OPEN ACCESS

Middle East Research Journal of Agriculture and Food Science
ISSN: 2789-7729 (Print) & ISSN: 2958-2105 (Online)
Frequency: Bi-Monthly
DOI: 10.36348/meriafs.2022.v02i01.001

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Research on Physiological Parameters of Some Peanuts Varieties (*Arachis hypogaea* L.) with Different Yields Grown in Vietnam

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Abstract: Analysis of the physiological parameters of some peanut varieties to find out the difference between them is one of the methods contributing to the prequalification of high-yielding varieties with good quality and good tolerance to harsh conditions and environmental disadvantages. This paper presents research results on some physiological parameters of high-yielding and low-yielding peanut varieties planted in Thanhhoa province, Vietnam. Experimental results have grouped peanut varieties according to actual yield into two groups: high-yielding group: L26, L18, and L08 (L26: 38.05 quintal/ha, L18: 35.42 quintal/ha, L08: 34.75 quintal/ha), low yielding group: L12, L23, and L14 (L12: 27.11 quintals/ha, L23: 29.92 quintals/ha, L14: 30.41 quintals/ha). The high-yielding peanut varieties showed some better physiological parameters than the low-yielding varieties, typically in photosynthetic intensity, accumulated dry matter, transpiration intensity, stomatal conductivity, leaf area, and chlorophyll content. This result is the basis for prequalifying high-yielding peanut varieties based on the difference in some physiological parameters during growth and development.

Keywords: Physiological parameters, peanut, yield.

Research Paper

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How to cite this paper:
Le Van Trong *et al* (2022). Research on Physiological Parameters of Some Peanuts Varieties (Arachis hypogaea L.) with Different Yields Grown in Vietnam. *Middle East Res J. Agri Food Sci.*, *2*(1): 1-6.

Article History:
| Submit: 19.11.2022 |
| Accepted: 24.12.2022 |
| Published: 28.12.2022 |

1. INTRODUCTION

Peanut (*Arachis hypogaea* L.) is an annual legume crop and grown widely as an essential oilseed plant (Smart, J. 1994; Kalariya *et al.*, 2013) originating from South America, this is a short-term industrial plant with high economic value. Compared with other industrial crops, the peanut is a short-seasoned crop and has strong adaptability and high productivity in different soil types, moisture levels, temperatures, and cultivation methods (Nigam, S. R. *et al.*, 1998; Tavora, F. A. J. F. *et al.*, 2002). Furthermore, peanut plays an essential role in soil improvement due to their legume nitrogen fixation in root nodules (Dakora, F. D. *et al*. 1997). Peanut is a major oil seed crop grown in the tropics and sub-tropic parts of the world.

In Vietnam, peanuts play an important role in the agricultural structure, especially in areas where the climate is often fluctuating and farming conditions are difficult. Peanuts are grown in all agroecological regions in our country with many different varieties (Chu, T. T. *et al.*, 2006). Therefore, it is necessary to research to find high-yielding peanut varieties suitable to local conditions.

Peanut is one of many plants that have been studied to create varieties with good characteristics in terms of yield and tolerance. Each variety has a different yield or tolerance with different physiological and metabolic characteristics, which are shown in physiological and biochemical characteristics. That allows us to be able to rely on the difference in physiological and biochemical parameters of different high- and low-yielding peanut varieties to select high-yielding, good-seeded varieties that are adaptable to the natural conditions of the specific region. On that basis, we conducted a study on some physiological parameters of high- and low-yielding groundnut varieties grown in Thanhhoa, Vietnam to find out the differences in their physiological characteristics that contribute to the pre-qualification high-yielding peanut varieties with good quality.

2. RESEARCH MATERIALS AND METHODS

2.1. RESEARCH MATERIALS

Research and analysis of 06 different peanut varieties grown in Thanhhoa province, Vietnam: L08, L12, L14, L18, L23, and L26. Varieties imported from China and hybridized at the Vietnam Institute of Agricultural Sciences are provided by the Center for

Research and Development of Beans - Vietnam Academy of Agricultural Sciences.

Figure 1: Some peanut varieties are grown in Thanhhoa province, Vietnam

Experiments to analyze some physiological parameters were conducted at the laboratory of the Department of Biology - Hong Duc University, and the laboratory of the Department of Plant and Applied Physiology - Hanoi National University of Education.

