Relationship of Environmental Factors to Development of *Sclerotinia minor* and Sclerotinia Blight of Peanut

by

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CHAPTER ONE

INTRODUCTION, LITERATURE REVIEW, OBJECTIVES

Sclerotinia blight of peanut (Arachis hypogaea L.) caused by Sclerotinia minor Jagger, in a few short years, has gone from an unknown to a major disease in Virginia. The following literature review provides information on both the disease and causal organism.

Literature Review

The first report of a peanut infected by a Sclerotinia spp. was from Argentina in 1922 (Marchionatta, 1922). The disease was called peanut wilt and the causal organism was identified as S. trifoliorum Ericks. Sclerotinia arachidis (Hanzawa) Yamamoto and S. miyabeana Hanzawa were associated with a peanut disease in China in 1933 (Chu, 1933). Kohn (1979b) designated S. arachidis as Botryotinia arachidis (Hanzawa) Yamamoto and was unsure of the taxon of S. miyabeana. Peanut wilt caused by S. sclerotiorum (Lib.) DeBary was reported in China in 1936 (Anon., 1936). An Australian communication of new plant diseases in 1948

listed peanut root and crown rot caused by S. minor Jagger (Anon., 1948). Peanut root and pod rot were found to be caused by S. minor and S. sclerotiorum in Argentina in 1960 (Frezzi, 1960).

The first discovery of Sclerotinia disease of peanut in the United States was made in 1971 in Virginia (Porter and Beute, 1973; Porter and Beute, 1974). The disease was called Sclerotinia blight of peanut and was caused by S. minor. In 1972, it was reported in North Carolina (Porter and Beute, 1974) and Oklahoma (Wadsworth, 1979).

There has been considerable controversy surrounding the taxonomy of S. minor and the other Sclerotinia spp. (Chivers, 1929; Kohn, 1979a, 1979b; Korf, 1974; Willets and Wong, 1980). The reorganization of the genus Sclerotinia by Whetzel (1945) provided the source of the major controversy. Whetzel placed the type specimen for the genus in a new genus, Ciborinia. By the rules of the International Code of Botanical Nomenclature, the type specimen should have remained Sclerotinia while other fungal members which didn't belong to this group should have been renamed. Following this reasoning, Whetzelinia sclerotiorum was proposed by Korf and Dumont (1972) as a new name for Sclerotinia sclerotiorum. After this, W. sclerotiorum was also used in the literature for S. minor and S. sclerotiorum. However

the change to Whezelinia met opposition from many plant pathologists and mycologists who felt that the extensive literature on S. sclerotiorum would become confused. They felt that since S. sclerotiorum represented Whetzel's concept of the Sclerotineaceae and because of its importance, the genus should be retained. Such a proposal was presented to the Special Committee on Fungi and Lichens and the General Committee of the International Association of Plant Taxonomists and it was accepted (Kohn, 1979a). A monographic revision of the genus Sclerotinia retained only S. minor, S. trifoliorum, and S. sclerotiorum as valid species and reassigned or placed in synonymy all other species (Kohn, 1979b).

Sclerotinia minor was described by Jagger in 1920 (Jagger, 1920). Keay (1939), Whetzel (1945), Bjorling (1951), Williams and Western (1965a) and Buchwald and Neergaard (1973) supported S. minor as a separate species. Purdy (1955) placed it under S. sclerotiorum designating it S. sclerotiorum 'minor'. Walker (1969); Morrall et al. (1972); and Price and Colhoun (1975) lumped S. minor, S. trifoliorum, and S. sclerotiorum together under S. sclerotiorum. It is the opinion of Wong and Willets (1973, 1975a, 1975b) that S. minor merits a distinct species classification based on conventional mycological taxonomic

methods (morphological characteristics and host range) as well as physiological tests (gel electrophoresis and mycelial compatibility) (Wong and Willets, 1973; Wong and Willets 1975a; Wong and Willets, 1975b). Willets and Wong (1980) compiled a list of factors distinguishing S. minor as a distinct species.

Sclerotinia minor was first observed in the U.S. as a pathogen in east coast lettuce and celery fields (Jagger, 1920). It has a broad host range (Willets and Wong, 1980). but has been studied most on lettuce (Abawi and Grogan, 1979; Adams and Tate, 1975; Letham et al., 1978). Sclerotinia minor may infect all parts of the peanut plant but primarily attacks pegs and lateral branches (Porter and Beute, 1974) Sclerotia serve as primary inoculum (Adams and Ayers, 1979). Sclerotia lying on or near the soil surface germinate myceliogenically and infect adjacent host tissue. A small, light green, water-soaked lesion is formed during humid weather similar to that described on bean hypocotys by Lumsden and Dow (1973). During drier conditions the lesion appears sunken. After a few days the lesion bleaches becoming tan. The infected tissue becomes shredded and small, irregular-shaped, black sclerotia (0.5-2.0 mm) form on the surface of the branches, inside the branches, or in infected pods, tap root cortex, pegs, and pod matrix (Porter

and Beute, 1974). The first major noticeable symptom of plant infection is the wilting or flagging of the tips of infected branches. Close scrutiny of portions of the wilted branch touching the ground or other infected tissue reveals lesion development.

Death of portions of plants or entire plants and loss of pods result in significant peanut yield losses (Porter et al., 1977). Losses have been estimated as high as $11,000,000 (>15% of the crop) for a single season (Thomas et al. 1981). Sclerotinia blight is currently considered the single most serious disease of peanuts in Virginia (D. M. Porter and P. M. Phipps,1981, pers. comm.). Table 1 shows the national estimated losses due to Sclerotinia blight for 1977-1980 (J. E. Bailey, 1981, pers. comm.; Phipps, 1978, 1979, 1980; R. V. Sturgeon, 1981, unpub. data; Sturgeon and Jackson, 1977; Thomas et al., 1981; J. C. Wells, 1980, unpub. data).

Sclerotinia minor overwinters as sclerotia (Adams and Ayers, 1979). Sclerotia are known to remain viable for several (3-5) years in field soil (Adams and Ayers, 1979; Porter and Steele, 1981) and can increase in the soil by production of secondary sclerotia (Adams, 1975). A 90% reduction in sclerotial population was found when sclerotia-containing soil was maintained at 35 C for six

Table 1. Estimated national losses due to Sclerotinia blight of peanut, 1977-1980.

Year	Type Loss	Estimated Loss		
		Virginia	North Carolina	Oklahoma
1977	%	2.0[u]	0.5[v]	1.5[w]
	$	1,135,680[u]	500,000[v]	825,930[w]
1978	%	7.0[u]	3.0[x]	0.5[x]
	$	5,352,941[u]	-	-
1979	%	5.0[u]	1.0[x]	1.0[x]
	$	3,098,592[u]	-	-
	%	>15[y]		
	$	11,000,000[y]		
1980	%	0.1[z]	0.0[v]	-
	$	15,625[z]	0[v]	-

[u]Phipps, 1978 , 1979, 1980.

[v]Bailey, T. E., 1981, pers. comm.

[w]Sturgeon and Jackson, 1978.

[x]Report of Peanut Plant Disease Loss Committee, 1980. Compiled by J. C. Wells, Chairman.

[y]Thomas, et al., 1981.

[z]Report of Peanut Plant Disease Loss Committee, 1981. Compiled by R. V. Sturgeon, Chairman.

weeks in the laboratory (Adams, 1975). Reduction in Sclerotinia spp. sclerotial inoculum in the field has been accomplished by flooding (Darley, 1961; Moore, 1949) and deep plowing (A. Greathead, 1980, pers. comm.). Alternate wetting and drying of S. minor and S. sclerotiorum sclerotia were shown to increase germination (Adams and Tate, 1975; Smith, 1972). Although increasing soil moisture increases the degeneration of Sclerotinia sclerotia, a balance between destruction and secondary sclerotium formation under saturated conditions has been reported by Williams and Western (1965b).

Carpogenic germination of S. minor sclerotia has been reported in Oklahoma (Wadsworth, 1979). Hadley and Beute (pers. comm.) observed apothecia in early March through April of 1974 in the previous year's peanut fields in Northampton County, North Carolina. Since peanut plants were not present at this time of the year, ascosporic infection did not occur. Carpogenic germination of S. minor sclerotia in Virginia peanut fields has not been reported. However, sclerotia of several Virginia peanut isolates, growing on glucose yeast extract agar, produced apothecial initials after two to three months storage in the

refrigerator (R. L. Dow and D. M. Porter, unpub. data) . Although present results indicate that ascospore production is not important in the disease cycle in Virginia and North Carolina, it may have a minor role in Oklahoma (Wadsworth, 1979).

Sclerotinia blight disease resistance has been reported by Porter et al. (1975). 'Florigiant' was the most resistant of 19 genotypes tested. Recently Coffelt and Porter (1981) have shown that 'Chico' and two numbered genotypes have greater resistance than 'Florigiant'. These varieties are believed to have resistance based on morphological escape due to canopy architecture. Two of the genotypes also have physiological resistance.

In Virginia, DCNA (dichloronitroaniline, made by Upjohn, Kalamazoo, MI) is recommended for control of Sclerotinia blight of peanut. Numerous other fungicides have been tested but with generally unsatisfactory results (Beute et al., 1975). Procymidone, an unlabeled fungicide provided by the Dupont Company, gave nearly complete control of Sclerotinia blight of peanut in Virginia (Phipps and Porter, 1979; Porter, 1980b). Suppression has also been obtained by use of dinitrophenol herbicides (Porter and Rud, 1980).

Sclerotinia diseases have generally been associated with specific environmental conditions. Many researchers have mentioned increased disease with cool weather (Abawi and Grogan, 1975; Burke et al., 1957; Chupp and Sherf, 1960; Eddins, 1937; Letham et al., 1978; Moore, 1955; Wadsworth, 1979; Weiss et al., 1980a; and Willets and Wong, 1980) and wet conditions (Abawi and Grogan, 1975; Abawi and Grogan, 1979; Adair, 1971; Eddins, 1937; Grogan and Abawi, 1975; Haas and Bolwyn, 1972; Letham et al., 1978; Moore, 1955; Moore et al., 1949; Natti, 1971; and Weiss et al., 1980b). Other factors such as canopy density (Coyne et al., 1974; Eddins, 1937; Haas and Bolwyn, 1972; Letham et al., 1976; Letham et al. , 1978; Partyka and Mai, 1962; Schwartz and Steadman, 1978; Skotland and Menzies, 1957; and Weiss et al., 1980a), plant growth habit (Blad et al., 1978; Coffelt and Porter, 1981; Coyne et al., 1974; Hawthorne, 1974; Natti, 1971; Partyka and Mai, 1962; Schwartz and Steadman, 1978; Schwartz et al., 1978; Steadman, et al. 1973), plant maturity (Burke et al, 1957; Haas and Bolwyn, 1972; Hawthorne, 1974) row spacing (Huang and Hoes, 1980 ; Steadman et al., 1973), row direction (Haas and Bolwyn, 1972), field location (Bennett and Elliott, 1972; Eddins, 1937; Haas and Bolwyn, 1972), soil type (Burke et al., 1957), and soil pH (Haas and Bolwyn, 1972). Agronomic

practices like tractor usage (Porter and Powell, 1978) and irrigation (Anon. 1980; Blad et al., 1978; Schwartz and Steadman, 1978; Weiss et al., 1980a) have also been cited. The use of fungicides such as chlorothalonil and captafol for Cercospora leafspot control have been shown to enhance the severity of Sclerotinia blight of peanut (Porter, 1980a).

The epidemiology of Sclerotinia diseases varies with species. Most S. sclerotiorum and S. trifoliorum infections arise from ascosporic inoculum (Abawi and Grogan, 1979) although sclerotia may also serve as primary inoculum (Burke et al., 1957; Huang and Hoes, 1980). Infections from S. minor are initiated primarily from myceliogenic germination of sclerotial inoculum (Abawi and Grogan, 1979; Adams, 1975). Several epidemiological studies of S. sclerotiorum on various hosts have been conducted (Abawi and Grogan, 1975; Abawi and Grogan, 1979; Cook et al.,1975; Haas and Bolwyn, 1972; Moore, 1955; Natti, 1971; Partyka and Mai, 1962; Stevens, 1911; Suzui and Kobayashi, 1972). However, most of this work is not applicable to Sclerotinia blight of peanut in Virginia since the primary inoculum for the disease is sclerotial instead of ascosporic. The epidemiology of S. minor has been studied primarily on lettuce (Adams and Tate, 1975; Jarvis, 1972). Little is

known however, about the specific environmental factors conducive to development of Sclerotinia blight of peanut. This study was undertaken to provide necessary information for an epidemiological understanding of this disease in Virginia.

Objectives

The general objective of this research was to determine the effects of environmental factors on Sclerotinia blight of peanut. Specific objectives were:

a) to determine *in vitro* the optimum temperature for myceliogenic sclerotial germination and growth of *Sclerotinia minor* Jagger,

b) to determine the effect of temperature on pathogenesis in 'Florigiant' peanut in the laboratory and field,

c) to determine the effect of relative humidity on myceliogenic germination of sclerotia,

d) to monitor environmental factors and development of Sclerotinia blight under field conditions and determine the relationships involved,

e) to determine the effects of peanut canopy modifications on Sclerotinia blight, and

f) to forecast disease development and apply control measures accordingly.

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CHAPTER TWO

RELATIONSHIP OF ENVIRONMENTAL FACTORS TO GERMINATION, GROWTH, AND INFECTION OF PEANUT BY SCLEROTINIA MINOR UNDER LABORATORY CONDITIONS

Introduction

Temperature and moisture are commonly mentioned as significant factors affecting development of diseases caused by Sclerotinia spp.. Sclerotinia minor grows over the range of 0-35 C on agar media (Goidanich, 1939; Keay, 1939 and Sereni, 1944). The relationship between mycelial growth of Sclerotinia spp. and temperature has been summarized by Willets and Wong (1980).

Infection of susceptible hosts by Sclerotinia spp. can occur over a range of temperatures from 0 to 28 C with the optimum at 15-21 C and nearly as invasive at 10 to 24 C (Chupp and Sherf, 1960). Abawi and Grogan (1975) found 20-25 C optimum for S. sclerotiorum mycelial growth, lesion initiation and development in bean. Disease development in Great Northern beans occurred from 10 to the optimum of 25 C but not at 30 C (Weiss et al., 1980). However, if infection occurred at 25 C with a subsequent 24 hours at 30 C and then

was returned to 25 C, disease would develop slowly. Haas and Bolwyn (1972) reported that a 15-25 C humid, warm microclimate was necessary for S. sclerotiorum infection of white beans. Gupta (1963) reported infection of coriander by S. sclerotiorum occurred at soil temperatures of 19 and 24 C but not at 29 and 33 C.

Sclerotinia sclerotiorum was found by Van den Berg and Lentz (1968) to grow at a relative humidity (RH) greater than 93% when nutrients were available. Mycelial growth stopped at less than 93% RH but the mycelium survived for up to one month. At 0 C, mycelium without nutrients survived at 95-100% RH. Sclerotinia sclerotiorum mycelial growth at 25 C was stimulated with decreasing osmotic potential (Y) from -1 to -14 bars; at lower Ys growth was reduced. After three days, growth was unrecordable at -91 bars but following 2-3 weeks, some growth occurred even at -100 bars (Grogan & Abawi, 1975). Lesion development on dehisced bean leaves from osmotically adjusted agar discs of S. sclerotiorum was increased when the Y of the medium decreased from -1 to -24 bars. Lesion diameter was similar for inocula grown on media with Y from -24 to -56 bars but decreased with media of Y less than -56 bars. Lesion initiation ceased with inoculum grown on media at -91 bars. Although mycelial growth and lesion development for various

Y values closely correlated, Grogan and Abawi (1975) found the near-optimal Y for lesion formation covered a broader range than that for mycelial growth.

Sclerotial germination of lettuce isolates of S. minor was best at soil moisture near field capacity (FC) (-.3 bars), however, considerable germination occurred at a soil water potential of -2 bars. Results of one experiment showed germination was 5, 95, 65, 36, 9, and 2% for soil water potentials of 0, -0.05, -0.2, -1.0, -2.0, and -5.0 bars, respectively (Abawi & Grogan, 1979).

Lettuce drop, caused by S. minor, was more severe when the soil moisture fluctuated between 100% FC and 30-40% FC than when it fluctuated between 100% and 80-90% FC (Adams and Tate, 1975).

Bean lesions caused by S. sclerotiorum were shown to require free moisture (Abawi and Grogan, 1975); lesion enlargement abruptly stopped if the infected tissue surface (except bulky stem tissues) became dry. Lesion expansion resumed when free water became available.

Since infection of peanut results from myceliogenic germination of sclerotia, conditions affecting germination influence the incidence of Sclerotinia blight. Information on the factors required for germination and infection may be useful to improve the timing of fungicide applications and

to develop cultural practices that suppress the rate of disease development.

The objectives of this research were: 1)to determine the optimum temperature for the myceliogenic germination and growth of three isolates of S. minor from the Virginia peanut growing region; 2) to determine the pathogenicity of three isolates on 'Florigiant' peanut; 3) to determine the optimum temperature for disease development of a selected isolate; 4) to observe the effect of different substrates on myceliogenic germination at different temperatures; 5) to determine the optimum RH for germination; 6) to observe the effect of varying humidity conditions on germination; 7) to observe the effect of tissue age, tissue location, and tissue type on infection at different temperatures and/or RHs. An abstract of these temperature studies has been published (Dow et al., 1981).

Materials and Methods

Temperature effects on myceliogenic sclerotial germination and mycelial growth.

Three isolates of S. minor (Sm1, Sm2, Sm3) from the Virginia peanut growing region were used. Sm1 was obtained

from infected horsenettle (Solanum carolinense L.), Sm2 from soybean (Glycine max (L.) Merr.), and Sm3 from peanut. The cultures were maintained on Difco potato-dextrose agar (PDA).

Unwashed sclerotia, scraped from 2-week-old PDA cultures were dried in a Microvoid transfer hood (Air Control Inc., Huntingdon PA) with constant filtered air flow for 24 hours. Seven sclerotia per isolate were placed on PDA in 9-cm diameter plates. Five plates of each isolate were incubated at 10, 15, 20, 25, and 30 C. Myceliogenic sclerotial germination and radial growth were measured after one, two, and three days.

For all the following experiments, sclerotia were produced at 20 C on a sterile medium of soil-cornmeal (50 g soil-cornmeal(5% w/w) + 20 ml distilled water in 9-cm-diameter petri dishes). Sclerotia were scraped from the surface of 2-week-old cultures, vigorously washed under high pressure tap water for ten minutes and dried on a screen in the transfer hood with constant air flow for 24 hours.

After studies on pathogenicity, isolate Sm3 was used for all further tests. Twenty sclerotia were placed on acid washed glass slides supported on glass rods above water in a petri dish or on moistened filter paper in a petri dish to

determine the effect of substrate on germination at different temperatures. Five dishes of sclerotia on slides and five dishes with sclerotia on filter paper were maintained at 15, 20, 25, or 30 C. Myceliogenic germination was observed after eight days.

Temperature effects on infection and colonization of peanut.

Three detached, fresh, fully expanded, young peanut leaflets were placed on moist filter paper in a petri dish. The leaflets were randomly selected from a collection of detached leaflets from several plants. Five sclerotia were spaced evenly on each of the three leaflets. Four plates of leaflets were incubated at each of four temperatures (15, 20, 25, 30 C). Germination and infection were monitored for one week.

Six week old 'Florigiant' plants were inoculated with a 7-mm diameter mycelial disc from an actively growing Sm3 PDA culture. The inoculum was placed on the lower internodes of the main stem and two lateral branches of each plant. Sterile moist gauze was held in place over the inoculum with masking tape. Five watered plants were placed in an inflated clear plastic bag in a 12-hr light cycle growth chamber set to establish temperatures in the bags of 15, 20, 25, or 30 C. Observations on infection, based on symptom expression, and lesion measurements were made after eight days.

Pathogenicity of three isolates on 'Florigiant' peanut.

To determine the most pathogenic isolate, three, two-month-old 'Florigiant' peanut plants were inoculated with mycelial inoculum of Sm1, Sm2, or Sm3 placed on two lateral branches and on the main stem as previously described. The plants were incubated at 20 C (a temperature providing optimum axenic growth on PDA). The percent infection (based on the presence of symptoms) and lesion length were determined after two weeks.

Tissue age effects on colonization and comparative susceptibility of lateral branch versus main stem tissue.

The main stem and two lateral branches of three 2-month-old 'Florigiant' peanut plants (not blossoming or pegging) and three 4-month- old 'Florigiant' peanut plants (blossoming and pegging) were inoculated with PDA disc mycelial inoculum and incubated at 20 C in a growth chamber as described previously. Observations on disease development were made after one week. This experiment was repeated using 6-week-old and 13-week-old plants.

Relative humidity effects on myceliogenic sclerotial germination.

Twenty sclerotia were placed on two sterile glass slides supported on glass tubing above saturated solutions in petroleum jelly-sealed, storage dishes (80 mm height x

100 mm diameter). Saturated solutions (Winston and Bates, 1960) of NH4NO3 + NaNO3, glucose, NH4NO3, NaCl + KCl, K tartrate, NH4Cl, KCl, Na tartrate, CaHPO4.2H20, and distilled, deionized water were used to establish RHs of 52.0, 55.0, 65.5, 70.0, 75.0, 79.5, 85.0, 92.0, 95.0, and 100%, respectively. Two dishes were used for each RH. The dishes were submerged in water and placed in a 20 ±0.5 C incubator.

Similarly the experiment was carried out at 25 C with the same saturated solutions establishing RHs of 50.0, 55.0, 62.5, 71.5, 75.0, 78.0, 85.0, 92.0, and 97.0%, respectively (Winston & Bates, 1960). Germination was counted at one and two weeks.

In another similar experiment, after one week's incubation the solutions under the sclerotia were changed to distilled deionized water and germination assessed after another week of incubation.

Another experiment was conducted to determine the amount of time for germination of most of the sclerotia and to determine if subjecting sclerotia to a drying and then wetting period would affect germination. Sclerotia were placed on slides above sterile deionized distilled water at 20 C. Every 12 hours, myceliogenic germination of 20 sclerotia was counted until a time when nearly all sclerotia

had germinated. After counting germination, slides containing the 40 sclerotia were transferred to dishes containing a solution establishing 79.5% RH. This was chosen because germination had not occurred at this RH but this RH had been observed under the canopy in the field. After a 2-day drying period, germination was counted. The slides containing the sclerotia which were exposed initially to varying periods of 100% RH were retransferred to dishes maintained at 20 C and 100% RH. After four days, germination was counted again. This experiment was repeated twice.

All experiments were repeated at least three times unless otherwise noted. Results were analyzed using analysis of variance and Duncan's multiple range test (P = 0.05).

Results

Temperature effects on myceliogenic germination and mycelial growth.

Figure 1 shows germination of sclerotia of the three isolates on PDA at five temperatures for three days. Percent myceliogenic germination at all temperatures after

three days was higher for isolate Sm2 than for Sm1. Percent germination for Sm3 was midway between Sm2 and Sm1. Depending on the replication of the experiment, germination of Sm3 was statistically similar to Sm1 or Sm2.

Myceliogenic germination was generally significantly better for all isolates after 24 hours at 20 C than at 10, 15, 25, or 30 C. Sm3 varied from replication to replication with sometimes better germination at 20 and sometimes better at 25 C. After three days, little difference was found in percentage germination among the isolates at 15, 20, and 25 C. Germination after three days was greater than 70% at each temperature except 30 C.

Isolate Sm3 germinated best at 20 to 25 C after eight days on moist filter paper (Fig. 2) or glass slides. Eruptive mycelial germination was common at 15 and 20 C while hyphal germination (single or few strands) was more characteristic at 10, 25, and 30 C. Mycelial growth after three days on PDA was optimum at 20-25 C for all isolates (Fig. 3).

Temperature effects on infection and colonization of peanut.

Germination of sclerotia on detached peanut leaflets was significantly better at 20 and 25 C than at 15 or 30 C. (Fig. 4). There was no difference between 15 and 25 C. Negligible infection occurred at 30 C.

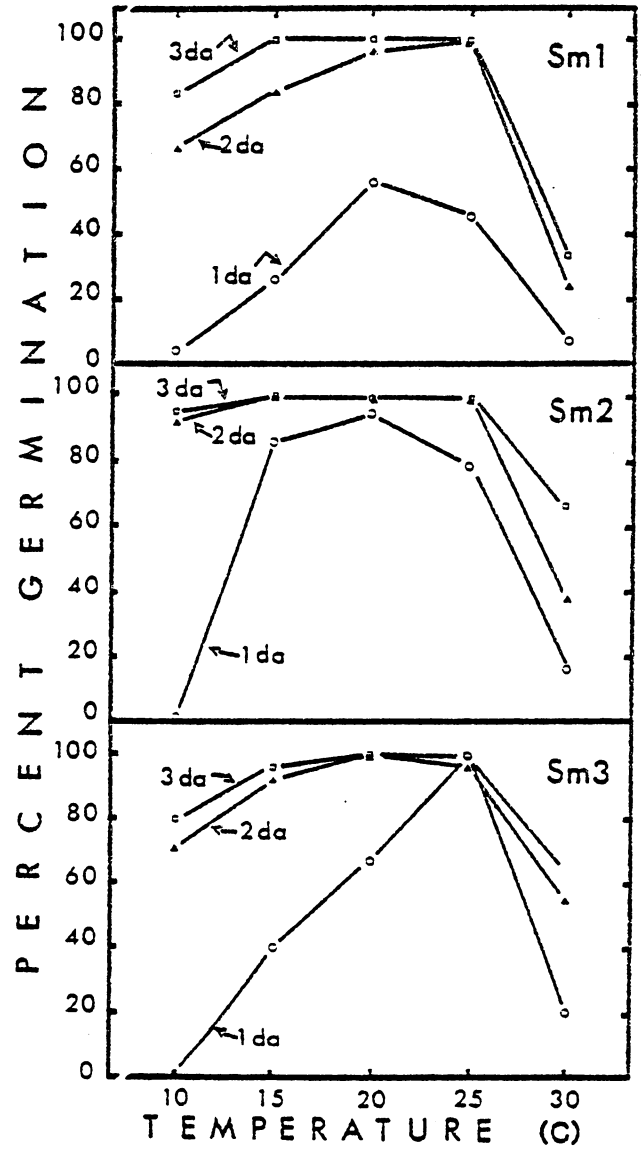

Fig. 1. Myceliogenic germination of three Sclerotinia minor isolates (Sm1, Sm2, Sm3) on potato dextrose agar at five temperatures after 1, 2, and 3 days.

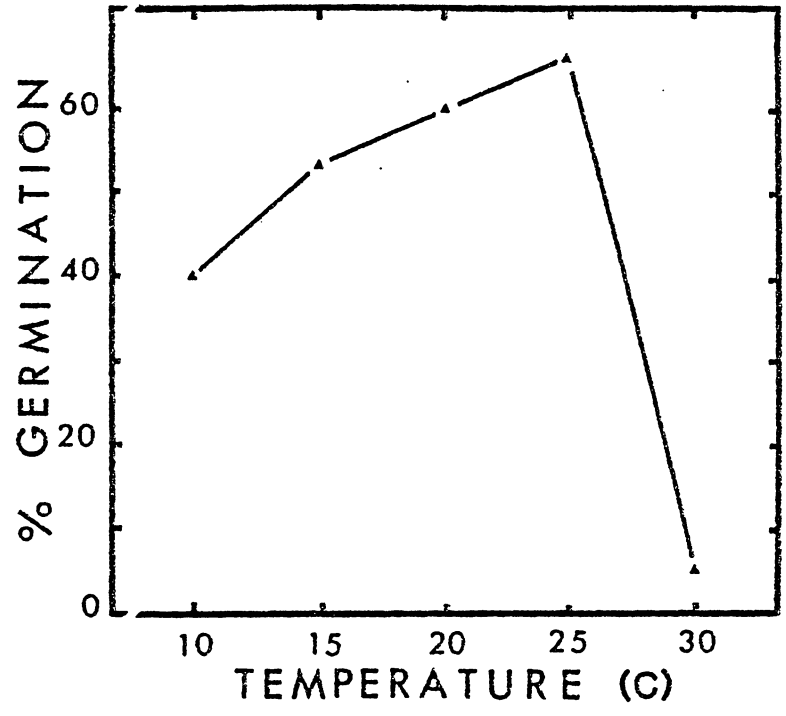

Fig. 2. Myceliogenic germination of Sclerotinia minor (isolate Sm3) on moist filter paper at five temperatures after eight days.

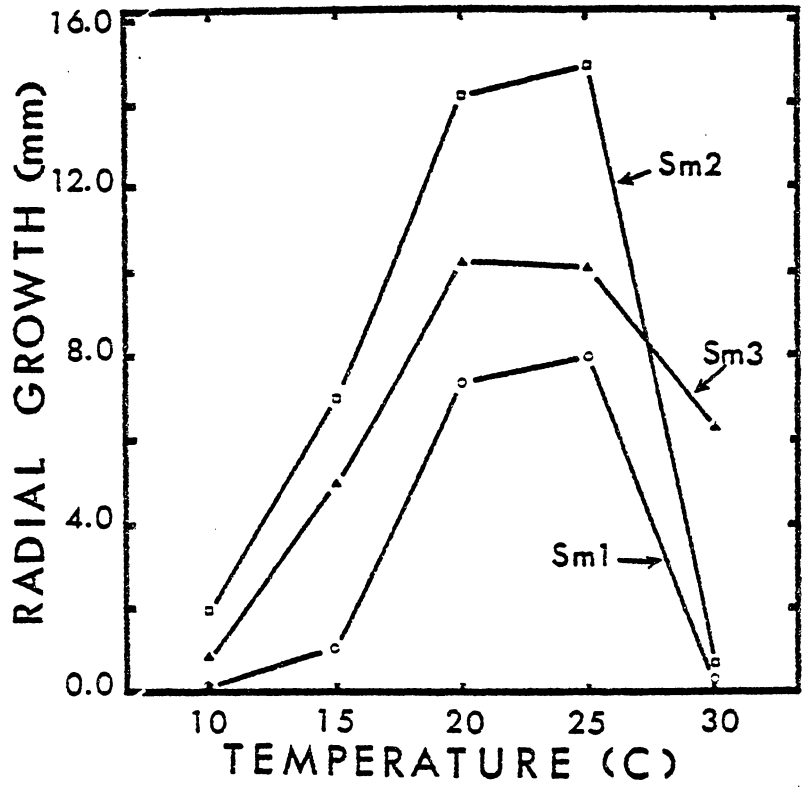

Fig. 3. Radial growth of three Sclerotinia minor isolates on potato dextrose agar at five temperatures after two days.

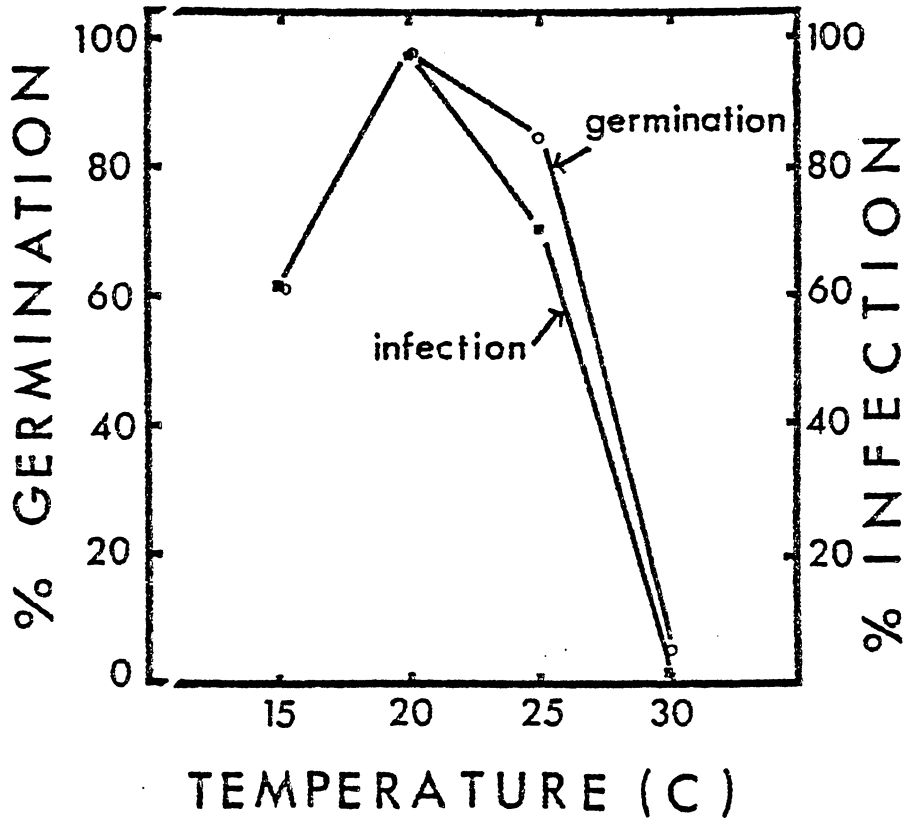

Fig. 4. Myceliogenic germination of Sclerotinia minor (isolate Sm3) and infection of detached 'Florigiant' peanut leaflets at four temperatures after one week.

Infection of main and lateral, lower internodes on intact peanut plants was greatest at 15 C (Fig. 5). Infection at 30 C resulted in hypersensitive reactions, characterized by minute, brown lesions. Overall, lesion development was greatest at 20 C (Fig. 6). The average of three replications is plotted in Fig. 5 and Fig. 6. Analysis of colonization of main stems and lateral branches at all temperatures tested and within the individual temperatures showed no significant difference between the two tissues (Fig. 7).

Pathogenicity of three isolates on 'Florigiant' peanut.

The average results of four replications of the isolate pathogenicity tests after two weeks at 20 C are given in Fig. 8. Isolate Sm3 was more pathogenic than the other two.

Tissue age effects on pathogenicity and comparison of susceptibility of lateral versus main stem tissue.

