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GROWTH AND YIELD OF IMPORTED GROUNDNUT (*ARACHIS HYPOGEAE* L.) VARIETIES IN SPRING SEASON IN THUA THIEN HUE

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Abstract. Groundnut is an important oilseed crop of Vietnam and numerous countries around the world. The objective of this study is the selection of good quality groundnut varieties that have a high yield, resistance to insects and diseases, and good adaptation to Thua Thien Hue's climate. Eleven imported groundnut varieties (nine varieties from India and two from the Research Institute For Oil And Oil Plants) are examined and compared with a control. The experiments are conducted in a randomized complete block design with three replicates from December 2016 to May 2017 in Huong Long Cooperative, Hue City. The data show that all introduced groundnut varieties have a short growth period ranging from 88 to 94 days. Four imported varieties have a high pod yield. Two of them have a higher pod yield than control and are resistant to the bacterial causing wilting and black mold.

Keywords: groundnut, India, introduced, Thua Thien Hue

1 Introduction

Groundnut (*Arachis hypogaea* L.) is an annual legume crop and grown widely as an important oilseed plant [11]. Dry groundnut seeds contain 44–56% oil and 22–30% protein and are a rich source of minerals, such as phosphorus, calcium, magnesium, potassium, and vitamins, such as B group, E, and K [10]. These nutrients are essential ingredients for the food processing industry for both human and animal husbandry. Groundnut is grown in most of the provinces from North to South Vietnam and is considered the key industrial crop of many countries around the world. Compared with other industrial crops, groundnut is a short-seasoned crop and has strong adaptability and high productivity in different soil types, moisture levels, temperatures, and cultivation methods [5, 12]. Furthermore, groundnut plays an essential role in soil improvement due to its legume nitrogen fixation in root nodules [2, 6].

In Thua Thien Hue, the total area of groundnut production was about 4,100 hectares in 2009, and it decreased to 3,489 hectares in 2016 [1]. The land for groundnut production accounts for a small portion of the whole cultivation area in the province. Moreover, growers use traditional groundnut varieties or order familiar varieties from other regions for the following crop, although the local varieties have good quality and adapt well to cultivation conditions.

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The improvement in growing methods is laborous and costly. Drought conditions frequently occurring during the year prevent producing high-yield groundnut. Therefore, the selection of groundnut varieties with good adaptability and high yield is one of our goals. In this study, we assess the growth ability and evaluate the yield of imported groundnut varieties regarding their adaptability and disease resistance under climate conditions of the spring season 2016–2017 in Huong Long Cooperative, Hue City.

2 Materials and methods

2.1. Materials

Nine varieties from India, two from the Research Institute For Oil And Oil Plants (IOOP), and a local variety as control were used (Table 1).

2.2. Methods

Experimental design

The experiment was conducted in a randomized complete block design with three replicates from December 2016 to May 2017 in Huong Long Cooperative, Hue City. Each plot area was 5 m^2, and the total experimental area was 180 m^2. The spacing was 0.3 m between rows and 0.1 m between plants.

Cultivation

The cultivation practices were based on the document of the National Technical Regulations on Testing for Value of Cultivation and Use (VCU) of Groundnut Varieties of the Ministry of Agricultural and Rural Development (QCVN 01-57:2011/BNNPTNT) [8]. The soil was ploughed and then incorporated with lime (about 300 kg/ha) and fertilized with manure before sowing. Five days after soil preparation, seeds were sown in a depth of 3–5 cm. The amount of fertilizer

Table 1. List of groundnut varieties

No.	Varieties	Place of collection	No.	Varieties	Place of collection
1	SVL1 (Control)	Huong Long, Hue City, Thua Thien Hue	7	LH19	India
2	LH03	India	8	VD01-1	India
3	LH05	India	9	VD01-2	India
4	LH14	India	10	VD99-6	India
5	LH15	India	11	VD6	IOOP
6	LH17	India	12	VD7	IOOP

for one hectare comprises five tons of manure, 65 kg urea (46% N), 80 kg P_2O_5, and 84 K_2O. The fertilizer was applied three times. The basal fertilizer consists of 100% manure, 100% P_2O_5, and 50% N; the first dressing comprises 50% N and 50% K_2O 15–20 days after sowing, and the second dressing contains the remaining K_2O 30–35 days after sowing. Weeding was carried out three times when seedlings had 2–3 true leaves, 6–8 true leaves, and 5–7 days after blooming. Watering was to ensure 70–75% soil moisture of the field. Fungicide (Bordeaux) and pesticide (Vibasu) were applied before and after sowing, respectively, to prevent field pests.

