Relationship Between Yield Loss and Severity of Early and Late Leafspot Diseases of Peanut

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ABSTRACT

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Levels of peanut leafspot caused by either *Cercospora arachidicola* or *Cercosporidium personatum* were adjusted by applying fungicides of differing effectiveness. Disease levels 2–3 wk before harvest were related to dry pod yield. In studies conducted for 4 yr, data indicated that for cultivar Florunner peanuts with a yield potential of about 4,400 kg/ha, yield was reduced by an average of 57 kg/ha for each percent of defoliation. Peanuts could tolerate low levels of infection, but all levels of defoliation resulted in yield loss. No difference in loss-producing potential (yield loss per unit of disease) was observed between *C. arachidicola* and *C. personatum*, since similar levels of disease caused similar losses. However, slopes of regression lines did differ significantly when years were compared.

Leafspot diseases caused in peanut (*Arachis hypogaea* L.) by *Cercospora arachidicola* Hori (agent of early leafspot) or *Cercosporidium personatum* (Berk. & Curt.) Deight. (agent of late leafspot) have long been recognized among the most destructive diseases affecting one of the world's most important high-protein crops (1,6). Losses of great magnitude have been documented by comparing yields in plots in which these diseases have been controlled with fungicides to those in untreated plots in which they have been allowed to progress (3,7). However, these data are of little value to farm managers and consultants trying to determine economic thresholds or to retrospectively analyze the economic effectiveness of their disease control programs.

The problem is further complicated because two distinct diseases occur in peanuts, and there is little or no epidemiological information on the relative pathogenic potential of either of the causal organisms. In the southeastern United States, *C. arachidicola* occurs earlier in the crop season and produces fewer spores per lesion than *C. personatum* (7), but how these phenomena relate to yield loss has not been reported.

The objectives of this study were to evaluate the relationship of disease severity to yield of cultivar Florunner peanuts for both the early and late leafspot diseases and to compare the relative damage potential of each of the two diseases.

MATERIALS AND METHODS

We have conducted leafspot control experiments with similar methodology since 1975. In each of these experiments, 20–30 fungicides or rates of fungicides were applied to replicated peanut plots and the resultant data were utilized for the development of loss information. Peanuts were planted in a 1-yr rotation with corn, and fungicides were applied with a standard ground sprayer equipped with hydraulic nozzles (hollow cone). Plots were sprayed every 14 days beginning 35–45 days after planting and continuing until 20 days before harvest (~140 days after planting). Typically seven fungicide applications were made in all. Each year, the peanut cultivar planted was Florunner, and the row spacing was 0.9 m. Plots were six rows by 12 m and the middle two rows were used for disease assessment and yield determinations. Most of the fungicides tested were of the contact type, although in any given year 20–30% were of the systemic type. Disease determinations were made 15 ± 4 days before harvest on 10 central stems systematically cut off at ground level throughout the two center rows of each plot. For each stem, the following information was recorded: total leaflets = nodes × 4; percent defoliation = [(leaflets lost) ÷ (total leaflets)] × 100; percent infection = 100 × (leaflets lost + leaflets infected) ÷ (total leaflets). Mean values for the plot were developed by averaging the scores for the individual stems.

Plot yields were determined from the two center rows at optimum harvest time (140 ± 5 days after planting) using standard farm harvesting equipment. Yields are reported as kilograms of dried pods per hectare. Treatment means for yields were related to mean disease ratings by regression analysis with both linear and quadratic models (8).

Disease and yield data from 1975, 1979, 1981, and 1982 were used, because during 1975, leafspot was caused almost entirely by *C. arachidicola*, while in 1979, 1981, and 1982 leafspot was caused almost entirely by *C. personatum*. Low levels of leafspot caused by *C. arachidicola* detected in the early portion of the latter three seasons were overwhelmed by late leafspot by 90 days after planting, and were virtually undetectable when disease evaluations were made 120–130 days after planting.

RESULTS AND DISCUSSION

Reductions in yields of Florunner peanuts were related ($P \leqslant 0.01$) to increased defoliation (Fig. 1). The slopes of the regression equations ranged from 40 to 79 kg of yield lost for each percent defoliation. However, some of the slopes differed significantly ($P \leqslant 0.05$) from the others. The slope of the regression line for the early leafspot year (1975) was near that for the mean of the three late leafspot years (1979, 1981, and 1982). Over the four crop years examined, yield losses averaged 57 kg/ha for each percent of defoliation for Florunner peanuts with an average yield potential of 4,400 kg/ha. Fig. 2 indicates a highly significant relationship between yield loss and infection, but in this case the relationship was best described by nonlinear models. For infection, there was little or no yield response at the lowest levels of disease; at higher disease levels, however, the slope of the line increased markedly (Fig. 2). Unlike infection, all levels of defoliation resulted in yield losses.

