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# Effect of Southern Corn Leaf Blight on Composition and Selected Physical Characteristics of Corn

James F. Cavins, Ordean L. Brekke, Edward L. Griffin, Jr., and George E. Inglett*

The 1970 corn crop was significantly affected by southern corn leaf blight. We have analyzed heavily damaged, moderately damaged, and undamaged kernels from blight-damaged ears of corn. The kernels were generally smaller in size and lower in weight, and the grain was lower in test weight as blight damage increased. Protein, ash, and fiber content increased with increased blight damage, while oil, starch, and pentosan content decreased. In general, amino acid data agreed favorably with those found for normal corn from years when no blight was present.

*Helminthosporium maydis*, Nisik et Miyake, Race T, the causative agent of southern corn leaf blight, markedly decreased the yield of corn grown during the 1970 crop year. This disease has been a problem in other years but to a lesser extent. The effect of blight on composition and physical characteristics is important to the farmer, processor, and consumer. The farmer suffers a discount for blighted grain that is downgraded because of kernel damage and low test weight, while dry- and wet-millers encounter higher cleaning losses and lower yields of their principal products (Anderson *et al.*, 1972; Brekke *et al.*, 1972). Several investigators have shown that blighted corn presents no problem in feeding

Northern Regional Research Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Peoria, Illinois 61604.

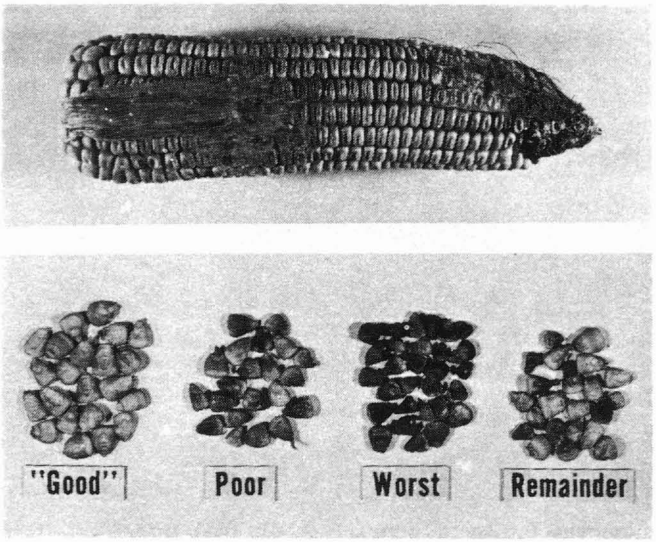


**Figure 1. Top, corn severely damaged by southern leaf blight. Bottom, kernels removed from damaged ears by selective hand shelling**

**Table I. Physical Analyses of Southern Leaf Blight-Damaged Corn[a]**

| Sample | Proportion,[b] % | Test weight, lb/bu | Weight, g/100 K | Size,[c] % | Germination, % |
|---|---|---|---|---|---|
| Moldy ears | | | | | |
| Good kernels | 27 | 51.2 | 17.0 | 14 | 40 |
| Moderately damaged kernels | 26 | 47.3 | 13.6 | 10 | 10 |
| Heavily damaged kernels | 18 | 33.2 | 8.4 | 5 | 0 |
| Remainder of kernels | 29 | 47.8 | 13.0 | 11 | 25 |
| Nonmoldy ears | | | | | |
| Tip kernels | | 52.8 | 15.0 | 10 | 79 |
| Butt kernels | | 53.9 | 19.6 | 36 | 81 |

[a] 10 to 15% moisture content. [b] As percentage by weight of all kernels on the moldy ears. [c] As percentage retained on a $^{21}/_{64}$-in. round-hole perforated sieve.

(Brown 1970), but none have clearly and adequately shown what compositional changes may occur. While the possibility of blighted corn being produced in the United States is greatly lessened because resistant varieties are available, this situation may not hold for other countries; therefore, data on composition and physical characteristics of such corn should be available.