Data collection

The methods of collecting data was based on the VCU testing criteria (following the Guidelines for testing the Groundnut varieties) Decision No. 1698 QĐ/BNN-KHCN on June 12, 2006 by the Ministry of Agriculture and Rural Development. Data were collected from 10 plants per replicate. The number of days from sowing to 50% of seed germination, primary branches, first flowering, and harvesting was recorded. Plant height is the distance between the cotyledons position to the highest position, and it was measured every 10 days from the stage of 6–7 leaves to harvesting. The total number of the first branches, all branches, and flowers per plant was also recorded. The number of pods and seeds per plant was measured after harvesting. One hundred randomized seeds per accession were weighed. The percentage of effective flower (%) = (number of effective pods/number of flowers per plant) × 100%. The theoretical yield was calculated according to the number of effective pods per plant, number of plants/m^2, and weight of 100 seeds. The actual yield (ton/ha) was measured from the actual yield per 1 m^2. The leaf worm density (worm/m^2) was investigated at five diagonal points from 10 plants per point. Dark sword-grass and cotton bollworm were observed at the stage of three true leaves and the end of flowering, respectively. The incidences of black mold and bacteria causing wilting (%) were recorded from monitored plants at flowering, the end of the flowering, and harvesting stage.

Data analysis

Data were analysed by using Excel version 2010 software, and least significant differences were determined on Statistix version 10.0.

Climate change in spring season, 2017

Groundnut is originated from tropical countries; therefore, this crop is suitable to grow under a hot and humid climate with sufficient light. The average temperature increased from February (20.5 °C) to April (26.0 °C) and was considered appropriate for groundnut growth (Table 2). The average temperature of 23.5–24.5 °C at the end of March and early April was suitable for hitting and podding. The total rainfall drastically decreased after February, from 205.1 mm to 25.2 mm.

Table 2. Meteorological data in spring season, 2017 in Thua Thien Hue

Month		Temperature (°C)			Rainfall		Sunny time (hour)	Air humidity (%)
		Average	Max.	Min.	Total rainfall (mm)	Rainny time (day)		
January		21.4	24.5	19.5	241.7	21.0	80.0	93.0
February		20.5	24.3	18.3	205.1	17.0	101.0	94.0
March		23.5	28.3	20.8	47.3	10.0	184.0	92.0
April	1st–10th	24.3	29.5	23.6	25.2	5.0	48.0	90.0
	11th–20th	27.2	33.0	23.5	32.0	3.0	73.0	86.0
	21st–30th	26.0	30.0	24.5	30.5	5.0	54.0	90.0

The humidity of air was high at 86–94%, enabling insects and diseases, such as dark sword-grass, cotton bollworm, bacterial causing wilting, and black mold, to develop.

3 Results and discussion

3.1 Growth time of imported groundnut varieties

Table 3 shows a slight difference in growth time (up to 4 days) in all varieties. Only the LH15, VD01-2, and VD99-6 varieties have a short time to the last flowering, 54 days against 62 days for the other varieties. This early flowering, in turn, entrains early harvest (88 days). Most imported varieties have a shorter overall growth time than control (88 and 90 days compared with 95 days). All experimental groundnut varieties here show a short growth period. This growth time is similar to that of some drought-tolerant varieties grown in Hue City [3].

