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# Heritabilities and correlations for late leafspot resistance and agronomic traits in peanut (*Arachis hypogaea* L.)

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## Abstract

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**Heritabilities and correlations for late leafspot resistance and agronomic traits in peanut (*Arachis hypogaea* L.)**
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**Late leafspot (*Phaeoisariopsis personata* (Berk. & M.A. Curtis) van Arx) is one of the most serious diseases of peanut. Although fungicide application is effective in controlling the disease, its high cost is considered uneconomical in many developing countries. In this situation, the use of resistant cultivars offers a better alternative. The objective of this study was to determine the heritability parameters of late leafspot resistance and agronomic traits and also to estimate correlations among the two parameters. Breeding materials including $F_2$ of crosses between Tainan 9 × RLRS 15, Lampang × RLRS 15 and Khon Kaen 60-1 × RLRS 15, three backcrosses to female parent and three to male parent were planted in a RCBD with 4 replications at Khon Kaen University Farm. Natural infection of late leafspot was allowed. Disease score, lesion number, lesion size and spore production were reccorded as the resistance parameters. Pod yield, seed yield, pods number/plant, pod length, 100-seed weight and shelling percentage were also measured. Heritability estimates were generally low for all resistance parameters except for lesion size in crosses**

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**Lampang × RLRS 15 and Khon Kaen 60-1 × RLRS 15 and sporulation in cross Tainan 9 × RLRS 15. This suggested that selection in early generation based on phenotype of individual plants would be ineffective, except for lesion size in these crosses and spore production in cross Tainan 9 × RLRS 15. Heritability estimates were low for all of agronomic traits, except for pod number per plant in crosses Tainan 9 × RLRS 15 and Lampang × RLRS 15 and seed yield in cross Khon Kaen 60-1 × RLRS 15. This suggested that selection of individual plants would be ineffective, except for pods per plant in crosses Tainan 9 × RLRS 15 and Lampang × RLRS 15 and seed yield in cross Khon Kaen 60-1 × RLRS 15. Most components for disease resistance and agronomic traits showed low correlations among each other. The results indicate that selection of individuals with high heritable resistant traits such as for small lesion size and little sporulation would not affect the agronomic traits.**

**Key words :** heritability, correlation, *Phaeoisariopsis personata*, agronomic traits, *Arachis hypogaea*

## บทคัดย่อ

**ทินกร กลมสะอาด สนั่น จอกลอย โสภณ วงศ์แก้ว และ กมล เลิศรัตน์**

**อัตราส่วนพันธุกรรมและสหสัมพันธ์ของลักษณะต้านทานต่อโรคใบจุดสีดำ และลักษณะทางการเกษตรของถั่วลิสง (*Arachis hypogaea* L.)**

