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# Peanut Yield, Market Quality and Value Reductions Due to Cylindrocladium Black Rot [1,2]

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## ABSTRACT

The effects of Cylindrocladium black rot (CBR) of peanut (*Arachis hypogaea* L.) on yield, market quality and monetary value of the peanut crop were determined for Florigiant, NC 8C and two advanced generation CBR-resistant breeding lines. Percentage extra large kernels (ELK) and fancy size pods (FS) were decreased by CBR. The reduction of ELK has a minor effect on value. The reduction of FS had no effect on value. Reduction of value due to CBR was primarily the result of lower peanut yields. A highly significant proportion of the variation in yield and value was explained by regressions of yield and value on % CBR incidence measured approximately 1 wk before digging. Yield losses ranged from 250 to 450 kg/ha and value reductions for Florigiant and NC 8C were from \$170 to \$190/ha in 1980 and 1981 and from \$270 to \$290/ha in 1982 for each 10% CBR incidence. The relationships among CBR and yield, quality and value were similar for NC 8C and Florigiant. Therefore, NC 8C should sustain lower losses due to CBR than Florigiant because NC 8C is moderatley CBR-resistant.

Key Words: *Cylindrocladium crotalariae*, disease loss assessment, epidemiology.

Cylindrocladium black rot (CBR) of peanut (*Arachis hypogaea* L.), caused by *Cylindrocladium crotalariae* (Loos) Bell and Sobers, is a problem in North Carolina and Virginia. Microsclerotia are the survival structures and inocula of *C. crotalariae* which is primarily a soil-borne pathogen (6). Because eradication of microsclerotia from infested fields is considered to be biologically impractical, efforts to control CBR have focused on breeding resistant cultivars and on developing a CBR management program that will reduce microsclerotial populations to inoculum densities at which moderately resistant cultivars can be economically grown in infested fields. One moderately resistant virginia-type cultivar, NC 8C, has recently been released (8). Crop rotations and reduced fall tillage have been recommended to lower microsclerotial populations (1,5). Reduction of inoculum density by in-row applications of certain soil

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fumigants appears to be promising and is currently being evaluated (J. E. Bailey, personal communication).

Evaluation of the economic aspects of CBR management requires accurate estimates of disease losses. Disease losses occur as reductions in yield and/or quality. Estimates of CBR incidence in relation to peanut yield were published in a preliminary report on CBR (2), and, results of a more extensive evaluation of CBR-yield relationships (3) indicate that approximately a 7.5% yield loss results from 10% CBR incidence at harvest. No information has been published concerning the effects of CBR on peanut quality. The objectives of this study were to evaluate the effects of CBR on peanut yield and market quality and to compare those effects in relation to monetary value of the peanut crop.

## Materials and Methods

Two cultivars, Florigiant and NC 8C, were evaluated in fields infested with *C. crotalariae* in Bladen Co., NC in 1980 and 1982 and in Martin Co., NC in 1981. Two advanced generation CBR-resistant breeding lines, NC 18016 and NC 18229, were also evaluated in the 1981 and 1982 trials. Florigiant is highly susceptible to CBR. NC 8C is moderately CBR-resistant. NC 18229 and NC 18016 are highly CBR-resistant. In the 1980 trial, 40 yield plots were established in mid-July in adjacent fields of NC 8C and Florigiant. Plots were two rows wide (0.91 m row width) and 6.1 m in length. In 1981 and 1982, the two breeding lines, Florigiant and NC 8C were planted in 80 four-row plots (0.91 m row width) that were 6.1 m in length with approximately 45 plants per row. Yield and CBR incidence were measured from the middle two rows of each plot. Plots were arranged as a randomized complete block with 20 replications; however, inoculum density (i.e. disease treatments) varied among and within blocks. Normal peanut production practices were followed in all trials (7). Peanuts were dug 30 September 1980, 2 October 1981 and 7 October 1982.

Incidence of CBR was measured as the number of dead and wilted plants per plot every 7 to 21 days from mid-July until late September or early October when peanuts were dug. A minimum of five ratings were made for each trial with a minimum of three ratings after 1 September when CBR epidemics were rapidly developing. Percentage CBR incidence was determined by dividing CBR incidence by stand counts and multiplying by 100. Symptomatic plants from border rows were sampled to confirm *C. crotalariae*. Perithecia of the perfect stage *Calonectria crotalariae* were also noted.

