Climatic Conditions and Attractiveness of Apple Varieties*

(Part I)

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Many good commercial apple varieties that have satisfactory color and attractiveness as grown in other apple producing regions show poor color development and finish when grown at Carbondale. In an earlier paper, Mowry (9) stated that the apple variety testing program at the Illinois Horticultural Experiment Station (IHES) was being conducted to find early maturing, highly colored, and attractive, dessert and culinary apples that were firm enough to be handled in the wholesale channels. In addition, the climatically adapted varieties are being used as parents for contributing specific characters in the apple scab resistance breeding program.

The IHES held an apple show in 1958 for which eight state experiment stations provided a total of 130 display samples of as many varieties as possible from a list suggesting 80 commercial varieties. Such display samples are assumed to be good representative specimens of the varieties for the particular geographic regions. However, conclusions about the relative value of the varieties should be regarded as tentative, because many inequalities in the condition of the samples undoubtedly existed. Differences in fruit color, firmness, and attractiveness would be induced by non-uniformity of storage conditions, seasons of maturity, stages of maturity and the necessary handling of the display samples. Conclusions about climatic adaptation would not be valid if the sample were not large enough or were improperly selected to be truly representative of the usual appearance of the variety as grown in that location.

The major fruit characteristics of all these selections were described and tabulated according to the standards in use at the IHES. The rating for attractiveness is a summary of the impression given by the ground color, red overcolor and the skin finish ratings. Extent of red overcolor is the percentage of the surface covered; intensity is the estimated chroma of the red overcolor; and type is the uniformity of coloration as described by stripe, splash, wash and similar terms. The skin finish rating includes the freedom from russet and scarf skin; the prominence of the dots; and the surface description, such as waxy or oily. The ground color is rated yellow or green.

According to IHES standards, an ideally attractive apple specimen is described as follows: yellow ground color; 100 percent medium red wash; no bloom, russet or scarf skin; inconspicuous dots; and waxy finish capable of high gloss when polished.

Literature Review

Climatic factors directly affect the development of red overcolor on apple fruits after certain basic requirements are fulfilled. Gourley and Howlett (6) inferred that each variety had a genet-

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ic capacity for the development of a certain extent, intensity and pattern of red overcolor at the proper stage of maturity. The overcolor, in common with all inherited phenotypic characteristics, resulted from the interaction of the genetic factors with the prevailing soil and climatic conditions.

Magness (7) found that an accumulation of carbohydrates in the fruit was essential for the development of any red overcolor due to anthocyanin pigments in the cell sap. This carbohydrate supply was dependent upon adequate water supply and nutrition to develop the necessary leaf area to support the fruit load on the tree.

TABLE I. Geographic and climatic features of locations represented by apple samples evaluated for attractiveness at Carbondale, Illinois in 1958.

Location	*North[1] latitude*	*Elev.[2] above sea level* Feet	*Bud[4] break* Ave. date	*First critical period*		
				Avg.[5] duration	*Avg.[3] precip.* Inches	*Avg.[4] temp.* °F.
Wash., Yakima	46°30′	1070	4–1	5–15 to 6–15	.49	62.8
Kans., Manhattan	39°	1010	3–24	5–24 to 6–24	4.40	72.7
Mo., Louisiana	39°30′	800	3–27	5–28 to 6–28	3.96	73.0
Ill., Urbana	40°	750	4–1	5–15 to 6–15	3.63	65.4
Ill., Carbondale	37°30′	450	3–16	5–1 to 6–1	4.36	66.0
N.J., New Brunswick	40°30′	200	4–8	5–24 to 6–24	3.81	70.3
N.Y., Geneva	43°	460	4–23	6–8 to 7–8	3.49	66.0
Ohio, Wooster	41°	910	4–16	6–1 to 7–1	3.87	67.6

Location	*July[4]*		*Summer[4]*			*Second critical period*		
	Avg. abs. humid. Inches mercury	*Avg. daily max. temp.* °F.	*Avg. precip.* In.	*Avg. poss. sun.* %	*Avg. temp.* °F.	*Avg.[5] duration* Dates	*Avg.[3] precip.* In.	*Avg.[4] temp.* °F.
Wash., Yakima	.33	85	1	73	60	9–1 to 10–1	.48	64.0
Kans., Manhattan	.58	89	13	73	76	8–24 to 9–24	3.94	68.1
Mo., Louisiana	.62	87	12	68	76	8–27 to 9–27	4.49	68.2
Ill., Urbana	.58	87	11	73	73	9–1 to 10–1	3.58	65.8
Ill., Carbondale	.67	91	12	72	76	8–15 to 9–15	3.99	73.7
N.J., New Brunswick	.60	81	14	62	71	9–8 to 10–8	3.85	67.4
N.Y., Geneva	.53	79	10	62	65	9–23 to 10–23	2.82	50.9
Ohio, Wooster	.57	81	12	63	70	9–15 to 10–15	2.92	57.6

[1]from (1) Ambassador World Atlas.
[2]from (4) Encyclopedia Britannica.
[3]from (15) Climate and Man.
[4]Mean daily temperature rises above 45°F. from (2) Atlas of American Agriculture.
[5]Calculated from Magness (8) and Powell *et al.* (10).