## SAMPLES

Samples of yellow corn were obtained from moldy ears collected from a field, located in central Illinois, severely damaged by southern corn leaf blight. The field had been planted with seed having Texas male sterile cytoplasm, and the crop yield was estimated at 8 bu/acre. Ears were hand-picked at about 18% moisture content and dried at room temperature to below 14% in a simple drier. By selective hand shelling, four samples were obtained from the moldy ears. On heavily damaged kernels, the surface of each was dark gray or almost black in color, and these kernels came from the center of moldy areas which were often found on the tip end of the ear. Moderately damaged kernels were taken from the area immediately surrounding the heavily damaged kernels and usually only a portion of each kernel was gray or black. "Good" kernels were pale yellow in color, came predominantly from the butt end of the ear, and were visibly void of blight. The remainder was a mixture of good and damaged kernels remaining on the ear after the first three samples had been removed. These four samples, along with a heavily damaged ear, are pictured in Figure 1.

For comparative purposes and to learn if location on the ear made any noticeable difference, tip and butt kernels were collected separately from the comparatively few nonmoldy ears in the lot.

Samples for the chemical analyses were ground in a cyclone hammer (Udy) mill and passed successively through 0.050-in. round-hole perforated (rhp) and 0.012 × 0.5 in. slotted screens.

## PHYSICAL CHARACTERISTICS

Some physical characteristics of the six samples described are reported in Table I. Test weight decreased from 51.2 to 33.2 lb/bu in going from the good to heavily damaged kernels removed from the moldy ears. Based upon test weight the best of any of the first four samples would have graded was U.S. No. 4. Tip and butt kernels from the nonmoldy kernels weighed 53–54 lb/bu, which would correspond to U.S. grade No. 3. Kernel weight also decreased along with test weight. However, all kernel weights were considerably under the range generally typical of good quality normal yellow dent corn; *i.e.*, 25–30 g per 100 kernels. Kernel size as determined by percentage of the sample retained on a $^{21}/_{64}$-in. round-hole perforated sieve decreased with blight damage, and all values, except for the butt-kernel sample, were abnormally low. Low values for kernel size and weight undoubtedly were due in part to the blight damage occurring most often on the tip end of ears, where the kernels naturally are smallest in size and lowest in weight. Good (*i.e.*, predominantly butt) kernels from the moldy ears were not much larger than tip kernels from the nonmoldy ears. This characteristic illustrates one effect that blight had on this lot of corn.

Internal examination of heavily damaged corn kernels revealed little or no vitreous endosperm, along with considerable damage to the germ portion of the kernel. The germ damage is reflected in the germination data (Table I). Heavily damaged kernels did not germinate and good kernels from moldy ears had a considerably lower germination than kernels from nonmoldy ears. Even the latter did not germinate as well as one might expect based upon the mild drying conditions used.

While a precise separation of the damaged kernels present on the moldy ears was difficult to make during hand shelling, the proportions given in Table I are reasonably indicative of the amounts actually present.

During hand shelling, care was necessary not to crush the heavily damaged kernels. With mechanical shelling, most of these and some of the moderately damaged kernels would have been reduced to fines and lost by sieving and aspiration during normal cleaning.

## PROXIMATE ANALYSIS

If blight affects corn composition, the effect should be revealed in proximate analysis of the grain (Table II). Fat acidity (AOAC, 1960 standard procedure) values increased from 29 to 100 as blight damage increased. These values are below the range of 112 to 284 reported by Baker *et al.* (1959) for samples incurring 100% blue eye mold damage and also below the 224–282 range for samples having 100% cob rot damage. However, only kernels from the nonmoldy ears had fat acidity values below 22, the level reported by Baker *et al.*