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**โรคใบจุดสีดำ เป็นโรคที่สำคัญของถั่วลิสง การใช้สารเคมีในการควบคุมแม้จะได้ผลดีแต่เป็นการเพิ่มต้นทุนการผลิต ดังนั้นการใช้พันธุ์ถั่วลิสงที่ต้านทานต่อโรคจึงเป็นวิธีการป้องกันกำจัดที่ดีกว่า งานวิจัยนี้มีวัตถุประสงค์เพื่อประเมินค่าอัตราส่วนทางพันธุกรรมของลักษณะความต้านทานต่อโรคใบจุดสีดำและลักษณะทางการเกษตรและหาค่าสหสัมพันธ์ระหว่างลักษณะทั้งสอง การศึกษาทำในประชากรลูกผสมชั่วที่ 2 จำนวน 3 คู่ผสม คือ Tainan 9 × RLRS 15, Lampang × RLRS 15 และ Khon Kaen 60-1 × RLRS 15 โดยปลูกลูกผสมชั่วที่ 2 และประชากรของลูกผสมกลับ (backcross) ในสภาพไร่ทดลองของมหาวิทยาลัยขอนแก่น โดยใช้แผนการทดลองแบบ RCB มี 4 ซ้ำ ปล่อยให้เป็นโรคใบจุดสีดำตามธรรมชาติและประเมินลักษณะความต้านทานต่อโรค คือคะแนนการเป็นโรค จำนวนแผล ขนาดแผล และการสร้างสปอร์ และลักษณะทางการเกษตร คือจำนวนฝักต่อต้น ผลผลิตฝัก ผลผลิตเมล็ด ความยาวฝัก น้ำหนัก 100 เมล็ด และเปอร์เซ็นต์การกะเทาะ จากการศึกษาพบว่า อัตราส่วนทางพันธุกรรมของลักษณะต้านทานโรคมีค่าต่ำ ในทุกลักษณะยกเว้นขนาดแผลของคู่ผสม Lampang × RLRS 15 และ Khon Kaen 60-1 × RLRS 15 และการสร้างสปอร์ในคู่ผสม Tainan 9 × RLRS 15 ทำให้การคัดเลือกต้นลูกผสมในชั่ว $F_2$ ของลักษณะต้านทานต่อโรคจะไม่ได้ผล ยกเว้นคัดเลือกเพื่อลักษณะขนาดแผลในคู่ผสม Lampang × RLRS 15 และ Khon Kaen 60-1 × RLRS 15 และการสร้างสปอร์ในคู่ผสม Tainan 9 × RLRS 15 อัตราส่วนของพันธุกรรมของลักษณะทางการเกษตร พบว่ามีค่าต่ำในทุกลักษณะยกเว้น จำนวนฝักต่อต้นในคู่ผสม Tainan 9 × RLRS 15 และ Lampang × RLRS 15 และผลผลิตเมล็ดของคู่ผสม Khon Kaen 60-1 × RLRS 15 ทำให้การคัดเลือกต้นลูกผสมในชั่ว $F_2$ ของลักษณะทางการเกษตรจะไม่ได้ผล ยกเว้นลักษณะจำนวนฝักต่อต้นในคู่ผสมของ Tainan 9 × RLRS 15 และ Lampang × RLRS 15 และผลผลิตเมล็ดในคู่ผสมของ Khon Kaen 60-1 × RLRS 15 และจากการศึกษาสหสัมพันธ์ระหว่างลักษณะทางการเกษตรกับลักษณะต้านทานโรคพบว่า มีสหสัมพันธ์ของสองลักษณะต่ำมากแสดงให้เห็นว่าหากมีการคัดเลือกลักษณะต้านทานโรคบางลักษณะที่มีค่าอัตราส่วนทางพันธุกรรมสูง เช่น มีขนาดแผลเล็ก มีการสร้างสปอร์น้อย จะไม่ส่งผลกระทบต่อการเพิ่มหรือลดลักษณะทางการเกษตร**

Late leafspot caused by (*Phaeoisariopsis personata* (Berk. & M.A. Curtis) van Arx) is an important disease in peanut (*Arachis hypogaea* L.). Smith (1984) reviewed the symptomatology, disease cycle, epidemiology and current control measures for the disease. Yield losses from this disease have been estimated to vary considerably from place to place and between seasons, ranging from 10 to 80% (McDonald *et al*., 1985; Miller *et al*, 1990). Fungicide application is an effective method to control the disease, but the production cost would be increased by 10% (Coffelt and Porter, 1986). Therefore the development of genotypes that combine high yielding ability with resistance to the disease would be desirable. To obtain such genotypes, estimation of heritabilities and correlations between late leafspot resistance and agronomic traits will be important in designing breeding schemes for those traits.

## Materials and Methods

### Development of breeding population

A late leafspot resistant cultivar, RLRS 15, was crossed with three high yielding adapted cutivars, Tainan 9, Lampang and Khon Kaen 60-1. The $F_1$'s of the three crosses were backcrossed to both parents to generate backcrosses to female parents (P1F1) and backcrosses to male parents (P2F1). The $F_1$'s of each cross were also self-pollinated to produce $F_2$ generation. The three crosses in the $F_1$, $F_2$ generation and their respective parents, P1F1 and P2F1 were used for late leafspot resistance and agronomic trait evaluations in this study.

### Late leafspot resistance and agronomic traits evaluation

The three crosses in the $F_1$, $F_2$ and their respective parents, P1F1 and P2F1 were planted at Khon Kaen University Experimental Farm in a randomized complete block design with 4 replications. Seeds were treated with fungicide and planted in twenty-five seeded, two-row plots with 50 cm between rows and 20 cm between plants within row. Normal cultural practices were followed during the growing season. From previous records of 3 consecutive years, peanuts in the experimental farm were predominantly infected by late leafspot (LLS) and rust and only light infection of early leaf spot (ELS) was sometime observed. To suppress the rust, oxycarboxin was sprayed once at 30 days after emergence and the ELS was frequently monitored during the early phase of peanut growth. As it turned out, there was only a trace of the ELS when the plants were 60 days old therefore no further precaution was made to control the ELS and the LLS was allowed to developed naturally. At 70 and 80 days after planting, leafspot was scored on a 9-point field scale (Subrahmanyam *et al*., 1995). Ten leaves per plot were sampled from the third leaf on main stem of each randomed plant. Lesion number per leaf and lesion size were determined on the sampled leaves. Spore production was scored based on visual rating of a 1-5 scale, with 1 indicating very little sporulation and 5 indicating heavy sporulation. Pods were harvested from individual plants and dried to approximately 8% moisture. The pod number per plant, dry pod weight (g/plant), seed weight (g/plant), pod length (average from 10 pods), seed size (g/100 seeds) and shelling percentage (seed weight × 100 / pod weight) were evaluated.

