Geocarposphere Temperature as It Relates to Florunner Peanut Production

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ABSTRACT

Geocarposphere (GCS) temperature was correlated to yield, grade, jumbos (outturns), aflatoxin, and germination of Florunner peanuts grown in Southwest Georgia during CY 1981-1987. Maximum daily GCS temperatures usually provided better correlations with yield and quality factors than minimum and mean daily GCS temperatures. Maximum daily GCS temperatures were also more indicative of plant stress. Minimum GCS temperatures were important for rapid emergence, root growth, and maturation. Both maximum and minimum daily GCS temperatures were important for reducing impact by wet and dry weather pests. Maximum yield and quality will be produced when production practices are managed to maintain GCS temperature in the range of 20-35 C (68-95 F) at planting time, 20-31 C (68-87 F) prior to and during the early part of fruiting, 21-28 C (70-83 F) during primary pod addition and 21-29 C (70-85 F) during primary pod maturation period. However, maximum GCS temperatures below 27 C (80 F) should be avoided to minimize impact of wet weather pests. This and other information that relate scouting data and field history to yield and quality have proven useful in developing an Expert System and models for managing peanut production and marketing.

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Temperature is extremly important in all phases of plant growth and development and in areas of pest control. Most studies on peanut (*Arachis hypogaea* L.) growth and development have been concerned with ambient temperatures with little attention given to soil temperatures in the region (geocarposphere) where the peanut pods develop. Between frost temperatures and 35 C (95 F), ambient temperatures determine the rate of peanut crop development (16). Disagreement exists as to the optimum day/night (maximum/minimum) ambient temperatures with the literature (15) reporting a range of 25/25 to 35/20. Drought and soil-borne pests are the primary factors limiting yield and quality of commercial peanut varieties (4). Thus more research is beginning to be devoted to the study of parameters in the root zone and geocarposphere. Ono *et al.* (18) reported that soil temperature in the geocarposphere is important to peanut pod development. Dreyer *et al.* (12) reported that maturity was advanced by higher geocarposphere temperatures but more pegs and pods were formed at lower temperatures. Using a unique experimental plot facility (3) to control geocarposphere (GCS) temperature, studies were conducted to determine the relationship of mean soil temperature to aflatoxin (*Aspergillus flavus* group L.) production during the 30-60 days prior to harvest. The results (2, 5, 7, 14, 19, 22) showed that drought periods of at least 3 weeks with mean daily GCS temperatures of 26-30 C (79-85 F) were necessary for the growth of *Aspergillus flavus* and subsequent production of aflatoxin. Using this facility, Sanders *et al.* (20, 21) also studied the relationship of GCS temperatures near harvest to peanut canopy, stem and fruit temperatures. Peanut stem temperatures in drought stressed plots were as much as 10 C warmer than peanut stems in irrigated plots. Optimum pod temperature for *A. flavus* growth was approximately 35 C. Mack *et al.* (17) reported that outbreak of lesser cornstalk borer (LCB) occurred in hot and dry years and the reproductive rate of LCB increased by 7 fold at high maximum daily temperatures (>35 C).

During CY 1980, field studies were initiated near Dawson, GA to obtain information for developing peanut production and marketing strategies. Specific objectives were to determine the relationships of GCS temperatures and other variables (water, plant, soil, pest, etc.) to yield and market quality and to explore the potential of using these temperatures and variables as an aid for managing the peanut crop and for predicting yield and quality of future crops.

The purpose of this paper is to present information on the relationships of GCS temperature to yield and market quality of Florunner peanuts grown in Georgia during CYs 1981-1987.

Materials and Methods

In each crop year (1981-1987), selected farmers in Southwest Georgia grew, harvested and dried Florunner peanuts using recommended practices (13). During CYs 1981-1983, only dryland fields were selected. An equal number of dryland and irrigated fields were selected during CYs 1984-1987. Fields were selected based upon production history to provide the normal range of yield potential 3.9-6.2 tonne/ha (3500-5500 lbs/acre) and soil types. Except for those noted in Table 1, fields were level (0-3°). Soil types ranged from a well drained sandy soil to a poorly drained heavy soil. The soil types as characterized by the Soil Conservation Service from sandy to heavy were Troup, Americus, Redbay, Orangeburg, Tifton, Norfolk, Faceville, Greenville and Sunsweet. Each field contained a minimum of 4 hectares (10 acres) to provide 2-8 farmer stock loads of peanuts. Each load was graded and marketed through commercial marketing facilities to provide yield and grade data. At least one large sample (136 kg) was removed from each field by cutting the entire stream of peanuts several times as they flowed into or from the drying trailers. The samples were evaluated for shelling outturn of premium priced kernels (jumbos), germination and aflatoxin. On the average, shelling of the 136 kg sample produced about 106 kg of kernels and about 30 kg of hulls. The kernels were screened and hand-picked to remove oil stock. The edible kernels were passed through a four-way sheet metal divider and then the 1/4 portion was put through a Federal State Inspection Service shelled stock divider to provide a 1 kg sample for germination tests. The germination sample was evaluated by the Georgia State Seed Testing Laboratory according to standard official procedures. All of the oil stock kernels from the 106 kg sample were mixed, comminuted in a Dickens mill and a 1100 gram sample of ground peanut meal was sent to the Albany, Georgia AMS Laboratory for aflatoxin analyses by the official TLC method. If no detectable (<1 ppb) aflatoxin was measured, the aflatoxin of the sample was considered to be zero. If aflatoxin was detected, the remaining portion of the 105 kg sample was comminuted in the Dickens mill and a 1100 g sample was evaluated by the AMS Laboratory. The final aflatoxin values for this latter case was calculated considering the weight proportions and aflatoxin values of each portion.

