Evaluation of Septoria Brown Spot Disease and the Disease Resistance in Soybean Cultivars

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ABSTRACT The present study was carried out to determine appropriate growth stage for evaluating resistance to septoria brown spot in field and to search resistance sources from soybean germ plasm. Disease severity expressed by $\log \frac{x}{1-x}$ was different with soybean genotypes and vertical progress of the disease was related to the diseased leaf area. Correlation between diseased leaf area and the area under septoria brown spot disease progress curve (AUBC) was highest at full blooming stage, indicating a reasonable stage for measuring the disease severity to evaluate resistance in field. There was no lines highly resistant to the disease among 1,428 native soybean lines tested.

Since the septoria brown spot was first reported in 1934 by Nakata and Takimoto,[6] little has been studied in Korea. The septoria brown spot develops on soybean leaves throughout whole growing season[5] and sometimes occur on stem and pods under warm, humid weather condition as the soybean plants approach mature stage.[8,9] In general, incidence of septoria brown spot was decreased during midsummer and it has reported to be due to unfavorable weather condition,[2] or a resistant physiological phase of soybean plants.[11] Noticeable yield reductions have been reported with variation according to soybean varieties, locations or inoculation time of causal organism.[5,8,11] To minimize yield reduction, search for sources of the disease resistance from soybean germ plasm was attempted by several investigators,[4,11] measuring disease resistance at seedling stage, or full pod stage in field. They found different disease reactions with growth stages of soybean plants and no lines with high level of resistance from the germ plasm. Therefore, present study was conducted to determine the optinum growth stage in field for evaluating the disease resistance of soybean.

MATERIALS AND METHODS

Two soybean varieties and three native lines were planted with spacing 70cm×10cm×3cm in the field. Disease assessment was made five times with 10 days interval from a week after inoculation in the field. Twenty plants selected at random in each plot were rated and averaged to obtain the per cent diseased leaf area. The septoria brown spot severity was calculated by using the method of Young and Ross[11] as follows: (% defoliation+% remaining leaves)×proportion of remaining leaf area diseased. Diseased leaf area was determined by using a modified Horsfall and Barrat scale.[3] Percent defoliation was derived from comparing total nodes to the number of nodes defoliated on the main stem. Vertical progress of septoria brown spot based on the number of infected leaves(nodes) to total nodes of main stem was determined on the same plants.

Soybean growth stage[1] was recorded on each disease rating date. The disease progress over time in each plot was estimated with logit transformation of brown spot severity. The area under the septoria brown spot progress curve (AUBC) was calculated for each plot to express the severity of septoria brown spot during the entire growth. AUBC was calculated by dividing the curves into segments corresponding to the time intervals when disease ratings were made.[7] This relationship was expressed by the following formula: $\text{AUBC}=\sum_{i=1}^{k-1}(X_{i+1}+X_i)\ (t_{i+1}-t)/20$, while X, t and k designate the severity of brown spot, the time of ratings and total number of observation, respectively.

In order to evaluate soybean germ plasm collections for septoria brown spot resistance in field,

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all lines were grown as the same method and the rating system for disease resistance was applied as follows: Grade 1(G_1)=less than five brown spots on the leaves without chlorosis, G_2=six to ten brown spots on the leaves without chlorosis, G_3=ten to twenty brown spots with traceable chlorosis around the spots or more than twenty brown spots without chlorosis, G_4=less than two leaves covered with chlorotic brown spots. G_5=more than two leaves covered with chlorotic brown spots or defoliation. Disease severity was measured at R_2 stage (full blooming) of soybean growth by natural infection.