2.2. Research methods

Photosynthetic intensity, transpiration intensity, stomatal conductance, and leaf area were determined by the photosynthetic intensity meter CI-340 manufactured in the US.

Leaf pigment content

Fresh groundnut leaf samples were frozen in liquid nitrogen and then ground into powder. A total of 5 mg of the powder and 100 µL of distilled water were put into a test tube and left still for 10 min. A total of 8 mL of acetone, 80% was added for chlorophyll extraction. Centrifugation was conducted to extract the filtrate (10 mL) and the optical density was measured at corresponding wavelengths: E663, E644, and E440.5 nm. The pigment content was determined using optical density measurement results (Le, V. T. *et. al.*, 2020).

Dry matter content

With treatments for each variety, three plants were collected randomly and placed into plastic bags to avoid dehydration. They were then brought to the laboratory where their initial fresh weights were measured. Next, weighed plants were put into a drying oven at the temperature of 105°C until they reached unchangeable weights, thereby determining the mass of dry matter (Le, V. T *et al.*, 2020).

Some indicators constituting yield and yield of some peanut varieties were determined by electronic balance with an accuracy of 10^{-4}.

Statistical analysis

All indicators were conducted three times independently. The results are expressed as mean values and standard deviation (SD). Statistical processing of results was performed by IRRISTAT software package, version 5.0.

3. RESULTS AND DISCUSSION

3.1. Yield and yield components of some peanut varieties

In terms of weight of 100 pots, the L26 variety had the highest average weight of 184.12g, the L18 variety reached 180.36g, the L08 variety reached 175.19g, and the L12 variety the lowest reached 149.25g. In terms of the weight of 100 seeds, the highest was L26 with an average of 67.28g, followed by L08 with 66.14g, while L12 still reached the lowest value of 56.23g. Varieties with a high mass ratio of unshelled peanuts such as L26, L18, and L08, these varieties have relatively high yields, of which the L26 variety has the highest yield of 38.05 quintals/ha, followed by L18 with 35.42 quintals/ha and L08 with 34.75 quintals/ha. In contrast, some varieties like L12, L23, and L14 have a low weight of 100 pods, weight of 100 seeds, the mass ratio of unshelled peanuts, number of pods per plant and final yield are all lower than L26, L18, and L08 varieties in which the peanut variety L12 achieved the lowest yield of 27.11 quintals/ha, followed by L23 with 29.92 quintals/ha and L14 with 30.41 quintals/ha.

Table 1: The yield and yield components of some peanut varieties

Peanut varieties	**Weight of 100 pods (*g*)**	**Weight of 100 seeds (*g*)**	**The mass ratio of unshelled peanuts (*%*)**	**Number of pods per plant (*pods*)**	**Converted yield (*quintals/ha*)**
L12	$149.25^{c} \pm 1.52$	$56.23^{c} \pm 1.48$	$68.36^{b} \pm 0.68$	$13.11^{c} \pm 0.70$	$27.11^{c} \pm 0.36$
L23	$160.17^{b} \pm 2.14$	$59.75^{b} \pm 1.49$	$69.15^{b} \pm 1.20$	$16.21^{b} \pm 1.28$	$29.92^{b} \pm 0.27$
L14	$162.39^{b} \pm 0.91$	$62.17^{b} \pm 0.69$	$70.56^{b} \pm 0.56$	$15.92^{b} \pm 1.29$	$30.41^{c} \pm 0.19$
L08	$175.19^{a} \pm 0.80$	$66.14^{a} \pm 1.39$	$71.02^{a} \pm 0.06$	$18.06^{a} \pm 0.15$	$34.75^{b} \pm 0.12$
L18	$180.36^{a} \pm 1.87$	$65.42^{a} \pm 1.19$	$71.27^{a} \pm 0.76$	$18.27^{a} \pm 0.87$	$35.42^{b} \pm 0.21$
L26	$184.12^{a} \pm 1.10$	$67.28^{a} \pm 0.78$	$71.19^{a} \pm 1.19$	$19.02^{a} \pm 1.11$	$38.05^{a} \pm 0.16$

In the same data column, values with similar letters represent non-significant differences, values with different letters represent significant differences ($p < 0.05$).

Research results show that there are significant differences in yield components of high-yielding and low-yielding varieties, this result is consistent with the study of Nguyen, T. T. H. *et al.*, (2011). These studies have shown that the lines and varieties with a total number of pods per plant are large, high weight of 100 pods, high mass ratio of unshelled peanuts and good growth and development giving high yields in both spring and autumn crops.

