Influence of Photoperiod, Plant Age, and Stage of Development on Brown Stem Rot of Soybean

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ABSTRACT

Brown stem rot symptom ratings were lower in young vegetative soybean plants than in older vegetative plants. Age did not influence symptom development in plants after floral induction. An increase in symptom rating occurred when young plants were changed from a long-day to a short-day photoperiod. Whether this response was associated with floral induction or was an independent response to change in photoperiod was not determined.

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Additional key words: Glycine max, Cephalosporium gregatum.

Brown stem rot (BSR) of soybean [*Glycine max* (L.) Merr.] is widespread in North America (8, 9, 10). Disease development is influenced by temperature (1, 3, 11, 12, 13), soybean cultivar (2, 4, 6, 7, 13), specific isolate of *Cephalosporium gregatum* Allington & Chamberlain (6, 11), and age or stage of development of the host (3, 7, 12). The disagreement on the influence of age and stage of development of the host on disease development (3, 4, 7, 12) may be due to differences in experimental procedures. However,

no attempts to separate the influence of chronological age from that of physiological age have been reported.

The purpose of these experiments was to determine the influence of photoperiod and of chronological and physiological age of the host on BSR development.

MATERIALS AND METHODS.—Production of soybean plants, cultivar Lee, inoculum preparation using *C. gregatum* isolate 5, stem puncture inoculation, and method of disease rating were similar to those previously described (11). Plants remained in growth chambers at 24 ± 2 C from the time seeds were planted until disease ratings were made. Inoculum concentration was ca. 2×10^7 spores/ml. The disease rating scale was 0 to 5: 0 = no internal stem discoloration; 1, 2, 3, 4, and 5 = discoloration through the 1st, 2nd, 3rd, 4th, and 5th node, respectively, above the inoculation point (hypocotyl).

All plants within one experiment were inoculated on the same day with the same inoculum, and disease ratings were made 28 days later. Different-aged plants were obtained by planting the seeds on different dates.

Two long-day photoperiods were used to prevent flowering: (i) a daily 16-hr light period at 2,300 ft-c (16-hr photoperiod), and (ii) a daily 12-hr light period at 2,300 ft-c with a 90-min light period (150 ft-c) midway through the dark period (12-hr + photoperiod). The 12-hr + photoperiod provided a long-day photoperiod which was similar to a short-day photoperiod relative to time allowed for photosynthesis. To induce flowering, plants were exposed to a daily 12-hr photoperiod at 2,300 ft-c (12-hr photoperiod), and remained under this photoperiod until disease ratings were made. The age of plants, time under a 12-hr photoperiod, and stage of development are presented in Table 1.

RESULTS.—All inoculated plants and none of the noninoculated control plants developed internal stem discoloration typical of brown stem rot. Inoculation apparently did not influence flowering or later reproductive stages, since inoculated and control plants under the same photoperiod were always in the same stage of development.

Chronological age.—Chronological age had little influence on disease development in plants which had been induced to flower or were in later reproductive stages (Table 1). However, if the plants remained vegetative throughout the experiment, young plants had lower disease ratings than older plants. A change in susceptibility apparently occurs between 56 and 70 days after planting, since vegetative plants 56 days old (at time of disease rating) had lower disease ratings than plants 70 or more days old (Table 1). Plants 63 days old had higher disease ratings than younger plants, but the difference was not statistically significant, possibly indicating an intermediate stage between younger, less susceptible plants and older, more susceptible plants.

Physiological age.—Physiological age did not influence disease development in plants 63 days (at time of disease rating) or older (Table 1). However, younger plants (56 days or less) had lower disease ratings when they were vegetative than when they had been induced to flower or were in later reproductive stages (Table 1). This response was apparently not associated with differences in photosynthesis, since plants under a 16-hr photoperiod and those under a 12-hr + photoperiod had similar disease ratings (Table 1).

DISCUSSION.—These results demonstrate that chronological age and physiological age of the host influence development of brown stem rot in soybeans. However, they are not independent, since chronological age influenced disease development only in vegetative plants, and physiological age influenced disease development only in young plants.

An increase in disease rating occurred at floral induction or, when plants remained vegetative, sometime between 56 and 70 days after planting. This corresponds closely to an increase in rate of stem browning 55 days after emergence reported by Kunkel & Dunleavy (7). Chamberlain & McAlister (3) reported that BSR progressed more rapidly in plants in the pod-filling stage than in those in the flowering stage. In this study, no differences in symptom development were detected in plants at any stage after floral induction.

Schneider et al. (12) reported an inverse relationship between plant age at inoculation and the extent of internal browning in plants inoculated 6, 8, 10, and 12 weeks, and rated 16 weeks after planting. Their results indicate increased internal browning associated with increased time between inoculation and disease rating. Such a relationship might be expected if plants 6 weeks or older at inoculation were uniformly susceptible, as indicated by the results of this study.

The effect of photoperiod length on vascular disease development is not well documented. Foster & Walker (5) reported more extensive Fusarium wilt in tomato plants exposed to a 6-hr photoperiod for 30 days prior to inoculation than in those exposed to an 18-hr photoperiod. However, they reported that plants under short days were lower in vigor and somewhat etiolated compared to those under long days. In addition, they reported similar results when plants were kept under the same photoperiod at different light intensities; i.e., plants kept under low light had more extensive wilt than those under high light intensities. Thus, it is possible that the response they observed was associated with a difference in photosynthesis and was not a response to length of photoperiod per se.

