LEAFSPOT OCCURRENCE ON THREE SPANISH AND FLORUNNER CULTIVARS OF PEANUTS AND YIELD RESPONSE TO DISEASE CONTROL

By

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CHAPTER I

INTRODUCTION

The peanut (Arachis hypogaea L.) is one of the important crops grown for food in the tropical, subtropical, and warm temperate zones of the world (31). Peanut production is limited by numerous plant diseases. The most prevalent of these diseases are the early leafspot and late leafspot caused by Cercospora arachidicola Hori (Mycosphaerella arachidicola Jenkins) and Cercosporidium personatum (Berk & Curt) Deighton (Mycosphaerella berkeleyii Jenkins), respectively. Early and late leafspots are the most important disease problems of peanuts in the world. Worldwide economic losses are estimated at 15-50 percent of total yield annually in many areas (11, 22, 43). In the United States, peanuts are grown in the southern part of the country. Among the foliar diseases, Cercospora leafspot, commonly called peanut leafspot, is regarded as one of the most important peanut diseases in Oklahoma. Cercospora leafspot, if not properly controlled, can cause losses of 20 to 30 percent or more (18, 39, 41, 42). The peanuts are considered one of Oklahoma's important crops. According to 1981 statistics, Oklahoma farmers produced about 85,848 tons of peanuts valued at $42,583,500. With no diseases the estimated

production would have been 110,686 tons at a value of $54,903,945. Losses due to foliar diseases mainly caused by Cercospora and Cercosporidium in Oklahoma during 1981 were estimated at 4.7 percent, costing the growers approximately $2,580,485 (39).

Peanut leafspot is caused by two fungi. Early leafspot caused by Cercospora arachidicola Hori develops during the early growing season and late leafspot caused by Cercosporidium personatum (Berk. & Curt.) Deighton usually develops in the later part of the growing season (20, 44). The pathogens can attack the leaves, stems, pegs and pods although losses from the diseases are mainly due to extensive defoliation during the growing season causing reduction in both yield and quality of peanuts (40). Lesions caused by C. arachidicola are brown or dark brown surrounded by a yellow halo of varying widths while lesions produced by the C. personatum are darker in color than those of C. arachidicola (20, 45). Jenkins (23) reported that C. personatum was the more destructive of the two fungi, particularly late in the season and on late maturity varieties.

For control of the two leafspot causing fungi, resistant varieties would be the most economical and effective method. However, at the present time resistant cultivars with good agronomic characters are not available (4, 22, 38). Some cultivars are tolerant to early leafspot but not to the late leafspot disease (6, 17, 26). Foliar diseases are now controlled with fungicides properly applied as sprays. The

fungicides must be applied before the disease becomes established because most fungicides are protectants. In the early years, sulfur dust alone or sulfur in combination with copper were the most commonly used fungicides to control leafspot (32). Later, certain new organic fungicides, carbamates, and systemic benzimidazole compounds were used in control programs in many peanut production areas (1, 14, 36). Recently, because of the extensive use of the systemic fungicide benomyl, resistant or tolerant strains of Cercospora and Cercosporidium developed (2, 7, 12, 28, 37). Other recommendations for control of these diseases are the reduction of primary inoculum for early season infection by crop rotation and removal or destruction of peanut debris and volunteer plants (16, 25, 28, 35). To develop an effective and economical disease control program, it is necessary to study the response of peanut cultivars commonly used by Oklahoma growers under a closely monitored program. There was also a need to study the population of the two foliar pathogens during the growing season as they relate to disease incidence under Oklahoma conditions.

The objectives of this study were: (1) To monitor certain peanut cultivars for the occurrence of Cercospora arachidicola and Cercosporidium personatum under a selected fungicide control program; (2) To record seasonal population levels of the two fungal species and determine their relation to the environmental factors and influence on plant response.

CHAPTER II

LITERATURE REVIEW

In 1933, Woodroof (44) reported that Berkeley in 1875 was first to recognize the leafspot disease on peanuts. It was identified from material collected by Ravenel in South Carolina in 1855. Woodroof named the causal fungus Cladosporium personatum. Ten years later Ellis and Everhart renamed the fungus Cercospora personata. In 1917, the related species Cercospora arachidicola was described by Hori from Japan. In 1967, Deighton (8) proposed the name Cercosporidium personatum (Berk. & Curt.) Deighton for the fungus Cercospora personata. The perfect stages of C. arachidicola and C. personata are Mycosphaerella arachidicola and Mycosphaerella berkeleyii, respectively, and these perfect stages may be involved in the initial dissemination of the fungus (23). Nuesry (33) reported the perfect stage of the two fungi had not been found in Oklahoma and that these fungi survived the winter in the imperfect stage in peanut debris. Cercosporidium personatum has been found to be the major species that causes loss of yield in Africa (18) and India (22), yet C. arachidicola is more commonly found in other peanut producing areas of the world. In the United States C. arachidicola is found early in the season (22, 44)

while C. personatum, the cause of late leafspot, is found predominately in the latter part of the growing season (30). In 1979, Jackson (21) reported late leafspot was the predominate leafspot of peanuts in Florida and had been increasing in spite of fungicide treatments. C. personatum appeared to be more difficult to supress with fungicides recommended for peanuts than C. arachidicola and was the main cause of defoliation during the latter part of the season. In addition to being less affected by fungicides, C. personatum apparently has other factors giving it a competitive advantage over C. arachidicola during the late season (3).

During the 1980 season in Oklahoma, late leafspot disease was found the first week of August in Hughes County. Should the prevalence of C. personatum continue to develop this early in the season, perhaps the names early and late leafspots may be inappropriate (39).

The two leafspot fungi have frequently caused premature harvesting, reducing the yield of the peanuts and, when these fungi are adequately controlled, peanut harvest can be delayed several weeks promoting increased production. Heavy infection reduces the number of nuts produced; however, it increases the number of mature nuts harvested (15, 46). Studies show greater yield reduction occurred with severe early infection. When the disease was controlled during the early stages of plant growth and control practices discontinued at least 45 days before harvesting allowing the leafspot fungi to defoliate the plants, an average yield of

quality peanuts was produced (41). In terms of control, crop rotation can reduce the amount of initial inoculum and can reduce the early-season infection by 88-93 percent. This amount of disease reduction could allow growers to delay their first fungicide application by several weeks (28).

Fungicide control programs are considered to be the most effective method to prevent yield loss (5). During the early years sulfur and sulfur-copper dusts and, later, organic fungicides were used to reduce the losses from leafspot diseases (15, 32). In recent years, extensive use of a systemic fungicide caused the development of fungal resistance. In 1973, workers in Alabama and Georgia reported finding several isolates of the fungus resistant to the systemic fungicide benomyl. This was followed with reports of resistance to benomyl and other related compounds from other peanut producing regions (2, 7, 9, 29, 37). The current most effective fungicide used for control of these leafspots is chlorothalonil, which has provided effective control of both fungal species (34). In addition, the Florunner peanut cultivar, reported to be more resistant than any other peanut cultivars, is now available to growers (34).

Temperature and relative humidity have the greatest effect on sporulation and conidial germination. Gobina (13) reported that C. arachidicola sporulation and germination were highest at 35 C after being incubated for 12 hours at

100 percent relative humidity. The conidia were moved from plant to plant mainly by air currents and secondary infection increased when the relative humidity was 95 percent or greater for 10 hours or longer, with temperatures generally above 30 C (3, 24, 25). A disease forecasting system for peanuts has been developed using these factors (10, 25).

CHAPTER III

MATERIALS AND METHODS

Three Spanish peanut cultivars (Pronto, Comet, and Tamnut) and Florunner are commonly grown in Oklahoma. The characteristics of these peanut cultivars are as follows:

Spanish type:

1. Pronto--The cultivar was developed in Georgia and Oklahoma from a cross between two Spanish cultivars, Chico and Comet, and released to growers in 1980. Pronto is an early maturing cultivar requiring about 113 days from planting to harvest and is superior to Tamnut and Comet in yield. Pronto carries no known genetic resistance to the common typical diseases of peanuts.
2. Tamnut 74--The cultivar was developed in Texas and released in 1974. The maturity ranges between 115-135 days.
3. Comet--The cultivar was developed in Oklahoma and derived from a single plant selected from the Starr cultivar. The Comet cultivar will mature between 140-145 days.

Runner type:

Florunner--The cultivar was derived from a cross

between the cultivars Early Runner and Florispan. The Florunner produces greater yields, and is about the same in disease resistance as the Spanish cultivars at similar stages of maturity. The growth habit of Florunner is prostrate with a sequential branching pattern. While all cultivars are susceptible to both C. arachidicola and C. personatum under Oklahoma conditions, each cultivar seems to have a different degree of susceptibility to these two fungal pathogens.

The study was made on the Wilson farm in a river bottom area near Wetumka, in Hughes County, Oklahoma. This river bottom area had been in peanuts for several years and had a history of heavy peanut leafspot infection. Severe infection of both C. arachidicola and C. personatum caused heavy losses in 1979. The plots were established in a 10.12 hectare field surrounded by tall trees and near the North Canadian River.

The plots consisted of eight 0.91 meter spaced rows, 18 meters long, replicated five times in a randomized complete block design. Four rows were sprayed with a fungicide and four rows were not sprayed. The plots were planted on May 28 and harvested October 29, 1981. Four rows of each plot were sprayed with Bravo 500 (40.4 percent chlorothalonil) produced by Diamond Shamrock Corporation, Cleveland, Ohio. The rate of fungicide for each application was 1169 g a.i/ha, applied 8 times on 7-14 day schedule beginning July 15, 1981. Two non-sprayed spreader rows were maintained between each eight row plot. These spreader rows were used

as drive rows and as an additional source of inoculum for increased disease pressure.

The soil was a Brazo loamy sand and was fertilized according to Oklahoma State University recommendations. Two herbicides were used:

1. Trifluralin (Treflan), was applied pre-plant and was incorporated at 5.67 kg/ha to control grasses and annual weeds.
2. Metolachlor (Dual) at 2.35 liters/ha was applied as a post emergence weed control (about 20 days after planting).

Control of the soil-borne diseases caused by Fusarium sp. Rhizoctonia solani, Pythium sp., and Sclerotium rolfsii was accomplished by applying PCNB + ethazol (Terrachlor Super X 10 -2.5 G.) at a rate of 22.67 kg/ha at planting. An additional application of 102.05 kg/ha was applied over the row on August 21, 1981.

Soil samples were taken from the field prior to planting and from the plots during mid-growing season on August 3, to determine the presence of plant parasitic nematodes.

Fungicides were applied in 275.5 liters of water per hectare (water pH 7.0) to the four row-plots with a side drop boom (tractor mounted) sprayer using 3 Blumhart CI 100 cone jet nozzles per row at 4.22 kg/cm^2. The fungicide applications were made on July 22 and 30, August 12 and 31, September 10 and 24, and October 2 and 19.

After peanuts from each plot were dug, they were

threshed, sacked, and weighed. One gallon (3.8 liters) samples from each plot were extracted, all replications were bulked and the grade determined according to Oklahoma Federal-State Inspection Services.

Disease ratings were made on October 19, 1981, based on a scale where 0 equalled no disease and 9 equalled 90 percent or more of the peanut leaves infected with Cercospora arachidicola and or Cercosporidium personatum. Defoliation was based on a scale where 0 equalled no defoliation and 9 equalled 90 percent or more defoliation.

During the study two hygrothermographs were maintained in a standard U.S. N.O.A.A. instrument shelter, placed 0.6 meter above ground level in the peanut field. Data were collected on a daily basis. Temperature and relative humidity were used to determine the correlation between spore production and infection. Hours of continuous relative humidity above 90 percent at a temperature of 30 C or above were recorded.

