Diseases, Physiological Disorders, and Injuries of Plums Marketed in Metropolitan New York

J. M. WELLS, Research Plant Pathologist, and J. E. BUTTERFIELD, Biological Research Technician, U.S. Department of Agriculture, Agricultural Research Service, Eastern Regional Research Center, 600 E. Mermaid Lane, Philadelphia, PA 19118; and M. J. CEPONIS, Research Plant Pathologist, retired, USDA-ARS, Department of Plant Pathology, Cook College, Rutgers University, New Brunswick, NJ 08903

ABSTRACT

Wells, J. M., Butterfield, J. E., and Ceponis, M. J. 1994. Diseases, physiological disorders, and injuries of plums marketed in metropolitan New York. Plant Dis. 78:642-644.

Retail and consumer losses in nine major cultivars of western plums marketed in metropolitan New York and sampled for 15 consecutive weeks during the 1983 and 1984 seasons averaged 4.2 and 5.0%, respectively, for a total market loss of 9.2%. Specific causes were parasitic diseases (3.4%), physiological disorders (2.1%), and injuries (3.7%). Total losses were higher in the cultivars Casselman and President than in Red Beaut, Santa Rosa, Eldorado, Simka, Friar, Italian Prune, and Angelino. In a sample of three of the cultivars in 1992, total consumer losses were 4.7%, statistically unchanged from 1983–1984 levels. The principal disease in both surveys was brown rot (*Monilinia* spp.), which caused up to 50% of the disease losses. Dehydrated and overripe fruit were the leading categories of physiological disorders; and bruising, cuts, punctures, and freeze damage were the chief categories of injury loss.

A yearly average of 8,081 metric tons of fresh plums arrived in the wholesale markets of metropolitan New York during the 1988–1990 seasons (7). In 1991, this volume represented 3.3% of western plum (*Prunus domestica* L. and/or *P. salicina* Lindl.) production and was valued at $9,470,000 (8). Most shipments were from California, with the balance from Idaho, Michigan, Oregon, and Washington. The most important California cultivars with number of shipments (each representing 1,000 containers of 12.8 kg each) were Friar (3,500), Black Amber (1,700), Santa Rosa (1,750), Angelino (1,000), Red Beaut (1,300), and Casselman (900) (3).

Plums are a perishable crop subject to most of the postharvest diseases and disorders affecting stone fruits (4,6). Ceponis et al (1) searched Federal Inspection Certificates for plum shipments arriving in the New York wholesale markets and at large retail chain stores, and found that blue mold (*Penicillium expansum* Link) and grey mold (*Botrytis cinerea* Pers.:Fr.) were the most frequently cited diseases. The category of unidentified diseases, however, caused the greatest losses. Earlier, Ceponis and Friedman (2) found that bruised Italian Prune plums were most frequently infected with Penicillium rot, which accounted for over 50% of losses. These reports appear inconsistent with the general observation that brown rot, caused by *Monilinia* spp., is the most important postharvest disease of stone fruits, including plums (4,6).

Apart from the report by Ceponis et al (1) tabulating the incidence of postharvest disorders on plums arriving in New York wholesale markets, there have been no published reports of actual market losses of plums. An accurate assessment of market losses should include examinations of the commodity at several points from the wholesale market to consumer. Wholesale losses alone may not reflect problems in shipments with physiological disorders, surface injuries, and grade defects that are discounted in value by the commodity brokers and moved on to retail markets. Furthermore, retail and con-

Table 1. Percent retail and consumer losses of western plums in the New York market in 1983 and 1984 due to parasitic diseases, physiological disorders, and mechanical injuries