Taylor and Downing (13) reported that most of the growth of apple fruits occurred during the late summer and autumn months, and soil moisture had the most effect on size and yield during the month before harvest.

Clements (3) reported that pome fruit lenticels (dots) were formed from stomata before the fruit was two to four weeks old. Environmental factors must be effective before this time to influence the number or distribution of dots. The soil moisture supply was effective in altering the number of dots formed. Tukey and Young (14) stated that after the first month of fruit growth cell division was very slow, and additional growth of the fruit was accomplished primarily by cell enlargement. The attractiveness of the fruit at harvest would be improved if climatic factors during the four weeks after bloom are unfavorable for the formation of many stomata which may develop into dots on the fruit surface. According to Salisbury (12) formation of stomates is discouraged by a low soil water supply, low light intensity, and high relative humidity caused by low temperatures, high atmospheric moisture and low wind velocities.

Magness (7) reported that high light intensity, cloudless days, low temperatures and low humidity—conditions generally characteristic of high altitudes and latitudes— were most favorable for the maximum development of intense red overcolor on apple fruits. According to Uota (16) low average night temperatures during the four weeks before harvest improved red overcolor development on McIntosh apples. Reger (11) stated that chlorophyll, responsible for green ground color in immature fruits, reduced attractiveness by partially masking the red color, and by screening blue-violet light important in anthocyanin formation. Chlorophyll was most readily decomposed at low temperatures, thus allowing the yellow ground color and a brighter red overcolor to show, which enhanced the attractiveness of the fruit. However, Magness (7) stated some red summer apple varieties were capable of developing attractive red overcolor at high temperatures because sufficient carbohydrates had been accumulated in the fruit for anthocyanin formation. Evidently, the effect of climatic factors on the attractiveness of the fruit at harvest is most apparent during two critical periods in the growth of the fruit—(1) the four weeks following pollination and (2) the four weeks preceding harvest.

Verner (17) noted that high relative humidity during the summer and fall months caused enlargement of the lenticels and development of russet on fruits. Cracking and weathering of the epidermis resulted in increased development of corky parenchyma cells, particularly under the dots. Gardner *et al.* (5) thought russeting of fruit also acccompanied low light intensity. High relative humidity might be effective in causing russet by the atmospheric moisture intercepting the ultra violet light and thus reducing light intensity.

Powell *et al.* (10) estimated the time sequence of apple tree development for Illinois. Growth of apple trees generally began about March 16 in southern Illinois, full bloom occurred about April 16, petal fall about April 26, and Delicious was harvested about September 10. This date for start of growth is identical with the average date at which the mean daily temperature rises above 45°F. at Carbondale as reported by Baker (2). This temperature is commonly considered to be close to the minimum temperature effective for growth and development of flower parts during pollination and fertilization. Therefore, the date the mean daily temperature rises above 45°F. may be used as a rough indication of the time of bud break in

various localities. Time of bloom can be estimated as four weeks later than bud break and petal fall another two weeks later. Thus, the four week period in the early growth of the fruit during which dots are being formed, extends from approximately six to ten weeks after bud break in specific localities. The calendar dates of this period approximate the month of May for Carbondale, the earliest region considered, and the period June 8 to July 8 in Geneva, New York, the latest location considered.

The approximate time of harvest can be obtained by adding the days to maturity, reported by Magness (8) for important commercial varieties, to the time of bloom previously stated to be approximately four weeks after the average date when the mean daily temperature rises above 45°F. Thus for Delicious, 150 days after April 16 gives the harvest date of September 16 at Carbondale; which is quite close to the actual harvest time.

Table I shows pertinent geographic and climatic conditions associated with the locations represented by apple samples which were evaluated for attractiveness. Since the desired climatic records were sometimes unavailable for the desired period, some calculations were made from records that were available. Average precipitation and average temperature data were obtained for all periods and for each location. Absolute humidity or vapor pressure, as compared with relative humidity, was considered a more accurate measure of the potential effect of water vapor in the atmosphere on the finish of apples, because it is not subject to wide diurnal variations with temperature changes. Average absolute humidity, average precipitation and average daily maximum temperature records were available for July at all locations. A correlation analysis of the average July precipitation and July absolute humidity showed a very close direct association ($r = .80^{**}$). Thus, the average absolute humidity was considered directly proportional to the average precipitation during periods for which absolute humidity records were unavailable.

