# Evaluation of Advanced Peanut Breeding Lines for Large Seed and Early Maturity in the East, Thailand

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***Abstract*—Large-seeded peanut varieties with high yield, early maturity and non-spreading growth habit are desirable for cropping systems in Thailand. The objective of this study was to evaluate newly-developed peanut breeding lines for large seed and early maturity in the East, Thailand. The study was conducted in two experiments. On farm experiments were laid out in randomized complete block design with six replications for both experiments. Data were recorded for above ground fresh and dry weight, number of pods, pod dry weight, number of seeds, seed weight, seed size (100-seed weight), shelling percentage and harvest index. In experiment I, (Luhua 11 x China 97-2) F6-11-4 was the best performer in breeding line group. It showed high 100-seed weight (64.3 g), high shelling percentage (58%) and high harvest index (0.55). In experiment II, (Luhua 11 x China 97-2) F5-13 and (Luhua 11 x KK 60-3) F5-11 revealed the greatest characters for 100-seed weight and harvest index. (Luhua 11 x China 97-2) F5-13 had 77.9 g and 0.59 of 100-seed weight and harvest index, respectively. (Luhua 11 x KK 60-3) F5-11 had 73.7 g and 0.58 of 100-seed weight and harvest index, respectively. Moreover, all breeding lines were early mature (110-115 days after planting). The results of this study would be useful to select the best peanut varieties for recommendation and release to Thai farmers.**

***Index Terms*—large-seeded peanut, peanut breeding line, on farm experiment**

## I. Introduction

Peanut (*Arachis hypogaea* L.) is an inexpensive and healthiest source for human food and animal feed which ranks 6th in oil crops and 3rd in protein crops [1]. Peanut is rich in nutrients and phytochemicals useful to health such as protein, fatty acids, vitamins, fiber and arginine [2]. Peanut is used to produce a variety of processed products such as peanut oil, peanut flour and peanut butter [3]. Peanut oil has high quality for cooking and frying similar to that of olive as it contains approximately 80% unsaturated and 20% saturated fatty acids, especially monounsaturated fat. Palmitic, oleic and linoleic constitute the largest portion of fatty acids in peanut. The constituents of peanut oil vary depending on the genotype, seed maturity and environment [4]. Peanut flour is a good source of low fat, high protein, gluten-free and dietary fiber [5]. Peanut butter is a palatable staple for people in USA and Europe. Dairy butter has almost 100% fat without any protein, while the peanut butter comprises approximately 20-28% protein, 50% fat and also contains other nutrients [6], [7].

Variation in seed size is common among peanut varieties. Seed size is an important yield component of peanut. The demand for large-seeded peanut is increasing because it can be processed to various food products. The new varieties that are suitable for cropping systems and industrial use are required to respond to the consumers' demand and farmers' requirements. Early mature peanut varieties generally have lower yield than late mature varieties because they have fewer days for growth. However, some early mature varieties can maintain high pod yield because of their rapid growth and high harvest index. The possibility to develop peanut varieties with high pod yield and early maturity is challenging.

In Thailand, large-seeded peanut varieties have long been released by the department of agriculture and some universities for cultivation. Most varieties such as KKU 72-1, KKU 72-2, Khon Kaen 60-3, Kasetsart 50 and Kaset 1 are not suitable for cropping systems in Thailand because of late maturity and spreading growth habit.

Peanut is one component of many cropping systems in Thailand. In the upland rain-fed areas, peanut is grown in the early and late rainy seasons or before another crop and after another crop. In lowland paddy fields with irrigation, peanut is grown after rice harvest. Peanut is also grown on the banks of rivers after water recedes with or without irrigation, and all these cropping systems need early mature peanut varieties.

Large-seeded peanut breeding lines were developed at Khon Kaen University (KKU) and they were subjected to the successive evaluations of standard yield trial, regional

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yield trial and on-farm trial for high pod yield, early maturity and non-spreading growth habit. However, these advanced breeding lines have not been evaluated in the growing areas in the East, Thailand. Therefore, the objective of this study was to evaluate the peanut advanced breeding lines for pod yield, large seed and early mutuality on farms in the East, Thailand. The information from this study is important for selection of new peanut varieties with large seed and early maturity.