3.2 Growth ability and yield of imported groundnut varieties

Fig. 1 shows the difference in plant height from 28 days after sowing to harvesting. Most plants are shorter than control at the first flowering, except for LH15, LH17, LH19, and VD99-6. At 38 days after sowing, LH15, LH17 and LH19 are higher than the control; whereas, LH14 is short. At 48 days, only LH19 is more elevated than the control. At 58 days, LH05, LH15, and LH19 are higher than control. At the end of the flowering period (68 days after sowing), most plants have a similar height to the control plants; whereas, the LH15, LH17, and LH19 varieties are higher. At harvesting time, the LH05, LH15, LH17, LH19, VD01-1, and VD6 varieties are higher than control (35.9 cm), with LH15 (46 cm) and LH19 (45.2 cm) being the highest. The imported groundnut varieties belong to the medium-size group [3].

Table 3. Growth time of imported groundnut varieties

Varieties	Growth time (day)				
	To germination	To primary branching	To first flowering	To last flowering	To harvesting
SVL1 (Control)	9	16	27	62	94
LH03	8	14	24	62	90
LH05	8	13	24	62	90
LH14	9	16	27	62	94
LH15	8	13	24	54	88
LH17	9	16	27	62	90
LH19	8	13	24	62	90
VD01-1	8	13	24	62	90
VD01-2	9	16	27	54	88
VD99-6	9	15	27	54	88
VD6	9	14	26	62	90
VD7	9	16	27	62	94

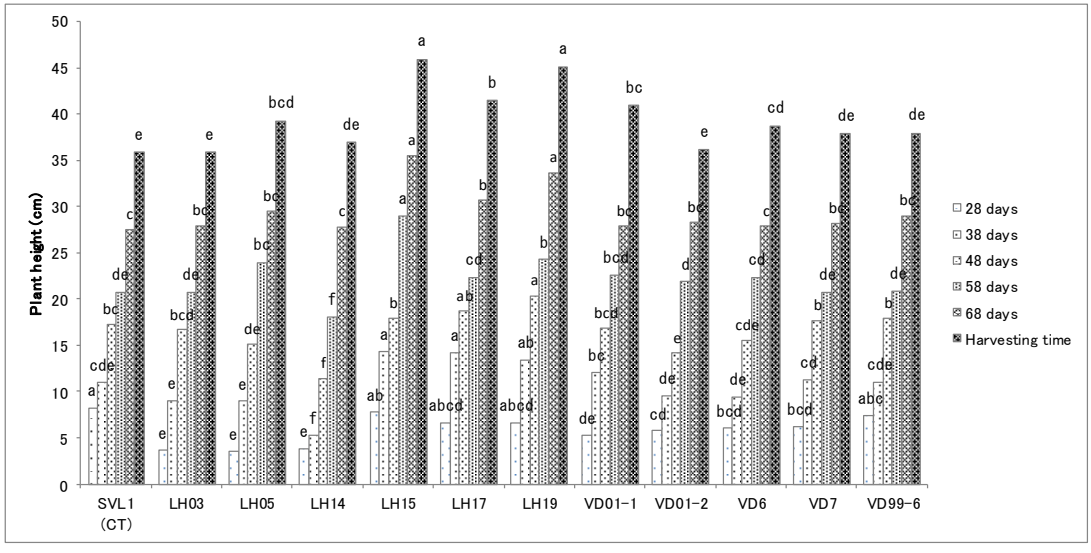

Fig. 1. Plant height of groundnut varieties from 28 days after sowing to harvest

Note: Different letters in each column indicate a significant difference at $p \leq 0.05$.

The number of primary branches per plant is an essential trait because they contribute significantly to the effective pods of groundnut. They range from 4.1 (LH17) to 5.2 (LH15)

Table 4. Number of primary branches and total number of branches per plant of groundnut varieties grown in spring season, 2017 in Thua Thien Hue

Varieties	No. primary branches per plant (branch)	Total no. branches per plant (branch)
SVL1 (Control)	4.5^{ey}	7.1^{cd}
LH03	4.9^{bc}	8.6^{b}
LH05	4.8^{cd}	6.5^{d}
LH14	4.4^{e}	7.3^{cd}
LH15	5.2^{a}	8.7^{b}
LH17	4.1^{f}	7.1^{cd}
LH19	5.0^{bc}	10.6^{a}
VD01-1	4.8^{cd}	7.2^{cd}
VD01-2	4.2^{f}	7.2^{cd}
VD99-6	4.4^{e}	7.6^{c}
VD6	5.1^{ab}	7.2^{cd}
VD7	4.7^{d}	7.3^{cd}
LSD 0.05	0.2	1.0

Note: Different letters in each column indicate a significant difference among varieties at $p \leq 0.05$.

