

EFFECT OF SEED-BORNE FUNGI ON SEED GERMINATION IN SOYBEANS

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SUMMARY

Seed of 46 soybean (*Glycine max* (L.) Merrill) genotypes in maturity groups V through VIII, consisting of 36 advanced breeding lines and 10 cultivars were tested for the presence of seed-borne fungi and germination on potato-dextrose agar at room temperature.

It was found that 61.6% of soybean seed infected with *Phomopsis spp.* did not germinate compared to only 8.6% of the seed infected by other fungi. Highly significant inverse relationships between germination percentage and percent of seed infected by *Phomopsis spp.* and other fungi at room temperature were evident. Seed infected by *Phomopsis spp.* was responsible for greater proportion of the variation in seed germination at room temperature. Some genotypes showing better germination and less seed infection by seed-borne *Phomopsis spp.* than the average genotype were identified. The occurrence of *Phomopsis spp.* was more frequent and germination was lower in early maturing genotypes than the late ones.

INTRODUCTION

Every population of soybean seeds is a potential carrier of various microorganisms, including fungi, bacteria, and viruses (Sinclair and Shurtleff, 1975). Prior to harvest many of them can invade soybean and reduce seed quality and viability. *Diaporthe phaseolorum* (Cke. and Ell.) var. *sojae* Whem. is one of the most important fungi lowering seed quality and affecting germination in soybeans. *Aspergillus spp.*, *Cercospora kikuchii* (T. Matsu and Tomoyasu) Gardner, and *Macrophomina phaseolina* (Tassi) Goid. are the others among fungi, contributing to lower seed quality in soybeans (Sinclair and Shurtleff, (1975).

The association of fungal species with soybean seeds has been reported from many parts of the world (Chamberlain and Gray, 1974; Franco Neto and Henning, 1980; Mengistu and Sinclair, 1979; Singh *et al.*, 1973), including Sri Lanka (Premala Jeyanandarajah, 1983). *Diaporthe phaseolorum* var. *sojae* was the predominant organism isolated from soybean seeds harvested in Illinois, U.S.A. (Chamberlain and Gray, 1974). Seed-borne *Aspergillus spp.* was isolated from 85% of the seed lots of a soybean cultivar "Lee 68" when seeds were incubated at 30°C (Dhingra *et al.*, 1973). Franco Neto and Henning (1980) found that the main factor leading to low germination in soybeans was seed infection with *Phomopsis spp.* One species of *Phomopsis* was isolated from seed lots produced in Sri Lanka and found lowering germination in soybeans (Premala Jeyanandarajah, 1983). Furthermore, an inverse correlation between germination and infection by *Diaporthe* in soybean seeds was reported by some workers (Kulik and Schoen, 1981; Tenne *et al.*, 1974; Wallen and Cuddy, 1960).

Kilpatrick (1957) observed that in general 100% fungal infection of soybean seed occurred sooner in early maturing varieties or strains than in the late ones. In contrast, the occurrence of the fungi *Phomopsis spp.* was found related to year and growing region but not to cultivar (Foor *et al.*, 1976).

The research reported in this paper was conducted to assess the infection by seed-borne fungi in the seed lots of 46 soybean genotypes produced in the East Texas, and their influence on seed germination at room temperature.

MATERIALS AND METHODS

Seed of 46 soybean genotypes in maturity group V through VIII, consisting of 36 advanced breeding lines and 10 cultivars, were assessed for infection by seed-borne fungi and their effect on germination at room temperature (approximately 25°C). The seeds for the test were produced from planting made during the first week of May 1981 and harvested in October at the Texas A & M University Agricultural Research and Extension Centre, Beaumont, Texas, U.S.A. The seeds were kept in cold storage until tested at the same institution. A completely randomized design with five replications was adopted for this experiment.

Twenty-five randomly selected seeds from each advanced breeding line or cultivar were surface disinfected by soaking in 0.5% sodium hypochlorite (10% Clorox) solution for four minutes and rinsed with sterile distilled water

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for one minute. The seeds were plated on potato-dextrose-agar (PDA) in 10 cm culture plates with five seeds per plate. The five replications of five seeds each for each genotype were incubated at room temperature (approximately 25°C). The number of germinated seeds and the number of seeds infected by *Phomopsis spp.* (*Phomopsis sojae* Leh., *Diaporthe phaseolorum* var. *sojae*, and *D. phaseolorum* var. *caulivora* Athrow and Caldwell) and other fungi (*Fusarium spp.*, *Cercospora kikuchii*, and *Macrophomina phaseolina*) were recorded after five days. A seed was considered germinated when the length of the radicle was one and one-half times the length of the seed and was apparently healthy. All data were analyzed by using linear correlations and regressions.

