# Development and Evaluation of a Computerized Forecasting Method for Cercospora Leafspot of Peanuts

D. W. Parvin, Jr., D. H. Smith, and F. L. Crosby

Assistant Professor, Department of Agricultural Economics, University of Georgia, College of Agriculture Experiment Stations, Georgia Station, Experiment 30212. Assistant Professor of Plant Pathology, Georgia Station, Agricultural Meteorologist, NOAA, NWS, Georgia Station. Present address of D. W. P.: Associate Professor of Agricultural Economics and Experimental Statistics, Mississippi State University, Mississippi State 39762. Present address of D.H.S.: Associate Professor of Plant Pathology, Texas A&M University, Plant Disease Research Station, Yoakum 77995. Present address of F.L.C.: Prinicpal Assistant, NOAA, NWS, Federal-State Agricultural Weather Service, Lakeland, Florida 33802.

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## ABSTRACT

A computer program for producing a worded daily peanut leafspot spray advisory was developed and compared with advisories issued by a National Weather Service agricultural meteorologist over a period of 3 yr. With the exception of a few marginal cases, the computerized and manually prepared advisories were identical. The advisory enables peanut growers to obtain maximum disease control with a minimum amount of fungicide.

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Peanut leafspot (*Cercospora arachidicola* Hori.) is the most serious disease of peanuts. Estimates of yield losses attributed to Cercospora leafspot of peanuts in Georgia are $10 to $17 million annually (1, 4). The disease is controlled with foliar fungicides.

Jensen and Boyle (2) developed a forecasting technique for Cercospora leafspot of peanuts by using daily temp and relative humidity (RH) conditions to estimate progress of leafspot epidemics. For example, when peanut foliage remains wet for a period greater than or equal to 10 h and the minimum temp is 21C or higher for two consecutive days or nights, conditions are favorable for rapid epidemic progress. Fig. 1 shows the temp and RH (T/RH) index for predicting progress of a peanut leafspot epidemic. When T/RH index for the previous two days is $\geqslant$ 4, a fungicide application is recommended if peanuts have not been sprayed within the last seven days.

Since 1968, The National Weather Service has used Jensen and Boyle's method (2) as the basis for an operational leafspot spray advisory. During the growing season, daily advisories are issued on a teletype network and then transmitted to peanut growers by radio and television stations in Georgia. The purpose of this report is to discuss a computer program which permits the output of a worded peanut leafspot spray advisory based on the observed daily meteorological conditions. The application of computer technology to disease forecasting is a relatively recent innovation. An excellent discussion of plant disease forecasting was included in a recent textbook of plant pathology (3).

MATERIALS AND METHODS. – Input to the computer program is in terms of hours per day with RH $\geqslant$ 95% and the minimum temp (degrees F) during the RH observation period at Tifton and Plains, Georgia for the previous 5 days. Measurements are from noon to noon and are measured in whole hours and whole degrees. Day 5 is treated as the most recent observation.

Average values from two locations (Plains and Tifton) for hours of RH $\geqslant$ 95% and the minimum temp are calculated. Calculations are rounded to whole numbers. Average values are used to determine the T/RH index for each of the five days (Fig. 1). For example, when hours of RH $\geqslant$ 95% equal 10 and the minimum temp during the period equals 21.1 C (70 F), the T/RH index is 2.0 (Fig. 1). With this procedure, hours of RH $\geqslant$ 95% in excess of 20 are set to 20, and values less than two are set to two. Observations on minimum temp during the RH observation period greater than 80 are set to 80, and values less than 62 are set to 62.