Prior to fruiting (about 40 days after planting [DAP]), instrumentation was installed in the fields to measure soil and ambient temperatures, soil moisture, and water (rainfall and irrigation). Temperatures at the 5 cm (2 in) depth were measured by thermocouples and maximum/minimum dial thermometers (± 1 F). Fields were scouted regularly (one to three times weekly) to record data from max/min thermometers, to check instrumentation, to transfer and record data, to check field conditions, and to collect plant, pest and root growth data. Root growth data was obtained by digging holes in the row and middles to measure the depth of tap and lateral roots, respectively. Fruit initiation data were determined by observing the first flush of blooms (>10 blooms/plant) or by subtracting eight days from the date at which there was an average of 10 healthy underground fruit components (all size pods plus pegs) per plant. When pests were noticed or exceeded threshold levels, the pests and corresponding GCS temperatures were recorded. Impact of these pests on yield and quality was assessed at harvest (after digging) by counting the number of plants impacted per 30.5 m (100 feet) of row (maximum of 1 plant per pest per 0.3 m of row) in several locations in the field. Approximately 3 weeks prior to normal harvest (141 DAP), pod maturity profile was determined (and weekly thereafter until harvest) by the hull scrape method (23). Variation in weather, soil types, fruiting dates, and water treatments (dryland vs irrigated) provided 33 different fields or data sets. Each data set represented 2-8 loads and 2-32 samples. The number of samples was dictated by practical limitations such as time, labor and cost. The data for each data set were averaged and analyzed by simple linear regression analyses to determine relationships of GCS temperature to yield, grade, jumbos (outturns), aflatoxin, and germination. Logbooks and field notes were also used to access situations relative to GCS temperatures.

Results

Seasonal data for the 33 data sets is given in Table 1 where the sets are arranged in ascending order according to yield. Table 2 provides the standard deviations and number of samples for the respective values in Table 1. Table 3 gives the correlation coefficients for the simple linear regressions of yield and the quality factors on each of the maximum, minimum, and mean GCS temperatures (FID-harvest). In most comparisons, GCS temperatures were correlated ($P < 0.01$) to yield and quality. The best correlations were found for regressions of yield and jumbos on maximum GCS temperatures, and the poorest correlations were for regressions of jumbos and germination on minimum GCS temperatures. Most correlation coefficients were negative except for aflatoxin. Thus, high GCS temperatures were generally associated with undesirable results (reduced yield and lower quality). Note from Table 1 that the four data sets (30-33) that had very high yields and quality also had average maximum and minimum GCS temperatures lower than 30 and 24, repsectively. Fields having the low GCS temperatures usually provided the farmer's expected maximum yield and quality potential of the field unless wet weather pests exceeded threshold levels.

Correlation coefficients (r) for specific fruiting periods are presented in Table 4. These coefficients were sometimes as good or better than for the entire fruiting period. Correlation coefficients (absolute value) generally decreased as the time from fruit initiation increased. Coefficients for the first 40 days of fruiting (primary 40-day fruit addition period) are presented in Table 5. On the average, this 40-day primary fruit addition period corresponded to 50-90 days after planting. Linear regression parameters for the best correlations (highest r and lowest P values) are presented in Table 6. Note from Tables 2-5 that generally average maximum GCS temperatures correlated better to yield and quality than mean and minimum GCS temperatures. However, field notes from visual measurements of vertical and lateral root distributions and pod maturity profiles indicated that minimum GCS temperatures were more indicative than maximum GCS temperatures for root growth and maturation rates. Note from Table 3 that the correlation coefficients for jumbos and germination versus minimum GCS were positive for the maturation period. Root growth and maturation rates became noticeably lower as minimum daily GCS temperature dropped below 21 C (70 F). *Rhizoctonia solani* spp. was noted after long periods (> 7 days) at minimum GCS temperature below 21 C (70 F). Lesser cornstalk borer (*Elasmopalpus lignosellus* Zeller) and *Aspergillus* crown rot were evident only when minimum GCS temperature exceeded 24 C (77 F) for more than 14 days.

High maximum GCS temperatures were usually related to a small canopy (ground cover) or an extended interval between irrigation or rainfall that resulted in observed plant stress (Figures 1 and 2). The plant stress was confirmed by digging 120 cm deep holes to evaluate rooting characteristics and available soil moisture. Generally, when the peanuts were not experiencing stress during the first 2 weeks of

Table 1. Geocarposphere Temperatures During Various Fruiting Stages, Associated Pest Activity, Yield and Peanut Quality[1].

