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Ear and Kernel Characteristics of Korean Indigenous Maize Lines Collected in Pusan and Kyungnam

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Abstract

In order to reserve abundant germplasm for breeding new corn varieties, major characteristics of ears and kernels were evaluated with a total of 210 Korean indigenous maize lines collected from various parts of Pusan City and Kyungnam Province, Korea.

The average ear length and ear diameter of indigenous maize lines collected was 12.52㎝ and 3.33㎝, respectively. The average ear weight of the maize lines was 63.70g. The ears collected from the north-west mountainous region were the heaviest, and The ears from the south coastal region were the lightest. The average kernel weight per ear was 50.54g, and the kernel weight per ear by region showed a tendency similar to the ear weight.

The kernels of maize lines collected in the north-west mountainous region were the longest, and kernel width and thickness were the largest in the west plain region. 100 kernel weight and embryo weight were the largest in the lines collected in the north-west mountainous region.

The degree of pericarp thickness was the smallest in the lines collected in the south coastal region, and largest in the lines collected in the west plain region.

Except for the correlation coefficient between kernel width and 100 kernel weight, all correlation coefficients between the characteristics of the lines showed highly significant differences.

Key words – Germplasm, ear, kernel, indigenous maize line, pericarp.

Introduction

To meet Korea's demand for corn consumption, a large amount of corn is imported from various countries, including the U. S., and the situation seems likely to continue for a long time. Lowering the dependence on the foreign imported corn and increasing the production of domestic corn are very important for solving food problems.

To increase the degree of self-sufficiency in corn production, it is important to increase the area for corn cultivation and also to breed new corn varieties of high yield and quality, with strong adaptations to the domestic climate and soil. For the purpose, it is urgent to collect and maintain abundant germplasms which can be used as breeding sources. Therefore it is necessary to collect and investigate the characteristics of Korean indigenous corns, which have never used as breeding sources.

In the United States, corn breeders have worked on achieving good hybrid corn since the 1920s, and they have made remarkable progress. However, most of the corns grown in the United States, which was the primary corn producing country, were genetically simplified and

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their ability of adaptation to the environment was limited. This made it difficult to breed new corn varieties with high yield and resistance to disease. To solve this problem, U.S. breeders have collected indigenous corns with a range of variations from all over the world[1-4,7,11].

In Korea, breeding by introduction of foreign cultivars has been tried mostly for the production of new corn varieties. Whereas, Korean indigenous maize lines were collected by the National Crop Experiment Station, RDA [9,12], and the Department of Agronomy, Chungnam National University[5,6]. In 1998, Lee[8] collected Korean indigenous maize from Pusan and Kyungnam Province and investigated morphological characteristics of them. In the study, it was suggested that several good lines with characteristics of high protein, multi-ears and tillers, super thin pericarp, and high quality waxy corn could be used to breed new corn varieties also of good quality.

The purpose of the present study is to investigate the ear and kernel characteristics of Korean indigenous maize lines collected in Pusan City and Kyungnam Province, Korea in an attempt to report good sources of breeding materials for new corn varieties.

MATERIALS AND METHODS

Twenty-three areas in Pusan City and Kyungnam Province were selected, and a total of 210 ears of indigenous corn were collected, beginning in October, 1998. Regions where corn was collected were shown in Table 1. To determine the characteristics of ears and kernels, collected indigenous corns were investigated for (1) ear length (2) ear diameter (3) ear weight (4) kernel weight per ear (5) kernel length (6) kernel width (7) kernel thickness (8) 100 kernel weight (9) embryo weight and (10) pericarp thickness.

To determine the characteristics of the ears, all ears collected were measured and investigated. 100 kernel weight was measured with kernels collected from the middle part of the ear. For pericarp thickness measurement, 10 kernels were collected from the middle part of the ear and soaked in water for 24 hours at room temperature. And then samples were prepared by the method of Wolf et al.[10]. Thickness was measured with a micrometer(Mitutoyo, Model-25M, Japan) at 8 positions: 2 points of top and bottom of germal right side, right back and lef back. For other characteristics, 20 kernels were measured or used.