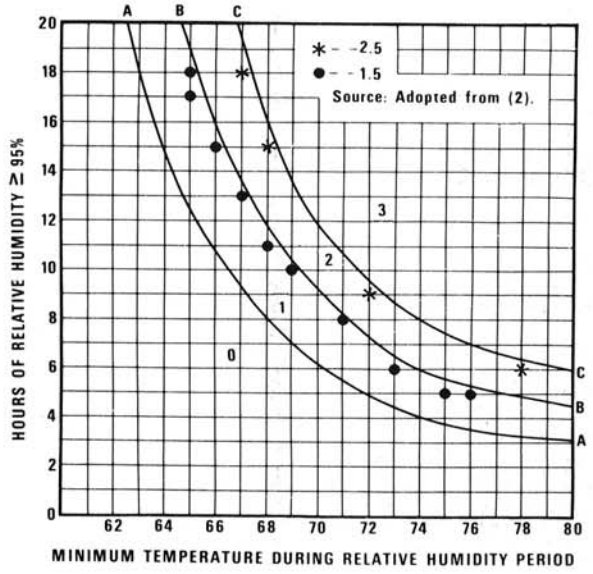
The T/RH indices for days 4 and 5 are summed. The spray advisory is a function of the sum (Table 1). When the sum equals 3.5 or a special 4.0 (1.5 + 2.5 only) and the T/RH index for day 3 equals 0.0, an unfavorable advisory is printed. An unfavorable advisory indicates that conditions are unfavorable for disease development and fungicide application is not recommended. If the T/RH index for day 3 is $\neq$ 0.0 and the average T/RH index for days 1 through 3 is $\leqslant$ 1.0, an unfavorable advisory is printed. If the T/RH index for day 3 is $\neq$ 0.0 and the average T/RH index for days 1 through 3 is $>$ 1.0, the advisory is favorable.

The computer program also outputs the reason(s) for the particular advisory. The T/RH nomogram is divided into four quadrants on the basis of $\leqslant$ 21C (71F) and $\leqslant$ 10 hours of RH $\geqslant$ 95% (Fig. 2). Consider X as the average of minimum temp during days 4 and 5 at Tifton and Plains. Let Y be the averaged hours with RH $\geqslant$ 95% for days 4 and 5 for the same locations. If the advisory is unfavorable and (X, Y) is in quadrant I, the reason for the unfavorable advisory is cool night temp and short periods of high RH. If (X, Y) is in quadrant II, the reason is a brief period of high RH. When (X, Y) is in quadrant III, the reason is cool night temp. When (X, Y) is in quadrant IV, the reason is an unusual combination of night temp and hours of RH $\geqslant$ 95% (Fig. 1, 2) since it is extremely unlikely that (X, Y) would be in quadrant IV and the advisory would be unfavorable. This unusual combination did not occur at any time during the 1969, 1970, or 1971 growing seasons. Under such conditions a message would be printed, instructing the meteorologist to check the advisory. When the advisory is unfavorable, an additional message is possible. If the sum of the T/RH index for days 4 and 5 is a special 4.0 (1.5 + 2.5 only) and the T/RH index for day 3 is not equal to 0.0, then a message is also outputed which reads "however, conditions will possibly be favorable by tomorrow."