In this study, little difference in vigor or color was noted between plants under long or short days. If the response were related to photosynthesis, then plants under the 12-hr + photoperiod should have responded similarly to those under the 12-hr photoperiod. However, if the response were related to length of photoperiod, then plants under the 12-hr + photoperiod should have responded similarly to those under the 16-hr photoperiod. The latter was clearly the case. No

TABLE 1. Influence of photoperiod and of age and stage of development of Lee soybeans on brown stem rot caused by *Cephalosporium gregatum*

Stage of development[a] at inoculation	At time of disease rating			Mean disease rating[d]
	Age of plants[b]	Time under short days[c]	Stage of development[a]	
	days	*days*		
Experiment 1				
V	84	0	V	5.0 a
V	84	14	V-F	4.9 a
V	84	28	F	4.7 a
V-F	84	42	P	4.9 a
F	84	56	P	5.0 a
P	84	70	P	4.5 a
V	70	0	V	4.8 a
V	70	14	V-F	4.7 a
V	70	28	F	4.8 a
V-F	70	42	P	4.3 a
F	70	56	P	5.0 a
V	56	0	V	3.6 b
V	56	14	V-F	4.7 a
V	56	28	F	4.9 a
V-I	56	42	P	5.0 a
Experiment 2				
V	63	0	V	4.4 abc
V	63	7	V-I	4.4 abc
V	63	14	V-F	5.0 a
V	63	21	F	4.6 ab
V	63	28	F	5.0 a
V	56	0	V	3.7 c
V	56	7	V-I	4.6 ab
V	56	14	V-F	5.0 a
V	56	21	V-F	4.7 ab
V	56	28	F	4.9 a
V	49	0	V	3.9 bc
V	49	7	V-I	5.0 a
V	49	14	V-I	4.9 a
V	49	21	V-F	4.9 a
V	49	28	F	4.9 a
Experiment 3				
V	49	0	V	2.7 b
V	49	0	V[e]	2.8 b
V	49	7	V-I	4.2 a
V	49	7	V-I[e]	4.2 a
V	49	14	V-I	4.1 a
V	49	14	V-I[e]	4.3 a

[a] V = vegetative; V-I = vegetative (flowering induced); V-F = flower buds present; F = flowers open; P = pods present.

[b] From the time seeds were planted. Plants were exposed to a daily 16-hr photoperiod until exposed to short days. All plants were inoculated 28 days before disease ratings were made.

[c] Plants were exposed to a daily 12-hr photoperiod and kept under this photoperiod until disease ratings were made.

[d] Mean of 10 determinations – numbers followed by the same letter are not significantly different at the 1% level. Comparisons valid within experiments only.

[e] Plants were exposed to a daily 12-hr photoperiod with a 90-min light period midway through the dark period, from time of inoculation, until exposed to short days.

information was obtained to indicate whether this change in susceptibility with change in photoperiod is associated with floral induction or is an independent response.

LITERATURE CITED

1. ALLINGTON, W. B., & D. W. CHAMBERLAIN. 1948.

Brown stem rot of soybean. Phytopathology 38:793-802.
2. CHAMBERLAIN, D. W., & R. L. BERNARD. 1968. Resistance to brown stem rot in soybeans. Crop Sci. 8:728-729.
3. CHAMBERLAIN, D. W., & D. F. MC ALISTER. 1954. Factors affecting the development of brown stem rot of soybean. Phytopathology 44:4-6.
4. DUNLEAVY, J. 1969. Time of brown stem rot symptom expression and percentage infection of plants of eight soybean varieties infected with Cephalosporium gregatum. Phytopathology 59:1024 (Abstr.).
5. FOSTER, R. E., & J. C. WALKER. 1947. Predisposition of tomato to Fusarium wilt. J. Agr. Res. 74:165-185.
6. GRAY, L. E. 1971. Variation in pathogenicity of Cephalosporium gregatum isolates. Phytopathology 61:1410-1411.
7. KUNKEL, J. F., & J. M. DUNLEAVY. 1965. Brown stem rot development in soybeans. Phytopathology 55:1065 (Abstr.).
8. LAI, P. Y., & J. M. DUNLEAVY. 1969. Sporulation of Cephalosporium gregatum on naturally infested soybean straw. Phytopathology 59:343-345.
9. MORGAN, F., & J. DUNLEAVY. 1966. Brown stem rot of soybeans in Mexico. Plant Dis. Reptr. 50:598-599.
10. PHILLIPS, D. V. 1970. Incidence of brown stem rot of soybean in Georgia. Plant Dis. Reptr. 54:987-988.
11. PHILLIPS, D. V. 1971. Influence of air temperature on brown stem rot of soybean. Phytopathology 61:1205-1208.
12. SCHNEIDER, R. W., J. B. SINCLAIR, & L. E. GRAY. 1972. Etiology of Cephalosporium gregatum in soybean. Phytopathology 62:345-349.
13. TACHIBANA, H. 1971. Virulence of Cephalosporium gregatum and Verticillium dahliae in soybeans. Phytopathology 61:565-568.