Data Set	CY[2]	Soil Type[3]	Fruiting Stages 1 max	1 min	2 max	2 min	3 max	3 min	4 max	4 min	Pest	Yield ton/ha	Grade %	Aflatoxin ppb	Germination %	Jumbos %
1	1	2	36.3	25.4	34.3	25.8	29.5	23.4	29.6	21.3	4,5	1.828	74.6	435	63.0	7.5
2	6	7	35.5	26.4	28.7	23.6	29.1	21.4	26.2	20.6	5,4,2	2.200	69.8	12.9	83.9	9.4
3	4	7	32.8	23.2	29.1	22.7	29.1	23.1	29.9	22.3	4,3,5	2.966	73.0	12.7	78.6	8.3
4	6	5	32.1	25.8	31.6	24.2	26.9	21.1	26.2	21.0	4,1	2.989	74.3	2.4	86.4	11.5
5	1	5	31.2	24.1	30.2	25.5	29.7	24.1	27.1	21.5		3.087	69.0	0	86.0	15.7
6	6	1	33.3	24.3	30.6	23.5	25.9	21.1	25.9	20.6	4,1,2	3.094	71.0	0	70.5	10.4
7	7	9	29.1	25.6	28.4	25.5	28.4	24.8	28.0	23.7	1	3.098	73.8	0	90.4	18.8
8	3	6	30.8	23.2	29.3	24.3	29.3	22.2	25.1	18.1	4	3.239	72.3	0	88.1	13.5
9	7	8	29.5	24.5	30.2	25.5	32.0	26.4	29.5	24.4	4	3.250	71.3	4	90.1	18.9
10	7	9	29.4	25.0	29.1	25.2	28.2	24.4	26.8	23.0	1,3	3.440	71.5	0	90.9	21.4
11	3	3	33.2	23.2	31.3	24.8	27.1	22.3	24.8	17.6		3.447	71.5	0	86.6	15.9
12	3	5	30.8	23.2	30.1	23.4	28.7	22.3	28.6	20.3	1	3.530	71.6	0	91.0	21.8
13	5	4	28.2	22.4	26.2	22.7	26.8	23.2	26.2	22.7	1,3	3.555	70.0	0	85.6	26.6
14	4	5	29.8	23.3	28.0	22.4	26.8	22.5	28.8	21.3	1,3	3.660	74.5	12.8	66.4	25.8
15	1	8	33.7	24.7	30.2	24.3	31.4	24.2	26.7	20.7	4,1	3.693	72.0	0	83.7	15.4
16	6	7	30.8	23.3	28.0	23.0	27.1	21.3	26.8	21.4	1	3.722	64.5	0	95.2	12.8
17	7	1	32.4	24.6	33.6	26.2	29.2	25.8	28.4	23.9	4,3	3.756	68.5	3	84.4	13.2
18	2	5	29.2	23.9	28.4	23.7	28.3	23.5	28.9	22.8		3.857	75.2	0	82.6	15.6
19	5	5	26.4	22.7	26.4	23.3	27.0	23.1	27.3	23.4	1,2,3	3.857	74.5	0	96.0	27.2
20	5	5	26.4	22.7	26.4	23.4	26.6	22.9	26.6	23.1	1,2,3	4.040	72.5	0	94.0	22.6
21	2	2	30.1	23.8	28.8	23.6	27.9	22.9	28.1	21.3		4.046	77.5	0	87.2	25.6
22	6	1	31.3	23.9	27.6	23.1	26.6	21.2	25.7	20.9	1,2	4.054	71.0	0	83.8	14.0
23	7	1	29.0	23.3	27.6	23.1	28.4	24.7	27.6	23.3	1,3	4.131	70.0	0	90.6	19.3
24	4	5	30.1	23.7	27.4	22.2	27.2	22.1	25.9	19.9	1,2,3	4.152	72.5	0	90.9	19.2
25	7	8	28.6	24.6	29.2	25.8	28.1	24.6	27.3	23.5	1	4.170	73.5	0	93.7	26.3
26	2	8	28.2	23.4	27.9	23.3	27.1	22.7	27.7	21.2		4.201	72.5	0	85.4	20.4
27	6	3	31.6	25.2	27.4	23.7	25.9	21.4	25.3	21.2	1,3	4.305	74.3	0	93.1	23.4
28	4	7	30.1	23.3	27.6	22.8	28.1	22.6	27.6	20.7		4.337	72.5	0	89.5	25.0
29	5	4	28.6	22.9	26.1	23.3	25.9	23.3	26.4	23.3	1,3	4.374	73.0	0	88.9	31.9
30	4	1	28.8	23.5	27.0	22.6	27.2	22.2	26.1	19.4	1,3,2	5.030	75.0	0	87.5	25.9
31	4	1	29.7	23.5	26.9	22.3	27.1	22.2	25.8	19.6	1,3,2	5.325	72.5	0	86.4	25.6
32	5	2	27.6	22.8	27.2	23.8	26.7	22.8	27.1	22.7		5.444	76.5	0	94.4	22.5
33	5	2	27.6	23.3	26.8	23.7	26.9	22.6	26.8	21.9		5.795	74.5	0	94.1	26.2

[1]Fruiting Stage 1 = First 20 days after fruit initiation date (FID); 2 = Second 20 days after FID; 3 = Third 20 days after FID; 4 = 61 days after FID to harvest

[2]Number indicates crop year, i.e. 1 = 1981; 2 = 1982, ... 6 = 1986.