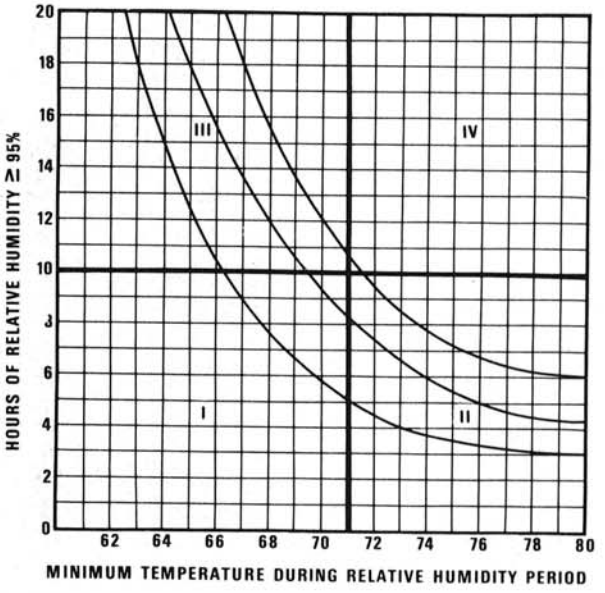
If the advisory is favorable, very favorable, or extremely favorable when (X,Y) is in quadrant I, the reason is an unusual combination of night temp and hours of high RH. This unusual combination was not observed during the 1969, 1970, or 1971 growing seasons. However, in the event of such an advisory, a message would be printed instructing the meteorologist to check the advisory closely. If (X,Y) is in quadrant II, the reason is warm night temp. If (X,Y) is in quadrant III, the reason is long hours of high RH. When (X,Y) is in quadrant IV, the reason is warm night temp with an extended period of high RH. There is one special case. If the sum of the T/RH indices for days 4 and 5 is 3.5, day 3 is not equal to 0.0 and the average of days 1 through 3 is greater than one; the reason is a gradual but steady increase in the rate of disease development during the previous 5 days.

RESULTS. – During the 1971 growing season, the computer program was compared on a daily basis with peanut leafspot spray advisories issued by the National Weather Service and the advisories produced by the computer program were identical to those issued by the agricultural meteorologist. Observations of RH $\geqslant$ 95% and minimum temp during the RH observation period were obtained for the 1969 and 1970 seasons, subjected to the computer program, and compared with advisories issued by the National Weather Service for the same dates. The computerized advisories were nearly identical to those issued by the agricultural meterologist. However, one tendency was observed. When the

1




2




3

PEANUT LEAF SPOT ADVISORY FOR SOUTH GEORGIA

**********INPUT DATA**********
**********PREVIOUS FIVE DAYS**********

| | HOURS OF RELATIVE HUMIDITY IN EXCESS OF 95 PER CENT | | | | | LOWEST TEMPERATURE DURING PERIOD | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TIFTON | 6 | 5 | 17 | 10 | 13 | 72 | 72 | 71 | 69 | 69 |
| PLAINS | 0 | 0 | 12 | 4 | 6 | 72 | 74 | 76 | 73 | 70 |
| AVERAGE | 3 | 3 | 15 | 7 | 10 | 72 | 73 | 74 | 71 | 70 |

**********

YESTERDAY ADVISORY CODE = 4
FAVORABLE

**********

DAILY INFECTION RATE 0.0 0.0 3.0 1.0 2.0

**********

**********ADVISORY**********

**********

WEATHER CONDITIONS HAVE BECOME
UNFAVORABLE
FOR RAPID INCREASE IN PEANUT
LEAFSPOT DISEASE DEVELOPMENT
BECAUSE OF
COOL NIGHTTIME TEMPERATURES AND A
RELATIVELY SHORT PERIOD OF HIGH HUMIDITY

4

PEANUT LEAF SPOT ADVISORY FOR SOUTH GEORGIA

**********INPUT DATA**********
**********PREVIOUS FIVE DAYS**********

| | HOURS OF RELATIVE HUMIDITY IN EXCESS OF 95 PER CENT | | | | | LOWEST TEMPERATURE DURING PERIOD | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| TIFTON | 12 | 10 | 15 | 14 | 8 | 69 | 71 | 71 | 73 | 71 |
| PLAINS | 0 | 0 | 10 | 8 | 4 | 68 | 69 | 72 | 73 | 72 |
| AVERAGE | 6 | 5 | 13 | 11 | 6 | 69 | 70 | 72 | 73 | 72 |

**********

YESTERDAY ADVISORY CODE = 6
EXTREMELY FAVORABLE

**********

DAILY INFECTION RATE 0.0 0.0 3.0 3.0 1.0

**********

**********ADVISORY**********

**********

WEATHER CONDITIONS CONTINUE
FAVORABLE
FOR RAPID INCREASE IN PEANUT
LEAFSPOT DISEASE DEVELOPMENT
BECAUSE OF
WARM NIGHTTIME TEMPERATURES