RESULTS AND DISCUSSION

characteristics of ears

Characteristics of indigenous corns collected in Pusan

Table 1. Regions of collection and number of Korean indigenous maize ears collected in Pusan and Kyungnam

Region*	County collected			Number of ears collected
A	Hamyang, Geochang	Hapcheon,	Sancheong	50
B	Jinju, Changryung,	Hadong, Haman,	Euiryung Kimhae,	28
C	Changwon Yangsan,	Ulsan,	Ulju	36
D	Milyang Sacheon,	Geoje,	Namhae,	33
E	Goseong, Jinhae,	Tongyoung, Gyjang	Masan,	63
Total	23			210

*A: West- north mountainous region, B: West plain region, C: Central plain region, D: East highland region, E: South coastal region

and Kyungnam were investigated for ear length, ear diameter, ear weight, and kernel weight per ear. The result is shown in Table 2.

As shown in Table 2, the average length of indigenous corns collected was 12.52㎝. The length of corns from the west-north mountainous region and east highland region were the longest, whereas corn from the south coastal region was the shortest. Ear diameter was the largest in corn from the west-north mountainous region and west plain region, the smallest ones are found in the corn from the south coastal region. The result shows that corns in the west-north mountainous region were mostly long and thick and those in the west plain region were predominantly short and thick, whereas corns in the east highland region were relatively long and thin.

Since corn yield is determined by the weight and number of ears, ear weight is one of the most important factors for yield. The average weight of indigenous corns collected was 63.70g. As shown in Table 2, ears from the west-north mountainous region were the heaviest, fol-

Table 2. Mean and other statistics for ear length, ear diameter, ear weight and kernel weight per ear of Korean indigenous maize lines.

Character	Region	Mean	S.D.	M.S.	C.V.	Max.	Min.	Range
	A†	13.35a*	3.20	10.26	23.99	19.58	8.83	10.65
	B	12.36a	2.33	5.42	18.83	16.67	8.77	7.90
Ear	C	11.98a	2.29	5.24	19.11	17.00	9.10	7.90
length	D	13.40a	2.84	8.10	21.24	17.70	8.90	8.80
	E	11.51a	1.45	2.10	12.58	13.86	9.80	4.06
	Total	12.52	2.42	6.22	19.15	16.96	9.08	7.88
	A	3.39a	0.73	0.54	21.63	4.00	1.23	2.77
	B	3.37a	0.38	0.14	11.22	3.83	2.80	1.03
Ear	C	3.25a	0.31	9.79	9.62	3.73	2.63	1.08
diameter	D	3.34a	0.44	0.20	13.26	4.20	2.65	1.55
	E	3.29a	0.25	6.15	7.53	3.63	2.88	0.75
	Total	3.33	0.42	3.36	12.65	3.88	2.44	1.44
	A	78.90a	36.69	1346.70	46.51	151.90	32.98	118.92
	B	62.56a	24.06	578.91	38.46	113.32	30.36	82.96
Ear	C	57.00a	17.84	319.30	31.35	85.88	28.41	57.47
weight	D	67.63a	29.65	897.07	43.84	109.97	22.41	87.56
	E	52.40a	10.82	117.00	20.64	65.95	36.65	29.30
	Total	63.70	23.82	651.80	36.16	105.40	30.16	75.24
	A	63.78a	28.42	807.47	44.56	120.06	28.63	91.43
	B	49.20a	19.63	385.20	39.89	92.37	24.77	67.60
Kernel wt	C	45.41a	13.90	193.22	30.61	62.22	25.00	37.22
/ear	D	54.85a	24.47	598.93	44.62	88.38	18.96	69.42
	E	41.45a	10.67	112.77	25.62	60.70	25.23	35.47
	Total	50.94	19.41	419.52	37.06	84.75	24.52	60.23

†A : West - north mountainous region, B : West plain region, C : Central plain region, D : East highland region
E : South coastal region

*Means followed by the same letter within column are not significantly different at the 5% level by Duncan's multiple range test.

lowed by corn from the east highland region. Ears from the south coastal region was the lightest. And, also, the same tendency was observed in ear length. Long ones tended to be heavier, and when ear length was almost the same, ears with the larger diameter tended to be heavier.

The average kernel weight per ear was 50.94g, and it was about 80% of ear weight. Kernel weight per ear by region showed the same tendency as the ear weight.