Market grade data were collected on samples from each plot and included: % foreign material (FM), % loose seed (LS), % fancy size pods (FS = nonshelled fruit that remain on rollers spaced 1.35 cm), % extra large kernels (ELK = kernels that remain on a 0.85 x 2.54 cm screen), % sound mature kernels (SMK = kernels that remain on a 0.60 x 2.54 cm screen), % sound splits (SS = split or broken kernels without damage) and % other kernels (OK = kernels that pass through a 0.60 x 2.54 cm screen). Weight of 100 seeds (WSD) was also measured. Total sound mature kernels (TSMK) was calculated by adding SMK and SS. Support price (SP) in $/100-lb was calculated according to the equations:

$$SP = (a \times TSMK) + (.07 \times OK) + (.0225 \times ELK) - (.05 \times FM) \quad \text{if } FS > 40 \qquad \text{Eq. 1}$$

$$SP = (.3195 \times TSMK) + (.07 \times OK) - (.05 \times FM) \quad \text{if } FS < 40 \qquad \text{Eq. 2}$$

where a = 0.3259 in 1980 and 1981 and a = 0.3988 in 1982. Value per acre was calculated according to the formula:

$$\text{Value} = [SP \times (\text{yield} - (\text{yield} \times LS \times .01)) + (.07 \times (\text{yield} \times LS \times .01)) - (.001 \times \text{yield})]/100 \qquad \text{Eq. 3}$$

where yield is in lb/A. Value per hectare was calculated by multiplying value per acre by 2.471.

The effect of CBR on yield, market quality and value per hectare was evaluated by least-squares regression analyses ($P < 0.05$) for each trial individually with cultivars as a qualitative variable. Based on results of an investigation of CBR-yield relationships (3), % CBR incidence approximately 1 wk before digging was determined to be the best CBR parameter from which to predict loss; and thus was selected as the independent variable in regressions.

## Results

Percentage CBR incidence varied among plots in all trials. In the 1980 trial, % CBR incidence approximately 1 wk before digging (23 September) ranged from 0 to 66% for Florigiant and from 9 to 50% for NC 8C. In the 1981 trial, the range of % CBR incidence approximately 1 wk before digging (25 September) was 25 to 100% for Florigiant, 6 to 89% for NC 8C, 2 to 77% for NC 18229 and 0 to 43% for NC 18016. The range of % CBR incidence approximately 1 wk before digging (3 October) in 1982 was 0 to 84% for Florigiant, 0 to 47% for NC 8C, 0 to 54% for NC 18229 and 0 to 39% for NC 18016.

Peanut yield was consistently reduced by CBR. A highly significant proportion of the variation in yield was explained by regressions of yield on % CBR incidence except for NC 18016 in 1981 (Fig. 1, Table 1). When regressions of individual trails were combined and analyzed by multiple regression with "dummy" variables for cultivars and locations, first-order interactions were

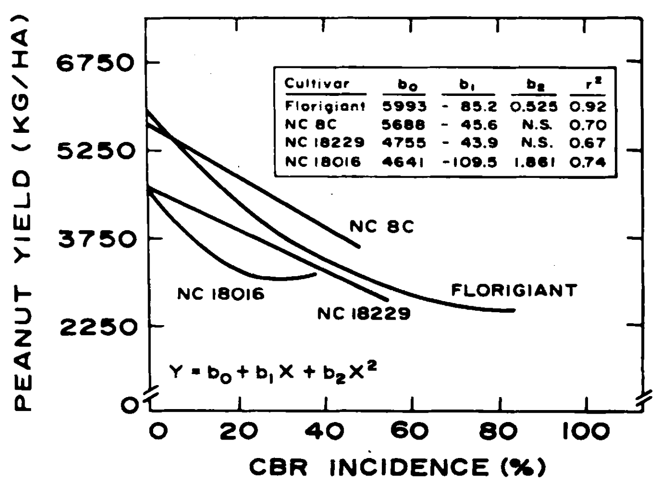


**Fig. 1. Regressions of peanut yield (kg/ha) on % CBR incidence approximately 1 wk before digging for Florigiant, NC 8C, NC 18229 and NC 18016 evaluated in Bladen Co., NC in 1982.**

