Disorders in Apple and Pear Shipments to the New York Market, 1972–1984

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Of all temperate zone fruit crops delivered to terminal markets, the apple is second only to grapes in importance. World production of apples annually is approximately 17 million t, of which the United States grows about 4.6 million t (15). About 50% of the U.S. commercial crop is consumed fresh. Ten commercially grown cultivars account for some 90% of the apples produced in the United States, with the Delicious cultivars composing the major group. The principal U.S. growing areas are Washington, Oregon, and California in the West and New York, Michigan, Pennsylvania, and Virginia in the East.

World production of pears is approximately 5 million t a year, with the United States producing about 14% (15). California is the leading producer, followed by Washington and Oregon; collectively, these states produce over 90% of the U.S. crop. The Bartlett, or "summer," pear is the world's leading cultivar and accounts for approximately 80% of U.S. production. The Anjou and Bosc cultivars account for about 75 and 20%, respectively, of the U.S. "winter" pear crop.

When the arrival condition of fresh produce is questioned by shippers or receivers, an inspection by the U.S. Department of Agriculture is requested to determine if grade and quality standards have been met. Inspectors, trained to identify disorders by symptomatology and pathogenic signs, record their findings on certificates. With the cooperation of the USDA, we have established a computerized data bank on the arrival condition of fresh produce at New York terminal markets. Data from these certificates retrieved from the computer provide the information for this report—a continuation of a series on the arrival condition of USDA-inspected fresh produce shipments on the New York market (1,2,5–11). This information may be valuable in formulating programs to upgrade quality and to reduce losses in the marketing channels.

Apples. During 1972–1984, inspections were conducted on 4,453 shipments containing 70,128 t, or 6%, of the apples delivered to the New York market (Table 1) from 23 states and eight countries (13,14). About 75% of the inspected shipments were from Washington State. Twelve parasitic diseases, 11 physiological disorders, and nine kinds of injury were reported, the number of occurrences totaling 5,674 (Table 2). More than two-thirds of the reports concerned injuries, most often bruise damage. Unidentified decays and blue mold rot accounted for 90% of the parasitic diseases, and scald, bitter pit, and internal breakdown accounted for 75% of the physiological disorders.

Blue mold rot (*Penicillium expansum*) was more damaging than other parasitic diseases even though unidentified decays were reported twice as often (Table 3). Practically all unidentified decays occurred in shipments with 1–5% of the fruit diseased, whereas blue mold rot occurred in a substantial number of shipments with more than 5% of the fruit affected. In all probability, many "unidentified decays" were early stages of blue mold rot; federal inspectors often do not name a disease when the grade tolerance is met or when the characteristic symptom expression is not fully developed or recognized. Gray rot (*Botrytis* sp.) was the only other parasitic disease of any economic importance. Occurrences of such field diseases as scab (*Venturia inaequalis*) and bitter rot (*Glomerella cingulata*) were negligible.

The most damaging physiological disorders were scald, bitter pit, and internal breakdown; these were reported in fewer shipments than unidentified decays and blue mold rot but were distributed in higher incidence classes. The causes of scald and bitter pit have not been established, but production factors influence the severity of both disorders. Internal breakdown may occur after such disorders as water core, freeze damage, and bruise damage, usually on large, overmature apples (12). External discoloration (a term USDA inspectors often use for surface discoloration of unknown etiology) was also noted in higher incidence classes in a number of shipments.

Bruise damage was the most important nondisease disorder, with 75% of the shipments affected and approximately 21% of the loads in these shipments sustaining 11 to more than 50% damage (Table 4). Although freeze damage was reported in only 4.3% of the shipments, most had 11 to more than 50% of the contents damaged. The other nondisease disorders of note were scars, cuts/punctures, misshapen fruit, and shriveling.

Table 5 gives the frequency of important diseases of the major apple cultivars. The sequence of important diseases was similar in shipments of Delicious, Golden Delicious, and Winesap apples. Unidentified decays and blue mold rot were reported in about the same percentage of shipments for all cultivars, but scald and bitter pit were reported in significantly more shipments of Granny Smith apples than of the other cultivars. Most of the data on Granny Smith apples were obtained from inspections of shipments from Australia and Chile.