	Percent total samples examined[a]				
	Retail		Consumer		
Cause of losses	1983	1984	1983	1984	Total[b]
Parasitic diseases					
Brown rot (*Monilinia*)	0.6	0.3	1.1	1.1	
Grey mold (*Botrytis*)	0.3	0.1	0.5	0.1	
Blue mold (*Penicillium*)	0.1	tr	0.5	0.4	
Alternaria rot	0.1	0.1	0.1	0.1	
Cladosporium rot	0.1	0.2	0.1	0.2	
Rhizopus rot	tr	0	0.1	0	
Yeasts (unidentified)	tr	tr	0	0	
Other pathogens	tr	tr	0.5	0.1	
Total disease losses	1.2	0.8	2.9	2.0	3.4
Physiological disorders					
Internal discoloration	0	0	0.3	0.2	
Dehydration	0.4	0.4	tr	tr	
Overripe	1.4	0.8	0	0	
Soft and leaky	0.1	tr	0.1	0	
Growth cracks	tr	tr	0	0	
Other	0.1	0	tr	0	
Total disorders	2.1	1.4	0.4	0.3	2.1
Mechanical injuries					
Bruises and crushed	0.5	0.4	0.2	0.2	
Cuts, punctures, gouges	0.5	0.4	0.2	0.2	
Field scars	0.3	0.1	0.2	0.1	
Freeze damage	tr	0.8	0.4	2.9	
Other	0	0	0	0.1	
Total injury losses	1.3	1.7	1.0	3.5	3.7
Grand total	4.6	3.4	4.3	5.7	9.2

[a]Data based on averages of 15 consecutive weekly examinations of plum samples each year. Average weekly retail sample sizes: 274.5 kg in 1983, 333.6 kg in 1984. Average consumer sample sizes: 10.1 kg in 1983, and 12.1 kg in 1984. tr = trace levels (0.01–0.4%).
[b]2-yr average.

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Accepted for publication 6 January 1994.

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sumer handling and storage practices, particularly refrigeration, may differ significantly from those at commercial transit and wholesale storage. The objective of this study, therefore, was to identify major causes of losses in nine cultivars of western plums at New York retail markets and under consumer holding conditions, and to assign values for total marketing losses.

MATERIALS AND METHODS

The incidence and type of defects among western plums in retail markets were recorded over a 2-yr period by examining 12.8-kg containers (lugs) weekly at each of six to eight supermarkets in metropolitan New York. Lugs were examined prior to retail display during 15 consecutive weeks of the 1983 and 1984 seasons. An average 274.5 kg of plums were examined weekly in 1983, and 333.6 kg in 1984. Plums were individually rated for the different categories of parasitic diseases, mechanical injury, and physiological disorders, as listed in Table 1. Fruit with defects were placed in paper bags, taken to the laboratory, and stored for 3 days at 21 C and 50–60% relative humidity to verify the initial diagnosis. Nine of the major cultivars, Red Beaut, Santa Rosa, Eldorado, Simka, Friar, Casselman, Italian Prune, Angelino, and President, were included in each year of the study. Total retail losses were calculated by averaging data for the 2 yr.

Losses at the consumer level were estimated from loose plum samples purchased from retail display shelves in supermarkets and held at 20 C and 50–60% relative humidity for 3 days in paper bags. Average weekly sample size was 10.1 kg in 1983 and 12.1 kg in 1984. Samples were examined for the disease and disorder categories listed in Table 1. Total consumer losses were calculated by averaging data for the 2-yr period. In 1992, three of the original nine cultivars were sampled for 10 wk, with an average weekly sample size of 4.2 kg, to determine if any changes in production practices or handling since the original survey had affected losses.

Dollar loss values were based on average wholesale prices in New York of $15.00 per container for all cultivars in 1991 (7). The value of consumer losses was based on an average retail price of $2.20/kg observed throughout the season in supermarkets from which samples were obtained. Comparisons of total loss values by cultivar for each year of the survey were made by a *t* test, wherein values for all cultivars were considered to be one population or group (5).