Infection was greatest in the younger non-pegging plants. There was no infection of any of the 4-month-old plants while the younger 2-month-old plants had 67% infection. Average infection of the 6-week-old plants was 100% and that of the 13-week-old plants was 67%. Lesion length was not significantly different in 6-week-old versus 13-week-old plants. However, numerically, lesion development was greater in the younger plants. For example,

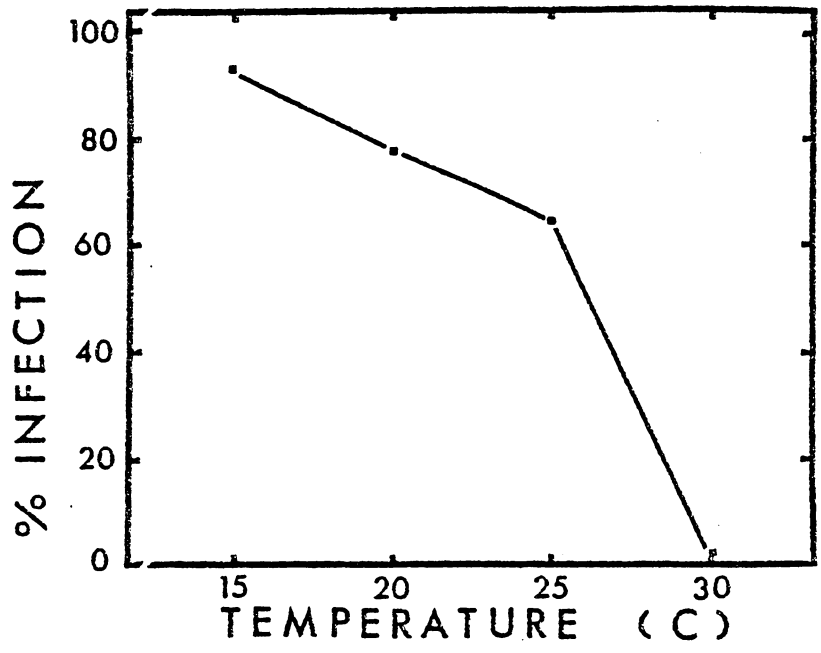

Fig. 5. Infection of main and lateral internodes of 'Florigiant' peanut plants at four temperatures after eight days.

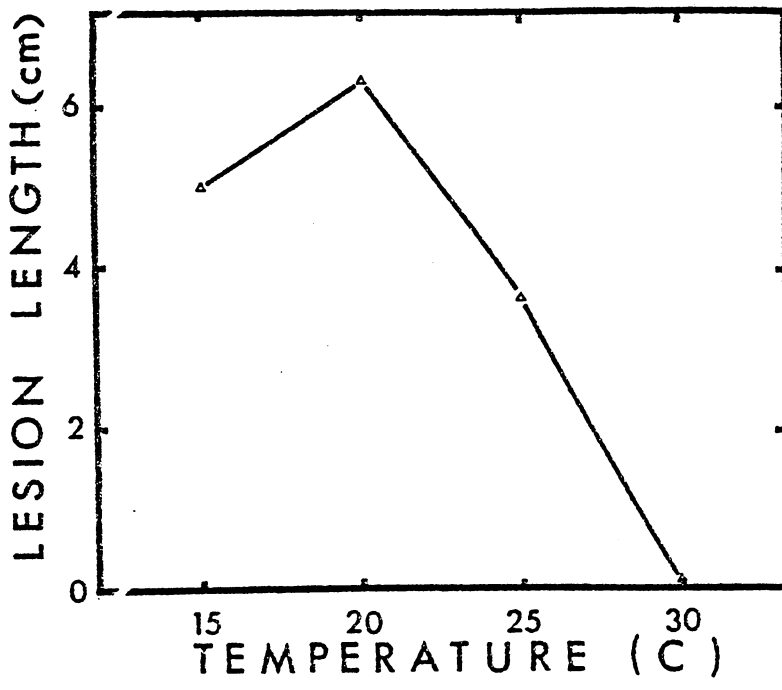

Fig. 6. Lesion length of Sclerotinia minor mycelial disc inoculated lower internode tissue of 'Florigiant' peanut plants at four temperatures for eight days.

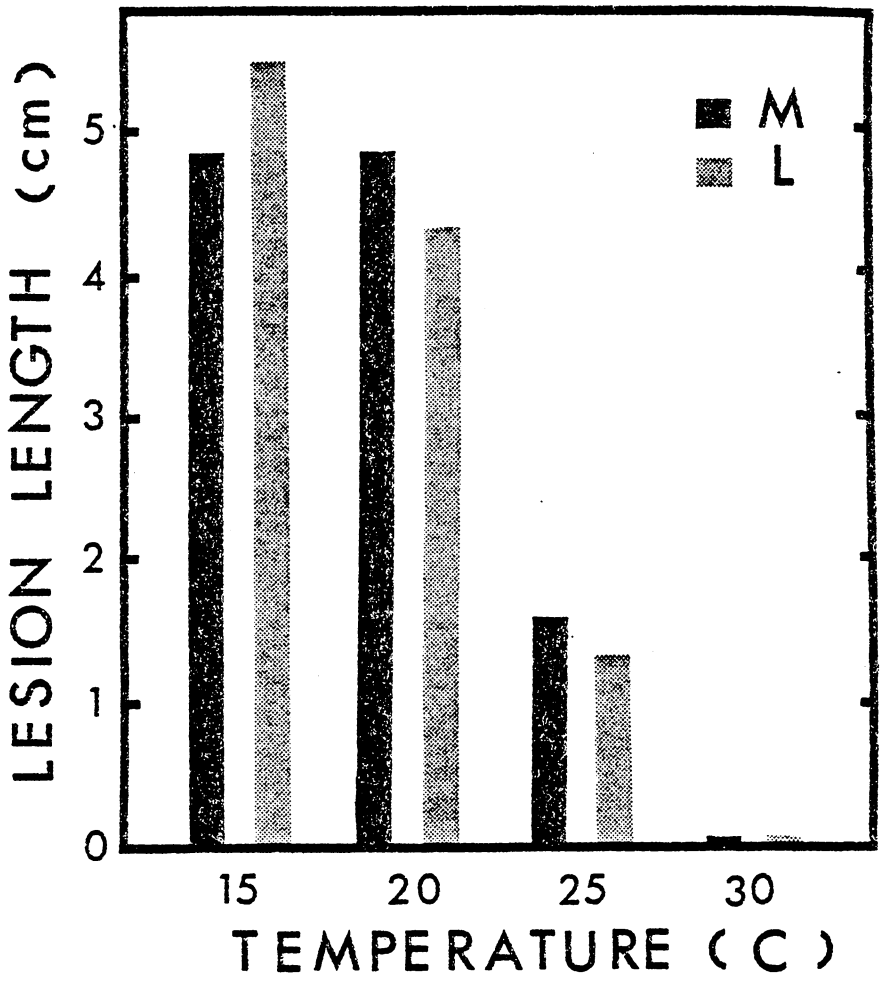

Fig. 7. Colonization of main stem (M) and lateral branches (L) of Sclerotinia minor mycelial disc inoculated 'Florigiant' peanut plants at four temperatures for eight days.

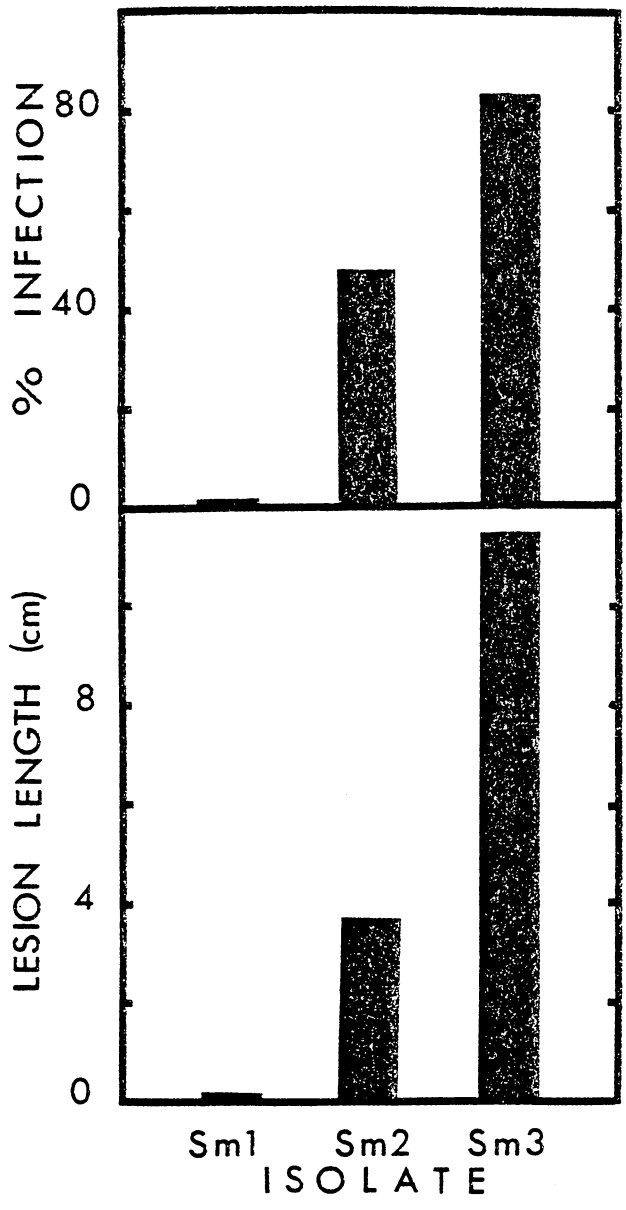

Fig. 8. Infection and colonization of 'Florigiant' peanut plants by Sclerotinia minor isolates (Sm1, Sm2, and Sm3) at 20 C.

average lesion length after two weeks in one test was 3.7 cm for the older plants and 10.0 cm for the younger plants.

Relative humidity effects on myceliogenic sclerotial germination.

Germination occurred at 95, and 100% RH at 20 C and at 97 and 100% RH at 25 C. In one replication of this experiment, however, 76% germination occurred within one week at 92% RH at 20 C. Three subsequent repetitions of the experiment showed no germination at 92% RH. The data from the aberrant repetition were thrown out. The average germination of three replicates is shown in Table 2. Following incubation at 20 or 25 C for one week, all solutions under the sclerotia were changed to distilled, deionized water and reincubated for another week at 20 or 25 C. Germination ranged from 83 to 97% at 20 C and 76 to 92% at 25 C. Germination occurred in all treatments. There was no significant difference in germination at 100% RH based on the RH of the preceeding one week period.

The results of two replications of varying the duration of exposure at 100% RH showed more than 12 hours exposure at 100% RH was necessary for germination (Table 3). Ninty-nine percent germination occurred after 96 hours. Sclerotia initially exposed for varying periods of time to 100% RH then transferred to 79.5% RH for two days, germinated

Table 2. Percent myceliogenic germination of *Sclerotinia minor* sclerotia after a 2-week exposure at 50-100% relative humidity and 20 or 25 C

Temperature	Percent germination[x] at indicated percent relative humidity[y]:														
(C)	50.0	52.0	55.0	62.5	65.5	70.0	71.5	75.0	78.0	79.5	85.0	92.0	95.0	97.0	100.0
20	-	0	0	-	0	0	-	0	-	0	0	0	90	-	90
25	0	-	0	0	-	-	0	0	0	-	0	0	-	95	95

[x]Means of four similar experiments.

[y]Relative humidities established using saturated solutions (Winston and Bates, 1960) or distilled, deionized water.

equally well after replacement in 100% RH conditions (Table 3). After the 2-day drying period, 80% or better germination was achieved by all treatments (Table 3).

Table 3. Percent myceliogenic germination of Sclerotinia minor sclerotia after initial exposure (first) to 100% relative humidity (RH) for 12-96 hours, and after a 4-day reexposure (second) to 100% RH following a 2-day drying (79.5% RH) period

Exposure	Percent germination[x] at 100% RH after times (hrs)							
	12	24	36	48	60	72	84	96
First	0	45	46	55	83	92	93	99
Second	81	92	92	92	94	89	93	-

[x]Means of two similar experiments. Sclerotia incubated at 20 C.

Discussion

It appears that 20 to 25 C is optimum for myceliogenic germination of S. minor sclerotia and infection as well as colonization of 'Florigiant' peanut tissue. This is similar to data reported by others for S. sclerotiorum (Abawi & Grogan, 1975; Weiss et al., 1980). Adams (P. B. Adams, unpub. data) also found 20-25 C optimum for myceliogenic germination of a New Jersey lettuce isolate of S. minor.

Temperature as suggested by the optimum range for infection and colonization as well as the broad range for germination and growth would not be a limiting factor to disease development in Virginia. Using data for 1980 (Va. Crop Reporting Serv., 1981), in the peanut growing season of April to October, there were five out of seven months with higher than normal temperatures. Even in this unusually warm season there was only one day which did not have at least one hour of ambient temperatures equal to 20-25 C, the optimum for infection and disease development (Va. Agro-Environmental Monitoring System, 1980; unpublished data).

Duration of optimum temperature, however, could be a limiting factor. According to the results, germination occurred at 24 hours but not at 12. After 24 hours

incubation, an average of 45% of the sclerotia had germinated. Thus more than 12 hours at 20 C with 100% RH were necessary for myceliogenic germination. Applying this to field data for the 1980 season, there were 59 days with at least 12 hours of ambient air temperatures less than or equal to 23.9 C between July 1 and October 14. The month of July was selected as the first month for consideration since in the past four peanut seasons, July was the month in which the first Sclerotinia blight infections were observed (R. L. Dow, P. M. Phipps, D. M. Porter, unpub. data). During this same time period, however, there were only 13 days with 24 hours of temperatures less than the 23.9 C. This low number of days with optimum temperatures for lesion development might explain why even after infection did occur during 1980, lesion development was poor.

The results indicate that only RHs greater than 95% promote germination when sclerotia are incubated for two weeks at 20 or 25 C. RH is likely to be an even more limiting factor to field germination of sclerotia than duration of temperature. Using 1980 ambient air RH data, there were 0 days during the period July 1 to October 14 that had 12 hours of RH > 95%. The maximum number of hours at this RH for any day during the 14-week period was 11.8, which occurred on the first day of October. There were two

days in July with over 11 hours at > 95% RH. Since infections did occur at the site where the weather data was obtained, the microclimate must have provided 95% RH conditions for periods greater than 12 hours. The conclusion that moisture is probably the more limiting factor to Sclerotinia blight was also the conclusion of Abawi and Grogan (1975) studying white mold of beans caused by S. sclerotiorum. The weather data interpreted with the laboratory findings would suggest that the fall would be the most favorable time for Sclerotinia blight because of the long periods of cool nights and high RH. This coincides with field observations (Chapter 5).

The data from the pathogenicity tests indicate that at 30 C, germination and infection are negligible. This also corresponds with the general observation that Sclerotinia blight is more severe in cool weather.

Drying of sclerotia of the S. minor peanut isolate after exposure to 100% RH, did not adversely affect their ability to germinate after humidity conditions are again optimum. Adams and Tate (1975) suggested that drying of the sclerotia stimulated germination of S. minor and infection of lettuce when soil moisture returned to field capacity.

Young peanut plants are rarely infected by S. minor in the field. Seedling infections have been noted only one

year out of the last 10 years (M. Beute, B. Hadley, and D. M. Porter, 1979 pers. comm.). Even that year it was uncommon. Infections in Virginia are generally first observed during the last two weeks of July. At this time the peanuts are beginning to peg. The plant age experiments were conducted to see if maturity affected susceptibility. The results demonstrate that the rarity of seedling infections is not due to susceptibility but more likely due to increased potential for infection. This may be the result of formation of a more favorable microclimate, increased plant size providing more tissue in contact with the soil allowing for greater chance of an encounter with inoculum, or possibly a combination of both of these.

In the field, lateral branches are more commonly infected and lesion development is more extensive (Dow, unpub. data). However, the results indicate that there's no difference in infection or colonization of main stems versus lateral branches. This again suggests that the laterals are more often infected and more colonized due to soil contact and more favorable microclimate conditions. Lateral branches lying on the soil surface would allow less air movement and drying of the lesion than would lesions on the main stem.

If low relative humidity conditions are as important as the data suggest, then this factor should be considered in pest management and disease resistance breeding programs.

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CHAPTER THREE

RELATIONSHIP OF ENVIRONMENTAL FACTORS TO INFECTION AND COLONIZATION OF PEANUT BY SCLEROTINIA MINOR IN FIELD CONDITIONS

Introduction

Various environmental conditions have been associated with diseases caused by Sclerotinia spp. Most commonly cool weather (Abawi and Grogan, 1975; Brown and Butler, 1936; Burke et al., 1957; Chupp and Sherf, 1960; Eddins, 1937; Letham et al., 1978; Moore, 1955; Wadsworth, 1979; Weiss, 1980b; Willets and Wong, 1980) and wet conditions (Abawi and Grogan, 1975; Abawi and Grogan, 1979; Adair, 1971; Brown and Butler, 1936; Eddins, 1937; Grogan and Abawi, 1975; Haas and Bolwyn, 1972; Letham et al., 1978; Moore, 1955; Moore et al., 1949; Natti, 1971; Weiss et al., 1980b) have been reported. Analyses of weather data for the 1974 through 1980 peanut growing seasons showed a pattern of cooler and wetter weather during the years when Sclerotinia blight was most severe (Porter and Thomas, pers. comm.). Research conducted on beans (Blad et al., 1978; Coyne et al., 1974; Haas and Bolwyn, 1972; Schwartz and Steadman, 1978; Schwartz

et al., 1978; Steadman et al., 1973; Weiss et al., 1980a), lettuce (Hawthorne, 1974), tomatoes, cauliflower (Letham et al., 1976), and potatoes (Partyka and Mai 1962) showed that canopy density and plant growth habit were important in determining the severity of disease. Planting location and plant density have also been related to disease severity (Haas and Bolwyn, 1972). Row spacing (Huang and Hoes, 1980; Steadman et al., 1973) has been indicated as a factor in disease development. Adams and Tate (1975) demonstrated the effect of wetting and drying of soil on germination of S. minor sclerotia indicating the importance of soil moisture.

A management model for a Sclerotinia disease has been developed by Hunter, Pearson, Seem, Smith, Palumbo and Cigna (J. E. Hunter, 1981, pers. comm). They used the phi coefficient, a nonparametric statistical procedure instead of standard regression techniques to determine which measurements best predicted the occurrence of ascoporic inoculum and Sclerotinia white mold of snap beans in New York. They found that the average, soil matric water potential 9 and 2 days before bloom or two days before bloom and seven days later during bloom was a good predictor. Precipitation was not considered as good a predictor as soil matric water potential. High canopy density was necessary for use of the matric water potential as a predictor. Since

this model predicts the occurrence of aerial inoculum, it does not directly apply to Sclerotinia blight of peanut.

Abawi and Grogan (1979) stressed the need for detailed and quantitative epidemiological data for the development of effective and economical Sclerotinia -incited disease control programs. This study addressed that need for Sclerotinia blight of peanut.

The objective of this study was to relate disease developoment to environmental factors by observing disease development in both naturally infested plots and in inoculated plants growing under natural conditions. Naturally infested field plots were used to determine the normal course of disease development with relationship to environmental factors. Disease severity increases were monitored with respect to time and environment. The inoculated plants provided the certain presence of inoculum at a specific location on the plant and allowed for identification of the onset of infection and subsequent disease development. Inoculations were made weekly to separate the effect of time of inoculum exposure to the environment from the effect of environmental factors on the inoculum and disease. A preliminary report on this work has been published (Dow et al., 1981b).

Materials and Methods

Inoculated plants.

This test was conducted during the 1979 and 1980 growing seasons at the Tidewater Research and Continuing Education Center (TRACEC), Suffolk, VA. Sclerotia of S. minor were scraped from the surface of soil-cornmeal(5% w/w) plates which had been incubated at 20-25 C for two weeks. The sclerotia were vigorously washed under high pressure tap water for ten minutes and dried on a screen in the transfer hood (Air Control Inc., Huntingdon, PA) with constant filtered air flow for 24 hours. A single sclerotium was placed in a lower leaf axil of a lateral branch of 20 'Florigiant' peanut plants which made up an inoculation group. Dated, numbered, pot labels were placed near the inoculated lateral branches. A plastic-metal tie (twist on fastener) was tied just below each inoculated node during the 1980 season to further identify the point of inoculation. Each week 20 more plants were similarly inoculated with sclerotia prepared as described above, while the previously inoculated plants were observed (Table 4). Germination of sclerotia (where observable); infection, based on symptom expression; lesion length; and disease development based on a 0-10 disease severity index (DSI) (0 = no disease and 10 = complete collapse of the plant) were

recorded. Initially during 1979, readings were made daily but this proved too difficult with many inoculation groups, so weekly readings were made.

The plants were part of a typical peanut field mechanically planted at the normal seeding rate (112 kg/hectare) and row spacing (0.9 m). Standard agronomic practices for peanut farming were used throughout the season with the exception of Sclerotinia blight control.

Environmental data were obtained throughout the season from the automatic agro-environmental monitoring station adjacent to the inoculated rows. Some of the environmental parameters recorded were: precipitation, ambient air temperature, dewpoint, wind speed, and wind direction, photosynthetically active radiation, and soil temperature at 5-, 10-, and 46-cm depths (Shaffer et al., 1981). The data were obtained at ten minute intervals, averaged daily, then averaged for weekly values to correspond with the week preceeding the day that disease observations were made. Soil moisture measurements were made gravimetrically with soil from under the plant canopy at the surface to 5-cm depth. Soil moisture was expressed on a dry weight basis.

Percent infection between inoculation groups with the same elapsed time after inoculation was compared using chi-square and multiple-comparison procedure for comparing

Table 4. Scheme for inoculation experiments

Inoculation	Week								
Group	0	1	2	3	4	.	.	.	13
1	I[x]	M[y]	M	M	M	.	.	.	M
2		I	M	M	M	.	.	.	M
3			I	M	M	.	.	.	M
4				I	M	.	.	.	M
.									
.									
.									
12							I	.	M

[x]Twenty plants inoculated (I).

[y]Twenty plants monitored (M).

proportions (Koopmans, 1981). The sum lesion length between inoculation groups with the same elapsed time after inoculation was compared using analysis of variance and Duncan's multiple range test. These tests were conducted to determine whether the percent infection or the sum of the lesion length for the inoculation groups were determined by the duration of exposure rather than exposure to specific conditions of a given time period.

Multiple linear regression analyses using several different variable selection techniques (stepwise, maximum R2, forward and backward elimination) were used to relate disease measurements for the season to environmental variables. Dependent variables used were the sum of the lesion length for the 20 plants of an inoculation group (LL) or the sum of the change in lesion length for an inoculation group (CLL). Independent variables used were: total precipitation (P), soil moisture at 0 to 5-cm depth (SM), average daily minimum temperature (TMIN), average daily average temperature (TAV), average daily maximum temperature (TMAX), average daily average relative humidity (RH), number of days with temperature $\leq$16.7 C (D17), for the week one week prior to the day of lesion length measurement. Also used was the interaction of D17 with P (D17*P). Similar variables for the week two weeks prior to lesion measurement

(Pp, SMp, TMINp, TAVp, TMAXp, RHp) were also used. A 5% improvement was designated necessary for retention of a variable in the maximum R2 improvement regression models.

Naturally infested plots.

Studies on three naturally infested fields were made in farmer established peanut fields during each of the 1978, 1979, and 1980 growing seasons. In 1978, the sites were located at the J. L. Porter farm in Southampton Co. (site P), at the J. Bryant farm in Isle of Wight Co. (site B), and at the M. Warren farm in the City of Suffolk (site W), Virginia. For 1979, the sites were located at the J. L. Porter farm in Southampton Co. (site P), the G. A. Prince farm in Southampton Co. (site Pr), and TRACEC in the City of Suffolk (site T). The same sites were used in 1980. The P site was used during all three years. The same field at the site was used in 1978 and 1980 but not in 1979 due to general crop rotation procedures.

Untreated control plots from an experiment using a randomized block design at each of the three test sites were used. Each plot contained four, 12.1 m rows, spaced 0.9 m apart. Standard peanut agronomic practices were used except for ommission of chemical applications for control of Sclerotinia blight and application of Cercospora leafspot fungicide by CO2-backpack sprayer instead of tractor-mounted spray equipment.

Plots were monitored weekly for symptomatic development of Sclerotinia blight. A T-shaped implement with 61-cm ruled, cross piece attached at the end opposite to the handle was used to push back the foliage to allow observation of the base of the plants and the tissue on the soil surface. The DSI and longest lesion length (LLL) were recorded for each 61-cm row section of the center two rows of a plot. A 1-5 DSI scale was used during 1978, with 1 being no disease and 5 equal to complete death of the tissue in the 61-cm row section. A 0-10 scale was used for 1979 and 1980 with 0 = no Sclerotinia blight and 10 = death of all tissue in the section. There were 20 DSI and 20 LLL measurements for each of the two center rows of each plot, giving a total of 160 DSI and 160 LLL measurements per field site.

A chart recording hygrothermograph (Weather Measure, Sacramento, CA) in a standard weather shelter placed 15 cm above the soil and a weighing bucket, chart recording, rain guage (Belfort Instrument Co., Baltimore, MD) were located at each field site that was not next to an agro-environmental monitoring station.

Soil moisture measurements were made weekly on soil from under the canopy at 0 to 5-cm and 5 to 10-cm depths. Two soil samples from each of the outer two plot rows were

pooled to make a single plot sample for each depth. Moisture was determined gravimetrically and expressed on a dry weight basis.

Plant canopy height and width measurements were made weekly. The height was measured from the soil to the tip of the leaves of the main stem when the leaves were held fully vertically extended. Width measurement was made perpendicular to the row direction from the outermost point of the plant on one side of the row, over the main stem used for height measurement, to the outermost point on the other side of the row. Measurements were made 1/4, 1/2, and 3/4 the way down each outer row of the plot.

Correlation and multiple linear regression analyses were used to relate DSI, change in DSI (CDSI), LLL, and change in LLL (CLLL) to environmental factors. Forty-one independent variables were generally considered (Table 5). Analyses were made on data from the naturally infested fields for each of the test sites, the three sites during a season, and all sites during the three seasons.

Results

Inoculated plants.

In 1979, many infections resulted from plant inoculations and lesion development was extensive by the end

Table 5. Variables used in correlation and multiple linear regression analyses of data from untreated plots with Sclerotinia blight of peanut, 1978-1980

Dependent Variable		Independent Variable[x]	
DSI	(disease severity index)	D17	(number of days with temperatures $\leq$ 16.7 C)
CDSI	(change in disease severity index)	D17*P	(interaction of D17 with precipitation)
LLL	(longest lesion length)	H	(canopy height)
		P	(total precipitation)
		PAV	(average daily precipitation)
		RHAV	(average daily average relative humidity (RH))
		RHMAX	(average daily maximum RH)
		RHMIN	(average daily minimum RH)
		RH75	(total time with $\geq$ 75% RH)
		RH80	(total time with $\geq$ 80% RH)
		RH85	(total time with $\geq$ 85% RH)
		RH90	(total time with $\geq$ 90% RH)
		RH95	(total time with $\geq$ 95% RH)
		SM	(soil moisture at 0-5 cm depth)
		SM5	(soil moisture at 5-10 cm depth)
		STAV	(average daily soil temperature at 5 cm)
		STMAX	(average daily maximum soil temperature at 5 cm)
		STMIN	(average daily minimum soil temperature at 5 cm)
		TAV	(average daily average temperature (T))
		TMAX	(average daily maximum T)
		TMIN	(average daily minimum T)
		T18	(total time with temperature $\leq$ 18.3 C)
		T21	(total time with temperature $\leq$ 21.1 C)
		T22	(total time with temperature $\leq$ 22.2 C)
		T24	(total time with temperature $\leq$ 23.8 C)
		W	(canopy width)
		WSAV	(average daily average wind speed)
		WSMAX	(average daily maximum wind speed)
		WSMIN	(average daily minimum wind speed)

Table 5. (continued)

Dependent Variable	Independent Variable[x]
	Hp
	Pp
	PDp
	RHAVp
	RHMAXp
	RHMINp
	SMp
	SM5p
	TAVp
	TMAXp
	TMINp
	Wp

[x]Variables followed by p were for period two weeks prior to disease measurement; all other variables were for period one week prior to disease measurement.

of the season. Percent infection during the season for each inoculation group is given in Fig. 9. The first inoculation was made July 6 and the last September 29, 1979. For inoculation groups 1-6, the first infections occurred in experiment week 6 regardless of whether the inoculum was present 1 to 6 weeks. The first infections in inoculation group 7 occurred in week 9, three weeks after inoculation. The first infections in groups 8 and 9 occurred in week 10, three and two weeks after inoculation, respectively. Inoculation group 10 showed the first infection in experiment week 12, three weeks after inoculation. Infection occurred in group 11 after only one week, and in group 12 after two weeks in experiment weeks 11 and 13, respectively. All inoculation groups showed increased infection during the twelfth and thirteenth week. Total infection for inoculation groups ranged from 50-90% with the exception of the last group which had only 10% infection.

Percent infection between inoculation groups with the same elapsed time after inoculation showed significant ($P = 0.05$) differences among groups except for one and 12 weeks (Table 6). There was a significant difference between groups with one week elapsed time using $P = 0.10$.

Comparison of the sum of lesion length for all inoculation groups exposed one week to the environment

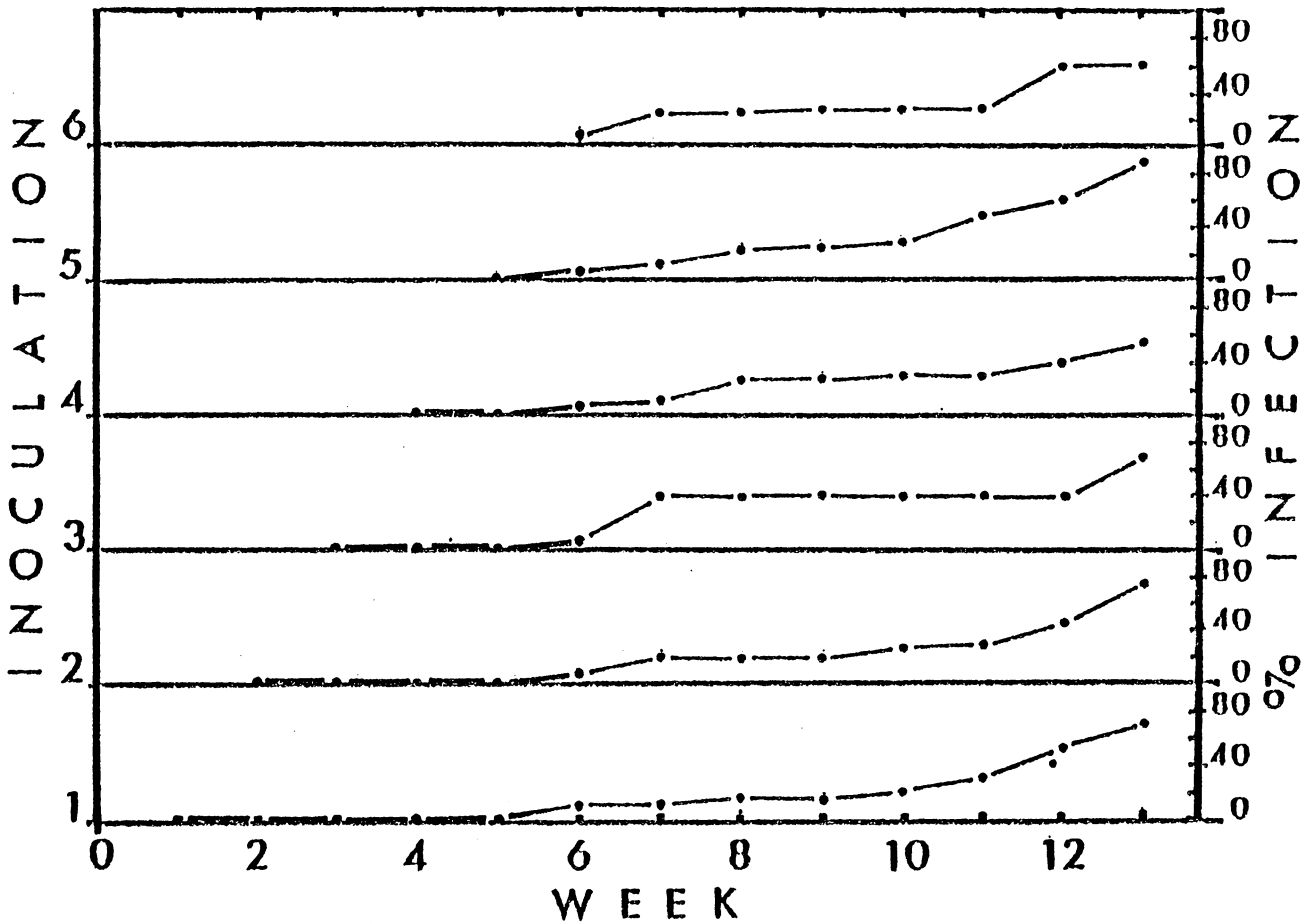

Fig. 9. Percent Sclerotinia minor infection for each inoculation group for the 1979 season. The first observation for an inoculation group began one week after inoculation. An inoculation group contained 20 field growing 'Florigiant' peanut plants each inoculated in a lower leaf axil with a sclerotium.