Table II. Proximate Chemical Analysis of Blight-Damaged Corn[a]

| Type of kernels | Fat acidity, mg KOH/10 g of dry grain | Crude protein, %[b] | Crude fat, % | Ash, % | Crude fiber, % | Starch, % | Amylose, % of starch | Pentosans, % |
|---|---|---|---|---|---|---|---|---|
| Moldy ears | | | | | | | | |
| Good kernels | 29 | 10.2 | 3.7 | 1.54 | 2.5 | 73.0 | 29.7 | 7.23 |
| Moderately damaged kernels | 81 | 10.9 | 3.2 | 1.74 | 2.9 | 72.0 | 29.3 | 6.64 |
| Heavily damaged kernels | 100 | 13.0 | 2.0 | 2.14 | 4.9 | 68.2 | 28.9 | 6.38 |
| Remainder of kernels | 45 | 10.9 | 3.5 | 1.63 | 2.7 | 71.8 | 28.7 | 7.20 |
| Nonmoldy ears | | | | | | | | |
| Tip kernels | 16 | 9.9 | 3.9 | 1.50 | 2.3 | 71.4 | 29.5 | 8.01 |
| Butt kernels | 12 | 10.6 | 3.9 | 1.48 | 2.5 | 71.6 | 29.7 | 7.57 |

[a] Analyses reported on dry solids basis. [b] Percent nitrogen × 6.25.

Table III. Effect Upon Composition of Partial Loss of Fat and Starch in Good Kernels as Compared to Heavily Damaged Kernels

| Constituent | Good kernel composition, g | Component loss, % | Good kernel composition after loss, g | Good kernel composition after loss, % |
|---|---|---|---|---|
| Fat | 4 | 63.0 | 1.5 | 1.9 |
| Protein | 10 | 0.0 | 10.0 | 13.0 |
| Starch | 73 | 30.0 | 52.6 | 68.2 |
| Other | 13 | 0.0 | 13.0 | 16.9 |
| Total | 100 | | 77.1 | |

(1957) as the approximately upper limit for freshly harvested corn. Deyoe *et al.* (1968) found that an increase in protein content accompanied grain sorghums of low test weight. In our study, as the degree of blight damage increased, small-to-moderate increases occurred in protein, ash, and fiber (AOAC 1965, standard procedure) contents (Table II). Crude fat (AOAC, 1960, standard procedure) content decreased as blight damage increased, and heavily damaged kernels contained approximately 50% less oil than the good kernels. The decreased oil content was expected in view of the visible damage to the germ portion of the kernel. Heavily damaged kernels also had a slightly lower starch content (Garcia and Wolf, 1972); however, amylose content (Wolf *et al.*, 1970) of the starch fraction remained constant. The pentosan content (AACC Approved Method, 1962) decreased with increasing blight damage.

The variation in chemical composition is in general agreement with changes observed by Bressani and Conde (1961) during maturation of corn from 23 to 58 days after flowering. The results suggest that the blight prevented the corn kernels from reaching their normal state of maturity.

*Helminthosporium maydis* is said to attack the starch and fat in a corn kernel (Hesseltine *et al.*, 1971). Assuming partial destruction of only these two components, appreciable quantities could be lost from a kernel without making large changes in the proximate analysis when the latter is made on a percentage basis. Differences between the heavily damaged and good kernels recorded in Table II could result from loss of more than one-half the fat and about one-fourth the starch normally present, as is shown by compositional data given in Table III.

### AMINO ACID ANALYSIS

When protein content of a grain changes, the possibility of an alteration in amino acid pattern must always be considered. To answer this question, all six samples were analyzed in dup-