RESULTS AND DISCUSSION

Total losses of plums at the retail level were 4.6% in 1983 and 3.4% in 1984, for an average of 4.2% over the two seasons (Table 1). The chief causes of retail losses were parasitic diseases, physiological disorders, and injuries, with average losses of 1.0, 1.7, and 1.5%, respectively. Brown rot (*Monilinia* spp.) was responsible for over 50% of disease losses, and dehydration and overripe fruit were responsible for over 80% of losses caused by physiological disorders. Bruises, cuts, punctures, and freeze damage were the most important types of injury at both

Table 2. Percent losses at the consumer level of selected western cultivars of plums in 1992

Cultivar[a]	Total sample size[b] No.	kg	Causes of losses (%) Diseases	Physiological disorders	Injury	Total losses (%)
Simka	150	12.7	1.4	0	0.1	1.5
Casselman	150	12.7	7.6	2.1	0.1	9.8
Angelino	143	10.8	1.7	0.4	0.5	2.5
Average	148	12.1	3.6	0.9	0.2	4.6

[a]Cultivar identity of some lots could not be verified, but general appearance and their season conformed to the cultivar designated.
[b]Each cultivar sampled 10 times during the season, 14–15 fruit per sample.

Table 3. Percent retail losses of nine western plum cultivars in the metropolitan New York markets

Cultivar[a]	Year	Sample size No.	kg	Diseases	Cause of losses (%) Physiological disorders	Injury	Total (%)
Red Beaut	1983	5,075	546	1.6	0.1	1.7	3.5
	1984	10,514	724	1.0	0.7	1.4	3.1
Santa Rosa	1983	1,524	102	1.1	0	1.0	2.1
	1984	3,069	203	0.4	0.5	6.2	7.0
Eldorado	1983	3,926	292	0.3	0.2	0.2	0.7
	1984	3,602	254	0	0.5	0.3	0.8
Simka	1983	2,691	203	0.3	0.1	0.2	0.6
	1984	8,098	737	0.5	1.3	2.0	3.8
Friar	1983	5,318	483	0.3	0.3	0.5	1.1
	1984	12,540	1,168	0.4	1.4	0.5	2.2
Casselman	1983	5,075	546	3.3	1.6	2.6	7.5
	1984	5,802	534	3.9	2.2	1.3	7.4
Italian Prune	1983	18,371	612	0.5	2.8	0.2	3.4
	1984	29,743	816	0.3	1.8	0.2	2.3
Angelino	1983	4,310	419	1.2	2.1	0.7	4.0
	1984	3,358	355	0.2	1.8	2.5	4.4
President	1983	4,665	368	1.2	16.0	2.1	19.3*[b]
	1984	2,923	265	3.5	8.6	0.5	12.6*

[a]In order of appearance in the market during the season.
[b]Values followed by an asterisk are significantly different from others, as determined by a *t* test at $P = 0.05$.

Table 4. Percent consumer losses in nine western plum cultivars and the chief cause of loss

Cultivar[a]	Year	Sample size (no.)[b]	Total losses (%)[c]	Chief cause of loss Defect	Percent total
Red Beaut	1983	350	4.8	Freeze damage	60
	1984	480	6.2	Freeze damage	85
Santa Rosa	1983	215	1.0	Cuts, bruises	85
	1984	300	4.9	Freeze damage	69
Eldorado	1983	155	2.9	Brown rot	83
	1984	220	1.0	Crushed	41
Simka	1983	175	2.6	Brown rot	81
	1984	240	7.0	Freeze damage	86
Friar	1983	285	3.4	Brown rot	88
	1984	360	8.2	Freeze damage	85
Casselman	1983	280	2.4	Rhizopus rot	31
	1984	160	10.2	Brown rot	78
Italian Prune	1983	585	9.9	Brown rot	41
	1984	765	5.5	Blue mold	42
Angelino	1983	90	3.0	Brown rot	73
	1984	40	0.8	Cladosporium rot	61
President	1983	135	7.1	Yeasts	42
	1984	180	2.9	Blue mold	72

[a]In order of appearance in the market during the season.
[b]Samples (10–12 kg) of loose plums collected from supermarket displays for 15 consecutive weeks and held at 20 C for 3 days prior to evaluations.
[c]Total losses caused by parasitic diseases, physiological disorders, and mechanical injury.

retail and consumer levels.

