BLOOMING RECORDS OF THE APPLE

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Recording plant processes that occur periodically is receiving more attention than formerly and there is increasing belief in the scientific and economic importance of records of this character. The making of flowering records is a comparatively simple matter; but, in order to make such records of value, they must be digested, brought into orderly form and interpreted in such manner as will develop principles and admit conclusions that may be formulated in a way to support some canon of science or guide economic procedure, and this is not a simple matter.

This applies not only to bloom records of apples, but to all other accumulated records touching any phase of the life of living plants. Problems that, at first, may appear simple soon develop an unexpected complexity; questions present themselves at every step, questions that may involve morphological studies, or inquiry into physiological functions or even determinations of chemical composition. The subjects are living organisms; they follow a fixed sequence of life events, but they vary in time and manner of meeting and passing these events.

The investigator may speculate on the causes of observed departures from expected occurrences, reach and announce conclusions that may or may not be correct, or he may by more or less prolonged experiments reach conclusions that will stand, or he may ignore the questions arising, merely state the facts and allow the reader to draw his own conclusions.

Bloom records to be considered were taken at the Illinois Agricultural Experiment Station; they include flowering dates and periods for 106 varieties having records of from ten to sixteen years.

For central Illinois the flowering period for apples is short; in some seasons very short. Heat waves, in some seasons, bring trees into full bloom with astonishing rapidity; flowers retain the ability to function for a brief period and the whole flowering process is over in a very few days. Other seasons are characterized by abnormal-

ly low temperatures, by excessive rainfall, or by rapidly alternating periods of heat and cold so that flowering is very irregular and the blooming period much prolonged.

Of the 106 varieties, 38 are recorded as having bloomed in each of the 16 years; 24 bloomed in each of 15 years; 23 in each of 14 years; 11 in each of 13 years; 5 in each of 12 years; 3 in each of 11 years, and 2 in each of 10 years. For the 16 years (1901-1916), flowering periods have ranged from 10 to 22 days; the average is approximately 16 days. Records of 1906 and 1911 are very near the average; seven years had periods one to six days longer than the average and seven years had periods one to six days shorter than the average.

The full flowering period for the 16 years is included between the dates April 2 and May 21 and is thus 50 days in length, but this includes one year so abnormal as to set it apart from all other years; I refer to 1910, in which year flowering began April 2 and ended April 19. Omit 1910 and the full flowering period has extended from April 18 to May 21, or 34 days.

Some varieties tend to bloom early, others late, but there is no variety holding place as earliest bloomer or as latest bloomer with constancy; they vary within wide limits. Causes for these variations must be looked for in seasonal differences in vigor of individual trees. All trees are subjected to the same atmospheric conditions and presumably the soil is uniform, but all trees do not behave in the same manner with reference to their functions; one tree, in a given year, makes greater growth than another, has more and better foliage and exceeds its neighbor in fruit production; in another year the performance of the two may be exactly reversed in all these particulars. In the same way response of flower buds to the stimulus of advancing spring may be quick and vigorous or tardy and weak, depending upon the condition of the individual.

The seasonal abnormality of 1910 was so great that it deserves brief mention. The bloom extended from April 2 to 19, a period of 18 days. A period of the same length was recorded for 1909, one a day shorter in 1904, another a day longer in 1905; nine of the 12 remaining years had

periods from 2 to 8 days shorter and for three years the periods were three and four days longer. Individual periods ranged from 4 to 9 days much as in normal years. It appears that the whole flowering period was simply moved forward until the ending of bloom for the latest flowering variety overlapped, by but one day, the earliest opening of flowers in any other year.

The early bloom is directly attributable to abnormal weather in March. The month was dry, the rainfall only .38 inch; mean maximum temperature 63°, mean minimum 37.7°, and mean daily 52.3°. For the last half of the month the absolute maximum was 85°, the mean maximum 73.9°, and mean minimum 44.7°. For the period of bloom, April 2-19, the mean daily temperature was 53.4°, the mean maximum 65.6°, and the mean minimum 42.1°.

I wish now to compare this earliest blooming period of 1910 with the period for 1904 which was the latest recorded—May 5-21. The comparison covers 102 varieties that bloomed in both years. The full flowering periods for the two years differ but by one day, 17 days in 1904 and 18 days in 1910, but the beginning date in 1910 was 34 days in advance of the beginning date in 1904.