[3]Number indicates soil type from lighter to heavier soils, i.e. 1 = Troup; 2 = Americus; 3 = Redbay; 4 = Orangeburg; 5 = Tifton; 6 = Norfolk; 7 = Faceville; 8 = Greenville, 9 = Sunsweet. Except for data sets 1, 6, 7, 10, and 22 (slope 3-5°), all fields were level (slope 0-3°).

[4]Pests that had exceeded threshold values. 1 = white mold; 2 = rhizoctonia; 3 = pod rot; 4 = crown rot; 5 = lesser cornstalk borer. Pests are listed in order of severity.

Table 2. Standard deviation and number of samples ( ) for data sets in Table 1.

Data Set	GSC temperature Fruiting Stages 1 max	1 min	2 max	2 min	3 max	3 min	4 max	4 min	Yield	Grade	Afla-toxin	Germi-nation	Jumbos
1	4.36(8)	1.91(8)	2.61(15)	1.01(15)	1.47(14)	0.67(14)	2.45(35)	1.97(3)	0.093(4)	1.0(4)	249(18)	18.6(8)	2.4(8)
2	3.09(6)	2.08(6)	1.65(5)	1.15(5)	3.19(6)	2.38(6)	0.42(7)	0.72(7)	0.138(4)	0.5(4)	255(8)	4.2(8)	1.8(8)
3	2.20(7)	1.53(7)	2.41(9)	1.69(9)	1.4(9)	0.79(9)	2.16(8)	0.83(8)	0.177(4)	1.0(4)	12(32)	0.7(8)	1.6(8)
4	3.02(6)	2.07(6)	0.84(6)	1.02(6)	1.7(6)	2.19(6)	0.89(6)	1.09(6)	0.259(4)	1.0(4)	86(8)	2.0(8)	1.6(8)
5	2.88(6)	1.57(6)	1.67(14)	0.68(1)	1.95(14)	0.79(14)	0.71(23)	1.4(23)	0.343(4)	1.7(4)	0(8)	3.6(8)	3.0(8)
6	3.50(7)	1.01(7)	2.4(7)	0.65(7)	0.89(6)	1.64(6)	0.72(5)	0.63(5)	0.428(4)	1.2(4)	0(8)	7.6(8)	1.0(8)
7	1.01(9)	0.96(9)	0.62(14)	0.65(14)	0.92(16)	1.15(16)	1.19(12)	0.99(12)	0.059(4)	1.0(4)	0(8)	3.0(8)	1.6(8)
8	2.04(10)	0.8(5)	1.13(5)	0.58(3)	2.75(9)	0.58(3)	2.87(14)	1.53(4)	0.121(4)	1.0(4)	0(8)	4.2(16)	2.5(8)
9	0.71(9)	1.21(9)	1.51(10)	1.29(10)	4.18(8)	1.22(8)	1.38(7)	1.67(7)	0.079(4)	1.9(4)	11(8)	3.3(8)	1.4(8)
10	1.07(8)	1.34(8)	0.67(11)	1.29(11)	1.03(14)	1.89(14)	0.82(10)	0.7(10)	0.247(40	0.6(4)	0(8)	3.6(8)	3.0(8)
11	1.85(16)	0.32(3)	3.15(16)	0.56(3)	2.16(14)	2.25(3)	2.87(19)	2.31(5)	0.189(4)	1.7(4)	0(8)	6.4(16)	2.1(8)
12	1.13(17)	1.01(4)	1.21(19)	0.98(2)	2.2(19)	0.96(3)	2.33(17)	1.67(3)	0.333(8)	2.4(8)	0(8)	5.2(32)	1.7(8)
13	1.46(9)	1.42(9)	0.85(8)	0.59(8)	1.27(9)	0.88(9)	1.01(10)	0.8(10)	0.167(2)	1.4(2)	0(8)	2.9(4)	8.2(2)
14	2.05(8)	0.87(7)	2.26(9)	0.91(9)	0.26(8)	0.42(8)	1.7(8)	1.54(8)	0.265(4)	2.1(4)	15(32)	0.8(8)	1.2(8)
15	1.79(3)	1.11(3)	1.87(15)	1.08(15)	2.37(14)	1.31(14)	1.42(33)	2.37(33)	0.339(8)	1.2(8)	0(8)	5.6(16)	1.3(16)
16	2.17(5)	1.07(5)	1.24(6)	1.39(6)	1.96(5)	0.3(5)	1.62(8)	1.19(8)	0.186(4)	2.1(4)	0(8)	1.6(8)	1.2(8)
17	1.42(7)	1.19(7)	1.91(9)	0.77(9)	0.72(8)	0.94(8)	0.99(5)	1.11(5)	0.404(4)	0.6(4)	8(8)	3.7(8)	1.6(8)
18	1.13(13)	0.5(13)	0.4(14)	0.67(14)	0.7(15)	0.53(15)	0.86(16)	1.04(16)	0.158(8)	1.2(8)	0(8)	4.3(32)	3.4(16)
19	0.76(11)	1.48(10)	0.56(8)	0.49(8)	0.67(9)	0.93(9)	1.27(9)	0.55(9)	0.102(2)	0.7(2)	0(8)	0.5(4)	1.1(2)