### Genetical statistic analyses

**Heritability estimates.** An estimate of narrow sense heritability for resistance and agronomic traits were computed from the variance components in the $F_2$ generation and two back crosses in three selected crosses (Tainan 9 × RLRS 15, Lampang × RLRS 15 and Khon Kaen 60-1 × RLRS 15) as described by Allard (1960) and Simmonds (1981)

$$2V_{F2} = 2V_A+2V_D+2V_E \quad \text{..... (1)}$$

$$V_{P1F1}+V_{P2F2} = V_A+2V_D+2V_E \quad \text{..... (2)}$$

$$(1)-(2) = V_A$$

$$h^2 = V_A/V_{F2}$$

where : $V_{F2}$ = variance of $F_2$ generation,

$V_A$ = additive variance,
$V_D$ = dominance variance,
$V_E$ = environmental variance,
$V_{P1F1}$, $V_{P2F2}$ = variance of backcross to female and male parents, respectively.
$h^2$ = narrow sense heritability.

## Correlation estimates

Phenotypic correlations among late leafspot resistance parameters, agronomic traits, and resistance parameters with agronomic traits were computed using this formula given by Falconer and Mackay (1996).

## Results and Discussion

### Heritability

**Late leafspot resistance.** Narrow-sense heritabilities for resistance to late leafspot are given in Table 1. Heritabilities for disease score and *P. personata* sporulation of the three crosses were low except for sporulation in the cross between Tainan 9 × RLRS 15 indicating that selection based on phenotypic differences of $F_2$ population would be difficult. Low heritabilities for lesion number were found in $F_2$ populations of Tainan 9 × RLRS 15 and Lampang × RLRS 15. However moderate heritability for this parameter was observed in the $F_2$ population of Khon Kaen 60-1 × RLRS 15. High heritabilities for lesion size were found in all $F_2$ crosses except in $F_2$ population of Tainan 9 × RLRS 15 indicating that selection based on phenotypic differences of lesion size would be effective in $F_2$ population of Lampang × RLRS 15 and Khon Kaen 60-1 × RLRS 15.

**Agronomic traits.** Narrow-sense heritabilities were low for all agronomic traits except pod number per plant in crosses 1 and 2 (Tainan 9 × RLRS 15 and Lampang × RLRS 15) and seed weight in cross 3 (Khon Kaen 60-1 × RLRS 15) (Table 1). The results indicated that selection of individual plants for most of agronomic traits in $F_2$ generation would be ineffective. However, selection of phenotypic difference in $F_2$ generation of crosses 1 and 2 for pods per plant and cross 3 for seed weight would be possible.

**Correlation.** Although the phenotypic correlations coefficients among the resistance parameters were significant, the coefficients were

**Table 1. Narrow-sense heritabilities for resistance to late leafspot and other agronomic traits.**

| Parameters | Tainan 9 × RLRS 15 | Lampang × RLRS 15 | Khon Kaen 60-1 × RLRS 15 |
|---|---|---|---|
| **Disease resistance parameter** | | | |
| Disease score at 70 days [1/] | a | a | a |
| Disease score at 80 days [1/] | a | a | a |
| Lesion number | 0.14 | 0.23 | 0.50 |
| Lesion size (mm) | a | 0.98 | 0.91 |
| Sporulation [2/] | 0.29 | 0.99 | a |
| **Agronomic traits** | | | |
| Pod weight (g/plant) | 0.26 | 0.30 | a |
| Seed weight (g/plant) | 0.34 | 0.30 | 0.49 |
| Pod number/plant | 0.40 | 0.58 | a |
| Pod length (mm) | 0.27 | a | a |
| 100 seed weight (g) | a | 0.32 | 0.30 |
| Shelling percentage | 0.23 | a | 0.17 |