**Fig. 1-4.** Computerized system for generating peanut leafspot (*Cercospora* spp.) spray advisory messages. **1)** Daily temp/relative humidity (T/RH) index. All readings to left of line A have Index of 0. Readings between lines A and B have Index of 1, except • which have Index of 1.5. Readings between lines B and C have index of 2, except * which have Index of 2.5, and all readings to right of line C have an Index of 3. **2)** Four quadrants used to determine the reason(s) for a given peanut leafspot spray advisory. **3)** Peanut leafspot advisory, South Georgia, 12 August 1971. **4)** Peanut leafspot advisory, South Georgia, 1 September 1971.

TABLE 1. Criteria for computerized peanut leafspot spray advisories

| Sum of T/RH index for days 4 and 5 | T/RH index for day 3 | Av. T/RH index for days 1-3 | Advisory |
|---|---|---|---|
| 6.0 | NA[a] | NA | Extremely favorable[b] |
| 5.0 or 5.5 | NA | NA | Very favorable |
| 4.0 or 4.5 | NA | NA | Favorable |
| 4.0[c] (1.5 + 2.5 only) | ≠0.0 | >1.0 | Favorable |
| 4.0 (1.5 + 2.5 only) | ≠0.0 | ≤1.0 | Unfavorable[d] |
| 4.0 (1.5 + 2.5 only) | 0.0 | NA | Unfavorable |
| 3.5 | ≠0.0 | >1.0 | Favorable |
| 3.5 | ≠0.0 | ≤1.0 | Unfavorable |
| 3.5 | 0.0 | NA | Unfavorable |
| 0.0 – 3.0 | NA | NA | Unfavorable |

[a]When the sum of the temperature/relative humidity (T/RH) index for days 4 and 5 is ⩾ 4.0 (except special 4.0), the advisory is independent of the T/RH index for days 1, 2 or 3.

[b]A favorable advisory indicates that conditions are favorable for disease development.

[c]Referred to as a "special 4.0" in the manuscript. Special 4.0 formed as sum of (1.5 + 2.5) or (2.5 + 1.5) only.

[d]An additional statement would be added to the advisory which reads "However, conditions will possibly be favorable by tomorrow".

National Weather Service meteorologist issued several consecutive unfavorable advisories, there was a tendency for the meteorologist to issue favorable advisories indicating a need for application of fungicides in borderline cases. In these cases, the advisory should have remained unfavorable according to the strict interpretation of the forecasting technique.

In the actual computer output, the T/RH index for the past 5 days is printed along with a message indicating that weather conditions have not changed or have changed relative to leafspot epidemic progress. Finally, the specific weather conditions resulting in a given advisory are printed (see Fig. 3, 4).

DISCUSSION. – The limitation of issuing computer-produced peanut leafspot spray advisories is that the procedure is reduced to the clerical level, and inaccurate data may enter the computer program. However, if the agricultural meteorologist responsible for the advisory inspects the advisories before they are issued, this limitation can be overcome. The computer-produced advisory has at least two distinct advantages. Firstly, it permits the meteorologist to perform other important tasks. Secondly, it insures the issuance of consistent daily advisories. As the National Weather Service improves the accuracy of its weather forecasts, it is probable that the computer-produced spray advisories can also be updated.

Perhaps one of the most significant aspects of the peanut leafspot advisory is that it enables peanut growers to obtain maximum disease control with a minimum amount of fungicide. The judicious application of fungicides based on prevailing weather conditions is often less expensive than a predetermined sequence of fungicide application. As an added dividend, environmental pollution is minimized.

The computer program for this method is on file in the Department of Agricultural Economics at the University of Georgia, Georgia Station, Experiment, Georgia 30212. Requests for copies of the program should be directed to the senior author.

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