Disorders in Tomato Shipments to the New York Market, 1972–1984

M. J. CEPONIS, 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, West Virginia University, Appalachian Fruit Research Station, Kearneysville, WV 25430

Thousands of fresh fruit and vegetable shipments are examined on the New York market each year by trained inspectors of the U.S. Department of Agriculture. Receivers or shippers request and pay for the services provided by the inspectors. Most inspections are conducted on fresh produce shipments whose acceptability is being questioned at the wholesale level, and results are recorded on certificates. Access to these certificates motivated us to establish a computerized data bank containing information abstracted from more than 125,000 federal inspections made during 1972–1984 on 30 major fruit and vegetable crops. This report concerns the condition of fresh tomato shipments on arrival at the New York market.

About 70,000 t of fresh tomatoes (*Lycopersicon esculentum* Mill.) are delivered annually to metropolitan New York, placing the commodity among the top 10 volume leaders of fresh fruits and vegetables (5,6). Florida supplies 42–48% of the total volume each year and California, 22–28%. The remainder come mainly from Mexico, Puerto Rico, southeastern states, and New York and neighboring states (5,6).

USDA inspectors classify tomatoes into three types: round, cherry, and plum. About 11% of all tomato shipments to the New York market during 1972–1984 were inspected. Of the 9,059 inspected shipments, 8,030 were of round tomatoes, 692 were of cherry tomatoes, and 337 were of plum tomatoes. Inspected shipments contained nearly 9 million packs (wooden boxes, lugs, cartons, or one- or two-layer flats or trays) of tomatoes (Table 1). Round and plum tomato packs weighed 9.1–13.6 kg, with most at 11.4 kg, and cherry tomatoes were usually prepackaged in 473-cm^3 plastic baskets, 12 to a flat. Truck shipments predominated every year; the number of rail shipments, which originated mainly in the West, decreased substantially after 1975.

More than 31,000 instances of damage affecting grade or condition (Table 2) were reported by USDA inspectors, trained to diagnose disorders by symptomatology. Physiological disorders were most numerous (13,405 instances) but parasitic diseases (11,503 instances) were more destructive. Injuries that were principally mechanical or caused by insects or temperature extremes were noted 6,627 times.

Inspectors identified 26 parasitic diseases. When requested, USDA market pathologists assisted inspectors. Surprisingly, sour/watery rot (*Geotrichum candidum*) was identified most frequently. Lesions on green fruit are usually firm and have a dull, greasy, water-soaked appearance. Advanced rot appears pickled and has a sour odor. Sour/watery rot on ripe or ripening fruit is soft and watery and often followed by bacterial soft rot (4). Possibly, many of the sour/watery rot lesions were early or indistinguishable stages of bacterial soft rot or Rhizopus soft rot. Gray mold rot (*Botrytis cinerea*) and bacterial soft rot (*Erwinia carotovora*) were also reported frequently. In 2,202 instances of decay, the cause was not identified.

Field diseases were not common, although late blight rot (*Phytophthora infestans*) and Phytophthora rot (*Phytophthora* spp.) were reported fairly often (Table 2). Late blight rot typically appears as a firm, brown to rusty brown lesion with a pebbly surface and indefinite margin. Phytophthora rots are firm and water-soaked, and a tough, sometimes wet, appressed white mold occurs in advanced stages (4). Other field diseases, such as anthracnose (*Colletotrichum coccodes*), buckeye rot (*Phytophthora* spp.), and early blight rot (*Alternaria solani*),