Table 1. Apple and pear shipments inspected by the USDA on the New York market, 1972–1984

	Apples		Pears	
Year	Shipments (no.)	Packs[a] (no.)	Shipments (no.)	Packs[b] (no.)
1972	512	419,467	577	435,801
1973	431	400,476	282	218,867
1974	405	401,143	354	305,777
1975	583	564,809	500	441,973
1976	441	399,714	632	609,630
1977	246	235,772	339	344,546
1978	187	178,616	127	141,756
1979	46	38,961	98	74,476
1980	259	198,863	210	157,573
1981	283	244,060	254	211,045
1982	337	253,467	456	378,000
1983	400	264,461	301	229,587
1984	323	257,238	279	217,547
Total	4,453	3,857,047	4,409	3,766,578

[a] Crates or cartons with 18.16 kg of fruit.
[b] Crates or cartons with 20.43–20.88 kg of fruit.

Table 2. Disorders reported in USDA inspections of 4,453 apple shipments on the New York market, 1972–1984

Parasitic diseases	Shipments (no.)	Physiological disorders	Shipments (no.)	Injuries	Shipments (no.)
Unidentified decays	668	Scald	198	Bruise damage	3,344
Blue mold rot	337	Bitter pit	157	Freeze damage	192
Gray mold rot	49	Internal breakdown	83	Scarring	167
Bitter rot	10	External discoloration	72	Cuts/punctures	148
Scab	9	Shriveling	19	Misshapen fruit	88
Bull's eye rot	9	Water core	10	Insect damage	31
Alternaria rot	5	Overripe fruit	8	Hail damage	30
Black rot	3	Russeting	7	Sunburn	6
Others[a]	4	Internal browning	6	Chemical damage	4
		Soft fruit	6		
		Cork spot	4		

[a] Brown rot, core rot, fruit spot, and moldy stems.

Table 3. Frequency of diseases reported in USDA inspections of 4,453 apple shipments on the New York market, 1972–1984

Disease	Shipments affected (%)	Number of shipments affected according to incidence class (% fruit)					
		0	1–5	6–10	11–20	21–50	>50
Unidentified decays	15.1	3,785	663	1	4	0	0
Blue mold rot	7.6	4,116	282	43	11	1	0
Scald	4.6	4,250	153	41	6	3	0
Bitter pit	3.5	4,296	103	26	27	1	0
Internal breakdown	1.9	4,370	39	21	17	5	1
External discoloration	1.6	4,381	46	13	12	0	1
Gray mold rot	1.1	4,404	49	0	0	0	0
Bitter rot	0.2	4,443	7	3	0	0	0
Water core	0.2	4,443	1	1	2	3	3
Scab	0.2	4,444	9	0	0	0	0
Bull's eye rot	0.2	4,444	9	0	0	0	0
Internal browning	0.1	4,447	2	1	2	1	0
Alternaria rot	0.1	4,448	5	0	0	0	0
Cork spot	0.1	4,449	2	2	0	0	0
Black rot	0.1	4,450	1	0	2	0	0
Others[a]	0.1	4,450	2	0	1	0	0

[a] Brown rot, moldy stems, and fruit spot.

Table 4. Frequency of disorders other than diseases reported in USDA inspections of 4,453 apple shipments on the New York market, 1972–1984

Disorder	Shipments affected (%)	Number of shipments affected according to incidence class (% fruit)					
		0	1–5	6–10	11–20	21–50	>50
Bruise damage	75.1	1,109	2,030	614	572	121	7
Freeze damage	4.3	4,261	17	44	62	46	23
Scarring	3.8	4,286	148	19	0	0	0
Cuts/punctures	3.3	4,305	145	3	0	0	0
Misshapen fruit	2.0	4,365	81	7	0	0	0
Insect damage	0.7	4,422	31	0	0	0	0
Hail damage	0.7	4,423	28	2	0	0	0
Shriveling	0.4	4,436	10	4	3	0	0
Overripe fruit	0.2	4,445	5	3	0	0	0
Russeting	0.2	4,446	7	0	0	0	0
Sunburn	0.1	4,447	5	1	0	0	0
Chemical damage	0.1	4,450	3	0	0	0	0

Table 5. Frequency of important diseases reported in USDA inspections of 2,261 Delicious, 1,350 Golden Delicious, 233 Winesap, and 177 Granny Smith apple shipments on the New York market, 1972–1984

