การทดสอบความสามารถในการปรับปรุงพันธุ์ผลผลิตและการแบ่งแยกตัวเองของข้าวโพดกัวเตมาลาพันธุ์พื้นเมืองและพันธุ์นำเข้ามาใหม่

Comparative Studies of the Adaptability, Production, and Segregating Behavior of the Indigenous and a Newly-Introduced Guatemala Corn Varieties.[1]

Jinda Jan-orn, Chamnan Tonglad, Wachari Suwanwihok, Amphorn Benponk, C.A. Breitenbach[2] and Slearmlarp Wusuwat

Bangkhen Agricultural Experiment Station,
Department of Agriculture

Field corn in Thailand has been grown mainly for export. Its most desirable characteristics are found in the flinted and semi-flinted types which have a deep yellow kernel and hard endosperm. A corn variety that possesses such characteristics is known locally as Guatemala corn. This variety has been introduced from Guatemala in 1952. After five successive generations of selection and tests, it has proved to adapt well and yield best among corn varieties of this type and were, thus, released to farmers in 1959 (1).

There are three types of kernel produced by this corn variety, i.e. a pure flinted type with a deep yellow kernel and entirely hard endosperm, an intermediate type with a deep yellow kernel and tinged spot of soft endosperm at the top of the kernel, and a denty type of yellow kernel and starchy endosperm. The first two are major characteristics of this corn which are favored by exporters.

During 1962, several samples of corn seed had been collected from exporting lots and kernel characteristics were determined. Some lots were found to possess a high percentage of undesirable denty type kernels. Steps have been made to improved this inferiority. Since the segregating behavior of the kernel type of this open-pollinated variety is still obscure, it is necessary to decide whether this inferiority is due to variety deterioration or a true-type characteristic of the Guatemala corn variety. Thus, an original variety of Guatemala corn was introduced directly from Guatemala in early 1963.

The purpose of this investigation was to study, under Thailand's conditions, the adaptability, production, and segregating behavior of ear type and kernel characteristics between a variety of Guatemala corn selected and produced in Thailand and a newly-introduced variety from Guatamala.

1 This paper was presented at the 1st Inter-Asian Corn Improvement Workshop, Bangkok, October 26-30, 1964.

2 Agronomy Advisor, USOM / Thailand.

MATERIALS AND METHODS

The newly-introduced Guatemala corn and a Thai variety from the 1962's controlled mass selection seed were compared for their growth habit, response to fertilizer, seasonal adaptibility, production and the segregation behavior of their ear type and kernel under natural crosses. A factorial experiment in randomized complete block design was employed to determine the differences and similarities of the characteristics mentioned. Four treatments undertook consisted of a Thai and a newly-introduced corn variety grown with 12-12-6 kgs. of fertilizer per rai* and without fertilizer. All treatments were planted 4 replications at monthly intervals for a period of one year beginning on June 1, 1963 at the Bangkhen Agricultural Experiment Station using the Thai standard of spacing, 1 meter between rows, 50 centimeters between hills, and 2 plants per hill. Each experimental plot consisted of 70 plants.

RESULTS AND DISCUSSION

1. Seed germination adaptability. Comparative studies on the survival adaptation during the period of germination of the two varieties were made. The adaptation was determined by the percentage of field germination of each planting using a laboratory germination test as a check treatment where all favorable conditions for corn seed germination were provided. During the period of 12 months, in the laboratory test both varieties showed uniformity in germination with a slight decrease in their viability. In the field, reduction of percentage of germination was significantly greater in corn seed of the introduced variety, from 90 percent at the first month planting to 35 percent at the twelfth month planting as compared to 90 to 59 percent of the Thai variety. Seeds of the two varieties possessed the same viability at the beginning, but none of the newly - introduced seed germinated better than the Thai variety seed. This indicated the better adaptability of the Thai seed corn for survival during germination than seed corn from the newly introduced variety.

2. Growth habits. Growth habits of the two varieties were determined by measuring the height of the corn plant at 15-day intervals until it reached its maximum growth. Combined analysis of all-year trials demonstrated significant differences between the two varieties. Without fertilizer, the Thai variety grew significantly faster and taller than the introduced variety. With fertilizer, the same difference was found only at the early stage up to 60 days. There were no differences in height at maximum growth between the two varieties in these treatments. The average rate of growth and height of the two varieties of corn are presented in Table 1.

Table 1. *Average rate of growth (in parenthesis) and height (cm.) of the Thai and the newly-introduced varieties of Guatemala corn.*

Days after planting	Without fertilizer		With fertilizer	
	Thai	Introduced	Thai	Introduced
15	48 (48)	41 (41)	54 (54)	47 (47)
30	121 (73)	108 (67)	137 (83)	116 (69)
45	204 (83)	187 (79)	221 (84)	211 (95)
60	243 (39)	227 (40)	253 (32)	245 (34)
90	248 (5)	234 (7)	253 (0)	250 (5)

* 1 rai=1,600 sq.m.

