QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

DIVISION OF PLANT INDUSTRY BULLETIN No. 368

EFFECT OF STORAGE TEMPERATURE AND ATMOSPHERE ON JONATHAN APPLES IN COOL STORE

By E. T. CARROLL, B.AGR.SC.

SUMMARY

Queensland-grown Jonathan apples appear to have a shorter storage life than those grown in the southern States of Australia but controlled atmospheres increase storage life.

Introduction

During the 1964 season the controlled atmosphere recommended by Trout, Tindale, and Huelin (1940) significantly reduced the percentage of disorders in fruit stored at 36°F, but soggy breakdown was still of major importance (Carroll 1965).

Because of the expense involved in controlled atmosphere storage, a changing temperature technique for long storage of Victorian-grown Jonathan apples recommended by Tindale (1964) has been investigated with Queensland-grown Jonathan apples, and a comparison made between this method and controlled atmosphere storage. Because of the high incidence of breakdown in the 1964 work, a temperature of 38°F was used instead of 36°F in the controlled atmosphere experiments in 1965.

Methods and Materials

The treatments used were as follows:—

(1) Air storage continuously at 38°F.

(2) Air storage continuously at 36°F.

(3) Air storage with temperature falling from 36°F to 32°F.

(4) Controlled atmosphere (16% O_2 + 5% CO_2) at 38°F.

The experimental fruit was obtained from one Granite Belt orchard on February 17, 1965. After transport to the Food Preservation Research Laboratory, the fruit was stored at the above temperatures. Fruit of treatment

4 was held in each of three 44-gal. gas-tight drums, each drum containing 6 half-bushel cases of apples. A 16% O_2 + 5% CO_2 atmosphere was maintained by restricting the flow of air to the drums, using manometric flowmeters. The storage atmosphere was analysed twice daily and the flow rate altered when necessary.

Fruit used in the changing temperature method was held for 1 month at 36°F, followed by 1 month at 34°F. The temperature was then lowered to 32°F for the duration of the storage period.

Removals each of six cases per treatment were made on July 7 (removal 1), July 20 (removal 2) and August 3 (removal 3). After 7 days at 70°F, all fruit was examined for storage disorders. Firmness readings were made on 10 fruit taken at random from each case, using a Magness penetrometer with the $\frac{7}{16}$ in. plunger. Readings were taken on the opposite sides of each apple and the mean of 10 readings was recorded.

Results

The results are summarized in Table 1.

TABLE 1

EQUIVALENT MEAN PERCENTAGES* OF DISORDERS AND FIRMNESS IN JONATHAN APPLES AFTER REMOVAL FROM COOL STORE

Treatment	Jonathan Spot (%)	Mould (%)	Superficial Scald (%)	Soggy Breakdown (%)	Bitter Pit (%)	Total Disorders (%)	Firmness (lb)
Normal air storage at 38°F							
R1	0	7·66	0	10·06	28·18	40·06	12·22
R2	0	8·74	0·51	9·14	32·52	44·60	11·08
R3	0·19	9·11	0·46	8·49	36·39	44·30	11·57
Normal air storage at 36°F							
R1	0	8·91	0	9·55	25·54	33·03	12·36
R2	1·44	7·94	0·40	4·39	12·89	24·98	11·31
R3	1·31	10·66	0	5·86	18·64	30·70	11·94
Temperatures lowered from 36°F to 32°F							
R1	0·73	5·21	0	5·84	10·39	21·93	12·71
R2	0	8·70	0	3·17	22·90	30·28	11·63
R3	0·82	8·34	0	4·27	26·19	35·76	12·06
Controlled atmosphere storage at 38°F							
R1	0	2·09	1·27	4·18	3·13	10·61	12·00
R2	0	0·48	4·55	4·72	5·52	13·46	11·08
R3	0·28	2·77	20·08	3·73	4·13	31·29	11·51

* arc-sine transformation used for analysis

Jonathan spot

No analysis of variance carried out

Mould

No significant differences between removals
Normal air storage at 38°F ⩾ C.A. storage at 38°F
Normal air storage at 36°F ⩾ C.A. storage at 38°F
Reducing temperature storage ⩾ C.A. storage at 38°F

Superficial scald

No analysis of variance carried out

Soggy breakdown

No significant differences between removals
Normal air storage at 38°F > Reducing temperature storage
Normal air storage at 38°F > C.A. storage at 38°F