Cultivar Disease	Shipments affected (%)	Number of shipments affected according to incidence class (% fruit)					
		0	1-5	6-10	11-20	21-50	>50
Delicious							
Unidentified decays	14.1	1,943	315	1	2	0	0
Blue mold rot	7.4	2,094	139	23	5	0	0
Scald	2.8	2,197	54	9	1	0	0
Internal breakdown	2.0	2,215	24	12	7	3	0
Bitter pit	1.7	2,222	23	12	4	0	0
Gray mold rot	1.2	2,234	27	0	0	0	0
Others[a]	1.3	2,232	20	2	1	3	3
Golden Delicious							
Unidentified decays	14.1	1,160	188	0	2	0	0
Blue mold rot	7.3	1,251	82	13	4	0	0
Scald	5.0	1,283	57	7	2	1	0
Bitter pit	4.5	1,289	46	7	8	0	0
Gray mold rot	0.8	1,339	11	0	0	0	0
Others[b]	1.5	1,330	15	3	2	0	0
Winesap							
Unidentified decays	18.9	189	44	0	0	0	0
Blue mold rot	6.0	219	12	2	0	0	0
Scald	2.2	228	5	0	0	0	0
Internal breakdown	0.9	231	1	0	1	0	0
Gray mold rot	0.4	232	1	0	0	0	0
Granny Smith							
Unidentified decays	25.4	132	45	0	0	0	0
Bitter pit	23.2	136	22	4	14	1	0
Scald	13.0	154	13	8	1	1	0
Blue mold rot	6.8	165	10	1	1	0	0
Gray mold rot	2.3	173	4	0	0	0	0
Others[c]	1.7	174	1	1	1	0	0

[a] Water core, scab, bitter rot, bull's eye rot, Alternaria rot, and cork spot.
[b] Alternaria rot, scab, cork spot, bull's eye rot, moldy stems, and water core.
[c] Alternaria rot, bitter rot, and internal breakdown.

Table 6. Disorders reported in USDA inspections of 4,409 pear shipments on the New York market, 1972–1984

Parasitic diseases	Shipments (no.)	Physiological disorders	Shipments (no.)	Injuries	Shipments (no.)
Blue mold rot	964	External discoloration	1,224	Bruise damage	771
Unidentified decays	669	Shriveling	105	Freeze damage	172
Gray mold rot	197	Scald	96	Scarring	132
Bull's eye rot	42	Overripe fruit	74	Cuts/punctures	82
Side rot	29	Core breakdown	39	Insect damage	47
Rhizopus rot	18	Soft fruit	38	Rolling damage	3
Brown rot	15	Black end	29	Hail damage	1
Moldy stems	9	Internal breakdown	29		
Alternaria rot	6	Misshapen fruit	25		
Black rot	2	Russeting	20		
Bitter rot	1	Sunken discoloration	12		
Black spot	1	Cork spot	3		
		Pithy brown core	2		
		Boron deficiency	1		

Pears. Pears from eight countries and eight states in 4,409 shipments of approximately 77,900 t, or 13% of the total delivered to the New York market, were inspected during 1972–1984 (Table 1). Twelve parasitic diseases, 14 physiological disorders, and seven kinds of injury were recorded, the number of occurrences totaling 4,858 (Table 6). Parasitic diseases, particularly blue mold rot and unidentified decays, were reported in more shipments than physiological disorders or injuries. Of all the disorders, external discoloration was reported most often. More than one-half of the injuries were bruise damage.

Blue mold rot was the most damaging disorder reported, affecting 22% of the shipments inspected and distributed throughout all incidence classes (Table 7); in 111 shipments, more than 10% of the fruit was rotted. Gray mold rot was reported less often than unidentified decays but probably was more damaging because it was distributed throughout all incidence classes. Rhizopus rot was also distributed throughout all incidence classes but affected less than 1% of the shipments; *Mucor* was probably misidentified as *Rhizopus* in some shipments. Scald was the most prevalent physiological disorder; of lesser importance were black end, core breakdown, and internal breakdown.

External discoloration and bruise damage were the most

Table 7. Frequency of diseases reported in USDA inspections of 4,409 pear shipments on the New York market, 1972–1984

Disease	Shipments affected (%)	Number of shipments affected according to incidence class (% fruit)					
		0	1-5	6-10	11-20	21-50	>50
Blue mold rot	21.9	3,445	649	204	69	29	13
Unidentified decays	15.2	3,740	659	3	6	0	1
Gray mold rot	4.5	4,212	147	28	14	6	2
Scald	2.1	4,313	73	21	2	0	0
Bull's eye rot	1.0	4,367	33	9	0	0	0
Core breakdown	0.9	4,370	16	5	6	9	3
Black end	0.7	4,380	16	4	6	2	1
Side rot	0.7	4,380	17	4	5	3	0
Internal breakdown	0.6	4,380	17	6	2	4	0
Rhizopus rot	0.4	4,391	7	6	1	3	1
Brown rot	0.3	4,394	6	6	3	0	0
Moldy stems	0.2	4,400	3	3	1	2	0
Alternaria rot	0.1	4,403	5	0	1	0	0
Cork spot	0.1	4,406	3	0	0	0	0
Black rot	<0.1	4,407	2	0	0	0	0
Others[a]	0.1	4,404	3	1	1	0	0

[a] Pithy brown core, bitter rot, black spot, and boron deficiency.