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

Year	Railcar		Truck		Other[a]		Total	
	Shipments (no.)	Packs[b] (no.)	Shipments (no.)	Packs (no.)	Shipments (no.)	Packs (no.)	Shipments (no.)	Packs (no.)
1972	193	169,432	948	682,981	4	3,568	1,145	855,981
1973	175	223,465	781	828,290	10	935	966	1,052,690
1974	149	190,983	561	566,497	3	2,531	713	760,011
1975	160	207,279	652	596,020	4	1,845	816	805,144
1976	103	141,030	673	661,982	9	4,709	785	807,721
1977	57	77,200	387	379,308	1	1,900	445	458,408
1978	9	12,830	322	309,460	9	3,656	340	325,946
1979	38	48,746	236	215,096	1	60	275	263,902
1980	22	25,782	505	414,021	10	7,606	537	447,409
1981	21	23,775	565	508,510	23	14,171	609	546,456
1982	91	93,044	550	523,247	24	15,124	665	631,415
1983	58	73,264	730	787,252	69	60,460	857	920,976
1984	39	58,832	649	707,561	218	205,428	906	971,821
Total	1,115	1,345,662	7,559	7,180,225	385	321,993	9,059	8,847,880

[a] Air, boat, or undetermined (on-site lot inspections).
[b] Principally cartons or lugs averaging 11.4 kg.

Table 2. Disorders reported in USDA inspections of 9,059 tomato shipments on the New York market, 1972–1984

Parasitic diseases	No.	Physiological disorders	No.	Injuries	No.
Sour/watery rot	3,202	Soft fruit	5,983	Shoulder scars	3,382
Gray mold rot	2,530	Sunken discoloration	3,342	Grade defects[a]	1,491
Bacterial soft rot	2,285	Misshapen/cat face	2,493	Bruise damage	1,270
Unidentified decays	2,202	Growth cracks	1,052	Insect damage	308
Alternaria rot	728	Surface discoloration	155	Sunscald/sunburn	86
Rhizopus soft rot	168	Blossom-end rot	144	Freeze damage	77
Late blight rot	152	Internal browning	91	Other[b]	13
Phytophthora rot	89	Fruit tumor (waxy blister)	51		
Anthracnose	24	Shriveling	45		
Bacterial speck	23	Puffiness	35		
Bacterial spot	19	Irregular coloring	14		
Buckeye rot	11				
Phoma rot	10				
Virus mottling	10				
Miscellaneous[c]	50				
Total	11,503		13,405		6,627

[a] Principally minor bruises, scars, and cuts.
[b] Cloudy spot, punctures, and abrasions.
[c] Fusarium rot, soil rot, ghost spot, stem-end rot, bacterial necrosis, Phomopsis rot, Sclerotium rot, Pleospora rot, blue mold rot, nailhead spot, early blight rot, bacterial canker, and spotted wilt.

Table 3. Diseases reported most frequently in USDA inspections of 9,059 tomato shipments on the New York market, 1972–1984

Year	Sour/watery rot (no.)	Gray mold rot (no.)	Bacterial soft rot (no.)	Unidentified decays (no.)	Alternaria rot (no.)	Rhizopus soft rot (no.)	Late blight rot (no.)	Blossom-end rot (no.)	Internal browning (no.)	Phytophthora rot (no.)
1972	246	303	583	239	244	22	8	17	18	0
1973	325	345	507	163	105	24	7	13	6	46
1974	253	174	268	210	12	17	5	16	4	3
1975	255	219	149	227	36	13	2	16	4	0
1976	171	101	105	249	11	7	3	12	10	0
1977	172	66	93	101	17	3	34	32	6	0
1978	160	42	117	64	9	2	3	7	0	0
1979	113	80	65	77	23	3	4	1	0	10
1980	176	70	44	220	42	4	19	1	3	2
1981	260	144	54	170	51	12	12	2	8	13
1982	280	258	48	166	23	15	31	2	1	3
1983	390	350	133	152	80	19	21	4	8	6
1984	401	378	119	164	75	27	3	21	23	6
Total	3,202	2,530	2,285	2,202	728	168	152	144	91	89
Percent	35.3	27.9	25.2	24.3	8.0	1.9	1.7	1.6	1.0	1.0

Table 4. Leading disorders reported in USDA inspections of tomato shipments to the New York market from principal sources of supply, 1972–1984

