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Use of Leaf Size for Indirect Selection of Seed Size in Soybean

Jongil Chung* and James E. Specht**

대두 종자크기에 대한 간접선발지표로써 잎 크기의 이용

정종일* · James E. Specht**

ABSTRACT : The objective of this research was to determine if leaf size (width and length) is correlated with seed size to the extent that leaf size can be used as a predictor of seed size in a population of soybean plants or lines. Twelve soybean strains, representing three distinct seed size groups, were analyzed. Data on seed size and leaf size of the 12 strains were obtained in 1994 and 1995 field experiments.

Strain seed size was positively associated with leaf width (r=0.918) and leaf length (r=0.925). The results of our study indicate that there is a significant correlation between seed size and leaf size in soybean. It is possible that selection for greater seed size either leads to, or results from, greater leaf size.

Key words : *Glycine max*, Seed size, Leaf width, Leaf length.

Seed size is an important yield component in soybean. Seed size of soybean cultivars ranges from 4 to 55 g/100 seed[4]. High yielding soybean cultivars with large or small seed need to be developed for niche markets.

The strong linear relationship is useful in that indirect selection for secondary character may be superior to direct selection for the primary character. Faser et al.[2] reported that soybean pod length and pod width were significantly correlated, not only with each other, with final seed size. Bravo et al.[1] evaluated the use of pod width for indirect selection of seed size in soybean. No data on the relationship between seed size and leaf size had been reported previously. The objective of this research was to determine if leaf size (width and length) is correlated with seed size to the extent that leaf size can be used as a predictor of seed size in a population of soybean plants or lines.

MATERIALS AND METHODS

The 12 soybean strains used in this study represented three distinct seed size groups (Table 1). Among the 12 strains, four strains

* 경상대학교 농학과(Dept. of Agronomy, Gyeongsang Natl. Univ., Chinju 660-701, Korea)
** 네브라스카 주립대학교 농학과(Dept. of Agronomy, University of Nebraska- Lincoln, Lincoln, NE68583-0915, U.S.A)
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Table 1. Phenotypic characteristics of the 12 soybean strains used in this study including the means and standard deviations in their seed size, leaf width, and leaf length

Strain	Maturity group	Seed size[1] (g/100 seed)	Leaf size[1] Width(cm)	Length(cm)
Large seed strains				
Saturn	Ⅲ	31.36±3.86	7.38±1.10	10.02±2.06
PI417.339	Ⅳ	36.26±3.52	7.51±1.18	11.19±1.99
PI417.468	Ⅳ	36.29±6.35	7.11±1.21	10.26±1.85
PI423.894	Ⅳ	37.47±4.19	7.87±1.16	11.64±1.85
Mean:		35.34±5.03	7.47±1.19	10.40±2.04
Medium seed strains				
Colfax	Ⅱ	17.84±1.26	7.04±1.00	8.62±1.25
Charleston	Ⅲ	15.28±1.43	6.37±0.90	9.29±1.71
Lancaster	Ⅲ	16.13±1.05	6.36±0.87	9.40±1.10
Ripley	Ⅳ	12.54±1.24	6.27±0.91	9.30±1.31
Mean:		15.44±2.28	6.51±0.97	9.15±1.38
Small seed strains				
Mercury	Ⅱ	8.85±0.41	4.94±0.84	8.28±1.54
PI398.374	Ⅳ	7.47±1.15	5.33±1.00	8.14±1.42
T208	Ⅳ	6.13±0.43	5.30±0.98	8.61±1.60
T215	Ⅳ	6.78±0.88	5.17±0.91	8.03±1.56
Mean:		7.30±1.27	5.18±0.94	8.25±1.54

[1] Means computed from 1994 and 1995 field test data.

