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Tipburn and other internal disorders

CABBAGE

by Robert F. Becker

INTERNAL TIPBURN

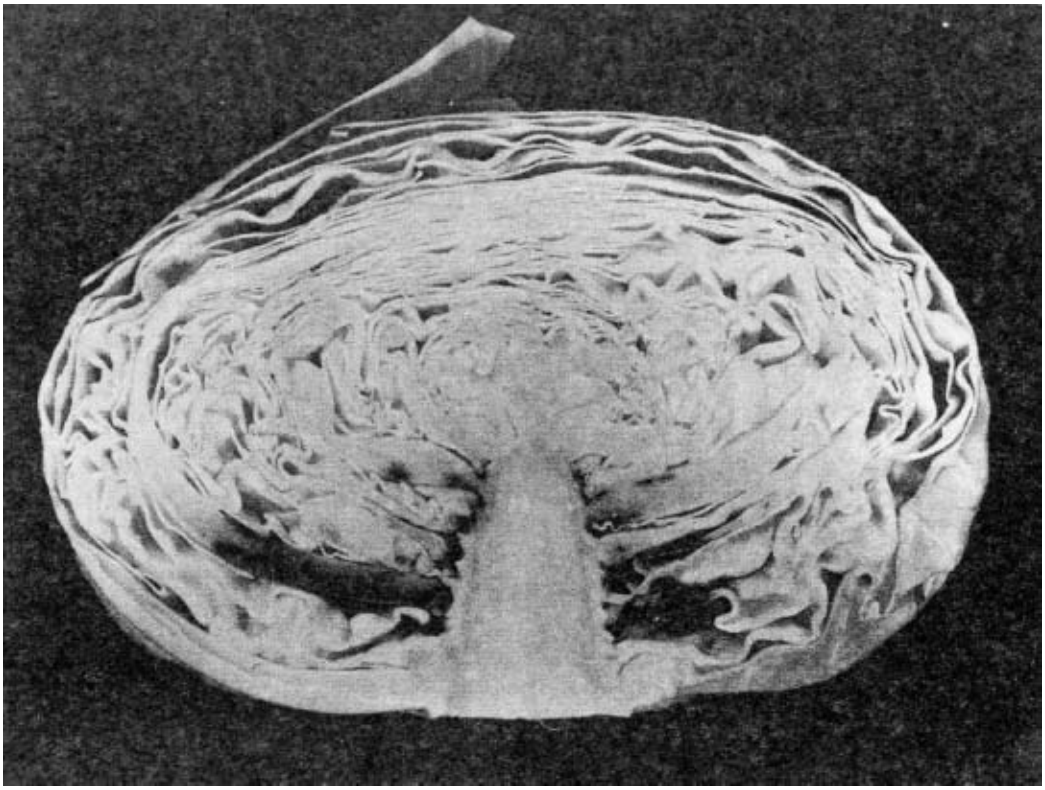
Internal tipburn has been an economic problem in the United States and northern Europe for at least the last 25 years, often causing severe losses to growers and processors. While it has perhaps always occurred in a minor degree, the problem has apparently become more severe in recent years, probably because more intensive production practices are being used to obtain high yields.