The Kramer-Collins 7-Day Drum Spore Sampler, was used to sample the air at the rate of 20 liters per minute once every hour (Figure 1)(27). The trapping surface on the spore drum consisted of a 15 mm wide cellophane adhesive tape coated with a thin layer film of vaseline on the exposed surface. The trap was placed in the field with the intake orifice 35 cm above the soil surface. After seven days, the exposed tape was replaced. The exposed tape was cut into seven 60 mm pieces, so that each piece represented

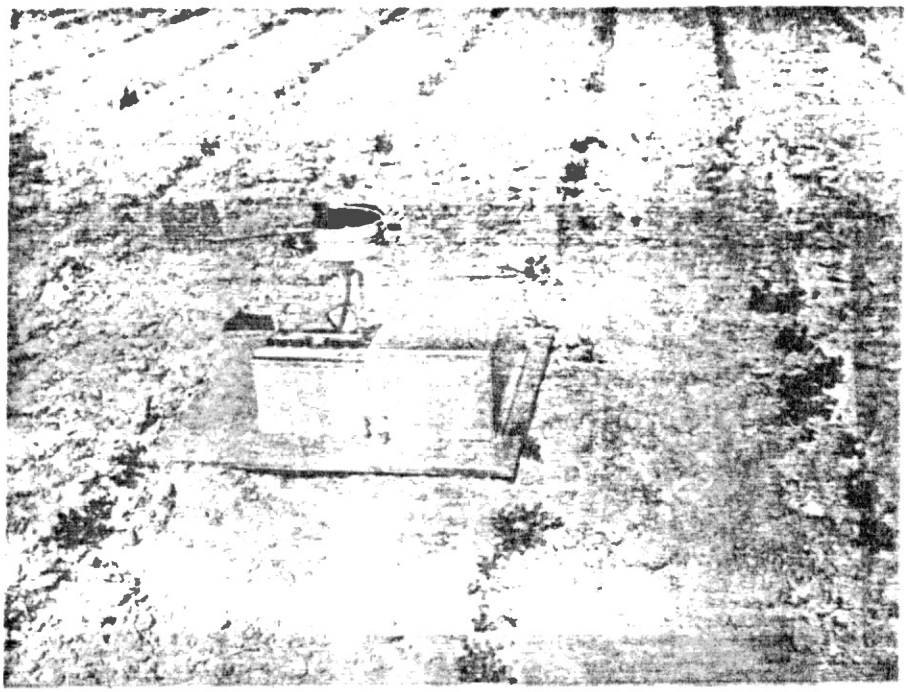

Figure 1. Kramer-Collins 7-Day Spore Sampler used to collect spores in the field. Intake orifice was 35 cm above ground level.

a 24-hour period of exposure, and transferred to glass microscope slides for examination. Each slide was divided further into 15 millimeter portions so that each portion represented an interval of six hours. Approximately four drops of mounting medium (Lactophenol + methyl blue) and cover slips were placed on the exposed area of the prepared tape which was then checked for Cercospora arachidicola and Cercosporidium personatum spores using a compound microscope at 200 X magnification (Figures 2 and 3).

The air was sampled for 18 weeks, starting June 24, and continued until October 25, 1981. As soon as the peanut stands were established, plots were visited each week and monitored for diseases present.

The following data were collected:

1. Visual identification was made of foliar disease development.
2. Percent infection was obtained by counting the number of infected leaves among a randomly collected 30 leaf sample from five locations, 5 meters apart within each plot. Leaves were collected equally, two from top, two from middle, and two from lower part of plant.
3. Number of spores trapped.
4. Relative humidity and temperature.

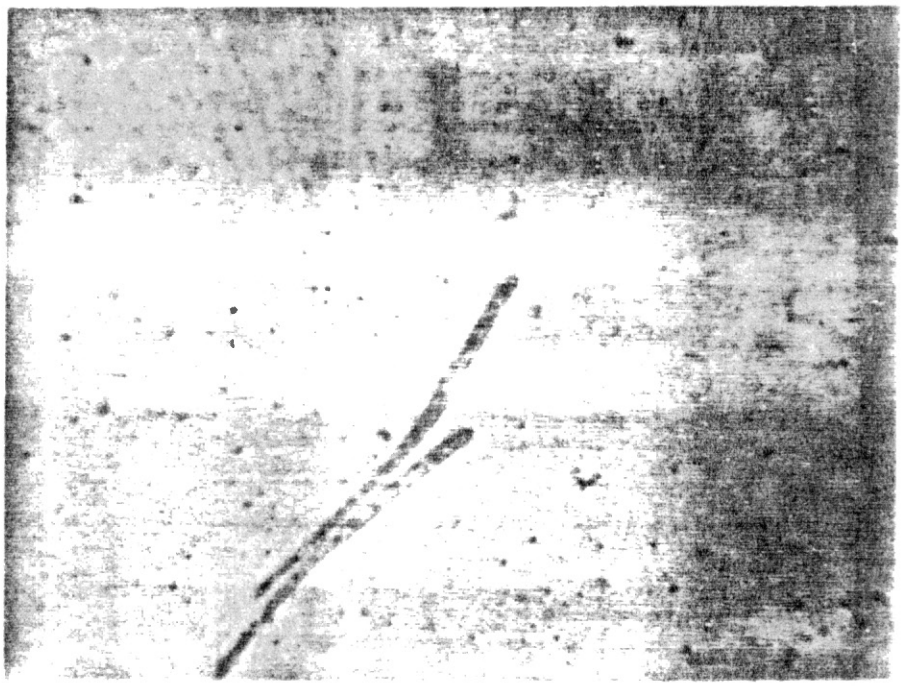

Figure 2. *Cercospora arachidicola* spores trapped on vaseline coated adhesive tape from Kramer-Collins 7-Day Spore Sampler. 200X

Figure 3. *Cercosporidium personatum* spore trapped on vaseline coated adhesive tape from Kramer-Collins 7-Day Spore Sampler.
200X

CHAPTER IV

RESULTS

The first leafspot infection was found on July 15, on the cultivar Comet and identified as Cercospora arachidicola. C. arachidicola symptoms appeared on Comet about seven days before the disease was found on the other Spanish cultivars. Infections of C. arachidicola were not found on Florunner cultivar until August 19, 35 days after the first lesions appeared on Comet and the first Cercospora personatum infections were found on every cultivar. Early leafspot caused by C. arachidicola was found predominantly during the early period of the growing season, and continued to increase until harvest, in October. During the latter part of the growing season the early leafspot symptoms were found primarily on the young leaves while late leafspot infections were found for the most part on older leaves. After first infection appeared both of the diseases became more severe in number and size of spots as the season progressed. Greater severity occurred in plots planted to Spanish peanuts compared to plots planted to Florunner regardless of whether the plots were sprayed or not. The level of leafspot severity varied among the cultivars and between the sprayed and non-sprayed plots (Tables I and II). However,

TABLE I

PERCENT OF LEAVES INFECTED BY C. ARACHIDICOLA OR C. PERSONATUM TAKEN AT WEEKLY INTERVALS DURING THE 1981 SEASON AT WILSON FARM, WETUMKA, OKLAHOMA.[a]

Date		Florunner		Pronto		Tamnut		Comet	
		S[b]	NS	S	NS	S	NS	S	NS
July	15	0	0	0	0	0	0	3	0
	22	0	0	3	5	3	3	7	8
	29	0	0	7	11	4	12	14	20
Aug.	5	0	0	5	18	7	19	12	21
	12	0	0	13	29	6	16	13	34
	19	3	3	12	47	14	35	10	49
	26	6	9	17	69	13	49	16	69
Sept.	2	7	3	20	78	13	69	14	76
	9	4	24	14	83	15	78	21	82
	16	12	33	14	90	16	79	29	84
	23	10	74	20	87	14	82	25	90
	30	6	65	16	83	19	38	30	84
Oct.	7	4	81	20	95	21	92	27	84
	14	8	85	21	92	16	87	24	93
	19	7	80	18	90	18	90	29	90

[a]Percent infection was obtained by counting the number of infected leaves among a randomly collected 30 leaf sample from five locations, five meters apart within each plot. Leaves were collected equally from top, middle and lower parts of plants.

[b]S = Sprayed; NS = Not sprayed.

TABLE II

PERCENT DEFOLIATION CAUSED BY C. ARACHIDICOLA AND C. PERSONATUM INFECTION TAKEN AT WEEKLY INTERVALS DURING THE 1981 SEASON AT WILSON FARM, WETUMKA, OKLAHOMA.[a]

Date		Florunner		Pronto		Tamnut		Comet	
		S[b]	NS	S	NS	S	NS	S	NS
July	15	0	0	0	0	0	0	0	0
	22	0	0	0	0	0	0	0	0
	29	0	0	0	0	0	0	0	0
Aug.	5	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	3	0	5
	19	0	0	0	5	3	5	5	12
	26	0	0	7	6	5	9	8	20
Sept.	2	0	2	10	17	7	17	15	28
	9	0	5	15	25	18	24	22	34
	16	3	11	18	27	28	36	27	48
	23	4	18	22	34	36	44	32	57
	30	4	24	35	58	49	72	46	74
Oct.	7	5	25	49	75	57	80	55	88
	14	5	28	52	78	60	85	58	90
	19	5	30	55	80	65	85	60	90

[a]Percent defoliation was obtained on the basis of the number of leaves remaining on plants in plots.

[b]S = Sprayed; NS = Not sprayed.

the lesions caused by C. arachidicola on Florunner were fewer and smaller compared to those found on the Spanish cultivars. The number and size of spots developed more slowly on Florunner than on the Spanish cultivars until near the end of the season (Table III). During the period October 7 to 19, the percent infected leaves on Florunner increased rapidly to approximately 82 percent, with Spanish cultivars averaging 89 to 92 percent infection at the same period.

Among the Spanish cultivars, Comet seemed to be the most susceptible to C. arachidicola followed by Tamnut and Pronto, respectively; however, in the sprayed plots Pronto showed a greater yield response than either of the other Spanish cultivars or Florunner. This susceptibility rating was based on the percent defoliation during the last three weeks prior to harvest of each cultivar (Table II). Comet had an average of 89 percent defoliation compared to Tamnut with 83 percent, Pronto 78 percent, and Florunner 28 percent. Although all cultivars were infected with C. personatum at about the same time. The disease developed more slowly on the cultivar Florunner and the severity of the disease did not develop sufficiently to show the difference between sprayed and non-sprayed plots until about September 9.

Cercospora personatum infection was first observed August 19 on the lower leaves of Pronto as small black lesions among the C. arachidicola infections. The number and size of

TABLE III

NUMBERS OF EARLY AND LATE LEAFSPOT LESIONS RECORDED AT WEEKLY INTERVALS DURING THE 1981 SEASON AT WILSON FARM, WETUMKA, OKLAHOMA.[a]

Date		Florunner				Pronto				Tamnut				Comet			
		ELS[b]		LLS		ELS		LLS		ELS		LLS		ELS		LLS	
		S[c]	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
July	15	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
	22	0	0	0	0	2	1	0	0	3	0	0	0	16	18	0	0
	29	0	0	0	0	4	8	0	0	2	5	0	0	21	39	0	0
Aug.	5	0	0	0	0	4	11	0	0	8	11	0	0	31	48	0	0
	12	0	0	0	0	10	16	0	0	14	21	0	0	41	67	0	0
	19	2	1	2	1	12	21	3	22	17	31	3	4	38	89	11	9
	26	6	15	5	6	24	38	18	37	28	40	29	42	49	84	36	43
Sept.	2	11	19	9	7	36	41	36	41	39	54	35	64	75	98	48	67
	9	14	27	11	4	34	43	43	38	44	74	48	71	71	96	56	74
	16	12	29	15	22	41	58	44	59	54	68	63	84	69	104	65	72
	23	24	35	24	31	37	57	46	74	51	64	71	82	87	121	63	89
	30	27	59	28	26	42	63	78	85	28	54	81	98	82	94	77	114
Oct.	7	43	77	18	33	36	67	75	98	21	37	74	112	71	79	84	142
	14	61	86	12	28	26	59	82	87	29	36	67	98	48	81	79	128
	19	65	89	10	35	28	64	54	93	32	47	64	102	56	85	87	135

[a]Number of lesions counted from 30 leaves randomly collected from each sprayed and non-sprayed plot.

[b]ELS = Early leafspot; LLS = Late leafspot.

[c]S = Sprayed; NS = Not sprayed.

C. personatum lesions increased each week as the season progressed especially among leaves found on the lower part of the plant. Although C. personatum infection was more prevalent on the more mature peanut leaves, C. arachidicola lesions were more prevalent on the younger leaves. About 35 percent fewer C. personatum lesions than C. arachidicola lesions were found on the sprayed and non-sprayed plots of Florunner. However, the opposite was found to occur on Comet, Tamnut and Pronto, where the sprayed and non-sprayed plots were 60 to 80 percent infected with C. personatum. The severe infection of C. personatum on Spanish cultivars caused heavy defoliation especially in the non-sprayed plots, while the lower severity and later time of infection caused less defoliation and allowed the Florunner plants to remain much healthier. Significantly less infection and defoliation occurred in sprayed and non-sprayed Florunner plots, when compared to Pronto, Tamnut, and Comet. There was no significant difference in the percent infection found among the non-sprayed plots of Pronto, Tamnut, and Comet, yet there was a significant difference in amount of infection on the sprayed Comet plots when compared to the sprayed plots of Pronto and Tamnut. There was significantly less defoliation in the sprayed plots of Pronto when compared to Tamnut, however, there was no significant difference between sprayed plots when Comet was compared to Tamnut and Pronto. There were no significant differences in amounts of defoliation among non-sprayed plots when Pronto and Comet were compared to Tamnut.