(Saturn, PI 417.339, PI 417.468, and PI 423.894) have a large seed size (>30 g/100 seed), and four strains (Colfax, Charleston, Lancaster, and Ripley) have the commercial standard seed size (12 to 18 g/100 seed), and four strains (Mercury, PI 398.374, T208, and T215) have small seed size (<10 g/100 seed). Colfax, Charleston, Lancaster, and Ripley are adapted cultivars with high yield in the midwestern USA. Mercury and Saturn are small- and large-seed cultivars grown in the USA to supply the specialty edamame and natto markets in Japan. All strains are maturity group Ⅱ, Ⅲ, or Ⅳ (adapted to northcentral USA production) and have a yellow seed coat. The field experiment was conducted on a field located on the East Campus of the University of Nebraska-Lincoln, Lincoln, Nebraska, U.S.A. in 1994 and 1995. Planting dates were 7 May 1994 and 17 May 1995 in bordered blocks of 25-seed, 0.75 m x 0.90 m plots planted with a tractor-drawn mechanical planter. The experimental design was a randomized complete block with five replications for both years. Standard agronomic practices were applied. Plots were harvested when the plants in the plot reached maturity. Harvested seed was air-dried to a seed moisture content of about 8.0%. Random 100-seed samples were drawn from the harvested seed of each plot and were weighed to measure seed size (g/100 seed). The seed size estimates for each strain (two years, five replications per year) were averaged to obtain a mean seed size. Leaf width and length (cm) of the 12 soybean strains was measured on the terminal leaflet of the fourth trifoliolate before flowering. Ten random plants per each plot and per year were selected and measured.

The leaf width and length estimates for each strain (two years, five replications per year, 10 leaf measurements per replicate) were averaged to obtain a mean leaf width and length. Correlations among seed size, and leaf width and length were calculated with the Proc Corr procedure of SAS.

RESULTS AND DISCUSSION

The phenotypic traits of the 12 strains, including the two- year strain means for seed size (g /100 seed) and leaf width and length (cm), are summarized in Table 1. These 12 strains had served as parents in the Nebraska soybean breeding project for the purpose of developing high-yielding cultivars with large and small seed sizes. The seed size range within the four large, four medium, and four small seed strains was 31 to 37, 12 to 17, and 6 to 8 g /100 seed, respectively. Significant differences were observed in the seed sizes of the 12 soybean strains (Table 1). Correlation coefficients were calculated between leaf width, leaf length, seed size (Table 2). Large seed strains had large leaf width and leaf length (Table 1).

Cell sizes and cell numbers are a direct measurement on plant and organ size. In the soybean, large seed size is typically associated with large plant organs, and not just the expected large cotyledons, but also flowers and leaves. Humphries and Wheeler[5] reported that there was general agreement that cell number was the main determinant of leaf size and that cell size was relatively unimportant. Guldan and Brun[3] suggested that much of the difference in seed size of soybean was due to the differences in the number of cells in the cotyledon. Swank et al.[6] reported that larger seed in soybean was associated with a larger number of cotyledon cells, but also noted that increased cell size contributed positively to genotypic differences in seed size. We have not determined if the seed size difference between our three groups of strains is due to differences in cell number or cell volume or both.

Table 2. Correlation between leaf width(cm), leaf length(cm), and seed size (g / 100 seed)

	Leaf width	Leaf length	Seed size
Leaf width	–	0.878*	0.918*
Leaf length	–	0.925*	
Seed size	–		

* All correlations were significant at $\alpha<0.001$ probability level.

In present study, only 12 soybean strains were used to determine the correlation between seed size and leaf size. Although the results indicate that there is a significant correlation, there are soybean strains and lines with small leaf size and large seed size. These strains and lines are not positively correlated between leaf size and seed size. However, Mercury strain used in this study is a high yielding cultivar with very small seed size and small leaf size. Also, Saturn ia a high yielding cultivar with large seed and leaf size. Generally, it seems that soybean strains and lines with large seed size have large leaf size. 12 soybean strains used in this study were crossed to obtain 66 F_1 and F_2 population using half diallel mating system. These populations will be used to determine more exact the correlation between seed size and leaf size and to know inheritance pattern of leaf size trait.

적 요

대두 종자크기에 대한 간접적인 선발형질로써 잎크기에 대한 이용 가능성을 알기 위하여 종자크기에 있어서 큰 차이를 보이는 12개의 line을 선발하여 2년간 포장시험을 실시하였다. 종자크기와 잎크기의 차이에 있어서 고도의 유의성을 나타내었고 개화전 종자크기에 대한 간접선발로써 잎크기의 이용성이 가능할 것으로 보였다.

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