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Susceptibility of Soybean Petioles to Attack By *Diaporthe Phaseolorum* Var. *Caulivora*¹

By JOHN DUNLEAVY²

Diaporthe phaseolorum var. *caulivora* is a fungus that causes stem canker disease of soybean. The fungus forms a dark canker at the node of a diseased stem (Figure 1) and as the canker enlarges it eventually girdles the stem killing the tissues above the canker. Stem canker is a disease of considerable economic importance in the north central portion of the United States. The fungus has been observed attacking more than 70 percent of the plants in severely diseased fields in Iowa. Prior to 1948 stem canker was confused with the pod and stem blight disease of soybean, caused by *Diaporthe phaseolorum* var. *sojae*, until Welch and Gilman (1948) made a distinction between the 2 fungi on a basis of morphological characteristics and pathogenicity. Athow and Caldwell (1954) confirmed the fact that *D. phaseolorum* var. *caulivora* was considerably more pathogenic than *D. phaseolorum* var. *sojae*, and reported that up to 40 percent of the plants were killed by the former fungus in some fields in Indiana. Hildebrand (1953) has also reported the disease serious in Ontario, Canada.

Stem canker is generally observed in late August and September and Athow and Caldwell (1954) have observed that natural infection never occurs before the plants are 70 days of age. Observation of the disease on the Hawkeye variety of soybean in Iowa has shown that infection rarely develops on a large scale before the plants are 100 days old. The causal organism is generally conceded to be disseminated by wind blown spores. Froshaiser and Kernkamp (1954) have reported production of pycnidia of the stem canker fungus on stems of a number of crop plants and weeds and that conidia may be more important as a source of inoculum than previously suspected.

Stem cankers occur almost without exception at a lower node of the main stem. This suggests the possibility of the fungus infecting the petiole and growing from the initial cite of infection into the main stem. *D. phaseolorum* var. *sojae* has frequently been isolated from petioles that have abscised from lower nodes of stems in July, and *D. phaseolorum* var. *caulivora* has occasionally been isolated from the same type of petioles. This study was made to

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determine the importance of petiole infection in stem canker disease. In considering petiole infection, the element of time is important because the fungus must grow down to the main stem and infect it before the petiole abscisses, or stem infection will not occur.

MATERIALS AND METHODS

Three soybean varieties were used in the study; Mandarin (Ottawa), an early maturing variety; Hawkeye, an intermediate variety; and Chief, a late variety. Each variety was planted in 10 foot rows and replicated 4 times. All varieties were planted on May 7, May 25, and June 12 in 1953 and May 12, June 7, and June 20 in 1954. The plants were inoculated by the toothpick method described by Crall (1952). In the 1953 test, petioles to be inoculated were cut off 1 inch from the stem and a toothpick tip bearing the fungus inserted in the cut end of the petiole stub. A small amount of petrolatum was added to cover the end of the toothpick tip to prevent drying. In the 1954 test, petioles were inoculated by inserting a toothpick tip in the uncut petiole 1 inch from the stem and exposed surfaces of the toothpick were covered with petrolatum. Ten plants of each row were inoculated on 5 different dates at 2 week intervals from early July through early September, using a different set of plants for each date. Thus, at each inoculation 40 plants of each variety were inoculated for each planting date.

RESULTS

One objection that might be raised to the 1953 experiment is that leaves and a large portion of a petiole were removed from plants just prior to inoculation. Such treatment might alter resistance or susceptibility of petioles to infection through physiologic changes. To study this point, intact petioles with leaves attached were inoculated 1 inch from the stems in a similar experiment in 1954. All plantings were made at dates later than those in 1953 and the plants from the last sowing were not large enough to be inoculated on July 12. Results were generally comparable to those obtained in 1953 (Tables 1 and 2) and it was concluded that removing the upper portion of the petiole and leaf had little effect on susceptibility. For this reason, discussion of results will be confined to the 1953 test.

Plants were examined 2 weeks after inoculation and the percent infection recorded. Considering the 1953 test (Table 1), younger plants from seed sown on May 25 and June 12 were more resistant to stem canker than the oldest plants from seed planted on May 7. Petiole resistance to infection by the fungus increased sharply for all plants as they began to approach maturity. At the time the data were recorded after the first inoculation, plants

from the first sowing were 75 days old, those from the second sowing 57 days, and those from the third sowing 39 days old. When the data were recorded after the last inoculation, plants from the first sowing were 131 days old, those from the second sowing 113 days, and those from the third sowing 95 days

Table 1

Average percentage infection with *D. phaseolorum* var. *caulivora* of the stems of 3 soybean varieties planted on 3 different dates. Plants were inoculated at 1 inch petiole stubs at 2 week intervals from July 7 through September 1, 1953

Inoculation Date	Average percent infection of stems								
	Mandarin(Ott.)			Hawkeye			Chief		
	Date of planting			Date of planting			Date of planting		
	5/7	5/25	6/12	5/7	5/25	6/12	5/7	5/25	6/12
7/7	90	70	50	80	76	70	80	60	73
7/21	75	33	43	63	43	53	68	43	50
8/4	50	18	20	63	30	53	33	48	23
8/18	1	1	0	13	22	1	43	30	20
9/1	....^a	....^a	....^a	20	18	1	45	25	45

*Plants were mature.