Flowering periods for individual varieties tend to concentration about the 6, 7, and 8 day periods in both years; the day-groups in 1904 number 8 with a range of from 4 to 14 days; in 1910 there were 6 day-groups with a range of from 4 to 9 days. The average period was 7.34 days in 1904 and 6.78 days in 1910, a half day longer (.56) in the year when the blooming period occurred 34 calendar days later than in the year of early bloom.

It would be reasonable to expect that in contrasting the blooming periods of two years, one of which was more than a month later in the season than the other, the periods of individual varieties would be shorter and concentrated under a less number of day-periods in that year in which the blooming period was latest in season, because the more powerful action of the sun and the presumed greater aggregate of heat units in the advanced season would so stimulate plant functions that blooming of varieties would proceed rapidly and result in concentration within narrow time limits of short individual

periods, but in this case the reverse is true. Not only are the full flowering periods, although separated by more than a month, of nearly equal length, but individual periods have a shorter average in the early year and there are twice as many varieties having 4 and 5 day-periods as in the later year.

Fluctuations in length of varietal flowering periods are common to all varieties and all years; they are no more marked in the years 1904 and 1910—the earliest and latest years—than they are in other years. Grandmother, which had a 5 day period in 1910, had a ten day period in 1904, and Repka Malenka with an 8 day period in 1910, had a 14 day period in 1904. There were 50 varieties that had periods from 1 to 6 days longer in 1904 than in 1910, while 29 other varieties had periods from 1 to 4 days longer in 1910 than in 1904. These differences suggest the operation of influences entirely apart from temperatures, moisture, or other climatic conditions.

For the 16 years of record, average varietal flowering periods ranged from 5 days to 10 days; this average was 5 days in 1910 and 1915, 6 days in 1908 and 1912; 7 days in each of 6 years, 8 days in each of 3 years, 9 days in 1903 and 1914 and 10 days in 1907. The lengths of blooming periods for individual varieties may be near together in one year and widely separated in another year. There is great variation in this; thus, in 1907 the minimum of 3 days was represented by two varieties, the maximum period of 17 days by one variety, and each number of days falling between 3 and 17 was represented by from 1 to 13 varieties; this largest number—13—falling on the 12-day period. The total number of periods, each differing from its neighbor by one day, was 15; at the other extreme the year 1915 has the record, for the 100 varieties blooming in that year concentrated into 3 periods; 7 varieties each had a 4-day period, 57 varieties had each a 5-day period, and 36 varieties had 6-day periods.

Amount of bloom is not open to exact determination, but estimates are believed to be helpful in summation of characteristics of varieties and in separating those having well-defined tendencies towards insufficient bloom from those having the opposite tendency. Observations

made year after year convey a very definite impression of wide seasonal differences in behavior of varieties and individuals; of very unequal response to exterior conditions observed and assumed to exert influence either as stimuli to increased activity, or as agents operating to retard or diminish plant processes and, further, of the fact that factors governing performance are complex and dependent upon physiological changes that are difficult to understand or rightly interpret.

Amount of bloom is not determined at blooming time, but during the preceding year at the time of bud formation and, whether the amount is large or small, must depend upon the condition of the trees and the conditions to which they are subjected during the bud forming period.

Classified as belonging to one or the other of two divisions, no bloom or not sufficient for a crop and enough for a crop, the 1696 records for the 106 varieties for 16 years divide as 636 with none or insufficient bloom and 1060 with sufficient for a crop. From examination of the records it appears that 1913 was the year of maximum performance, for in that year 101 or 95.29 percent of the varieties had sufficient bloom; next to this was 1915 with 97 or 91.51 percent with satisfactory bloom. At the other extreme, 1902 and 1907 had each only 41 or 38.68 percent of the varieties having sufficient bloom. In other years the distribution was irregular.

Very heavy or excessive bloom occurred 92 times on 58 varieties in 8 of the 16 years; 32 varieties appear in the list recording very heavy bloom but once; 21 varieties appear twice; 3 appear 3 times; one, 4 and another 5 times. For the 21 varieties each appearing twice, there were two cases in which the years of heavy bloom were consecutive, five cases of alternation with sufficient bloom in the intervening year and 14 cases in which the years of heavy bloom were separated by from 8 to 12 years.