			Disorders and percentage of shipments affected											
Source	Tomato type	No. of shipments	Soft fruit	Shoulder scars	Grade defects[a]	Misshapen/cat face	Sour/watery rot	Gray mold rot	Sunken discoloration	Bacterial soft rot	Unidentified decays	Bruise damage	Growth cracks	Alternaria rot
California	Round	2,763	66.4	51.5	44.7	34.1	32.4	31.2	28.4	27.4	27.1	16.6	12.9	6.1
	Cherry	152	77.0	13.2	13.8	2.6	15.1	13.2	10.5	9.2	26.3	8.6	···	4.0
Florida	Round	2,729	60.0	37.8	43.6	31.8	38.8	26.1	47.1	25.5	25.4	16.3	14.6	8.6
	Cherry	71	90.1	···	5.6	···	40.8	28.2	22.5	5.6	11.3	···	2.8	7.0
Mexico	Round	1,186	83.3	44.1	42.5	30.5	29.9	23.9	32.8	31.4	21.7	17.9	15.6	10.5
	Cherry	404	86.1	5.7	12.1	2.0	18.4	24.3	12.9	18.6	22.3	3.5	0.2	12.4
	Plum	261	91.2	1.2	7.3	0.4	42.9	38.3	39.1	15.0	18.8	3.4	···	16.9
Pennsylvania	Round	175	24.0	13.7	15.4	16.0	32.0	25.7	48.0	6.9	18.3	2.2	2.2	13.1
Virginia	Round	135	29.3	23.3	15.8	16.5	59.3	34.6	53.4	25.6	14.3	6.0	5.3	···
Puerto Rico	Round	108	64.2	2.8	6.5	2.8	46.3	51.9	70.4	29.6	7.4	3.7	0.9	5.6

[a] Principally minor bruises, scars, and cuts.

Table 5. Frequency of leading disorders reported in USDA inspections of 8,030 shipments of round tomatoes on the New York market, 1972–1984

Disorder	Number of shipments affected according to incidence class (% fruits)										
	0	1	2-5	6-10	11-15	16-20	21-25	26-33	34-50	51-75	>75
Soft fruit	2,926	377	1,613	1,257	719	447	226	229	187	41	8
Shoulder scars	4,699	30	642	857	654	450	280	241	150	24	3
Grade defects[a]	4,723	34	2,476	694	67	26	7	3	0	0	0
Sunken discoloration	4,906	126	940	935	597	247	120	89	54	15	1
Sour/watery rot	5,118	91	1,433	923	259	106	54	28	11	5	2
Misshapen/cat face	5,557	37	1,876	480	56	16	6	1	1	0	0
Gray mold rot	5,773	75	1,167	695	190	71	39	11	5	3	1
Bacterial soft rot	5,896	111	1,371	442	125	36	25	17	6	1	0
Unidentified decays	6,043	737	1,035	126	45	19	11	9	5	0	0
Bruise damage	6,805	60	954	155	30	14	6	5	1	0	0
Growth cracks	6,981	27	924	89	6	0	2	1	0	0	0
Alternaria rot	7,425	24	377	151	30	10	3	6	4	0	0
Insect damage	7,724	14	264	25	2	0	1	0	0	0	0

[a] Principally minor bruises, scars, and cuts.

Table 6. Frequency of leading disorders reported in USDA inspections of 692 shipments of cherry tomatoes on the New York market, 1972–1984

Disorder	Number of shipments affected according to incidence class (% fruits)										
	0	1	2-5	6-10	11-15	16-20	21-25	26-33	34-50	51-75	>75
Soft fruit	115	12	77	135	86	86	58	64	38	17	4
Gray mold rot	540	2	43	65	23	9	1	0	9	0	0
Unidentified decays	542	70	72	4	2	1	1	0	0	0	0
Sour/watery rot	543	2	54	48	15	19	5	2	4	0	0
Bacterial soft rot	591	6	51	28	8	4	4	0	0	0	0
Sunken discoloration	604	4	20	32	17	6	4	3	1	1	0
Grade defects[a]	607	6	61	18	0	0	0	0	0	0	0
Alternaria rot	627	1	26	22	4	7	1	0	3	1	0
Shoulder scars	645	1	21	7	3	6	6	2	1	0	0
Bruise damage	661	1	10	10	4	2	0	4	0	0	0
Freeze damage	662	0	0	2	6	6	0	1	3	8	4
Rhizopus soft rot	679	1	5	4	3	0	0	0	0	0	0

[a] Principally minor bruises, scars, and cuts.