## II. Materials and Methods

### A. Plant Materials

Six peanut lines and three commercial varieties used in this study were kindly donated from the Peanut and Jerusalem artichoke Improvement Project of Khon Kaen University, Khon Kaen, Thailand (Table I and Fig. 1). Six lines are the newly-developed breeding lines with high pod yield, non-spreading growth habit and early maturity and three commercial varieties are available in Thailand market.

TABLE I. Peanut Lines and Varieties Uesd in This Study

| |
|---|
| **Experiment I** |
| (Luhua 11 × China 97-2) F6-11-4 |
| [(NC. 17090 × B1)-25 x KK 60-3] F6-11-5 |
| (Luhua 11 × China 97-2) F5-7 |
| **Experiment II** |
| (Luhua 11 × China 97-2) F5-11 |
| (Luhua 11 × China 97-2) F5-13 |
| (Luhua 11 × KK 60-3) F5-11 |
| **Check varieties** |
| KK 5 : Spanish, Early Maturity, Medium Seed Size |
| KK 6 : Virginia, Large Seed Size |
| KKU 60 : Virginia, Large Seed Size |

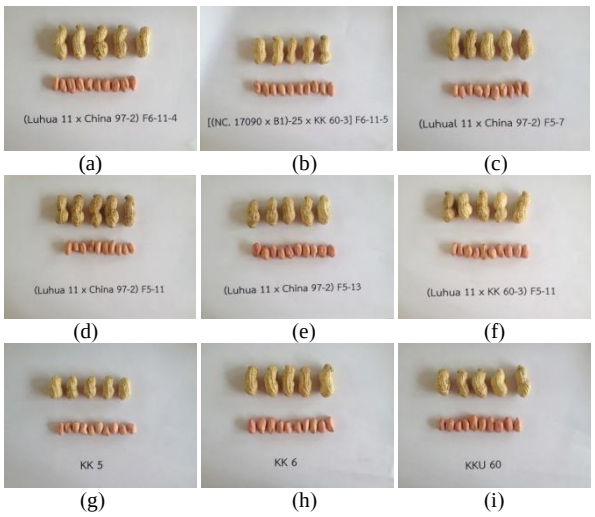


Figure 1. Pods and seeds of peanut lines and varieties (a) (Luhua 11 x China 97-2) F6-11-4, (b) [(NC. 17090 x B1)-25 x KK 60-3] F6-11-5, (c) (Luhua 11 x China 97-2) F5-7, (d) (Luhua 11 x China 97-2) F5-11, (e) (Luhua 11 x China 97-2) F5-13, (f) (Luhua 11 x KK 60-3) F5-11, (g) KK 5, (h) KK6, and (i) KKU 60

### B. Field Experiments

Two experiments were conducted at the experimental farm of the Faculty of Agricultural Technology, Burapha University, Sakaeo Campus, Sakaeo, Thailand (lat 13°44´ N, long 102°17´W, 87 masl). The crop was planted in different fields of the experiment station in the same season. The soil type in the experiment station was loamy sand. Three peanut lines (Luhua 11 × China 97-2) F6-11-4, [(NC. 17090 × B1)-25 x KK 60-3] F6-11-5 and (Luhua 11 × China 97-2) F5-7 and three commercial varieties were arranged in a randomized complete block design with six replications in one field, and three peanut lines ((Luhua 11 × China 97-2) F5-11, (Luhua 11 × China 97-2) F5-13 and (Luhua 11 × KK 60-3) F5-11 and three commercial varieties were planted in a randomized complete block design with six replications in another field in the dry season during January to May 2016 under furrow-irrigated field conditions. After rice harvest in December, the land was ploughed two times to eliminate weeds and to dry out soil. Lime (CaO) at the rate of 625 kg ha-1 was applied to adjust soil pH during soil preparation.