RESULTS AND DISCUSSION

The percentages of germination, seed infected with *Phomopsis spp.* and with other fungi are tabulated in Table 1. The germination percentage of the genotypes included in this experiment ranged from 12.0 to 100.0 while percentages of seed infected by *Phomopsis spp.* and other fungi respectively, varied from 4.0 to 100.0 and zero to 60.0 when germinated on PDA at room temperature. This indicates that the material utilized in this investigation had a wide range in seed quality.

An average of 31.7% of the seeds infected by *Phomopsis spp.* did not germinate as compared to only 1.5% of the seeds infected by other fungi (Table 1). Among these 46 genotypes, 61.6% of the *Phomopsis* infected seed and 8.6% of the seed infected by other fungi failed to germinate at room temperature. Furthermore, 95.5% of the nongerminated seeds were found infected by *Phomopsis spp.* Earlier findings also indicated that nongerminated seeds and low rate of germination were associated with heavy infection of *Phomopsis spp.* (Chamberlain and Gray, 1974).

The genotypes F77-1797, D77-6166, F77-1880, Centennial, D76-9695, and F77-1790 showed better germination and less seed infection by *Phomopsis spp.* compared to the rest of the genotypes included in this test. These genotypes were beyond the range of one standard deviation from the mean (Table 1). Infection by *Phomopsis spp.* was found to be greater and germination was lower in early maturing group V soybean genotypes R74-511, S77-7865, D77-6057, Nathan, N77-179, Essex, and R75-579 than the others in maturity groups VI through VIII. Therefore, it appears that

there is genotypic variation in seed infection by *Phomopsis spp.* and early maturing genotypes seem to be more susceptible to this fungal infection. This is in agreement with the observations made by Kilpatrick (1957). The genotypes showing better germination and less seed infection by *Phomopsis spp.* than the average genotype were also identified among the ones included in this investigation.

Seed infection by *Phomopsis spp.* and other fungi explained a large proportion of the variation in seed germination, which was indicated by high coefficients of determination (r^2) between germination and seed infection by these seed-borne fungi (Figures 1 and 2); however, of which the infection by *Phomopsis spp.* had great influence. Large negative slopes ($b=0.7402$ for germination and seed infection by *Phomopsis spp.* and $b=0.8826$ for germination and seed infection by *Phomopsis spp.* and other fungi) indicated the relative importance of seed-borne *Phomopsis spp.* and other fungi on seed germination at room temperature. Data from this study and others (Chamberlain and Gray, 1974; Foor *et al.*, 1976) show that examination of soybean seeds for seed-borne fungi including *Phomopsis spp.* and germination are important to determine seed quality in soybeans. Y intercepts above 100% in the regression equations (Figures 1 and 2) resulted from the germination of soybean seeds that were infected by fungi (Table 2) reveal that seed lots may tolerate some level of infection by seed-borne fungi.

Highly significant negative coefficients of correlation were found between percentage germination and percent of seed infected by *Phomopsis spp.* and percentage germination and percent of seed infected by other fungi (Table 3). However, the relationship between germination and infection by *Phomopsis spp.* was found to be more closely associated than that of germination and infection by other fungi. Similar relationship has been stated earlier by Kulik and Schoen (1981), Tenne *et al.* (1974), and Wallen and Cuddy (1960).

CONCLUSIONS

From this investigation it appears that *Phomopsis spp.* are the predominant fungi associated with nongerminated seeds in soybeans. Increase of seed infection by seed-borne *Phomopsis spp.* and other fungi seems to reduce the germination, of which *Phomopsis spp.* are more harmful to germination of soybean seed. However, soybean seed may tolerate some level of infection by these fungi. Examination of soybean seed lots for seed-borne fungi with more attention to *Phomopsis spp.* would be a useful criterion, in addition to germination test for determining seed quality in soybeans. This should be specially adhered to in early maturing soybean cultivars because of the fact that early maturing cultivars appear to be more susceptible to infection by seed-borne *Phomopsis spp.* than the late ones.

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ACKNOWLEDGEMENTS

The author wishes to express his sincere appreciation to Dr. Olin D. Smith and Dr. Glenn R. Bowers of the Texas A & M University, College Station, Texas, U.S.A. for their continuous encouragement and untiring efforts during the course of this study. He would like to thank FAO for providing financial assistance that enabled him to conduct this investigation.

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Table 1. Percentages of germination and infection by *Phomopsis* spp. and other fungi in surface sterilized seed of 46 soybean genotypes incubated at room temperature.