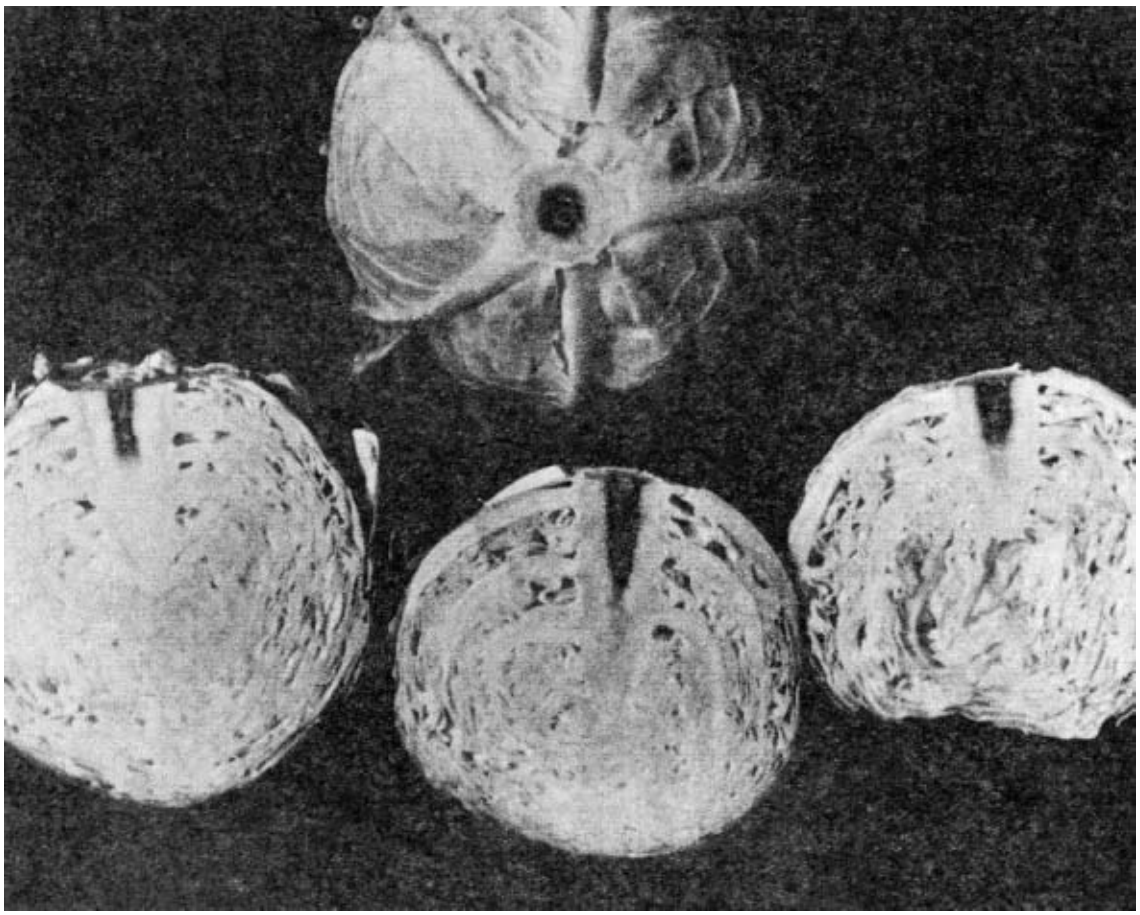
Tipburn consists of a breakdown of the plant tissue near the center of the head and develops as the crop approaches maturity. The affected tissue gradually becomes dried in appearance, tan to brown in color, and papery in texture. Later the tissue may become dark brown or black in color. The affected area may range from a narrow zone along the margins of one or two leaves to a rather extensive area. It appears that the condition is not progressive, but rather that the entire extent of the affected area is involved by the causal factor or factors at one time. White, red, and savoy cabbage are affected, and a similar condition exists in Brussels sprouts.

Although there is still much to learn about tipburn, no disease pathogen (such as fungus or bacteria) has ever been found associated with the problem, and it is believed that tipburn is a physiological disorder associated with growing conditions and plant nutrition. Research done in Wisconsin has shown that the calcium content in affected areas is very low, while the potassium content is high. It is felt that tipburn may result from an inadequate supply of calcium in the affected leaf margins, causing a collapse of the tissue and death of the cells. (Among other things, calcium is needed for normal cell wall development; since it is immobile within the plant it accumulates in the older tissue, and during periods of rapid growth new tissues do not receive an adequate supply.) A calcium deficiency may occur where the calcium content of the soil is low; or where the calcium content is adequate but an excess of soluble salts (for example, potassium) interferes with calcium absorption by the roots; or where there are soil moisture problems. Excessive soil moisture and insufficient soil moisture have both been suspected as contributing to a calcium deficiency. Tipburn in cabbage bears a resemblance to other physiological disorders such as blossom-end rot of tomatoes, black heart of celery, and tipburn of lettuce; calcium has been shown to be involved in these disorders.

Blossom-end rot of tomatoes and tipburn of lettuce have been found to occur under conditions where water loss from the plant exceeds its uptake. Irregularity of moisture supply and excessive rates of transpiration during periods of rapid growth are believed to be conducive to these disorders. High air temperature favors rapid water loss, whereas low soil temperature retards water absorption by the roots. Such a condition would prevail when a cool, rainy period is followed by a sunny, dry period.

It is also possible that certain respiratory pro-





Top: Black midrib tissue; Bottom: Internal core breakdown.

tion sometimes present in the core of the variety King Cole, and to a lesser extent in other varieties. This condition, which we will refer to as internal core breakdown, appears as a spindle-shaped area in the center of the core. In some cases, the affected area looks water-soaked; in others it becomes hollow; and in yet others a soft black decay develops. This condition looks very similar to boron deficiency in cabbage, but since internal core breakdown has been found in fields that have received large applications of boron over a period of years as part of the standard red beet fertilization program, it is doubtful that the problem is simply due to a lack of boron. Although boron nutrition may well be involved, environmental factors such as moisture and temperature, as well as perhaps other nutrients like calcium and potassium, may also be involved.