The peanut genotypes were planted on the plots with eight rows and plot size of five meters long and four meters wide with spacing of 50 cm between rows and 20 cm between plants within rows. Prior to sowing, seeds were treated with 0.2% ethephon to overcome possible seed dormancy. The seeds were also treted with captan at the rate of 5 g kg-1 seed in order to control soilborne diseases caused by fungi. High seed rate was used for planting and later the seedlings were thinned by hand to obtain a single plant per hill at 14 days after planting. At 30 days after planting, weed was controlled manually and the crop was applied with chemical fertilizer (12-24-12) of N-P2O5-K2O at the rate of 156 kg ha-1. Furrow irrigation was available to supply sufficient water to the crop at 7-day intervals or 15-day intervals depending on soil moisture in the field and the irrigation water was stopped in case of adequate rainfalls. Pesticides and fungicides were applied to control insect pests and fungal diseases if necessary. The crop was harvested at 110-115 days after planting, when 60-65% of the pods were mature.

### C. Data Collection

At harvest, above ground fresh and dry weight, number of pods, pod dry weight, number of seeds and seed weight were recorded per plant basis for each plot. Seed size was defined as weight of 100 seeds. Shelling percentage was determinded as seed weight divided pod weight of peanut in percentage, and harvest index was computed as the ratio of seed weight devided total weight without root.

### D. Statistical Analysis

Statistic analyses were performed using computer software STATISTIX8 [8]. Analysis of variance was performed for individual experiments. Least Significant Difference (LSD) at the 5% level was used to compare mean differences.

## III. Results and Discussion

### A. Experiment I

Six peanut genotypes were not different for plant fresh weight, plant dry weight, number of pods, pod dry weight

and seed weight (Table II). Differences among genotypes were highly significant for number of seeds. Numbers of seeds ranged from 1.67-1.90 seeds/pod and genotypes KK 6 (1.90 seeds/pod) and KK 5 (1.85 seeds/pod) had the highest number of seeds. Among peanut lines, numbers of seeds ranged from 1.67-1.77 seeds/pod and the lines showed larger seeds than did the check variety KKU 60 (1.67 seeds/pod).

Differences among genotypes were also significant for 100-seed weight, shelling percentage and harvest index.

The results indicate that these traits are useful for selection of large-seeded peanut in this experiment. Weights of 100 seeds ranked from 51.3-65.8 g. KKU 60, (Luhua 11 x China 97-2) F5-7, KK 6, (Luhua 11 × China 97-2) F6-11-4 and [(NC. 17090 x B1)-25 × KK 60-3] F6-11-5 had the highest 100-seed weights of 65.8, 65.7, 64.5, 64.3 and 64.1 g, respectively, whereas KK 5 (51.3 g) was lowest for this trait. All peanut lines had larger seeds than did Khon Kaen 84-7 (54.3 g), the large-seeded commercial variety in Thailand [9].

Shelling percentage is an important traits associated with pod yield. The shelling percentages in KK 5, KK 6, (Luhua 11 × China 97-2) F6-11-4, KKU 60 and (Luhua 11 × China 97-2) F5-7 were 59.2, 58.3, 58.0, 56.5 and 53.8%, respectively, whereas [(NC. 17090 × B1)-25 × KK 60-3] F6-11-5 had low shelling percentage (50.9%) and low seed weight.

Harvest index (HI) in peanut in this study represents the proportion of pods per the total crop biomass without root. (Luhua 11 x China 97-2) F6-11-4 and KKU 60 had the highest harvest index of 0.55 and 0.54, respectively.

In experiment I, three advanced breeding lines had an early maturity at 110-115 days after planting (data not shown). (Luhua 11 × China 97-2) F6-11-4 was remarkable genotype because it had good performance for 100-seed weight, shelling percentage, harvest index, seed weight and pod dry weight.

