Disorders in Cabbage, Bunched Broccoli, and Cauliflower Shipments to the New York Market, 1972—1985

M. J. CEAPONIS, Research Plant Pathologist, Agricultural Research Service, U.S. Department of Agriculture, New Brunswick, NJ 08903; R. A. CAPPELLINI, Professor of Plant Pathology, Rutgers University, New Brunswick, NJ 08903; and G. W. LIGHTNER, Computer Specialist, U.S. Department of Agriculture, Appalachian Fruit Research Station, Kearneysville, WV 25430

Cabbage (Brassica oleracea var. capitata L.), bunched sprouting broccoli (B. oleracea var. italica L.), and cauliflower (B. oleracea var. botrytis L.) are the principal crucifers consumed in the United States. All three crops are widely grown, but California is the principal supplier of cauliflower (70%) and broccoli (90%) for the fresh market (19). Until recently, cabbage was the leading crucifer shipped to New York City markets (17,18). Its volume has been declining annually, however, while that of broccoli and cauliflower has been increasing (Table 1). The consumption of cruciferous vegetables is expected to increase because of their alleged ability to protect against intestinal cancer (14,16).

This report is a continuation of a series (1—12) on the arrival condition of fresh produce shipped to the New York market. Field and market researchers concerned with maintaining the market quality of cruciferous vegetables should find this information useful in planning strategies to reduce losses from diseases and other disorders. This report was derived from computerized data initially abstracted from USDA inspection certificates.

USDA personnel examined 6,441 shipments of cabbage, broccoli, and cauliflower at New York terminal markets during 1972–1985 (Table 2). To arrive at a reliable appraisal of product quality in a shipment, six containers (cartons, crates, or sacks) of a commodity are routinely inspected; if necessary, more containers are inspected. Diseases and other disorders are either named or described by symptomatology.

Cabbage. Eight parasitic diseases, nine physiological disorders, and five types of injury were reported in 1,952 cabbage inspections (Table 3). About one-half of the 2,891 occurrences of disorders were due to parasitic diseases, with bacterial soft rot (Erwinia and Pseudomonas spp.) accounting for more than 80% of these. Yellowing of the outer leaves and grade defects were the most frequently reported physiological disorder and injury, respectively.

Bacterial soft rot was reported in 60% of the cabbage shipments and was distributed from the lowest incidence class (1—5% heads affected) to the highest (>50% heads affected) (Table 4). Other noteworthy diseases were Alternaria rot (Alternaria sp.), wetty soft rot (Sclerotinia sclerotiorum), black rot (Xanthomonas campestris pv. campestris), and gray mold rot (Botrytis cinerea). Unidentified decays were reported in a considerable number of shipments but mostly in the lowest incidence class. (Inspectors often do not name a disease when the decay does not affect the grade tolerance or when symptoms are not fully developed or are unrecognized.) A number of nonparasitic disorders were reported in all incidence classes, with yellowing, black discoloration, and bruise damage noted more frequently than tipburn and surface discoloration. Freeze damage was also reported in all incidence classes, with >50% of the heads damaged in about one-half of the affected shipments.

Important disorders of the leading cabbage cultivars from the main sources of supply are shown in Table 5. Parasitic diseases and other disorders were reported less frequently in the Chinese cultivar than in the Domestic cultivar. Proportionately more bruising was reported in New York cabbage shipments despite proximity of the producing areas to the market. Interestingly, no reports were made of Alternaria rot, watery soft rot, or gray mold rot in the inspected California shipments. Inspections of the Dutch cultivar from Holland revealed high incidences of bacterial soft rot as well as more black rot than reported in domestic shipments.

Broccoli. Five parasitic diseases, five physiological disorders, and three types of injury were reported in USDA inspections of 1,967 bunched broccoli shipments (Table 6). California shipments accounted for 93% of the inspections. Advanced maturity of bud clusters, manifested by enlargement and/or yellowing, was noted more frequently than the parasitic diseases. These disorders have a much higher tolerance than the more damaging diseases and are more likely to be marketed, although discounted.

Most of the parasitic disease occurrences were bacterial soft rot (Erwinia and Pseudomonas spp.). This disease was reported in all incidence classes, and its destructiveness in the high incidence classes probably resulted in total loss of some shipments. Gray mold rot (B. cinerea) occurred in fewer shipments but was found in all incidence classes and was equally destructive. Unidentified decays were reported in a substantial number of shipments but almost always in the lowest incidence class. Undoubtedly, many of these decays were bacterial soft rot. In the early 1970s, some winter shipments of broccoli arrived in a malodorous condition that may have been reported as an unidentified decay until shown to be suboxidation by Kasmire et al (13). Rhizopus rot (Rhizopus sp.) and watery soft rot (S. sclerotiorum) occurred in less than 1% of the inspected shipments.

