and fruiting of the crop takes place over a long period of time. Flowering of the peanut genotypes occurred over a period of about 17 weeks, with maximum production at about 13 weeks after sowing. Therefore, at the end of the growing season, there were some mature pods but also immature pods. Those immature pods are not economically justified, therefore varieties with fewer flowers and a higher percentage of flowers converted to gynophores and percentage of gynophores converted to pods are best suited for cultivation in the sandy soil zone.

CONCLUSIONS

The higher pod production obtained is not reflected by the higher number of flowers, gynophores and pods per plant.

The Viviana genotype with the highest production, had the lowest total number of flowers, gynophores and pods and the highest percentage of flowers transformed into pods and percentage of gynophores transformed into pods, among the studied genotypes.

The results obtained show that the percentage of flowers transformed into pods, the percentage of gynophores transformed into pods could be used in breeding programs as selection criteria, since they were positively correlated with the obtained pod production.

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