Bitter pit

No significant differences between removals
Normal air storage at 38°F ⩾ Normal air storage at 36°F
Normal air storage at 38°F ⩾ Reducing temperature storage
Normal air storage at 38°F ⩾ C.A. storage at 38°F
Normal air storage at 36°F ⩾ C.A. storage at 38°F

Total disorders

Removal 3 > Removal 1
Normal air storage at 38°F ⩾ Normal air storage at 36°F
Normal air storage at 38°F ⩾ Reducing temperature storage
Normal air storage at 38°F ⩾ C.A. storage at 38°F
Normal air storage at 36°F ⩾ C.A. storage at 38°F
Reducing temperature storage ⩾ C.A. storage at 38°F

Firmness

Removal 1 ⩾ Removal 2
Removal 1 ⩾ Removal 3
Removal 3 ⩾ Removal 2
Normal air storage at 36°F > C.A. storage at 38°F
Reducing temperature storage ⩾ Normal air storage at 38°F
Reducing temperature storage ⩾ C.A. storage at 38°F

The incidence of Jonathan spot was slight, irrespective of storage treatment. Superficial scald occurred mainly in the controlled atmosphere stored fruit and was important in fruit of removal 3. Soft scald did not occur in any of the treatments.

The three removals did not differ significantly in mould incidence. Controlled atmosphere stored fruit had significantly less mould than any of the other treatments.

The three removals did not differ significantly in the incidence of soggy breakdown recorded. Normal air storage at 38°F showed significantly more breakdown than either the controlled atmosphere stored fruit or fruit stored in the changing temperature environment.

No significant differences in bitter pit incidence were found in the three removals. Air storage at 38°F produced significantly more bitter pit than any of the other three treatments. Air storage at 36°F and falling temperature storage both produced significantly more bitter pit than controlled atmosphere storage at 38°F.

Removal 3 showed a significantly higher incidence of disorders than removal 1. Normal air storage at 38°F showed significantly more disorders than any of the other treatments. Air storage at 36°F and falling temperature storage both produced significantly more disorders than controlled atmosphere stored fruit.

Removal 1 gave significantly firmer fruit than removals 2 and 3. Fruit from removal 3 was significantly firmer than fruit from removal 2. Air storage at 36°F and falling temperature storage gave significantly firmer fruit than controlled atmosphere storage. Fruit from falling temperature storage also gave firmer fruit than air storage at 38°F.

Discussion

The results indicate that controlled atmosphere storage gave the best control of mould and bitter pit and the lowest percentage of total disorders. Soggy breakdown was significantly reduced both by controlled atmosphere storage and the falling temperature technique. However, air storage at 36°F and the falling temperature storage gave the firmest fruit. This is apparently due to the lower holding temperatures of these two treatments, as in earlier work (Carroll 1965) controlled atmosphere storage at 36°F gave significantly firmer fruit than air storage at 36°F.

Bitter pit incidence was markedly reduced in the controlled atmosphere stored fruit. A similar effect was obtained in earlier work with Delicious apples in controlled atmosphere storage (Stevenson and Carroll 1964). Superficial scald incidence indicates that problems can be expected in Jonathan apples stored for long periods in the controlled atmosphere.

This experiment indicated that controlled atmosphere storage is superior to the falling temperature technique for Queensland-grown Jonathan apples. In future work, a number of atmospheres will be used together with modifications of the falling temperature technique.

REFERENCES

CARROLL, E. T. (1965).—Controlled atmosphere storage of Jonathan apples. *Qd J. Agric. Anim. Sci.* 22:507-10.

STEVENSON, C. D., and CARROLL, E. T. (1964).—Further investigations into the behaviour of Delicious apples stored in controlled atmospheres. *Qd J. Agric. Sci.* 21:147-51.

TINDALE, G. B. (1964).—Apple and pear cool storage in Victoria. Part 3. Cool storage of the Jonathan apple. *J. Agric. Vict. Dep. Agric.* 62:351-9

TROUT, S. A., TINDALE, G. B., and HUELIN, F. E. (1940).—Investigations on the storage of Jonathan apples grown in Victoria. *Bull. Commonw. Scient. Ind. Res. Org.* No. 135.

(Received for publication March 4, 1966)

The author is an officer of the Food Preservation Research Branch, Division of Plant Industry, Department of Primary Industries, and is stationed at the Food Preservation Research Laboratory, Hamilton, Brisbane.