The figure in the parenthesis indicated the rate of growth from the previous measurement. For example, the Thai variety without fertilizer grew up to 48 cm. at 15 days and 121 cm. at 30 days. The rate of growth from 15 days to 30 days was 73 cm. In regard to the growth habits, it should be mentioned here that the two varieties possesed the same maximum rate of growth from 30 to 40 days after planting.

Adaptability of the Thai variety under natural conditions without fertilizer was better than the introduced one as indicated by its rapid growth and maximum height. With fertilizer, there were no differences in their growth habits.

3. Flowering date. There were no differences in time of flowering among the two varieties. It took about 50 days from planting to tasseling during the wet season (May, June, July, August and September) and 55 days in the dry season (October, November, December, January, February, March and April).

4. Number of seeds per ear. Combined analysis of number of corn seed per ear shown in Table 2 illustrated that the Thai variety set more seeds per ear than the introduced variety. This was due to the larger size of the ear and the higher percentage of fertilization of the Thai variety during the dry season than those of the introduced variety. However, during the wet season when environmental conditions were favorable for this type of corn, there were no significant differences.

Table 2. *Number of seeds per ear produced by the Thai and the introduced varieties of corn grown with and without fertilizer.*

Month planted	Without fertilizer		With fertilizer	
	Thai	Introduced	Thai	Introduced
June	375	392	400	366
July	406	441	421	421
August	491	471	462	488
September	428	448	452	429
October	370	324	427	458
November	414	401	421	430
December	305	291	340	365
January	325	269	318	272
February	280	229	326	293
March	262	217	333	280
April	419	385	419	412
May	425	393	433	410
All year average	375**	355	396**	377

Thai variety average=385. Introduced variety average=366.

L.S.D. for variety:	1 %=18	5 %=14
L.S.D. for treatment:	1 %=26	5 %=19
L.S.D. for variety of the same month:	1 %=52	5 %=39
L.S.D. for treatment of the same month:	1 %=73	5 %=55
L.S.D. for month:	1 %=45	5 %=33

C.V.=10.45%.

5. Production. Comparative yields of the two varieties, grown with and without fertilizer during the 12 month planting are shown in Table 3. Combined statistical analysis demonstrated no significant difference in production of the two varieties either with or without fertilizer. However, both varieties responded well to fertilizer since there were significant differences between the treatment with fertilizer and without fertilizer in both varieties.

Table 3. *Production (kilogram/rai)1 of the Thai and the introduced varieties of Guatemala corn grown with and without fertilizer.*

Month planted	Without fertilizer		With fertilizer	
	Thai	Introduced	Thai	Introduced
June	850	807	853	880
July	900	913	907	897
August	753	717	809	828
September	514	516	535	517
October	195	189	282	355
November	423	462	495	522
December	357	286	443	397
January	327	317	287	305
February	194	191	239	253
March	315	276	390	356
April	355	369	421	436
May	574	542	623	588
All year average	491	473	535**	538**

L.D.S. for treatment: 1% =37 5% =28

C.V.=11.42%

1 2.5 rai=1 acre.

6. Segregation behavior of ear types. After harvesting, ear types based on majority characteristics of seed of each variety were separated into groups of flint, intermediate, and dent. Combined results of all year plantations are as follows:

	Percentage of ear type		
	Flint	Intermediate	Dent
Thai variety	17	54 (71)	29
Introduced variety	25	54 (79)	21

Results indicated that the newly -introduced variety was also segregated in the ear types as well as the Thai variety. However, the segregation behavior of the former was slightly toward the flinty type than that of the latter variety. This is the first criterion in this experiment illustrating ear type characteristics of Guatemala corn.

7. Segregation behavior of kernel types. After threshing, corn seeds produced by each variety were thoroughly mixed, 4 samples of 200 seeds each were collected and individual kernel swere separated in groups of flint, intermediate, and dent type. Percentages of each group from seasonal plantation are presented in Table 4.

Table 4. *Segregation behavior of kernel types produced by the Thai and the newly-introduced Guatemala corn varieties.*

Season planted	Kernel types (%)		
	Flint	Intermediate	Dent
Rainy (June - Sept.)			
Thai	52	45 (97)	3
Introduced	58	40 (98)	2
Winter (Oct. - Jan.)			
Thai	86	12 (98)	2
Introduced	90	9 (99)	1
Summer (Feb. - May)			
Thai	56	39 (95)	5
Introduced	72	26 (97)	2
All year average			
Thai	65	32 (97)	3
Introduced	73	25 (98)	2

Overall comparison indicated that kernels from the newly-introduced variety were segregated more toward flint than the Thai variety. It also produced seeds which were more deeply golden yellow than the Thai variety. Kernel types in Table 4 indicated trends toward intermediate and flint (figures in parenthesis) more than the ear types reported in the previous section. This was due to numbers of flint and intermediate type kernels attached to the dent ears which, after threshing, fell into the class of flint and intermediate type kernels.