(Table 4). Varieties LH03 (4.9), LH05 (4.8), LH15 (5.2), LH19 (5.0), and VD01-1 (4.8) have more primary branches per plant than that of control (4.5). Variety LH17 is higher than control but has fewer primary branches (4.1). The total number of branches per plant of the control is 7.1, much lower than that of LH03 (8.6), LH15 (8.7), and LH19 (10.6). Other varieties have a similar total number of branches per plant like control.

In terms of the total number of flowers per plant, only varieties LH15 and VD6 have 40.0 and 41.9, higher than that of control (33.9) (Table 5). The number of effective flowers of LH03, LH15, LH19, VD6, and VD7 is 15.4, 16.6, 15.2, 18.5, and 14.6, respectively, while that of control is 13.2. Varieties LH14, LH17, VD01-2 and VD99-6 have fewer effective flowers than control. The percentage of the effective flower was highest in LH19 (51.6%) and higher than in control. The results show that imported varieties LH03, LH15, and LH19 have strong growth ability under weather conditions of the spring in Thua Thien Hue.

Varieties LH03, LH15, and VD6 produce higher pods per plant, a higher percentage of effective pods, and a higher percentage of seed per pod than LH14, LH17, VD01-2 and control (Table 6). All the varieties exhibit a significantly higher 100-seed weight ranging from 45.1 to 46.7 g. Varieties LH03, LH15, LH19, and VD6 have a higher theoretical yield at 3.9, 3.9, 3.8, and 3.8

tons/ha, respectively, than control, and the others show similar results. The actual pod yield is higher in LH03 (1.9 tons/ha), LH15 (2.1 tons/ha), LH19 (1.9 tons/ha), VD01-1 (1.8 tons/ha), and VD6 (1.8 tons/ha). This parameter of other varieties is similar to control, ranging from 1.1 to 1.5 tons/ha. Variety VD6 is reported as a high yielding accession with 3.6 tons/ha under Tay Ninh climate conditions [7]. In this study, the yield losses of the control and imported varieties could be due to drought exposure in March and April [4, 9].

Insect and disease

All investigated plants are damaged by worms (Table 7). Dark sword-grass is found more frequently in varieties VD01-2 (4.0 individual/m^2), LH14 (3.6 individual/m^2), LH19 (3.6 individual/m^2), and VD01-1 (3.3 individual/m^2). In most of the varieties, cotton bollworm is recorded from 3.0 to 4.0 individuals/m^2, except for VD6 (2.6 individual/m^2). Ten per cent of plants of variety LH3 is infected by bacteria wilt; a lower percentage of the infected plants is found in varieties LH15, VD01-1, VD99-6 and VD7. Incidence of the black mold is frequently observed in the LH03, LH14, LH17, and VD7 varieties with 3.3%, but it was lower than that of control (6.6%). No observation of bacteria wilt and the black mold is found in varieties LH05, LH19, and VD6.

Table 5. Total number of flowers, number of effective flower and percentage of effective flowers of groundnut varieties grown in spring season, 2017 in Thua Thien Hue

Accession	Total no. flowers per plant (flower)	No. effective flowers (flower)	Percentage of effective flowers (%)
SVL1(ĐC)	33.9$^{c\ y}$	13.2^{d}	42.6^{bcd}
LH03	37.9^{abc}	15.4^{bc}	41.9^{bcde}
LH05	37.7^{abc}	12.2^{de}	34.1^{def}
LH14	38.9^{abc}	10.9^{fg}	28.5^{f}
LH15	40.0^{ab}	16.6^{b}	45.7^{abc}
LH17	38.3^{abc}	10.7^{fg}	28.8^{f}
LH19	23.7^{c}	15.2^{c}	51.6^{a}
VD01-1	33.6^{c}	12.2^{de}	50.0^{ab}
VD01-2	36.3^{abc}	10.2^{g}	28.4^{f}
VD99-6	36.8^{abc}	11.7^{ef}	33.8^{ef}
VD6	41.9^{a}	18.5^{a}	45.4^{abc}
VD7	38.7^{abc}	14.6^{c}	38.3^{cde}
LSD $_{0.05}$	*6.3*	*1.3*	*8.6*

Note: Different letters in each column indicate significant differences among varieties at $p \leq 0.05$.

