Measurement of Leaf Area of Soybeans

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大豆葉面積의 簡易測定法

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張　　權　　烈

摘　　要

大豆의 葉面積은 收量과 높은 相關關係가 있고 그의 簡易測定法은 매우 意義 깊은 일이므로 圃場에서 生體대로葉面積을 測定할 수 있도록 簡易測定法을 考案하였다.

大豆의 3個品種 咸安, 東山 6號, Patten을 材料로 節位別로, 主小葉과 側小葉別로 葉面積과 葉長, 最大葉幅과의 關係를 調査, 實驗하였으며 總供試葉數는 2246매이었다.

大豆의 主小葉의 面積은 (葉長×最大葉幅)×0.658, 側小葉의 面積은 (葉長×最大葉幅)×0.683에 依해서 求할수 있음을 알았다. 即 主小葉長에 最大葉幅을 곱한 積에 係數 0.683를 곱함으로써 全處理區에서 planimeter에 依한 葉面積과 높은 相關關係를 보였고 이때의 相關係數 r의 平均은 0.994 이었다.

그리고 側小葉長에 最大葉幅을 곱한 積에 係數 0.683을 곱함으로써 全處理區에서 planimeter에 依하여 求한 葉面積과 높은 相關關係를 보이고 또한 相關係數 r의 平均은 0.996 이였다.

이方法에 依하면 時間과 勞力을 크게 節減시킬수 있을 뿐만 아니라 生體대로 쉽게 葉面積을 求할수 있는 利點이 있다.

INTRODUCTION

The importance of leaf area as related to transpiration and photosynthesis is generally recognized. In general, a compound leaf of soybean consist of one main leaflet and two side leaflets from each node of the stem. Takahashi and Fukuyama (1919)[12] classified soybeans into three types, namely the long leaf type, round leaf type, and intermediate type, in which the last one had round leaves at the base and long leaves in the upper part of the stem. Nagai (1925)[7] and Takahashi (1935).[11] dealt with the genetics of the leaf form and association with other charaters. The closely relationships, the correlation coefficients from 0.64 to 0.73, were shown between the leaf area and the soybean yield in the experiments by Nagai (1942)[8]. Nagata (1950)[9] also tested the varietal differences of the variation of leaf length and its ratio to the leaf width on the nodes of stem, and finally divided varieties into five types.

Three methods of measuring area of strawberry leaves were used by Darrow (1932)[2]. The first involved determining a factor to be used with length or length x width measurements. The second method involved placing leaves on pieces of cardboard of known area cut to the shape of the leaves. Direct use of the planimeter on intact leaves was Darrow's third method. Miller (1938)[5] enumerated several methods to determine the leaf surface area in plants, some of which were extremely laborious and required removing leaves from plants. They included tracing outlines of leaves on paper and measuring the enclosed area with a planimeter or cutting out the traced areas and comparing the weights obtained with the weight of a known paper. Another method involved placing the form of

the leaf on sensitized paper with the area being determined by measuring or weighing as above. Miller further stated that the photoelectric cell can also be utilized to estitmate leaf area.

Working with field beans, Davis (1940)[3] found that 0.004517 (length x width) of the center leaflet was the most nearly accurate of four methods attempted. A simple procedure to measure leaf area in corn was devised by Montgomery (1911)[1] and used by Kiesselbach (1950).[4] The formula was length x width x 0.75. Stickler et al. (1961)[10] have succesfully used length times width x 0.747 to estimate area of grain sorghum leaves. Bhan and Pande(1966)[1] has also used length x width x 0.802 to determine leaf area of rice varieties.

The main objectives of the present investigation were to develop an accurate, rapid method to determine leaf area in soybean varieties and to examine certain data associated with leaf area determinations.

EXPERIMENTAL PROCEDURES AND RESULTS

To develop a simple formula to estimate leaf area, randomly selected 344 main leaflets and 346 side leaflets of Haman (Korean local variety,) 456 main leaflets and 456 side leaflets of Tousan No. 6 (Japanese variety) 322 main leaflets and 322 side leaflets of Patten (American variety) were removed from the soybean plants at Chinju, Korea. Seed sowing was conducted on 29th, June in 1967. These varieties were grown under the common level of fertilization (N. 2 ks, P_2O_5 : 3 kgs, K_2O_6 kgs/10a) and the leaves were detached at 75 day after seeding of these varieties.