20	1.01(9)	0.68(9)	0.28(8)	0.41(8)	0.69(9)	0.77(9)	1.07(5)	0.64(5)	0.227(2)	0.7(2)	0(8)	1.5(4)	1.0(2)
21	1.36(13)	0.57(13)	0.74(13)	0.58(13)	0.47(13)	0.5(13)	1.31(22)	1.87(22)	0.192(4)	1.5(4)	0(8)	4.0(8)	1.0(8)
22	2.96(6)	1.08(6)	0.62(7)	1.26(7)	0.5(5)	2.44(5)	0.59(7)	0.3(7)	0.412(4)	1.8(4)	0(8)	2.4(8)	0.5(8)
23	1.05(11)	1.09(11)	0.91(8)	1.42(8)	0.68(9)	0.83(9)	0.83(9)	0.94(9)	0.845(4)	2.2(4)	0(8)	5.2(8)	1.6(8)
24	2.04(8)	0.84(8)	0.95(9)	1.41(8)	0.41(8)	0.49(8)	1.28(7)	1.49(7)	0.189(4)	2.6(4)	0(8)	2.7(8)	3.4(8)
25	1.53(10)	1.07(10)	0.5(12)	1.07(12)	0.51(18)	0.87(18)	0.81(7)	0.77(7)	0.230(4)	1.0(4)	0(8)	3.2(8)	1.8(8)
26	0.85(13)	0.8(13)	0.56(14)	0.88(14)	0.42(15)	0.51(15)	1.79(23)	2.22(23)	0.192(8)	1.1(8)	0(8)	3.3(16)	3.3(16)
27	3.04(6)	2.64(6)	0.96(5)	0.00(5)	0.84(6)	1.39(6)	0.3(6)	0.35(6)	0.478(4)	0.5(4)	0(8)	3.3(8)	1.6(8)
28	0.93(6)	1.69(6)	1.11(9)	0.94(8)	1.07(8)	0.65(8)	0.74(9)	1.5(9)	0.317(4)	1.7(4)	0(8)	2.4(8)	1.6(8)
29	2.09(9)	1.23(9)	0.5(8)	0.55(8)	0.46(9)	0.8(9)	1.11(10)	0.62(10)	0.139(2)	0.0(2)	0(8)	3.3(4)	0.0(2)
30	1.32(9)	0.93(8)	1.33(8)	0.66(8)	0.48(9)	0.59(9)	1.41(6)	1.33(6)	0.276(4)	0.0(4)	0(8)	3.2(8)	1.2(8)
31	1.19(8)	0.84(8)	1.22(8)	0.84(8)	0.61(9)	0.43(9)	1.47(8)	1.51(8)	0.231(4)	0.8(4)	0(8)	5.4(8)	1.9(8)
32	1.35(8)	0.98(8)	0.45(9)	0.69(9)	0.95(9)	0.86(9)	0.92(7)	1.59(7)	0.152(4)	0.8(4)	0(8)	2.7(8)	1.9(4)
33	1.75(8)	0.9(8)	0.31(9)	0.73(9)	1.16(9)	0.7(9)	0.63(7)	1.78(7)	0.352(4)	1.0(4)	0(8)	2.2(8)	2.4(4)

fruiting (70-90% canopy coverage), the maximum GCS temperature was below 31 C (88 F). Later (>90% canopy coverage), the maximum GCS temperature was below 29 C (84 F) unless there was plant stress. Near full canopy coverage, a maximum GCS temperature of 28 C (83 F) usually corresponded to a soil moisture deficit of 20 and 30 centibars in the deep root zone (60-120 cm) for sandy and heavy soils, respectively. As evident from the grade data and pod maturity profiles, slightly higher soil water deficits (40-60 centibars) and 1-2 C higher maximum GCS temperatures were beneficial for the maturation period. Note from Table 4 the positive correlation of maximum GCS temperature to grade during this period. Typical maximum and minimum GCS temperatures for irrigated and dryland peanuts are plotted in Fig. 3.

Correlation coefficients probably would have been higher if field potentials had been normalized and wet weather diseases (such as *Sclerotium rolfsii* [white mold], *Rhizoctonia*

Table 3. Correlation coefficients[1] for the simple linear regression of yield and certain quality factors on daily geocarposphere temperature during fruit addition and pod filling periods (FID to harvest).