There was significantly more defoliation in non-sprayed plots of Comet compared to Pronto. There was significantly more infection and defoliation in non-sprayed plots compared to sprayed plots among all cultivars. Table IV gives the percent infection and defoliation rating for the season.

A greater number of C. arachidicola lesions were found on non-sprayed and sprayed plots of Florunner than C. personatum lesions. The data show more C. personatum than C. arachidicola lesions on both non-sprayed and sprayed plots of Pronto, Tamnut, and Comet. These data are presented in Figures 4, 5, 6, and 7.

The spore data collected from the Kramer-Collins spore sampler are presented in Appendix A. Spores of C. arachidicola were first caught at 22.9 spores per cubic meter of air per day on July 1, 1981. C. arachidicola spores were caught throughout the period of July 1 through October 22.

The number of C. arachidicola spores collected increased to the highest number during the 12th week or the middle of September (Figure 8). On September 9, C. arachidicola spores were trapped at 195 spores per cubic meter per day. After this period, the number of C. arachidicola spores caught declined. Spores of C. personatum (Figure 8) were first collected on August 5, or 46 days after C. arachidicola spores were collected with the number of C. personatum spores increasing to the highest level during the 12th week or September 10. Greater numbers of C. arachidicola spores were collected during July and late August and early

TABLE IV

OCCURRENCE OF *CERCOSPORA ARACHIDICOLA* AND *CERCOSPORIDIUM PERSONATUM* ON THREE SPANISH CULTIVARS AND FLORUNNER PEANUTS[a]

Cultivar	% Infection[b]		% Defoliation[c]	
	Sprayed	Non-sprayed	Sprayed	Non-sprayed
Florunner	7	80	5	30
Pronto	18	90	55	80
Tamnut	18	90	65	85
Comet	29	90	60	90
LSD 0.05 =	6.17		7.89	

[a]Plots received eight applications of chlorothalonil at 1169 g a.i/ha applied by tractor mounted sprayer at 4.22 kg/cm^2 at a rate of 275.5 liters/hectare.

[b]Percent infection determined by number of infected leaves on October 19, 145 days after planting.

[c]Percent defoliation determined by number of leaves remaining on plants October 19, 145 days after planting.

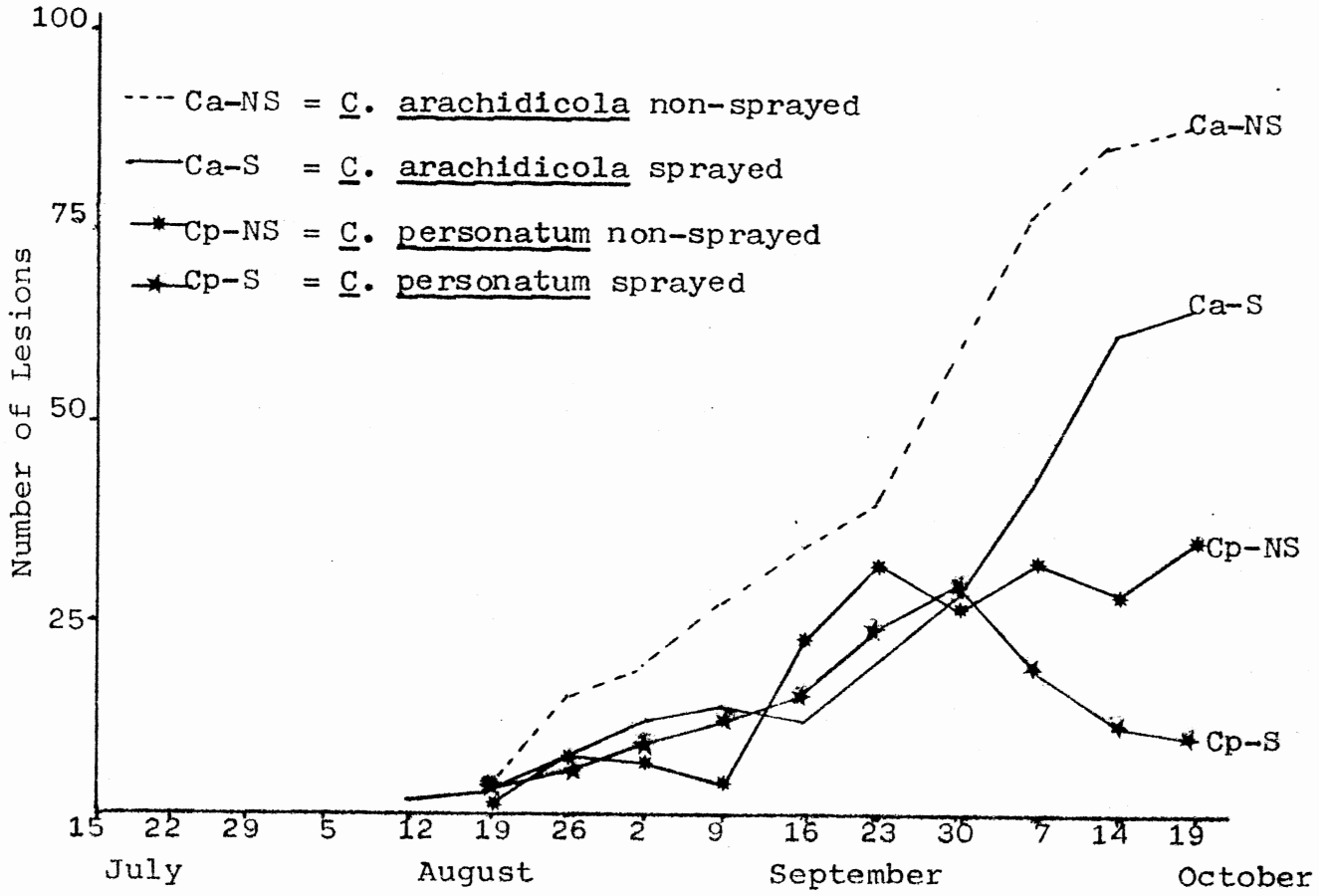

Figure 4. Number of lesions caused by C. arachidicola and C. personatum on Florunner cultivar counted each week from July 15 - October 19, 1981.

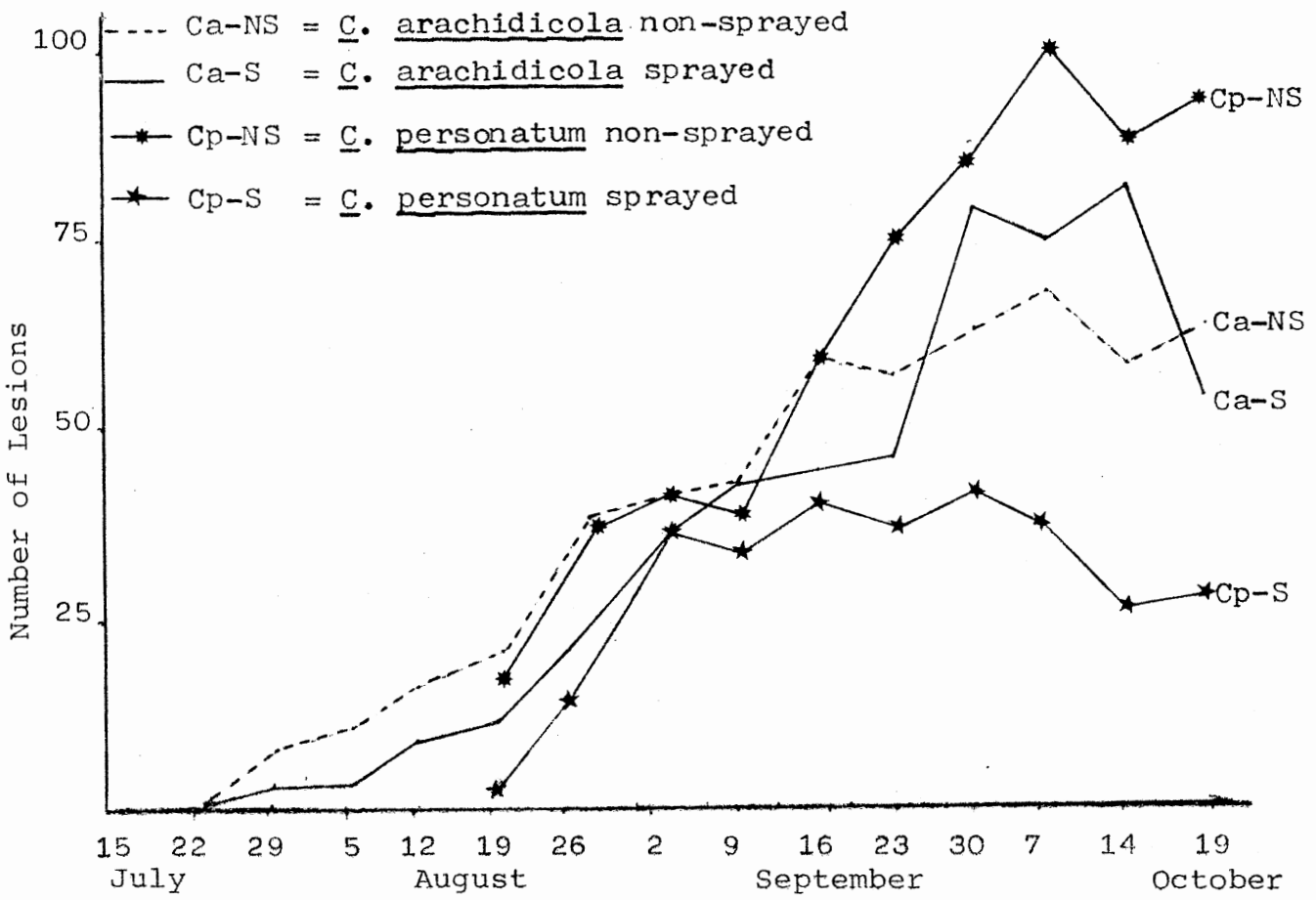

Figure 5. Number of lesions caused by C. arachidicola and C. personatum on Pronto cultivar counted each week from July 15 - October 19, 1981.

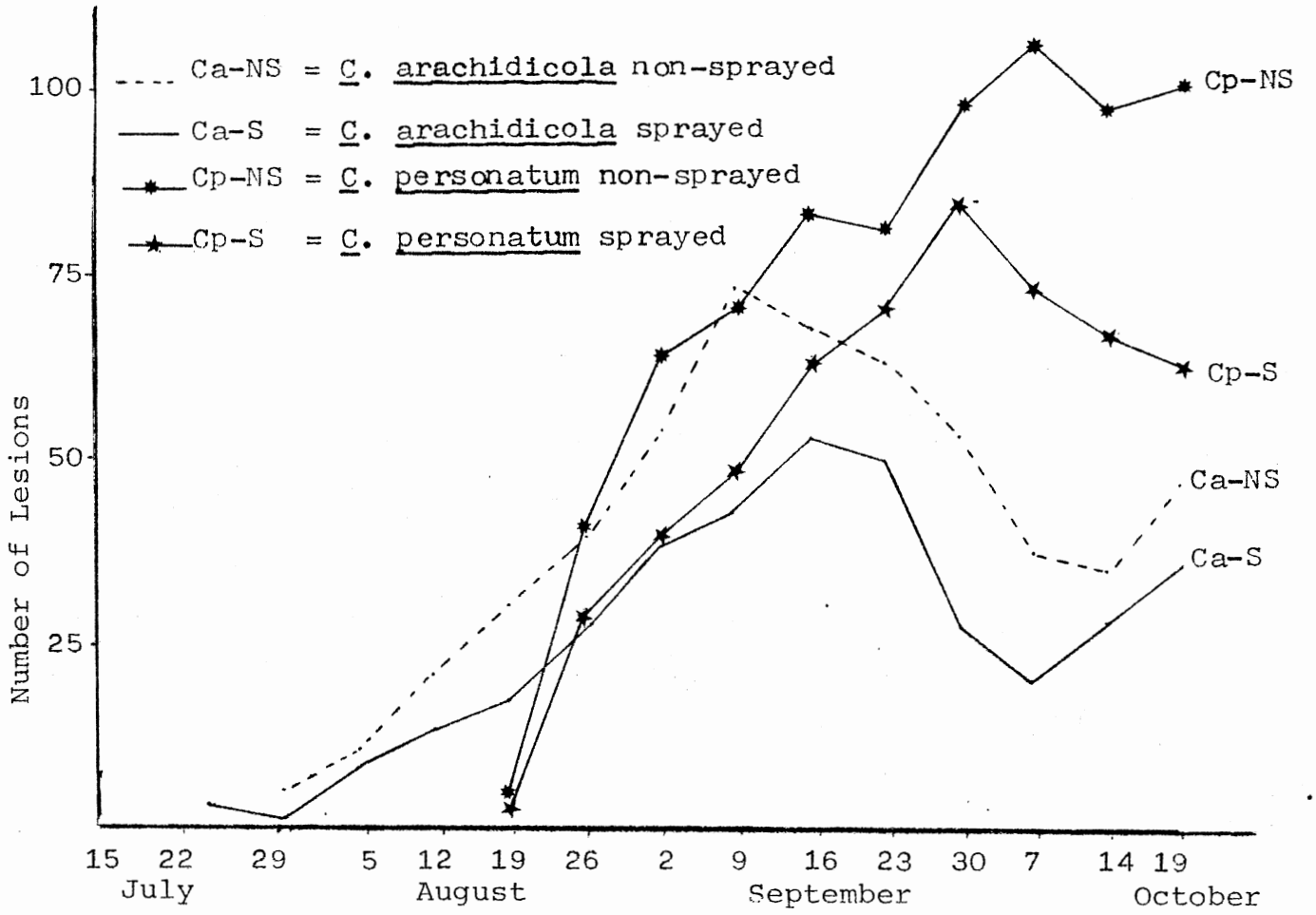

Figure 6. Number of lesions caused by C. arachidicola and C. personatum on Tamnut cultivar counted each week from July 15 - October 19, 1981.

