

Comparing the Harvest and Storage Characteristics of Mutsu and Shizuka Apples

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There is interest, especially among apple growers who are retailing fruit, to find new “niche” varieties which consumers like and which can be profitably grown and sold. A green/yellow Fall cultivar is something customers look for (the Granny Smith influence). We have been attempting to identify some of the most promising varieties suitable for growing in the northeast by planting and systematically evaluating apples at the University of Massachusetts’ Cold Spring Orchard Research & Education Center (CSOREC) in Belchertown, MA. For the past four years we have been evaluating storage qualities of Mutsu and Shizuka. Mutsu, also known as Crispin, is a variety which has consumer following, but it is susceptible to Blister Spot, a bacterial disease which renders fruit unsaleable. Shizuka is a similar apple (same parents, Golden Delicious x Indo) which appears to be resistant to Blister Spot and has been

suggested to be an alternative to Mutsu. The two apples are quite similar in appearance. They are large fairly round green/yellow fruit which often develop a pink blush. Shizuka may be considered slightly more attractive as its skin is smoother and it has less tendency to russet (although russet is not severe on Mutsu, either). Lenticels are attractive and are more noticeable on Shizuka than on Mutsu. We have compared storage qualities of these two varieties over the past four seasons.

Harvest Information

Three trees of each cultivar from a block at CSOREC were used for the evaluations. Trees were planted in 1991, and all are on Mark rootstock. Each tree produced 3 to 4 bushels of fruit in each of the four years.

Table 1. Assessments of Mutsu and Shizuka fruit at harvest, 1998-2001.

Harvest year	Grams per fruit		Internal ethylene (ppm)		Starch index		Firmness (pounds)	
	Mutsu	Shizuka	Mutsu	Shizuka	Mutsu	Shizuka	Mutsu	Shizuka
1998	282	290	1	3	3.9	4.4	19.6	16.7
1999	333	292	4	1	3.2	4.8	19.1	16.2
2000	345	268	2	6	3.8	5.3	18.3	15.8
2001	311	213	9	3	3.2	3.9	20.0	18.1
Average	318	266	4	3	3.5	4.6	19.3	16.7
Comment	Mutsu larger		Not different		Shizuka Ariper®		Mutsu firmer	

Table 2. Changes in average starch index and firmness of Mutsu and Shizuka apples as harvest progressed, 1998-2001.

Harvest date	Starch index		Firmness (pounds)	
	Mutsu	Shizuka	Mutsu	Shizuka
Sept 22-25	2.6	3.5	20.4	16.8
Sept 26-29	3.2	3.9	20.5	17.6
Sept 30- Oct 3	3.3	4.5	19.3	16.7
Oct 4-7	4.0	5.2	18.1	16.1
Oct 8-11	4.4	5.9	18.5	15.9
Oct 12-16	4.8	6.3	17.5	15.9
Oct 23	6.5	8.0	17.0	15.2

In an attempt to determine optimum time of harvest for stored fruit, both varieties were harvested over the period of late September through mid October in 1998, 1999, 2000, and 2001. At each harvest, ten to thirty representative fruit were selected from each variety, and brought to the lab for measurement of size, internal ethylene and starch hydrolysis to estimate fruit maturity, and firmness as a crude indicator of quality. Internal ethylene was measured by gas chromatography, starch degradation was rated using the Cornell Generic Starch Index, and firmness was measured with either a Wagner pressure tester or an EPT1 pressure tester. A bushel or more of fruit was harvested from each cultivar on selected harvest dates and placed in refrigerated air storage at 32°F. Fruit from one harvest in 1998 were also stored in controlled atmosphere storage (CA), at 38°F, 2.8% O₂, and varying CO₂ up to 5%.

Harvest data are presented in Tables 1 and 2. Table 1 shows extensive year-to-year differences in harvest qualities of the fruit. All factors listed in the table varied significantly from year to year. Harvest dates were not exactly the same every year (as shown in Table 2), but the same

time span was evaluated. The fact that the Shizuka were not as firm as the Mutsu may be attributed in part to earlier ripening rather than being inherently less firm.