The variety having very full bloom in 4 years was Oldenburg; the years were 1902 and 1904, and 1914 and 1916; between each of these pairs was a year of moderate bloom and for the 16 years the variety has record of 12 good and 4 poor years.

The variety Borsdorf has the highest record of any of the 106 in that in no one of the 16 years was there a deficiency; it had moderate bloom in 2 years, full bloom in 11 years, and very full bloom in 3 years.

There are wide differences in varieties as regards their blooming tendencies. Some are inclined to produce sufficient bloom nearly every year while others rarely attain satisfactory production.

Cases of alternation of full or heavy with light or no bloom occur occasionally, but they are less common than the occurrence of from 3 to 5 or even 6 consecutive years characterized by the same amount of bloom, either scant, moderate, or full.

In this fact is seen evidence of the inequality of response by different varieties to the same attendant conditions. Each variety appears to follow a course of its own, individuality stands out strongly and there appears no single agency or group of agencies that operate on more than very restricted lists of varieties for limited periods to govern performance in flower production.

Effort has been made to trace relationship between amount of bloom, in a given year, and conditions of temperature and moisture prevailing during the months of June, July, and August of the preceding year, but the irregularities found were such as to render existence of any definite relation doubtful; correlation cannot be established for the reason that temperature and rainfall are only two of a long array of factors, all of which may operate to influence bloom performance. Temperature and rainfall may be the most important, but taken alone they cannot lead to correct interpretation of observed results because other, and possibly equally important factors are left out.

Computations from incomplete data serve only to confuse; they do not aid in understanding observed phennomena and hence accomplish no good purpose. Even with full data at hand, determination of the causes of observed irregularities in flowering would be difficult because of the complex nature of the problem. Like any other problem involving the physiological processes of plants the factors that influence results are very numer-

ous, these factors interact among themselves, they are difficult to isolate, and, to associate correctly any one of them with observed phenomena is possible only through close and prolonged study.

With all varieties there are marked irregularities in the alternation of long and short blooming periods, and, further, there are conspicuous departures from those relative lengths of periods of different varieties that might easily be assumed to be constant; thus, where two varieties, in any one year, have blooming periods differing in length by several days, one, say twice as long as the other, it would not be unreasonable to suppose that the varieties in question would hold to an approximation of the difference in other or all seasons. As matter of fact the relative lengths of the periods in one season may be reversed in the succeeding season.

This occurrence indicates plainly that temperature and general atmospheric conditions, commonly regarded as the chief determiners of lengths of blooming periods, do not act equally on all varieties in all seasons, or that varieties develop within themselves qualities that render them less susceptible to stimulation, or more resistent to adverse conditions in one season than in another.

In illustration, the records of Tolman and Whitney for the years 1903 and 1908 may be cited. The flowering period for Tolman in 1903, a year having a long average flowering period (9.2 days) for all varieties, was six days, while in 1908, when the average period for all varieties was short (5.94 days) the period recorded was 16 days. In contrast with this record, Whitney, with a variety average for 16 years of 7¾ days, had its flowering period lengthened to 14 days in 1903 and contracted to 5 days in 1908. Bringing these records side by side for ready comparison they appear as below:

	1903	1908
Blooming period for Tolman.....	6 days	16 days
Blooming period for Whitney....14	days	5 days

The trees compared were of the same age, grew but a few rods apart and had received the same care each year.

Variations in lengths of blooming periods such as those cited are of common occurrence and cannot be caused by spring weather conditions alone; by their marked irregularities they suggest that the individual rather than the variety must be the basis from which performance is considered. Trees of one variety growing together in the same row do not act alike; one starts earlier, pushes stronger, and completes its period of bloom in less time than does its neighbor. It is said of such a tree that it was in better condition than the other, had more vigor and was thus enabled to outclass its neighbor; this is true, but when the question is asked, Why was the tree in better condition and possessed of greater vigor? the answer is not immediately forthcoming.

The tree of greater vigor may be constitutionally better than its neighbor; it may have had access to better food supply; it may have recovered more completely from a fruiting effort; it may have escaped a parasite that damaged its neighbor; any of these or possible other causes, singly or in combination, may have operated to bring about the recorded differences, leaving no evidence of operation that is apparent at the time bloom record is made.