Table 7. Frequency of leading disorders reported in USDA inspections of 337 plum tomato shipments on the New York market, 1972–1984

Disorder	Number of shipments affected according to incidence class (% fruits)										
	0	1	2-5	6-10	11-15	16-20	21-25	26-33	34-50	51-75	>75
Soft fruit	35	8	49	81	51	36	17	26	21	11	2
Sour/watery rot	196	2	42	54	19	16	2	3	2	1	0
Sunken discoloration	207	3	59	29	23	6	3	4	3	0	0
Gray mold rot	216	0	36	47	21	10	4	2	1	0	0
Unidentified decays	272	17	45	3	0	0	0	0	0	0	0
Alternaria rot	282	1	16	24	6	2	1	3	1	1	0
Bacterial soft rot	287	4	21	19	3	1	1	1	0	0	0
Grade defects[a]	312	2	12	10	0	0	0	1	0	0	0
Internal browning	313	2	4	6	5	4	1	0	2	0	0
Bruise damage	323	2	7	2	3	0	0	0	0	0	0
Rhizopus soft rot	325	0	3	6	0	2	0	0	0	0	1

[a] Principally minor bruises, scars, and cuts.

were noted in relatively few shipments, as were bacterial spot (*Xanthomonas vesicatoria*) and bacterial speck (*Pseudomonas tomato*). Occurrences of virus diseases (mottling) and spotted wilt were negligible.

The most common physiological disorder was soft fruit, attributable to overripeness, transit delays, high temperatures during transit, or unfavorable growing conditions. Before 1977, the term "sunken discoloration" described a condition usually found at the shoulders of tomatoes that the inspectors distinguished from shoulder scars. Because symptoms can be similar, some cases of bacterial necrosis (*Aerobacter, Xanthomonas*, and other bacteria) were probably listed under sunken discoloration. Chilling injury also can produce similar symptoms under certain conditions. Starting about 1977, the

Table 8. Frequency of diseases reported in USDA inspections of 2,763 California round tomato shipments on the New York market, 1972–1984

Disease	Number of shipments affected according to incidence class (% fruits)										
	0	1	2–5	6–10	11–15	16–20	21–25	26–33	34–50	51–75	>75
Sour/watery rot	1,867	40	516	232	60	25	9	5	6	2	1
Gray mold rot	1,900	30	489	234	68	22	15	3	1	1	0
Bacterial soft rot	2,007	50	511	139	40	7	5	1	2	1	0
Unidentified decays	2,015	316	358	39	15	9	6	3	2	0	0
Alternaria rot	2,595	7	111	35	12	1	1	1	0	0	0
Phytophthora rot	2,691	1	35	29	3	4	0	0	0	0	0
Blossom-end rot	2,702	3	38	11	6	1	2	0	0	0	0
Late blight rot	2,709	0	31	11	7	4	0	0	1	0	0
Rhizopus soft rot	2,709	2	38	10	2	1	1	0	0	0	0
Fruit tumor	2,726	5	17	10	1	1	3	0	0	0	0
Bacterial spot	2,751	4	6	2	0	0	0	0	0	0	0
Internal browning	2,752	2	3	4	0	1	1	0	0	0	0
Buckeye rot	2,754	0	4	2	2	1	0	0	0	0	0
Virus mottling	2,755	0	2	3	1	2	0	0	0	0	0
Fusarium rot	2,758	0	3	1	1	0	0	0	0	0	0
Bacterial speck	2,758	0	5	0	0	0	0	0	0	0	0
Miscellaneous[a]	2,746	0	12	5	0	0	0	0	0	0	0

[a] Soil rot, bacterial necrosis, bacterial canker, nailhead spot, Sclerotium rot, stem-end rot, and spotted wilt.