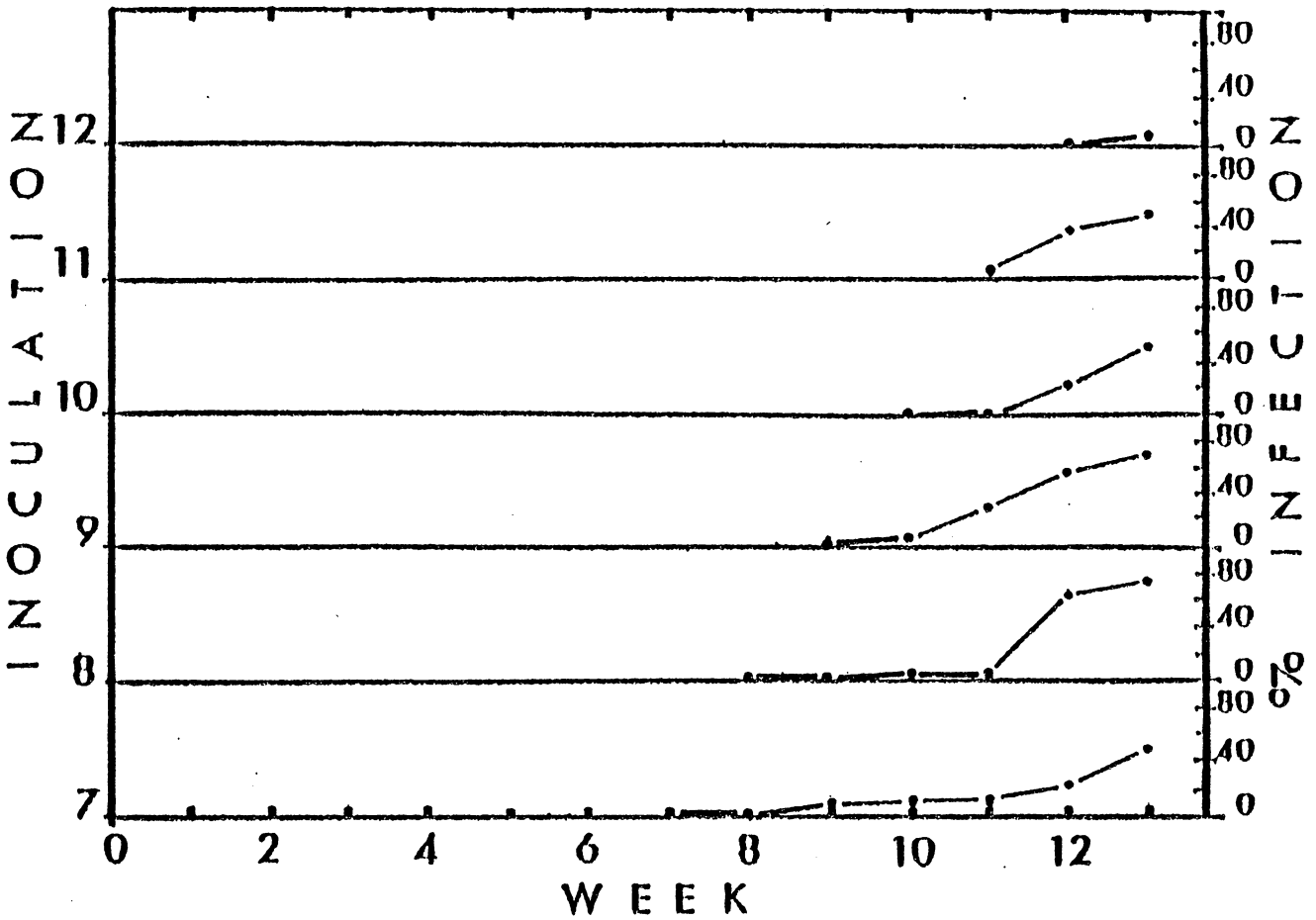

Fig. 9. (Continued)

Table 6. Comparison of percent infection between groups of peanut plants having the same elapsed time after inoculation with Sclerotinia minor in 1979

Inoculation Group[x]	Percent infection[y] after elapsed time (wk): 1	2	3	4	5	6	7	8	9	10	11	12	13
1	0 a	0 c	0 c	0 c	0 e	10 b	10 c	15 b	15 b	20 b	30 b	55 a	75
2	0 a	0 c	0 c	0 c	5 e	20 b	20 bc	20 b	25 b	30 ab	45 ab	75 a	
3	0 a	0 c	0 c	5 c	40 cb	40 b	40 abc	40 ab	40 b	40 ab	70 a		
4	0 a	0 c	5 bc	10 bc	25 cde	25 b	30 abc	30 ab	40 b	55 a			
5	0 a	10 c	15 bc	25 bc	25 cde	30 b	50 ab	60 a	90 a				
6	5 a	25 b	25 b	30 b	30 cd	30 b	60 a	60 a					
7	0 a	0 c	10 bc	15 bc	15 cde	25 b	50 ab						
8	0 a	0 c	5 bc	5 c	60 ab	80 a							
9	0 a	5 c	10 bc	60 a	75 a								
10	0 a	0 c	25 b	55 a									
11	5 a	40 a	55 a										
12	0 a	5 c											

[x]Each week a new group was inoculated beginning with group 1 on July 6. A group consisted of 20 'Florigiant' peanut plants inoculated with a single sclerotium in a lower leaf axil of a lateral branch.

[y]Values within columns followed by the same letter(s) are not significantly different (P = 0.05) according to a multiple-comparison procedure for comparing proportions.

showed significant differences at P = 0.10 (Table 7). Significant (P = 0.05) differences were also found for lesion length comparisons between groups with two to nine weeks elapsed time after inoculation. No difference in lesion length was found between groups with 10, 11, or 12 weeks elapsed time.

DSI measurements were not useful because they were too insensitive. The readings were too similar from week to week so only LL or CLL were used in regression analyses.

The independent variables most often important to CLL in the regression models for inoculation groups 1-11 during 1979 were: TMAX, TMAXp, Pp, and SMp. The regression relationship was negative for TMAX and TMAXp and positive for Pp and SMp. The R2 values for the regression models of the individual inoculation groups ranged from 0.40 to 0.99. Regression analyses for LL using data from all weeks for all inoculation groups showed TMAX to be the only significant variable. The model (LL = 354.46-3.92 TMAX) explained only 37% of the variation in LL (P=0.0001). Addition of other independent variables made little improvement on the model.

CLL of inoculation group 1 during the 1979 season and the environmental variables important to the regression model for this group are shown in Fig. 10. Inoculation of the group occurred at 0 week, July 6, and the last

Table 7. Comparison of lesion length between groups of peanut plants (G) having the same elapsed time after inoculation with Sclerotinia minor in 1979

G[x]	Sum[y] of lesion length (cm) after elapsed time (wk):												
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	0.0 b	0.0 c	0.0 b	0.0 d	0.0 b	5.1 b	8.9 c	39.4 c	88.9 c	127.0 b	283.2 a	381.0 a	441.3
2	0.0 b	0.0 c	0.0 b	0.0 d	3.8 b	26.7 b	33.0 c	33.0 c	97.8 c	200.7 b	275.6 a	327.7 a	
3	0.0 b	0.0 c	0.0 b	1.3 c	21.6 b	48.3 b	87.6 bc	100.3 bc	147.3 bc	175.3 b	272.5 a		
4	0.0 b	0.0 c	11.4 b	34.3 bcd	99.1 ab	120.6 ab	182.9 ab	255.3 ab	308.6 a	323.9 a			
5	0.0 b	1.3 c	15.2 b	47.0 bcd	78.7 ab	116.8 ab	205.7 ab	271.8 a	372.1 a				
6	6.4 a	27.9 b	71.1 a	116.8 a	151.1 a	185.4 a	242.6 a	280.2 a					
7	0.0 b	0.0 c	2.5 b	7.6 cd	7.6 b	36.8 b	107.4 bc						
8	0.0 b	0.0 c	1.3 b	1.3 c	30.5 b	195.6 a							
9	0.0 b	1.3 c	12.7 b	86.4 ab	210.3 a								
10	0.0 b	0.0 c	19.3 b	70.1 abc									
11	5.1 ab	50.8 a	99.3 a										
12	0.0 b	1.3 c											

[x]Each week a new group was inoculated. A group consisted of 20 'Florigiant' peanut plants inoculated with a single sclerotium in a lower leaf axil of a lateral branch.

[y]Values represent the sum of lesion length of 20 inoculated lateral branches. Sums within columns followed by the same letter(s) are not significantly (P = 0.05) different according to Duncan's multiple range test. P = 0.10 used for 1 wk values.

observations were made September 29, 1979. Although the LL for the group could only remain the same or increase throughout the season, the CLL decreased as well as increased. Infections first occurred following rainfall and decreasing maximum temperatures during the week prior to lesion measurement. Increase in lesion length in observation week 10 and 11 followed heavy rainfall at the end of week 9 and a trend of decreasing maximum temperatures. Lesion length continued to increase as light rainfall occurred and the maximum temperature continued to fall.

Percent infection from weekly S. minor inoculations in 1980 is shown in Fig. 11. The first infection occurred during the third week (Aug. 13 to Aug. 19) Inoculation group 1 exhibited fifteen percent infection at the end of the growing season. Infection was low compared to the 1979 season. The maximum percent infection in any inoculation group was only 40%. During the last week of the season, symptoms of infection were observed in four inoculation groups (3, 6, 7, and 8). Five inoculation groups (2, 4, 5, 9, and 10) had no symptoms of infection of Sclerotinia blight.

Comparison of the percent infection between 1980 inoculation groups having the same elapsed time after

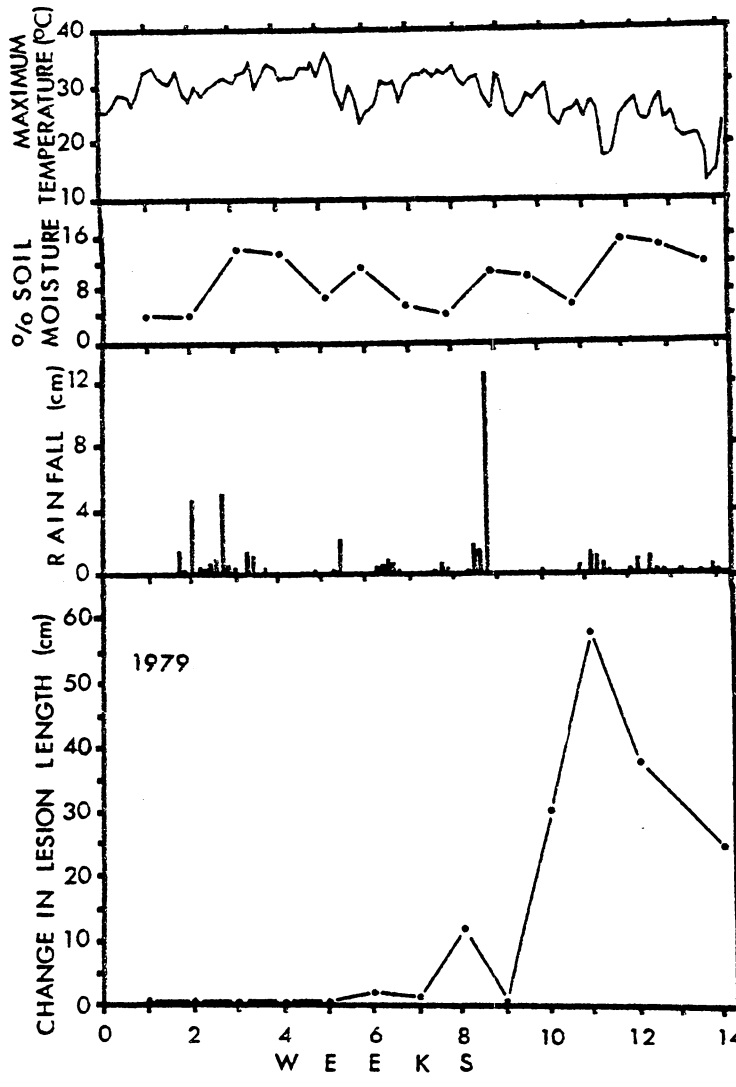

Fig. 10. Relationship of rainfall, soil moisture, and average daily maximum temperature to the change in Sclerotinia blight of peanut, lesion length for inoculation group one during the 1979 peanut growing season. The inoculation group contained 20 'Florigiant' peanut plants each inoculated with a single Sclerotinia minor sclerotium in a lower leaf axil at week 0 (July 6).

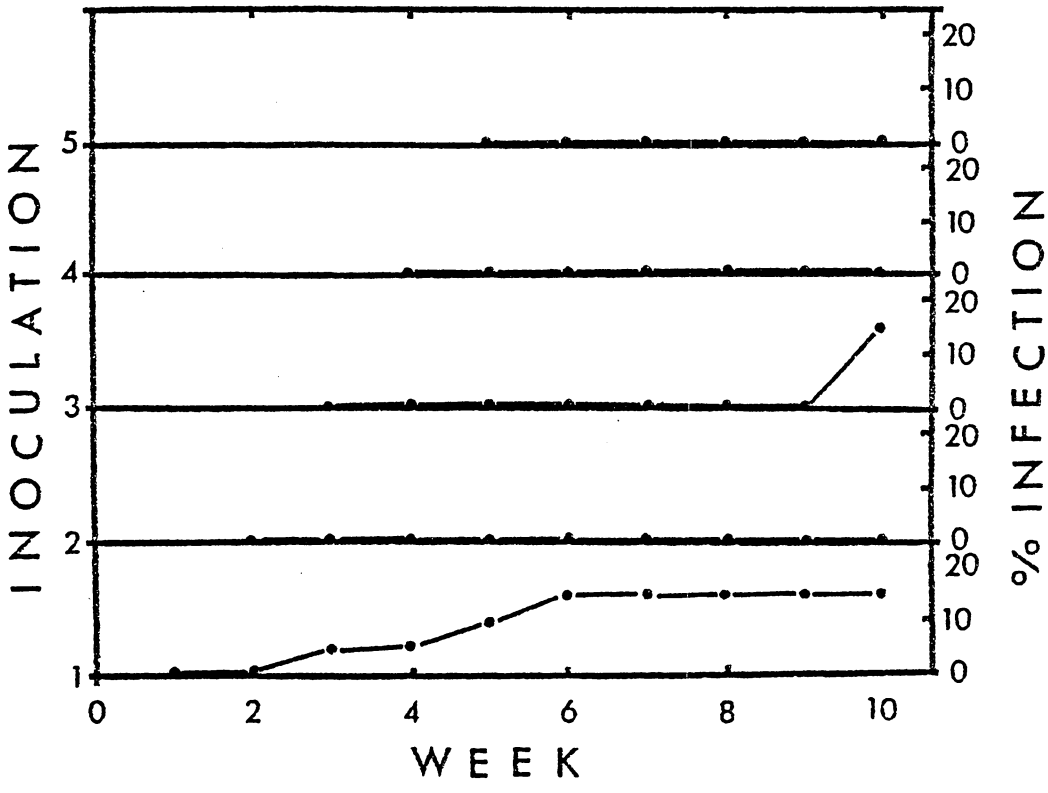

Fig. 11. Percent Sclerotinia minor infection for each inoculation group for the 1980 season. An inoculation group contained 20 'Florigiant' peanut plants each inoculated with a single sclerotium in a lower leaf axil.

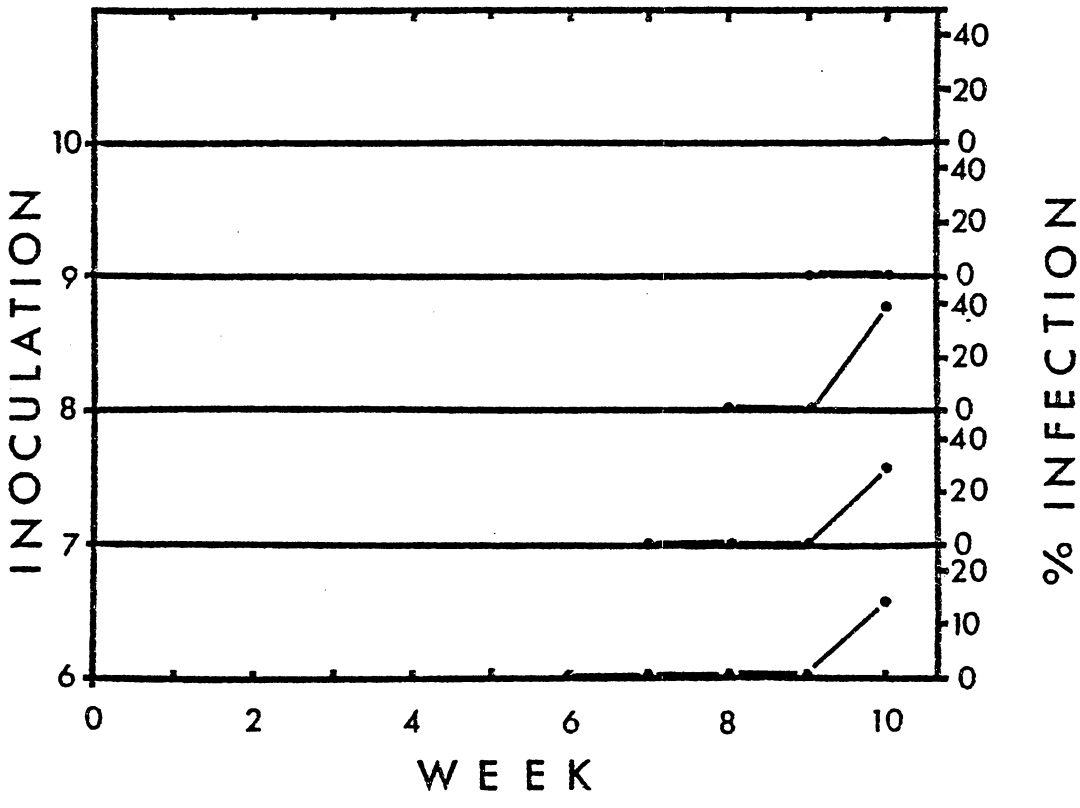

Fig. 11. (Continued)

inoculation showed significant (P = 0.05) differences among groups after 3, 4, 5, 6, and 7 weeks (Table 8).

Comparison of LL of 1980 inoculation groups having the same elapsed time after inoculation also showed significant (P = 0.05) differences between groups for weeks 3, 4, 6, and 9 (Table 9). Significant differences were present also after 5 and 7 weeks at P = 0.10.

Regression analyses of 1980 data were conducted using only the results from inoculation group one since the other groups did not have infection until the last week. The multiple linear regression model for change in LL was:

$$CLL = 6.30 + 0.35\ Da17 + 1.09\ Da17*P - 0.10\ RH$$

with R2 = 0.87. These three independent variables explained 87% of the variation in CLL and were significant in a stepwise regression. The model obtained for LL was:

$$LL = 39.97 - 0.46\ TAV - 2.66\ Pp$$

with R2 = 0.87.

CLL for inoculation groups 1, 3, 6, 7, and 8 for the 1980 season and maximum temperature, number of days with a temperature ≤16.7C, mean percent RH, and cm of precipitation for the season are shown in Fig. 12. The first infection occurred following rainfall in the preceding week, declining maximum temperatures, increasing number of cool days (≤16.7 C) and increasing RH. As temperatures continued to drop,

Table 8. Comparison of percent infection between groups of peanut plants having the same elapsed time after inoculation with *Sclerotinia minor* in 1980

Inoculation Group[x]	Percent infection[y] after elapsed time (wk):									
	1	2	3	4	5	6	7	8	9	10
1	0 a	0 a	5 b	5 b	10 ab	15 a	15 a	15 a	15 a	15
2	0 a	0 a	0 b	0 b	0 b	0 b	0 b	0 a	0 a	
3	0 a	0 a	0 b	0 b	0 b	0 b	0 b	15 a		
4	0 a	0 a	0 b	0 b	0 b	0 b	0 b			
5	0 a	0 a	0 b	0 b	0 b	0 b				
6	0 a	0 a	0 b	0 b	15 a					
7	0 a	0 a	0 b	30 a						
8	0 a	0 a	40 a							
9	0 a	0 a								
10	0 a									

[x]Each week a new group was inoculated beginning with group 1 on July 30. A group consisted of 20 'Florigiant' peanut plants inoculated with a single sclerotium in a lower leaf axil of a lateral branch.

[y]Values within columns followed by the same letter are not significantly different (P = 0.05) according to a multiple-comparison procedure for comparing proportions.

Table 9. Comparison of lesion length between groups of peanut plants having the same elapsed time after inoculation with Sclerotinia minor in 1980

Inoculation	Sum[y] of lesion length (cm) after elapsed time (wk):									
Group[x]	1	2	3	4	5	6	7	8	9	10
1	0.0 a	0.0 a	1.3 b	5.1 b	6.4 a	14.0 a	15.0 a	15.0 a	17.8 a	25.0
2	0.0 a	0.0 a	0.0 b	0.0 b	0.0 a	0.0 b	0.0 a	0.0 a	0.0 b	
3	0.0 a	0.0 a	0.0 b	0.0 b	0.0 a	0.0 b	0.0 a	7.6 a		
4	0.0 a	0.0 a	0.0 b	0.0 b	0.0 a	0.0 b	0.0 a			
5	0.0 a	0.0 a	0.0 b	0.0 b	0.0 a	0.0 b				
6	0.0 a	0.0 a	0.0 b	0.0 b	8.9 a					
7	0.0 a	0.0 a	0.0 b	18.4 a						
8	0.0 a	0.0 a	25.4 a							
9	0.0 a	0.0 a								
10	0.0 a	0.0 a								

[x]Each week a new group was inoculated beginning with group 1 on July 30. A group consisted of 20 'Florigiant' peanut plants inoculated with a single sclerotium in a lower leaf axil of a lateral branch.

[y]Values represent the sum of lesion length of 20 inoculated lateral branches. Sums within columns followed by the same letter are not significantly (P = 0.05) different according to Duncan's multiple range test.

CLL for inoculation group 1 increased. As temperatures increased during the fourth week and the mean % RH decreased, CLL for inoculation group 1 decreased. With precipitation increasing RH and decreasing temperature, CLL increased for inoculation group 1. CLL for the 7th week was nearly 2 cm, indicating that lesion growth was still occurring with light rainfall, a mean of 70% RH, and four days with temperatures ≤16.7 C. During the 8th week, there was no increase in lesion length (0 change) for inoculation group 1. Following rainfall and cooler temperatures, lesion length increased for inoculation group 1 and initial infection occurred in four other inoculation groups.

Naturally infested plots.

Disease development in the field was less during 1980 than in 1978 and 1979. This is demonstrated by the following data for DSI at site P in the untreated naturally infested plots. On the last day before harvest in 1978, 1979, and 1980, the DSI's were 3.13, 0.79, and 0.07, respectively. Since 1978's DSI was on a 0-5 scale and 1979 and 1980 on a 0-10 scale, the difference is even more striking. Differences between the 1978 and 1980 growing season may be further emphasized considering the fact that tests in these two seasons were conducted in the exact same test area at site P. Comparison of the 1979 and 1980

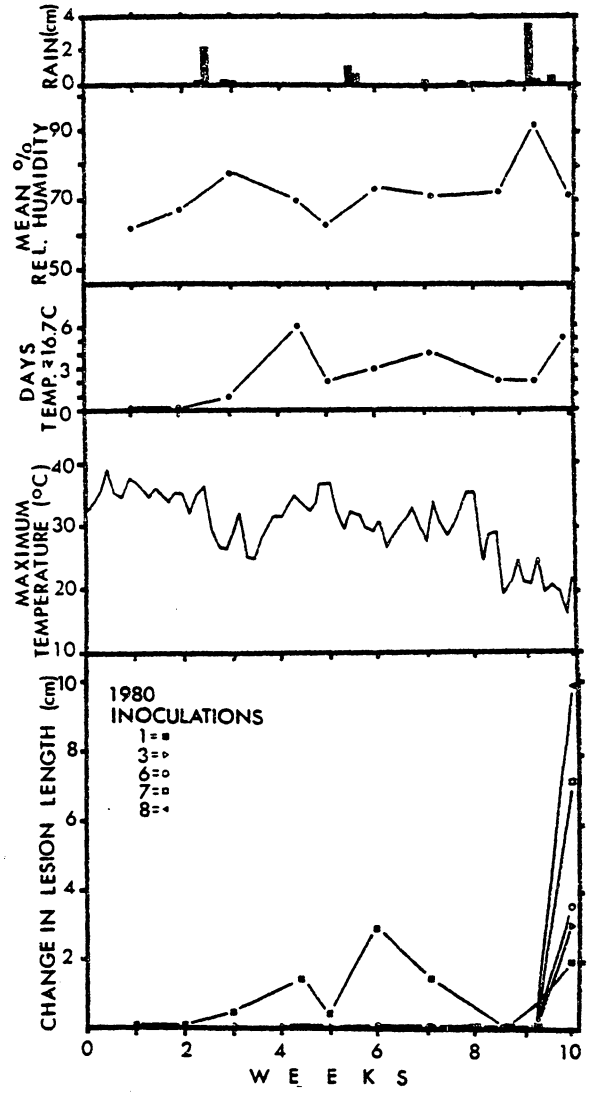

Fig. 12. Relationship of average daily maximum temperature, number of days with temperatures ≤16.7 C, mean percent relative humidity, and rainfall to the change in Sclerotinia blight of peanut lesion length for inoculation groups with infected plants during the 1980 peanut growing season. An inoculation group contained 20 'Florigiant' peanut plants each inoculated in a lower leaf axil with a single Sclerotinia minor sclerotium. The first inoculation group was inoculated at week 0 (July 30). Each week thereafter, another group was inoculated.

seasons can also be made with data from sites Pr and T. The DSI at site Pr was 7.51 at harvest in 1979 and 5.08 in 1980. The difference was even greater at site T with 4.09 at harvest in 1979 and 0.06 at harvest in 1980. These tests were not conducted in the exact same areas during 1979 and 1980 at sites Pr and T but 1980's tests were located within 100 - 250 m of the 1979 test areas.

Eight environmental variables were associated with DSI at all three sites during 1978 (Table 10). For purposes of this study, a correlation coefficient of $\geq|0.49|$ and a statistical significance of $P = 0.10$ were required minima. Relationships reported here met both of these criteria. The factors negatively correlated with DSI were: TMAX, TMIN, TAV, RHMAX (Site P), Pp, SMp, and SM5p. Positively correlated factors were D17 (all sites) and RHMAX (site B and site W). Twenty four variables were associated with DSI at site B, 17 at site P, and 19 at site W. The strongest correlation (0.94) at site B was with RHMAX. At site P, DA17 (0.89), STMAX (-0.89), STMN(-0.90), STAV (-0.90) were highly correlated with DSI. At site W, TMIN, T21 and T22 were most correlated with coefficients of -0.86, 0.87, and 0.91, respectively.

No environmental variable was significantly correlated with CDSI at all three sites. P and PAV were correlated

Table 10. Variables with correlation coefficients >|0.49| and a significant (P = 0.10) association with the Sclerotinia blight disease severity index (DSI) and change in DSI (CDSI) at three field sites during the 1978 peanut growing season

Variable[x]	Site B		Site P		Site W	
	DSI	CDSI	DSI	CDSI	DSI	CDSI
Maximum temperature (TMAX)	-0.76	<[y]	-0.53	<	-0.66	<
Minimum temperature (TMIN)	-0.83	<	-0.78	<	-0.86	<
Average temperature (TAV)	-0.86	<	-0.79	<	-0.78	<
18 C (T18)	0.69	<	-	-	0.73	<
21 C (T21)	0.84	<	-	-	0.87	<
22 C (T22)	0.86	<	-	-	0.91	<
24 C (T24)	0.77	-0.53	-	-	0.77	<
Maximum relative humidity (RHMAX)	0.94	<	-0.59	<	0.76	<
Minimum relative humidity (RHMIN)	0.78	<	<	<	-0.61	<
Average relative humidity (RHAV)	<	<	-0.62	<	-0.53	<
75% relative humidity (RH75)	0.81	<	-	-	<	<
80% relative humidity (RH80)	0.73	<	-	-	<	<
85% relative humidity (RH85)	0.83	<	-	-	<	<
90% relative humidity (RH90)	0.83	<	-	-	<	0.69
95% relative humidity (RH95)	0.86	<	-	-	0.71	<
Total precipitation (P)	-0.60	-0.62	-0.59	-0.53	<	<
Average precipitation (PAV)	-0.54	-0.54	-0.59	-0.53	<	<
Soil moisture, 0-5 cm (SM)	-0.63	-0.68	<	<	-0.57	<
Soil moisture, 5-10 cm (SM5)	-0.63	-0.70	<	<	-0.62	<
Maximum temperature --p (TMAXp)	-0.66	<	<	0.68	-0.59	<
Minimum temperature --p (TMINp)	-0.75	<	<	<	-0.83	<
Average temperature --p (TAVp)	-0.79	<	<	<	-	-
Total precipitation --p (Pp)	-0.52	<	-0.56	<	-0.74	<
Average precipitation --p (PAVp)	<	<	<	<	-0.74	<

Table 10. (continued)

Variable[x]	Site B		Site P		Site W	
	DSI	CDSI	DSI	CDSI	DSI	CDSI
Soil moisture, 0-5 cm --p (SMp)	-0.78	<	-0.54	<	-0.73	<
Soil moisture, 5-10 cm --p (SM5p)	-0.79	<	-0.62	<	-0.77	<
Days with temperature $\leq$ 16.7 C (DA17)	0.70	<	0.89	<	0.79	<
DA17 x precipitation (DA17*P)	0.56	-0.58	0.58	<	<	<
Maximum soil temperature, 5 cm (STMAX)	-	-	-0.89	<	-	-
Minimum soil temperature, 5 cm (STMIN)	-	-	-0.90	<	-	-
Average soil temperature, 5 cm (STAV)	-	-	-0.90	<	-	-

[x]Variables were measured for period one week prior to disease measurement unless followed by --p which were measured for period two weeks prior to disease measurement.

[y]< indicates correlation coefficient was $<|0.50|$ and/or had a nonsignificant association with DSI or CDSI.

(-0.53 to -0.62) at sites B and P with the CDSI. Also correlated at site B were SM (-0.68) and SM5 (-0.70). At site P, TMAXp (0.68) and at site W, RH90(0.69) were associated with CDSI.

In 1979, DSI was significantly associated with TMAX, TAV, RHMAX, Wp, Hp, RH95, T22, and T24 at all sites (Table 11). The relationship was negative with TMAX, TAV, RHMAX, RH95, T22, and T24. The association was positive with Wp and Hp. In addition to the same variables that were correlated at all sites with DSI, LLL was also correlated with H at all sites. DSI and LLL were generally similarly correlated to environmental factors. The strongest correlation (-0.88 to -0.95) with DSI and LLL at all sites was with RHMAX.

In 1980, the correlation results were less similar for all sites (Table 12). Only TMAX was correlated at all sites with DSI and LLL. TMAXp was correlated with DSI at all sites. A negative association with DSI and/or LLL was obtained with both of these variables. Data was missing at site P for several variables; nevertheless, few of the variables tested were correlated with either DSI or LLL. TAV, T24, and Pp were correlated with DSI and LLL at two of the three sites.

Table 11. Variables with correlation coefficients >|0.49| and a significant (P = 0.10) association with the Sclerotinia blight disease severity index (DSI) and longest lesion length (LLL) at three field sites during the 1979 peanut growing season

Variable[x]	Site P		Site Pr		Site T	
	DSI	LLL	DSI	LLL	DSI	LLL
Maximum temperature (TMAX)	-0.88	-0.85	-0.75	-0.81	-0.77	-0.72
Minimum temperature (TMIN)	-0.54	<[y]	<	-0.51	-0.64	-0.64
Average temperature (TAV)	-0.75	-0.70	-0.64	-0.69	-0.78	-0.75
18 C (T18)	-0.53	<	<	<	<	<
21 C (T21)	-0.59	-0.55	<	-0.52	-0.55	<
22 C (T22)	-0.60	-0.56	-0.51	-0.55	-0.63	-0.58
24 C (T24)	-0.65	-0.61	-0.56	-0.60	-0.58	-0.50
Maximum relative humidity (RHMAX)	-0.90	-0.95	-0.93	-0.95	-0.91	-0.88
Average relative humidity (RHAV)	<	<	-0.53	<	<	<
90% relative humidity (RH90)	-0.64	-0.71	-0.67	-0.71	<	<
95% relative humidity (RH95)	-0.56	-0.67	-0.71	-0.72	-0.80	-0.78
Soil moisture, 0-5 cm (SM)	0.85	0.80	<	0.57	<	<
Canopy width (W)	<	<	0.69	0.65	0.52	0.55
Canopy height (H)	0.54	0.54	0.78	0.73	<	0.53
Canopy width --p (Wp)	0.57	0.58	0.79	0.74	0.53	0.56
Canopy height --p (Hp)	0.61	0.63	0.86	0.86	0.81	0.53
Days with temperature ≤ 16.7 C (DA17)	<	<	0.51	0.55	0.69	0.68
DA17 x precipitation (DA17*P)	<	<	<	<	0.64	0.56

[x]Variables were measured for period one week prior to disease measurement unless followed by --p which were measured for period two weeks prior to disease measurement.

[y]< indicates correlation coefficient was <|0.50| and/or had a nonsignificant association with DSI or LLL.

Table 12. Variables with correlation coefficients >|0.49| and a significant (P ≤ 0.10) association with the Sclerotinia blight disease severity index (DSI) or longest lesion length (LLL) at three field sites during the 1980 peanut growing season

Variable[x]	Site P		Site Pr		Site T	
	DSI	LLL	DSI	LLL	DSI	LLL
Maximum temperature (TMAX)	-0.60	-0.61	-0.87	-0.82	-0.81	-0.75
Minimum temperature (TMIN)	<[y]	<	<	<	-0.78	-0.77
Average temperature (TAV)	<	<	-0.68	-0.62	-0.83	-0.78
18 C (T18)	-	-	0.50	0.54	<	<
21 C (T21)	-	-	<	<	0.64	0.65
22 C (T22)	-	-	<	<	0.52	0.54
24 C (T24)	-	-	0.62	0.56	0.51	0.52
85% relative humidity (RH85)	-	-	<	<	<	-0.55
90% relative humidity (RH90)	-	-	-0.57	<	<	<
95% relative humidity (RH95)	-	-	<	<	<	-0.55
Total precipitation (P)	<	<	<	-0.57	<	<
Soil moisture, 0-5 cm (SM)	<	<	-0.80	-0.73	<	<
Soil moisture, 5-10 cm (SM5)	-	-	-0.73	-0.69	<	<
Canopy width (W)	<	<	0.52	0.56	<	<
Canopy height (H)	<	<	0.55	0.64	<	<
Maximum temperature --p (TMAXp)	-0.55	<	-0.77	-0.71	-0.51	-0.51
Minimum temperature --p (TMINp)	<	<	<	<	-0.55	-0.60
Average temperature --p (TAVp)	<	<	-0.56	<	-0.60	-0.65
Total precipitation --p (Pp)	-0.73	-0.75	-0.80	-0.85	<	<
Days with temperature ≤ 16.7 C x precipitation (DA17*P)	<	<	<	<	0.59	0.52

[x]Variables were measured for period one week prior to disease measurement unless followed by --p which were measured for period two weeks prior to disease measurement.

[y]< indicates correlation coefficient was <|0.50| and/or had a nonsignificant association with DSI or LLL.

When data from the three sites were analyzed together for each season, only variables that were present for each of the sites were used. At least fourteen environmental variables were used for the correlations. TMAX was the only variable associated with DSI with a correlation coefficient $\geq|0.49|$ for two of the three seasons. Correlation for data from all sites in 1978 showed seven variables (TMAX, TMIN, TAV, P, Pp, DA17, DA*P) correlated with DSI at $\geq|0.49|$ (Table 13). In 1979, two variables (TMAX and RHMAX) were correlated with DSI and three (TMAX, TAV, and RHMAX) with LLL at the established correlation threshold and significance level. In 1980, only one variable (H) was strongly correlated with DSI and LLL. When all data from all sites in all seasons were combined, no variables had a correlation coefficient with DSI or LLL $\geq|0.49|$; however, TMAX was close with a correlation coefficient of -0.49 with DSI and LLL (Table 13). Height had a correlation coefficient of 0.47 with LLL. Only data from 1979 and 1980 were used for calculating the correlations with LLL since LLL measurements were not taken during 1978. H had a correlation coefficient of 0.47 with LLL.

Regressions were made using all independent environmental variables for a site as well as with selected environmental variables which were not strongly correlated

Table 13. Variables with correlation coefficients >|0.45| and a significant ($P \leq 0.10$) association with the Sclerotinia blight disease severity index (DSI) and longest lesion length (LLL) for three field sites during 1978, 1979 and 1980 and all sites for the three years

Variable[w]	1978[x]	1979		1980		1978-1980	
	DSI	DSI	LLL	DSI	LLL	DSI	LLL[y]
Maximum temperature (TMAX)	-0.51	-0.52	-0.56	<[z]	<	-0.49	-0.49
Minimum temperature (TMIN)	-0.73	<	<	<	<	<	<
Average temperature (TAV)	-0.70	-0.46	-0.51	<	<	<	<
Maximum relative humidity (RHMAX)	<	-0.61	-0.67	-	-	<	<
Total precipitation (P)	-0.52	<	<	<	<	<	<
Minimum temperature --p (TMINp)	-0.46	<	<	<	<	<	<
Total precipitation --p (Pp)	-0.52	<	<	<	<	<	<
Canopy height (H)	<	<	<	0.83	0.87	<	0.47
Days with temperature $\leq$ 16.7 C (DA17)	0.78	0.46	0.52	<	<	<	<
DA17 x precipitation (DA17*P)	0.79	<	<	<	<	<	<

[w]Variables were measured for period one week prior to disease measurement unless followed by --p which were measured for period two weeks prior to disease measurement.