TABLE II. PLANT FRESH WEIGHT (PFW), PLANT DRY WEIGHT (PDW), NUMBER OF PODS (NP), SHEATH (POD) DRY WEIGHT (SDW), NUMBER OF SEEDS (NS), SEED WEIGHT (SW), 100-SEED WEIGHT (100SW), SHELLING PERCENTAGE (%SH) AND HARVEST INDEX (HI) OF SIX PEANUT GENOTYPES OF EXPRIMENT I IN THE DRY SEASON, 2016

| Genotypes | PFW (g/plant) | PDW (g/plant) | NP (pods/plant)) | SDW (g/plant) | NS (seeds/pod) | SW (g/plant) | 100SW (g) | %SH (%) | HI |
|---|---|---|---|---|---|---|---|---|---|
| (Luhua 11 x China 97-2) F6-11-4 | 42.1 | 15.6 | 11.6 | 21.1 | 1.72c | 13.1 | 64.3a | 58.0a | 0.55a |
| [(NC. 17090 x B1)-25 x KK 60-3] F6-11-5 | 57.0 | 21.1 | 9.2 | 17.7 | 1.77bc | 9.7 | 64.1a | 50.9b | 0.43b |
| (Luhua 11 x China 97-2) F5-7 | 58.7 | 19.7 | 8.8 | 18.5 | 1.67c | 10.6 | 65.7a | 53.8ab | 0.46b |
| KK 5 | 68.0 | 21.9 | 10.1 | 17.0 | 1.85ab | 10.3 | 51.3b | 59.2a | 0.43b |
| KK 6 | 61.5 | 22.5 | 9.2 | 17.9 | 1.90a | 10.9 | 64.5a | 58.3a | 0.42b |
| KKU 60 | 49.8 | 18.5 | 11.6 | 24.5 | 1.67c | 14.4 | 65.8a | 56.5ab | 0.54a |
| F-test | ns | ns | ns | ns | ** | ns | * | * | * |
| CV (%) | 27.8 | 21.6 | 23.1 | 25.4 | 5.5 | 28.6 | 12.0 | 8.8 | 12.0 |

Means with different letters in the same column are significantly different at $P < 0.05$ by Least Significant Difference
$^{ns}$, *, ** non-significant and significant at $P < 0.05$ and $P < 0.01$ probability levels, respectively

### B. *Experiment II*

Six peanut genotypes were not significantly different for number of pods, pod dry weight, seed weight and shelling percentage (Table III). The shelling percentage was calculated from seed weight per pod weight. Peanut genotypes were not different for shelling percentage in this experiment because they rather similar for seed weight and pod dry weight.

Peanut genotypes were significant for plant fresh weight, plant dry weight, number of seeds, 100-seed weight and harvest index. Check varieties in experiment II were higher than those in experiment I for plant fresh weight and plant dry weight. The differences were possibly due to higher soil fertility in experiment II. However, the ranks of peanut genotypes for plant fresh weight and dry weight were rather similar between experiments. KK 6 and KK 5 were the highest genotypes for plant fresh weight, plant dry weight and seed weight. Plant fresh weights of 114.8 and 101.8 g/plant were recorded in KK 6 and KK 5, respectively, whereas plant fresh weights of 73.6, 69.5 and 69.1 g/plant were observed in (Luhua 11 × KK 60-3) F5-11, (Luhua 11 × China 97-2) F5-11 and (Luhua 11 × China 97-2) F5-13, respectively, which were the highest breeding lines.

In check varieties, plant dry weights of 30.0 and 27.4 g/plant were recorded in KK 6 and KK 5, respectively. In breeding lines, plant dry weights of 20.6, 19.7 and 19.5 g/plant were recorded in (Luhua 11 × KK 60-3) F5-11, (Luhua 11 × China 97-2) F5-13 and (Luhua 11 × China 97-2) F5-11, respectively. KKU 60 had a low plant fresh weight (61.6 g/plant) and plant dry weight (17.3 g/plant).

In check varieties, KK 6, KK 5 and KKU 60 had seed number of 1.93, 1.88 and 1.77 seeds/pod, respectively. In breeding lines, seed numbers ranked from 1.67-1.72 seeds/pod. (Luhua 11 × China 97-2) F5-13, (Luhua 11 × KK 60-3) F5-11 and (Luhua 11 × China 97-2) F5-11 had seed numbers of 1.72, 1.70 and 1.67 seeds/pod, respectively.