<i>Genotype</i>	<i>Germination</i>	<i>Nongerminated seed with</i>		<i>Total seed with</i>	
		<i>Phomopsis spp.</i>	<i>Other fungi</i>	<i>Phomopsis spp.</i>	<i>Other fungi</i>
F77-1797	100.0*	0.0	0.0	12.0	20.0
D77-6166	96.0	4.0	0.0	24.0	28.0
F77-1880	96.0	0.0	0.0	4.0	36.0
Centennial	92.0	8.0	0.0	20.0	0.0
D76-9695	92.0	8.0	0.0	16.0	24.0
F77-1790	92.0	8.0	0.0	12.0	36.0
F77-1995	88.0	12.0	0.0	68.0	20.0
N77-940	88.0	12.0	0.0	36.0	28.0
C079-501	84.0	12.0	4.0	12.0	44.0
D77-7926	84.0	12.0	0.0	36.0	16.0
F76-8757	84.0	16.0	0.0	36.0	16.0
F77-7142	84.0	12.0	0.0	28.0	24.0
Wright	84.0	12.0	0.0	52.0	16.0
D77-12	80.0	20.0	0.0	64.0	12.0
Hutton	80.0	20.0	0.0	40.0	24.0
N76-1507	80.0	20.0	0.0	36.0	24.0
D78-5576	76.0	24.0	0.0	44.0	12.0
F77-1576	76.0	20.0	4.0	32.0	24.0
Braxton	72.0	24.0	0.0	52.0	28.0
F77-1793	72.0	20.0	4.0	36.0	36.0
R74-39K	72.0	24.0	4.0	68.0	20.0
Cobb	68.0	24.0	8.0	28.0	60.0
F77-2000	68.0	28.0	4.0	32.0	16.0
F77-7450	68.0	32.0	0.0	32.0	32.0
Forrest	68.0	24.0	4.0	44.0	8.0
N75-2213	68.0	32.0	0.0	64.0	8.0
F76-8827	64.0	32.0	0.0	52.0	16.0
D76-9454	64.0	36.0	0.0	44.0	8.0
D78-5502	64.0	32.0	0.0	52.0	16.0
Jeff	64.0	32.0	0.0	52.0	8.0
Tracy (M)	64.0	24.0	0.0	56.0	8.0
D77-6103	60.0	40.0	0.0	60.0	24.0

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Table 1 continued

<i>Genotype</i>	<i>Germination</i>	<i>Nongerminated seed with</i>		<i>Total seed with</i>	
		<i>Phomopsis spp</i>	<i>Other fungi</i>	<i>Phomopsis spp.</i>	<i>Other fungi</i>
D78-3238	60.0	40.0	0.0	60.0	0.0
N77-114	52.0	48.0	0.0	88.0	12.0
V75-345	52.0	48.0	0.0	72.0	0.0
V76-600	52.0	44.0	4.0	84.0	4.0
F77-7016	48.0	40.0	12.0	48.0	32.0
F77-1840	40.0	60.0	0.0	76.0	12.0
N77-1602	40.0	60.0	0.0	60.0	16.0
R75-579	40.0	60.0	0.0	80.0	4.0
Essex	32.0	68.0	0.0	100.0	0.0
N77-179	32.0	64.0	4.0	84.0	8.0
Nathan	32.0	68.0	0.0	96.0	0.0
D77-6057	28.0	72.0	0.0	84.0	4.0
S77-7865	20.0	76.0	4.0	96.0	4.0
R74-511	12.0	88.0	0.0	88.0	4.0
Mean	66.0	31.7	1.5	50.6	17.5
Standard deviation	21.8	22.0	2.5	25.3	13.0

*Values are in percentages and means of five replications.

Table 2. Relation of *Phomopsis spp.* and other fungi to germination of selected soybean genotypes at room temperature.

<i>Genotype</i>	<i>Germination</i>	<i>Nongerminated seed with</i>		<i>Germinated seed with</i>	
		<i>Phomopsis spp.</i>	<i>Other fungi</i>	<i>Phomopsis spp.</i>	<i>Other fungi</i>
F77-1797	100.0*	0.0	0.0	12.0	20.0
D77-6166	96.0	4.0	0.0	20.0	28.0
Centennial	92.0	8.0	0.0	12.0	0.0
Hutton	80.0	20.0	0.0	20.0	24.0
D76-9454	64.0	36.0	0.0	8.0	8.0
D78-3238	60.0	40.0	0.0	20.0	0.0
Essex	32.0	68.0	0.0	32.0	0.0
D77-6057	28.0	72.0	0.0	12.0	4.0
R74-511	12.0	88.0	0.0	0.0	4.0
Mean of 46 genotypes	66.0	31.7	1.5	18.9	16.0

*Values are means of five replications of five seeds each in percentages.

