Relation Between Pre and Post-Harvest Bitter Pit of 'Goldspur' and 'Wellspur' Apples[1]

DOUGLAS H. ENGLAND AND FENTON E. LARSEN[2]

Abstract: 'Goldspur' and "Wellspur' fruits, sampled several times prior to harvest, at harvest, and twice during the storage period and held at 20 to 22°C to detect bitter pit, showed an increase in the percent of pitted apples until 3 weeks ('Goldspur') and one week ('Wellspur') before harvest, then showed no change after that time. There were, however, fewer pits which developed in individual fruits of 'Goldspur' after removal from storage as compared to the fruit sample at harvest time. The data indicate that prediction of the incidence of storage bitter pit might be possible 1-3 weeks prior to harvest.

Bitter pit is an increasingly troublesome disorder to the apple industry. As a result of efforts to reduce harvest costs and increase production, high density orchards have become common. Rather severe pruning is often used on these orchards. Bitter pit is associated with severe pruning methods (6).

The bitter pit problem has been studied for many years, but recent studies have tended to emphasize the lower levels of calcium associated with the occurrence of pitting (3). Calcium sprays have been some help in reducing the problem (2, 5, 6). Studies by Allen (1) and Palmer (4) noted a reduction in the amount of pitting on the tree after the time for best commercial harvest. Such reductions in pitting have not been explained in light of lower calcium noted in late-harvested fruit (5).

In this study, the incidence and time of appearance of bitter pit were examined to evaluate the possibility of a pre-harvest prediction of post-harvest pitting. Preliminary observations in 1969 indicated that early prediction might be possible. Thus in 1970, observations were made weekly from 5 weeks before harvest until harvest and twice from apples in storage. Apples were tested from 6-year-old trees at the Washington State University Royal Slope Research Unit in the Columbia Basin. 'Goldspur' and "Wellspur' on 9 rootstocks were used as test trees. The trees were planted 9 trees per plot with 3 replications of each scion-rootstock combination.

Uniformly-sized fruits were picked from each plot for pre-harvest samples. At harvest (9/24), 2 boxes of uniformly-sized fruit were picked from each plot. From each of these 2-box samples, apples were randomly selected on 9/24 and twice during storage for evaluation. All samples were held at 20 to 22°C[3] after collection or removal from storage. Evaluation of the percent affected fruit and number of pits per fruit was made after 10 to 14 days holding time, although there was little or no increase in bitter pit after 7 days. Samples were selected on 8/16, 8/25, 9/1, 9/8, 9/16, 9/24 (harvest), 1970, and 1/18 and 4/6, 1971. Sampling was continued during the 1971 and 1972 growing seasons to provide additional data, but no pitting has occurred in our plots since 1970.

[1]Washington State University, College of Agriculture Research Center, Pullman, Wash. Received for publication November 6, 1972. Scientific paper No. 3963. Work was supported by Project 1639.

[2]Graduate Student and Associate Professor, respectively.

[3]This holding temperature was based on unpublished work by M. E. Patterson which shows this to be the best temperature for bitter pit expression.

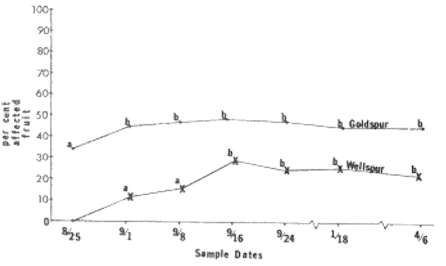

Figure 1. The occurrence of bitter pit, expressed as percent affected fruit, on 'Goldspur' and 'Wellspur' apples from field samples between 8/25 and 9/24/70 and from storage on 1/18 and 4/16/71. Samples were collected from 7 trees from each of 3 replicates. Harvest was on 9/24. Within cultivars, means with the same letters are not significantly different (.05).

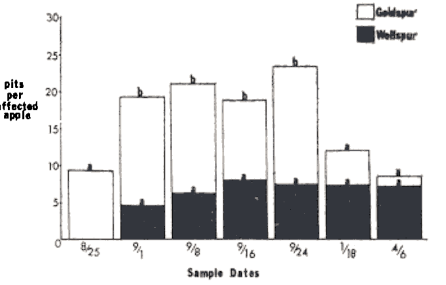

Figure 2. Mean number of bitter pits per affected 'Goldspur' or 'Wellspur' apple from field samples between 8/25 and 9/24/70 and from storage on 1/18 and 4/16/71. Samples were collected from 7 trees from each of 3 replicates. Harvest was on 9/24. Within cultivars, means with the same letters are not significantly different (.05).