The above result shows that ear size and grain yield, such as ear length, ear diameter, ear weight and kernel weight per ears were the largest in the west-north mountainous region and the smallest in south coastal region. Choe et al.[6] reported the same tendencies concluding that corns from the mountainous region were bigger than those from coastal or plain region. However, even though these characteristics are different from region to region, the difference is not statistically significant. In terms of variance, coefficient of variation, and maximum and minimum value, the indigenous corns displayed significant difference between lines.

Characteristics of kernels

Characteristics of kernels of indigenous corns collected in Pusan and Kyungnam were investigated for kernel length, kernel width, kernel thickness, 100 kernel weight, embryo weight and pericarp thickness. The results are shown in Table 3.

As shown in Table 3, the average length of kernels was 0.68㎝. Kernels from the west-north mountainous region were the longest, whereas those from the south coastal region were the shortest. Kernels from other regions were about the same size. The average width of kernels was 0.64㎝. Kernel width was the largest for corn from the west plain region and smallest for corn from the central plain region. This result deviated from the kernel length outcome. The shape and size of each kernel varied greatly from one another. Kernels from the west plain region were surprisingly short in length and big in width.

The average thickness of kernels was 0.31㎝. Kernels from the west plain region were the thickest, and those from the east coastal region were the thinest. It is uncertain that kernels from the west plain region are wide and thick, but it is clear that many indigenous corn lines are wide. Corns with small kernels seem to show this characteristic to a greater extent.

The average 100 kernel weight was 16.83g. Those from the west-north mountainous region were the heaviest, with a weight of 18.99g, and those from the west plain region were the second heaviest, with a weight of 18.53g. Kernels from the south coastal region were the lightest with a weight of 14.23g. This shows that the length of kernels effect 100 kernel weight more than the width or thickness of kernels. For the west plain region, the kernel width and thickness value were higher, but they were lighter in weight than kernels from the west-north mountainous region in 100 kernel weight measurements.

The average embryo weight of indigenous corn was 15.03㎎. Those from the west-north mountainous region were the heaviest and the ones from the south coastal region were lightest.

The average pericarp thickness of indigenous corns collected was 45.02㎛, which was a little thinner than 50 ㎛, the critical thickness for edibility. Corns from the west plain region had the thickest pericarp and those from the south coastal region the thinnest. This is because in the south coastal region waxy corn is cultivated mainly, and the pericarp of waxy corn is usually thinner than that of regular corn.

As mentioned above, the characteristics of indigenous corns differed from region to region, but they did not show statistically significant differences. Comparison of variance, coefficient of variation, maximum value and minimum value, shows more significant differences among the line than among the region.

Table 3. Mean and statistics for kernel length, kernel width, kernel thickness, 100 kernel weight, embryo weight and pericarp thickness of Korean indigenous maize lines

Character	Region	Mean	S.D.	M.S.	C.V.	Max.	Min.	Range
kernel length (cm)	A	0.74a*	0.11	1.19	14.84	1.00	0.63	0.37
	B	0.68a	7.99	6.39	11.73	0.82	0.58	0.24
	C	0.67a	5.87	3.45	8.81	0.74	0.57	0.17
	D	0.68a	9.97	9.95	14.60	0.81	0.49	0.32
	E	0.64a	6.46	4.18	10.14	0.76	0.55	0.21
	Total	0.68	6.08	5.03	12.02	0.83	0.56	0.27
kernel width (cm)	A	0.68a	0.13	1.58	18.43	0.88	0.49	0.39
	B	0.71a	0.10	1.00	14.02	0.91	0.56	0.35
	C	0.60a	0.11	1.28	18.77	0.79	0.48	0.31
	D	0.61a	0.10	1.01	16.39	0.79	0.43	0.36
	E	0.61a	6.79	4.61	11.20	0.80	0.52	0.28
	Total	0.64	1.45	1.90	15.76	0.83	0.50	0.33
kernel thickness (cm)	A	0.31a	4.43	1.96	14.50	0.4	0.24	0.16
	B	0.34a	3.80	1.44	11.25	0.42	0.29	0.13
	C	0.31a	5.35	2.87	17.53	0.43	0.25	0.18
	D	0.30a	0.05	2.19	15.73	0.38	0.24	0.14
	E	0.29a	2.98	8.92	10.30	0.37	0.25	0.12
	Total	0.31	3.32	3.48	13.86	0.40	0.25	0.15
100 kernel weight (g)	A	18.99a	6.71	45.03	35.33	33.99	10.62	23.37
	B	18.53a	5.14	26.41	27.73	31.08	12.60	18.48
	C	16.19a	4.34	18.80	26.78	24.75	11.06	13.69
	D	16.21a	4.81	23.10	29.64	22.95	6.88	16.07
	E	14.23a	2.70	2.27	18.95	20.14	11.33	8.81
	Total	16.83	4.73	23.12	27.69	26.58	10.50	16.08
Embryo weight (mg)	A	20.48a	8.05	64.78	39.30	39	7	32
	B	19.50a	6.99	48.85	35.84	40	11	29
	C	19.00a	4.66	21.71	24.53	30	12	18
	D	19.06a	7.25	52.56	38.04	45	8	37
	E	15.03a	4.90	24.03	32.61	27	4	23
	Total	18.61	6.37					
Pericarp thickness (μm)	A	49.62a	17.28	298.62	34.83	74.67	21.50	53.17
	B	50.55a	10.86	117.86	21.48	61.42	25.75	35.67
	C	42.48a	15.84	251.04	37.30	66.33	23.92	42.41
	D	44.15a	8.92	79.63	20.21	54.25	24.08	30.17
	E	40.99a	11.36	128.95	27.70	67.33	21.25	46.08
	Total	45.02	12.85	175.22	28.30	64.80	23.30	41.50