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These results indicate that loss relationships are similar for both leafspot diseases, regardless of the parameter selected (percent defoliation or infection) for estimating disease severity. Further, the data indicate that low levels of infection (those not resulting in defoliation) could be tolerated by the peanut plant with little or no loss of yield, while all levels of defoliation resulted in yield reductions. The high correlations between yield and defoliation or infection indicate a close relationship between yield loss and disease severity. In addition, coefficients of determination (r^2) were usually high (ranging from 0.42 to 0.92 for defoliation, and averaging 0.71 over the four years), indicating that much of the variance was explained by and was due to leafspot severity. Seasonal variation plays an important role in the maximum achievable level of disease control. Further, year to year differences in environmental factors

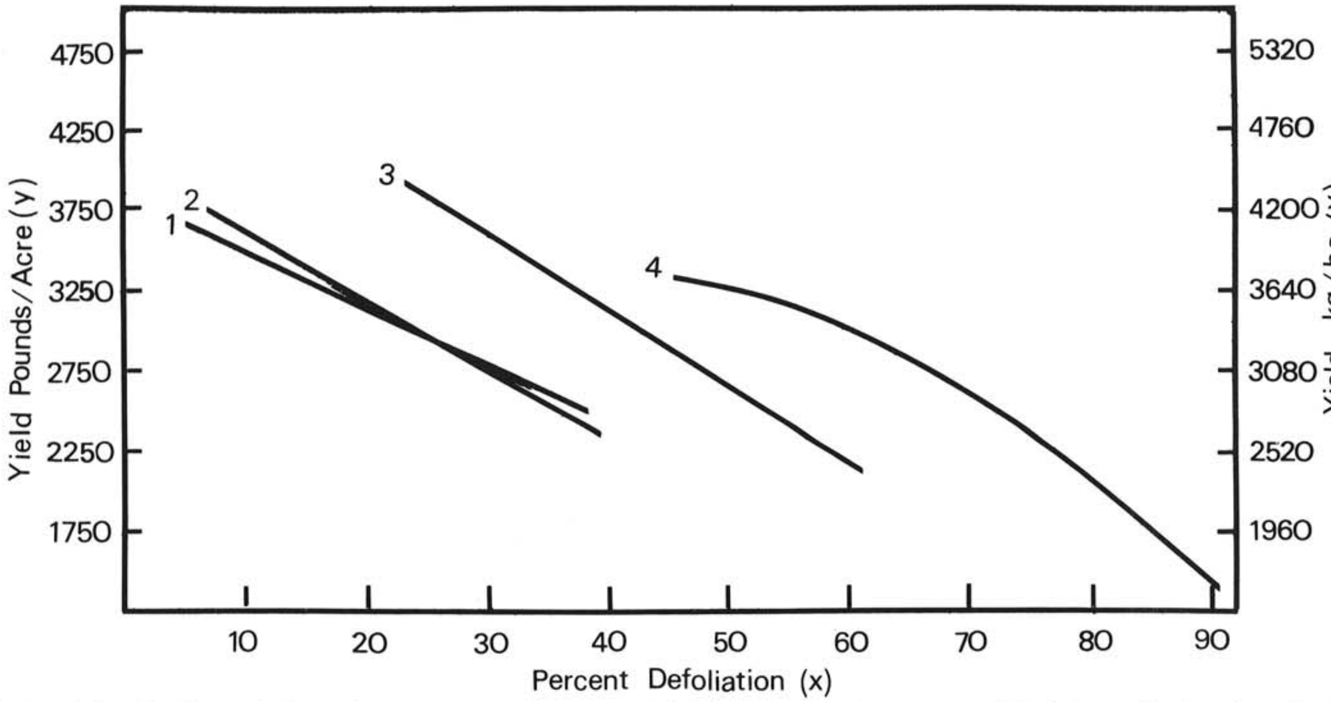

Fig. 1. Relationship of mean yield in cultivar Florunner peanuts to mean defoliation caused by *Cercospora arachidicola* (agent of early leafspot, line 3) or *Cercosporidium personatum* (agent of late leafspot, lines 1, 2, and 4) assessed ~2 wk before harvest in peanut leafspot control plots. Given that $Y =$ yield (kilograms per hectare) and $D =$ percent defoliation, the regession equations and their associated coefficients of determination relating yield to defoliation are: line 1 (1981), $Y = 4{,}941 - 63D$, $r^2 = 0.72$; line 2 (1979), $Y = 4{,}569 - 40D$, $r^2 = 0.42$; line 3 (1975), $Y = 5{,}848 - 52D$, $r^2 = 0.77$; and line 4 (1982), $Y = 2{,}532 + 72D - 0.91D^2$, $R^2 = 0.92$. All models are highly significant ($P < 0.01$).