**Table 1. Regressions of peanut yield (kg/ha) on % CBR incidence[a] approximately 1 wk before digging for Florigiant, NC 8C, NC 18229 and NC 18016 evaluated in trials in 1980 and 1981.**

| Cultivars and breeding lines | Year | Regression equation | $r^2$ |
|---|---|---|---|
| Florigiant | 1980 | Y = 5072 - 38.9 X | 0.76 |
| | 1981 | Y = 5064 - 38.2 X | 0.85 |
| NC 8C | 1980 | Y = 4757 - 36.5 X | 0.42 |
| | 1981 | Y = 4467 - 33.5 X | 0.87 |
| NC 18229 | 1981 | Y = 3937 - 24.4 X | 0.53 |
| NC 18016 | 1981 | N.S. | N.S. |

[a]% CBR incidence measured as number of dead and wilted plants per plot divided by stand count and multiplied by 100.

significant. This indicates that slopes of regression equations (i.e. yield loss responses) differed among cultivars and years. Yield losses were approximately 250 to 450 kg/ha for each 10% CBR incidence.

The effect of CBR on market quality was more subtle than the effect on yield; nevertheless, reductions of FS and ELK due to CBR were significant in all 3 years. Reduction of WSD due to CBR was also significant in 1981 and 1982. Support price and TSMK were not affected by CBR except for Florigiant in 1981. No significant differences due to CBR occurred for OK, LS, or FM.

For FS and ELK, cultivar and CBR main effects were significant and cultivar x CBR interactions were not significant any of the 3 years. Thus, the responses of Florigiant, NC 8C and the two breeding lines were similar within years (Figs. 2 and 3). Regression coefficients

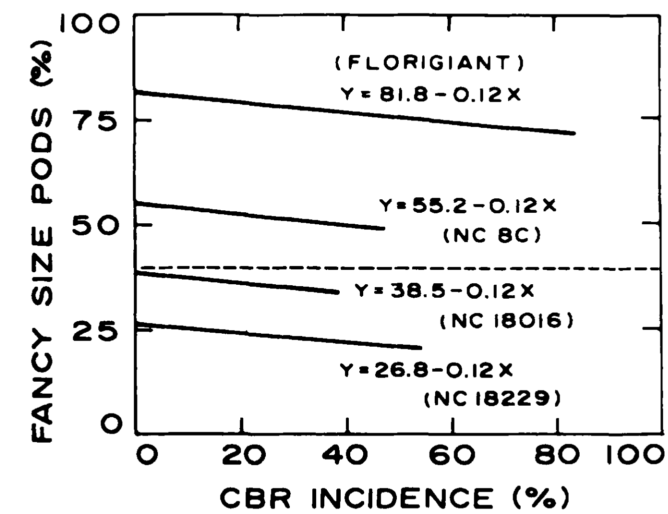


**Fig. 2. Regressions of % fancy size pods (FS) on % CBR incidence approximately 1 wk before digging for Florigiant, NC 8C, NC 18229 and NC 18016 evaluated in Bladen Co., NC in 1982. Support price for peanuts calculated from Eq. 1 (in text) if FS > 40% or from Eq. 2 if FS < 40%.**

were -0.20, -0.11 and -0.12 for FS and -0.08, -0.14 and -0.14 for ELK in 1980, 1981 and 1982, respectively. Consequently, FS was decreased approximately 1 to 2% and ELK was decreased approximately 0.8 to 1.4% for each 10% CBR. In all trials, sums of squares for cultivars were much greater than those for CBR which indicates that differences in FS and ELK among the cultivars and breeding lines were greater than the effects of CBR on these traits. When the cultivars and breeding lines were analyzed individually, coefficients of determination were relatively low ($r^2 < 0.53$) which suggests that even though CBR significantly reduces FS and ELK, a number of other factors are also affecting these traits.

The analysis of WSD data from 1981 and 1982 was very similar to that for FS and ELK. Cultivar and CBR main effects were significant and the interaction term was not. Regression coefficients were -0.11 and -0.10 in 1981 and 1982, respectively, which indicates that WSD was lowered approximately 1 g for each 10% CBR. Sum of squares for cultivars was greater than sum of squares for CBR; and, coefficients of determination from individual regressions were relatively low.