Table 2 illustrates the influence of harvest date on firmness of Mutsu and Shizuka. Starch Index is an indicator of progression of ripening. As expected, firmness decreased with later harvest of both cultivars, and Starch Index increased with later harvest. Year-to-year differences in all three measurements were found, but in all years Mutsu was the firmer apple and had a lower starch index on any given date.

Starch degradation appears to be a good indicator of fruit ripening in both Mutsu and Shizuka. Even taking into consideration that Shizuka could probably have been harvested up to a week earlier than Mutsu at comparable starch scores, Shizuka was never as firm an apple as Mutsu. Internal ethylene concentrations were quite variable and are not shown.

Since Mutsu and Shizuka are both green to yellow fruit, color should be a minor factor in choosing time of harvest, although both cultivars can develop an attractive pink blush during the ripening period. Over half of the fruit of both cultivars did develop this pink blush covering at least 5% of the fruit's surface area. Further, the conversion from green to yellow would be

Table 3. Firmness (lbs)^z of Mutsu and Shizuka fruit on removal from storage.

Harvest year	Mutsu		Shizuka	
	December	January	December	January
1998	14.7	12.8	12.1	11.1
1999	14.3	13.1	12.4	11.0
2000	15.4	14.0	12.9	12.0
2001	16.8	15.8	15.2	14.7

^z Firmness was measured with a Wagner penetrometer in 1998 and with an EPT1 in 1999, 2000, and 2001.

Table 4. Results of poststorage taste tests to assess flavor and overall desirability of 32F air-stored Mutsu and Shizuka apples.

Harvest year	Desirability ^z			
	December		January	
	Mutsu	Shizuka	Mutsu	Shizuka
1998	3.2	2.7	2.1	2.3
1999	3.8	3.6	3.2	2.5
2000	3.8	3.2	3.3	2.7

^z Rating is on a scale of 1 to 5, with 1=poor, 2=fair, 3=acceptable, 4=very good, 5=outstanding, and, incorporates firmness, flavor, acidity, crispness, and appearance components.

removal from cold storage. Fruit firmness after storage was greater for Mutsu than for Shizuka, and these differed significantly from year to year. There was a significant drop in firmness from mid-December to mid-January for both varieties. The Mutsu lost more firmness between December and January than did the Shizuka, but still remained the firmer apple in January. If we arbitrarily assign a firmness of 12 pounds at removal from storage to be the lower limit of acceptability, then the Shizuka were dropping below the level of acceptability by mid January. Taste tests, results of which are shown in Table 4, confirm this. Unfortunately no taste tests were done in the 2001-02 season in which the fruit were firmest.

“Desirability” incorporates assessments of firmness, flavor, crispness, attractiveness, acidity, juiciness, and astringency. A score of less than 3 is considered less than acceptable. In the December ratings, time of harvest was not a factor, but in the January ratings, the earlier harvests were judged higher for both varieties. Both varieties were in the acceptable range in December (except for Shizuka in 1998), but a month later even the Mutsu were not consistently acceptable. Some of the poor showing for desirability in the January rating of the 1998 fruit may be because the mid-January removal

influenced by nitrogen level, as well as by fruit maturity.

Storage Information

Fruit were placed in cold storage immediately following harvest. Half the fruit were removed from storage for evaluation in mid December and the other half were removed a month later (7 weeks later 1998-99). In addition, some fruit were stored in controlled atmosphere (CA: 38°F, 2.8% O₂, up to 5% CO₂) for the 1998-99 season. Those fruit were removed for evaluation on February 12, 1999. Results of CA storage will be discussed separately.

There were three parts to the fruit evaluation. (1) At the time of each removal from storage, half the removed fruit were immediately pressure tested. (2) The pressure tested fruit were kept refrigerated and were taste tested over a few days following removal from the cold storage. (3) The removed fruit which were not pressure tested were kept at room temperature (68°F) for a week and then evaluated for storage disorders.