Results and Discussion

'Goldspur'—Bitter pit first appeared on the 8/25 sample during the 2-week holding period. There was an increase in the number of affected fruits per plot on the 9/1 sample, but no significant change after that date (Fig. 1). Pitting did not appear in the field until after the 9/1 sample. The number of pits per affected fruit increased significantly until 9/1. In the samples taken from storage, the number of pits per fruit which developed during the 20-22°C holding period was significantly less than at harvest (9/24) (Fig. 2), even though the fruit was from the same 2-box sample taken at harvest.

'Wellspur' — The 'Wellspur' fruit generally showed pitting later in the pre-harvest season than 'Goldspur' (Fig. 1). Pitting first appeared in the 9/1 sample but not until later in the field. The number of affected apples increased until 9/16, but the number of pits per apple did not change significantly after 9/1. There was no significant change of either measure during storage.

Most literature indicates that the initiation of bitter pit occurs just prior to harvest (3). In this study, pitting of 'Goldspur' was initiated prior to August 25, but was not apparent in the field until after 9/1. The August 25 sampling date was 4 weeks before commercial harvest. It was also evident by September 1 for 'Goldspur' and September 16 for "Wellspur' that essentially as much of the crop was affected as at harvest or thereafter. It was also apparent that the incidence of storage bitter pit could be predicted by these dates.

While late-harvested fruit, as reported by Allen (1) and Palmer (4), may show less pitting such fruit is not suited for long term storage. Thus, the necessity is not reduced for an early prediction. No attempt was made in this study to hold the fruit past the stage of development for good storage quality. Knowing the level of bitter pit to expect, the grower could weigh various alternatives for handling and disposal of the crop.

The reason for the occurrence of fewer pits per fruit in the 'Goldspur' storage samples is not clear. It is possible that an endogenous compound exists that would promote pitting but could metabolically be utilized under special conditions.

Although more testing will be required to observe seasonal differences, it appears that the incidence of storage bitter pit for 'Delicious' and

'Golden Delicious' apples could be predicted prior to harvest. This early prediction should be of value to the commercial orchardist.

Literature Cited

1. Allen, F. W. 1931. Maturity and rate of ripening of Gravenstein apples in relation to bitter pit development. *Proc. Amer. Soc. Hort. Sci.* 28:639-645.
2. Cline, R. A. and A. Hutchinson. 1969. Calcium sprays to control bitter pit in Northern Spy apples. *Ann. Rept. Hort. Res. Inst. of Ontario* Vineland Expt. Sta. pp. 15-22.
3. Faust, M. and C. B. Shear. 1968. Corking disorders of apples: a physiological and biochemical review. *Bot. Rev.* 34(4):411-469.
4. Palmer, R. C. 1943. The influence of amount of crop and harvesting maturity on bitter pit in Okanagan-grown Newtown apples. *Proc. Amer. Soc. Hort. Sci.* 43:63-68.
5. van der Boon, J., B. J. vân Goor, and L. K. Wiersum. 1970. Discussion—meeting on bitter pit in apples. *Acta Horticulturae.* 16:1-30.
6. Woodbridge, C. G. 1970. Is there an answer to bitter pit? *Proc. Wash. St. Hort. Soc.* 66:151-165.

Nomenclature of Malling Apple Rootstocks

H. C. PEREIRA*

When the 'Paradise' apple rootstocks were described by R. G. Hatton in 1917 (*Jl R. hort. Soc., 42,* 361-399) they were referred to by roman numerals as Type I, Type II, Type III, etc. Subsequently it was recognized that these rootstocks were not types of a 'paradise' rootstock but were genetically distinct clones and they were then referred to as Malling No. I, Malling No. II, Malling No. III, etc. or briefly as M.I, M.II, M.III, etc. In recent years many countries have dropped the roman numerals in favour of arabic numbers and at East Malling, the new rootstocks described after M.XXV have been referred to by arabic numbers—Malling 26 (M.26) and Malling 27 (M.27).

In the interests of uniformity and simplicity, therefore, East Malling Research Station will now cease to use roman numerals in referring to the apple rootstocks from M.I to M.XXV and will use instead their arabic equivalents. It is hoped that authors, journals, and commercial nurserymen will also adopt this simplification in nomenclature.

*Director, East Malling Research Station, Maidstone, Kent, England.