[x]LLL was not measured in 1978.

[y]LLL uses data from 1979 and 1980 only.

[z]< indicates correlation coefficient was <|0.46| and/or had a nonsignificant association with DSI or LLL.

with each other (based on the results of a correlation matrix) but were highly correlated with DSI or LLL. This was necessary to decrease the problem of multicolinearity.

The models from individual regressions using all independent environmental variables from each site during the three seasons varied from site to site and year to year. The models were also different for DSI and LLL. The factors most commonly important in these regression models were: TMAX, Pp, and W for the dependent variable DSI and TMAX, Pp, W, and SM for the dependent variable LLL.

Models for DSI and CDSI or LLL using variables highly correlated with DSI, CDSI, or LLL are given in Table 14. The factors most commonly important in the regression models for DSI were RHMAX (seven models), TAV (two models), SM (two models), Hp (two models), and TMAX (two models). The factors most commonly important in the regression models for LLL were RHMAX (two models) and SM (two models). Two out of three CDSI models contained P.

The results of combining data from all three sites for each year are given in Table 15. The models for each year explained 41-70% of the variation in the DSI, however, when all data from all three years was combined, the model explained only 38% of the variation. Similarly, the model for LLL had a poorer fit when data from 1979 and 1980 were

Table 14. Models for Sclerotinia blight of peanut disease severity index (DSI) and change in DSI (CDSI) or longest lesion length (LLL) at field sites, 1978-1980

Year	Site	Model	R^2
1978	B	$\hat{DSI} = -3.98 + 0.07\ RHMAX^n - 0.02\ TAV^o$	0.94
		$\hat{CDSI} = 0.24 - 0.04\ P^p - 0.02\ DA17*P^q$	0.65
	P	$\hat{DSI} = 12.63 - 0.14\ TAV$	0.80
		$\hat{CDSI} = -2.10 + 0.03\ TMAXp^r - 0.02\ P$	0.55
	W	$\hat{DSI} = -9.53 + 0.16\ RHMAX - 0.04\ TMIN^s - 0.07\ SM5p^t$	0.94
		$\hat{CDSI} = -0.22 + 0.06\ RH90$	0.48
1979	P	$\hat{DSI} = 1.84 + 0.01\ SM^u - 0.02\ RHMAX + 0.01\ Hp^v$	0.96
		$\hat{LLL} = 14.53 + 0.01\ SM - 0.15\ RHMAX$	0.97
	Pr	$\hat{DSI} = 39.10 + 0.20\ Hp - 0.40\ RHMAX$	0.94
		$\hat{LLL} = 117.24 - 1.16\ RHMAX$	0.90
	T	$\hat{DSI} = 35.32 - 0.35\ RHMAX - 0.09\ DA17^w$	0.77
		$\hat{LLL} = 4.83 - 0.08\ TAV + 0.07\ Wp^x$	0.73

Table 14. (continued)

Year	Site	Model	R^2
1980	P	$\hat{DSI} = 0.30 - 0.002\ Pp^{y} - 0.02\ TMAX$	0.73
		$\hat{LLL} = 0.92 - 0.01\ TMAX - 0.08\ Pp$	0.75
	Pr	$\hat{DSI} = 5.31 + 4.52\ Pp - 0.23\ SM$	0.70
		$\hat{LLL} = 2.79 - 0.22\ SM$	0.70
	T	$\hat{DSI} = 0.88 - 0.01\ TMAX$	0.66
		$\hat{LLL} = 0.27 - 0.0001\ RH95^{z} - 0.003\ TMAX$	0.77

[n]RHMAX = average daily maximum relative humidity.
[o]TAV = average daily average temperature.
[p]P = total precipitation for week prior to disease measurement.
[q]DA17*P = interaction of the number of days of temperature $\leq$ 16.7 C with P.
[r]TMAXp = average daily maximum temperature for week two weeks prior to disease measurement.
[s]TMIN = average daily minimum temperature for week prior to disease measurement.
[t]SM5p = soil moisture, 5-10 cm, for week two weeks prior to disease measurement.
[u]SM = soil moisture, 0-5 cm for week prior to disease measurement.
[v]Hp = canopy height for week two weeks prior to disease measurement.
[w]DA17 = number of days with temperatures $\leq$ 16.7 C in week prior to disease measurement.
[x]Wp = canopy width for week two weeks prior to disease measurement.
[y]Pp = P for week two weeks prior to disease measurement.
[z]RH95 = minutes in week prior to disease measurement with relative humidity $\geq$ 95%.

combined (R2 = 0.44) than when they were analyzed separately (R2 = 0.51 and 0.75).

The relationship of DSI to the independent variables obtained in regression analyses for site P and site Pr are graphically shown (because of the continuity of site in the case of P and because of the consistantly high disease development at site Pr) in Figs. 13, 14, 15, 16, and 17.

The relationship between DSI and TAV for site P in the 1978 season is shown in Fig. 13. The first symptoms of infection occurred with cooler temperatures following a hot day (July 26). Major increases in DSI (July 25, Sept. 8, and Sept. 28) occurred after one or several hot days followed by a cooling trend. Overall, as the average daily temperature decreased, the DSI increased.

Figure 14 shows graphically the relationship between SM, RHMAX, Hp, and DSI for the 1979 season at site P. Infection was first observed at the end of July during a period with high relative humidity and increasing canopy size. During a period of decreased RHMAX and SM, disease progress was low but following a sharp increase in soil moisture the disease progress increased.

The relationships between Pp, TMAX, and DSI at site P in 1980 are shown in Fig. 15. Very little precipitation occurred during the 1980 season at this site. The DSI was

Table 15. Models for Sclerotinia blight of peanut disease severity index (DSI) and change in DSI (CDSI) or longest lesion length (LLL) using combined data from three sites for each year and all sites for all years

Year	Model	R^2
1978	$\hat{DSI} = 1.30 + 0.003\ DA17*P^{x}$	0.63
	$\hat{CDSI} = -0.62 - 0.03\ P + 0.01\ TMAXp$	0.24
1979	$\hat{DSI} = 28.93 + 0.22\ DA17 - 0.29\ RHMAX$	0.41
	$\hat{LLL} = 59.90 + 0.51\ DA17 - 0.60\ RHMAX$	0.51
1980	$\hat{DSI} = -2.02 + 0.16\ H$	0.70
	$\hat{LLL} = -5.27 + 0.42\ H$	0.75
1978-80	$\hat{DSI} = 8.45 + 0.14\ H - 0.11\ TMAX$	0.38
1979-80	$\hat{LLL} = 14.49 + 0.39\ H - 0.21\ TMAX$	0.44

[x] DA17*P = interaction of the number of days of temperature $\leq$ 16.7 C with the precipitation for week prior to disease measurement.

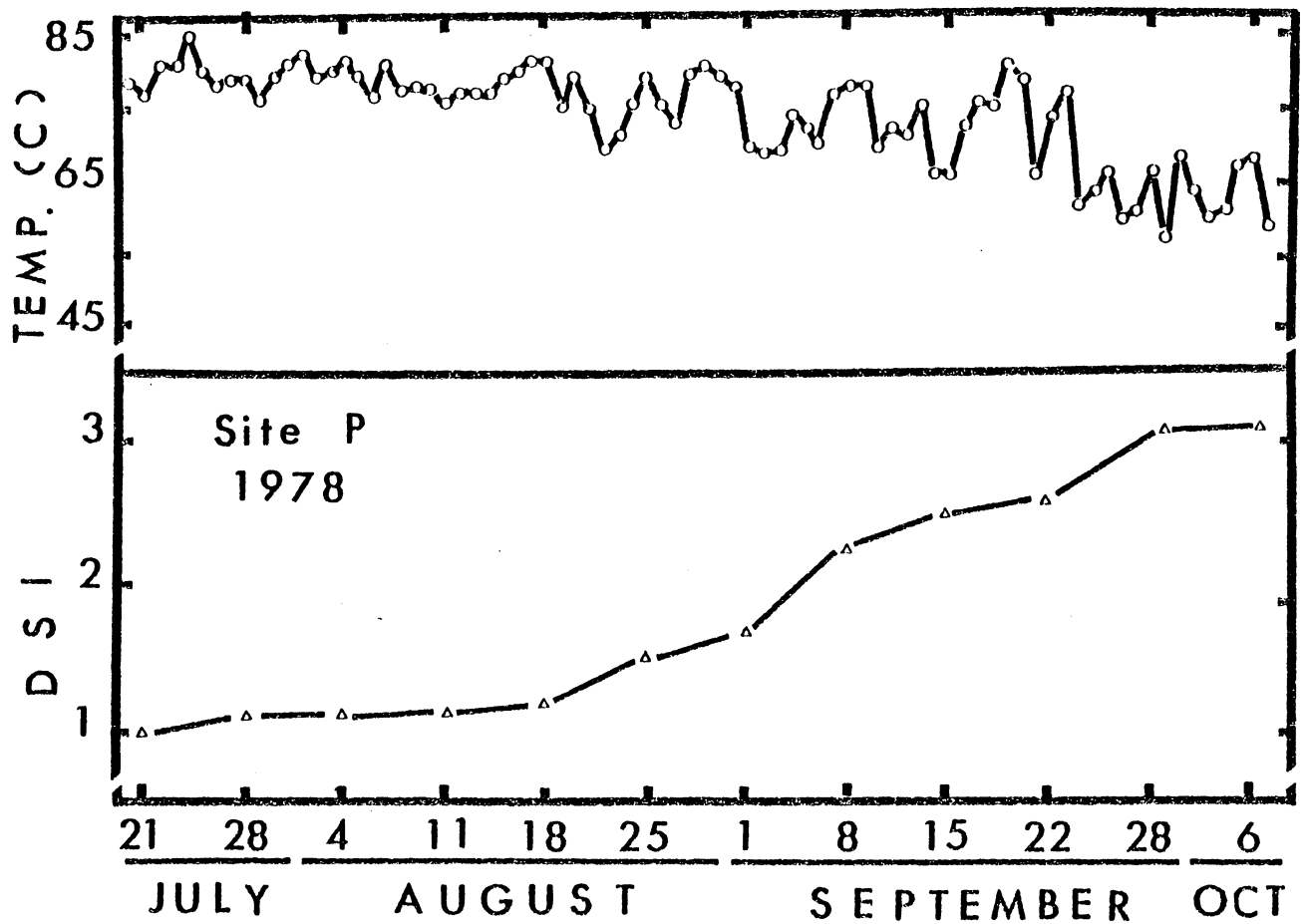

Fig. 13. Relationship of the average daily temperature to the Sclerotinia blight of peanut disease severity index (DSI) at field site P during the 1978 season. The DSI (an average of 160 observations) was based on a 1-5 scale with 1 = no disease and 5 = complete death of plants in a 61-cm row section.

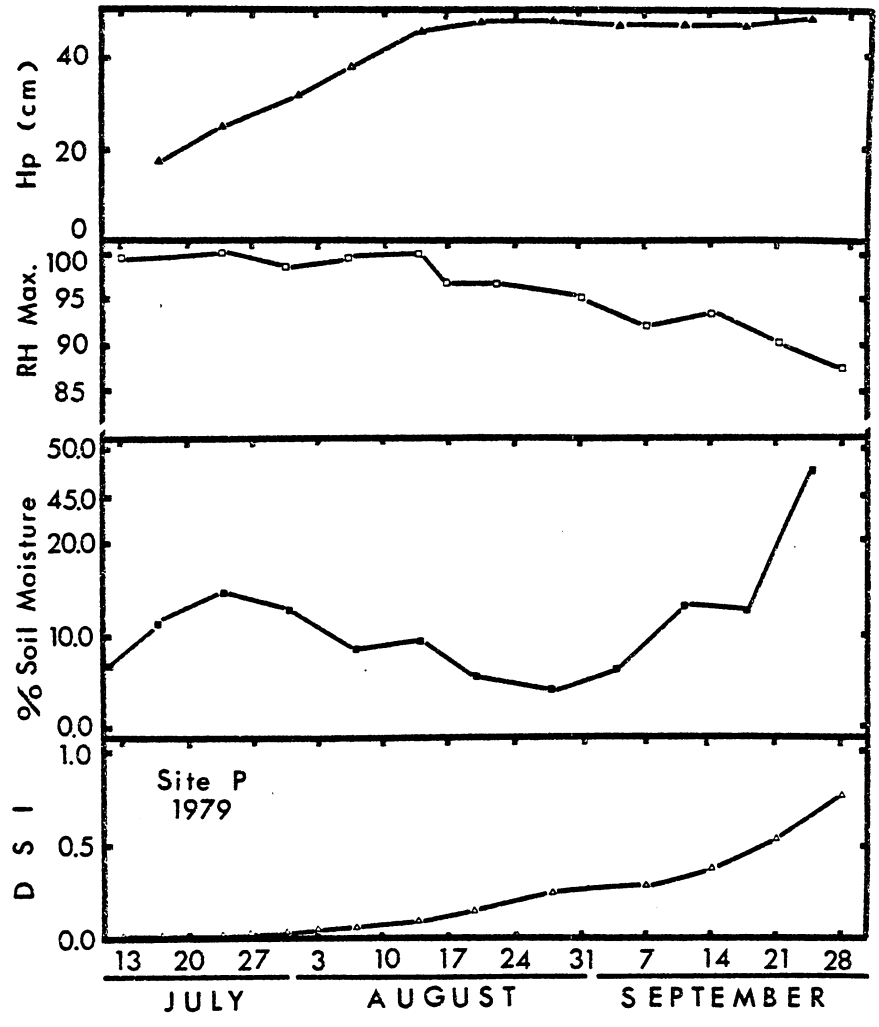

Fig. 14. Relationship of the percent soil moisture under the canopy at 0 to 5-cm depth, average daily maximum percent relative humidity (RHMax) and the height of plants for the week two weeks prior to disease measurement (Hp) to the Sclerotinia blight disease severity index at site P during the 1979 peanut growing season. The DSI (an average of 160 observations) was based on a 0-10 scale with 0 = no disease and 10 = complete death of plants in a 61-cm row section.

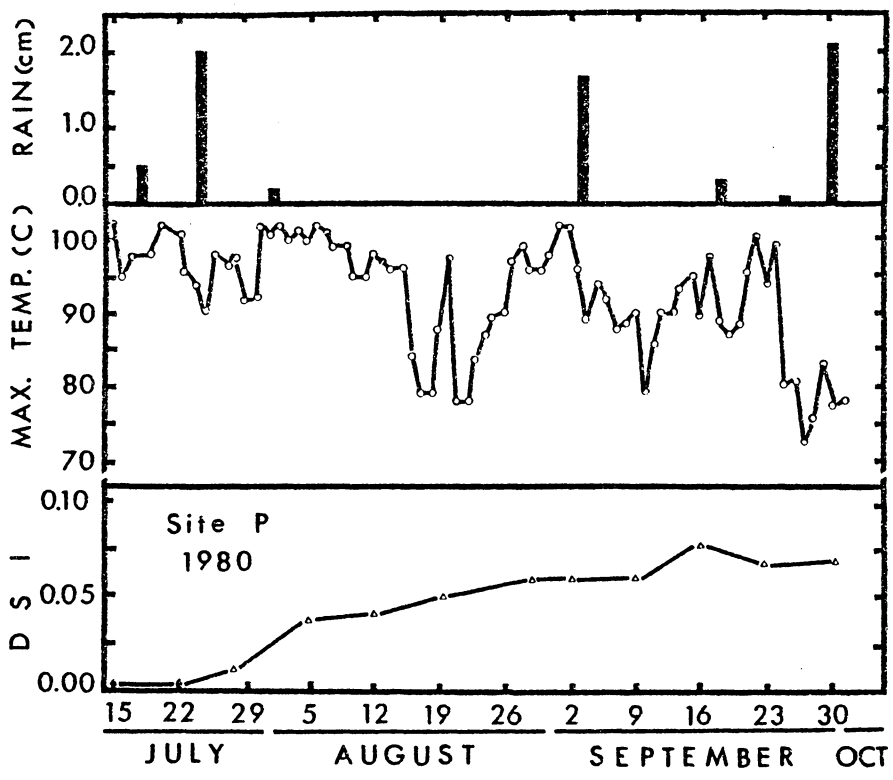

Fig. 15. Relationship of the average daily maximum temperature and weekly rainfall to the Sclerotinia blight of peanut disease severity index (DSI) at site P during the 1980 peanut growing season. The DSI (an average of 160 observations) was based on a 0-10 scale with 0 = no disease and 10 = complete death of plants in a 61-cm row section.

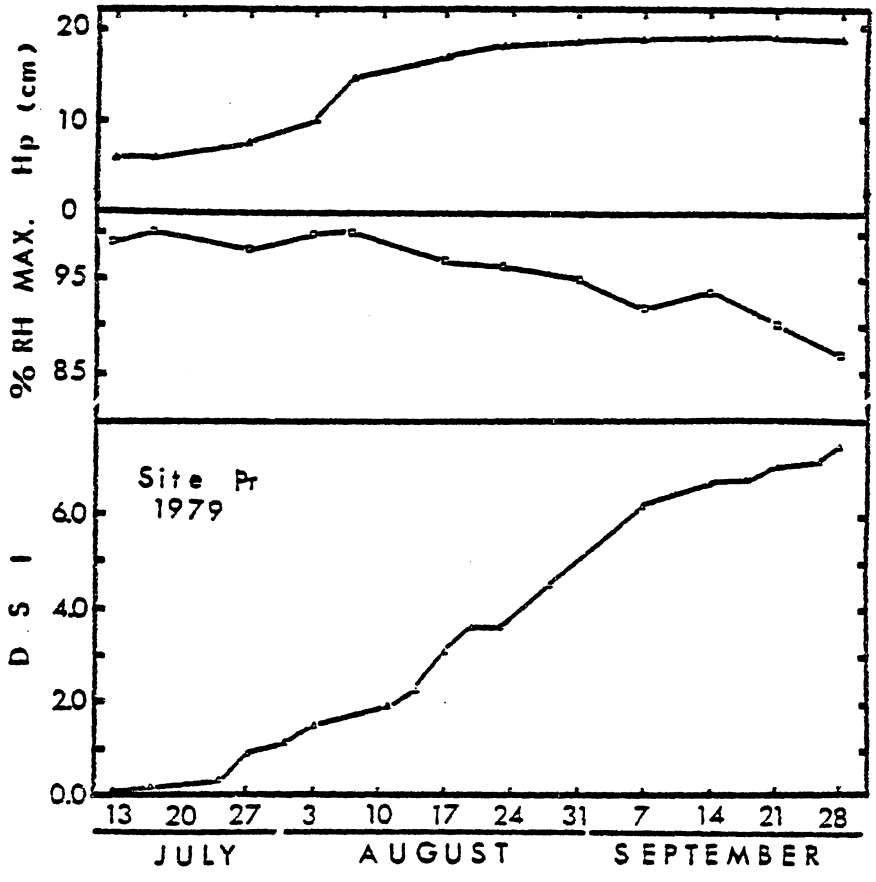

Fig. 16. Relationship of the average daily maximum percent relative humidity (RHMax) and the plant height for the week two weeks prior to disease measurement (Hp) to the Sclerotinia blight of peanut disease severity index (DSI) at site Pr during the 1979 peanut growing season. The DSI (an average of 160 observations) was based on a -10 scale with 0 = no disease and 10 = complete death of the plants in a 61-cm row section.

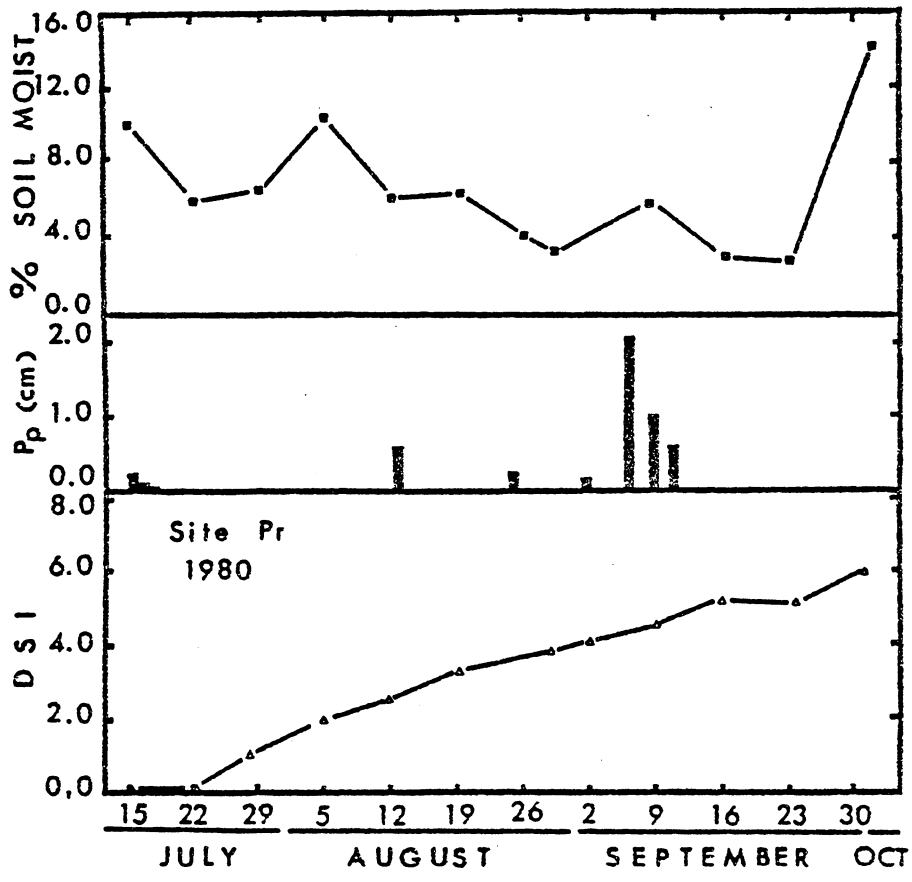

Fig. 17. Relationship of precipitation for the week two weeks prior to disease measurement (Pp), and soil moisture at 0 to 5-cm depth to the Sclerotinia blight of peanut disease severity index (DSI) at site Pr during the 1980 peanut growing season. The DSI (an average of 160 observations) was based on a 0-10 scale with 0 = no disease and 10 = complete death of plants in a 61-cm row section.

extremely low compared to the 1978 and 1979 seasons (figure13 and Fig. 14). The first recorded infection at the site (July 28) followed 2 cm of rainfall in the preceeding week along with decreasing average maximum daily temperatures. In mid September, again following rain and cooling temperatures, an apparent increase in disease occurred.

The relationships between DSI, Hp, and RHMAX at site Pr in 1979 are graphically shown in Fig. 16. The percent average daily maximum relative humidity decreased across the season as the DSI increased. The Hp increased as the DSI increased.

Figure 17 shows the relationship between SM, Pp, and DSI at site P in 1980. The DSI increased throughout the season at a steady rate. The daily precipitation is shown in the graph. In regression analyses the weekly sum was used. Considering this, a positive linear relationship can be seen between Pp and DSI.

Discussion

Comparison of the percent infection and sum of lesion length between groups with the same elapsed time after

inoculation showed significant differences between groups. This is important since it demonstrated that the time of exposure of the sclerotium to the plant and surrounding environment was not the determining factor for infection and lesion development. The result in 1979 of all inoculation groups having first infections during the same week regardless of the elapsed time after inoculation (1-6 weeks) indicated that an important event occurred in the environment to trigger germination and infection. Two key factors occurred: rainfall (22.6 cm) and lowered temperatures. Four days with temperature ≤16.7 C occurred during the week before the first symptoms occurred. Two weeks earlier there were 30 cm of rainfall but temperatures remained high (0 days with temperature ≤16.7 C) and no infection occurred.

The system of Analytis (1973) for prescreening the independent variables using a correlation matrix proved advantageous in reducing the problems of intercorrelation. Multiple linear regression techniques helped simplify the complex interrelationship of the host, parasite, and environment into a mathematical expression.

Maximum temperature, precipitation, and soil moisture for the period two weeks prior to disease measurement and the maximum temperature during the week prior to disease

measurements were found to be significant and commonly obtained in regression models for CLL of the inoculation groups in 1979. Based on the regression coefficients of these variables, it can be predicted that as maximum temperature decreases, lesion length increases and as precipitation and soil moisture increase, lesion length increases. The regression model for CLL in 1980 indicated that DA17, DA17*P, and RH were significant factors while the model for LL had Pp and TAV. The regression coefficients for DA17 and DA17*P were positive in the models while that of Pp, RH, and TAV were negative. This would indicate as DA17 and DA17*P increase, so would lesion length but as Pp, RH, and TAV decrease, lesion length increases. The signs of the coefficients for P and RH do not follow what would be expected. The failure of the model to show the expected, may be due to the extremely low rainfall and RH recorded in the latter half of the 1980 season. RHMAX and temperature (TMAX, TMIN or TAV) were found to be important variables in models developed from the naturally infested field plot data. The importance of RHMAX is consistent with laboratory studies discussed earlier, which showed that 95-100% RH for greater than 12 hours was necessary for sclerotial germination (Chapter 2). The importance of temperature is supported by the resulting disease development in 1980 in

both the inoculated and naturally infested plots. At site T (also the site of the inoculation tests), July, August, and September of 1980 averaged 13.1, 12.6, and 9.5 hours with temperatures greater than 24 C per day, respectively. With the optimum temperature for myceliogenic sclerotial germination, infection, and colonization at 20-25 C (Dow et al., 1981a) and the need for greater than 12 hours of high humidity for germination, it is not surprising that infection and disease development during 1980 were low.

Combination of data from all sites for all years provided regression models with poor fit. This is expected since it becomes more difficult for a simple model to reflect the complexity and variability of all seasons.

Clearly seasonal differences play a distinct role in the severity of Sclerotinia blight of peanut. Disease onset and development based on the number of inoculation groups with infection, the percent infection of the individual groups, and the sum of lesion length of the inoculation group, were severely suppressed in inoculation studies in 1980 compared to 1979. Disease development at harvest in 1980 in the naturally infested field plots was also much less than in 1978 or 1979. The 1980 summer was exceptionally hot and dry. In the peanut season from April to October, 6 out of 7 months had less than normal rainfall

(Va. Crop Reporting Service, 1981). During June through September, there were 39.4 cm less rain than normal. Five out of seven months (from April to October) had higher temperatures than normal. July, August, and September exceeded the norm for these months by approximately 3 C per month. Infection in the 1980 inoculation tests occurred following rainfall and cool temperatures. When temperatures were high and precipitation lacking, new infections did not occur. With the onset of rain in October increasing the maximum relative humidity and with decreasing maximum temperatures providing more days with temperatures ≤16.7 C, infections occurred in several inoculation groups and established infections increased in lesion length.

Various relationships betweeen disease development and environmental factors have been determined for several quite different seasons. The models indicate the conditions conducive for disease development. These models may be utilized in a forecasting system for Sclerotinia blight of peanut in Virginia.

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CHAPTER FOUR

EFFECTS OF MODIFICATION OF THE CANOPY ENVIRONMENT ON SCLEROTINIA BLIGHT OF PEANUT

Introduction

Macroclimate conditions may be quite different from those of the plant microclimate. Because of this Sclerotinia - incited diseases may occur where macro conditions are unfavorable for disease development. For example, white mold of dry beans occurs in the Northern High Plains region of the United States where the macroclimate is hot and dry (Weiss et al., 1980). However within the canopy, temperature and moisture are conducive to white mold development due to the influence of the canopy and irrigation (Steadman, et al., 1973; Coyne et al., 1974).

Many authors have associated Sclerotinia diseases with conditions of canopy density (Coyne et al., 1974; Eddins, 1937; Haas and Bolwyn, 1972; Letham et al., 1976; Letham, et al., 1978; Partyka and Mai, , 1962; Schwartz and Steadman, 1978; Skotland and Menzies, 1957; Weiss et al., 1980). Plant growth habits which may determine canopy density have also been cited as playing a major role in Sclerotinia

disease development (Blad et al., 1978; Coffelt and Porter, 1981; Coyne et al., 1974; Hawthorne, 1974; Natti, 1971; Partyka and Mai, 1962; Schwartz and Steadman, 1978; Schwartz et al., 1978; Steadman et al., 1973).

Plant canopies affect soil temperature, soil moisture, amount and duration of leaf wetness, canopy relative humidity, and canopy temperature (Oke, 1978). For example, 16 to 24 hours of leaf wetness are required for infection of beans from moist actively colonized bean blossoms and 72 hours of leaf wetness is necessary for infection by S. sclerotiorum from dry infected blossoms (Abawi and Grogan, 1975). Hunter, Pearson, Seem, Smith, Palumbo, and Cigna (J. E. Hunter, 1981, pers. comm.) found that canopy density was a more critical factor in determining disease development than was precipitation or soil water matric potential. Although they found that soil matric potential was a good predictor, disease was unlikely when canopy density was low. The distribution of peanut leaf area near the soil surface, the plant canopy structure, and the plant canopy density associated with the growth habit were considered factors in determining the favorability of the microclimate for Sclerotinia blight development (Coffelt and Porter, 1982).

Conditions which are optimum for Sclerotinia blight development in the growth chamber (20-25 C with 95-100% RH)

are uncommon in the macroclimate in the Virginia peanut growing region during most of the growing season (R. L. Dow, unpub. data; Va. Crop Reporting Serv., 1976-1981). Under a dense plant canopy, conditions are often more favorable (R. L. Dow, unpub. data). Canopy modifications were studied because of the apparent importance of the plant canopy to the environment of the S. minor infection court. Since primary infection of peanut by S. minor is thought to be initiated only by myceliogenically germinating sclerotia near peanut tissue, only conditions affecting soil-borne inoculum near the plant need to be considered. Therefore, a test was conducted involving thinning, nonthinning and the use of water-filled troughs as a method of canopy modification. Thinning was used to decrease canopy humidity and water-filled troughs under the unthinned canopy were used to increase the humidity.

The objectives of this study were 1) to determine the effect of canopy modification on Sclerotinia blight development; 2) to monitor the effect of these modifications on canopy light interception, soil moisture, canopy relative humidity, and canopy temperature; and 3) relate these changes to Sclerotinia blight development. A preliminary report on this research has been published (Dow et al., 1981).

Materials and Methods

This test was conducted at the Tidewater Research and Continuing Education Center, Suffolk, Virginia, during the 1980 growing season. Field plots were established in a field mechanically planted with 'Florigiant' seed at the normal seeding rate of 112 kg/hectare.

A randomized block design was used. Each block contained three plots with four, 9.1 m rows, 0.91 m apart. An alley of 3.0 m separated two of the blocks from the other two blocks. Treatments were unthinned rows (U), thinned rows (T), and unthinned rows with troughs (UT). Unthinned rows had a plant spacing of 10 cm while thinned rows contained plants seeded no closer than 20 cm. Thinning was done after the plants began blossoming to prevent growth compensation by the fewer plants in the rows.

Standard agronomic practices were used in plot management except for the omission of chemical application(s) for Sclerotinia blight control and the use of a CO2-backpack sprayer instead of tractor-mounted spray equipment. The sprayer was used for application of chlorathalonil on the standard 14-day schedule for control of Cercospora leafspot.

Troughs (Fig. 18) were made from 10-cm-diameter, corrugated, flexible, polyethylene, drainage tubing which was split in half and then cut into 90-cm lengths. Drainage tubing end-caps were also split in half and glued with fiberglass resin to make the ends of the troughs. Because there were not enough end-caps available, sheet fiberglass was also used. It was cut to fit in the ends of the troughs and sealed with fiberglass resin.

Troughs were located under the canopy approximately 5 cm from the base of the peanut plants. Troughs were placed 60-cm apart, beginning 30 cm from the end of the row. Each row of the trough plots contained six, 90-cm trough sections.

Troughs were kept filled with water throughout the season. Troughs were checked several times each week to maintain a high water level, to check for leaks, and to note any physical disturbance or need for repair.

Canopy height and width measurements were made during seven weeks of the season. Canopy height was measured from the soil to the tip of the upper leaves of the main stem when the leaves were held fully vertically extended. Width was measured at the same plant where height was measured. It was made perpendicular to the row, from the outermost point on one side of the row, to the outermost point on the

Fig. 18. Troughs (90 cm long) made of split flexible, corrugated, polyethylene, drainage tubing and split end caps. The troughs were placed under the canopy and filled with water to raise the canopy relative humidity.

other side of the row. Measurement was made 1/4, 1/2, and 3/4 the way down each of the plot's outer rows. The plot average was made from the six readings.

Soil moisture measurements were made weekly on soil from under the canopy at surface to 5-cm and 5-cm to 10-cm depths using a 2.54-cm-diameter soil sampling tube. Each plot soil sample was a pooled sample made up of two samples from each of the two outer rows, taken 1/4 and 3/4 of the way down each row. The outer rows of the plots were used to prevent disturbance of the inoculum and plant injury during sampling to the center rows. The center rows were monitored for disease development and used for final yield determinations.

Temperature and relative humidity (RH) measurements were obtained from under the canopy in the center rows of the plots in order to relate directly to the disease development of these rows. The RH was calculated from temperature measurements made using a Psychron psychrometer (Bendix Corp., Baltimore,MD) or a digital psychrometer (Atkins Technical Inc., Gainesville, FL). When the Psychron psychrometer was used, the instrument was placed under the canopy and then moved an arms length down the row from the

entry point to prevent opening the canopy and changing the atmosphere in the area of the reading. When the digital psychronometer was used the air intake barrel was pointed directly into the canopy where the reading was desired. Since the barrel is only 1-1/2 cm in diameter, little disturbance occurred. Measurements were made between 9:00 and 10:00 AM. This time was chosen since it would be a transition time due to the sun increasing the canopy temperature and thus affecting the RH of the canopy atmosphere. Treatment differences were assumed to be most apparent then. In the beginning, measurements were made at three sites in each of the two center rows (1/4, 1/2, and 3/4 the way down each row) in each plot. This took too much time and large changes in temperature occurred between the first and last readings, thus making the relative humidity values more representative of the time and order in which they were taken than of the treatment. Consequently, only two readings were made in each of the two center rows and only two or three plots were read each morning, depending on how rapidly the ambient air temperature changed. Plot selection for a day's readings was based on a randomized numbers table.

Canopy light interception was measured using a radiometer developed at Virginia Polytechnic Institute and

State University (Wolf et al., 1972). A reading was made above the canopy and another within the canopy along the main stem, 10 cm above the soil surface. The difference between the reading above the canopy and that within, was divided by the above canopy reading to normalize the data for comparison between different days. Readings were made when the sun was unobstructed by clouds.