3.2. Photosynthetic intensity and dry matter accumulation

Photosynthesis is a physiological process closely related to crop yield (Kalariya *et al.*, 2013), photosynthesis capacity depends on many factors such as intensity and duration of light, the water content in leaves, chlorophyll content and other physiological processes in plants (Nguyen, N. K. *et al.*, 2012). Photosynthetic intensity indicates the photosynthetic activity of plant populations (Richards A., 2000), this indicator varies greatly depending on varieties, different organs, growth and development stages, plant growth, and environmental conditions (Lincoln, T. *et al.*, 2010).

Table 2: The photosynthetic intensity and dry matter weight of some peanut varieties

Peanut varieties	Photosynthetic intensity ($\mu mol/m^2/s$)	Dry matter content (g)
L12	$22.72^c \pm 0.29$	$23.18^c \pm 0.12$
L23	$23.81^c \pm 0.17$	$23.67^c \pm 0.07$
L14	$25.38^b \pm 0.24$	$24.84^b \pm 0.16$
L08	$25.74^b \pm 0.32$	$25.31^b \pm 0.31$
L18	$25.91^b \pm 0.37$	$25.19^b \pm 0.14$
L26	$26.46^a \pm 0.30$	$27.87^a \pm 0.15$

In the same data column, values with similar letters represent non-significant differences, values with different letters represent significant differences (p < 0.05)

Table 2 shows that high-yielding varieties such as L26, L18, and L08 have higher photosynthetic intensity and dry matter accumulation than low-yielding varieties L12, L23, and L14. The intensity of photosynthesis and dry matter accumulation of the L26 variety reached 26.46 $\mu mol/m^2/s$ and 27.87g, the L18 variety reached 25.91 $\mu mol/m^2/s$ and 25.19g, the L08 variety reached 25.74 $\mu mol/m^2/s$ and 25.31g. The peanut varieties L12, L23, and L14 had the lowest photosynthetic intensity and dry matter weight, the photosynthetic intensity index and dry matter weight of the L12 variety was the lowest at 22.72 $\mu mol/m^2/s$ and 23.18g, followed by the L23 variety reached 23.81 $\mu mol/m^2/s$ and 23.67g.

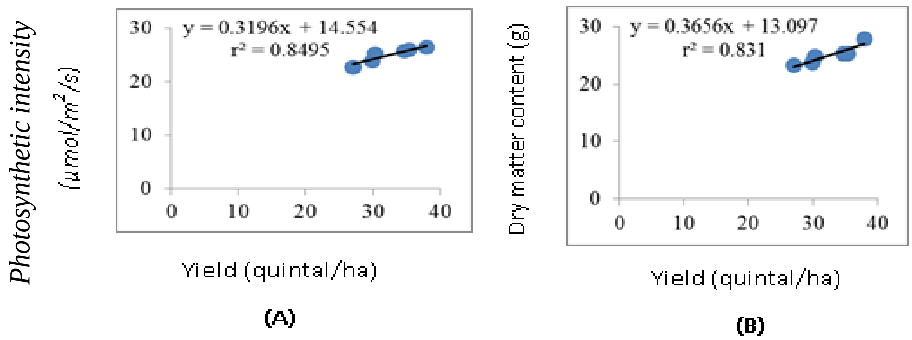


Figure 2: Correlation between photosynthetic intensity, dry matter and yield of some peanut varieties

In high-yielding cultivars, higher photosynthetic indices resulted in faster dry matter accumulation. This is because photosynthesis will produce a large amount of dry matter in the plant, while the high rate of dry matter accumulation before flowering is significant in producing more semi-structural carbohydrates in stems and leaves, semi-structured carbohydrates and semi-structured carbohydrates. This structure is positively correlated with the rate of semi-structured carbohydrate transport to the fruit at an early stage in seed hardening (Takai *et al.*, 2006). The varieties L26, L18, and L08 belonging to the high-yielding group had higher dry matter accumulation than the low-yielding varieties L12, L23, and L14. The results are in agreement with the results of Nageswara Rao *et al.* (1989), who observed that increased biomass production contributed to higher yields.