Table 1. Volume of cabbage, broccoli, and cauliflower shipped to the New York market, 1972–1985

<table>
<thead>
<tr>
<th>Year</th>
<th>Cabbage</th>
<th>Broccoli</th>
<th>Cauliflower</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>1,875</td>
<td>269</td>
<td>170</td>
</tr>
<tr>
<td>1973</td>
<td>1,198</td>
<td>247</td>
<td>175</td>
</tr>
<tr>
<td>1974</td>
<td>1,178</td>
<td>269</td>
<td>178</td>
</tr>
<tr>
<td>1975</td>
<td>1,211</td>
<td>328</td>
<td>174</td>
</tr>
<tr>
<td>1976</td>
<td>1,050</td>
<td>182</td>
<td>97</td>
</tr>
<tr>
<td>1977</td>
<td>1,037</td>
<td>199</td>
<td>124</td>
</tr>
<tr>
<td>1978</td>
<td>1,028</td>
<td>211</td>
<td>80</td>
</tr>
<tr>
<td>1979</td>
<td>759</td>
<td>250</td>
<td>97</td>
</tr>
<tr>
<td>1980</td>
<td>968</td>
<td>261</td>
<td>144</td>
</tr>
<tr>
<td>1981</td>
<td>1,041</td>
<td>354</td>
<td>266</td>
</tr>
<tr>
<td>1982</td>
<td>885</td>
<td>438</td>
<td>226</td>
</tr>
<tr>
<td>1983</td>
<td>879</td>
<td>489</td>
<td>201</td>
</tr>
<tr>
<td>1984</td>
<td>700</td>
<td>569</td>
<td>214</td>
</tr>
<tr>
<td>1985</td>
<td>650</td>
<td>714</td>
<td>221</td>
</tr>
<tr>
<td>Total</td>
<td>13,670</td>
<td>4,780</td>
<td>2,367</td>
</tr>
</tbody>
</table>

© 1987 The American Phytopathological Society
Table 2. Volumes of cabbage, broccoli, and cauliflower in shipments inspected by USDA on the New York market, 1972-1985

<table>
<thead>
<tr>
<th>Year</th>
<th>Cabbage (Shipments (no.)</th>
<th>Packsa (no.)</th>
<th>Broccoli (Shipments (no.)</th>
<th>Packsb (no.)</th>
<th>Cauliflower (Shipments (no.)</th>
<th>Packsc (no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972</td>
<td>342</td>
<td>161,411</td>
<td>386</td>
<td>232,646</td>
<td>231</td>
<td>166,566</td>
</tr>
<tr>
<td>1973</td>
<td>324</td>
<td>167,662</td>
<td>98</td>
<td>61,339</td>
<td>111</td>
<td>82,081</td>
</tr>
<tr>
<td>1974</td>
<td>188</td>
<td>95,255</td>
<td>76</td>
<td>58,462</td>
<td>64</td>
<td>51,332</td>
</tr>
<tr>
<td>1975</td>
<td>110</td>
<td>51,641</td>
<td>70</td>
<td>48,755</td>
<td>136</td>
<td>98,159</td>
</tr>
<tr>
<td>1976</td>
<td>105</td>
<td>58,273</td>
<td>44</td>
<td>36,488</td>
<td>99</td>
<td>65,533</td>
</tr>
<tr>
<td>1977</td>
<td>103</td>
<td>58,970</td>
<td>38</td>
<td>38,935</td>
<td>82</td>
<td>54,641</td>
</tr>
<tr>
<td>1978</td>
<td>105</td>
<td>60,129</td>
<td>33</td>
<td>27,116</td>
<td>59</td>
<td>32,674</td>
</tr>
<tr>
<td>1979</td>
<td>112</td>
<td>29,806</td>
<td>70</td>
<td>51,564</td>
<td>74</td>
<td>42,311</td>
</tr>
<tr>
<td>1980</td>
<td>36</td>
<td>16,933</td>
<td>79</td>
<td>74,109</td>
<td>138</td>
<td>64,702</td>
</tr>
<tr>
<td>1981</td>
<td>62</td>
<td>32,244</td>
<td>75</td>
<td>44,173</td>
<td>179</td>
<td>81,346</td>
</tr>
<tr>
<td>1982</td>
<td>117</td>
<td>46,315</td>
<td>105</td>
<td>72,309</td>
<td>184</td>
<td>93,431</td>
</tr>
<tr>
<td>1983</td>
<td>89</td>
<td>44,669</td>
<td>258</td>
<td>205,053</td>
<td>382</td>
<td>198,972</td>
</tr>
<tr>
<td>1984</td>
<td>172</td>
<td>90,987</td>
<td>240</td>
<td>176,285</td>
<td>351</td>
<td>220,604</td>
</tr>
<tr>
<td>1985</td>
<td>135</td>
<td>67,339</td>
<td>395</td>
<td>298,264</td>
<td>432</td>
<td>311,617</td>
</tr>
</tbody>
</table>

Total 1,952 981,634 1,967 1,425,498 2,522 1,563,969

a Carton, crate, or sack with net weight of 22.7 kg.
b Carton or crate with net weight of 10.5 kg.
c Film-wrapped carton or crate with net weight of 10.0 or 27.2 kg, respectively.