Table 3 shows the condition of the fruit on

Table 5. Poststorage disorders of Mutsu and Shizuka apples rated after 32F storage until mid-December and mid-January followed by 1 week at 70F.

Harvest year	Percent breakdown		Percent superficial scald	
	Mutsu	Shizuka	Mutsu	Shizuka
1998	2	3	43	12
1999	26	8	12	0
2000	0	1	10	0
2001	0	0	0	2

Table 6. Some storage characteristics of Mutsu and Shizuka apples harvested October 2, 1998.

Storage through:	Superficial scald (%)		Firmness ^z		Desirability ^{zy}	
	Mutsu	Shizuka	Mutsu	Shizuka	Mutsu	Shizuka
12/15/98 (32F air)	25	0	3.0	1.8	3.3	2.5
2/1/99 (32F air)	83	0	1.5	1.5	2.0	2.2
2/8/99 (CA)	4	0	2.3	2.5	3.5	3.0

^z Firmness and desirability are both rated on a scale of 1 to 5, with 1=poor, 2=fair, 3=acceptable, 4=very good, 5=outstanding.

^y Desirability includes firmness, flavor, acidity, crispness, and appearance components.

“soft” room; 38°F, 2.8% O₂, varying CO₂ to 5%. Table 6 shows how dramatically CA storage improved some poststorage characteristics of Mutsu and Shizuka. The reduction in superficial scald development on Mutsu is of particular interest.

from storage actually happened on February 1, 1999.

Assessment of poststorage fruit disorders was made following a week at room temperature, and results of the assessments are shown in Table 5. Because findings were similar for fruit removed from cold storage in December and January, results have been combined. Table 5 shows that poststorage disorders did not occur with consistency. Senescent breakdown was a problem in Mutsu following the 1999-2000 storage season. However, no significant senescent breakdown was found in either variety following storage and a week at room temperature the following two years, and very little developed in the 1998-99 storage season. There was a substantial amount of superficial scald following storage in 1998-99, but much less in the following years. Mutsu was more scald susceptible than was Shizuka. Neither scald nor breakdown could be attributed to time of harvest, although the year with the most scald (1998) was one in which there was no late harvest, and scald is most likely to develop on early harvested fruit. Other disorders assessed were bitter pit and decay, neither of which occurred with enough frequency to analyze. We did note moderate skin greasiness on Shizuka from the late harvests of 2000 and 2001 after they had spent a week at room temperature in January.

Controlled Atmosphere (CA) Storage

Fruit were stored in CA as well as in refrigerated air during the 1998-99 storage season. The CA was a

Conclusions

Based on the 1998-99 storage season’s data, CA appears to be necessary for both Mutsu and Shizuka if they are to be stored beyond mid-December. Even in mid-December the Shizuka did not emerge from air storage in good condition in 1998, although they did better in subsequent years. The Shizuka had probably reached the limit of their quality CA life in 1998-99 when they were tested in February, while the Mutsu could have gone longer in CA and emerged in acceptable condition. The quality difference between air and CA storage was dramatic for both cultivars.

Mutsu retains good quality in storage longer than Shizuka. The areas in which Shizuka fared better were appearance (3.1 vs 2.7 on the 1 to 5 scale) and scald resistance. Shizuka does tend to be a smaller apple which could be an advantage, since both cultivars can be very large. Where blister spot is not a limiting factor, Mutsu would be the more highly recommended cultivar in a marginal storage situation. Shizuka could be an acceptable substitute if the fruit were marketed primarily in the fall or stored in CA. It is a more attractive fruit than Mutsu, and for the September market, Shizuka has the advantage of ripening slightly earlier. If Shizuka is to be stored longer than mid-December, it should be placed in CA.

Either Mutsu or Shizuka can be an acceptable large green/yellow apple for the autumn market if handled properly after harvest.