The study of photosynthesis parameters and accumulated dry matter mass of peanut varieties with high and low yield showed that these two parameters have a close correlation with yield (shown in the correlation graph in Fig 2), in that photosynthetic intensity was more closely related to yield ($r^2 = 0.8495$) (A) than dry matter weight ($r^2 = 0.831$) (B).

3.3. Evaporation intensity and stomatal conductivity

The transpiration in the leaves creates the upper driving force of water absorption and lowers the temperature of the leaves so that the leaves are not heated by sunlight, especially when transpiration takes place, the stomata open. creating conditions for CO_2 to easily diffuse inward and O_2 to escape to the outside to facilitate the photosynthesis of plants (Lincoln, T. *et al.*, 2010), this is the basis for increasing biomass and is a prerequisite for increasing crop yields. The high-yielding varieties (L26, L18, L08) had higher transpiration intensity and stomatal conductivity than the low-yielding varieties (L12, L23, L14) through the growth and development stages.

Table 3: Transpiration intensity and stomatal conductivity of some peanut varieties

Peanut varieties	Transpiration intensity ($mmol/m^2/s$)	Stomatal conductivity ($mol/m^2/s$)
L12	$9.64^c \pm 0.06$	$0.55^b \pm 0.01$
L23	$9.75^c \pm 0.09$	$0.52^b \pm 0.03$
L14	$9.58^c \pm 0.09$	$0.58^b \pm 0.01$
L08	$10.84^b \pm 0.09$	$0.67^a \pm 0.02$
L18	$10.75^b \pm 0.03$	$0.65^a \pm 0.02$
L26	$11.06^a \pm 0.08$	$0.68^a \pm 0.04$

In the same data column, values with similar letters represent non-significant differences, values with different letters represent significant differences ($p < 0.05$)

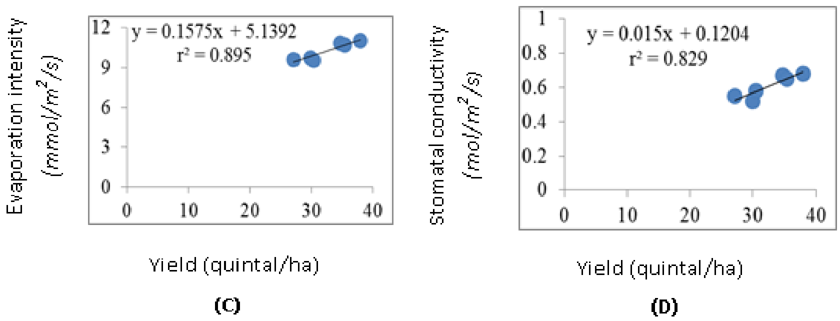


Figure 3: Correlation between transpiration intensity, stomatal conductivity and yield of some peanut varieties

The data in table 3 shows that the L26 variety has a transpiration intensity index and stomatal conductivity index of 11.06 $mmol/m^2/s$ and 0.68 $mol/m^2/s$, respectively, followed by the L08 variety with 10.84 $mmol/m^2/s$ and 0.67 $mol/m^2/s$ respectively, the lowest still is the L12 variety with indexes at this stage of 9.64 $mmol/m^2/s$ and 0.55 $mol/m^2/s$ respectively. Strong or weak transpiration largely depends on stomatal opening and closing, so both indices are positively correlated.

The results of the correlation assessment show that these two parameters are related to peanut yield, in which the intensity of transpiration is more closely related to the yield with $r^2 = 0.895$ (C) compared to the stomatal conductivity $r^2 = 0.829$ (D) (Fig 3).