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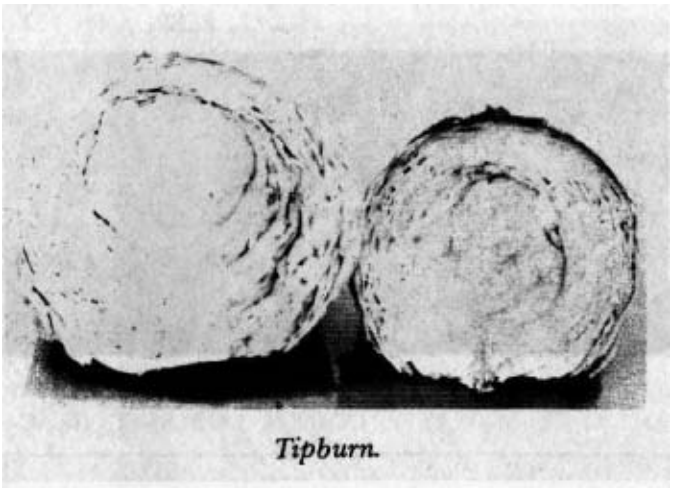

Tipburn.

ducts which under certain conditions build up in the leaf tissue to toxic levels are involved in tipburn expression.

Field observations indicate that tipburn development is favored by rapid plant growth and that the disorder usually occurs in years when yields are high. High fertilization (especially with nitrogen and potassium), wide plant spacing and abundant moisture are believed to be contributing factors. For example, there is usually a greater amount of tipburn in low areas in a field, where moisture, fertility, and organic matter levels tend to be higher than on the knolls. High-yielding vigorously growing varieties seem to be more susceptible than small-headed, low-yielding varieties. Tipburn tends to become more noticeable as the cabbage ripens and is most evident in the fastest-maturing heads in any given field.

Even if the exact nature of internal tipburn were known, control would be difficult if not impossible, because growers have limited control of the environment. Work in Wisconsin showed that weekly sprays of calcium applied for a month prior to maturity did not help, nor did high soil applications of calcium. Reducing the rate of fertilization might help, but since growers are interested in high yields this does not seem like the most practical approach to the problem.

Perhaps the most promising control of tipburn is through selection for disease resistance. For example, the variety TBR (tipburn-resistant) Globe, developed at the University of Wisconsin, tends to be less susceptible to the problem than the parent variety Globe. However, selecting for resistant breeding material is most difficult because of the large number of trials that must be performed under various environmental conditions before one is sure that an individual breeding line really has resistance. To date no breeding material has been found that is truly immune to tipburn. Resistant lines have only a degree of resistance, which may not stand up under conditions which promote severe tipburn.

BLACK MIDRIB TISSUE

Besides tipburn there are at least two other disorders that occur within cabbage heads which are suspected of being physiological in nature.

It has been observed that in some fields in certain years, as heads approach maturity, the bottom side of the petioles (leaf midribs) turn black at or near the point where they attach to the core. The affected area may be quite limited or extend as much as 3 inches along the petiole. Although this condition has not occurred too extensively, it has on occasion caused serious processing problems. Observations would indicate that the degree of susceptibility differs with variety.

When affected tissue was examined under a microscope it was found that the cytoplasm (material within the cell) in the parenchyma cells had collapsed, blackened, and hardened on the cell walls. Cells in the vascular bundles were found to be clear and free of discoloration. No disease pathogen could be isolated from the affected area.

In 1968, this black tissue disorder was observed in a cabbage fertility trial at the New York State Agricultural Experiment Station in Geneva. It was found that plants grown using high rates of potassium chloride (240 and 960 lbs KC1/A) exhibited far less blackened tissue than plants grown at low levels of potassium fertilization (0 or 60 lbs KCl/A), especially if high rates of superphosphate were also used. Chemical analysis of midribs showed that if the petioles contained over 1 per cent potassium (on a dry weight basis) the tissue was not discolored, but if the petioles contained less than 1 per cent potassium, blackened tissue might be present. A survey of growers' fields in 1968 revealed a similar relationship between the per cent potassium and black tissue in the petioles. However, since this condition has only been noted in certain years, it is suspected that an additional undetermined factor or factors influence the appearance of the disorder. Probably, as in the case of tipburn, this is a complex physiological disorder where weather conditions play an important role.

Since research has shown that high rates of potassium chloride fertilization increase the number of burst heads, the beneficial effect of high rates of KC1 in reducing the occurrence of black midrib tissue must be considered in the light of the adverse effect of increased bursting.

INTERNAL CORE BREAKDOWN

Still another problem which also appears to be a physiological disorder is an as yet unnamed condi-