Table 8. Frequency of disorders other than diseases reported in USDA inspections of 4,409 pear shipments on the New York market, 1972–1984

Disorder	Shipments affected (%)	Number of shipments affected according to incidence class (% fruit)					
		0	1-5	6-10	11-20	21-50	>50
External discoloration	27.8	3,185	647	243	275	54	5
Bruise damage	17.5	3,638	611	107	45	6	2
Freeze damage	3.9	4,237	10	39	51	44	28
Scarring	3.0	4,277	102	28	2	0	0
Shriveling	2.4	4,304	68	23	9	4	1
Cuts/punctures	1.9	4,327	76	5	1	0	0
Overripe fruit	1.7	4,335	35	16	7	12	4
Insect damage	1.1	4,362	46	1	0	0	0
Soft fruit	0.9	4,371	22	6	8	2	0
Misshapen fruit	0.6	4,384	22	2	1	0	0
Russeting	0.5	4,389	19	1	0	0	0
Rolling damage	0.1	4,406	2	1	0	0	0
Hail damage	<0.1	4,408	1	0	0	0	0

frequently reported nondisease disorders and were noted in all incidence classes (Table 8). Freeze damage, shriveling, and overripe fruit, although reported much less often, caused substantial damage, as evidenced by their distribution in the higher incidence classes.

The sequence of important diseases was similar among the Bartlett, Anjou, and Bosc cultivars (Table 9), although blue mold rot was reported more than twice as often in Bosc pears as in the other two cultivars. Black end was reported almost exclusively in Bartlett pears, whereas side rot (*Phialophora malorum*) was noted principally in Bosc pears.

Summary. The information presented here is not wholly representative of the arrival condition of all apples and pears on the New York market. Many inspections were made at the request of receivers who questioned the condition of the fruit because of malfunctioning of protective services, transit delays, or some apparent loss of quality. However, trained inspectors examined a minimum of six boxes of fruit and more if requested. Thus, at least 1 million kilograms of fruit were examined over the 13-year period, representing a fairly accurate appraisal of the type and incidence of disorders found in apples and pears. As the fruit moves through the marketing channels, some of these disorders worsen and cause additional deterioration at the retail and consumer levels (3,4). The information in this report should be useful to the industry in improving quality and reducing serious losses in apples and pears during marketing.

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Table 9. Frequency of important diseases reported in USDA inspections of 1,645 Bartlett, 1,443 Anjou, and 766 Bosc pear shipments on the New York market, 1972–1984

Cultivar Disease	Shipments affected (%)	Number of shipments affected according to incidence class (% fruit)					
		0	1–5	6–10	11–20	21–50	>50
Bartlett							
Blue mold rot	15.3	1,393	174	42	19	10	7
Unidentified decays	13.3	1,427	214	2	2	0	0
Gray mold rot	4.1	1,577	51	8	7	2	0
Scald	2.3	1,604	31	10	0	0	0
Core breakdown	1.6	1,619	13	4	4	4	1
Black end	1.0	1,628	9	0	5	2	1
Rhizopus rot	0.7	1,634	2	5	1	3	0
Bull's eye rot	0.6	1,635	7	3	0	0	0
Others[a]	0.8	1,632	7	5	1	0	0
Anjou							
Blue mold rot	19.0	1,169	203	50	16	5	0
Unidentified decays	16.6	1,203	239	0	1	0	0
Gray mold rot	4.0	1,386	51	4	0	2	0
Scald	1.5	1,421	16	6	0	0	0
Core breakdown	1.2	1,426	7	2	3	4	1
Bull's eye rot	0.8	1,431	10	2	0	0	0
Others[b]	1.3	1,424	15	4	0	0	0
Bosc							
Blue mold rot	42.6	440	191	88	31	12	4
Unidentified decays	14.5	655	109	1	1	0	0
Gray mold rot	6.5	716	34	13	2	0	1
Bull's eye rot	2.6	746	16	4	0	0	0
Side rot	2.2	749	9	4	2	2	0
Scald	1.7	753	10	3	0	0	0
Brown rot	1.4	755	6	2	3	0	0
Core breakdown	0.9	759	3	1	1	1	1
Others[c]	1.3	756	6	1	3	0	0

[a] Side rot, black rot, Alternaria rot, moldy stems, and pithy brown core.
[b] Side rot, Rhizopus rot, black end, black spot, cork spot, and boron deficiency.
[c] Rhizopus rot, Alternaria rot, cork spot, and pithy brown core.

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