Sclerotinia minor was grown at 20-25 C for two weeks on soil-cornmeal(5% w/w) in 30 cm by 46 cm, foil covered dissecting trays. Sclerotia were scraped from the media surface, washed under high pressure tap water for 10 minutes and dried under the transfer hood with constant filtered air flow for 24 hours. Each row of the plots was inoculated August 14, with 4 g of dry sclerotia which were sprinkled under the canopy and lightly raked into the top 1 cm of soil. Four grams established an inoculum density of 0.04 sclerotia/g soil in a 30.5-cm-wide swath, 1 cm deep, under the canopy of each row.

The two center rows of each plot were observed weekly for disease development. A T-shaped implement with a 61-cm ruled cross piece on one end was used to push back the foliage to allow observation of the base of the plants and the tissue lying on the soil surface. A disease severity index (DSI) reading was made weekly for each 61-cm row

section based on the percent of symptomatic tissue in the section with 0 being no symptomatic tissue and 10 being complete death of the tissue. A longest lesion length (LLL) measurement was also recorded for all of the 61-cm row sections. Fifteen DSI readings and 15 LLL measurements were made for each 9.1 m center row. Thus from every plot, 30 DSI and 30 LLL values were obtained giving 120 DSI and 120 LLL for each treatment.

Yield was obtained from the two center rows of each plot following mechanical harvesting in October. Quality factors were determined using govermental standards.

The data was analyzed using analysis of variance with Duncan's multiple range test and multiple linear regression techniques. A paired-T test was used for comparing the relative humidities of two treatments read on the same days. This test was used because all plots of all treatments were not read on each day that readings were made.

Results

The number of infection foci was far greater in the U- and UT- plots than in the T-plots. On the last day of the season there were an average of 10, 8, and 4 foci per row for the U, UT, and T plots, respectively. DSI readings and

LLL measurements were made for 13 weeks. Symptoms were not observed until the second week. Figure 19 shows the disease progress curve for the three treatments based on the longest lesion length measurement per 61-cm row section. The LLL was significantly greater in the UT plots than in the T and U plots during the second week of readings. By the end of the season it was greatest in the U plots followed by the UT plots and shortest in the T plots. The season's mean LLL in the 61-cm row section was 4.6, 4.1, and 2.6 cm for the U, UT, and T treatments, respectively. Analyzing together the LLL readings for all weeks, the plants in the U plots had significantly longer lesions than those in the UT which had significantly longer lesions than those in the T plots.

Figure 20 shows the disease progress curves for the three treatments for the season based on the DSI. For the first two weeks there were no significant differences in the DSI values for the three treatments. In the third and sixth week the DSI of the T plots was less than the U plots while the DSI of the UT plots was not significantly (P=0.05) different from the T or U plots. By the tenth week after inoculation the DSI values of all three treatments were significantly (P=0.05) different. For nine of the 13 weeks there were no significant differences between the DSI values of the U and UT plots, but these values were significantly

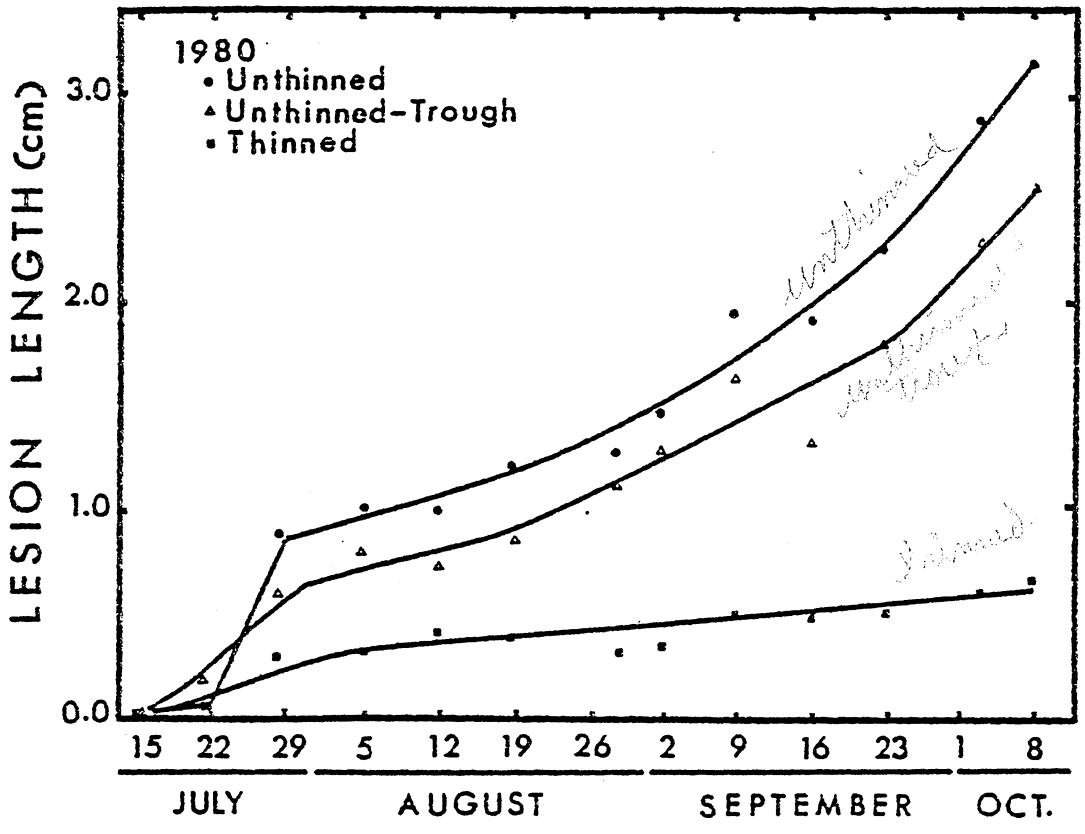

Fig. 19. Sclerotinia blight of peanut disease progress based on longest lesion length (120 observations per treatment per date) in unthinned, unthinned-trough, and thinned peanut plots during the 1980 season.

higher than the DSI values of T plots. On the day before digging the peanuts in preparation for harvest (October 7), the mean DSI per 61-cm row section was 1.4, 1.4, and 0.3 for the U, UT, and T plots, respectively (Table 16). The mean LLL was 4.6, 4.1, and 2.8 for the U, UT, and T plots. The T plots contained significantly fewer plants in the two center rows than the U and UT plots (278, 233, 112, respectively).

Analysis of the DSI readings for each treatment for all season showed the U plots significantly greater than the UT plots which were greater than the T plots. Overall disease development was low for the season. A maximum DSI reading at any observational site in a row on the last day of the season was only 8 (regardless of plot). The maximum DSI row average was 6.5.

Canopy measurements are given for seven weeks in Fig. 21. After August 12, there was no significant difference in width of the plants of the U and UT treatments or in the UT and T treatments. When all weeks were analyzed the plants in U rows were wider than those in the UT rows which were wider than those in the T rows.

Plant height for the three treatments is shown for seven weeks in Fig. 21. For five of the seven weekly readings, there were no significant differences in height between the two unthinned treatments. Results of analyses

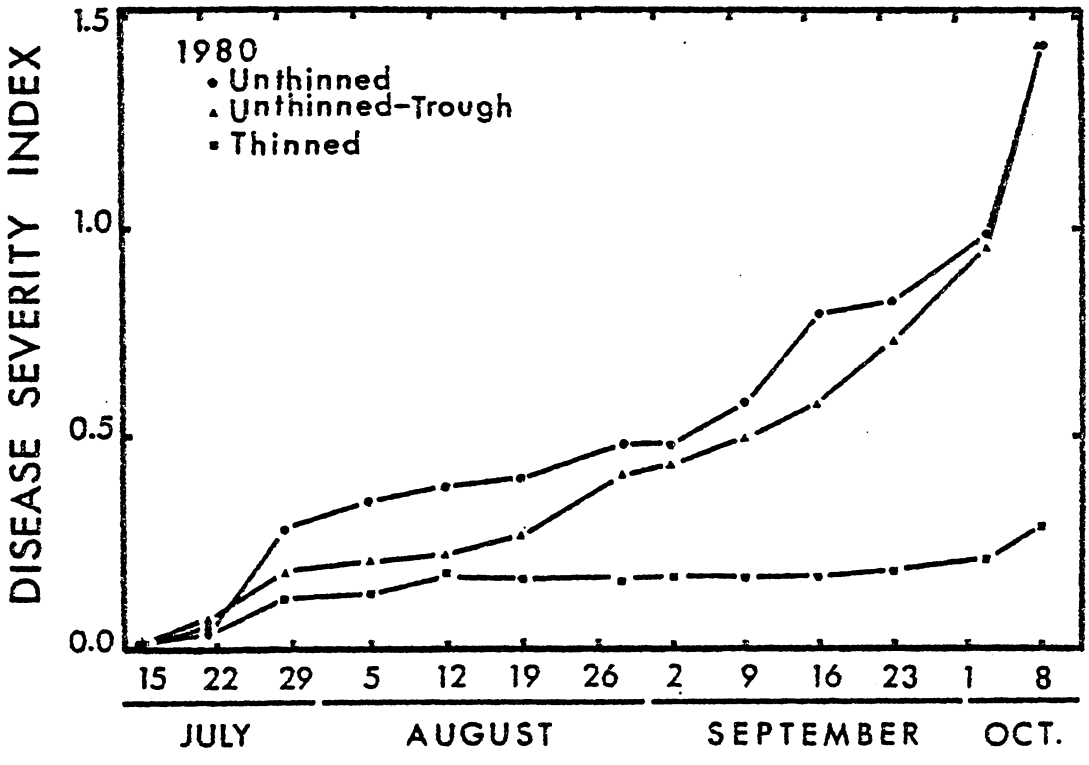

Fig. 20. Sclerotinia blight of peanut disease progress based on the disease severity index (DSI) (120 observations per treatment per date) in unthinned, unthinned-trough, and thinned peanut plots during the 1980 season. DSI was based on a 0-10 scale with 0 = no disease and 10 = complete death of plants in a 61 cm row section.

Table 16. Comparison of Sclerotinia blight disease severity index (DSI), lesion length (LL) and plant number in unthinned, unthinned-trough, and thinned 'Florigiant' peanut plots

Treatment[v]	DSI[wz]	LL[xz]	No. Plants[yz]
Unthinned	1.4 a	4.6 a	9.3 a
Unthinned-trough	1.4 a	4.1 a	7.8 a
Thinned	0.3 b	2.8 b	3.7 b

[v]Unthinned rows had a plant spacing of approximately 10 cm while thinned rows contained plant mainstems no closer than 20 cm. Troughs (90 cm long) filled with water, were placed 60 cm apart and 5 cm from the base of the plants in the unthinned-trough rows.

[w]Mean of all 61 cm row sections.

[x]Mean of only diseased 61 cm row sections.

[y]Mean of all 61 cm row sections.

[z]Means in columns followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test.

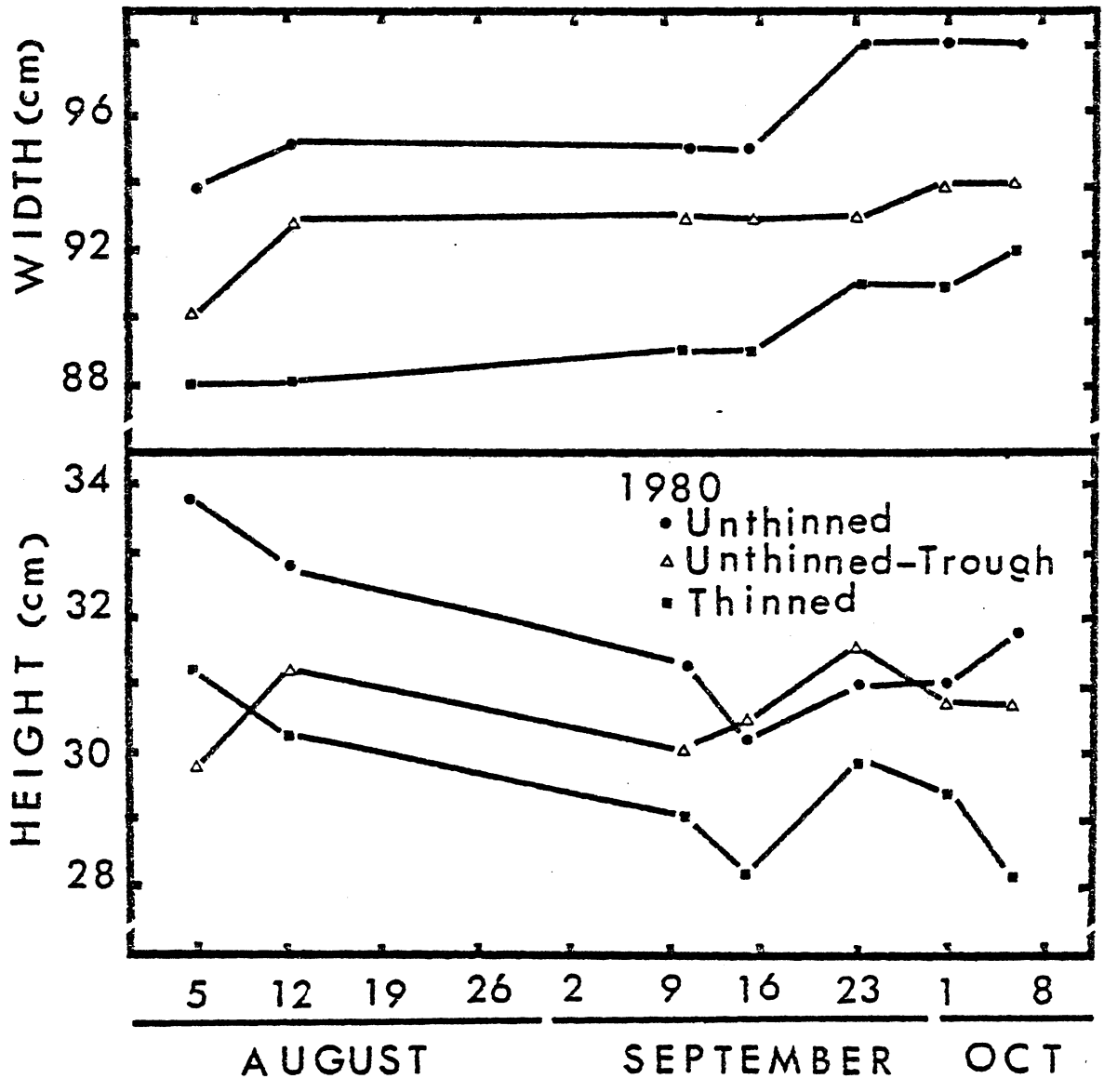

Fig. 21. Canopy development (height and width) in unthinned, unthinned-trough, and thinned 'Florigiant' peanut plots during the 1980 season.

of all weeks data showed plants in the U treatment were taller than the UT plants which were taller than the T treatment plants.

Thinning, as expected, decreased canopy density, (Fig. 22). The light interception of the two unthinned treatments was similar in three out of the five weeks. In two of the five weeks, canopy light interception in the U plots was greatest. When all weeks of the season were considered, the plant canopy of the U plots was densest and that of the T plots least dense.

Canopy RH of the U plots was greater than that in the T plots (Fig. 22) but was significantly greater only at $P = 0.15$. Troughs did not significantly increase RH in the canopy over that of the unthinned rows without troughs, but canopy RH in the UT plots was greater than that in the T plots at $P = 0.08$.

Each week soil moisture under the canopy at the surface to 5-cm depth in the UT plots was greater than in T plots but there was no significant difference in treatments at the 5-10 cm depth (Fig. 22). When data from all weeks were analyzed, similar results were found for the surface to 5-cm depth. Analysis of all weeks data at 5 to 10-cm depth, indicated soil moisture in UT plots was greater than soil moisture in U plots but soil moisture in T plots was similar to UT and U plots.

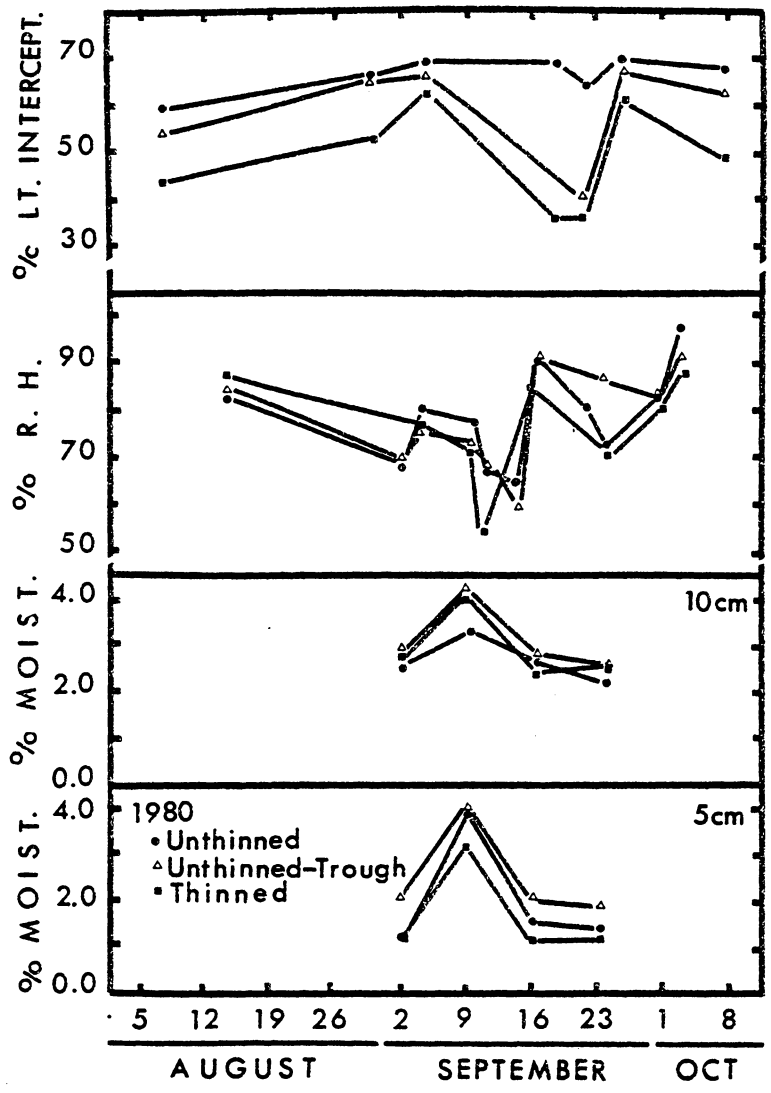

Fig. 22. Percent soil moisture, percent canopy light interception, and within canopy percent relative humidity for the unthinned, unthinned-trough and thinned plots in 1980.

Yield was greater in the U and UT than in the T plots (Table 17). Yield of T plots was one third less than that of U plots. Table 17 also shows the net dollars per hectare($/ha) and dollars per hundred weight($/cwt) earned by each treatment. There was no significant difference in peanut quality factors between treatments so the differences in $/ha and the $/cwt for the treatments reflected yield differences.

Regression of height and width for the season on DSI for the U plots showed that they were significant to the model at the 0.05 and 0.07 alpha level but the model with only those two factors explained little of the variation in DSI. Similarly, height was significant in a regression on DSI for the T plots. The reverse was the case for the UT plots.

A stepwise regression using light interception and soil moisture for the U plots regressed on the DSI for the same weeks showed light interception to be a significant variable ($P = 0.01$). This single variable explained 48% of the variation in the DSI. When LLL was used instead of DSI, the soil moisture at the 5 to 10-cm depth was significant ($P = 0.03$) and explained 38% of the variation in LLL with this single variable model. The slope was positive indicating that as soil moisture increased, LLL also increased.

Table 17. Peanut pod yield (kg/ha) and value (dollars per hectare ($/ha) and dollars per hundredweight ($/cwt)) for the thinned, unthinned, and unthinned-trough plots

Treatment[w]	kg/hectare[x]	$/hectare[xy]	$/cwt[xz]
Unthinned	3280 a	1670 a	31.26 a
Unthinned-trough	2940 a	1452 a	30.59 a
Thinned	2270 b	1112 b	30.26 a

[w]Unthinned rows had a plant spacing of approximately 10 cm while thinned rows contained plant mainstem no closer than 20 cm. Troughs (90 cm long) filled with water, were placed 60 cm apart and 5 cm from the base of the plants in the unthinned trough rows.

[x]Means in columns followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Based on yield and grading factors.

[z]Based on grading factors.

Stepwise regression of DSI for the T plots against light interception and soil moisture at the two depths provided a model with soil moisture at the 0 to 5 and 5 to 10-cm depths (significant at P=0.01) explaining 58% of the variation in DSI. A model was not obtained for LLL.

Stepwise regression of DSI for UT plots with light interception and soil moisture gave a single variable model using light interception (significant at P=0.001), explaining 71% of the variation. When LLL was used, 90% of the variation was similarly explained.

Discussion

Thinning reduced initial infection as evidenced by the reduced number of infection foci. Thinning reduced tissue colonization which was demonstrated by reduced lesion development. Also, thinning reduced secondary infections. This was shown by the lower disease severity which reflects the branch to branch disease increase from an infection focus as well as the number of foci. The reduction in DSI was not simply a linear factor of fewer plants since the number of plants in the T plots was 60% less than in the U plots, yet the DSI was 80% less.

The troughs did not serve the purpose of raising the canopy RH. This might have been due to several factors: the intensity of the daytime temperatures, the wilting of the canopy, the number of repair problems associated with the troughs due to dogs damaging them, and/or general ineffectual nature of the troughs.

The weather during the 1980 summer was much hotter and drier than normal. RH in the canopy was consistently lower than that found in the 1978 or 1979 season (R. L. Dow, unpub. data). Typically drought causes reduced transpiration. With less transpiration, there would be less moisture in the canopy atmosphere so evaporation from the troughs would be high but with the air surrounding the canopy also dry, there would be a steep moisture gradient tending to readily dissipate the canopy moisture. Also, with drought caused wilting of the plants and folding of the leaves the canopy was more open thus allowing increased moisture movement out of the canopy. It appears in a season like 1980, it would have taken much more than the troughs to greatly increase the canopy humidity. Cheese cloth wicking on the troughs was tried but was not effective.

Thinning decreased canopy light interception, however, it did not significantly alter the soil moisture despite the fact that the mean percent moisture for each week was

slightly higher in both of the unthinned plots. Perhaps, because of the small number of samples, differences could not be shown. In any event, it is not possible to say that the increased disease in the unthinned plots was due to higher soil moisture.

Although the RH differences were not significant at the normal 95% level, perhaps the results are indeed biologically significant. The numerically higher RHs in the canopies of the U and UT plots than in the T plots suggests that RH, combined with the unmeasured duration of these periods may have been important for increased disease development in these plots.

Regression of DSI or LLL on percent soil moisture and light interception gave mixed results. The UT plot models had 70-90% of the variation in LLL or DSI explained by the single factor, light interception. The U plots DSI stepwise model also incorporated the light interception factor but the model was weaker, explaining only 48% of the variation. The model for LLL in the U plots and the model for DSI in the T plots used only soil moisture in a stepwise model.

Consideration of the effects of the canopy on the canopy microclimate of peanuts may be especially important in areas where peanuts are irrigated. The macroclimate temperatures of the southwestern U. S. peanut growing

region are not considered conducive to Sclerotinia blight ; however with irrigation and dense canopies, or plantings in moist low lying areas (Wadsworth,pers. comm.) Sclerotinia blight is found. It appears that under these conditions using agronomic practices to modify the canopy microclimate may be worthwhile. Decreased seeding rate, wider row spacing, planting of rows parrallel with the prevailing wind direction, use of growth regulators, and use of cultivars with less dense canopy structure might be considered.

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CHAPTER FIVE

FUNGICIDE TESTING, DISEASE FORECASTING, AND ASSOCIATED FACTORS RELATED TO DISEASE DEVELOPMENT

Introduction

Sclerotinia blight of peanut has been reported in Virginia (Porter and Beute, 1974), North Carolina (Porter and Beute, 1974), and Oklahoma (Wadworsth, 1979). It is now considered Virginia's most important peanut disease (D. M. Porter and P. M. Phipps, 1981, pers. comm.).

Sclerotinia blight may be initiated when hyphae from myceliogenically germinating sclerotia contact peanut tissue on or in the soil. Ascospore-initiated infections have not been reported in Virginia or North Carolina but were suspected in Oklahoma (Wadsworth, 1979).

Sclerotinia blight has been associated with cool, wet weather. It has been observed that 1974, 1976, 1978, and 1979 were favorable seasons for disease development while 1975, 1977, and 1980 were not (D. M. Porter, 1980, pers. comm.). The 1974 and 1976 growing seasons had lower than normal ambient temperatures with normal rainfall while 1975,

1977, and 1980 growing seasons had higher than normal ambient temperatures and lower than normal rainfall in August and September (Va. Crop Reporting Service, 1975, 1976, 1977, 1978, 1979, 1980, and 1981). This weather associated variability increases the potential for developing a weather based disease forecasting system for Sclerotinia blight.

Numerous disease forecasting systems utilizing weather data to predict disease development for diseases with airborne propagules have been reported (Bourke, 1957; Jensen and Boyle, 1966; Kranz et al., 1973; Krause et al., 1975; Parvin et al., 1974; Waggoner and Horsfall, 1969; Waggoner et al., 1972). None have been reported for diseases with only soil-borne inoculum. Instead predictive systems and epidemiological studies for soilborne diseases rely primarily on inoculum density or potential (Baker, 1971; Lumsden et al., 1974; Mitchell, 1975; Pavavizas et al., 1975; Taubenhaus and Killough, 1923; Wilhelm, 1950).

Work on development of predictive systems for other Sclerotinia diseases has occurred. Schwartz and Steadman (1978) considered a predictive system based on inoculum potential for S. sclerotiorum in bean fields but found poor correlation with disease development. Hunter, Pearson, Seem, Smith, Palumbo, and Cigna (J. E. Hunter, 1981, pers.

comm.) have developed a disease forecasting system for Sclerotinia white mold of snap beans in New York. They found that soil matric water potential (Ym) measurements (within row at surface to 4-cm depth) made nine and two days before bloom or two days before bloom and seven days later during bloom were good for prediction of ascosporic inoculum of S. sclerotiorum and white mold of beans. They also found that rainfall was not a good predictor. Less disease occurred in small canopied plants regardless of the Ym. They would forecast disease when the average Ym is > -30 cb for the measurements nine and two days before 70-80% of the plants first have at least one open blossom, or two days before the 70-80% point and seven days later during bloom. They predict that disease, regardless of Ym value, is unlikely when canopy density is low. When the soil moisture and canopy density conditions are met, a single fungicide application should be made promptly after the 70-80% blossom point is reached. They suggested that a second application should be applied five days later if the average Ym for week-one (week prior to bloom), week-two, or week-three is between 0 and -20 cb and the canopy density > 3 (moderately dense).

Before a forecasting system can be made operational, an effective control mechanism must be available, otherwise the

system may have only academic value. Currently available fungicides give only partial control (Beute and Porter, 1975). In 1978, Porter (1978) reported on a promising fungicide DPX-4424 (procymidone).

This report discusses the results of a comparative study of a test fungicide, DPX-4424 (3-(3,55-dichlorophenyl)-1, 5-dimethyl-3-azobicyclo (3.1.0) hexane-2-4-dione), and the commonly recommended fungicide, DCNA (2, 6 dichloro-4-nitroaniline), for control of Sclerotinia blight of peanut. This report also discusses the results of a forecasting system for a soil-borne disease based on weather factors. Soil moisture and canopy development at the test sites during the three seasons of study are given. Also reported are sclerotial populations at four depths at each site during 1978, 1979, and 1980.

Materials and Methods

This study was conducted during three seasons. The tests were established in peanut fields planted by farmers at the normal seeding rate (112 kg/ha) and row spacing (91 cm).

In 1978, the sites were located at the J. L. Porter farm in Southampton Co. (site P), J. Bryant farm in Isle of

Wight Co. (site B), and the M. Warren farm in the City of Suffolk (site W), Virginia. For 1979, two sites were located in Southhampton Co.: the J. L. Porter farm (site P) and the G. L. Prince farm (site Pr). The third site was located at the Tidewater Research and Continuing Education Center in the City of Suffolk (site T). The same sites were also used in 1980, however the tests were not conducted in the same fields because of normal crop rotation practices. The P site was used during all three years. The same field at this site was used in 1978 and 1980.

Standard agronomic practices were used throughout the study except for the application of Cercospora leafspot fungicide by CO2-backpack sprayer instead of a tractor-mounted sprayer.

The cultivar GK3 was planted at site P for 1978 and 1979. 'Va72R' was grown at site Pr in 1979. All other sites used 'Florigiant', the most commonly planted peanut cultivar in the Virginia production area.

In 1978, a three treatment, randomized block design was prepared. Each plot contained 4 rows, 12 meters long. Fallow soil alleys, 3-m wide, were made between the blocks with a 6-m alley at the end of the test plots to provide tractor turn-around-space at harvest time. The treatments were: 1) no Sclerotinia blight fungicide, 2) DCNA (Botran

75W), and 3) procymidone (DPX-4424 50W). DCNA was applied at 2.10 kg active ingredient(a. i.) /ha. and procymidone was applied at 1.12 kg a. i./ha per application. The 1978 season was used to study the effect of the two fungicides and to gather information on disease development with respect to environmental factors.

A three treatment randomized block design similar to that used in 1978 was employed for 1979 and 1980. The treatments consisted of: 1) no Sclerotinia blight fungicide, 2) procymicone (0.56 kg a.i./ha) applied on a calendar schedule, and 3) procymidone (0.56 kg a.i./ha) applied according to disease forecasting. The calendar schedule required one application at the end of July and another at the end of August. Conditions were considered conducive for disease development when two days of minimum temperatures equal to or less than 15.6 C occurred following rainfall within the previous week. The chemical procymidone, an experimental chemical from the DuPont Company, was used because of its efficacy in 1978. It was felt that if infection was just beginning, this chemical would be more effective in controlling disease development, thus more clearly demonstrating the effect of application timing. The rate used in 1979 and 1980 was half that used in 1978 because during 1978, procymidone almost completely

controlled Sclerotinia blight. It was felt that such a high rate would mask the timing effects.

Unless otherwise mentioned, the following procedures were used throughout the three seasons. Low pressure (30 psi) fungicide application was made two rows at a time, using a CO2-backpack sprayer. The fungicide was applied with 205 liters water/ha. Two nozzles (number D2-13 disc and core tips) were directed to give canopy coverage in an approximately 46-cm band across the row.

Soil samples were taken weekly from 0 to 5-cm and 5 to 10-cm depths under the canopy of the outside rows of each plot. Samples were taken using a 2.54-cm-diameter soil sampling tube, approximately 1/4 and 3/4 of the distance down the row. Four samples at each depth from each plot were pooled, weighed, dried at 104 C for 24 hours, cooled in dessicator jars, and reweighed. Percent soil moisture was expressed on a dry weight basis.

Canopy development was monitored by measuring the height and width of the outside two rows of each plot. In 1978, two measurements were made weekly at approximately 1/4 and 3/4 the distance down the rows. In 1979 and 1980, three readings were taken at 1/4, 1/2, and 3/4 the way down the rows. Measurement for height was made from the soil surface at the base of the main stem to the tip of the uppermost

leaflets when held vertically. Width was measured over the same main stem on which height was measured. Width was taken perpendicular to the row direction from the tip of the longest lateral branch on the one side of the plant to the tip of the longest lateral branch on the other side.

Inoculum density was monitored weekly during 1978 and approximately monthly during 1979 and 1980. In 1978, ten locations were sampled in a grid pattern of the outer rows of each plot of a block. In 1979 and 1980, samples were taken 1/4, 1/2, and 3/4 the way down the outer rows of each plot. All samples were taken under the canopy using a 2.54-cm diameter soil sampling tube. Samples were taken at four depths: 0-5, 5-10, 10-15, and 15-20 cm. The block samples (1978) or plot samples from six sites within the plot (1979 and 1980) were grouped to make a single bulk sample for each depth. They were air-dried in perforated, open, plastic bags in a controlled temperature room (21-24 C). After sieving each soil sample through a 10-mesh (2.00 mm) screen and mixing it thoroughly, two, 40 or 50 g, samples for each depth for each block in 1978 and for each plot in 1979 and 1980 were processed for 6.75 minutes in a soil elutriator (Porter and Steele, 1981). Initially 50 or 70 g samples were used but it was difficult obtaining this size sample if any spillage occurred. Sclerotia were

collected on a 40-mesh (425 um) sieve and counted using a dissecting microscope at 10 x magnification. When the elutriator was inoperative, soil samples were wet-sieved using 40-mesh screens.

Environmental data were obtained from each site. Agro-environmental monitoring stations were operative at site P in 1978 and site T in 1979 and 1980. The monitoring stations were located adjacent to the plots. Data from sensors for windspeed, wind direction, solar radiation, photosynthetically active radiation, rainfall, dewpoint, ambient temperature, and soil temperature at 5, 15, and 45-cm depths were obtained. At all of the other sites, a weighing bucket, recording rain guage (Belfort, Instrument Co., Baltimore, MD) recorded the precipitation and a recording hygrothermograph (Weather Measure, Sacramento, CA) recorded the ambient temperature and percent relative humidity (RH). The rain guage and hygrothermograph (contained within a standard National Weather Service weather shelter, 15 cm off the ground) were located in the center of the test site.

The two center rows of each plot were observed approximately weekly during 1978 and 1980 and biweekly during 1979, for signs and symptoms of Sclerotinia blight. A T-shaped implement with a 61-cm ruled cross piece was used

to push back the foliage to allow observation of the base of the plant and the tissue lying on the soil surface. A disease severity index (DSI), based on the percent symptomatic tissue in the 61-cm row section, was made using a 1-5 scale in 1978. A rating of 1 meant no disease and 5 indicated complete death of plants in the 61-cm row section. In 1979 and 1980, a 0-10 scale was used with 0 being no Sclerotinia blight and 10 being 100% death of the plants in the 61-cm row section. Twenty readings were made for each center row giving a total of 160 readings for each treatment. The two center rows were protected from all other sampling and traffic to prevent plant injury and subsequent increased Sclerotinia blight (Porter and Powell, 1978).

At the end of the season the two center rows of each plot were mechanically harvested. Pod yield and grade quality of shelled peanuts were determined according to government standards. Crop value was calculated based on the yield and grade results. The percent increase in yield was calculated for the fungicide treated plots.

Results were analyzed using analysis of variance and Duncan's multiple range procedures. Unless otherwise mentioned, a significance level of $P=0.05$ was used to determine significant differences between treatments.

Results

Disease progress for the three treatments at the three sites during 1978 is shown in Fig. 23. The stars indicate the times of fungicide application. Infection was observed on the first observational date (July 21) at site P while it was August 4 for site B and August 11 for site W. Disease was recorded in all treatments two days after fungicide application. Disease development was reduced in the procymidone plots at all sites.