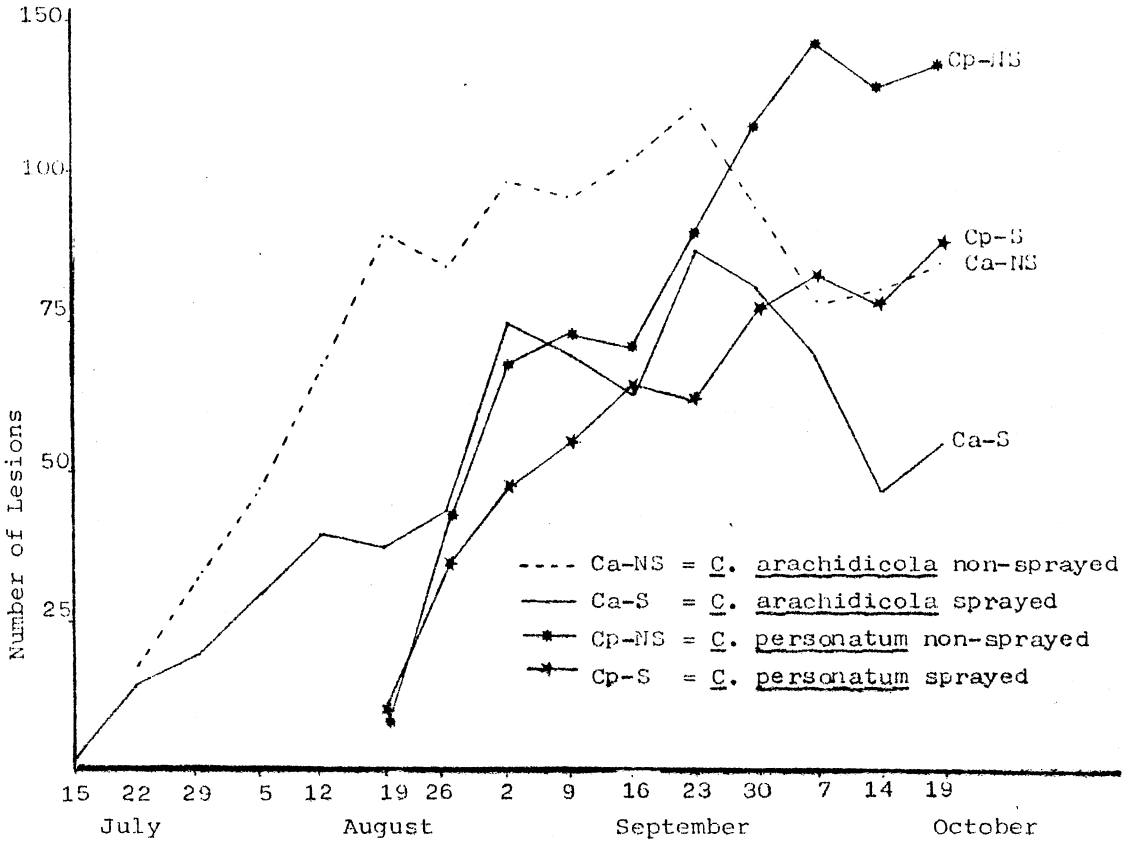

Figure 7. Number of lesions caused by C. arachidicola and C. personatum on Comet cultivar counted each week from July 15 - October 19, 1981.

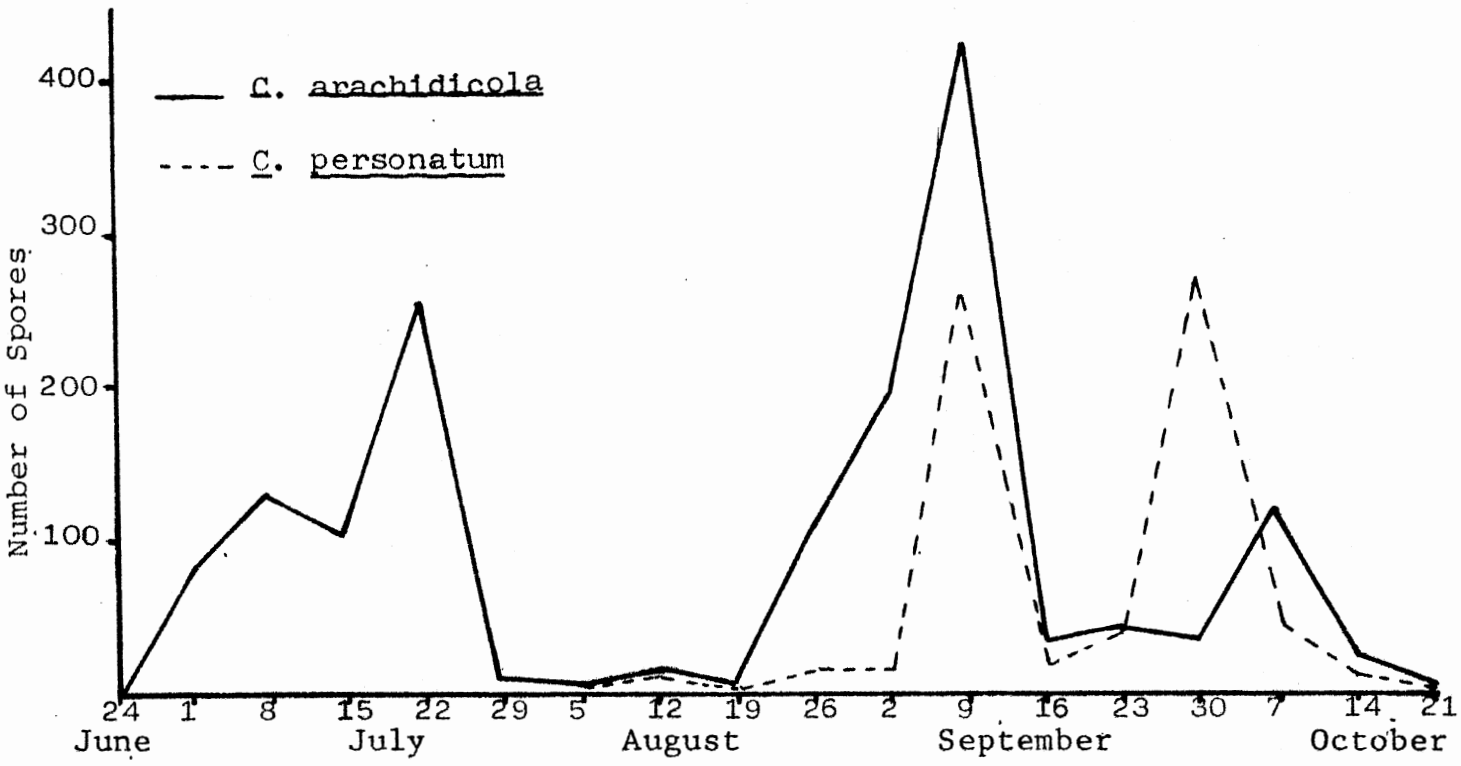

Figure 8. Weekly counts of Cercospora arachidicola and Cercosporidium personatum spores trapped in peanut field at Wilson Farm, Wetumka, Oklahoma from June 24 - October 21, 1981.

September while C. personatum spore numbers peaked on September 9 and 30.

Temperature and Relative Humidity

The temperature and relative humidity (Figure 9) were highest during the month of July and August with a high temperature of over 36 C during July 15-25 and on August 6 and 15. Both temperature and humidity declined during September and October, dropping to below freezing on October 22, 1981 (detail records on daily relative humidity and temperature are in Appendix B).

The highest relative humidity of 97 percent was recorded on June 22 and the lowest relative humidity of 22 percent occurred during the period of October 2. On October 15 the highest relative humidity of 93.5 and low of 92.5 were recorded (Figure 9). The daily high relative humidity remained rather constant at approximately 85-97 percent during the season, however, there was great fluctuation among the daily low relative humidities ranging from 22 to 92 percent.

The period of time or number of hours during each day during which relative humidity remained above 90 percent was determined because this factor has a great influence on the infection process of both C. arachidicola and C. personatum.

Temperatures for June 18 to October 25 remained for the most part in the range low enough for spore germination and infection. Only during the period of July 15 through 25 when temperatures were above 38 C were they high enough to

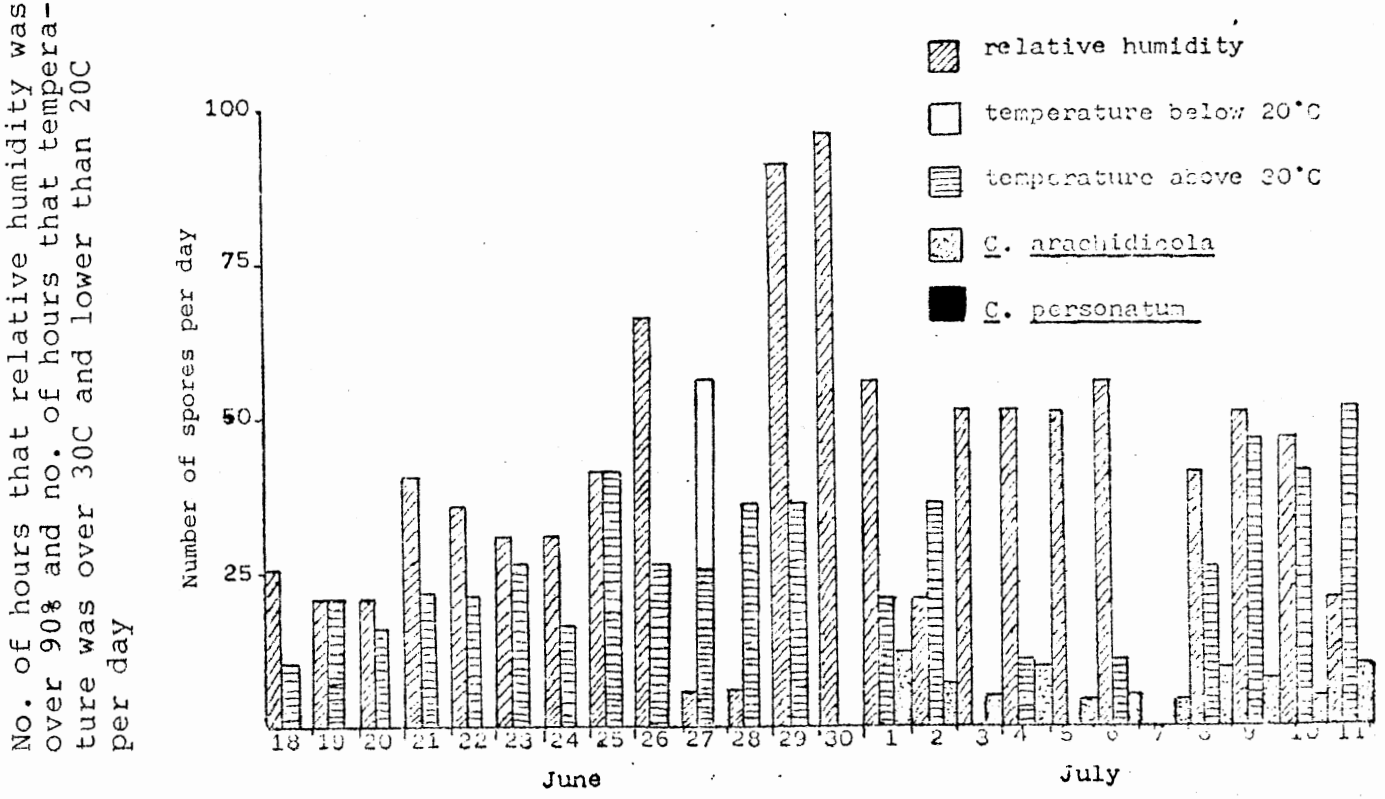

Figure 9. Daily record of number of hours per day relative humidity was over 90% and number of hour temperature was over 30C and below 20C and number of C. arachidicola and C. personatum spores trapped during June 18 - October 24, 1981.