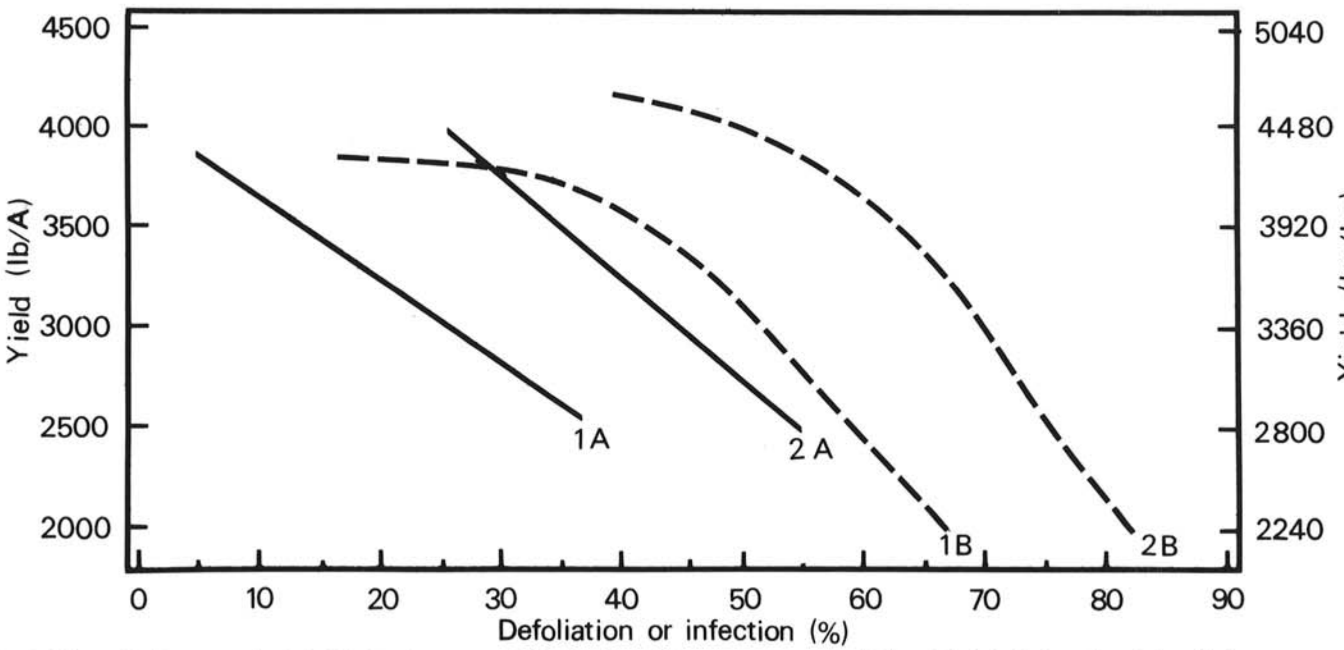

Fig. 2. Effect of leafspot severity 2–3 wk before harvest on yields of cultivar Florunner peanuts. Solid lines (labeled A) show the relationship between percent defoliation (D) and yield (kilograms per hectare) (Y); dotted lines (labeled B) show the relationship between percentage infection (I) and yield. Curves labeled 1 show the effects of late leafspot, and curves labeled 2 relate to early leafspot. The regression equations (and coefficients of determination) are: for late leafspot (1981 data), $Y = 4{,}569 - 40.2D$, in which ($r^2 = 0.42$) (curve 1A) and $Y = 3{,}165 + 57.5I - 1.14I^2$ ($R^2 = 0.48$) (curve 1B); for early leafspot (1975 data), $Y = 5{,}847 - 52.2D$, ($r^2 = 0.80$) (curve 2A) and $Y = 2{,}001 + 119.3I - 1.40I^2$, $R^2 = 0.81$ (curve 2B). All models are highly significant ($P < 0.01$), and relate treatment mean values from leafspot control plots.

and cultural practices affected the performance of the 14-day spray interval programs evaluated here (3,7). Additionally, environment can affect leaf loss resulting from senescence as well as leaf loss caused by other non-leafspot-causing organisms. These phenomena can cause displacement of the lines along the X-axis as depicted in Figs. 1 and 2.

The slopes of the yield loss equations for defoliation by early leafspot in 1975 were nearly equal to those for defoliation for the mean of the three late leafspot years, indicating that there were no disease determinants produced by one causal organism that were not produced by the other. Greater losses reported for peanuts suffering from late leafspot disease were probably due to the relatively faster progress of the epidemic, more spores per lesion, producing a greater rate component, and resulting in greater disease severity at harvest.

Reports of fungicide effects on yield that were not related to control of the target disease (4,5) would seem to compromise the use of fungicides to achieve differing levels of disease to regress against yield. However, since fungicides are known to have both positive and negative nontarget effects (2) and since these data were developed with a broad range of fungicidal products over many crop seasons, the authors are convinced that these effects will tend to cancel each other, even though individually they may add to the variance.

The loss equations developed here relate only to Florunner peanuts with a yield potential of about 4,400 kg/ha, and not to other peanut cultivars. Further, since differences in yield were the result of fungicide programs used to control a natural epidemic, they represent preventable losses that can be achieved with presently available technology—they are not theoretical yields developed on peanuts with no disease history which were infected with selected aggressive isolates at discrete points in time.

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