	Maximum Temperature	Minimum Temperature	Mean Temperature
Yield	-0.71	-0.28	-0.63
Grade	-0.25	-0.17	-0.26
Jumbos	-0.72	-0.08*	-0.55
Aflatoxin	0.53	0.17	0.46
Germination	-0.55	0.05*	-0.36

[1]All correlation coefficients were statistically significant at 0.01 level except for those noted with an asterisk.

Table 4. Correlation coefficients[1] for the simple linear regression of yield and certain quality factors on the geocarposphere temperature during various days after fruit initiation date (FID).

Linear correlation coefficients for various fruiting periods after FID

Dependent Variables	0-20 Max	0-20 Min	0-20 Mean	21-40 Max	21-40 Min	21-40 Mean	41-60 Max	41-60 Min	41-60 Mean	61-Harvest Max	61-Harvest Min	61-Harvest Mean
Yield	-0.67	-0.52	-0.68	-0.63	-0.41	-0.59	-0.45	-0.09*	-0.31	-0.26	0.01*	-0.13
Grade	-0.29	-0.10	-0.25	-0.23	-0.19	-0.24	-0.30	-0.23	-0.30	0.16	-0.01*	0.07*
Jumbos	-0.77	-0.49	-0.75	-0.68	-0.30	-0.58	-0.40	0.12	-0.17	-0.12	0.21	0.07*
Aflatoxin	0.47	0.29	0.45	0.51	0.31	0.47	0.21	0.05*	0.15	0.35	-0.03*	0.16
Germination	-0.60	-0.24	-0.54	-0.50	-0.03*	-0.35	-0.12	0.10	-0.02*	-0.32	0.20	-0.04*

[1]All correlation coefficients were statistically significant at the 0.01 level except for those noted with an asterisk.

Table 5. Correlation coefficients[1] for the simple linear regression of yield and certain quality factors on daily geocarposphere temperatures during primary pod addition period (FID to 40-days after FID).

	Average Maximum Temperature	Average Minimum Temperature	Average Mean Temperature
Yield	-0.70	-0.52	-0.70
Grade	-0.28	-0.17	-0.27
Jumbos	-0.79	-0.44	-0.74
Aflatoxin	0.52	0.34	0.51
Germination	-0.60	-0.14	-0.49

[1]All correlation coefficients were statistically significant at the 0.01 level.

Table 6. Linear regression parameters for selected correlations[1] of geocarposphere temperatures to yield and quality.

Dependent Variable (Y)	Fruiting Stages[2]	GCS Temp (X)	Regression Coefficients Slope	Regression Coefficients Intercept	Correlation Coefficient r
Yield	1-4	Max	-0.44	16.2	-0.71
	1-2	Max	-0.29	12.3	-0.70
Grade	1-4	Max	-0.42	84.5	-0.30
	1-2	Max	-0.29	81.2	-0.28
Jumbos	1-2	Max	-2.48	92.4	-0.79
Aflatoxin	1-4	Max	29.44	-824.8	0.53
	1-2	Max	19.39	-558.1	0.52
Germination	1	Max	-1.95	145.8	-0.60
	1-2	Max	-2.24	152.8	-0.60

[1]All correlations were statistically significant at the 0.01 level. These correlations were selected in consideration of the highest absolute value of the coefficients as well as the potential use of the regression equations for predicting the dependent variable at the end of the earliest possible fruiting stage.

[2]Fruiting stages are relative to fruit initiation date (FID), i.e., 1 = First 20 days after FID: 2 = 21 days after FID to 40 days after FID; 1-4 = FID to harvest; 1-2 = first 40 days after FID.

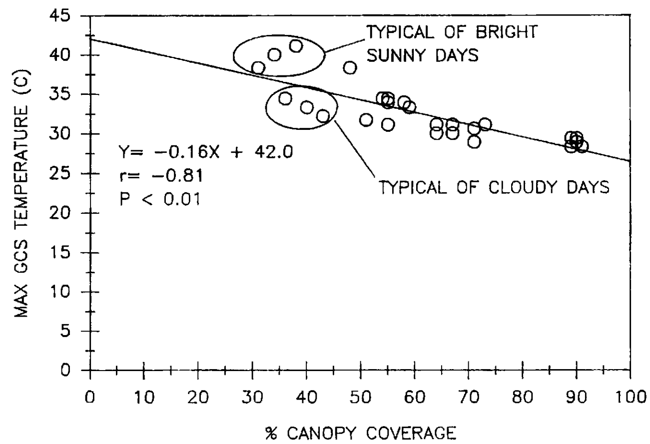

Fig. 1. Typical relationship of maximum GCS temperature to canopy coverage in absence of plant stress.