Breitenbach and his co-workers (2) had studied numbers of samples of corn seed grown by farmers and reported average percentage of flint, intermediate, and dent types of kernel to be 45, 31 and 24 respectively which were less in percentage of flint and intermediate type than the government's selected seed or the newly-introduced variety studied here. Most Thai farmers produced their own seed, with a preference in selected

planting seed from large-eared corn of high yielding ability. Thus created a tendency of selection toward dent type of corn instead of flint or intermediate type that have smaller ears. This information indicated the need of a strong program of seed multiplication, certification, and distribution from the government in order to produce enough corn seed of desirable characteristics to replace the farmer's seed.

8. Adaptability of Guatemala corn. Production figures in Table 3 showed similar trends of increase or decrease in yields of the two varieties. From these studies at various times of planting during the year these yields indicated that these two varieties preferred the same environmental conditions. To study favorable conditions for Guatemala corn, some environmental conditions were recorded. Comparative figures together with the average yield of all treatments are presented in Table 5.

Table 5. *Average yield, relative humidity, monthly rainfall (average 3 months), soil moisture evaporation during the growing period of Guatemala corn.*

Month planted	Yield (kg./rai)	Relative humidity (%)	Monthly rainfall (mm.)	Soil moisture evaporation (mm.)
June	847	74	187	72
July	904	76	279	63
August	777	79	307	53
September	636	79	257	50
October	341[1]	76	105	58
November	480	71	15	72
December	360	66	11	85
January	304	64	26	98
February	219	65	54	106
March	334	70	123	96
April	395	72	168	83
May	582	75	199	66

1 Strong wind and flood caused heavy losses in the field.

Evidences illustrated in Table 5 indicated that the Guatemala corn is well adapted to a tropical climate with high rainfall and humidity. The trend of yield increasing was well correlated with the relative humidity. Its optimum yield was obtained only during the rainy season planting and would give maximum yield when planted during June and July. Results found in this experiment is in agreement with what had been investigated previously by Kasetsart University (2).

SUMMARY

Under growing conditions in Thailand, Guatemala corn variety selected and produced in Thailand possessed better adaptability in survival during germination and growth habit than the newly-introduced variety. Both varieties had the same agronomical and botanical characteristics including response to fertilizer and yielding ability. In reference to kernel color, the newly-introduced variety produced corn seed of a slightly darker deep yellow color in

flinted and semi-flinted types of kernel but the same canary yellow of denty type kernel in the Thai variety. Ear types and kernel characteristics produced by both varieties segregated into 3 classes: flint, semi-flint, and dent types with a majority in the first two classes. Further segregation behavior of these 3 types of kernel are a present, under study at the Bangkhen Agricultural Experiment Station.

สรุป

ตามสภาพการเพาะปลูกข้าวโพดในประเทศไทย ปรากฏว่าข้าวโพดกัวเตมาลาที่คัดเลือกและผลิตในประเทศ สามารถปรับปรุงตัวเองทางด้านความงอกและเจริญเติบโตดีกว่าข้าวโพดกัวเตมาลาพันธุ์ที่สั่งเข้ามาใหม่ โดยกระทรวงเศรษฐการปีพ.ศ.2506 ทั้งสองพันธุ์มีลักษณะพันธุ์ ความสามารถในการใช้ปุ๋ยและให้ผลผลิตอย่างเดียวกัน ข้าวโพดพันธุ์ที่สั่งเข้ามาใหม่ผลิตเมล็ดที่มีการแบ่งแยกเป็นประเภท หัวแข็งสีเหลืองเข้ม หัวแข็งสีเหลืองเข้มจุดขาว และเมล็ดสีเหลืองอ่อนหัวขาวเช่นเดียวกับพันธุ์ไทย แต่เมล็ดในสองประเภทแรกมีสีเหลืองเข้มกว่าพันธุ์ไทยเล็กน้อย

ในการปลูกทดสอบทุก ๆ เดือนตลอดปีครั้งนี้ปรากฏว่า ในสภาพการปลูกของบางเขน ปลูกเดือนมิถุนายน – กรกฎาคม จะให้ผลดีที่สุด

REFERENCES

1. Breitenbach, C.A., Klom Sombatsiri, and Slearmlarp Wasuwat, 1962.
Why Guatemala corn has changed its color. Kasikorn 36:265-273.
2. Kasetsart University, 1962.
The Annual Report of Kasetsart University for 1960.
Kasetsart Univ., Bangkhen, Bangkok. 127 p.
3. Slearmlarp Wasuwat, 1961.
Varietal improvement of corn in Thailand. A paper intended to submit to the U.N. Conference of the Application of Science and Technology for the Benefit of Less Developed Areas. 6 p. (Mimeographed).