Records of the average percentage of possible sunshine were available for only the summer months. For other periods, the duration and intensity of sunshine was considered inversely proportional to the average precipitation with its accompanying cloudiness. The duration of the first and second critical periods was calculated from the average date (2) at which the mean daily temperature rises above 45°F. in each location, and the time schedule (8, 10) for fruit development of Delicious apples.

(to be continued)

Literature Cited

1. Ambassador World Atlas. 1958. C. S. Hammond & Co., Maplewood, N. J.
2. Baker, O. E. 1936. Atlas of American Agriculture. 227 pp. U. S. Government Printing Office, Washington, D. C.
3. Clements, H. F. 1935. Morphology and physiology of the pome lenticels of *Pyrus malus*. Bot. Gaz. 97:101–117.
4. Encyclopedia Britannica. 1959. Encyclopedia Britannica, Inc., Chicago.
5. Gardner, V. R., Bradford, F. C. and Hooker, H. D. 1939. The Fundamentals of Fruit Production. 2nd ed. 788 pp. McGraw-Hill, New York. See p. 90.
6. Gourley, J. H. and Howlett, F. S. 1947. Modern Fruit Production. 579 pp. Macmillan, New York. See p. 179.
7. Magness, J. R. 1929. Observations on color development in apples. Proc. A.S.H.S. 25:289–292.

8. Magness, J. R. 1941. Apple varieties and important producing sections of the United States. USDA Farmers Bul. 1883:1–32.
9. Mowry, J. B. 1956. A survey of Illinois peach and apple varieties. Trans. Ill. State Hort. Soc. 90:54–61.
10. Powell, D., Owen, F. W. and Meyer, R. H. 1959. Illinois Fruit Calendar, 1959. Ill. Agr. Ext. Serv.
11. Reger, M. W. 1944. Thiocyanate induced chlorosis predisposes development of anthocyanin by exposing apple skin tissue to more blue-violet light. Proc. A.S.H.S. 45:111–112.
12. Salisbury, E. J. 1927. On the causes and ecological significance of stomatal frequency, with special reference to the woodland flora. Phil. Trans. Roy. Soc. B 216:1–65.
13. Taylor, E. P. and Downing, G. J. 1917. Experiments in the irrigation of apple orchards. Ida. AES Bul. 99:1–48.
14. Tukey, H. B. and Young, J. O. 1942. Gross morphology and histology of developing fruit of the apple. Bot. Gaz. 104:3–25.
15. United States Department of Agriculture. 1941. Climate and Man. 1248 pp. 1941 Yearbook of Agriculture. U.S. Gov't. Printing office, Washington, D. C.
16. Uota, M. 1952. Temperature studies on the development of anthocyanin in McIntosh apples. Proc. A.S.H.S. 59:236–237.
17. Verner, L. 1935. A physiological study of cracking in Stayman Winesap apples. Jour. Agr. Res. 51:191–222.

Apple Varieties for Quebec

McIntosh now constitutes 65% of all the apple trees in Quebec, according to Dr. D. S. Blair, of the Experimental Station at Ottawa. Indications are that this variety will increase to 75% within ten years. Dr. Blair recommends to Quebec growers that they decrease their McIntosh plantings to 50% because of the difficulty in picking this variety at the proper stage for best keeping quality. The varieties and percentages that he recommends for Quebec are as follows: O-342 and T441—5%; Red Atlas—5%; Red Melba—5%; Lobe—10%; McIntosh—50% and Bankroft—25%. Red Melba and Red Atlas are highly colored varieties for the August market. Lobo is harvested ahead of McIntosh. Bankroft, most promising of the newer late varieties for Quebec, has good size, appearance, keeps longer than McIntosh, is high yielding, and has acceptable eating and cooking quality.

Cimarron Grape

The Cimarron grape was originated by Dr. H. A. Hinrichs and introduced by the Oklahoma Agricultural Experiment Station in 1958, and will be available in 1960. It is a blue-black grape with heavy bloom. Flesh is tender, juicy, sweet, with low acidity and ripens evenly. It is similar in shape and color to Concord, but somewhat smaller. Vine is apparently hardy to cold, resistant to black rot and drough, and is healthy and productive.—*R. M. Brooks.*

On the basis of a strawberry variety test at the Delta Branch Experiment Station of Mississippi State College at Stoneville, in 1956 and 1957, W. W. Watson has recommended for both home garden and commercial planting in that area the varieties Dixieland, Albritton, Pocahontas and Blakemore.