Table 9. Frequency of diseases reported in USDA inspections of 2,729 Florida round tomato shipments on the New York market, 1972–1984

Disease	Number of shipments affected according to incidence class (% fruits)										
	0	1	2–5	6–10	11–15	16–20	21–25	26–33	34–50	51–75	>75
Sour/watery rot	1,672	33	503	371	89	31	18	10	1	1	0
Gray mold rot	2,016	31	337	253	57	22	8	4	1	0	0
Bacterial soft rot	2,032	36	452	151	38	12	5	2	1	0	0
Unidentified decays	2,035	253	375	40	15	5	4	1	1	0	0
Alternaria rot	2,495	13	129	68	9	7	1	4	3	0	0
Rhizopus soft rot	2,685	2	31	8	1	0	2	0	0	0	0
Internal browning	2,687	2	21	16	3	0	0	0	0	0	0
Late blight rot	2,706	0	12	8	3	0	0	0	0	0	0
Bacterial speck	2,712	0	14	3	0	0	0	0	0	0	0
Blossom-end rot	2,718	0	5	3	0	0	1	2	0	0	0
Phoma rot	2,721	1	6	0	0	1	0	0	0	0	0
Phytophthora rot	2,722	0	7	0	0	0	0	0	0	0	0
Anthracnose	2,722	0	2	3	1	0	0	1	0	0	0
Bacterial spot	2,723	0	6	0	0	0	0	0	0	0	0
Miscellaneous[a]	2,715	1	10	2	0	1	0	0	0	0	0

[a] Fusarium rot, bacterial necrosis, soil rot, fruit tumor, Phomopsis rot, bacterial canker, stem-end rot, blue mold rot, and ghost spot.

Table 10. Frequency of diseases reported in USDA inspections of 1,186 Mexico round tomato shipments on the New York market, 1972–1984

Disease	Number of shipments affected according to incidence class (% fruits)										
	0	1	2–5	6–10	11–15	16–20	21–25	26–33	34–50	51–75	>75
Bacterial soft rot	814	14	241	73	25	8	5	4	2	0	0
Sour/watery rot	831	8	189	94	34	15	8	5	1	0	1
Gray mold rot	903	10	162	65	21	9	10	2	2	2	0
Unidentified decays	929	80	145	19	8	2	0	2	1	0	0
Alternaria rot	1,061	3	93	22	6	1	0	0	0	0	0
Late blight rot	1,134	0	10	20	12	3	2	3	2	0	0
Blossom-end rot	1,156	1	16	7	5	1	0	0	0	0	0
Rhizopus soft rot	1,164	0	14	3	3	0	1	0	1	0	0
Internal browning	1,174	2	6	3	1	0	0	0	0	0	0
Anthracnose	1,181	0	1	2	1	0	0	1	0	0	0
Fruit tumor	1,183	0	2	1	0	0	0	0	0	0	0
Phytophthora rot	1,183	0	0	1	1	1	0	0	0	0	0
Miscellaneous[a]	1,179	0	2	4	0	0	0	1	0	0	0

[a] Soil rot, Sclerotium rot, Phomopsis rot, bacterial spot, stem-end rot, and virus mottling.

condition described as shoulder scars was included under sunken discoloration. Consequently, almost all instances of shoulder scars were reported before 1977 and almost all instances of sunken discoloration, after 1977. Instances of misshapen or cat face fruit and growth cracks were also numerous (Table 2).

Physiological disorders reported with some regularity (Table 2) were blossom-end rot, manifested by water-soaked or dry brown tissue at or near the blossom scar, and internal browning, also known as gray or brown wall, in which the tissues of the wall are discolored or necrotic and fruit does not color uniformly. Fruit tumor, also called waxy blister, was observed in a few shipments. In this disorder, waxlike blisters develop on mature green tomatoes after slight mechanical injury during transit (4).