Support price and TSMK were reduced by CBR for

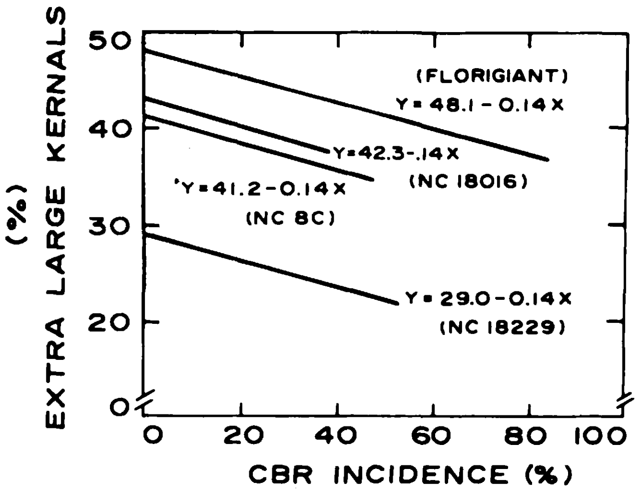


**Fig. 3. Regressions of % extra large kernals on % CBR incidence approximately 1 wk before digging for Florigiant, NC 8C, NC 18220 and NC 18016 evaluated in Bladen Co., NC in 1982.**

Florigiant in 1981; however, these factors were not affected in the 1981 and 1982 trials or for NC 8C, NC 18229 or NC 18016. Regressions for the 1981 Florigiant data were: TSMK = 68.7 - 0.12 X ($r^2$ = 0.42) and SP = 23.42 - 0.04 X ($r^2$ = 0.45), where X = % CBR incidence approximately 1 wk before digging. Consequently, TSMK was decreased approximately 1.2% and SP was lowered approximately $0.40/100-lb for each 10% CBR in the 1981 Florigiant trial.

The monetary value of the peanut crop was reduced by CBR. Regression analysis of value per hectare on % CBR incidence were similar to those for yield. A large proportion of the variation in value of Florigiant and NC 8C could be explained by % CBR incidence (Fig. 4,

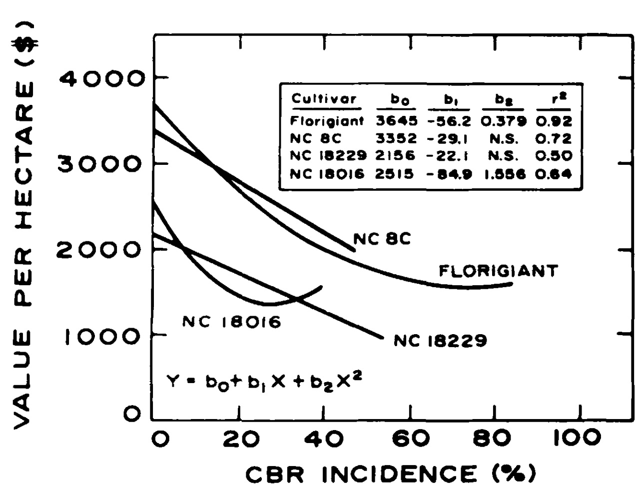


**Fig. 4. Regressions of value per hectare ($) on % CBR incidence approximately 1 wk before digging for Florigiant, NC 8C, NC 18229 and NC 18016 evaluated in Bladen Co., NC in 1982.**

Table 2). In general, a lower proportion of the variation in value of NC 18229 and NC 18016 was explained by CBR than for NC 8C and Florigiant (Fig. 4, Table 2).

## Discussion

Reductions of monetary value due to CBR were primarily the result of lower peanut yields. Minor reduc-

Table 2. Regressions of value per hectare ($) on % CBR incidence[a] approximately 1 wk before digging for Florigiant, NC 8C, NC 18229 and NC 18016 evaluated in trials in 1980 and 1981.

| Cultivars and breeding lines | Year | Regression equation | $r^2$ |
|---|---|---|---|
| Florigiant | 1980 | Y = 2332.1 - 18.7 X | 0.72 |
| | 1981 | Y = 2440.1 - 19.3 X | 0.87 |
| NC 8C | 1980 | Y = 2255.8 - 18.0 X | 0.33 |
| | 1981 | Y = 2190.5 - 17.3 X | 0.79 |
| NC 18229 | 1981 | Y = 1731.2 - 11.7 X | 0.54 |
| NC 18016 | 1981 | N.S. | N.S. |

[a]% CBR incidence measured as number of dead and wilted plants per plot divided by stand counts and multiplied by 100.

tions in value resulted from decreased market quality.