No. of hours that relative humidity was over 90% and no. of hours that temperature was over 30C and lower than 20C per day

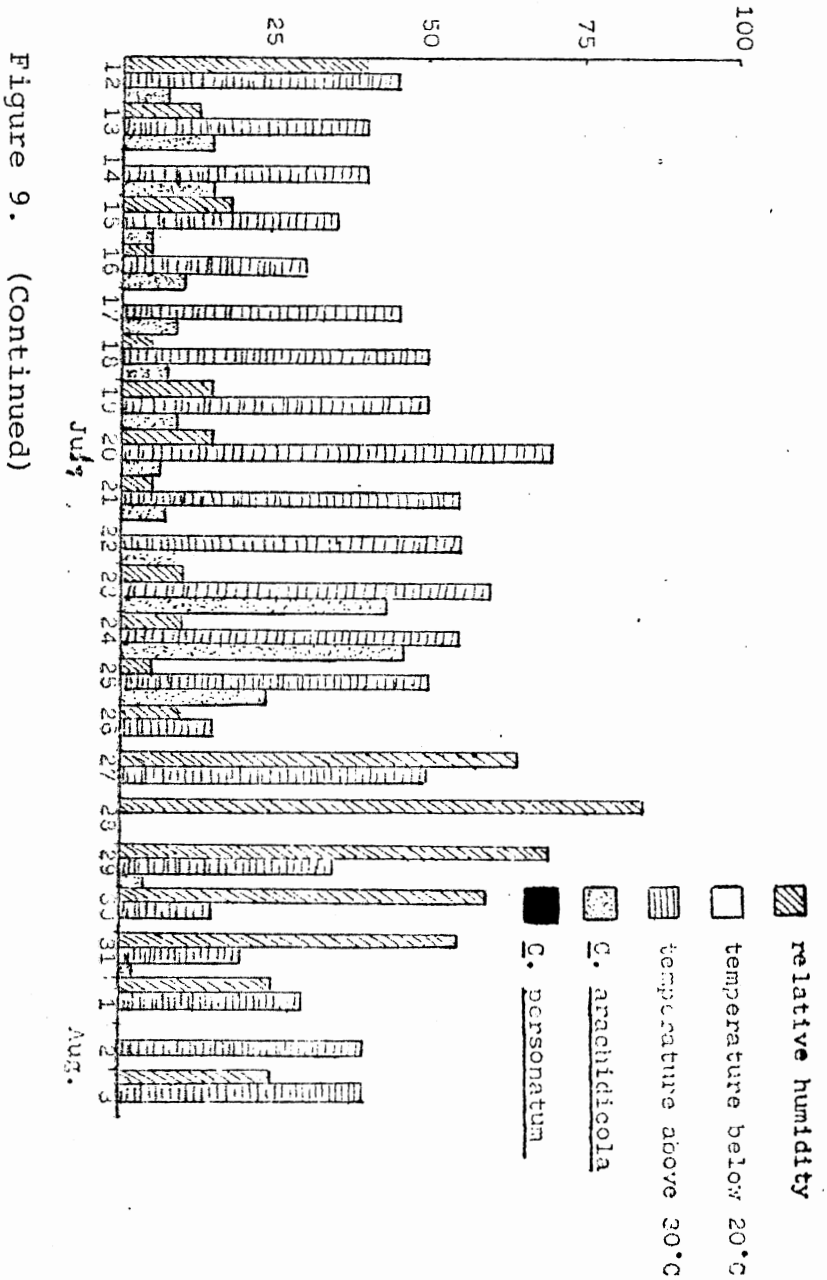

Figure 9. (Continued)

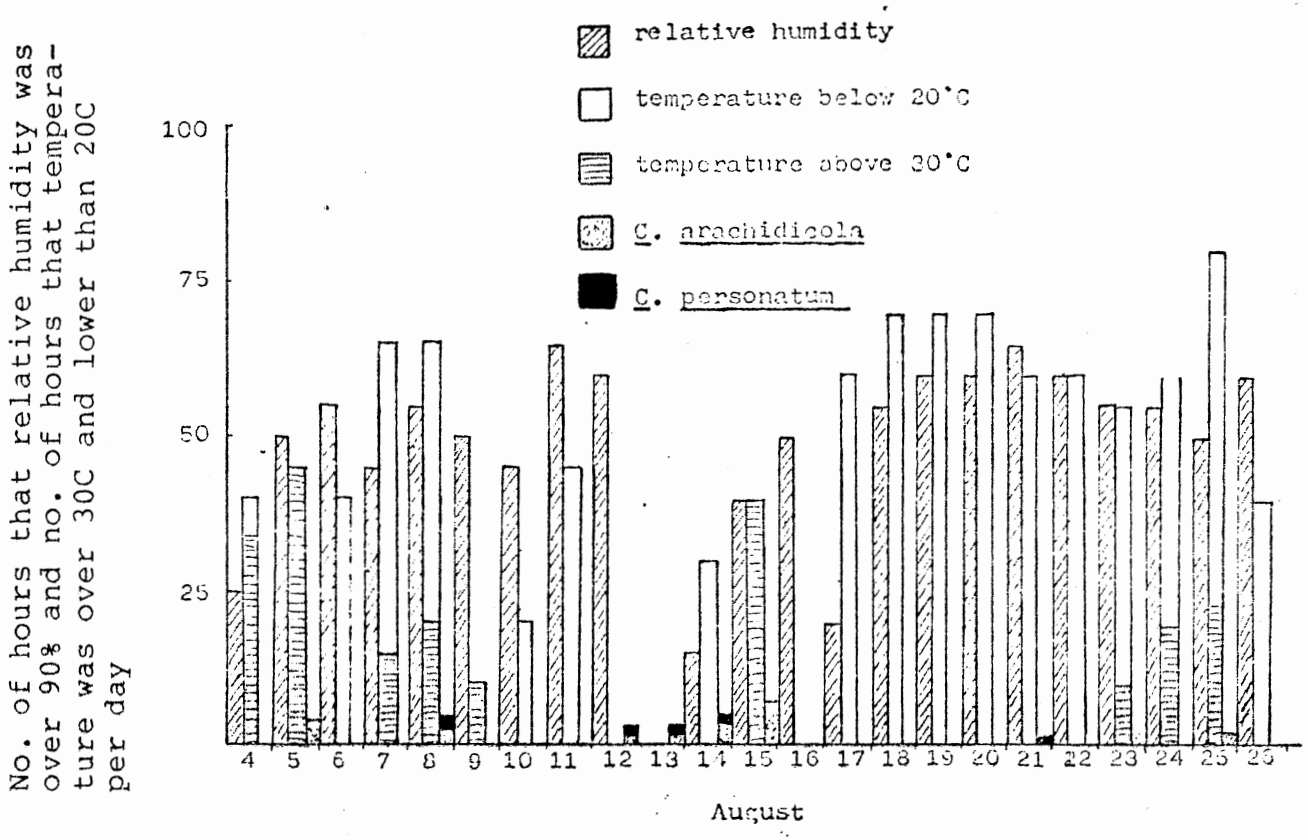

Figure 9. (Continued)

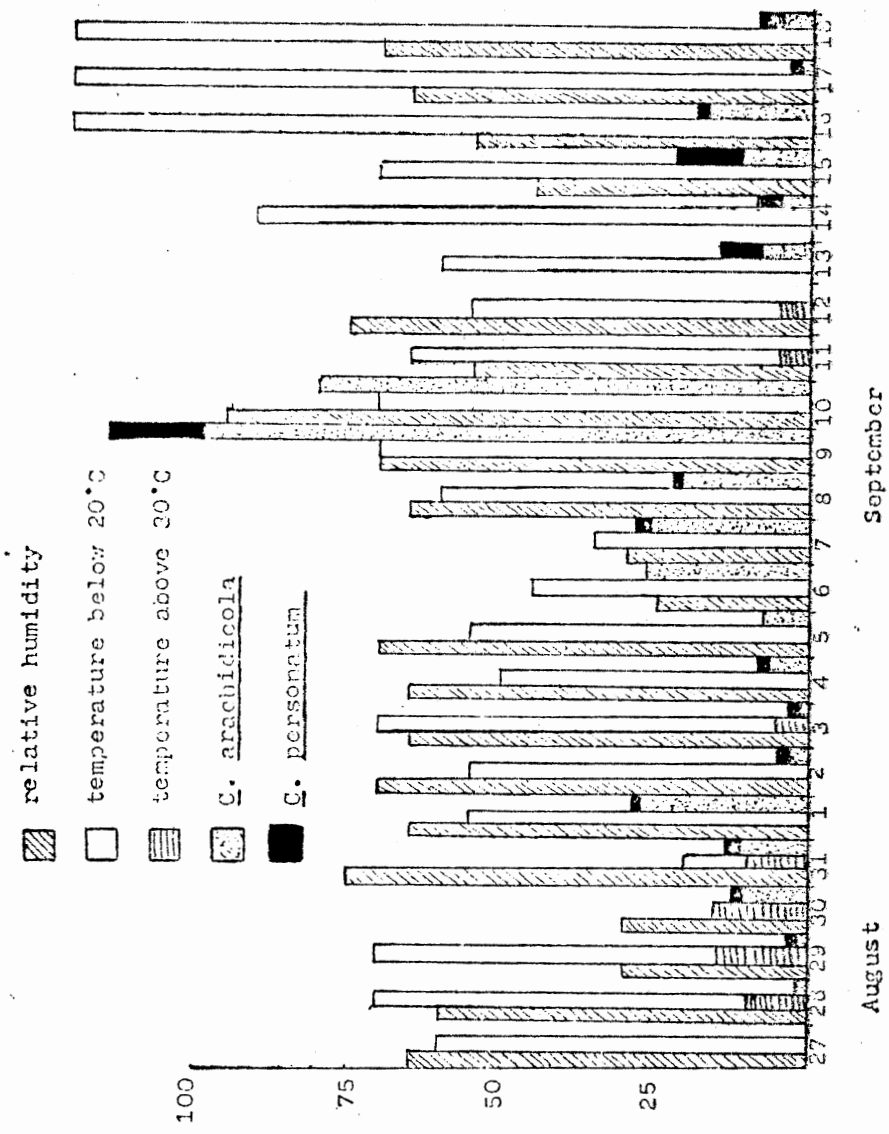

Figure 9. (Continued)

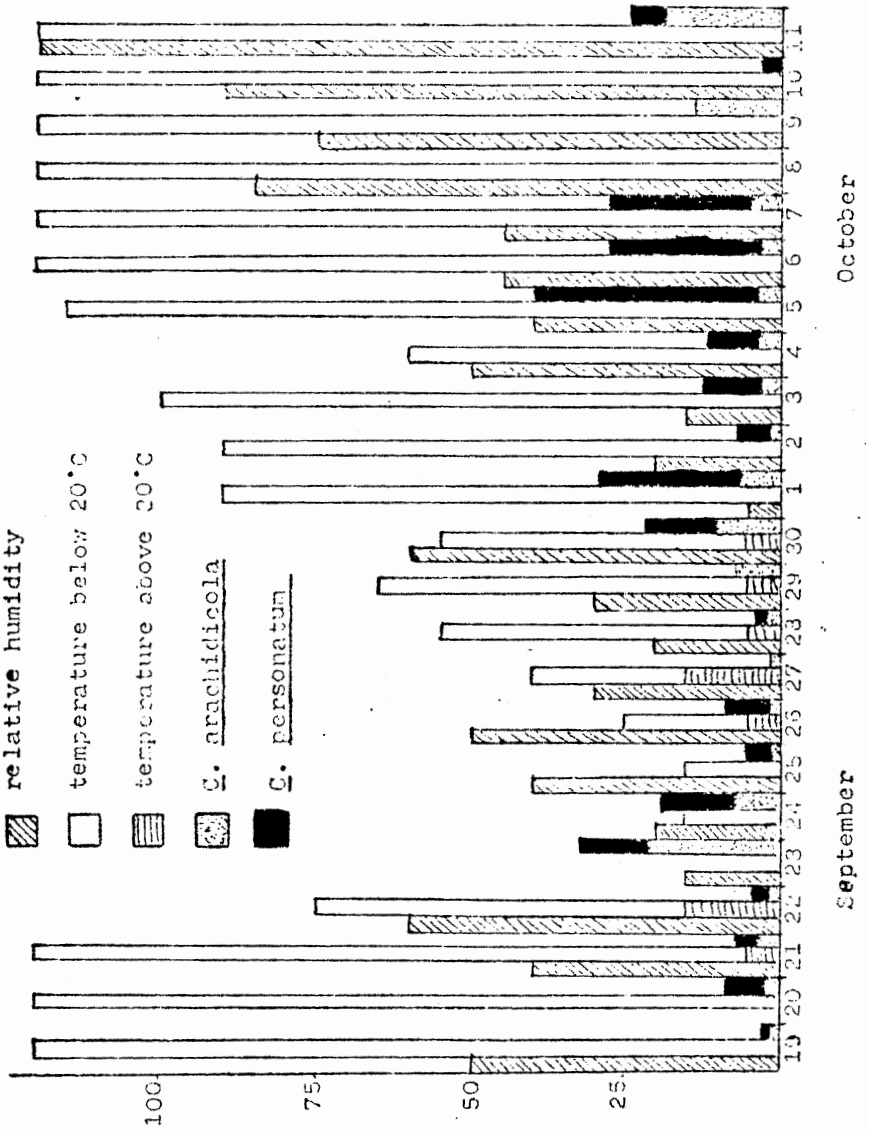

Figure 9. (Continued)