Table 6. Yield components and yield of imported groundnut varieties grown in spring season, 2017 in Thua Thien Hue

Varieties	Total no. pods per plant	Effective pods per plant, %	100-seed weight, g	Seed per pod, %	Theoretical pod yield, ton/ha	Actual pod yield, ton/ha
SVL1 (Control)	13.2$^{d\,y}$	76.8^{c}	38.3^{e}	75.3^{cd}	2.9^{c}	1.3^{cd}
LH03	15.4^{bc}	82.1^{a}	47.4^{a}	81.2^{ab}	3.9^{ab}	1.9^{a}
LH05	12.2^{de}	75.7^{cd}	45.8^{cd}	71.4^{de}	3.3^{bc}	1.5^{bc}
LH14	10.9^{fg}	69.2^{ef}	45.1^{d}	68.8^{ef}	2.9^{c}	1.2^{cd}
LH15	16.6^{b}	81.2^{ab}	46.9^{ab}	83.0^{a}	3.9^{a}	2.1^{a}
LH17	10.7^{fg}	66.1^{f}	45.1^{d}	66.1^{f}	2.9^{c}	1.1^{d}
LH19	15.2^{c}	79.6^{abc}	46.7^{abc}	78.3^{abc}	3.8^{ab}	1.9^{a}
VD01-1	12.2^{de}	75.7^{cd}	45.8^{cd}	71.4^{de}	3.3^{bc}	1.8^{ab}
VD01-2	10.2^{g}	66.1^{f}	45.1^{d}	68.0^{ef}	2.9^{c}	1.2^{cd}
VD99-6	11.7^{ef}	72.8^{de}	45.4^{d}	70.9^{de}	3.1^{c}	1.4^{cd}
VD6	18.5^{a}	83.5^{a}	46.5^{bc}	80.4^{ab}	3.8^{ab}	1.8^{ab}
VD7	14.6^{c}	77.5^{bc}	45.4^{d}	77.2^{bc}	3.4^{bc}	1.5^{c}
$LSD_{0.05}$	*1.3*	*3.9*	*0.8*	*4.7*	*0.5*	*0.4*

Note: Different letters in each column indicate a significant difference among varieties at $p \leq 0.05$.

Table 7. The damage of insect and disease in imported groundnut varieties grown in spring season, 2017 in Thua Thien Hue

Varieties	Density of insect (individual/m^2)		Incidence of diseases (%)	
	Dark sword-grass	Cotton bollworm	Bacteria wilt	Black mould
SVL1 (Control)	2.6	3.6	–	6.6
LH03	2.3	4.0	10.0	3.3
LH05	2.6	3.3	–	–
LH14	3.6	3.0	–	3.3
LH15	2.3	3.6	6.6	–
LH17	3.3	3.0	–	3.3
LH19	3.6	3.3	–	–
VD01-1	3.3	4.0	6.6	–
VD01-2	4.0	3.3	3.3	–
VD99-6	2.6	3.0	6.6	–
VD6	2.3	2.6	–	–
VD7	2.6	3.3	6.6	3.3

4 Conclusion

The study reveals that the total growth time of imported groundnut varieties grown in the spring season in Thua Thien Hue ranges from 88 to 94 days in all varieties. LH14, LH17, VD01-2, and VD99-6 exhibit poor adaptability than the others with a lower number of primary branches, effective flowers, pods, and percentage of the effective pods. The LH19 and VD6 varieties are recommended for trial crops because they have a higher yield than control and resist bacterial wilt and black mold. The imported groundnut varieties should be grown in different seasons to evaluate their adaptability to climate.

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