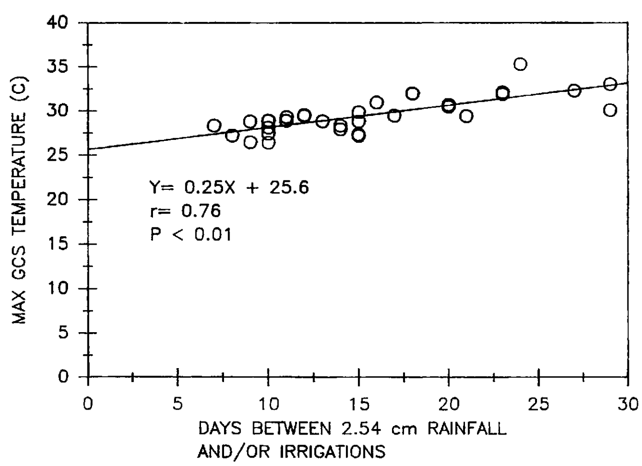

Fig. 2. Relationship of drought stress to maximum GCS temperature during primary pod addition period.

spp., and pod rot) had not reduced yield and quality. When maximum daily GCS temperature was below 27 C (80 F), high humidity conditions underneath the peanut vines was evident. Thus, with a thick canopy and when maximum temperatures were below 27 C (80 F) for periods longer than 3-7 days, white mold, *Rhizoctonia* spp. and pod rot exceeded threshold levels as shown in Fig. 4. As shown in Fig. 5, crown rot exceeded threshold levels when maximum GCS temperature remained above 29 C (85 F) for periods longer than 14 days.

Generally, jumbo outturns were good except when severe drought resulted in high GCS temperatures and a delay in fruit initiation. As evidenced by plant samples, the delay in fruit initiation produced a limb crop (addition of small pods away from the taproot) instead of a taproot crop (addition of large pods near the taproot).

Mean GCS temperatures for the period prior to harvest (FID4) averaged above 26 C (79 F) only on 3 fields (data sets 3, 9, and 17) and these peanuts had measurable amounts of aflatoxin. Four other fields (data sets 1, 2, 4, and 14) produced peanuts with measurable amounts of aflatoxin. These four fields had long periods of maximum GCS temperatures above 29 C (85 F), but usually at periods other than the one prior to harvest.

Seed quality, as indicated by germination, was good except for data sets 1, 3, 6, and 14 where visual drought stress produced high GCS temperatures during primary canopy development and pod calcium absorption stage (first 40 days of fruiting). Severe drought during this period resulted in a very small canopy at harvest and low calcium in the seed. The small canopy at harvest generally resulted in the picking machine (combine) imparting excessive mechanical damage to the pod and seeds as evidenced by grade LSK (not shown) exceeding the normal average of 4 percent. The small peanut plants did not absorb enough of the combine picking action to minimize pod and seed damage. Excessive mechanical damage, together with the low seed calcium, reduced health and vigor of the seed.

Discussion

Considering the many variables that affect peanut yield and quality and the inherent variability in yield and quality potential between fields, the correlations of GCS temperature to yield and quality were usually very good ($P < 0.01$). Within each field, GCS temperature reflected severity of drought stress and the potential for rapid root growth rate, rapid maturation rate and potential for adverse impact by wet and dry weather pests. Ketring *et al.* (15) also reported that a GCS temperature range of 20-35 C (68-95 F) was needed at planting time to provide rapid germination and emergence.

Bare ground 5.1 cm (2 in) soil temperature was approximately the same as GCS temperature until the peanut canopy covered approximately 40% of the ground area and then the shading and transpiration of the peanut plant started cooling the GCS temperatures well below the bare ground 5.1 cm (2 in) soil temperature. As the canopy shaded more of the ground there was less direct solar radiation on the soil to heat up the geocarposphere. During daylight hours when the peanuts were not experiencing stress, their leaf surfaces oriented perpendicular to the sun rays to intercept maximum sunlight as described by Babu *et al.* (1) providing maximum cooling from shading and transpiration. However, when the plants were experiencing stress, the leaf surfaces oriented parallel to the sun rays intercepting a minimum of sunlight and providing minimum shading thereby increasing the GCS temperature. Under severe stress, the leaves folded and the stomata closed reducing transpiration and cooling of the GCS that resulted in even higher GCS temperatures. When excessive vines and wet conditions lowered the GCS temperature below the dew point for 24 hours for several days, wet weather pests exceeded threshold values.

Based upon the literature and information obtained in this study, GCS temperatures should be useful in managing Florunner peanut production in Southwest Georgia. Selecting planting dates and managing irrigation to provide GCS temperatures within the range of 20-35 C (68-95 F) should provide maximum field emergence. Managing

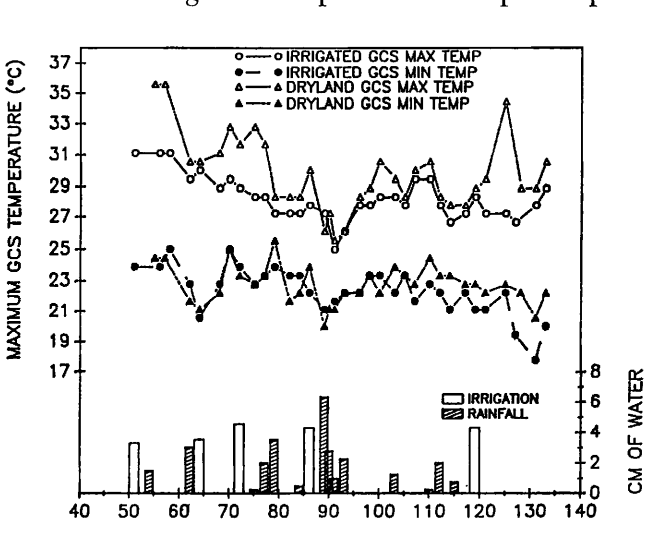

Fig. 3. Typical GCS temperatures for irrigated and dryland fields (see data sets 28 and 3 in Table 1).