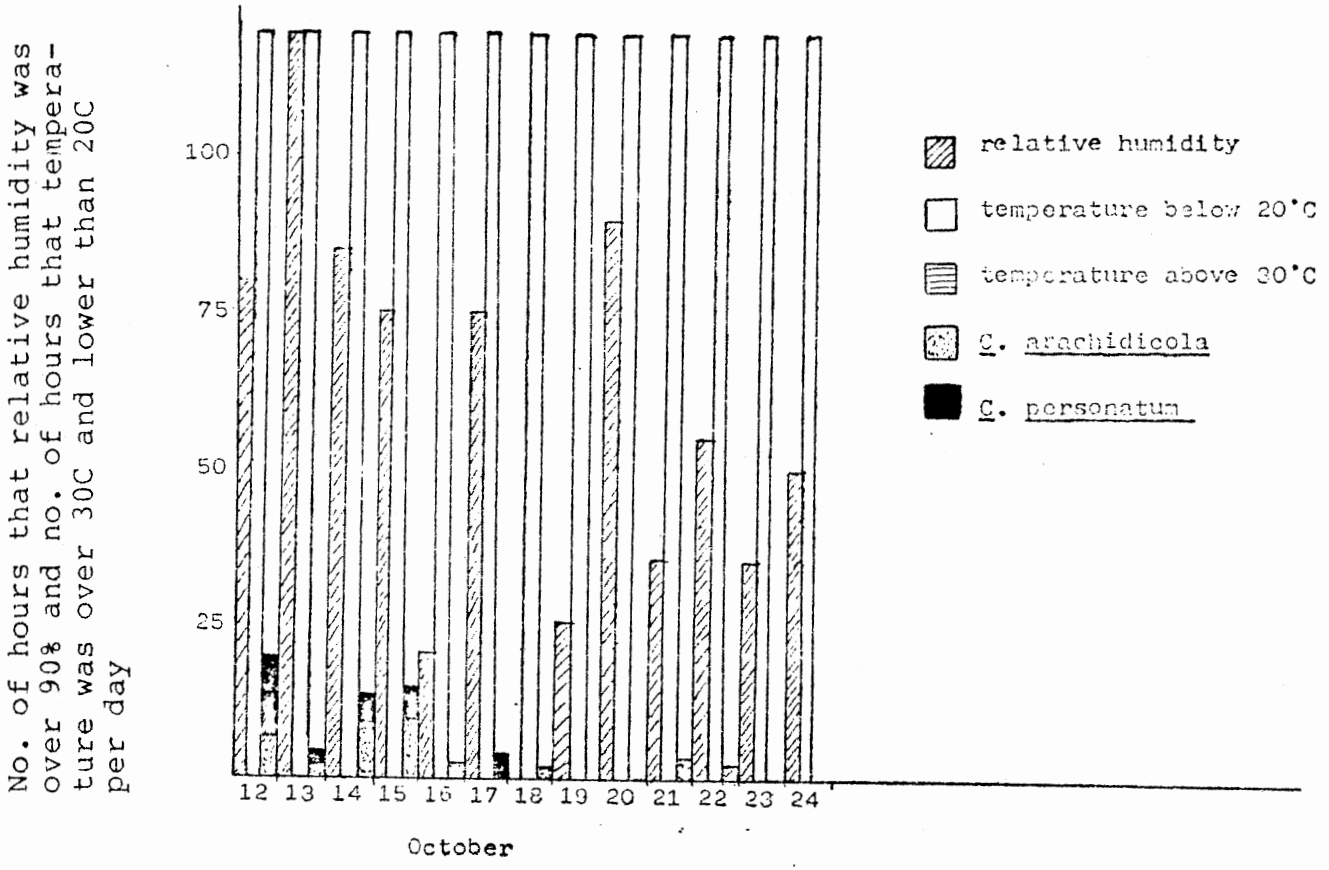

Figure 9. (Continued)

retard or prevent spore germination. The temperatures throughout the season were not considered high enough for any period of time to critically suppress spore germination.

About 12 to 15 days following a period of 10 hours or more of 90 percent relative humidity. Peak periods of spore production occurred. However, so much environmental conditions support the high count of spores of C. personatum during the period of September 25 through October 5. Perhaps this can be explained on basis of lower temperatures (Figure 9).

Yield Response

Table V shows the yield and grade of the different peanut cultivars receiving foliar disease control and no control. Plots receiving the fungicide disease control program produced significantly higher yields than those with no control. Response comparison of sprayed and non-sprayed plots of each cultivar were: Pronto sprayed produced 27 per-cent or 433.4 kg. more peanuts than non-sprayed, followed by Florunner at 19 percent or 392.6 kg., Tamnut at 20 percent or 330.4 kg., and Comet 14 percent or 227.1 kg. However, the sprayed Florunner plots produced the highest yield, 2475.5 kg. per hectare, with the non-sprayed Florunner plots producing a greater yield than sprayed and non-sprayed Spanish cultivars. The yield produced from sprayed Florunner plots was significantly greater than sprayed Tamnut and Comet but not significantly different for sprayed Pronto plots.

TABLE V

YIELD RESPONSE OF THREE SPANISH CULTIVARS AND FLORUNNER PEANUTS TO FOLIAR DISEASE CONTROL, WILSON FARM, WETUMKA, OKLAHOMA, 1981.[a]

Variety	Fungicide App.[b]	Yield Kg/Ha	Grade[c]
Florunner	S	2475.5	70.2
	N	2082.9	70.2
Pronto	S	2042.2	71.0
	N	1608.8	71.6
Tamnut	S	1939.0	69.8
	N	1608.6	72.2
Comet	S	1835.9	71.6
	N	1608.8	71.6
Average	S	2073	70
	N	1727	71
LSD 0.05	S = 523	N = 222.6	NS

[a]Each mean is an average of five replications. The plots were harvested on October 29, 1981.

[b]Eight applications of Bravo 500 applied at 4.22 kg/cm^2 at a rate of 275.5 liters/ha S = Sprayed plots; N = Non-sprayed plots

[c]Grade determined by the Oklahoma Federal-State Inspection Service.

Pronto sprayed plots had almost twice the yield of Comet plots. There were no significant differences between yields produced by sprayed Spanish cultivar plots. There were no significant differences among the quality of kernels or grades determined for the various treatments.

Yield response of the four cultivars from sprayed and non-sprayed plots are presented in Figure 10. Florunner had the least leafspot, less defoliation, and produced the greatest yield while Comet had the most disease and defoliation with the lowest yield.

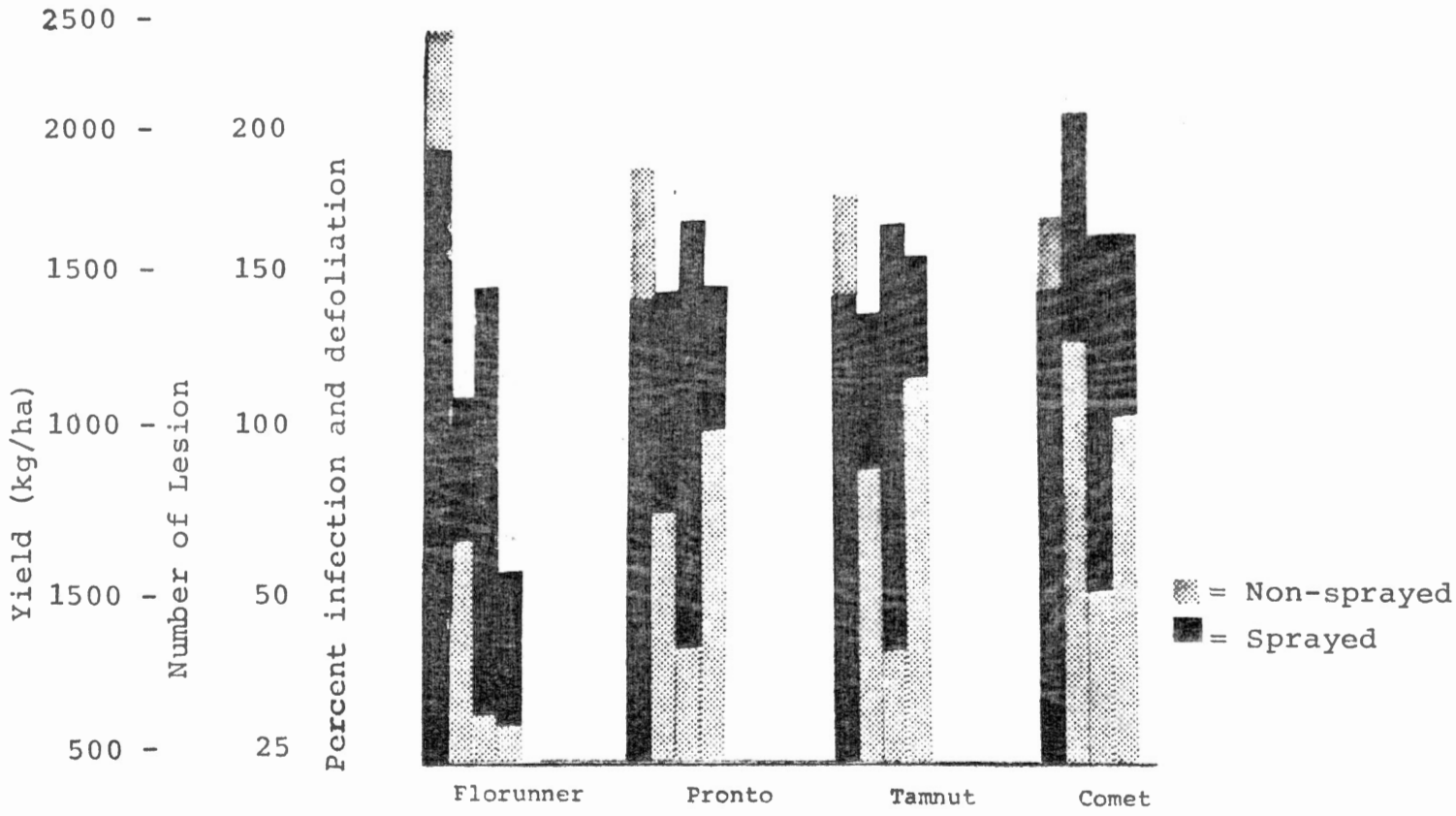

Figure 10. Yield response of Florunner and three Spanish cultivars in plots sprayed to control Cercospora arachidicola and Cercosponidium personatum.

CHAPTER V

DISCUSSION

The atmospheric environment is known to greatly affect the development of foliar diseases of peanuts, yet little is known of the occurrence of the two fungal species, C. arachidicola and C. personatum, on four peanut cultivars commonly grown in Oklahoma. Temperature and relative humidity are the main weather factors that influence the occurrence of the early and late leafspot diseases. Ability of the fungus to produce spores is related to weather and requires a favorable microenvironment. Horne, Lee, and Philley (19) using weather stations in the field to monitor temperature and relative humidity developed a system of improving control of foliar diseases of peanuts for Texas growers. Jensen and Boyle (25) developed a peanut leafspot forecasting technique correlating temperature and relative humidity favorable for leafspot infection to determine if prevailing weather conditions favored the development of the leafspot disease. High humidity with free water and favorable temperatures are required for spore germination and for the leafspot fungus to complete its life cycle (24). In the laboratory, sporulation of C. arachidicola was significantly greater at 30 C and lowest at 35 C and percent conidial germination was

highest after 12 hours incubation at 35 C (13).