RESULTS

Disease severity of five different varieties, as expressed by $\log \frac{x}{1-x}$, was determined to evaluate the disease resistance in the field. Each variety showed different response to septoria brown spot. KAS 320-4 was the highest in the disease response and KAS 639-8 was lowest as compared to check variety Bongeui (Fig. 1). Vertical progress of septoria brown spot was also different with the varieties. In general, the higher the disease severity, the higher was vertical progress of septoria brown spot, even though there was no significance in correlation between the disease severity and vertical disease progress, when they were expressed by AUBC values (Table 1). Since the relationship between the severity of septoria brown spot and yield reduction in soybean could best be expressed

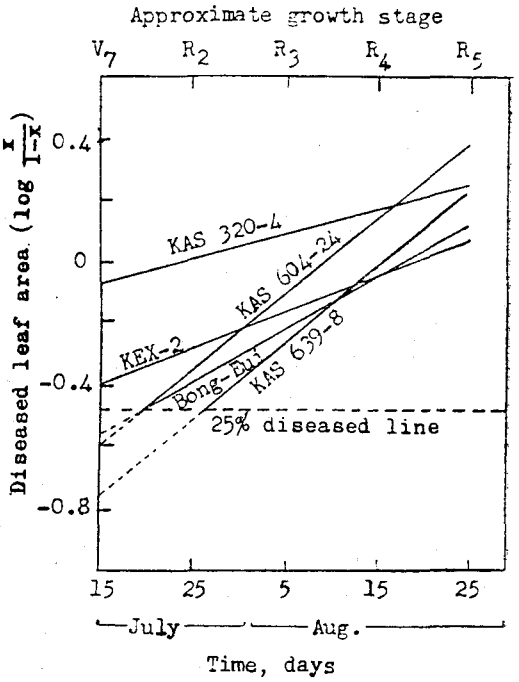

Fig. 1. Progress of septoria brown spot on soybean varieties based on the diseased leaf area per plant in field.

by the regression of yield reduction on AUBC values,[7] the appropriate growthstage capable of discriminating resistance to septoria brown spot in the field was determined by the relationship between diseased leaf area at different growth stages and the AUBC values (Table 2). The highest correlation coefficient (r=0.973) was appeared in full blooming stage (R_2), but significant correlation

Table 1. Relationship between diseased leaf area and vertical disease progress of Septoria brown spot in soybean

Variety	Diseased leaf area(%)			Vertical disease progress[a]		
	AUBC[b]	Variance	S.d.[c]	AUBC	Variance	S.d.
Bong-Eui	163.5	0.102	0.319	186.9	8.102	2.846
KEX-2	214.4	1.547	1.244	270.4	4.328	2.080
KAS 320-4	265.4	5.500	2.345	299.4	11.780	3.432
KAS 604-24	206.5	5.086	2.255	276.3	21.830	4.672
KAS 639-8	169.7	3.930	1.982	274.0	7.391	2.719
F-value	1553.0**			523.3**		
LSD(.01)	4.2729			9.3309		
r=0.714[d]						

[a] Percent vertical progress of septoria brown spot calculated by comparing total leaves of main stem to the number of the leaves infected on time.
[b] Area under the septoria brown spot progress curve.
[c] Standard deviation of the estimates
[d] Correlation coefficient between AUBC of diseased leaf area and vertical disease progress.

Table 2. Correlation between septoria brown spot severity on time and the area under the septoria brown spot progress curve in different soybean varieties.

Variety	Diseased leaf area at the stage[x] of					b[y]	AUBC[z]
	V_5	V_7	R_2	R_3	R_4		
Bong-Eui	10.5	26.7	30.3	32.0	41.1	0.010	163.5
KEX-2	15.1	36.1	39.4	39.7	54.9	0.009	214.4
KAS 320-4	19.7	50.3	53.8	54.2	59.0	0.005	265.4
KAS 604-24	12.5	25.4	39.6	39.8	58.0	0.013	206.5
KAS 639-8	7.8	16.5	24.9	36.3	53.7	0.017	169.7
Correlation to AUBC	0.961*	0.902*	0.973*	0.966*	0.051		

[x] Approximate growth stage of the soybean plants.
[y] Regression coefficient of disease progress line which is the same as Van der Plank's apparent infection rate(r).
[z] Area under septoria brown spot progress curve.

was also shown at growth stage with five nodes on the main stem (V_5), stage with seven nodes (V_7), and stage with pod 0.5cm long at one of the four uppermost nodes (R_3).