*Means followed by the same letter within column are not significantly different at the 5% level by Duncan's multiple range test.

Table 4. Correlation coefficients between characteristics of Korean indigenous maize lines

	A†	B	C	D	E	F	G	H
B	.614**							
C	.858**	774**						
D	.508**	580**	716**					
E	.516**	566**	736**	683**				
F	.429**	588**	575**	863**	543**			
G	.353**	440**	398**	708**	251*	690**		
H	.407**	472**	574**	837**	585**	688**	584**	
I	.517**	483**	583**	614**	413**	591**	460**	469**

†A : Ear length, B : Ear diameter, C : Ear weight, D : Kernel length, E : Kernel width, F : Kernel thickness, G : 100 kernel weight, H : Embryo weight, I : Pericarp thickness

* **: Significant difference at 5% and 1% level, respectively

Correlation between characteristics of ears and kernels

Correlations between 9 characteristics: ear length, ear diameter, ear weight, kernel length, kernel width, kernel thickness, 100 kernel weight, embryo weight, pericarp thickness, are shown in Table 4.

All the correlation coefficients between the characteristics of indigenous corns shows positive correlations. Except for the correlation between the width and 100 kernel weight, all correlations between the characteristics shows highly significant level. Especially between the ear length and the ear weight, the kernel length and the kernel thickness, the kernel length and the embryo weight, there were highly significant correlations. Choe et al.[6] reported that there were highly significant positive correlations between 100 kernel weight and ear length, ear weight and kernel weight per ear, 100 kernel weight, and kernel size, which are confirmed by our current study one more.

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초록 : 부산, 경남지역에서 수집된 한국 재래종 옥수수의 이삭 및 낟알의 특성

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부산 · 경남지역에서 수집한 한국 재래종 옥수수 210계통에 대하여 이삭 및 낟알의 특성을 조사하고 그 특성들간의 상관관계를 조사하였다. 수집된 이삭의 길이와 직경의 크기는 각각 12.53㎝ 와 3.33㎝이었으며 수집지역간 약간의 차이를 나타내었다. 이삭의 무게는 평균 63.70g이었으며, 북서부 산간지역에서 수집된 것이 78.90g으로서 가장 무거웠고 남부해안지역에서 수집된 것이 52.40g으로서 가장 가벼웠다. 100개 낟알의 무게는 평균 66.83g이었고 embryo의 무게는 18.61㎎이었다. 전체적으로 북서부 산간지역에서 수집된 옥수수는 이삭의 크기가 크고 낟알도 큰 것으로 나타났고 남부해안지역에서 수집된 것은 이삭과 낟알의 크기가 작은 것으로 나타났다. 과피의 두께는 남부 해안 지역에서 수집된 것이 40.99㎛로서 가장 얇았고 서부 평야 지역에서 수집된 것이 50.55㎛로서 가장 두꺼웠다. 조사된 이삭 및 낟알의 특성간에는 대부분 높은 상관관계를 나타내었다.