Table 3. Disorders reported in USDA inspections of 1,952 cabbage shipments on the New York market, 1972-1985

<table>
<thead>
<tr>
<th>Parasitic diseases</th>
<th>Shipments (no.)</th>
<th>Physiological disorders</th>
<th>Shipments (no.)</th>
<th>Injuries</th>
<th>Shipments (no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial soft rot</td>
<td>1,175</td>
<td>Yellowing</td>
<td>372</td>
<td>Grade defects</td>
<td>441</td>
</tr>
<tr>
<td>Unidentified decays</td>
<td>107</td>
<td>Black discoloration</td>
<td>250</td>
<td>Bruise damage</td>
<td>193</td>
</tr>
<tr>
<td>Alternaria rot</td>
<td>44</td>
<td>Sunken discoloration</td>
<td>75</td>
<td>Insect damage</td>
<td>40</td>
</tr>
<tr>
<td>Watery soft rot</td>
<td>27</td>
<td>Tippburn</td>
<td>59</td>
<td>Freeze damage</td>
<td>30</td>
</tr>
<tr>
<td>Black rot</td>
<td>27</td>
<td>Surface discoloration</td>
<td>24</td>
<td>Sunscald</td>
<td>1</td>
</tr>
<tr>
<td>Alternaria leaf spot</td>
<td>25</td>
<td>Burst heads</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray mold rot</td>
<td>21</td>
<td>Internal black discoloration</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black leg</td>
<td>1</td>
<td>Black leaf speck</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shriveljing</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Frequency of disorders reported in USDA inspections of 1,952 cabbage shipments on the New York market, 1972-1985

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Shipments affected (%)</th>
<th>Number of shipments affected according to incidence class (% heads)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Bacterial soft rot</td>
<td>60.2</td>
<td>777</td>
</tr>
<tr>
<td>Grade defectsa</td>
<td>21.1</td>
<td>1,541</td>
</tr>
<tr>
<td>Yellowing</td>
<td>19.1</td>
<td>1,580</td>
</tr>
<tr>
<td>Black discoloration</td>
<td>12.8</td>
<td>1,702</td>
</tr>
<tr>
<td>Bruise damage</td>
<td>9.9</td>
<td>1,759</td>
</tr>
<tr>
<td>Unidentified decays</td>
<td>5.5</td>
<td>1,845</td>
</tr>
<tr>
<td>Sunken discoloration</td>
<td>3.8</td>
<td>1,877</td>
</tr>
<tr>
<td>Tippburn</td>
<td>3.0</td>
<td>1,893</td>
</tr>
<tr>
<td>Alternaria rot</td>
<td>2.3</td>
<td>1,908</td>
</tr>
<tr>
<td>Insect damage</td>
<td>2.0</td>
<td>1,912</td>
</tr>
<tr>
<td>Freeze damage</td>
<td>1.5</td>
<td>1,922</td>
</tr>
<tr>
<td>Watery soft rot</td>
<td>1.4</td>
<td>1,925</td>
</tr>
<tr>
<td>Black rot</td>
<td>1.4</td>
<td>1,925</td>
</tr>
<tr>
<td>Alternaria leaf spot</td>
<td>1.3</td>
<td>1,927</td>
</tr>
<tr>
<td>Surface discoloration</td>
<td>1.2</td>
<td>1,928</td>
</tr>
<tr>
<td>Burst heads</td>
<td>1.2</td>
<td>1,929</td>
</tr>
<tr>
<td>Gray mold rot</td>
<td>1.1</td>
<td>1,931</td>
</tr>
<tr>
<td>Miscellaneousb</td>
<td>0.6</td>
<td>1,940</td>
</tr>
</tbody>
</table>

a Minor mechanical damage, old worm and insect injuries, poor trimming of heads, presence of dirt and other foreign substances, and unidentified defects.
b Internal black discoloration, black leaf speck, shriveljing, black leg, and sunscald.
A condition described by the USDA inspectors as a dark discoloration also was reported in all incidence classes and apparently caused considerable damage. The etiology of this disorder should be investigated. Bruising and freezing were the other important damaging disorders.