Dissemination and dispersal of fungus spores are important factors for development of the peanut leafspot diseases. Movement of C. arachidicola and C. personatum spores within the peanut field as well as the spore densities are also important to disease development.

Temperature and relative humidity were monitored to relate number of spores trapped and occurrence of peanut leafspot infections. The first symptoms of C. arachidicola infections were observed on July 15 and were associated with a low number of spores. Beginning July 1, eight to 10 hours of high relative humidity (over 90 percent) and favorable temperatures for infection occurred for 10 to 12 days.

The first C. personatum spores were collected August 5, with symptoms observed on August 19. Infection could have occurred during the seven days of favorable infection periods following the first spore movement. Ten to 15 hours per day of temperatures over 30 C with only two to three hours of relative humidity over 90 percent occurred during the week prior to the peak of heavy movement of C. personatum spores. This period of heavy spore production, July 23 through 25, may have been influenced by the warm dry condition, because spore movement ceased following a rain and during the next five days with 12 to 16 hours of relative humidity over 90 percent and six to 10 hours per day of temperatures below 20 C. The increased hours of high relative humidity in combination with eight to 12 hours per

day of temperatures below 20 C also may have influenced the occurrence of C. personatum. Spores of C. personatum were first trapped and symptoms found during this period of low August temperatures and increased relative humidity. The lower temperatures and high relative humidity in August and early September are reflected in the high spore counts of both C. arachidicola and C. personatum. The increased weekly counts of C. arachidicola and C. personatum spores seem to follow and be closely related to temperature periods reported favorable for spore production. Temperatures during June, July, August, and September ranged between 20-30 C except for a few days in July, when temperatures reached 38 C. During September the temperatures dropped to lows of 2.5-4 C with a high temperature range of 17-20 C. Extended periods of high relative humidity of 90 percent prevailed throughout the season, with short periods of high humidity over 95 percent occurring in September and during some days in June and July (Figure 10). Large numbers of C. arachidicola spores were collected during July 22-29 and August 26 through September 9 and a large number of C. personatum spores were collected September 2 and 30. Temperature seemed to have the greatest influence on spore movement which, in turn, should relate to spore production.

Large numbers of both C. arachidicola and C. personatum spores were caught during August 26 through September 9, with a high temperature range of 26-35 C and a low range of 12-20 C. The high relative humidity range was 90-96

percent, and the low range was 31-71 percent. The number of hours that relative humidity remained above 90 percent was between seven and 19 hours per day. During September 23 through October 7, greater numbers of C. personatum spores were trapped than C. arachidicola. This change of species number within the spore population collected could be due to the lower temperatures influencing increased number of late leafspot lesions (Table III).

There seems to be about 10 to 15 days between movement of C. arachidicola and C. personatum spores and appearance of disease symptoms with increased infection following movement of spores and favorable environmental conditions. The increased number of spores trapped during the first two weeks of September (Figure 8) can be contributed to favorable temperatures and humidity, and the increased number of lesions of C. arachidicola on the Spanish cultivars providing an increase source of inoculum (Figures 5, 6, 7). The greatest number of C. personatum spores trapped as compared to C. arachidicola during the last week of September may be due to influence of lower temperatures during this period. Occurrence of spores of the two species and periods of high numbers shown in Figure 8 can be directly correlated with temperature periods shown to be more favorable for spore production. While infections seem to be related or influenced by periods of high relative humidity.

The first observed infections of C. arachidicola were found July 15, only on the Spanish cultivars, with no

infection found on Florunner at this time. The infection levels on the Spanish cultivars continued to increase as the season progressed, reaching 80 percent or more on non-sprayed Spanish plots. Although inoculum was present, infected leaves were not found in Florunner plots until August 19 and infection levels in the non-sprayed plots did not exceed 50 percent until September 23. Since inoculum was present and favorable infection periods existed during July and August, the lack of infection of Florunner must have been due to a type of resistance and not lack of inoculum and favorable infection periods. Later season infection would indicate the fungicide spray program for Florunner plots could have been delayed until late August or early September.

The early season, July 15, infections of C. arachidicola can be correlated with the early July movement of C. arachidicola spores and weather conditions more favorable for sporulation and infection. The same is true with C. personatum except the occurrence of this species can be correlated with cooler temperatures. Increased number of C. personatum were not trapped until temperature periods of 20 C became more common. It is interesting to observe the change in number of C. personatum spores trapped compared to the number of C. arachidicola spores toward the end of the season. During the September 16 through October 21 period, when more than twice the number of C. personatum spores were trapped than C. arachidicola spores, the average high

temperature was only 26 C and the low was 17 C. Cercospora personatum is known to be favored by lower temperatures for sporulation. Also during this period more C. personatum lesions were reported than C. arachidicola lesions.

Occurrence of infection from the two fungal species on each of the four cultivars under sprayed and non-sprayed conditions as shown in Figures 4, 5, 6, and 7 provides information important to understanding disease development of the fungal species on each cultivar. Lesions caused by C. arachidicola were found on Comet, Tamnut, and Pronto approximately 35 days before Florunner, hence, this supports the need for earlier fungicide sprays on the Spanish cultivars. The greater number of C. arachidicola and C. personatum lesions found on Comet as compared to Pronto, Tamnut, and Florunner would indicate Comet may be more susceptible to the two fungal species. Populations of each fungal species tended to increase as the season progressed, however, there was a difference at the end of the season in number of C. arachidicola and C. personatum lesions among the cultivars. There were more C. personatum lesions than C. arachidicola on the Spanish cultivars. Although infection on Florunner occurred later than on Spanish, C. personatum remained low while C. arachidicola increased on both sprayed and non-sprayed plots. This difference in lesions caused by the two species could indicate a difference in cultivar resistance. The data indicate Florunner was more susceptible to C. arachidicola and Comet,

Tamnut, and Pronto more susceptible to C. personatum. The information obtained from monitoring the number of lesions caused by the two fungal species would suggest a fungicide sprayed program for Florunner could be started much later in the season with a longer spray interval than required for the Spanish cultivars. The increased number of C. personatum lesions and early infection of both fungal species would require starting the sprays earlier and reducing the number of days between sprays toward the end of season on the Spanish cultivars. The data would indicate the cost of controlling the two fungal species on Spanish cultivars to be much higher than on Florunner. The low number of C. personatum lesions found on the Florunner plots does not support the concept that increased acreage of Florunner in Texas and Oklahoma in recent years encouraged the increased occurrence of C. personatum.

Yield or amount of peanuts a cultivar is capable of producing is a very important factor when a grower selects the kind of peanut to plant, however, the final figure each grower must consider is potential profit of the peanut cultivar he selects. The yields of the four cultivars have been shown to be influenced by amount of C. arachidicola and C. personatum infections (Figure 10). The increased yields obtained from the four cultivars receiving eight fungicide sprays and no spray are reported in Table V. Florunner had the least infection among all cultivars in the study, while percent infection on non-sprayed were similar among all

cultivars. Although, among non-sprayed plots the size and number of spots per leaflet on Florunner were smaller than those occurring on the Spanish cultivars shown on Table IV. Plots receiving fungicide control programs produced higher yield compared to no control. Between sprayed and non-sprayed plots for each cultivar, Pronto sprayed had a 27 percent or 433.4 kg. increase in yield over non-sprayed followed by Florunner with 19 percent or 392.6 kg., Tamnut 20 percent or 330.4 kg., and Comet 14 percent or 227.1 kg. However, the sprayed Florunner plots produced the highest yield, with the non-sprayed Florunner plots producing a greater yield than the sprayed and non-sprayed Spanish cultivars. Yield response and occurrence of C. arachidicola and C. personatum for the four cultivars from sprayed and non-sprayed plots are presented in Figure 10. Florunner with the least defoliation produced the greatest yield and Comet with heaviest defoliation, the lowest yield. All fungicide-treated plots showed an increase in yield, however, only Florunner produced significantly higher yields than Comet. Each cultivar showed a significant difference in yield between sprayed and non-sprayed plots. The quality of kernels showed only slight differences between sprayed and non-sprayed plots and no significant difference between cultivars. This study indiçates Florunner is more resistant to C. personatum and C. arachidicola than the Spanish cultivars, and capable of producing a greater yield and dollar return regardless of disease control.

CHAPTER VI

SUMMARY

1. Temperatures seemed to have a greater influence on spore production, while relative humidity over 90 percent had a greater influence on infection.

2. Increased numbers of C. arachidicola spores were trapped during the higher temperatures of 26 to 35 C, while a greater number of C. personatum spores were caught when temperatures were in the 20 C range.

3. Cerospora arachidicola infections were found on Spanish cultivars on July 15, approximately 35 days before infection was found on Florunner.

4. Since inoculum was present and conditions favorable for infection existed during July and August, the lack of infection of Florunner must have been due to a type of resistance and not lack of inoculum and favorable infection periods.

5. The greater number of C. arachidicola and C. personatum lesions found on Comet as compared to Pronto, Tamnut, and Florunner would indicate Comet was more susceptible to the two fungal species.

6. The data indicated Florunner was more susceptible to C. arachidicola and Comet, Tamnut, and Pronto more susceptible to C. personatum.

7. The information obtained from monitoring numbers of lesions caused by the two fungal species would suggest a fungicide spray program for Florunner could be started much later in the season with a longer spray interval than required for the Spanish cultivars.

8. The increased number of C. arachidicola lesions and early infection of both fungal species would require starting sprays earlier and reducing number of days between sprays toward end of the season on the Spanish cultivars. Hence, the cost of controlling the two fungal species on Spanish cultivars would be much higher than on Florunner.

9. The low number of C. personatum lesions found in the Florunner plots does not support the concept that increased acreage of Florunner in Texas and Oklahoma in recent years increased C. personatum.

10. Yields of the four cultivars were influenced by amount of C. arachidicola and C. personatum infection and defoliation.

11. Florunner had the least infection and defoliation among all cultivars in the study, while percent infection in non-sprayed plots were similar among all cultivars.

12. Florunner plots produced the highest yield, with non-sprayed Florunner plots producing greater yield than the sprayed and non-sprayed Spanish cultivars.

13. All fungicide treated plots showed an increase in yield, however, only Florunner produced significantly higher yields than Comet.

14. Yields were significantly different between sprayed and non-sprayed plots.

15. This study indicates Florunner was more resistant to C. personatum and C. arachidicola than the Spanish cultivars and capable of producing a greater yield and dollar return regardless of disease control.

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APPENDIXES

APPENDIX A

NUMBER OF *CERCOSPORA ARACHIDICOLA* AND *CERCOSPORIDIUM PERSONATUM* SPORES TRAPPED AT WETUMKA BY A KRAMER-COLLINS SPORE SAMPLER FROM JUNE 24 - OCTOBER 25, 1981

NUMBER OF *CERCOSPORA ARACHIDICOLA* AND *CERCOSPORIDIUM PERSONATUM* SPORES TRAPPED AT WETUMKA BY A KRAMER-COLLINS SPORE SAMPLER FROM JUNE 24 - OCTOBER 25, 1981

Week	Date	Number of Spore Trapped on Tape Per Period [a,b] I	II	III	IV	C.a.[c]	C.p.[d]	Total Spores Per Day Per m^3
01	June 24	0	0	0	0	0	0	0.0
	25	0	0	0	0	0	0	0.0
	26	0	0	0	0	0	0	0.0
	27	0	0	0	0	0	0	0.0
	28	0	0	0	0	0	0	0.0
	29	0	0	0	0	0	0	0.0
	30	0	0	0	0	0	0	0.0
02	July 1	6	2	1	2	11	0	22.9
	2	0	1	3	2	6	0	12.5
	3	2	0	0	2	4	0	8.3
	4	0	8	0	0	8	0	16.6
	5	2	0	0	1	3	0	6.2
	6	0	1	0	3	4	0	8.3
	7	0	1	0	2	3	0	6.2
03	8	2	1	2	3	8	0	16.6
	9	1	2	2	1	6	0	12.5
	10	0	1	1	1	3	0	6.2
	11	2	4	2	1	9	0	18.7
	12	1	4	2	0	7	0	14.5
	13	5	3	0	7	15	0	31.1
	14	14	1	0	0	15	0	31.1
04	15	1	0	3	1	5	0	10.4
	16	3	4	0	3	10	0	20.8
	17	5	2	2	0	9	0	18.7
	18	2	1	0	4	7	0	14.5
	19	3	2	1	3	9	0	18.7
	20	3	0	2	1	6	0	12.5
	21	4	2	1	0	7	0	14.5
05	22	4	2	2	0	8	0	16.6
	23	1	1	39	2	43	0	89.5
	24	12	8	17	9	46	0	95.8
	25	11	11	2	0	24	0	50.0
	26	0	0	0	0	0	0	0.0
	27	0	0	0	0	0	0	0.0
	28	0	0	0	0	0	0	0.0