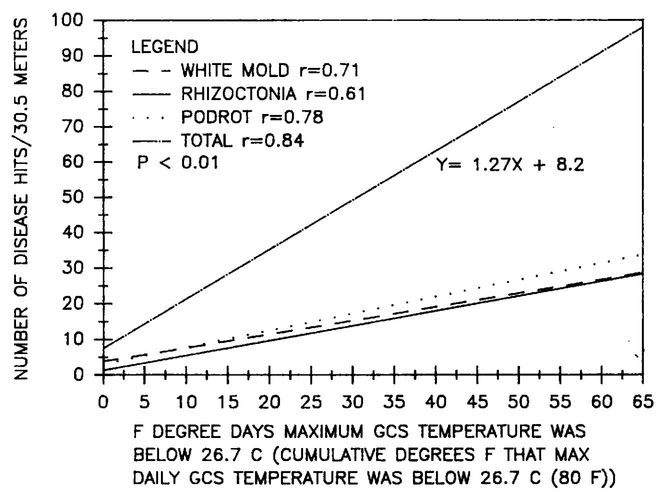

Fig. 4. The potential for major wet weather diseases as indicated by maximum GCS temperatures.

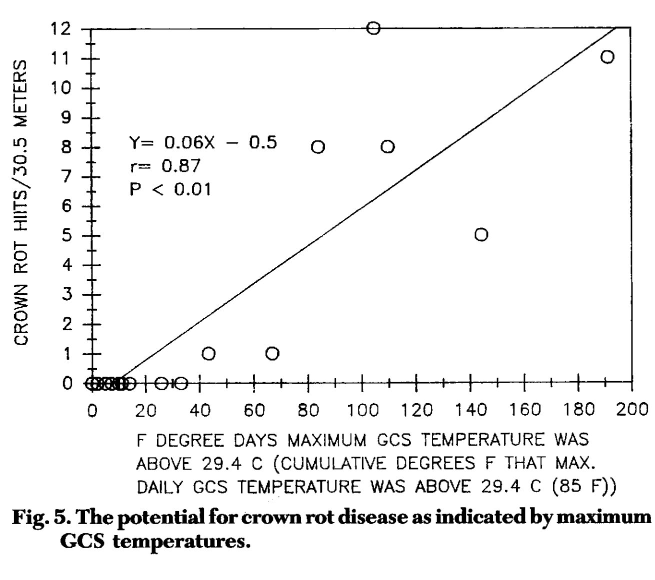

Fig. 5. The potential for crown rot disease as indicated by maximum GCS temperatures.

irrigation practices to maintain the GCS temperatures between 20 C (68 F) and 31 C (87 F) prior to fruiting should promote good root growth and minimize problems with dry and wet weather pests. During the first 40 days of fruiting, managing the irrigation to maintain the GCS temperatures between 21 C (70 F) and 31 C (87 F) for partial canopy coverage and between 21 C (70 F) and 28 C (83 F) when canopy coverage is greater than 90% should promote maximum fruit addition and minimize drought and pest pressure. Immediately after the first 40 days of fruiting for a period of 1-2 weeks irrigation should be managed to maintain GCS temperatures of 22-29 C (72-85 F) to promote pod development and minimize pest pressure. After 50-55 days of fruiting, irrigation practices should be managed to maintain GCS temperatures of 21 to 29 C (70-85 F) to promote rapid maturation and to minimize pest pressure. One exception to the above limits is that maximum temperatures below 28C (80 F) should be avoided because of the impact of wet weather pest (Fig. 4). An expert system, EXNUT, for managing the irrigation of Florunner peanuts in Georgia has been developed using these limits as well as other information that relate scouting data (water, plant, soil and pest) and field history to yield and quality. Field validation of EXNUT in Georgia with 19 "expert" farmers has been successful. On the average EXNUT-managed fields provided higher yields, quality and returns; prevented aflatoxin production during the growing season; and prescribed less water and pesticides than those managed by the "expert" farmers (10). The potential use of GCS as an aid to managing peanut production is also being evaluated in other major peanut growing areas.

The above relationships of GCS temperatures and other variables to yield and quality have been used to develop yield and quality prediction models to manage marketing of farmers stock peanuts. Models for Georgia were validated during CY 1987 (7), CY 1988 (8), CY 1989 (9) and CY 1990 (11). These models proved more accurate and required considerably less effort than the conventional plant sampling, pod count, pod weight and land area technique. The models also allowed more accurate prediction of yield potential prior to July 31.

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