**Cauliflower.** Eleven parasitic diseases, six physiological disorders, and three types of injury were identified or described in USDA inspections of 2,522 cauliflower shipments (Table 7). Most inspections (88%) were conducted on California shipments. The leading parasitic disease was bacterial soft rot and the leading physiological disorder was brown discoloration of the curd. Because of its relationship to brown discoloration, bruise damage probably occurred more often than cited.

Bacterial soft rot (*Erwinia* and *Pseudomonas* spp.) was reported in 57% of inspected shipments and accounted for 72% of all disease occurrences. Its seriousness is well illustrated by the substantial number of shipments in the high incidence classes. Jacket leaf decay (probably bacterial soft rot) occurred in fewer shipments and in some cases could have been associated with decay of the curd. Unidentified decays, as with broccoli and cabbage inspections, occurred in substantial numbers, with nearly all in the lowest incidence class. Although *Alternaria* rot (*Alternaria* sp.) was reported infrequently, brown discoloration in some shipments was probably the early stages of brown rot (*A. brassicaceae*) (15). All the other diseases were noted in less than 1% of the inspections.

We listed brown discoloration as a physiological disorder because the symptoms usually develop progressively after an external stimulus. Bruising, in addition to *Alternaria*, was unquestionably a factor. Fuzziness and rinciness describe a curd surface that is, respectively, pubescentlike and abnormally rough. These disorders and “spreading” of the curd are not considered particularly damaging in commerce. Freezing, on the other hand, occurred in relatively few shipments but caused extensive damage.

**Summary.** The data reported here do not represent the general condition of the three cruciferous crops on arrival on the New York market during 1972–1985. USDA inspections in most cases were because the quality of a shipment was suspect or impaired by transit delays or failure of protective services. The contents in the inspected shipments comprised about 4% of cabbage, 7% of broccoli, and 15% of cauliflower volumes delivered. Nonetheless, inspection of so many shipments by trained personnel over 14 years illustrates the seriousness of specific diseases and other disorders that continue to distress these crops during marketing. The preeminence of soft rot bacteria in parasitizing cabbage, broccoli, and cauliflower should come as no surprise. The frequency and magnitude of bacterial soft rot in shipments presumed to be initially sound, however, calls for rectification. No doubt, inappropriate handling and inadequate temperature control provided suitable conditions for invasion by opportunistic soft rot bacteria. The information in this report should be of value to those parties interested in improving quality and reducing losses in the marketing of cruciferous crops.
Table 7. Frequency of disorders reported in USDA inspections of 2,522 cauliflower shipments on the New York market, 1972–1985

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Shipment affected (%)</th>
<th>Number of shipments affected according to incidence class (% heads)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1–5</td>
</tr>
<tr>
<td>Brown discoloration</td>
<td>81.6</td>
<td>464</td>
</tr>
<tr>
<td>Bacterial soft rot</td>
<td>57.5</td>
<td>1,071</td>
</tr>
<tr>
<td>Jacket leaf decay</td>
<td>13.9</td>
<td>2,772</td>
</tr>
<tr>
<td>Fuzziness</td>
<td>12.8</td>
<td>2,199</td>
</tr>
<tr>
<td>Yellowing</td>
<td>9.0</td>
<td>2,321</td>
</tr>
<tr>
<td>Unidentified decays</td>
<td>6.7</td>
<td>2,354</td>
</tr>
<tr>
<td>Riciness</td>
<td>5.7</td>
<td>2,377</td>
</tr>
<tr>
<td>Spreading</td>
<td>5.1</td>
<td>2,394</td>
</tr>
<tr>
<td>Freeze damage</td>
<td>1.4</td>
<td>2,487</td>
</tr>
<tr>
<td>Alternaria rot</td>
<td>1.1</td>
<td>2,492</td>
</tr>
<tr>
<td>Bruise damage</td>
<td>1.1</td>
<td>2,495</td>
</tr>
<tr>
<td>Gray mold rot</td>
<td>0.4</td>
<td>2,513</td>
</tr>
<tr>
<td>Insect damage</td>
<td>0.4</td>
<td>2,513</td>
</tr>
<tr>
<td>Black surface mold</td>
<td>0.2</td>
<td>2,517</td>
</tr>
<tr>
<td>Rhizopus rot</td>
<td>0.1</td>
<td>2,519</td>
</tr>
<tr>
<td>Miscellaneous*</td>
<td>0.2</td>
<td>2,517</td>
</tr>
</tbody>
</table>

* Watery soft rot, brown rot, Fusarium rot, cottony leak, and soft heads.

ACKNOWLEDGMENT

We thank the New York office of the USDA Fresh Fruit and Vegetable Inspection, Fresh Products Branch of the Agricultural Marketing Service for making available the inspection certificates from which the data for this report were obtained.

LITERATURE CITED