3.4. Leaf area and chlorophyll content

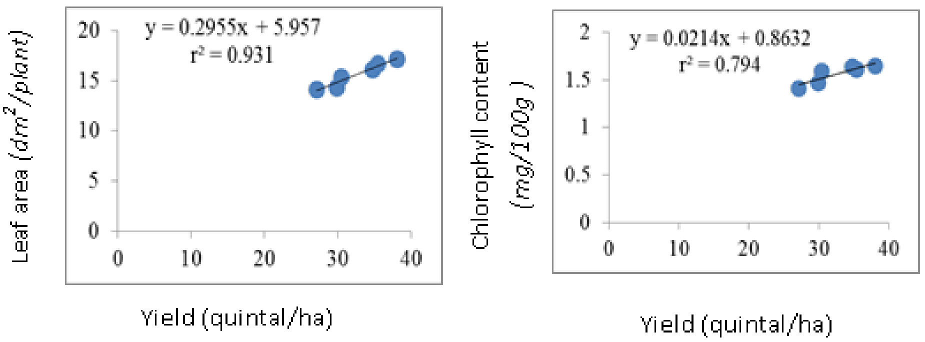
Leaves are photosynthetic organs, in leaves, there are chloroplasts with photosynthetic pigment systems that absorb light energy and transfer the absorbed energy to the dark phase to fix CO_2 to create organic matter for plants. Therefore, leaf area is an indicator closely related to photosynthesis intensity, chlorophyll content, and chlorophyll density. Leaf area reflects photosynthetic capacity and biomass production (El Hafid *et al.*, 1998), and photosynthesis is also closely related to biomass production in most crops (Anyia *et al.*, 2004). The leaf area and chlorophyll content of the varieties increased gradually from the pre-flowering stage to the full-blooming stage - irradiation accurately reflected the change of photosynthetic intensity and dry matter accumulation capacity of the plant.

Table 4 shows that high-yielding varieties such as L26, L18, and L08 have higher leaf area and chlorophyll content than low-yielding varieties L12, L23, and L14. Which, L26 variety has a leaf area of 17.13 *dm^2/plant* and chlorophyll content of 1.65 *mg/100g* fresh leaves, the L18 variety achieves the respective indexes of 16.68 *dm^2/plant* and 1.61 *mg/100g* fresh leaves, L08 variety achieved the respective indexes of 16.05 *dm^2/plant* and 1.64 *mg/100g* fresh leaves. Meanwhile, leaf area and chlorophyll content in the L12 variety were the lowest and reached 14.10 dm^2*/plant* and 1.41 *mg/100g* fresh leaves.

Table 4: Leaf area and chlorophyll content of some peanut varieties

Peanut varieties	Leaf area (dm^2/plant)	Chlorophyll content (mg/100g)
L12	$14.10^{d} \pm 0.07$	$1.41^{c} \pm 0.02$
L23	$14.25^{d} \pm 0.09$	$1.47^{c} \pm 0.04$
L14	$15.31^{c} \pm 0.08$	$1.59^{b} \pm 0.07$
L08	$16.05^{b} \pm 0.08$	$1.64^{a} \pm 0.03$
L18	$16.68^{a} \pm 0.19$	$1.61^{b} \pm 0.01$
L26	$17.13^{a} \pm 0.09$	$1.65^{a} \pm 0.02$

In the same data column, values with similar letters represent non-significant differences, values with different letters represent significant differences ($p < 0.05$).



(E) (F)

Figure 4: Correlation between leaf area, chlorophyll content and yield of some peanut varieties

Comparison of leaf area and chlorophyll content of high-yielding peanut varieties with low-yielding peanut varieties showed that high-yielding varieties (L26, L18, L08) had higher values than low-yielding groups (L12, L23, L14). This result reflects the relationship between leaf area, chlorophyll content and photosynthesis intensity, the increased photosynthetic intensity of plants is due to the increase in leaf area (Richards A., 2000).

The data on leaf area, chlorophyll content in leaves show that leaf area and chlorophyll content are closely correlated with crop yield, in which leaf area is an indicator closely related to yield. peanut yield was higher than that of chlorophyll (shown by $r^2 = 0.931$ (E) and $r^2 = 0.794$ (F), (Fig 4).

4. CONCLUSION

Experimental results grouped peanut varieties according to yield into 2 groups: high-yielding group: L26, L18, L08 (L26: 38.05 quintal/ha, L18: 35.42 quintal/ha, L08: 34.75 quintals/ha), low-yielding group: L12, L23, L14 (L12: 27.11 quintal/ha, L23: 29.92 quintal/ha, L14: 30.41 quintal/ha). High-yielding varieties have higher physiological parameters than low-yielding varieties as shown by the correlation value (r^2) between physiological parameters and yield (Photosynthetic intensity, $r^2 = 0.8495$; dry matter content, $r^2 = 0.831$; transpiration intensity, $r^2 = 0.895$; stomatal conductivity, $r^2 = 0.829$; leaf area, $r^2 = 0.931$; chlorophyll content, $r^2 = 0.794$). This difference is the scientific basis contributing to the pre-qualification of high-yielding, good quality peanut varieties in Thanhhoa province, Vietnam and other areas with similar conditions.

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