Yield losses in this study varied for cultivars and locations. When yield data from this study were included with additional CBR-yield data in an extensive evaluation of CBR yield loss, the responses of Florigiant, NC 8C and NC 18229 were similar over locations if yield was expressed as the percentage of the maximum yield at a location (3). Estimates of % yield reduction for each 10% CBR incidence were 7.3% for Florigiant, 7.5% for NC 8C and 6.7% for NC 18229.

Reduction of FS by CBR had no effect on SP or value. In all trials, FS was above 40% for Florigiant and NC 8C and below 40% for NC 18229 and NC 18016 (Fig. 2). Consequently, SP was calculated from Eq. 1 for Florigiant and NC 8C and from Eq. 2 for NC 18016 and NC 18229.

Reduction of ELK due to CBR had a minor effect on SP. The portion of SP derived from ELK was figured as $0.0225 x ELK. Consequently, in 1981 and 1982, 10% CBR lowered SP approximately $0.0315 due to fewer ELK (1.4% reduction in ELK x $0.0225). Because the portion of SP derived from TSMK was figured as $0.3259 x TSMK or $0.3988 x TSMK, random variation in TSMK obscured the minor influence of ELK in the analyses of SP. Therefore, analyses of SP were similar to those for TSMK. Likewise, reduction of ELK by CBR had only minor effects on value per hectare; and, analyses of value per hectare were similar to those for yield.

To compare the effects of yield and quality reductions due to CBR on monetary value, an example based on 1982 Florigiant data was examined. The best estimate of maximum yield for the Bladen Co. field in 1982 was 5993 kg/ha in the absence of CBR. Mean support price was $27.50/100-lb. Assumptions were: CBR = 10%, LS = 0% and TSMK did not vary. In the absence of CBR, value per hectare was $3633.19. The best estimate of Florigiant yield reduction at 10% CBR was 7.3%; therefore, yield was decreased to 5555.5 kg/ha. If SP were unchanged, value per hectare would be $3367.96. However, if TSMK did not vary, SP would be lowered $0.0315 because of a $.4% reduction in ELK; and, value per hectare would be $3364.10. Therefore, 10% CBR caused a $269.09 reduction in value per hectare which was a result of a $265.23/ha reduction due to lower yield ($3633.19 - 3367.96) and a $3.86/ha reduction due to fewer ELK ($3367.96 - 3364.10). A greater reduction in monetary value due to decreased quality may occur if both ELK and TSMK are decreased by CBR as with Florigiant in 1981.

Yield, quality and value reductions due to CBR will vary among fields, years and cultivars depending on maximum potential yields, SP and % CBR incidence. Results from this study indicated that for Florigiant and NC 8C approximately $170 to $190/ha were lost for each 10% CBR incidence in 1980 and 1981 and approximately $280/ha were lost for each 10% CBR incidence in 1982. These differences among years were primarily due to higher yields and SP in 1982. Since the relationships among CBR and yield, quality and value are similar for NC 8C and Florigiant, NC 8C should sustain lower losses due to CBR than Florigiant because NC 8C is moderately CBR-resistant. Percentage CBR incidence is lower for NC 8C than Florigiant under equal conditions (4). Additionally, NC 8C may provide "future benefits" over Florigiant which have not been considered in these crop loss models. Growing NC 8C instead of Florigiant in infested fields will result in reduced microsclerotial production due to less CBR, and subsequently, inoculum density should be lower in those fields in future years if NC 8C is planted.

Even though these CBR loss estimates vary, they can be useful in economic evaluations of CBR management tactics, if SP, potential yields and the occurrence of CBR can be reasonably predicted. To predict the occurrence of CBR, peanut growers must rely on past experiences of CBR in particular fields. Further research on the value of late season CBR assessments for predicting future CBR occurrence and research on the survival of *C. crotalariae* microsclerotia will provide information that will supplement these crop loss estimates, and thus, will allow growers to make better management decisions.

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