At the consumer level, total losses averaged 5.0% for 1983 and 1984 (Table 1), and 4.7% for 1992 (Table 2). Parasitic diseases were proportionally more important in 1983, causing 68% of the total losses for that year compared to 34% in 1984, a year of high incidence of freeze damage. Disease losses in 1992 accounted for 78% of total losses, following the pattern of 1983. Brown rot was the most important disease in all 3 yr of the survey (data for 1992 not shown), followed by blue mold (*P. expansum*). The pattern in total consumer losses appeared not to have been substantially changed in the 9 yr between the 1983–1984 and 1992 surveys, despite changes in cultural practices and pest control.

Total losses for plums due to all causes in 1983–1984 averaged 9.2%. Dollar value for retail losses, calculated on a loss of 4.2% and based on 1991 prices, is estimated at $398,000. Losses to consumers, based on 5% of their purchases and on an average 1991 retail price of $2.20/kg, equaled $844,000, for a combined loss of over $1.2 million.

The cultivars Casselman and President had the greatest retail losses in 1983–1984 compared to other cultivars (Table 3). While average retail losses in 1983–1984 seldom exceeded 5% for most cultivars, Casselman losses averaged 7.5% in the 1983–1984 period and 9.8% in 1992. Most of the Casselman losses (49% in 1983–1984, and 77% in 1992) were due to disease, primarily brown rot. President, a late-season cultivar, sustained 19.3 and 12.5% losses in 1983 and 1984, respectively, due to high incidence of physiological disorders, 80% of which were overripe fruit. In 1984, losses in Santa Rosa were also unusually high (7%) due to freeze injury in the majority of the samples examined.

At the consumer level, total losses by cultivar in 1983 and 1984 ranged from approximately 1 to 10%, with half of the values at or above 4.8% (Table 4). Losses were at the higher level in both years for cultivars Red Beaut and Italian Prune, and for at least one of the years for Santa Rosa, Simka, Friar, Casselman, and President. Five of the nine cases of high incidence (in cultivars Red Beaut, Santa Rosa, Simka, and Friar) were due to a condition we attributed to freeze damage. Damaged plums were externally symptomless and appeared sound, but internally the flesh was water-soaked and discolored, either hard or flaccid, and off-flavored. Tissue disruption and leakage, typical of hard-freeze injury, was absent. It was possible that the plums had been subjected to prolonged storage at near-freezing temperatures, or that the condition was a generalized physiological breakdown associated with the limit of the storage life of the fruit. Brown rot, blue mold, and yeast infections were the chief causes of high losses in the remaining cultivars.

The types of diseases and physiological disorders we observed generally agreed with those identified by the Federal Inspection Service as being prevalent on plums at arrival at the wholesale markets. Our results, however, on percent losses due to the various postharvest pathogens may be more accurate, since federal inspections are based largely on cursory examinations of commercial shipments by trained but nontechnical personnel.

This report, therefore, confirms the predominance of brown rot as a leading cause of losses in plums. The category of unidentified decays reported by Ceponis et al (1) probably included a significant percentage of fruit that arrived in New York at incipient stages of *Monilinia* infection, which could have developed in the retail markets. The predominance of *Penicillium* on the cultivar Italian Prune and the absence of brown rot in the 1957 report by Ceponis and Friedman (2) were probably due to the special conditions of that study, where the plums were subjected to bruise damage prior to storage. In our study, incidence of blue mold on Italian Prune at the retail level was at trace levels, as it was with the other cultivars examined. At the consumer's level, however, blue mold became more prevalent, particularly in Italian Prune, where it caused 42% of the losses in 1984.

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