[1/] **a scale of 1-9 where 1 = no disease and 9 = severe damage.**
[2/] **a scale of 1-5 where 1 = very little sporulation and 5 = heavy sporulation.**
**a = $V_{P1F1} + V_{P2F2} > 2V_{F2}$ expected $h^2$ for these traits equal zero.**

generally low except for lesion size and sporulation (Table 2). Less sporulation genotype tended to have smaller lesion size. Correlation coefficients among agronomic traits were highly significant due to the high number of degrees of freedom. However, the coefficients were relatively low for the agronomic traits (Table 3). The coefficients were high for pod weight-seed weight, pod weight-pod number per plant and seed weight-pod number per plant. Correlation of resistance parameters to agronomic traits were quite low (Table 4). The results indicate that agronomic traits and disease-resistance genes were not associated.

Narrow-sense heritability for leafspot resistance parameters and agronomic traits were quite low except for lesion size in crosses Lampang × RLRS 15 and Khon Kaen 60-1 × RLRS 15 and for sporulation in cross Lampang × RLRS 15. The results suggest that selection of individual plant for most of resistance parameters and agronomic traits in $F_2$ generation would not be effective. Similar results were also reported by Pensuk *et al* 1993; Jogloy *et al*., 1999; Trisuvanwat *et al*.,1997. In contrast, Anderson *et al* (1986) reported that high heritability was found for late leafspot resistance in $F_2$ generation. Selection was possible only for highly heritable traits such as lesion size in crosses Lampang × RLRS 15 and Khon Kaen 60-1 × RLRS 15, sporulation in cross Lampang × RLRS 15, seed weight in cross Khon Kaen 60-1 × RLRS 15 and pod number per plant in cross Tainan 9 × RLRS 15 and Lampang × RLRS 15. The results suggested that selection for decreased lesion size, slight sporulation and high pod number per plant was possible in the $F_2$ population of cross Lampang × RLRS 15. The significant correlation between lesion size and sporulation support this suggestion.

**Table 2. Phenotypic correlation coefficients for late leafspot resistance in $F_2$ population**

| Parameters | Disease score (80 days) | Lesion number | Lesion size | Sporulation[2/] |
|---|---|---|---|---|
| Disease score at 70 days[1/] | 0.23** | 0.06 | 0.11** | 0.06 |
| Disease score at 80 days[1/] | | -0.21** | 0.16** | 0.00 |
| Lesion number | | | 0.12** | 0.33** |
| Lesion size | | | | 0.47** |

**** Significant at 1% level.**
**[1/] a scale of 1-9 with 1 indicating no disease and 9 indicating severe damage.**
**[2/] a scale of 1-5 with 1 indicating very little sporulation and 5 indicating heavy sporulation.**

**Table 3. Phenotypic correlation coefficients for agroromic traits in $F_2$ population.**

| Agronomic traits | Seed weight (g/plant) | Pods/plant | Pod length (mm) | 100 seed weight(g) | Shelling percentage |
|---|---|---|---|---|---|
| Pod weight(g/plant) | 0.98** | 0.87** | 0.34** | 0.39** | 0.20** |
| Seed weight(g/plant) | | 0.85** | 0.31** | 0.42** | 0.33** |
| Pod number/plant | | | 0.11** | 0.12** | 0.16** |
| Pod length(mm) | | | | 0.25** | -0.09* |
| 100 seed weight(g) | | | | | 0.31** |

**** Significant at 5% and1% level, respectively.**

**Table 4. Phenotypic correlation coefficients of resistant parameters and agronomic traits in $F_2$ population.**

| Parameters | Disease score[1/] | | Lesion Number | Lesion Size (mm) | Sporulation[2/] |
|---|---|---|---|---|---|
| | 70 days | 80 days | | | |
| Pod weight (g/plant) | -0.15** | -0.06 | 0.07 | -0.07 | 0.09* |
| Seed weight (g/plant) | -0.15** | -0.05 | 0.05 | -0.06 | 0.10 |
| Pod number/plant | -0.15** | -0.06 | 0.03 | -0.10** | 0.07 |
| Pod length (mm) | -0.02 | -0.07 | 0.07 | -0.03 | 0.00 |
| 100 seed weight (g) | -0.06 | -0.02 | 0.04 | 0.07 | 0.07 |
| Shelling percentage | -0.02 | 0.11** | -0.07 | 0.02 | 0.05 |

**** Significant at 5% and1% level,respectively.**
**[1/] a scale of 1-9 where 1 = no disease and 9 = severe damage.**
**[2/] a scale of 1-5 where 1 = very little sporulation and 5 = heavy sporulation.**

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