After sampling, the outline of each leaflet was immediately traced on plain white paper. The maximum width and length were also determined. Each leaflet tracing was then measured with a planimeter and the area recorded. The relationship between leaf area obtained by the planimeter and leaf area obtained as a product of leaf length times maximum leaf width was found by using equation $y=aX$, where y (leaf area obtained by planimeter) and X (leaf area as the product of leaf length times maximum leaf width) are the means of their respective populations. Values of the constant "a" were calculated under different main and side leaflets from different nodes, and varieties.

They are given in Tables 1 and 2.

Table 1. Values of constant "a" and correlation coefficient "r" at main leaflets from different soybean varieties.

Main leaflet position from nodes	Varieties					
	Haman		Tousan No. 6		Patten	
	a	r	a	r	a	r
12	0.638	0.97	0.645	0.96	0.649	0.97
11	0.643	0.97	0.650	0.98	0.651	0.96
10	0.643	0.96	0.638	0.96	0.649	0.95
9	0.654	0.98	0.647	0.97	0.658	0.95
8	0.670	0.96	0.649	0.97	0.663	0.96
7	0.677	0.97	0.662	0.95	0.663	0.88
6	0.689	0.97	0.677	0.97	—	—
5	—	—	0.671	0.97	—	—
4	—	—	0.682	0.96	—	—
Average	0.659	0.999	0.658	0.994	0.656	0.997

For all data "a"=0.658, r=0.994, all r values are significant at the 1% level.

The average planimeter main leflet area of all varieties was 0.658 x maximum length x maximum width as shown in table 1, and the average planimeter side leflet area of these varieties was 0.683 x maximum length x maxium width, respectively.

The main leaflet area obtained as a product of leaflet length times maximum leaflet width multiplied by 0.658 gave a strong correlation ($r=0.994$) with the main leaflet area taken by planimeter under all conditions, and also the side leaflet area obtained as a product of side

Table 2. Values of constant "a" and correlation coefficient "r" at side leaflets from different nodes and different soybean varieties.

Side leaflet position from nodes	Varieties					
	Haman		Tousan No. 6		Patten	
	a	r	a	r	a	r
12	0.664	0.97	0.657	0.98	0.663	0.97
11	0.667	0.96	0.678	0.97	0.684	0.96
10	0.666	0.96	0.678	0.96	0.677	0.96
9	0.669	0.97	0.672	0.95	0.678	0.94
8	0.684	0.96	0.670	0.97	0.693	0.94
7	0.707	0.97	0.674	0.95	0.694	0.97
6	0.720	0.97	0.696	0.88	—	—
5	—	—	0.717	0.96	—	—
4	—	—	0.724		—	—
Average	0.682	0.999	0.685	0.995	0.682	0.998

For all data "a"=0.683, r=0.995, all r values are significant at the 1% level.

leaflet length times maximum side leaflet width multiplied by0.683 gave a strong correlation (r=0.995) with the side leaflet area taken by planimeter under all conditions, respectively.

It can be concluded from the studies that main leaflet area of the soybean can be estimated a product of leaflet length 0.658, and that side leaflet area of the soybean can be estimated as a product of leaflet length times maximum leaflet width multiplied by 0.683. This will give a leaflet area very near to that obtained by the planimeter, and, in addition to saving time and labor, the method will be useful in measuring leaf area without destroying the leaf.

Summary

The product of maximum length x maximum width x 0.658 was found to be an accurate and reliable method of estimating the main leaflet area, and the product of maximum length x maximum width x 0.683 was also found to accurately estimate the side leaflet area in three soybean varieties. Those areas obtained as a product of leaflet length times width multiplied by constant "a" gave a strong correlation with the leaflet area taken by planimeter under all conditions. This method will be useful in measuring leaflet area without destroying the leaflet, and, in addition to saving time and labor.

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