Table 2

Average percentage infection with *D. phaseolorum* var. *caulivora* of the stems of 3 soybean varieties planted on 3 different dates. Plants were inoculated at intact petioles 1 inch from the main stem, at 2 week intervals from July 12 through September 7, 1954

Inoculation date	Average percent infection of stems								
	Mandarin(Ott.)			Hawkeye			Chief		
	Date of planting			Date of planting			Date of planting		
	5/12	6/7	6/20	5/12	6/7	6/20	5/12	6/7	6/20
7/12	90	63	....^a	93	63	....^a	70	53	....^a
7/26	60	47	40	50	53	40	70	50	40
8/9	53	20	25	45	35	35	53	47	35
8/23	10	5	18	35	38	33	48	35	40
9/7	....^b	....^b	5	18	10	18	50	35	48

*Plants too young to inoculate

^bPlants were mature

old. Plants within a given sowing were most susceptible after the first inoculation. The largest percentage infection obtained in each variety was after the first inoculation of plants from seed sown on May 7. At the time the data were recorded these plants were 75 days old. From 75 days to maturity susceptibility decreased.

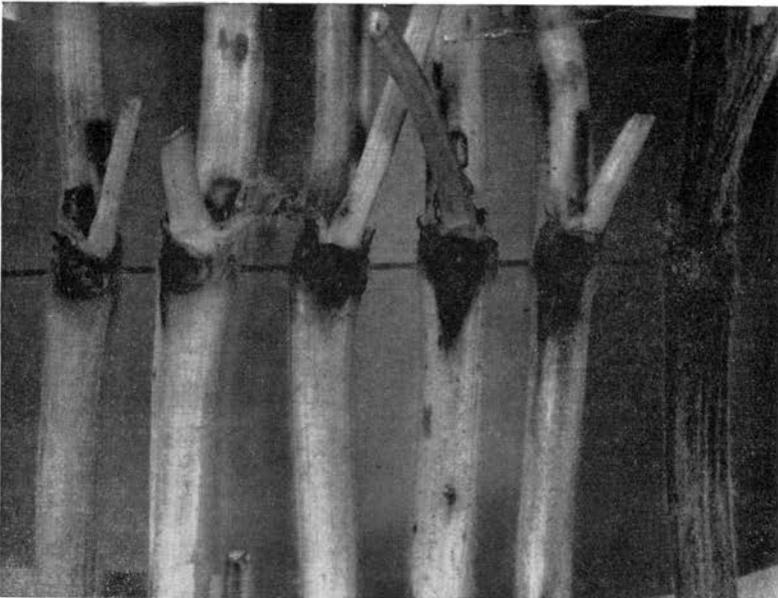


Fig. 1. Progressive development of stem canker disease of soybean. The stem on the left has been infected a short time and the canker is beginning to develop. The canker has girdled the stem on the right killing the portion of the plant above the canker.

This general relationship was similar for the other varieties with the exception that the late-planted Chief variety inoculated September 1 increased in susceptibility.

Considering both the 1953 and 1954 tests it appears that susceptibility of soybean plants to infection through petioles reaches a maximum about mid-July and then decreases. This, of course, presupposes that infection in nature occurs through petioles and not in the stem directly. It is noteworthy that the variety Mandarin (Ottawa) has never been observed to be naturally infected by the stem canker fungus in Iowa while Hawkeye and Chief are both commonly infected. It is also noteworthy that Chief remains susceptible to infection for a longer period than Hawkeye and much longer than Mandarin (Ottawa). An early variety thus might escape infection while a later variety would more likely become infected.

Plants from the second and third sowings never reached the level of susceptibility expressed by plants in the first sowing for the earliest inoculation. The reason for this is not clear. Mean temperatures are higher in July and early August than in the period preceding and following. It may be that rate of growth of the fungus was depressed and thus fewer plants were infected at a given stage in plant development.

It is a logical view of the fact that

inoculations were in the petioles and not in stems. Young, actively growing petioles would be much more likely to adhere to the stem after inoculation than would more mature petioles which tend to absciss readily. Also, younger tissues might offer more resistance to penetration of the fungus hyphae than would older tissues. It would seem then that soybean plants from early plantings (May 7) are most susceptible to attack by the fungus in petioles at about 75 days after planting, at a time when petiole tissues probably offer less resistance to penetration but do not absciss readily when infected. Since field grown plants have never been observed to be naturally infected prior to 70 days of age (1) and since the great majority of naturally infected plants are found much later than this (100-120 days for Hawkeye in Iowa), it appears unlikely that infected petioles could be an important source of infection for development of cankers on main stems.

Soybeans are usually sown in Iowa between May 15 and June 1 and thus, plants from seed sown at this time would be less susceptible to petiole infection than if seed were sown earlier. The May 25 planting most closely approximated an average planting date for Iowa. Seventy-six percent of the stems of Hawkeye plants from seed sown on May 25 were infected 2 weeks after the July 7 inoculation date when the plants were 57 days old. Two weeks after the September 1 inoculation date when the plants were 113 days old, only 18 percent of the stems were infected. If 18 percent of the stems were infected when the fungus was placed in petioles, it does not seem likely that 50 to 80 percent infection of stems via petioles could occur naturally. Considering that the tendency of petioles to remain attached to stems following the first inoculation decreased, and that formation of cankers is dependent upon the fungus entering the main stem at a node before the infected petiole abscisses, the possibility of such being the main source of infection so late in the season is rather remote. Results of this study indicate that although some of the earliest cankers may result from infected petioles the majority of infection cannot be attributed to this cause.

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