Table 3. Coefficients of correlation between germination percentages and percent of seed infection by *Phomopsis spp.* and other fungi at room temperature.

<i>Percent of seed infection</i>	<i>Germination percentage</i>
Nongerminated seed with <i>Phomopsis spp.</i>	-0.99**
Other fungi	-0.17
Total seed with <i>Phomopsis spp.</i>	-0.83**
Other fungi	-0.51**

**Significant at $P=0.01$

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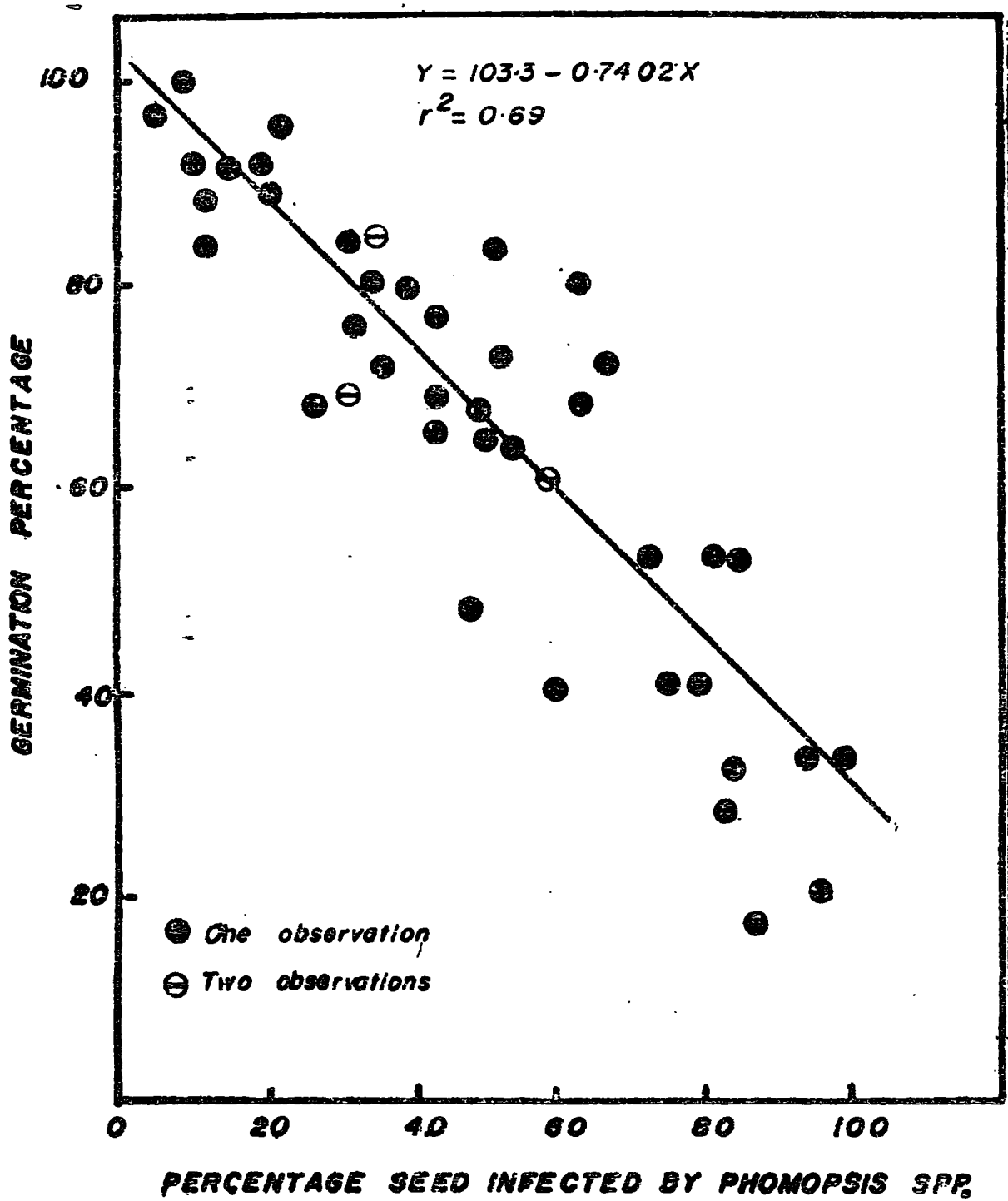


Figure 1. Relationship between germination and the infection of *Phomopsis* spp. in soybean seed incubated at room temperature.