The rate of increase in DSI of the untreated control plots and the DCNA plots increased sharply between August 21 and September 5 at site W. However, after the second fungicide application, the rate of disease progress in the DCNA plots was reduced for two weeks compared to the untreated control.

The rate of increase in DSI of the DCNA treatment at site P closely parallels that of the control. The DSI of the DCNA and control plots steadily increased throughout the season with only the last reading for the control indicating a plateauing in the disease progress curve. The second fungicide application resulted in no apparent change in the DSI rate of increase in the DCNA treatment since it remained

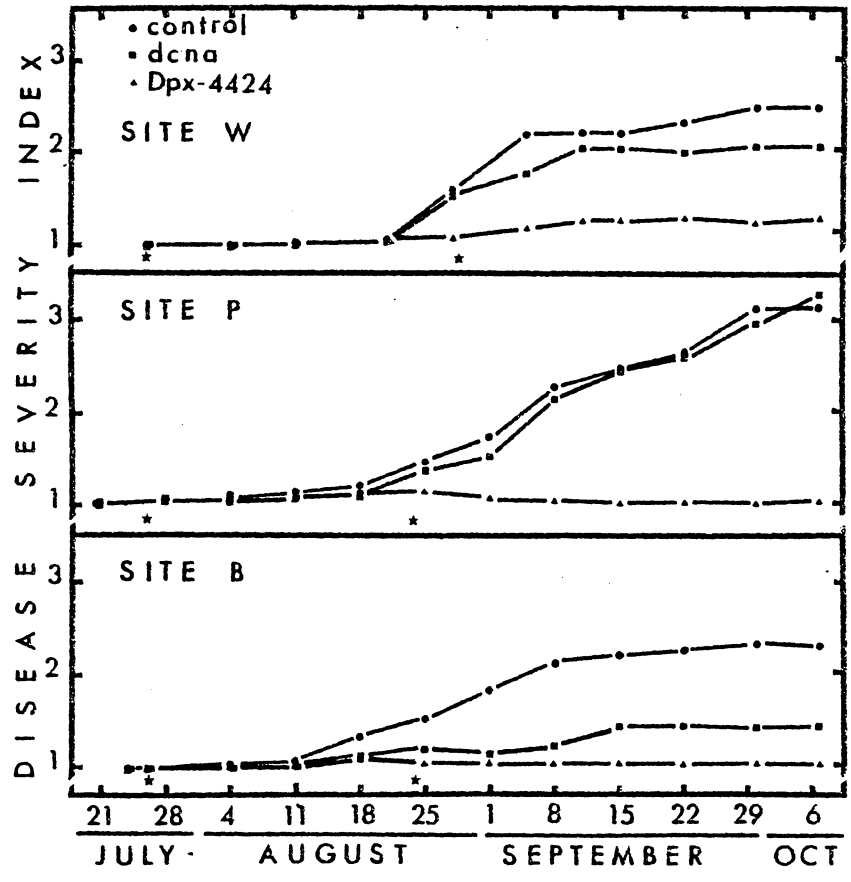

Fig. 23. Sclerotinia blight of peanut disease progress based on the disease severity index (DSI) for untreated control, dichloronitroaniline (DCNA) and procymidone (DPX-4424)-treated plots at three sites during the 1978 peanut growing season. DCNA applied at 2.10 kg a.i./ha/application and DPX-4424 applied at 1.12 kg a.i./ha/application. DSI (average of 160 observations) per treatment per data was based on a 1-5 scale with 1 = no disease and 5 = complete death of plants in a 61-cm row section. The stars indicate the dates of fungicide application.

nearly linear till the end of the season. At site B the DSI for the DCNA treatment was lower compared to the control, than at the other sites. Disease development in the control was low for the last four weeks. There was only a 5% increase during this time.

Statistical differences between the treatment's DSIs according to Duncan's multiple range test are shown in table 18. The procymidone treatment had a lower DSI than the DCNA or control treatments (1.00, 1.44, 2.33 for site B; 1.05, 3.28, 3.13 for site P; and 1.22, 2.06, 2.46 for site W, respectively) at all sites during the last four weeks of the season. procymidone achieved nearly complete disease control at all sites. Disease severity for the last observation before harvest (October 1 or 7) was two to three times greater in the control plots than in the procymidone-treated plots.

Few foci of infection occurred in the procymidone plots. On the last day before harvest (October 7), there was only one focus observed in the 160, 61-cm row sections of the procymidone plots at site B. In comparison, disease was recorded in 51 of the DCNA and 83 of the control plot's 61-cm row sections. At site P, 8, 115, and 139 of the 160 row sections in the procymidone, DCNA, and control plots had disease. Site W had 30, 104, and 130 row sections with

Table 18. Severity of Sclerotinia blight in untreated control, DCNA (dichloronitroaniline), and DPX-4424 (procymidone) treated peanuts at three sites in 1978

Date		Disease Severity Index[w]								
		Site B			Site P			Site W		
Mo	Day(s)[x]	Control	DCNA[y]	DPX[z]	Control	DCNA[y]	DPX[z]	Control	DCNA[y]	DPX[z]
Jul	21P,24B	1.00 a	1.00 a	1.00 a	1.00 a	1.01 a	1.01 a	-	-	-
	26BW,28P	1.00 a	1.00 a	1.00 a	1.01 a	1.01 a	1.01 a	1.00 a	1.00 a	1.00 a
Aug	4	1.01 a	1.00 a	1.01 a	1.11 a	1.09 a	1.04 a	1.00 a	1.00 a	1.00 a
	11	1.08 a	1.01 a	1.06 a	1.14 a	1.12 a	1.07 a	1.01 a	1.00 b	1.00 b
	18BP,21W	1.34 a	1.10 b	1.09 b	1.22 a	1.13 bc	1.11 c	1.09 a	1.04 a	1.02 b
	25BP,28W	1.56 a	1.21 b	1.04 c	1.48 a	1.39 a	1.18 b	1.59 a	1.53 a	1.09 b
Sep	1BP,5W	1.85 a	1.17 b	1.01 b	1.72 a	1.52 b	1.08 c	2.17 a	1.79 b	1.15 c
	8BP,11W	2.11 a	1.21 b	1.01 b	2.26 a	2.16 a	1.04 b	2.17 a	2.04 b	1.24 c
	15	2.23 a	1.28 b	1.00 c	2.46 a	2.47 a	1.04 b	2.17 a	2.04 b	1.24 c
	22	2.23 a	1.46 b	1.01 c	2.61 a	2.59 a	1.03 b	2.30 a	1.96 b	1.28 c
	30	2.34 a	1.41 b	1.02 c	3.13 a	2.98 a	1.03 b	2.44 a	2.03 b	1.20 c
Oct	7	2.33 a	1.44 b	1.00 c	3.13 a	3.28 a	1.05 b	2.46 a	2.06 b	1.22 c

[w]DSI on a 1-5 scale: 1 = no disease, 5 = complete death of the plants in a 61 cm row section. Means within site on the same date, followed by the same letter(s) are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

[x]Letters indicate sites observed on that day.

[y]Two applications (2.10 kg a.i./ha/application) made Jul 26 and Aug 24BP,29W.

[z]Two applications (1.12 kg a.i./ha/application) made Jul 26 and Aug 24BP,29W.

Sclerotinia blight in the procymidone, DCNA, and control plots. Disease development was most severe at site P; however, control with procymidone was as good as at the other sites.

The average percent soil moisture at 0 to 5 and 5 to 10-cm depths was also greatest at the P-site (Table 19) (statistics not shown). There was little difference in soil moisture between the treatments within sites for each date throughout the season. There was no significant difference in the season's mean soil moisture at the 0 to 5-cm depth between treatments at any of the sites. At the 5 to 10-cm depth, the mean percent soil moisture for the season was greater in the control plots at sites B and P.

Average percent soil moisture for each date at each site is shown in Table 20. The highest percent soil moisture was measured on July 28 at site B, on August 16 at site P, and on August 8 at site W. The minimum percent soil moisture measured at both depths at sites B, P, and W occurred on September 20 - 21. Soil moisture was critically low with wilting of plants at site B and W. The percent soil moisture of 1.57-1.61% and 1.52-1.83% at 0 to 5-cm and 2.24- 2.59% and 2.69-3.05 at 5 to 10-cm were measured in the treatments at the B and W sites.

Table 19. Percent soil moisture at 0-5 cm and 5-10 cm depths in untreated control, DCNA (dichloronitroaniline), and DPX-4424 (procymidone) treated peanut plots at three sites in 1978

Date		Percent Soil Moisture[w]								
		Site B			Site P			Site W		
Mo	Day(s)[x]	Control	DCNA[y]	DPX[z]	Control	DCNA[y]	DPX[z]	Control	DCNA[y]	DPX[z]
					0-5 cm depth					
Jul	12P	-	-	-	16.6	15.5	16.8	-	-	-
	19P	-	-	-	18.2 b	18.8 ab	19.5 a	-	-	-
	26W,27P,28B	14.8	13.5	13.4	16.6	16.0	16.6	9.6	9.3	9.5
Aug	1W,2P,3B	5.9 a	5.1 b	5.3 ab	13.3	13.1	12.8	5.7	5.7	5.7
	8W,9P,10B	10.2	9.9	10.7	19.1	19.5	19.3	12.7	12.0	11.4
	15W,16P,17B	9.8	8.9	9.3	24.4	24.2	25.4	11.3	11.2	11.0
	22W,23P,24B	4.6	4.0	4.1	16.0	16.3	15.6	5.9	5.7	5.5
	29W,30P,31B	5.1	4.2	4.8	16.2	16.0	16.5	5.6	5.2	5.4
Sep	5W,6P,7B	3.9	3.0	3.4	15.6	16.2	16.0	4.4	4.4	4.8
	12W,13P,14B	3.3	2.6	2.9	15.6 a	13.9 b	14.4 ab	4.0 a	3.5 ab	3.3 b
	20P,21BW	1.6	1.6	1.6	10.1	9.6	9.0	1.5	1.8	1.6
	27PW,28B	6.2	5.6	5.8	12.7 a	14.5 b	12.8 b	4.9	5.3	5.2
Oct	3W,4P,5B	7.9	7.9	7.1	17.8	17.9	17.4	9.2	9.3	9.4
	Mean	6.7	6.0	6.2	16.3	16.3	16.0	6.8	6.7	6.6
					5-10 cm depth					
Jul	12P	-	-	-	16.2 a	15.1 a	15.6 a	-	-	-
	19P	-	-	-	19.0 a	19.4 a	19.0 a	-	-	-
	26W,27P,28B	13.8 a	11.2 b	10.7 b	17.2 a	16.7 a	17.0 a	9.7 a	9.5 a	9.7 a

Table 19. (continued)

Date		Percent Soil Moisture[w]								
		Site B			Site P			Site W		
Mo	Day(s)[x]	Control	DCNA[y]	DPX[z]	Control	DCNA[y]	DPX[z]	Control	DCNA[y]	DPX[z]
Aug	1W,2P,3B	6.2	5.7	5.5	14.4 a	14.0 a	13.8 a	6.9 a	6.9 a	7.2 a
	8W,9P,10B	9.8	9.0	9.3	19.0 a	18.4 a	18.7 a	12.2 a	12.2 a	12.1 a
	15W,16P,17B	9.8	9.0	9.1	21.7 a	22.5 a	22.3 a	11.2 a	11.1 a	10.9 a
	22W,23P,24B	5.2	4.2	4.2	17.1 a	16.4 a	16.6 a	6.8 a	6.6 a	6.8 a
	29W,30P,31B	4.3	3.3	4.1	14.6 a	14.9 a	15.2 a	5.4 a	5.4 a	5.3 a
Sep	5W,6P,7B	4.3	3.5	3.7	17.0 a	16.3 a	16.4 a	5.3 a	5.1 a	5.1 a
	12W,13P,14B	3.6	2.8	2.9	16.1 a	14.2 b	14.1 b	3.9 a	3.7 a	3.7 a
	20P,21BW	2.6	2.3	2.2	10.9 a	10.1 a	10.3 a	3.0 a	2.7 b	2.8 ab
	27PW,28B	6.3 a	6.0 ab	5.7 b	13.9 a	13.6 ab	12.4 b	5.3 a	4.9 a	5.2 a
Oct	3W,4P,5B	7.9	8.0	7.6	17.8 a	17.6 a	16.9 a	9.6 a	9.2 b	9.4 ab
	Mean	6.7 a	5.9 b	5.9 b	16.5 a	16.1 ab	16.0 b	7.2 a	7.0 a	7.1 a

[w]Percent soil moisture on a dry weight basis. Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[x]Letters indicate site(s) sampled on that day.

[y]Two applications (2.10 kg a.i./ha/application) made Jul 26 and Aug 24BP,29W.

[z]Two applications (1.12 kg a.i./ha/application) made Jul 26 and Aug 24BP,29W.

Table 20. Percent soil moisture at 0-5 and 5-10 cm depths for each sampling date at three sites during the 1978 peanut growing season

Date		Percent Soil Moisture[x]		
Mo	Day(s)[y]	Site B	Site P	Site W
			0-5 cm depth	
Jul	12P	-	16.3 d	-
	19P	-	18.8 b	-
	26W,27P,28B	13.3 a	16.4 d	9.4 c
Aug	1W,2P,3B	5.4 ef	13.2 f	5.8 d
	8W,9P,10B	10.4 b	19.4 b	12.1 a
	15W,16P,17B	9.4 c	24.6 a	11.2 b
	22W,23P,24B	4.3 gh	16.1 d	5.8 d
	29W,30P,31B	4.8 fg	16.1 d	5.5 d
Sep	5W,6P,7B	3.7 hi	15.9 d	4.6 f
	12W,13P,14B	3.1 i	14.4 e	3.6 g
	20P,21BW	1.7 j	9.6 g	1.7 h
	27PW,28B	6.0 c	13.2 f	5.2 e
Oct	3W,4P,5B	7.9 d	17.7 c	9.4 c
			5-10 cm depth	
Jul	12P	-	15.8 e	-
	19P	-	19.1 b	-
	26W,27P,28B	11.5 a	17.2 cd	9.6 c
Aug	1W,2P,3B	6.0 d	14.1 f	7.0 d
	8W,9P,10B	9.5 b	18.7 b	12.3 a
	15W,16P,17B	9.3 b	22.6 a	11.2 b
	22W,23P,24B	4.6 e	16.5 de	6.8 d
	29W,30P,31B	4.0 f	14.8 f	5.6 e
Sep	5W,6P,7B	4.2 ef	16.3 e	5.2 f
	12W,13P,14B	3.3 g	14.8 f	3.9 g
	20P,21BW	2.4 h	10.5 h	2.9 h

Table 20. (continued)

Date		Percent Soil Moisture[x]		
Mo	Day(s)[y]	Site B	Site P	Site W
	27PW,28B	6.1 d	13.3 g	5.3 ef
Oct	3W,4P,5B	8.0 c	17.5 c	9.5 c

[x]Percent soil moisture on a dry weight basis. Values (mean of 12 samples) in a column followed by the same letter are not significantly different (P = 0.05).

[y]Letters indicate site(s) sampled on that day.

Canopy height and width at the three sites is shown in Table 21. Width was similar for all treatments at a given site. Development between sites, however, was different. A continuous canopy (formed subsequent to overlap of lateral branches of adjacent rows) occurred first at site P. Not until four weeks later was it continuous at site W. The mean height for all seasons was greater in the control and procymidone plots than in the DCNA plots at sites B and W while at site P height was greater in the control and DCNA plots.

Peanut pod yield and value ($/ha) were significantly greater in the procymidone plots at sites B and W (Table 22) The percent increase in yield as a result of procymidone treatments was 36 and 24% for sites B and W, respectively. Site P showed a 26% yield increase with the procymidone treatment but the yield and value for this treatment were not significantly different from the untreated control. Yield and $/ha from DCNA-treated plots at the three locations were not significantly different from the untreated control plots. The fungicide treatments did not affect the grade quality of the peanuts; there was no significant difference in dollars/hundredweight ($/cwt) among treatments at any of the sites.

Table 21. Canopy measurement (width and height) of untreated control, DCNA (dichloronitroaniline) treated and DPX-4424 (procymidone) treated 'Florigiant' (sites B and W) and 'GK-3' (site P) peanut varieties in 1978

Date		Canopy Measurement [v]								
		Site B			Site P			Site W		
Mo	Day(s)[w]	Control	DCNA[x]	DPX[y]	Control	DCNA[x]	DPX[y]	Control	DCNA[x]	DPX[y]
					Width (cm)					
Jul	21P,26W	-	-	-	70.1	74.2	71.4	53.8	54.9	54.4
Aug	1BW,2P	89.9	84.1	84.6	93.2	96.0	93.7	73.9	68.8	76.9
	7	91.7	86.9	88.6	*[z]	*	*	82.8	80.8	85.9
	16P,17B	*	*	*	*	*	*	-	-	-
	22W,23P,24B	*	*	*	*	*	*	93.7	91.7	97.0
	30P,31B	*	*	*	*	*	*	-	-	-
Sep	5W,6P,7B	*	*	*	*	*	*	*	*	*
	13PW,14B	*	*	*	*	*	*	*	*	*
	30	-	-	-	-	-	-	*	*	*
Oct	4P,5B,6W	*	*	*	*	*	*	*	*	*
	Mean	91.2	89.9	90.2	80.9	89.9	89.2	84.5	83.8	85.6
					Height (cm)					
Jul	21P,26W	-	-	-	27.2	29.7	28.1	23.1	22.4	23.4
Aug	1BW,2P	26.9 a	21.8 b	23.4 ab	36.1 b	38.3 a	36.8 ab	25.1 b	24.4 b	27.9 a
	7	31.5 a	25.7 b	27.1 ab	41.4 b	47.0 a	43.2 ab	28.2	27.4	30.0
	16P,17B	39.6 a	33.3 b	35.8 ab	50.8 b	56.1 a	52.3 ab	-	-	-

Table 21. (continued)

Date		Canopy Measurement [v]								
		Site B			Site P			Site W		
Mo	Day(s)[w]	Control	DCNA[x]	DPX[y]	Control	DCNA[x]	DPX[y]	Control	DCNA[x]	DPX[y]
	22W,23P,24B	41.7	37.8	39.4	52.8 b	60.7 a	55.9 b	33.5	30.2	33.5
	29W,30P,31B	42.9 a	34.3 b	41.9 a	54.1 b	59.1 a	56.1 ab	28.2 a	23.6 b	26.7 ab
Sep	5W,6P,7B	41.7 a	34.0 b	41.1 a	56.1 b	61.0 a	58.9 ab	31.2	28.4	31.0
	13PW,14B	29.7	24.4	29.5	53.6 b	59.2 a	53.1 b	33.7 a	31.0 b	32.8 ab
	30	-	-	-	-	-	-	25.4 a	21.8 b	23.1 ab
Oct	4P,5B,6W	38.4	34.8	38.4	49.8 c	55.9 a	53.6 b	26.4	25.4	27.9
	Mean	36.6 a	30.7 b	34.5 a	46.9 c	51.8 a	48.7 b	28.4 a	26.2 b	28.4 a

[v]Values represent the mean of 16 readings/treatment. Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[w]Letters indicate site(s) observed on that day.

[x]Two applications (2.10 kg a.i./ha/application) made Jul 26 and Aug 24BP,29W.

[y]Two applications (1.12 kg a.i./ha/application) made Jul 26 and Aug 24BP,29W.

[z]* indicates no measurement; lateral branches of adjacent rows forming continuous canopy. Mean $\geq$ 91 cm.

Table 22. Pod yield (kg/ha) and value ($/ha, $/cwt) in untreated control, DCNA (dichloronitroaniline) and DPX-4424 (procymidone) treated peanuts with percent yield increase for the fungicide treatments at three sites in 1978

	Site B				Site P				Site W			
Treatment	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase
Control	2495 b	1052 b	20.09 a	-	2490 a	1045 a	19.94 a	-	2790 b	1230 b	20.83 a	-
DCNA[z]	2928 ab	1237 ab	20.42 a	17	2704 a	1156 a	20.04 a	8	3075 ab	1425 ab	21.57 a	10
DPX-4424[z]	3395 a	1445 a	20.71 a	36	3126 a	1344 a	20.28 a	26	3449 a	1583 a	21.73 a	24

[x]Mean of four plots. Means within columns followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Means based on yields and grading factors.

[z]Two applications (DCNA: 2.10 kg a.i./ha/application, DPX-4424: 1.12 kg a.i./ha/application).

Sclerotia of S. minor were generally equally numerous among blocks within depth at each of the sites (Tables 23-26). A minimum of 0.0 to a maximum of 4.0 sclerotia per 40 g soil sample (0-10/ 100 g) were recovered from soil at sites B and P with 0-7.5 sclerotia/per 40 g soil (0-18.8/100 g) isolated from site W. Sclerotia were equally numerous within the four depths sampled at sites B and W (Table 27). At site P, greater numbers of sclerotia were isolated from the 10 to 15-cm depth. The average number of sclerotia for samples from the four depths was numerically greater at the B and P sites.

A clear-cut pattern for sclerotial population change at the three sites with respect to date was not found (Table 28). Sclerotia were somewhat more numerous at the end of the season than at the beginning at sites P and W. At site B the greatest number of sclerotia were present September 15, four weeks before harvest.

Figure 24 shows the disease progress curve based on DSI for the three treatments at the three sites during the 1979 peanut growing season. Fungicide application according to the calendar schedule was made on July 26 and August 23. Fungicide application for the forecast-treated plots was made on August 2 and September 13. The first infection was recorded July 17 at the P and Pr sites and July 30 at the T site.

Table 23. *Sclerotinia minor* sclerotial population at 0 to 5-cm depth in four blocks at each site during the 1978 peanut growing season

Date		Sclerotia[x]/40 g soil														
		Site B					Site P					Site W				
Mo	Day(s)[y]	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean
Jul	28	2.0	1.2	1.6	1.6	1.6	0.5 ab	0.0 b	1.0 ab	1.5 a	0.8	0.5	0.5	0.0	0.5	0.4
Aug	3P,4BW	0.0	1.5	0.5	0.5	0.6	1.0	0.5	0.5	0.0	0.5	1.0	0.0	1.0	1.0	0.8
	10P,11BW	1.5	2.0	1.0	1.0	1.4	1.0	1.5	1.0	1.5	1.2	0.5	0.0	1.0	0.0	0.4
	18	1.6	2.4	1.2	1.6	1.7	1.0	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.0	0.4
	25BP,28W	1.0 b	1.5 ab	2.5 a	1.0 b	1.5	1.5	2.0	1.5	1.5	1.6	0.5	0.5	1.0	1.5	0.9
Sep	1BP,5W	2.5	1.0	0.5	1.0	1.2	1.5	1.5	2.0	2.0	1.8	0.8	1.2	0.4	0.4	0.7
	6	-	-	-	-	-	0.4 b	0.4 b	2.0 a	0.4 b	0.8	-	-	-	-	-
	8BP,11W	1.5	1.5	2.0	1.0	1.5	1.0	1.5	1.5	2.5	1.6	0.5	0.0	0.5	0.0	0.2
	15	2.5	1.5	3.0	2.0	2.2	1.5	1.0	1.0	0.5	1.0	-	-	-	-	-
	22BP,25W	1.5	1.5	3.0	1.5	1.9	2.0	2.0	1.5	2.5	2.0	1.0 b	0.5 b	1.0 b	7.5 a	2.5
	29BP,30W	1.5	1.0	2.0	1.5	1.5	3.0 ab	1.0 bc	0.5 c	4.0 a	2.1	1.0	1.5	1.5	1.0	1.2
Oct	6	1.5	2.0	1.0	2.0	1.6	-	-	-	-	-	1.0	1.5	1.0	1.0	1.1

[x]Mean of two replications/block sample with 10 sampling sites/block. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

Table 24. *Sclerotinia minor* sclerotial population at 5 to 10-cm depth in four blocks at each site during the 1978 peanut growing season

Date		Sclerotia[x]/40 g soil														
		Site B					Site P					Site W				
Mo	Day(s)[y]	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean
Jul	28	2.0	1.6	1.2	0.8	1.4	0.0 b	0.5 ab	1.5 a	1.0 ab	0.8	0.5	1.0	0.5	1.5	0.9
Aug	3P,4BW	2.0	2.0	2.0	1.0	1.8	0.5	1.0	1.5	1.0	1.0	0.5	0.5	0.5	1.5	0.8
	10P,11BW	1.0	1.5	1.5	1.0	1.2	1.5	1.5	1.5	1.5	1.5	0.5	0.5	0.5	1.0	0.6
	18	4.0	1.6	0.8	1.6	2.0	0.5 b	2.0 a	1.5 ab	1.2	0.5	0.5	0.5	0.5	1.0	0.6
	25BP,28W	0.5	1.5	1.5	2.5	1.5	1.5	1.0	1.5	1.5	1.4	1.0	0.5	1.5	1.0	1.0
Sep	1BP,5W	1.5	0.5	0.5	0.5	0.8	1.5	0.5	1.5	2.0	1.4	0.4	0.4	0.0	0.4	0.3
	6	-	-	-	-	-	0.4	1.2	1.2	1.6	1.1	-	-	-	-	-
	8BP,11W	1.5	2.5	2.0	2.0	2.0	0.5	1.5	0.5	1.0	0.9	0.5	1.0	0.5	0.5	0.6
	15	3.0	1.5	4.0	2.0	2.6	1.0	0.5	1.5	1.0	1.0	-	-	-	-	-
	22BP,25W	1.5	1.5	1.5	1.5	1.5	1.0	1.0	2.5	2.0	1.6	1.0 b	1.0 b	0.5 b	3.0 a	1.4
	29BP,30W	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2.0	1.6	1.5	1.0	1.0	1.0	1.1
Oct	6	1.5	2.0	1.5	1.0	1.5	-	-	-	-	-	0.5	0.5	1.0	1.0	0.8

[x]Mean of two replications/block sample with 10 sampling sites/block. Sclerotia collected on 425-µm mesh sieves in an
Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

Table 25. *Sclerotinia minor* sclerotial population at 10 to 15-cm depth in four blocks at each site during the 1978 peanut growing season

Date		Sclerotia[x]/40 g soil														
		Site B					Site P					Site W				
Mo	Day(s)[y]	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean
Jul	28	1.6 b	3.6 b	0.8 b	1.2 b	1.8	0.5 b	0.0 b	2.5 a	2.5 a	1.4	1.5	0.5	1.0	0.5	0.9
Aug	3P,4BW	1.5	1.0	1.5	2.0	1.5	1.5	2.0	1.0	1.5	1.5	0.5	1.0	0.0	0.5	0.5
	10P,11BW	1.5	2.0	1.0	2.5	1.8	2.5 a	3.5 ab	2.0 b	2.0 b	2.5	0.5	1.0	0.0	0.5	0.5
	18	2.0	2.0	1.6	1.6	1.8	1.5	1.5	1.0	1.5	1.4	1.0	0.5	1.5	1.5	1.1
	25BP,28W	1.5 b	2.0 ab	3.5 a	1.5 b	2.1	1.0	1.5	3.0	2.0	1.9	1.5	1.0	1.0	1.5	1.2
Sep	1BP,5W	2.0	1.0	1.5	1.0	1.4	1.0	1.5	1.0	1.0	1.1	0.4 a	0.4 a	0.4 a	0.0	0.3
	6	-	-	-	-	-	1.2	1.2	1.2	0.8	1.1	-	-	-	-	-
	8BP,11W	2.5	1.5	1.5	2.5	2.0	2.0	0.5	1.5	2.0	1.5	1.5	0.5	1.5	1.5	1.2
	15	1.5	2.5	2.5	1.5	2.0	0.5	1.5	0.5	0.5	0.8	-	-	-	-	-
	22BP,25W	2.0	1.5	1.5	1.5	1.6	0.5	0.5	2.5	3.0	1.6	0.5	1.5	1.0	1.5	1.1
	29BP,30W	1.5	1.5	1.5	1.0	1.4	2.0	3.0	3.5	1.5	2.5	2.5	1.0	1.5	2.0	1.8
Oct	6	2.5	2.0	1.5	2.0	2.0	-	-	-	-	-	0.5	0.5	0.5	0.5	0.5

[x]Mean of two replications/block sample with 10 sampling sites/block. Sclerotia collected on 425-µm mesh sieves in an
Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

Table 26. *Sclerotinia minor* sclerotial population at 15 to 20-cm depth in four blocks at each site during the 1978 peanut growing season

Date		Sclerotia[x]/40 g soil														
		Site B					Site P					Site W				
Mo	Day(s)[y]	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean	Blk 1	Blk 2	Blk 3	Blk 4	Mean
Jul	28	2.5	2.0	1.5	2.0	2.0	0.0 b	1.5 a	1.5 a	1.0 ab	1.0	0.5	1.0	0.5	1.5	0.9
Aug	3P,4BW	0.4 b	2.4 a	2.0 a	0.8 a	1.4	1.5	1.5	1.5	1.0	1.4	1.0	1.0	1.5	1.0	1.1
	10P,11BW	1.5 ab	0.5 b	1.0 ab	2.0 a	1.2	1.5 a	3.5 ab	1.0 b	1.0 b	2.0	1.0	1.5	1.0	1.5	1.2
	18	1.6	2.0	1.2	1.2	1.5	0.5	1.0	1.5	2.0	1.2	0.5	0.5	0.0	0.5	0.4
	25BP,28W	1.5 ab	1.0 ab	2.5 a	0.5 b	1.4	1.5	1.5	2.0	2.0	1.8	1.0	0.5	0.5	1.0	0.8
Sep	1BP,5W	1.0	1.5	2.0	1.5	1.5	0.5	1.5	1.5	1.5	1.2	1.2	0.4	0.4	0.4	0.6
	6	-	-	-	-	-	0.8	0.4	0.4	0.8	0.6	-	-	-	-	-
	8BP,11W	2.0	1.5	2.5	1.5	1.9	0.5	0.5	0.5	1.0	0.6	1.0 b	0.5 b	2.0 a	1.0 b	1.1
	15	2.0	2.0	2.0	2.5	2.1	0.5	0.5	1.5	1.0	0.9	-	-	-	-	-
	22BP,25W	2.0	2.5	2.0	2.0	2.1	1.0 b	2.5 ab	3.5 a	2.0 ab	2.2	0.5	1.0	1.5	1.5	1.1
	29BP,30W	1.5	1.0	1.5	1.0	1.2	1.0 b	0.5 b	2.0 a	1.0 b	1.1	1.0	0.5	1.5	2.5	1.4
Oct	6	1.5	1.5	1.5	1.5	1.5	-	-	-	-	-	1.0	0.5	1.0	1.0	0.9

[x]Mean of two replications/block sample with 10 sampling sites/block. Sclerotia collected on 425-µm-mesh sieves in an
Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

Table 27. Sclerotinia minor sclerotial population at 0 to 5, 5 to 10, 10 to 15, and 15 to 20-cm depths at each site for the 1978 peanut growing season

Depth (cm)	Sclerotia[x]/40 g soil		
	Site B	Site P	Site W
0-5	1.5 a	1.2 b	0.9 a
5-10	1.6 a	1.2 b	0.8 a
10-15	1.8 a	1.6 a	0.9 a
15-20	1.6 a	1.3 b	1.0 a

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieve in elutriator. Means within columns followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test.

Table 28. *Sclerotinia minor* sclerotial population at 0 to 20-cm depth at each site for the 1978 peanut growing season

Date		Sclerotia[x]/40 g soil		
Mo	Day(s)[y]	Site B	Site P	Site W
Jul	28	1.6 bcde	1.0 d	0.8 bc
Aug	3P,4BW	1.3 de	1.1 cd	0.8 bc
	10P,11BW	1.4 cde	1.8 a	0.7 bc
	18	1.8 bc	1.1 cd	0.6 bc
	25BP,28W	1.6 bcd	1.7 ab	1.0 b
Sep	1BP,5W	1.2 e	1.4 bc	0.5 c
	6	-	0.9 d	-
	8BP,11W	1.8 b	1.2 cd	0.8 bc
	15	2.2 a	0.9 d	-
	22BP,25W	1.8 bc	1.9 a	1.5 a
	29BP,30W	1.4 cde	1.8 a	1.4 a
Oct	6	1.6 bcd	-	0.8 bc

[x]Mean of 32 samples from four depths (0-5, 5-10, 10-15, and 15-20 cm) in 4 blocks. Sclerotia collected on 425-µm mesh sieve in elutriator. Means within columns followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

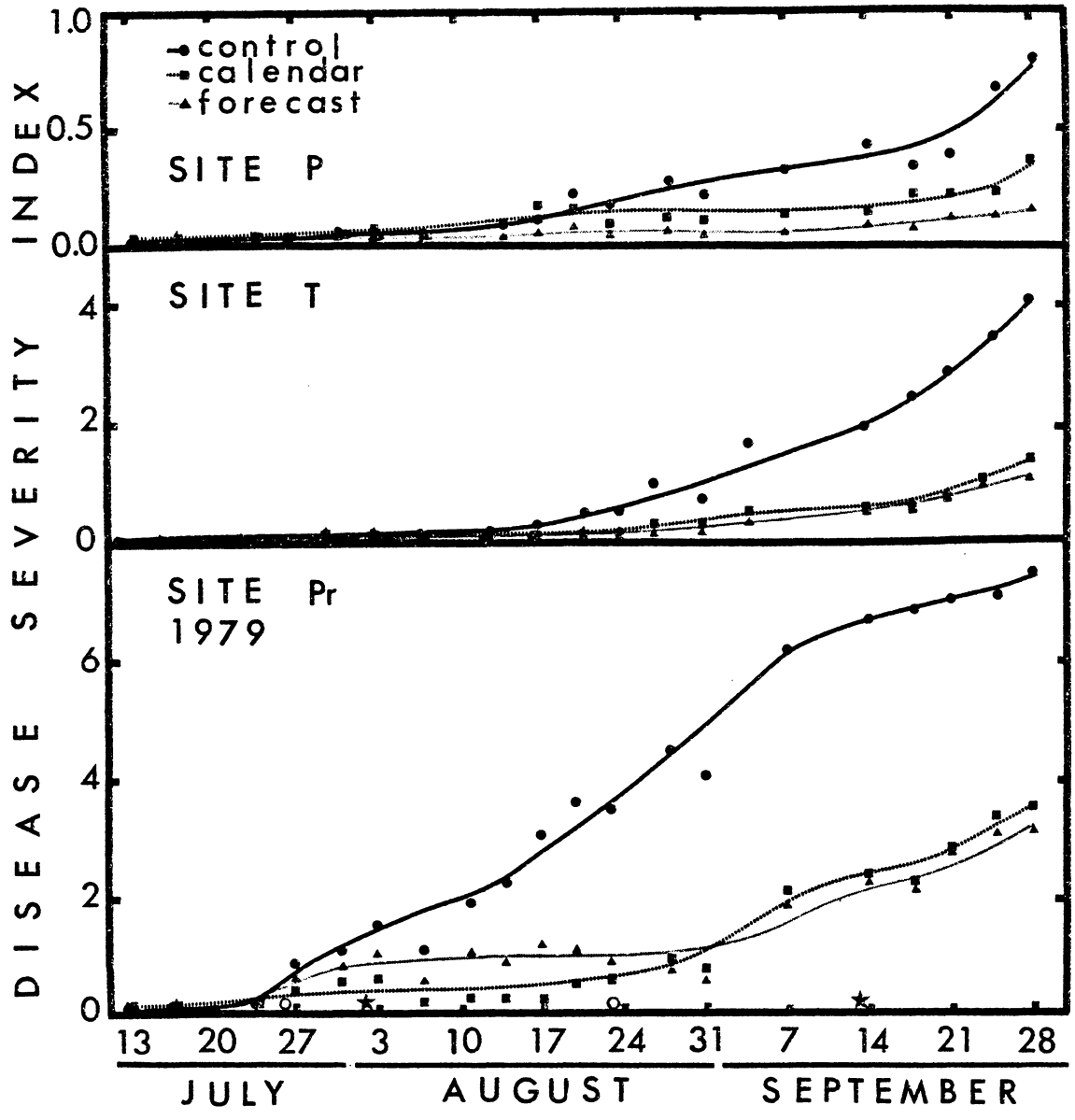

Fig. 24. Sclerotinia blight of peanut disease progress based on the disease severity index (DSI) for untreated control, calendar, and forecast system fungicide-treated plots at three sites during the 1979 peanut growing season. DSI (average of 160 observations per treatment per date) was based on a 0-10 scale with 0 = no disease and 10 = complete death of plants in a 61 cm row section. The o's indicate the dates of fungicide application for the calendar treatment and the stars for the forecast treatment.