In search for sources of resistance from soybean germ plasm collection, there was no lines resistant to septoria brown spot but only 4 lines were moderately resistant among 1,428 entries tested at R_2 stage (Table 3). Most of the entries were susceptible with brown spots surrounded by chlorotic tissue and a large number of leaf defoliation. The

Table 3. Frequency distribution of disease severity in native soybean collections following natural infection of *Septoria glycines*.

Disease[a] index	Seed coat color				Total No. of line
	Green	Yellow	Brown	Black	
G-1	0	0	0	0	0
G-2	0	0	1	3	4
G-3	130	33	9	18	1,190
G-4	38	137	71	118	364
G-5	86	380	149	255	866
Total	254	550	230	394	1,428

[a] G-1 : less than five brown spots on the primary leaves without chlorosis.
G-3 : ten to twenty brown spots with traceable chlorosis around the spots.
G-5 : more than two leaves covered with chlorotic brown spots or defoliation.

percentage of leaf area diseased for septoria brown spot lesions without surrounding chlorotic tissue were lower than the estimates for lesions surrounded by chlorotic tissue. Most of the entries with a low severity of septoria brown spot (G_3) were grown from green seeds. Apparently, the brown spots surrounded by chlorotic tissue were more visible than the brown spots without chlorotic lesions, but no difference in the amount of defoliation was observed between plants grown from yellew and green seeds.

DISCUSSION

The differential response of soybean varieties to septoria brown spot was accentuate by evaluating relationship between vertical progress of septoria brown spot and plant development. The soybeans with higher vertical disease progress was higher in disease severity, even though it was not always coincide each other. This relationship enables to obtain quantitative information concerning septoria brown spot epidemics during the growing season. Lim[4] suggested that one should give a particular attention to quantitative measurements for evaluating septoria brown spot reactions. Disease severity, defoliation and density of pycnidia were mentioned as some quantifiable characters that might be used. Accordingly, vertical disease progress seemed to be one of the factors available for evaluating septoria brown spot resistance.

Young and Ross[11] reported that evaluations of resistance should be done in the field after full-pod stage, since a form of resistance may delay symptom development until after dry matter accumulation in the seed has occurred. In this study, however, disease severity at growth stage with pod 2cm long at one of the four uppermost nodes (R_4) was not significantly correlated with area under septoria brown spot progress curve, while full-blooming stage was significantly correlated with disease

severity. This indicated that optimum growth stage for measuring disease severity to discriminate septoria brown spot resistance in field was R_2 stage but the other one of early growth stage was also seemed to be reasonable for rating the disease resistance. It was likely because development of bacterial blight and other foliar diseases were increased at the later growth stage in this field.

From the evaluation of soybean germ plasm collections for septoria brown spot resistance, neither immunity nor high levels of resistance were found in the 1,428 lines tested at full blooming stage in the field. This indicates difficulties in searching for sources of resistance from the soybean germ plasm as reported by others.[4,11] Possibly, induced mutation may be helpful to obtain genetic sources of resistance.

摘 要

大豆 갈색무늬병에 대한 抵抗性의 圃場檢定에 적합한 生育時期를 결정하고 蒐集在來種으로부터 抵抗性因子源을 찾기 위하여 本實驗을 수행하였던 바,

1. 갈색무늬병에 대한 抵抗性은 品種間에 差異가 현저하였으며 垂直感染率과 病斑面積率間에는 相關이 있었다.

2. 病斑面積率과 病進展曲線面積과의 相關度는 大豆生育期中 開花期에서 가장 높아 포장에서의 저항성 검정시기는 開花期가 적당한 것으로 보였다.

3. 蒐集在來種 1,428계통의 抵抗性 檢定結果 高度抵抗性 系統은 발견할 수 없었고 中度抵抗性인 4系統을 선발할 수 있었다.

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