Table IV. Amino Acid Content of Blight-Damaged Corn

| Amino acid | Good kernels (Moldy ears) | Moderately damaged kernels (Moldy ears) | Heavily damaged kernels (Moldy ears) | Remainder of kernels (Moldy ears) | Tip kernels (Nonmoldy ears) | Butt kernels (Nonmoldy ears) | LSD[a] |
|---|---|---|---|---|---|---|---|
| | g/16 g of Nitrogen | | | | | | |
| Lysine | 3.40 | 3.48 | 3.34 | 3.42 | 3.29 | 3.23 | 0.56 |
| Histidine | 3.04 | 2.86 | 2.25 | 2.93 | 3.01 | 3.05 | 0.30 |
| Arginine | 5.50 | 5.17 | 4.70[b] | 5.47 | 5.40 | 5.25 | 0.55 |
| Aspartic acid | 7.33 | 7.08 | 7.69 | 7.42 | 7.10 | 7.16 | 0.64 |
| Threonine | 3.96 | 3.96 | 4.39 | 4.06 | 3.92 | 3.87 | 0.46 |
| Serine | 4.97 | 4.99 | 5.22 | 5.07 | 4.96 | 5.00 | 0.34 |
| Glutamic acid | 20.24 | 19.53 | 20.14 | 19.90 | 20.67 | 20.86 | 1.00 |
| Proline | 9.25 | 10.41 | 10.63 | 9.56 | 9.23 | 9.68 | 1.43 |
| Glycine | 4.47 | 4.30 | 4.58[b] | 4.45 | 4.39 | 4.19[b] | 0.16 |
| Alanine | 7.76 | 7.80 | 7.60 | 7.73 | 7.77 | 7.82 | 0.45 |
| Cystine | 1.44 | 1.33 | 1.45 | 1.53 | 1.43 | 1.65 | 0.37 |
| Valine | 5.05 | 5.73 | 5.33 | 5.03 | 5.18 | 4.94 | 1.25 |
| Isoleucine | 3.61 | 3.69 | 3.93 | 3.57 | 3.59 | 3.53 | 0.41 |
| Leucine | 13.09 | 12.51 | 13.41 | 12.51 | 13.16 | 13.32 | 2.29 |
| Tyrosine | 4.71 | 4.63 | 4.57 | 4.57 | 4.77 | 4.40 | 0.55 |
| Phenylalanine | 5.25 | 5.04 | 5.60 | 5.07 | 5.32 | 4.88 | 0.57 |
| Methionine | 3.12 | 2.99 | 3.05 | 2.93 | 3.17 | 3.08 | 0.23 |

[a] Least significant difference (0.05 level) for samples. [b] Significant variation (0.05 level).

licate by the procedure of Benson and Patterson (1965) and the results were statistically evaluated (Table IV). Only arginine and glycine showed statistically significant variation at the 5% level and the variation was associated with the heavily damaged kernels. When a mold is present, the appearance of another protein could be expected; however, none was detected in a quantity sufficient to alter the protein composition. Several unusual amino acid peaks were noted in the heavily damaged kernels as might be expected with mold or bacteria present, but their quantity was small. Only two amino acids were significantly affected, and then only in heavily damaged kernels. Blighted corn had essentially the same protein composition as the nonmoldy corn tested.

## LITERATURE CITED


American Association of Cereal Chemists, AACC Approved Methods 7th ed., St. Paul, Minn., Sec. 52–10, 1962.

Anderson, R. A., Ellis, J. J., Griffin, E. L., Jr., *Cereal Sci. Today* **17**, 41 (1972).

Association of Official Agricultural Chemists, "Official Methods of Analysis," 9th ed., Washington, D. C., 1960.

Association of Official Analytical Chemists, "Official Methods of Analysis," 10th ed., Washington, D. C., 1965.

Baker, D., Neustadt, M. H., Zeleny, L., *Cereal Chem.* **34,** 226 (1957).

Baker, D., Neustadt, M. H., Zeleny, L., *Cereal Chem.* **36,** 308 (1959).

Benson, J. V., Patterson, J. A., *Anal. Chem.* **37,** 1108 (1965).

Brekke, O. L., Peplinski, A. J., Griffin, E. L., Jr., Ellis, J. J., *Cereal Chem.* **49,** 466 (1972).

Bressani, R., Conde, R., *Cereal Chem.* **38,** 76 (1961).

Brown, R. H., *Feedstuffs* **42,** 1 (1970).

Deyoe, C. W., Shoup, F. K., Sanford, P. E., *Poultry Sci.* **47,** 1667 (1968).

Garcia, W. J., Wolf, M. J., *Cereal Chem.* **49,** 298 (1972).

Hesseltine, C. W., Ellis, J. J., Shotwell, O. L., J. AGR. FOOD CHEM. **19,** 707 (1971).

Wolf, M. J., Melvin, E. H., Garcia, W. J., Dimler, R. J., Kwolek, W. F., *Cereal Chem.* **47,** 437 (1970).


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