The diseases reported most frequently are shown in Table 3. Sour/watery rot was found in 35.3% of all inspected shipments, gray mold rot in 27.9%, bacterial soft rot in 25.2%, and unidentified (lacking characteristic symptoms) decays in 24.3%. The incidence of gray mold rot was highest during the first 2 and the last 2 years of the inspections. The number of bacterial soft rot occurrences declined notably, from 583 in 1972 to 119 in 1984. Alternaria rot was reported in 8% of inspections, and Rhizopus soft rot, late blight rot, blossom-end rot, internal browning, and Phytophthora rot in less than 2% (Table 3).

The pattern of all disorders was similar for tomatoes shipped from California, Florida, and Mexico, the main sources of supply (Table 4). Soft fruit was the leading quality disorder and sour/watery rot, gray mold rot, and bacterial soft rot were the most frequently reported diseases, regardless of tomato type. Because of their size, round tomatoes probably were more vulnerable to bruising, scarring, and cracking than cherry or plum tomatoes. With the exception of bacterial soft rot in cherry tomatoes, the principal diseases affected all fruit types fairly consistently. Although grade defects were reported less often in tomatoes shipped from nearby Pennsylvania and Virginia, disease incidences were quite high, probably because proportionately more "distressed loads" (shipments failing to meet grade or quality specifications agreed upon by receivers and shippers) were inspected from these states.

The frequencies of the leading disorders in 8,030 shipments of round tomatoes are shown in Table 5. Soft fruit was reported most frequently, with incidence of affected fruit ranging from 1% in 377 shipments to over 75% in eight shipments. Shoulder scars, sunken discoloration, sour/watery rot, and gray mold rot were also reported in every incidence class.

The frequencies of the leading disorders in 692 shipments of cherry tomatoes and 337 shipments of plum tomatoes are shown in Table 6 and Table 7, respectively. Soft rot remained the most frequently reported disorder, but gray mold rot, sour/watery rot, and bacterial soft rot were more common than grade defects.

The frequencies of diseases in shipments of round tomatoes from California, Florida, and Mexico are shown in Table 8, Table 9, and Table 10, respectively. The three most frequent diseases were sour/watery rot, gray mold rot, and bacterial soft rot, with bacterial soft rot first in 1,186 shipments from Mexico and third in 2,763 shipments from California and 2,729 shipments from Florida. For all three sources, the fourth and fifth most frequent diseases were unidentified decays and Alternaria rot. Phytophthora rot was sixth in shipments from California but twelfth in shipments from Florida and Mexico. The frequency of late blight rot in shipments from Mexico was about twice that in shipments from California and about five times that in shipments from Florida. The only other parasitic disease of consequence was Rhizopus soft rot. The leading nonparasitic disease was blossom-end rot in shipments from California and Mexico and internal browning in shipments from Florida.

Although the data reported here do not represent the arrival condition of all tomatoes shipped to the New York market during 1972–1984, the USDA inspection reports do provide reliable information on the extent and nature of damage in 9,059 shipments of fresh tomatoes that presumably were in good condition when shipped. Since the general practice is to examine six or more packs of fruit per shipment, more than 54,000 packs averaging 10–11 kg were inspected. The federal inspection office in New York City's Produce Terminal Market at Hunt's Point estimates that 0.6–1% of a shipment or lot is examined.

Some shipments with more than 50% of the contents badly damaged were probably dumped. Culled fruit from salvaged shipments represent other losses. Furthermore, extended movement of fruit from the wholesale level invariably results in more losses. In a recent 3-year study conducted in metropolitan New York (2), fresh tomato losses at retail and consumer levels were estimated at 9,000 t annually; parasitic diseases, principally Alternaria rot, gray mold rot, Rhizopus soft rot, and bacterial soft rot, caused two-thirds of these losses. As we noted in previous reports on potatoes (1) and lettuce (3), a more concerted production and marketing research effort is needed to reduce losses.

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