There was no significant difference in the DSI between the treatments at site P from July 13 to August 20 (Table 29). Overall, the forecast-treated plots had lower disease severity than the calendar-treated plots. Disease severity in all the treatments was lower at the P site than at the other two sites.

At site Pr, there was no significant difference in the treatments until July 27. Disease severity in the calendar treatment was less than that in the other two treatments for three and one half weeks, beginning one week after the first fungicide application on July 26. There was no significant difference between the two fungicide treatments after August 23. Just before harvest (September 28), the DSI was numerically less in the forecast-treated plots than in the calendar-treated plots; however, there was no significant difference between them. The season's mean DSI was significantly less for the calendar-treated plots than the forecast-treated plots. Disease onset (July 30) was later at site T than at the other sites. At the time of the first calendar fungicide application (July 26) no disease had been observed in any of the plots. The DSI was less in the calendar-treated plots ten days after treatment (August 7) than in the forecast-treated plots. Nineteen days after fungicide application in the forecast plots (August 21)

Table 29. Severity of Sclerotinia blight in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Disease Severity Index[x]								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Jul	12T,13PPr	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
	16T,17PPr	0.00 a	0.02 a	0.01 a	0.02 a	0.02 a	0.01 a	0.00 a	0.00 a	0.00 a
	23T,24PPr	0.01 a	0.03 a	0.00 a	0.32 a	0.23 a	0.24 a	0.00 a	0.00 a	0.00 a
	27	0.02 a	0.04 a	0.03 a	0.95 a	0.53 b	0.73 ab	-	-	-
	30T,31PPr	0.05 a	0.04 a	0.07 a	1.12 a	0.62 b	0.83 b	0.01 a	0.01 a	0.00 a
Aug	3	0.05 a	0.09 a	0.04 a	1.55 a	0.66 c	1.09 b	0.05 a	0.01 a	0.02 a
	7	0.04 a	0.01 a	0.03 a	1.04 a	0.18 c	0.60 b	0.03 ab	0.01 b	0.04 a
	11	-	-	-	1.92 a	0.37 c	1.10 b	-	-	-
	13T,14PPr	0.08 a	0.09 a	0.04 a	2.29 a	0.28 c	0.96 b	0.18 a	0.02 b	0.18 a
	17	0.13 a	0.17 a	0.06 a	3.11 a	0.33 c	1.25 b	0.29 a	0.09 b	0.36 a
	20PPr,21T	0.21 a	0.16 a	0.09 a	3.64 a	0.56 c	1.06 b	0.56 a	0.14 b	0.26 b
	23PPr,24T	0.18 a	0.10 ab	0.04 b	3.55 a	0.64 b	0.98 b	0.58 a	0.14 b	0.22 b
	27T,28PPr	0.26 a	0.13 ab	0.04 b	4.58 a	0.92 b	0.88 b	1.00 a	0.38 b	0.26 b
	31	0.16 a	0.10 a	0.02 b	4.08 a	0.86 b	0.66 b	0.72 a	0.29 b	0.16 b
Sep	4T,7PPr	0.31 a	0.14 b	0.06 b	6.23 a	2.11 b	1.92 b	1.72 a	0.55 b	0.38 b
	14	0.43 a	0.14 b	0.09 b	6.75 a	2.41 b	2.24 b	1.98 a	0.61 b	0.60 b
	18	0.32 a	0.21 ab	0.07 b	6.81 a	2.23 b	2.09 b	2.44 a	0.64 b	0.78 b
	21	0.39 a	0.21 b	0.11 b	7.06 a	2.85 b	2.86 b	2.88 a	0.79 b	0.81 b

Table 29. (continued)

Date		Disease Severity Index[x]								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
	25	0.66 a	0.24 b	0.11 b	7.14 a	3.41 b	3.04 b	3.54 a	1.14 b	1.06 b
	28	0.79 a	0.36 b	0.15 b	7.51 a	3.55 b	3.11 b	4.09 a	1.41 b	1.11 b
	Mean	0.22 a	0.12 b	0.05 c	3.48 a	1.14 c	1.28 b	1.11	0.35 b	0.35 b

[x]DSI on a 0-10 scale: 0 = no disease, 10 = complete death of the plants in a 61 cm row section. Means within site on the same date, followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) observed on that day.

[z]Two applications (0.56 kg a.i./ha/application) made Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

there was no significant difference between calendar and forecast-treated plots. The DSIs of these treatments were not significantly different for the rest of the season despite the difference in timing of the fungicide application. The mean DSI for the season at site T was lower for the fungicide-treated plots compared to the untreated control plots. Timing of application, however, did not result in significant differences in the DSI between the calendar and forecast-treated plots.

Figure 25 shows the disease progress curve based on longest lesion length measurements for the three treatments at the three sites for the 1979 peanut growing season.

At site P, the first fungicide application to calendar- (July 26) and forecast-treated (August 2) plots had little effect on lesion development compared to that in the untreated control plots (Table 30). With the exception of only one observational date (August 3), there was no significant difference in the longest lesion length between the two fungicide treatments.

At site Pr, prior to fungicide treatment, the longest lesion length measurement was less in the calendar-and forecast-treated plots than in the control plots (Table 30). There was no difference between the calendar- and forecast-treated plots. One week after the calendar

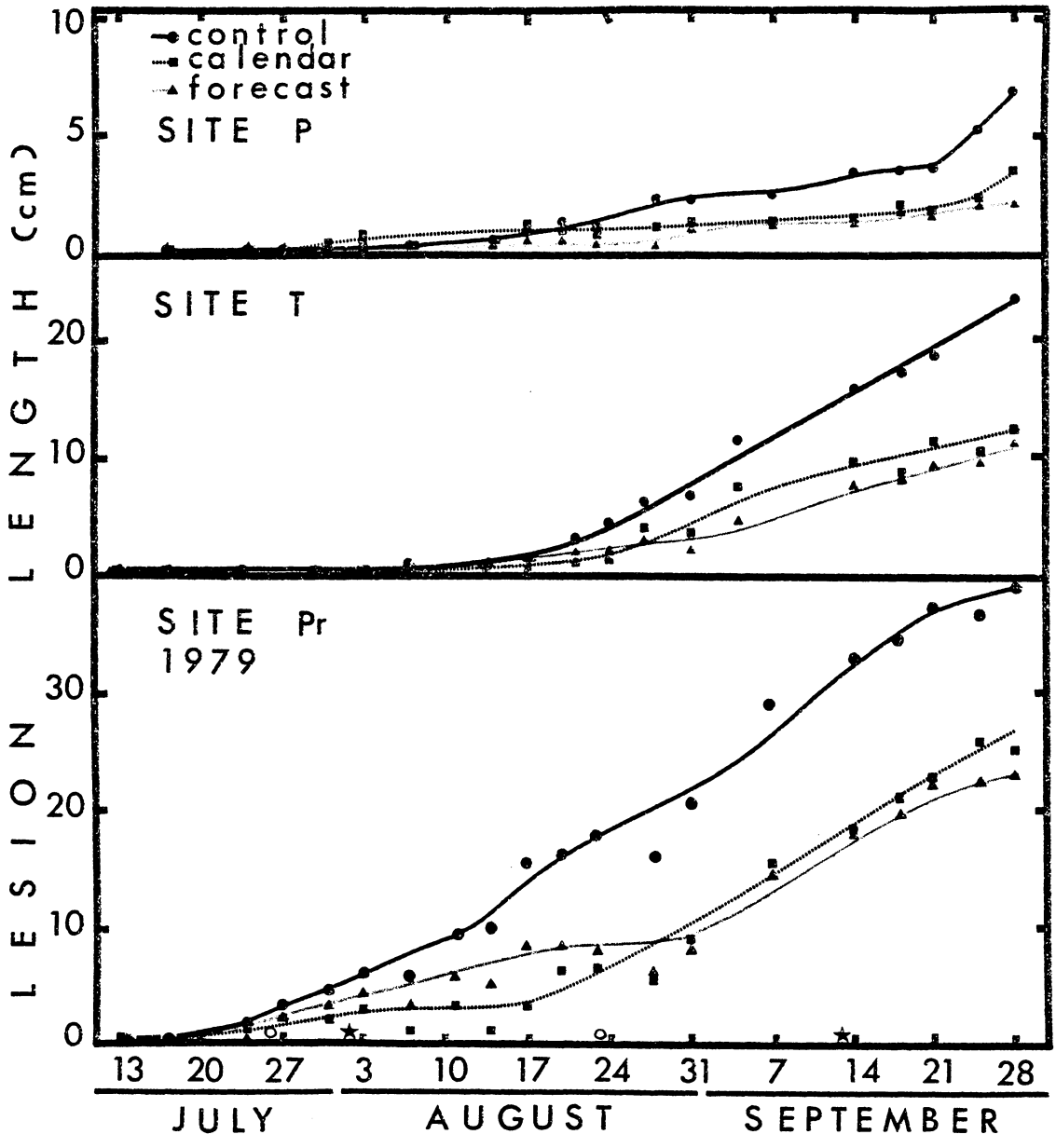

Fig. 25. Sclerotinia blight of peanut disease progress based on the longest lesion length (LLL) for untreated control, calendar, and forecast system fungicide-treated plots at three sites during the 1979 peanut growing season. LLL = the average of 160 observations per treatment per date. The o's indicate the dates of fungicide application for the calendar treatment and the stars for the forecast treatment.

Table 30. Longest Sclerotinia blight, lesion length per 61-cm row section in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plants at three sites during the 1979 peanut growing season

Date		Longest Lesion Length (cm)[x]								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Jul	12T,13PPr	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a	0.00 a
	16T,17PPr	0.00 a	0.10 a	0.02 a	0.10 a	0.05 a	0.08 a	0.00 a	0.00 a	0.00 a
	23T,24PPr	0.02 a	0.15 a	0.00 a	1.52 a	1.12 b	0.89 ab	0.00 a	0.00 a	0.00 a
	27	0.05 a	0.23 a	0.18 a	3.38 a	1.91 b	2.57 b	-	-	-
	30T,31PPr	0.33 a	0.28 a	0.43 a	4.70 a	2.84 b	3.68 b	0.02 a	0.02 a	0.00 a
Aug	3	0.23 b	0.74 a	0.20 b	6.12 a	3.10 c	4.67 b	0.36 a	0.10 a	0.10 a
	7	0.25 a	0.20 a	0.23 a	5.82 a	1.24 c	3.68 b	0.23 a	0.00 b	0.10 ab
	11	-	-	-	9.27 a	3.10 c	5.82 b	-	-	-
	13T,14PPr	0.56 a	0.58 a	0.28 a	10.03 a	1.02 c	5.05 b	0.81 a	0.15 a	0.81 a
	17	0.94 a	1.22 a	0.76 a	15.52 a	3.40 c	8.84 b	1.47 a	0.58 b	1.45 a
	20PPr,21T	1.27 a	1.30 a	0.80 a	16.23 a	6.30 c	8.74 b	3.00 a	1.07 b	1.75 b
	23PPr,24T	1.37 a	0.94 a	0.53 a	17.81 a	6.65 b	8.08 b	4.60 a	1.47 b	2.41 b
	27T,28PPr	2.39 a	1.35 ab	0.38 b	16.00 a	5.56 b	5.99 b	6.65 a	4.04 b	2.76 b
	31	2.39 a	1.19 b	1.12 b	20.80 a	9.14 b	8.74 b	6.71 a	3.66 b	2.01 c
Sep	4T,7PPr	2.49 a	1.37 a	1.37 a	29.18 a	15.65 b	14.71 b	11.23 a	7.44 b	4.60 c
	14	3.45 a	1.45 b	1.27 b	33.07 a	18.54 b	18.49 b	16.00 a	9.63 b	7.72 b
	18	3.53 a	2.05 ab	1.68 b	34.72 a	21.23 b	20.29 b	17.30 a	8.41 b	7.80 b
	21	3.53 a	1.83 b	1.68 b	37.41 a	23.06 b	22.76 b	18.44 a	11.20 b	9.30 b
	25	5.31 a	2.44 b	2.01 b	36.78	25.81 b	22.61 c	21.97 a	10.44 b	9.30 b
	28	6.83 a	3.68 b	2.08 b	38.99 a	25.14 b	23.52 b	23.22 a	12.01 b	11.33 b
	Mean	1.85 a	1.12 b	0.71 a	16.87 a	8.84 c	9.47 b	7.34 a	3.91 b	3.40 c

[x]Mean of 160 readings. Means within site, on the same date, followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) observed on that day.

[z]Two applications (0.56 kg a.i./ha/application) applied Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

fungicide application on August 3, the longest lesion length in the calendar plots was less than that in the untreated forecast plots. This remained the case until August 28. From this date until September 25, there was no significant difference between the two fungicide-treated plots. Overall, lesion development was greater in the untreated control plots but there was no difference between lesion length in the calendar and forecast fungicide-treated plots.

At site T (Table 30), lesion development was greatest in the control plots. There was little difference between longest lesion length in the forecast and calendar-treated plots. There were only two dates in the entire season with significant differences in lesion development between the two fungicide treatments.

The percent soil moisture (Table 31) at 0 to 5 and 5 to 10-cm depths was similar between treatments within sites. Only at site T were there any differences between treatments during the season; however, the overall seasonal treatment means were not significantly different.

The percent soil moisture was similar at the three sites with a range of 10.0-13.4% at 0-5 cm and 9.7-13.4 at 5-10 cm (Table 31). Soil moisture at the 5 to 10-cm depth was somewhat lower at site Pr. The maximum percent soil moisture at all sites occurred at the end of the season

Table 31. Percent soil moisture at 0 to 5-cm and 5 to 10-cm depths in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Percent Soil Moisture[w]								
		Site P			Site Pr			Site T		
Mo	Day(s)[x]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
					0-5 cm depth					
Jul	10PPr, 11T	6.9	6.8	6.8	3.7	3.4	3.8	7.1	6.9	6.7
	16T, 17PPr	11.3	11.8	11.7	6.1	6.0	6.2	6.7	6.4	6.7
	23T, 24PPr	15.0	15.2	15.4	9.9	10.2	10.3	17.0	17.4	16.9
	30T, 31PPr	12.9	12.6	13.1	9.8	9.8	9.4	16.0	16.1	15.9
Aug	6T, 7PPr	8.6	8.5	9.3	8.5	8.3	8.5	9.6	10.1	9.7
	13T, 14PPr	9.7	9.7	9.9	7.4	7.7	7.9	14.0	14.5	14.7
	20PPrT	5.8	5.9	6.4	6.0	5.8	6.0	4.5	4.7	5.2
	27T, 28PPr	4.4	4.9	4.5	4.1	3.3	3.6	7.5 a	6.8 b	6.6 b
Sep	4PPrT	6.7	7.2	6.9	9.7	10.4	11.0	15.1	15.3	15.2
	10T, 11PPr	13.1	14.0	14.4	8.8	8.9	8.8	12.3	12.3	12.2
	17T, 18PPr	12.8	13.2	14.0	8.0	8.0	8.2	9.2	8.9	9.2
	24T, 25PPr	47.8[z]	47.8[z]	47.8[z]	38.1[z]	38.1[z]	38.1[z]	17.3 b	18.2 a	17.9 ab
	Mean	12.9	13.1	13.4	10.0	10.0	10.2	11.4	11.5	11.4
					5-10 cm depth					
Jul	10PPrT	8.8	9.2	9.2	5.4	4.8	5.0	7.7	8.6	8.9
	16T, 17PPr	11.8	11.8	11.7	5.9	6.1	6.2	7.5	7.6	7.6
	23T, 24PPr	13.7	14.0	13.9	10.1	9.8 a	9.8	16.3	17.0	16.1
	30T, 31PPr	13.1	13.2	13.3	10.2	9.6	9.7	15.1	15.6	15.2
Aug	6T, 7PPr	9.8	9.9	9.8	8.4	8.2	8.3	10.1	10.6	10.8
	13T, 14PPr	9.9	9.9	10.0	7.7	7.5	7.8	13.4	13.8	13.2
	20PPrT	6.3	6.6	6.5	5.8	5.8	5.8	4.4	4.6	4.6
	27T, 28PPr	5.4	5.7	5.4	4.5	3.8	4.2	7.7	7.2	7.4

Table 31. (continued)

Date		Percent Soil Moisture[w]								
		Site P			Site Pr			Site T		
Mo	Day(s)[x]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Sep	4PPrT	4.7	4.9	4.9	7.8	8.4	7.8	13.4	13.7	13.7
	10T,11PPr	13.6	14.3	14.6	9.1	8.2	8.6	12.0	12.2	12.2
	17T,18PPr	13.0	13.6	13.8	8.7	8.2	8.2	9.5	9.5	9.7
	24T,25PPr	47.8[z]	47.8[z]	47.8[z]	38.1[z]	38.1[z]	38.1[z]	16.2	17.3	17.0
	Mean	13.2	13.4	13.4	9.7	9.9	10.0	11.1	11.5	11.4

[w]Percent soil moisture on a dry weight basis. Means within site on the same date not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[x]Letters indicate site(s) sampled on that day.

[y]Two applications (0.56 kg a.i./ha/application) made Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

[z]Saturated soil due to heavy rains. Percent soil moisture determined for saturated soil in laboratory (4 samples/site).

during a rainy period. The minimum recorded soil moisture at the 0 to 5-cm depth occurred September 28 at the P- and Pr-sites and September 20 at the T-site. The minimum soil moisture at 5 to 10-cm was recorded on September 4 for P, August 28 for Pr, and August 20 for T. The average soil moisture at site P was greater in 1978.

Width and height were similar among the treatments at site Pr (Table 32). Width measurements among treatments at sites P and T were similar while the season's mean height was greatest in the untreated control plots and least in the calendar-treated plots at site P. At site T the season's mean height was least in the untreated control plots and greatest in the forecast-treated plots.

Pod yield and value ($/ha and $/cwt) were not significantly different between the treatments at site P (Table 33). A non-significant 7% yield increase over that of the untreated control was obtained in the forecast-treated plots. At site Pr, the calendar and forecast treatments out-yielded the control plots. The value in $/ha was also equally greater with the fungicide treatments. A 58% yield increase was realized with the calendar treatment and a 75% increase occurred with the forecast program. At site T the lowest yield was in the control plots and the highest yield was in the

Table 32. Canopy measurement (width and height) of 'Florigiant' peanut (Site T), 'GK 3' (Site P), and 'Va 72R' (Site Pr) in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Canopy Measurement[w]								
		Site P			Site Pr			Site T		
Mo	Day(s)[x]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
					Width (cm)					
Jul	10PPr,11T	49.5	46.5	46.8	45.8	45.5	45.2	42.1	45.2	43.8
	16T,17PPr	63.4	63.4	63.1	59.3 b	57.9 b	62.8 a	45.9	50.2	50.2
	23T,24PPr	69.7	69.6	68.0	67.4	69.0	70.1	54.6 b	60.4 a	59.4 a
	30T,31PPr	92.7 a	89.0 b	90.7 ab	93.2	92.7	92.9	64.8 b	73.2 a	68.9 ab
Aug	6T,7PPr	*[z]	*	*	*	*	*	88.5	91.6	92.7
	13T,14PPr	*	*	*	*	*	*	91.3	94.9	93.8
	20	*	*	*	*	*	*	92.3 b	95.5 a	93.8 ab
	27T,28PPr	*	*	*	*	*	*	92.3 b	95.5 a	93.8 ab
Sep	4	*	*	*	*	*	*	92.3 b	95.5 a	93.8 ab
	10T,11PPr	*	*	*	*	*	*	93.4 b	96.5 a	94.0 ab
	17T,18PPr	*	*	*	*	*	*	93.4 b	96.5 a	94.0 ab
	24T,25PPr	*	*	*	*	*	*	96.5	96.5	96.5
	Mean	87.3	86.7	86.7	86.5	86.4	86.9	79.0 c	82.6 a	81.2 b
					Height (cm)					
Jul	10PPr,11T	16.9	17.7	16.8	15.9	16.0	15.7	17.2 a	18.2 a	17.7 a
	16T,17PPr	24.7	24.8	24.0	19.0	17.9	18.7	17.0 b	18.9 a	18.8 a
	23T,24PPr	30.4	29.2	30.6	25.3	26.1	25.8	24.4	25.4	26.4
	30T,31PPr	37.8	37.3	38.4	37.6 a	35.6 ab	34.8 b	30.3 b	33.3 a	33.8 a

Table 32. (continued)

Date		Canopy Measurement[w]								
		Site P			Site Pr			Site T		
Mo	Day(s)[x]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Aug	6T,7PPr	45.3	42.7	45.2	44.2	44.6	43.7	40.0	38.1	40.2
	13T,14PPr	47.0	43.9	44.9	45.9	47.0	46.6	38.8 b	40.2 b	43.6 a
	20	46.9	44.8	45.8	47.4	46.0	46.4	41.8	42.7	43.3
	27T,28PPr	46.8	43.6	44.9	46.7	47.0	46.7	40.6	41.8	43.1
Sep	4	46.2 a	42.9 b	43.6 ab	47.6	48.0	47.6	40.9	43.6	43.2
	10T,11PPr	46.1	43.8	45.0	46.2	46.3	47.6	40.5 b	43.0 ab	44.2 a
	17T,18PPr	42.9 a	40.4 b	41.9 ab	44.1	45.0	44.8	36.9	37.3	32.3
	24T,25PPr	43.9	41.9	43.7	40.3 b	45.0 a	44.6 a	41.6	41.7	43.1
	Mean	39.6 a	37.7 c	38.7 b	38.4	38.7	38.6	36.7 c	35.4 b	36.2 a

[w]Mean of 24 measurements. Means within site on the same date not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[x]Letters indicate site(s) sampled on that day.

[y]Two applications (0.56 kg a.i./ha/application) made Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

[z]* indicates no measurement; lateral branches of adjacent rows forming continuous canopy. Width $\geq$ 91 cm.

calendar-treated plots. The yield from forecast-treated plots was statistically similar to both the control and calendar-treated plots. A 28% yield increase over the untreated control plots was obtained with the calendar application system. A 22% increase was obtained with the forecast system. There was no significant difference in grade factors between treatments within sites.

Figure 26 shows the disease progress curve based on the DSI for the three treatments at the three sites for 1980. Fungicide applications for the calendar-treated plots were made on July 28 and September 12. Applications were made on August 20 and September 8 to the forecast-treated plots.

Disease severity was low throughout the season at site P, regardless of the treatment. There was no significant difference between the untreated control and fungicide-treated plots on any of the observational dates (Table 34). The season's mean DSI at site P was significantly lower in the calendar- treated plots.

Site Pr had the greatest disease development of the three sites tested for 1980 (Figs. 26-27). Disease was observed at this site on July 15. Despite application of the first fungicide treatment on July 28 to the calendar-treated plots, there was no significant difference in disease severity compared to the control until August 29

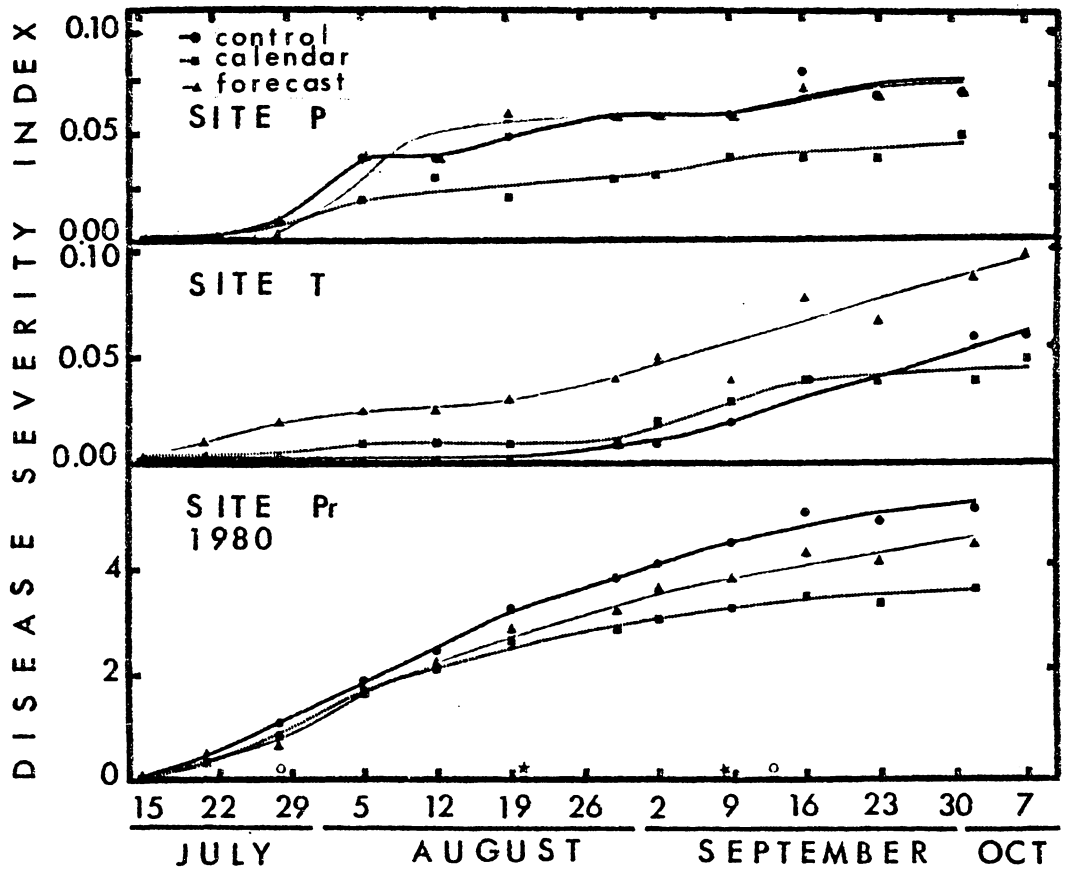

Fig. 26. Sclerotinia blight of peanut disease progress based on the disease severity index (DSI) for untreated control, calendar, and forecast system fungicide-treated plots at three sites during the 1980 peanut growing season. DSI (average of 160 observations per treatment per date) was based on a 0-10 scale with 0 = no disease and 10 = complete death of plants in a 61-cm row section. The o's indicate the dates of fungicide application for the calendar treatment and the stars for the forecast treatment.

Table 33. Pod yield (kg/ha) and value ($/ha, $/cwt) in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots with percent yield increase for the fungicide treatments at three sites in 1979

	Site P				Site Pr				Site T			
Treatment	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase
Control	4207 a	1623 a	21.50 a	-	2484 b	1059 b	20.50 a	-	2994 b	1260 b	19.75 a	-
Calendar[z]	4111 a	1598 a	21.00 a	0	3786 a	1675 a	21.50 a	58	3822 a	1607 a	19.50 a	28
Forecast[z]	4516 a	1770 a	21.25 a	7	4118 a	1857 a	21.00 a	75	3652 ab	1557 ab	20.00 a	22

[x]Means of four plots. Means within columns followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Means based on yields and grading factors.

[z]Two applications (0.56 kg a.i./ha/application) made Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 34. Sclerotinia blight disease severity in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1980 peanut growing season

Date		Disease Severity Index[x]								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Jul	15	0.00 a	0.00 a	0.00 a	0.00 b	0.00 b	0.05 a	0.00 a	0.00 a	0.00 a
	21	0.00 a	0.00 a	0.00 a	0.13 a	0.11 a	0.15 a	0.00 a	0.00 a	0.01
	28	0.01 a	0.01 a	0.00 a	1.06 a	0.86 a	0.78 a	0.00 b	0.00 b	0.02 a
Aug	5	0.04 a	0.02 a	0.04 a	1.95 a	1.71 a	1.90 a	0.00 a	0.01 a	0.02 a
	12	0.04 a	0.03 a	0.04 a	2.53 a	2.21 a	2.27 a	0.00 a	0.01 a	0.02 a
	19	0.05 a	0.02 a	0.06 a	3.33 a	2.71 a	2.86 a	0.00 b	0.01 ab	0.03 a
	29	0.06 a	0.03 a	0.06 a	3.82 a	2.86 b	3.22 ab	0.01 b	0.01 ab	0.04 a
Sep	2	0.06 a	0.03	0.06 a	4.15 a	3.14 b	3.76 ab	0.01 b	0.02 ab	0.05 a
	9	0.06 a	0.04 a	0.06 a	4.51 a	3.26 b	3.86 ab	0.02 a	0.03 a	0.04 a
	16	0.08 a	0.04 a	0.07 a	5.18 a	3.49 c	4.36 b	0.04 a	0.04 a	0.08 a
	23	0.07 a	0.04 a	0.07 a	4.90 a	3.42 b	4.21 a	0.04 a	0.04 a	0.07 a
Oct	1Pr,2PT	0.07 a	0.05 a	0.07 a	5.08 a	3.62 b	4.56 a	0.06 a	0.04 a	0.09 a
	7	-	-	-	-	-	-	0.06 a	0.05 a	0.10 a
	Mean	0.04 a	0.03 b	0.04 a	3.05 a	2.28 c	2.66 b	0.02 b	0.02 b	0.04 a

[x]DSI on a 0-10 scale: 0 = no disease, 10 = complete death of the plants in a 61 cm row section. Means within site on the same date followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) observed on that day.

[z]Two applications (0.56 kg a.i./ha/application) made Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

(Table 34). After two fungicide applications to the forecast treated plots (August 20 and September 8), the DSI was not significantly different from the control until September 16. On the last day before harvest, the calendar-treated plots showed the least disease. There was no significant difference between the DSI of the forecast-treated and untreated control plots. The season's mean DSI was lowest for the calendar treatment (2.28), intermediate for the forecast (2.66) and greatest for the untreated control plots (3.05).

Site T, like P, had low disease development in all plots (Figs. 26-27). At the end of the season the control, calendar-, and forecast-treated plots had DSIs of 0.02, 0.02, and 0.04, respectively (Table 34). The DSI in the forecast treatment was greater than that in the other two treatments. At all sites during 1980, the season's mean DSI was lower for the calendar- than for the forecast-treated plots.

Figure 27 shows lesion development in the three treatments at the three sites. A similar trend to that for the DSI is found for LLL.

Table 35 shows the statistical significance between the treatments within sites. Lesion development was similar between treatments on most dates at sites P and T. At site

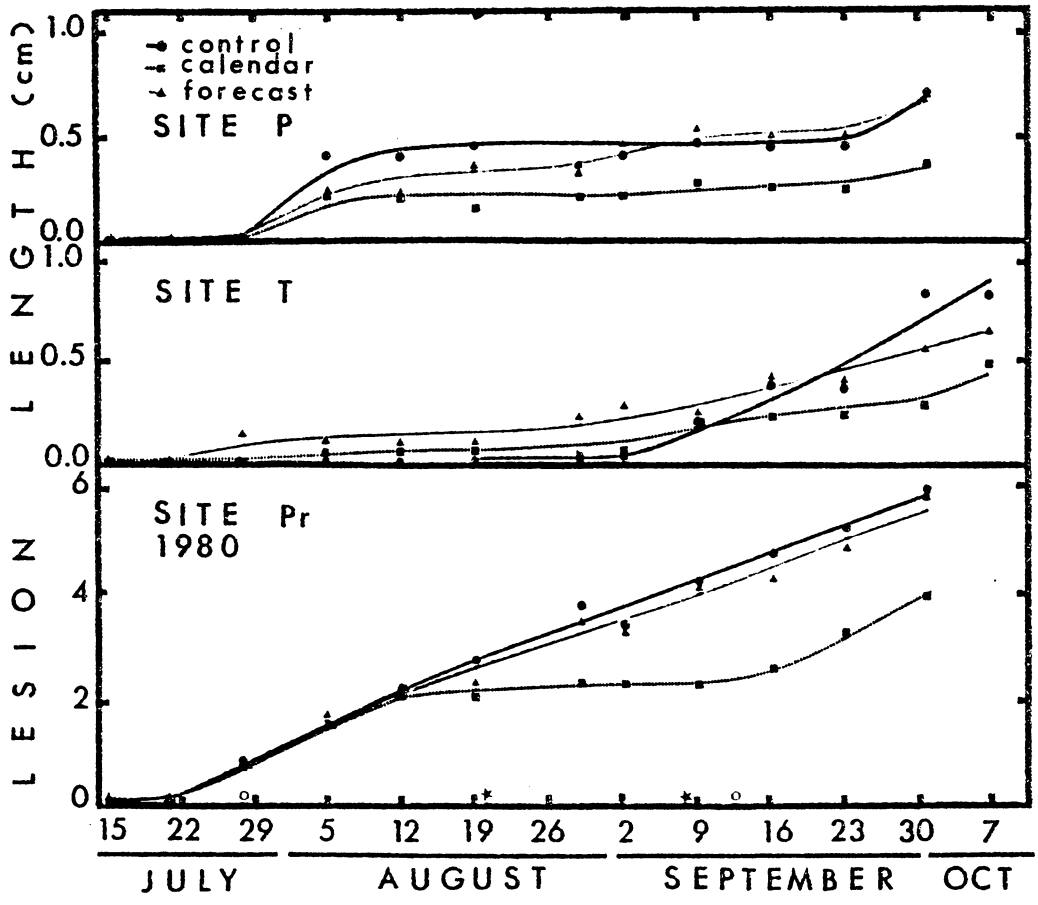

Fig. 27. Sclerotinia blight of peanut disease progress based on the longest lesion length (LLL) for untreated control, calendar schedule, and forecast system fungicide-treated plots at three sites during the 1980 peanut growing season. LLL = the average of 160 observations per treatment per date. The o's indicate the dates of fungicide application for the calendar treatment and the stars for the forecast treatment.