Seed size (100-seed weight) is an important character for peanut. Large seeds produced more vigorous seedlings than did small and medium seeds [10]. (Luhua 11 x China 97-2) F5-13, (Luhua 11 x KK 60-3) F5-11 and KK 6 had the highest 100-seed weights of 77.9, 73.7 and 71.8 g, respectively. Seed sizes in this investigation were somewhat smaller than those reported in Japan in which X90037 and X90042 had 100-seed weights of 127.8 and 125.0 g, respectively. Although they have the exceptionally large seeds, they have been spreading growth habit and late maturity [11]. Seed sizes in our study were larger than those reported in India in which

ICGV 96466, ICGV 96468 and ICGV 96469 had 100-seed weights of 54, 62 and 49 g, respectively [12].

The breeding lines had a higher harvest index than did the two check varieties (KK 5 and KK6), but they were similar to KKU 60. The data pointed out that high pod yield in these peanut breeding lines (although they were lower than KK 5 and KK 6) was due mainly to high harvest index. Harvest indexes in (Luhua 11 x China 97-2) F5-13, (Luhua 11 x KK 60-3) F5-11, KKU 60 and (Luhua 11 x China 97-2) F5-11 were 0.59, 0.58, 0.58 and 0.57, respectively.

The information from experiment II revealed that (Luhua 11 x China 97-2) F5-13 and (Luhua 11 x KK 60-3) F5-11 were the best lines for 100-seed weight and harvest index compared to the check varieties. Moreover, all breeding lines had an early maturity from 110-115 days after planting (data not shown).

TABLE III. PLANT FRESH WEIGHT (PFW), PLANT DRY WEIGHT (PDW), NUMBER OF PODS (NP), SHEATH (POD) DRY WEIGHT (SDW), NUMBER OF SEEDS (NS), SEED WEIGHT (SW), 100-SEED WEIGHT (100SW), SHELLING PERCENTAGE (%SH) AND HARVEST INDEX (HI) OF SIX PEANUT GENOTYPES OF EXPERIMENT II IN THE DRY SEASON, 2016

| Genotypes | PFW (g/plant) | PDW (g/plant) | NP (pods/plant)) | SDW (g/plant) | NS (seeds/pod) | SW (g/plant) | 100SW (g) | %SH (%) | HI |
|---|---|---|---|---|---|---|---|---|---|
| (Luhua 11 × China 97-2) F5-11 | 69.5b | 19.5b | 11.2 | 26.6 | 1.67c | 14.3 | 63.4c | 53.3 | 0.57a |
| (Luhua 11 × China 97-2) F5-13 | 69.1b | 19.7b | 12.9 | 30.5 | 1.72c | 16.8 | 77.9a | 53.8 | 0.59a |
| (Luhua 11 × KK 60-3) F5-11 | 73.6b | 20.6b | 13.1 | 28.3 | 1.70c | 15.8 | 73.7ab | 55.8 | 0.58a |
| KK 5 | 101.8a | 27.4a | 12.4 | 20.1 | 1.88ab | 12.0 | 53.5d | 59.7 | 0.42c |
| KK 6 | 114.8a | 30.0a | 10.9 | 26.9 | 1.93a | 15.1 | 71.8ab | 55.9 | 0.48b |
| KKU 60 | 61.6b | 17.3b | 13.4 | 25.0 | 1.77bc | 14.5 | 68.4bc | 57.0 | 0.58a |
| F-test | ** | ** | ns | ns | ** | ns | ** | ns | ** |
| CV (%) | 28.3 | 20.9 | 13.5 | 22.4 | 6.8 | 24.8 | 8.2 | 7.3 | 7.4 |

Means with different letters in the same column are significantly different at $P < 0.05$ by Least Significant Difference
ns, ** non-significant and significant at $P < 0.01$ probability level, respectively

## IV. CONCLUSION

In this work, 100-seed weight, shelling percentage and harvest index were used as selection criteria. (Luhua 11 × China 97-2) F6-11-4, (Luhua 11 × China 97-2) F5-13 and (Luhua 11 × KK 60-3) F5-11 were the outstanding lines in this study, and they are promising for growing areas in the East. However, the data from one experiment were still not enough for giving recommendations to the farmers, and further evaluations in more locations and seasons are required.

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