Week	Date	Number of Spore Trapped on Tape Per Period [a,b] I	II	III	IV	C.a.[c]	C.p.[d]	Total Spores Per Day Per m^3
06	29	3	1	0	0	4	0	8.3
	30	0	0	0	0	0	0	0.0
	31	2	0	0	0	2	0	4.1
	Aug. 1	0	0	0	2	2	0	4.1
	2	0	0	0	0	0	0	0.0
	3	0	0	0	0	0	0	0.0
	4	0	0	0	0	0	0	0.0
07	5	2	1	0	0	20	1	6.2
	6	0	0	0	0	0	0	0.0
	7	0	0	0	0	0	0	0.0
	8	2	2	0	0	2	2	8.3
	9	0	0	0	0	0	0	0.0
	10	0	0	0	0	0	0	0.0
	11	0	0	0	0	0	0	0.0
08	12	0	2	0	0	1	1	4.1
	13	0	2	0	0	1	1	4.1
	14	0	5	0	0	3	2	10.4
	15	0	0	7	0	7	0	14.5
	16	0	0	0	0	0	0	0.0
	17	0	0	0	0	0	0	0.0
	18	0	0	0	0	0	0	0.0
09	19	0	0	0	0	0	0	0.0
	20	0	0	0	0	0	0	0.0
	21	0	1	0	0	0	1	2.0
	22	0	0	0	0	0	0	0.0
	23	1	0	0	0	1	0	2.0
	24	0	0	0	0	0	0	0.0
	25	0	1	0	0	1	0	2.0
10	26	0	0	0	0	0	0	0.0
	27	0	0	0	0	0	0	0.0
	28	1	0	0	0	1	0	2.0
	29	1	0	0	2	1	2	6.2
	30	2	1	9	0	10	2	25.0
	31	2	9	1	1	11	2	27.0
	Sept. 1	3	24	1	0	27	1	58.3
11	2	1	1	0	3	3	2	10.4
	3	1	1	0	0	1	1	4.1
	4	2	3	1	2	7	1	16.6
	5	1	0	0	6	7	0	14.5

Week	Date	Number of Spore Trapped on Tape Per Period [a,b] I	II	III	IV	C.a.[c]	C.p.[d]	Total Spores Per Day Per m^3
	6	5	3	14	4	23	3	54.1
	7	8	7	12	0	25	2	56.2
	8	1	5	6	10	21	1	45.8
12	9	20	36	4	54	94	20	237.5
	10	75	52	6	5	80	58	287.5
	11	7	4	13	30	32	22	121.5
	12	0	0	0	0	0	0	0.0
	13	8	4	2	1	7	8	31.2
	14	3	0	2	4	5	4	18.7
	15	2	2	9	9	11	11	45.8
13	16	10	4	4	0	16	2	37.5
	17	2	1	0	0	1	2	6.2
	18	2	0	5	2	5	4	18.7
	19	1	0	1	0	1	1	4.1
	20	3	1	4	0	2	6	16.6
	21	2	0	4	0	3	3	12.5
	22	0	0	2	2	1	3	6.3
14	23	7	21	2	2	21	11	66.6
	24	5	1	9	4	7	12	39.5
	25	1	0	1	3	1	4	10.4
	26	1	7	0	0	1	7	16.6
	27	0	0	1	0	1	0	2.0
	28	3	0	0	0	2	1	6.2
	29	0	1	2	4	7	0	14.5
15	30	7	1	2	10	10	11	43.7
	Oct. 1	24	1	0	14	6	23	81.2
	2	4	1	0	1	1	5	12.5
	3	8	3	2	0	3	10	27.0
	4	2	4	2	3	4	7	22.9
	5	33	0	3	4	3	37	83.3
	6	2	5	18	2	3	24	65.2
16	7	8	3	13	4	22	5	56.2
	8	0	0	0	0	0	0	0.0
	9	13	0	0	1	14	0	29.1
	10	0	0	0	2	0	2	4.1
	11	11	13	0	0	19	5	50.0
	12	17	2	0	0	6	13	39.5
	13	3	0	0	0	1	2	6.2

Week	Date	Number of Spore Trapped on Tape Per Period [a,b] I	II	III	IV	C.a.[c]	C.p.[d]	Total Spores Per Day Per m^3
17	14	0	0	0	13	9	4	27.0
	15	13	1	0	0	9	5	29.1
	16	1	0	0	0	1	0	2.0
	17	2	0	0	1	1	2	6.2
	18	1	0	0	0	1	0	2.0
	19	0	0	0	0	0	0	0.0
	20	0	0	0	0	0	0	0.0
18	21	2	0	0	0	2	0	4.1
	22	0	1	0	0	1	0	2.0
	23	0	0	0	0	0	0	0.0
	24	0	0	0	0	0	0	0.0
	25	0	0	0	0	0	0	0.0

[a]Period I: 3.30 PM - 9.30 PM
Period II: 9.30 PM - 3.30 AM
Period III: 3.30 AM - 9.30 AM
Period IV: 9.30 AM - 3.30 PM

[b]Air was sampled at 20 liters per minute once each hour.

[c]C.a.: Cercospora arachidicola

[d]C.p.: Cercosporidium personatum

APPENDIX B

TEMPERATURE (C), RELATIVE HUMIDITY

AT WILSON FARM, WETUMKA, FROM

JUNE 18 - OCTOBER 25, 1981

TEMPERATURE (C), RELATIVE HUMIDITY
AT WILSON FARM, WETUMKA, FROM
JUNE 18 - OCTOBER 25, 1981

Week	Date		Temperature (C)			Percent Relative Humidity		
			Max.	Min.	Mean	Max.	Min.	Mean
1	June	18	30	21	25.5	93	54	73.5
		19	31	20.5	26	95	53	74
		20	30.5	21.6	26	96	57	76.5
		21	30	21.6	26	95	50	72.5
		22	29	19.4	24.4	97	55	76
		23	31	20	25.5	94	41	67.5
2		24	34.4	19	26.6	92	38	65
		25	35.5	21.6	28.6	90	36	63
		26	31	19	25	90	47	68.5
		27	31.6	16.6	24	91	39	65
		28	33	21.1	27	90	43	66.5
		29	26.6	21.1	24	91	44	67.5
		30	24	21.6	23	91	81	86
3	July	1	31	19	25	92	59.5	74
		2	28.6	19	24	90	47	68.5
		3	28.6	20	24.4	92	59	75.5
		4	29.4	18	24	92	50.5	71
		5	29.4	17.5	23	91.5	49	70
		6	28.3	19.4	24	91	45	68
		7	28	21.6	25	90	59	74.5
4	July	8	31	20	25.5	92.5	51.5	72
		9	33	20	26.6	91.5	47	69
		10	34	20.5	27	91.5	38.5	65
		11	34	22	27.9	90	36	63
		12	33	21	27	91	43	67
		13	33.6	22	27.7	90	34.5	62
		14	34	23	28.6	87	39	63
5		15	36	21	29	91.5	38	65
		16	34	21	27.7	90.5	36.5	63
		17	34	23	28	90	40.5	65
		18	34	23.6	29	90	35.5	63
		19	36	23	29.4	92.5	40	66
		20	40	23	31	92.5	29.5	1
		21	37	23	30	91	35	63
6		22	36	24	30	88	36.5	62
		23	38	23	30	86.5	33	60
		24	37	22.5	30	94.5	29.5	62

Week	Date	Temperature (C)			Percent Relative Humidity		
		Max.	Min.	Mean	Max.	Min.	Mean
	25	36.6	24	30	90.5	35	63
	26	35	22	28.6	95	42.5	69
	27	31	18.6	25	95.5	50	73
	28	24.4	20.5	22.5	92.5	75	84
7	29	25	20	23	91.5	74.5	68
	30	29	21	25	91.5	61.5	80.5
	31	31	21.6	26	92.5	51.5	72
	Aug. 1	32	21.6	26.6	91	51.5	71
	2	33	23	28	91.5	46.5	69
	3	34	21	27	93	40	66
	4	34	23	28.6	91.5	40	66
8	5	35	23	28	94.5	41	68
	6	36	20	28	94	35.5	65
	7	29.4	14	22	93.5	38.5	66
	8	29.4	14	22	93	31	62
	9	33	16	24.4	92.5	25.5	59
	10	32	21	26.6	93	35.5	64
9	11	25	20.5	23	91.5	46	69
	12	26	20	23	92	74	83
	13	33	19	26	92.5	73	83
	14	34.4	22	28	89	40.5	65
	15	36.6	21	29	92.5	39.5	66
	16	28	20	24.4	94.5	34.5	64.5
	17	23	20	21.6	92.5	59.5	76
10	18	25	20	22.5	92	57.5	75
	19	24.4	12.5	18	92.5	48.5	70.6
	20	25.5	13.6	19.4	92	46.5	69
	21	29	13	21	91.5	40.5	66
	22	29	13.6	21	91.5	42.5	67
	23	32	16.5	23	91.5	38	65
	24	33	18	25.5	93	32.5	63
11	25	35	17.5	26	96	31.5	64
	26	30	16	23	93.5	54.5	74
	27	27	15.5	21	92	49.5	71
	28	30	17	23	91.5	39.5	65.5
	29	30	20	25	91.5	50	71
	30	30.5	21	26	92.5	56	74
	31	30.5	19.4	25	94	62	78
12	Sept. 1	26	16.8	21	94	71	82.5
	2	28	16.6	22	91.5	52.5	72

Week	Date	Temperature (C)			Percent Relative Humidity		
		Max.	Min.	Mean	Max.	Min.	Mean
	3	30	17.5	24	91	50	46
	4	29.4	16	23	91.5	44.5	68
	5	26	18.6	22	91.5	53	72
	6	28	19	23	90.5	58	74
	7	27	12	19.4	92	62.5	77
13	8	25	10	18	93	35.5	64
	9	28	10	19	93	33	63
	10	23	16.6	22	91	35	63
	11	31	13	22	92.5	46.5	69.5
	12	30	17	23	92	60.5	76
	13	29	16	23	92	52.5	72
	14	26	15	20.5	92	60.5	76
14	15	21.6	12	17	92.5	74	83
	16	19.4	4	11.6	93.5	35	64
	17	17	2.5	10	93	36	64.5
	18	20	4	11.6	93.5	30.5	62
	19	24	7	15.5	92.5	31.5	62
	20	27	14	20.5	85	34	59.5
	21	30.5	13.6	22	93	40	66.5
15	22	31	15	23	93	32.5	63
	23	29.4	20.5	25	90	43.5	67
	24	27	19.4	23	92.5	50	71
	25	29	21	25	87	45.5	66
	26	30	16	23	94	49.5	72
	27	30.5	16.6	23	94.5	54	74
	28	30	17	24	94.5	42	68
16	29	30.5	16	23	94.5	37	66
	30	30	15.5	23	94	35	64.5
	Oct. 1	21	10	15.5	97.5	34.5	66
	2	25	11.6	18	91	22.5	57
	3	25	19.4	22	91	37	64
	4	28	20.5	24.4	92.5	58	75
	5	30	14	22	94	51.5	73
17	6	18	10	14	92	46	69
	7	12	9	10.5	93	73	83
	8	16	11	14	92	53.5	73
	9	15	12	13	94	56	75
	10	17	7	12	93.5	66	80
	11	18.6	15	16.6	92	72.5	82
	12	18.6	17	18	91	84.5	88

Week	Date	Temperature (C)			Percent Relative Humidity		
		Max.	Min.	Mean	Max.	Min.	Mean
18	13	18	21	16.6	92	90.5	91
	14	25.5	15.5	20.5	94.5	60.5	77.5
	15	18	16	17	93.5	92.5	93
	16	20	17	18.6	92.5	85	89
	17	24	6.6	15.5	94	46.5	70
	18	18	1.4	10	94	32	63
	19	20.5	8.6	14.4	87.5	32	60
19	20	20.5	10.5	15.5	93	34	63.5
	21	20.5	5	13	95	57	76
	22	15	-0.5	7	93.5	33	63
	23	8.6	-3	3	95	36	65.5
	24	11.6	6	9	93	34.5	64
	25	12	4	8	93	42.5	68

1. Data on temperature and relative humidity were collected weekly from hygrothermo graph.

2. Period of time that relative humidity above 90 percent was also recorded.

VITA

Lakchai Menakanit

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