Pr, the calendar-treated plots generally had less lesion development. The season mean at all sites for the calendar-treated plots was less than for the forecast-treated plots. Lesion development was greatest at the Pr site.

Soil moisture was low on most of the sampling dates during the 1980 season (Table 36). Five percent or less soil moisture at the 0 to 5-cm depth was recorded for 50, 42, and 78% of the weeks at the P-, Pr-, and T-sites, respectively. The first and last sampling dates at P and Pr had nearly twice the moisture that was recorded for all the other dates. Without the soil moisture of these readings, the seasonal means would be 4.6, 4.6, 4.7, 5.3, 5.1, and 5.6% for the 0 to 5-cm depth in the control, calendar, and forecast plots at the P and Pr sites, respectively. Similarly, without the first and last readings for the 5 to 10-cm depth, the season's mean percent soil moisture would also be much lower. The average soil moisture for the season for all treatments at all sites at both depths would then be less than 6%.

Canopy measurements for all treatments at all sites in 1980 are shown in Table 37. The plants remained small throughout the season at the P-site. The lateral branches did not meet to form a continuous canopy. Throughout the

Table 35. Longest Sclerotinia blight, lesion length per 61-cm row section in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plants at three sites during the 1980 growing season

Date		Longest Lesion Length (cm)[x]								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Jul	15	0.00 a	0.00 a	0.00 a	0.00 b	0.02 b	0.08 a	0.00 a	0.00 a	0.00 a
	21	0.00 a	0.00 a	0.00 a	0.15 a	0.13 a	0.18 a	0.00 a	0.00 a	0.02 a
	28	0.02 a	0.05 a	0.00 a	0.86 a	0.79 a	0.74 a	0.00 b	0.00 b	0.15 a
Aug	5	0.41 a	0.23 a	0.25 a	1.57 a	1.57 a	1.68 a	0.00 a	0.05 a	0.10 a
	12	0.41 a	0.23 a	0.23 a	2.26 a	2.01 a	2.24 a	0.00 a	0.05 a	0.08 a
	19	0.46 a	0.15 a	0.36 a	2.79 a	2.01 b	2.34 ab	0.00 a	0.05 a	0.10 a
	29	0.36 a	0.23 a	0.33 a	3.81 a	2.34 b	3.58 a	0.02 b	0.02 b	0.23 a
Sep	2	0.41 a	0.23 a	0.48 a	3.40 a	2.31 b	3.35 a	0.02 b	0.05 b	0.28 a
	9	0.48 a	0.28 a	0.51 a	4.27 a	2.36 b	4.22 a	0.20 a	0.20 a	0.23 a
	16	0.46 a	0.25 a	0.53 a	4.83 a	2.62 b	4.32 a	0.36 a	0.23 a	0.41 a
	23	0.46 a	0.25 a	0.53 a	5.36 a	3.28 b	4.93 a	0.36 a	0.23 a	0.38 a
Oct	1Pr,2PT	0.71 a	0.38 a	0.71 a	5.97 a	3.94 b	5.84 a	0.56 a	0.28 a	0.53 a
	7	-	-	-	-	-	-	0.56 a	0.46 a	0.64 a
	Mean	0.36 a	0.18 b	0.33 a	2.95 a	1.93 b	2.79 a	0.15 b	0.13 b	0.25 a

[x]Mean of 160 readings. Means within site, on the same date, followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) measured on that day.

[z]Two applications (0.56 kg a.i./ha/application) applied Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 36. Percent soil moisture at 0 to 5-cm and 5 to 10-cm depths in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1980 peanut growing season

Date		Percent Soil Moisture[x]								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
					0-5 cm depth					
Jul	15	10.6	11.8	12.0	10.2	9.8	10.0	-	-	-
	22	7.5	6.6	7.2	6.0	5.5	6.2	-	-	-
	29	8.1	8.6	8.7	6.6	6.1	7.0	-	-	-
Aug	5	5.0	5.2	5.9	9.2 b	9.1 a	9.7 a	1.4 b	2.0 a	1.5 ab
	12	3.3	3.2	3.2	6.0	6.2	5.6	1.2 b	2.3 a	1.0 b
	18T,19PPr	3.4	3.3	3.3	7.2	7.2	7.8	8.6	9.5	9.3
	25T,26PPr	3.4	2.7	2.9	4.0	4.2	5.6	2.2	2.6	3.4
Sep	2T,3PPr	2.6	2.9	2.6	3.4	3.2	3.6	1.4	1.5	1.6
	8T,9PPr	6.0	6.5	6.2	4.9	4.6	5.0	7.5	7.8	7.6
	15T,16PPr	3.6	3.4	3.6	3.2	2.3	2.6	1.7	2.4	2.1
	22T,23PPr	3.2	3.2	3.2	2.7	2.3	2.7	1.7	1.8	1.7
	29	-	-	-	-	-	-	1.7	1.4	1.8
Oct	1	23.2	23.2	23.2	14.1	13.8	12.0	-	-	-
	Mean	6.7	6.5	6.8	6.5	6.2	6.5	3.0 b	3.5 a	3.3 ab
					5-10 cm depth					
Jul	15	13.0	12.4	12.1	10.1	10.2	10.0	-	-	-
	22	7.6	7.8	7.8	6.4	6.2	6.7	-	-	-
	29	8.8	9.0	9.2	7.1	6.7	7.0	-	-	-

Table 36. (continued)

Date		Percent Soil Moisture[x]								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Aug	5	6.2	6.1	6.2	9.2	8.7	9.0	2.8 b	2.9 ab	3.0 a
	12	4.9	4.8	4.9	4.4	5.4	5.2	2.4	2.2	2.0
	18T,19PPr	4.4	4.6	3.6	7.8	7.1	6.6	6.6	6.4	6.4
	25T,26PPr	4.3 b	4.8 a	4.2 b	5.2 b	5.8 a	4.8 b	3.0	3.2	3.2
Sep	2T,3PPr	3.6	4.4	4.5	4.4	4.2	4.3	2.6	2.5	2.6
	8T,9PPr	5.9	6.2	5.6	5.0	4.8	5.0	6.8	6.9	6.9
	15T,16PPr	4.7	4.6	4.6	4.1	3.7	3.5	2.8	2.6	3.1
	22T,23PPr	4.4	4.7	4.5	3.9	3.8	4.2	2.7	2.6	2.6
	29	-	-	-	-	-	-	2.4 b	2.4 b	2.7 a
Oct	1	20.5	20.6	20.5	13.5	13.2	12.2	-	-	-
	Mean	7.4	7.5	7.3	6.8	6.6	6.5	3.6	3.6	3.6

[x]Percent soil moisture on a dry weight basis. Means within site on the same date not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

[z]Two applications (0.56 kg a.i./ha/application) made Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

season, distinct rows and bare-soil strips were evident. The lateral branches at sites Pr and T formed continuous canopies. Plant height at the P site was greatest on July 29. After that the plants were less erect and consequently, shorter. The season's mean width was lowest in the calendar-treated plots at site P; at site T the width of the calendar-treated plots was similar to that of the forecast treated plots and both were smaller than the untreated control plots. There was no significant difference in width between the treatments at site Pr. The height was also less than either of the other treatments in the calendar-treated plots at the P-site. At the Pr-site, the mean height for the season was lower in the fungicide treated plots compared to the untreated plots. No difference in the mean height for the season was found at the T-site.

There was no significant difference in yield between treatments within sites in 1980 (Table 38). There was also no significant difference in yield and value between treatments within sites. A yield increase due to either fungicide schedule at site P did not occur. A nonsignificant, seven percent yield increase over the control plots occurred with the calendar treatment at site Pr. At site T both the fungicide schedules produced a nonsignificant 12% yield increase.

Table 37. Canopy measurement (width and height) of 'Florigiant' peanut in untreated control, calendar (procymidone applied to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1980 peanut growing season

Date		Canopy Measurement[w]								
		Site P			Site Pr			Site T		
Mo	Day(s)[x]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
					Width (cm)					
Jul	15	68.6	65.3	65.7	81.9	80.0	81.8	74.2 a	70.6 ab	68.6 b
	22	80.8	78.2	82.0	91.9	92.2	92.2	88.1 a	83.6 b	83.1 b
	29	89.2	86.9	89.4	91.4	91.4	91.4	92.5	90.7	90.7
Aug	5	88.6	86.1	87.6	92.5 a	91.4 b	91.4 b	92.5	90.9	90.7
	12	90.7 a	86.4 b	88.9 ab	*[z]	*	*	*	*	*
	18T,19PPr	86.1	88.4	88.1	*	*	*	*	*	*
	25T,26PPr	86.1	85.3	86.9	*	*	*	*	*	*
Sep	2T,3PPr	86.1	85.3	86.9	*	*	*	*	*	*
	8T,9PPr	86.1	85.3	87.1	*	*	*	*	*	*
	15T,16PPr	84.3	83.3	84.1	*	*	*	*	*	*
	22T,23PPr	85.3	83.3	84.6	*	*	*	*	*	*
	29	-	-	-	-	-	-	*	*	*
Oct	1	85.9	86.1	87.6	*	*	*	-	-	-
	Mean	84.8 a	83.3 b	84.8 a	90.7	90.2	90.7	90.2 a	88.9 b	88.9 b
					Height (cm)					
Jul	15	28.1	28.7	28.7	38.8	39.8	39.1	30.0	28.7	28.7
	22	32.7	30.7	31.5	47.2	45.7	45.9	32.3	30.7	31.5
	29	33.7	31.0	32.3	50.5 a	48.5 b	49.5 ab	32.5	31.0	32.3

Table 37. (continued)

Date		Canopy Measurement[w]								
		Site P			Site Pr			Site T		
Mo	Day(s)[x]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Aug	5	33.2	31.2	32.8	53.5	52.8	53.0	31.8	31.2	32.8
	12	32.5	32.2	33.0	54.6	52.8	52.5	32.0	32.2	33.0
	18T,19PPr	33.5	33.0	32.8	54.3	52.8	52.5	33.0	33.0	32.8
	25T,26PPr	33.2	32.3	32.0	53.3	52.0	52.5	32.5	32.3	32.0
Sep	2T,3PPr	32.7	33.0	33.3	51.5 ab	52.8 a	48.2 b	33.0	33.0	33.3
	8T,9PPr	31.0	31.2	31.5	54.1 a	51.5 b	52.0 b	31.2	31.2	31.5
	15T,16PPr	31.5 a	31.2 b	31.8 ab	52.8	52.8	54.1	32.0	31.2	31.8
	22T,23PPr	32.5	33.0	34.3	52.5 a	50.5 b	50.8 ab	31.8 b	33.0 ab	34.3 a
	29	-	-	-	-	-	-	29.5 b	30.7 ab	32.0 a
Oct	1	32.5	30.7	31.4	50.5	50.8	50.8	-	-	-
	Mean	32.2 a	31.0 b	32.0 a	52.0 a	50.2 b	50.2 b	31.8	31.5	32.0

[w]Mean of 24 measurements. Means within site on the same date not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[x]Letters indicate site(s) sampled on that day.

[y]Two applications (0.56 kg a.i./ha/application) made Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

[z]* indicates no measurement; lateral branches of adjacent rows forming continuous canopy. Width $\geq$ 91 cm.

Table 38. Pod yield (kg/ha) and value ($/ha, $/cwt) in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots with percent yield increase for the fungicide treatments at three sites in 1980

	Site P				Site Pr				Site T			
Treatment	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase	kg/ha[x]	$/ha[x]	$/cwt[xy]	Percent Increase
Control	1507	662	21.50	-	3025	1355	20.50	-	2472	1174	22.00	-
Calendar[z]	1264	534	21.00	0	3228	1515	21.50	7	2775	1302	21.75	12
Forecast[z]	1462	623	21.25	0	3013	1377	21.00	0	2780	1320	22.00	12

[x]Mean of four plots. Means within columns were not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Means based on yields and grading factors.

[z]Two applications (0.56 kg a.i./ha/application) made on Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

Sclerotial population was monitored at six sites during 1979 and 1980. The population data from these two years are presented together because of the similarity in treatments and test sites as well as for convenience of comparison. In 1979, there was no significant difference at the 0-5 cm depth, between the season's mean sclerotial population for the treatments within site (Table 39). At site P on July 31, more sclerotia were recovered from the forecast-treated plots than the calendar-treated plots. Each was not significantly different from the control. On July 10 at the Pr site, more sclerotia were recovered from the forecast-treated plots than from the control plots.

At the 5-10 cm depth there were differences in the sclerotial population on July 10, 1979, at the P site (Table 40). More sclerotia were recovered from the calendar-treated plots than from the control or forecast-treated plots. On the last sampling date, fewer were recovered from the calendar-treated plots. At site Pr on July 7, there were more sclerotia in the control plots than in the calendar- or forecast-treated plots. On the next sampling date (July 17), there were more sclerotia recovered from the forecast-treated plots. This variability had nothing to do with the treatments since the first fungicide application was made on July 26. On the last

Table 39. *Sclerotinia minor* sclerotial population at 0 to 5-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Jul	6	-	-	-	-	-	-	0.6	0.2	0.2
	10	0.1	0.9	0.2	1.7 a	1.3 ab	0.8 b	-	-	-
	17	0.2	0.2	0.5	0.4	0.4	0.6	-	-	-
	31	0.2 ab	0.1 b	0.6 a	0.1	0.2	0.3	-	-	-
Aug	6	-	-	-	-	-	-	1.0	0.2	0.2
Sep	24	-	-	-	-	-	-	0.2	0.2	0.3
	25	0.4	0.4	0.2	1.4	0.8	0.6	-	-	-
Mean		0.2	0.4	0.4	0.9	0.7	0.6	0.6	0.2	0.2

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date, not followed by a letter or followed by the same letter(s), are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Two applications (0.56 kg a.i./ha/application) made on Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperature $\leq$ 15.6 C following week with rainfall.

sampling at the T plots, the most sclerotia were recovered from the untreated control plots and the least from the forecast-treated plots. The number recovered from the calendar treatment was similar to the control and the forecast-treated plots. There was no difference in the season's mean sclerotial population between treatments, within sites.

At the 10-15 cm depth (Table 41), sclerotia were more numerous at site P on July 31, in the control and calendar-treated plots than in the forecast treated plots. The season's mean sclerotial population was greater in the calendar than in the forecast-treated plots. There was no difference between the numbers found in the control and those in the calendar or forecast plots. Sclerotial population at the P-site was similar between treatments for each sampling date. At site T on two out of the three sampling dates, recovery of sclerotia was greater in the forecast than calendar treated plots. The season's mean number of sclerotia per 40 g was greater in the forecast plots than the calendar plots ($P = 0.10$). The population in the control was not significantly different from that in the other treatments ($P = 0.10$).

Table 42 shows the sclerotial population at the 15-20 cm depth for the three treatments at the three sites during

Table 40. Sclerotinia minor sclerotial population at 5 to 10-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Jul	6	-	-	-	-	-	-	0.6 a	0.2 a	0.6 a
	10	0.0 b	0.8 a	0.0 b	3.4 a	1.1 b	1.4 b	-	-	-
	17	0.2 a	0.5 a	0.0 a	0.1 b	0.6 ab	1.0 a	-	-	-
	31	0.2 a	0.2 a	0.3 a	0.3 a	0.5 a	0.2 a	-	-	-
Aug	6	-	-	-	-	-	-	0.2 a	0.4 a	0.3 a
Sep	24	-	-	-	-	-	-	0.6 a	0.4 ab	0.1 b
	25	0.4 ab	0.2 b	0.8 a	1.1 a	1.0 a	0.7 a	-	-	-
Mean		0.2	0.4	0.3	1.2	0.8	0.8	0.5	0.4	0.3

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Two applications (0.56 kg a.i./ha/application) made on Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 41. *Sclerotinia minor* sclerotial population at 10 to 15-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Jul	6	-	-	-	-	-	-	0.5 ab	0.1 b	1.0 a
	10	0.0 a	0.1 a	0.0 a	1.8 a	0.7 a	0.9 a	-	-	-
	17	0.5 a	0.6 a	0.4 a	1.1 a	0.9 a	1.0 a	-	-	-
	31	1.0 a	1.2 a	0.3 b	0.4 a	0.1 b	0.6 a	-	-	-
Aug	6	-	-	-	-	-	-	1.2 a	0.2 a	0.2 a
Sep	24	-	-	-	-	-	-	0.2 b	0.3 b	0.9 a
	25	0.3 a	0.4 a	0.3 a	0.5 a	1.0 a	1.1 a	-	-	-
Mean		0.5 ab	0.6 a	0.2 b	0.9	0.7	0.9	0.6	0.2	0.7

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Two applications (0.56 kg a.i./ha/application) made on Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

1979. There was no significant difference between the treatments on the sampling dates at site P and site T. At site Pr, more sclerotia were recovered on July 17 from the control plots than the other plots. The season's mean sclerotial population at 15-20 cm depth was greater in the control than in the calendar-treated plots. The numbers recovered from the forecast-treated plots were similar to control and calendar treated plots.

The mean sclerotia recovered from the three treatments at the 0 to 20-cm depth was not significantly different in three out of four sampling dates at site P and Pr (Table 43). Significantly, more sclerotia were recorded from the calendar treated plots at site P and from the control plots at site Pr on July 10, 1979. More sclerotia were recovered on August 6 from the control plots than the forecast plots at site T. The number of sclerotia obtained from the calendar treatment was not significantly different from either of the other treatments.

There were differences in the number of sclerotia recovered from the different depths (Table 44). These differences were not entirely consistent between dates. Overall, more sclerotia were present at the three sites in the 15 to 20-cm depth than most of the other depths.

Table 42. *Sclerotinia minor* sclerotial population at 15 to 20-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Jul	6	-	-	-	-	-	-	0.9 a	1.2 a	1.0 a
	10	0.5 a	0.6 a	0.4 a	2.3 a	0.9 a	1.4 a	-	-	-
	17	0.5 a	1.0 a	0.4 a	2.6 a	0.9 b	1.2 b	-	-	-
	31	0.3 a	0.4 a	0.7 a	0.6 a	0.4 a	0.3 a	-	-	-
Aug	6	-	-	-	-	-	-	0.6 a	0.8 a	0.4 a
Sep	24	-	-	-	-	-	-	0.5 a	0.9 a	0.5 a
	25	0.3 a	0.3 a	0.3 a	2.2 a	1.4 a	2.1 a	-	-	-
Mean		0.4	0.6	0.4	1.9 a	0.9 b	1.3 ab	0.7	1.0	0.6

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Two applications (0.56 kg a.i./ha/application) made on Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 43. *Sclerotinia minor* sclerotial population at 0 to 20-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1979 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]	Control	Calendar[y]	Forecast[y]
Jul	6	-	-	-	-	-	-	0.7 a	0.5 a	0.7 a
	10	0.2 b	0.6 a	0.2 b	2.3 a	1.0 b	1.2 b	-	-	-
	17	0.4 a	0.6 a	0.3 a	1.1 a	0.7 a	1.0 a	-	-	-
	31	0.4 a	0.5 a	0.5 a	0.3 a	0.3 a	0.3 a	-	-	-
Aug	6	-	-	-	-	-	-	0.7 a*	0.4 ab*	0.3 b*
Sep	24	-	-	-	-	-	-	0.4 a	0.4 a	0.4
	25	0.4 a	0.3 a	0.4 a	0.3 a	0.3 a	0.3 a	-	-	-

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test. *Indicates P = 0.10.

[y]Two applications (0.56 kg a.i./ha/application) made on Jul 26 and Aug 23 for calendar and Aug 2 and Sep 13 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 44. *Sclerotinia minor* sclerotial population at 0-5, 5-10, 10-15 and 15-20 cm depths at three sites during the 1979 peanut growing season

Depth (cm)	Sclerotia[x]/40 g soil													
	Site P					Site Pr					Site T			
	Jul 10	Jul 17	Jul 31	Sep 25	Mean	Jul 10	Jul 17	Jul 31	Sep 25	Mean	Jul 6	Aug 6	Sep 24	Mean
0-5	0.4 a	0.3 a	0.3 b	0.3 a	0.4 ab*[y]	1.3 ab*	0.5 b	0.2 b*	0.9 b	0.7 b	0.4 b	0.5 a	0.2 b	0.4 b*
5-10	0.2 ab	0.2 a	0.2 b	0.5 a	0.3 b*	2.0 a*	0.6 b	0.3 ab*	0.9 b	1.0 b	0.5 b	0.3 a	0.4 ab	0.4 b*
10-15	0.0 b	0.5 a	0.9 a	0.3 a	0.4 ab*	1.1 b	1.0 b	0.4 ab*	0.8 b	0.8 b	0.5 b	0.5 a	0.5 ab	0.5 ab*
15-20	0.5 a	0.6 a	0.5 b	0.3 a	0.5 a*	1.6 ab*	1.6 a	0.4 a*	1.9 a	1.4 a	1.0 a	0.6 a	0.6 a	0.8 a*

[x]Mean of 24 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within columns followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]* indicates P = 0.10.

Table 45 compares sclerotial recovery for the different sampling dates at the three sites. At site P, there were more (significant at P=0.10) sclerotia at the end of July than in mid July or end of September. At the Pr site more sclerotia were recovered on July 10, than at the end of July but there was no difference in population from those recovered at the end of September. There was no difference in sclerotial recovery on different sampling dates at site T.

In 1980, there was no difference in sclerotial numbers between treatments within sites at the 0 to 5-cm depth (Table 46). However, at site Pr, the season's mean recovered sclerotia was greater in the control than in the calendar-treated plots. Recovery from the forecast-treated plots was similar to that from the other treatment's plots. There was also no difference in sclerotial population between treatments within site at the 5 to 10-cm depth (Table 47). Similarly, at the 10 to 15-cm depth, there was no difference in the season's mean number of sclerotia between treatments within sites (Table 48). More sclerotia were recovered on October 31 from the calendar-treated plots than from the control plots. At the 15 to 20-cm depth, more sclerotia were obtained over the season at site P from the control plots (Table 49). There was no difference between treatments at sites Pr and T.

Table 45. Sclerotinia minor sclerotial population at 0-20 cm depth at each site for the 1979 peanut growing season

Date		Sclerotia[x]/40 g soil		
Mo	Day	Site P	Site Pr	Site T
Jul	6	-	-	0.6 a
	10	0.3 b*	1.5 a	-
	17	0.4 ab*	0.9 b	-
	31	0.5 a*	0.3 c	-
Aug	6	-	-	0.5 a
Sep	24	-	-	0.4 a
	25	0.4 ab*	1.2 ab	-

[x]Mean of 24 samples. Sclerotia collected on 425-μm mesh sieves. Means within columns followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

*Indicates P = 0.10.

Inconsistent results between sites in 1980 were obtained for the population pattern at the four depths (Table 50). At site P, the greatest number of sclerotia were found at the 0 to 5-cm depth. At site Pr, there was no difference between the numbers of sclerotia recovered from 0 to 5 or 15 to 20-cm depth. However, the 0 to 5-cm depth samples contained more sclerotia than the 5 to 10-cm or 10 to 15-cm depth samples. At site T there was no significant difference between depths.

More sclerotia were obtained from samples taken on September 9 at site P than on August 12 or November 5 (Table 51). The reverse was the case at site Pr while there was no difference between the population obtained on the three sampling dates at site T.

Table 46. *Sclerotinia minor* sclerotial population at 0 to 5-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1980 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Aug	9T,12PPr	0.5	1.2	0.5	1.9	0.6	0.8	0.2 ab	0.0 a	0.5 a
Sep	8T,9PPr	1.8	1.4	1.2	0.8	0.6	0.9	0.1	0.2	0.0
Oct	28T,31PPr	-	-	-	2.2	1.0	2.2	0.0	0.6	0.1
Nov	5	1.0	2.2	2.0	-	-	-	-	-	-
	Mean	1.1	1.6	1.2	1.6 a	0.7 b	1.3 ab	0.1	0.3	0.2

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

[z]Two applications (0.56 kg a.i./ha/application) made on Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 47. *Sclerotinia minor* sclerotial population at 5 to 10-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1980 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Aug	9T,12PPr	0.6	0.6	0.5	0.4	0.8	1.5	0.2	0.0	0.0
Sep	8T,9PPr	1.2	1.5	1.1	0.5	0.8	0.6	0.1	0.2	0.4
Oct	28T,31PPr	-	-	-	0.8	0.4	0.6	0.0	0.2	0.0
Nov	5	1.0	0.6	1.0	-	-	-	-	-	-
	Mean	1.0	0.9	0.9	0.5	0.6	0.9	0.1	0.2	0.1

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

[z]Two applications (0.56 kg a.i./ha/application) made on Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 48. *Sclerotinia minor* sclerotial population at 10 to 15-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1980 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Aug	9T,12PPr	0.4	0.7	0.7	0.5	0.9	1.5	0.4	0.0	0.1
Sep	8T,9PPr	1.2	0.9	1.0	0.9	0.9	0.4	0.3	0.8	0.1
Oct	28T,31PPr	0.1 b	0.9 a	0.4 ab	-	-	-	0.1	0.2	0.1
Nov	5	-	-	-	0.8	0.4	0.8	-	-	-
	Mean	0.6	0.8	0.7	0.7	0.7	0.9	0.2	0.3	0.1

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

[z]Two applications (0.56 kg a.i./ha/application) made on Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures $\leq$ 15.6 C following week with rainfall.

Table 49. *Sclerotinia minor* sclerotial population at 15 to 20-cm depth in untreated control, calendar (procymidone applied according to calendar schedule), and forecast (procymidone applied according to forecasting system) plots at three sites during the 1980 peanut growing season

Date		Sclerotia[x]/40 g soil								
		Site P			Site Pr			Site T		
Mo	Day(s)[y]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]	Control	Calendar[z]	Forecast[z]
Aug	9T,12PPr	1.5 a	0.8 ab	0.1 b	1.8	0.5	1.0	0.1	0.4	0.2
Sep	8T,9PPr	1.9	1.0	1.2	0.5	1.0	0.5	0.0	0.1	0.0
Oct	28T,31PPr	-	-	-	1.1	1.0	0.4	0.0	0.0	1.0
Nov	5	0.6 a	0.0 b	0.6 a	-	-	-	-	-	-
	Mean	1.3 a	0.6 b	0.7 b	1.1	0.8	0.6	0.0	0.2	0.4

[x]Mean of 8 samples. Sclerotia collected on 425-µm mesh sieves in an elutriator. Means within site on the same date, not followed by a letter or followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

[y]Letters indicate site(s) sampled on that day.

[z]Two applications (0.56 kg a.i./ha/application) made on Jul 28 and Sep 12 for calendar and Aug 20 and Sep 8 for forecast. Forecast application made after occurrence of two days with minimum temperatures ≤ 15.6 C following week with rainfall.

Table 50. *Sclerotinia minor* sclerotial populations at 0-5, 5-10, 10-15, and 15-20 cm depths at each site for the 1980 peanut growing season

Depth (cm)	Sclerotia[x]/40 g soil		
	Site P	Site Pr	Site T
0-5	1.3 a	1.2 a	0.2 a
5-10	0.9 b	0.7 b	0.1 a
10-15	0.7 b	0.8 b	0.2 a
15-20	0.9 b	0.9 ab	0.2 a

[x]Mean of 24 samples. Sclerotia collected on 425-µm mesh sieves. Means within columns followed by the same letter(s) are not significantly different (P = 0.05) according to Duncan's multiple range test.

Table 51. *Sclerotinia minor* sclerotial population at 0 to 20-cm depth at each site for the 1980 peanut growing season

Date		Sclerotia[x]/40 g soil		
Mo	Day	Site P	Site Pr	Site T
Aug	9	-	-	0.2 a
	12	0.7 b	1.0 a*	-
Sep	8	-	-	0.2 a
	9	1.3 a	0.7 b*	-
Oct	28	-	-	0.2 a
	31	-	1.0 a*	-
Nov	5	0.9 b	-	-

[x]Mean of 96 samples. Sclerotia collected on 425 µm mesh sieves in an elutriator. Means within columns followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test. * indicates P = 0.10.

Discussion

Procymidone at 1.12 kg a.i./ha provided nearly complete control of Sclerotinia blight of peanut at the three test sites in 1978. Pod yield and value ($/ha) were greater from plots treated with procymidone but the results were not always significant (P=0.05). DCNA was not as effective in reducing disease severity. DCNA-treated plots did not show significant (P=0.05) increased yield in all cases over that of the untreated control plots.

These results agree with those by Porter (1980). He found four foliar applications (0.56 kg a.i./ha) completely controlled Sclerotinia blight in the field during 1977 and 1978. Phipps and Porter (1979) and Phipps (1980a,1980b) found procymidone superior to several other fungicides tested. Procymidone plots also provided the highest yield while DCNA plots (1 x 0 kg/ ha or 2 x 2.80 kg/ha) were no better than the untreated control plots.

At site B in 1978, only a 5% increase in disease occurred in the control plots during the last four weeks of the season (Table 18). The average percent soil moisture at 0 to 5-cm depth had dropped from a high of 10.4% on August 10 to a low of 1.7% on September 21 (Table 20). When the soil moisture was limiting (wilting occurred), the rate of

increase in DSI in the untreated control plots reached the lowest level.

The percent soil moisture was higher at site P. Canopy height and width were greater at site P as was disease severity. Under these conditions with high disease pressure, the effectiveness of procymidone remained while DCNA was unable to provide disease suppression. Comparing the disease severity of the DCNA and control plots, it's interesting to note that the numerically taller canopy, regardless of treatment, had the numerically greater DSI.

At sites W and P in 1978, the DSI was low until the week of August 25; at this time the second fungicide application was made. The control and DCNA treatments showed increasing disease severity following fungicide application while there was little change in DSI in the procymidone treatment.

The disease forecasting system treatments tested in 1979 and 1980 generally did not suppress disease as much as the calendar treatments. In only one out of six tests was the disease severity lower in the forecast- treated plots. At two sites the longest lesion length was lower in the forecast-treated plots.

The 1980 season was exceptionally hot and dry. Disease development was very low at the T- and P-sites. Despite the

addition of fungicide in the forecast-treated plots, the DSI and longest lesion length were greater or equal to that of the untreated control plots. Neither treatment provided increased yield at the three sites during this season. Soil moisture was limiting at the P- and T-sites. The permanent wilting point (-15 bars) was 5.6% soil moisture on a dry weight basis at the T-site (B. K. Teo, unpub. data). At this site, seven of the nine sampling dates had less than 5.6% moisture at the 0 to 5-cm. During these seven dates the soil moisture ranged from 1.0 to 3.4%. At -15 bars Ym, soil RH is 98.6%. Since soil moisture was considerably lower than 5.6% much of the time and considering that the moisture content in the top cm of soil would be even less, sclerotia in this environment would be exposed to RHs less than 95%. Myceliogenic sclerotial germination under these conditions would not occur (Chapter 2). Primary infections therefore would be prevented. The low number of infection foci at site T (only 12 of 480 61-cm row sections contained infection foci) and the low disease severity (11 of the 12 row sections with disease had a DSI of only 1) reflect the importance of the low soil moisture.

The permanent wilting point was 2.6% at the P-site in soil adjacent to the test plots (B. K. Teo, unpub. data). Soil moistute at the 0 to 5-cm depth on September 3 was

2.6%. Five other dates during the season had soil moisture levels near 3.5% or approximately -6.5 bars. Plants were wilted for 4 weeks at this site(beginning August 12) suggesting that within the test site variation in soil and soil moisture tension occurred. The wilting plants suggest that in the upper cm of soil the RH was less than 99%, no doubt less than 95%. The low disease development (Figs. 26-27) during the reduced soil moisture period (August 12 - September 3) shows that S. minor was not initiating new infections nor active in the colonized tissue. Wilting caused by the low soil moisture opened the canopy and thus intensified the dry conditions. This no doubt aided in the suppression of disease development. At the Pr-site, -15 bars corresponds to 1.5% soil moisture (B. K. Teo, unpub. data). Soil moisture at the Pr-site did not get that low. The lowest level reached was 2.3%. At no time did the plants wilt at this site. Disease development was also greater here than at the other sites.

In 1979, sclerotial recovery was lower at the P-site in the forecast treatments than in the calendar treatment. This was not significantly different from the control. At the Pr site, both fungicide treatments had lower sclerotial populations than the untreated control. Recovery of sclerotia from the plots in 1980 was not affected by the

plot treatments. At sites T and P this may have been due to the low disease level. Analyses of variance in sclerotial recovery for different sampling dates did not show a consistant trend in population change at the sites in either 1979 or 1980.

During 1979 generally more sclerotia were present at the 15 to 20-cm depth while in 1980 usually there were more in the 0 to 5-cm depth. At site Pr, where disease development was high, one would expect more sclerotia at the end of the season at the 0 to 5-cm depth in both years. Possibly in 1980, due to the drought, fewer sclerotia from the previous year degenerated. Porter and Steele (1981) found more sclerotia in the surface layer of soil than at lower depths. Following plowing, the sclerotia from the surface were turned under and recovery was greater at 20 cm.

Although in this study the disease forecasting system did not prove superior to the calendar treatment scheule, disease forecasting in other studies has shown potential as a valuable tool for peanut crop production (Dow et al., 1981) Forecasting systems can be very cost effective since they allow accurate timing of pesticide applicatons corresponding to periods conducive to disease development. Research on a peanut leafspot forecasting system in 1978 and 1979 in the Virginia peanut growing region showed two less

fungicide treatments were required in the forecast-treated plots compared to plots sprayed on a 14-day interval (Powell et al., 1980). Despite fewer fungicide applications, the yield and yield value of the forecast-treated plots was similar to that of the 14-day-interval plots. The overall effect was a higher return from the forecast-treated plots.

It appears that more research is needed to develop an effective Sclerotinia blignt forecasting system. The lack of readily available resistant varieties (Porter et al., 1975) increases the need for an effective control program.

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RELATIONSHIP OF ENVIRONMENTAL FACTORS TO DEVELOPMENT OF *SCLEROTINIA MINOR* AND SCLEROTINIA BLIGHT OF PEANUT

by

Roberta Louise Dow

(ABSTRACT)

Sclerotinia minor Jagger myceliogenic sclerotial germination, growth, infection, and colonization of peanut (*Arachis hypogaea* L.) tissue was optimum at 20-25 C. Ninty-five to 100% relative humidity (RH) for more than 12 hours was necessary for germination. There was no difference in infection and colonization of main stem versus lateral branch tissue but younger plants were more susceptible than older plants. Correlation and regression analyses were conducted on data from field experiments with artificially and naturally infected plants. Important independent variables in regression models for lesion length (LL), weekly change in lesion length, or disease severity index (DSI) were: number of days with temperature ≤16.7 C (DA17), the interaction of DA17 with precipitation (DA17*P), RH, maximum temperature (TMAX), and plant height for the week prior to disease measurement, and TMAX, P, and soil moisture (SM) at 0 to 5-cm for the period two weeks prior to disease measurement. Infection and disease development were studied in field plots with modified canopy