

**A STUDY OF SOME
FACTORS INFLUENCING
FRUITFULNESS IN APPLES**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649317547

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**A Study Of
Some Factors Influencing Fruitfulness
in Apples**

CLEO CLAUDE WIGGANS, B.S. Agr., A.M.

SUBMITTED IN PARTIAL FULFILMENT OF THE
REQUIREMENT FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF MISSOURI
COLUMBIA

1918

UNIVERSITY OF MISSOURI
COLLEGE OF AGRICULTURE
Agricultural Experiment Station

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¹In U. S. Military Service.

²In service of U. S. Department of Agriculture.

SOME FACTORS FAVORING OR OPPOSING FRUITFULNESS IN APPLES •

The Effect of Certain Conditions and Practices on the Development and Performance of the Individual Fruit Spur

C. C. WIGGANS

INTRODUCTION

It is a generally observed fact that certain varieties of apples tend to bear crops in alternate years, while others produce annual yields. Some varieties are light bearers but others yield heavy crops. In some cases the same variety, or even the same tree, shows great variation in its performance from year to year. The principles underlying these variations in behavior are of scientific interest as well as of great importance to practical fruit growers. Horticultural literature contains numerous references to the biennial crops of the Baldwin in the New England and New York fruit growing sections. Among the varieties grown in Missouri, the Ben Davis, Gano, Ingram, and York show marked alternation of crops, while the Jonathan, Winesap, Grimes, and Missouri generally may be depended upon to give satisfactory crops each year.

The investigator in considering the factors influencing fruitfulness in apples, must, first of all, give his attention to a study of the principles underlying fruit bud formation, for the flower must, of course, precede the fruit. Many and varied have been the opinions of investigators as to the factors causing flower production. The argument has sometimes been advanced that the blooming power is inherited, while some writers have maintained the view that flowers are dependent upon the presence of a certain specific "blossom building" substance. The latter view has been especially noticeable among German investigators. Environmental factors such as light, heat, accident, etc., have been considered the all important ones in some cases, while in others, the effects of certain cultural practices have been used as a basis for the explanation of the phenomenon. Seemingly, the problem has been of as much interest to plant physiologists and morphologists, as to the practical growers themselves.

*Also presented to the Graduate School of the University of Missouri, June, 1918, as a thesis in partial fulfillment of the requirements for the degree of Doctor of Philosophy.
ACKNOWLEDGMENT. The writer wishes to acknowledge his indebtedness to the following named men who assisted him to plan and carry out this investigation: Dr. J. C. Whitten, Dr. G. M. Reed, Dr. F. F. Trowbridge, and Mr. H. G. Swartwout.

It has long been recognized by those interested in plant life that in every plant there are two seemingly antagonistic forces, one of which is striving to preserve the individual plant, and the other, to perpetuate the species. The first of these activities expresses itself in the formation of purely vegetative parts, such as stems, roots and leaves, thru which the life of the individual may be lengthened, while the latter has to do with the formation and maturation of seeds in greater or smaller numbers by which the species may be carried over from one generation to the next. The former may be spoken of as vegetative activity and the latter as reproductive activity, or, in the case of fruit trees, as wood growth and fruit growth.

Vegetative activity always precedes reproductive development and, so long as it proceeds with undiminished vigor, few or no blossoms will be formed. With our tree fruits the period of vegetative activity may be several years in length while with certain annual plants it may be a matter of only a few weeks. In any case, however, the maximum vegetative period passes before heavy reproduction begins. Maintaining the vigor of the wood growth serves very materially to delay the formation of fruits, while, on the other hand, a heavy fruit crop tends to decrease greatly the vegetative growth. From these general observations, the obvious conclusion has been reached that it is impossible to have the greatest efficiency in both wood and fruit growth simultaneously in a single individual. A plant, then, cannot be of the highest degree of service to itself and to its species at one and the same time.

Apple trees during the first few years of their life produce few or no blossoms. The energies of the plant are directed to the formation of a framework of branches upon which the later crops of fruit are to be borne. Finally, however, the bearing age is reached but this is found to differ very materially in the different varieties and even in the same variety when grown under different cultural and soil conditions. From this time until its death, the tree remains a potential fruit bearing organization. The amount of fruit borne, however, often shows a very striking variation, ranging from a very light crop to a very heavy one. This phenomenon is sometimes spoken of as alternation.

Alternation, referring primarily to the bearing of heavy and light crops in alternate seasons, seems to be more or less a varietal characteristic. With certain varieties regular crops are expected, while with others a heavy crop is almost invariably followed by a light one. This habit of alternation also seems to be much more

characteristic of our later commercial varieties than of some of the older sorts grown in the orchards of the early settlers. This may have come about because of the emphasis that is now placed upon high yields. In the earlier days, when markets were limited, regular crops were more desirable than heavy crops.

In an investigation of the factors influencing fruitfulness in apples, so many avenues of research are open that it is folly to attempt to take all of them into consideration in a single investigation which must be more or less limited to certain lines. Previously, nearly all investigators have been inclined to consider the problem from the standpoint of the entire tree, or, of the entire orchard, in its relation to a specific treatment or factor. In this study, however, the main idea centers around the factors and conditions influencing the behavior of an individual fruit spur. Since the tree is composed of numerous individual fruiting parts, the factors influencing the individual spur must ultimately have a proportionate influence upon the entire organization. Hence an attempt has been made to keep constantly in mind the fruiting parts as individuals rather than in mass, and the greater part of the work has been done with the individual fruit spurs.

Moreover, for the purpose of this study, it is generally assumed that a blossoming spur is also a fruiting spur. Under field conditions, however, some flower clusters may fail to set fruit, but the fact still remains that a spur developing a blossom is a potential fruiting spur for the following year, and it is here so considered.

LITERATURE

A critical review of the literature bearing upon the factors favoring or opposing fruitfulness in apples reveals the fact that many explanations have been offered for the variations found in the fruiting habit of an apple tree. It is quite noticeable that many of these explanations are based upon general observations and conclusions rather than upon actual scientific data, and especially is this true in the older writings. Definitely planned experimental work is virtually confined to the last twenty-five years, and dates approximately from the time the agricultural experiment stations became well established in research work.

Not all writers have been interested directly in the production of an increased number of blossoms for some have been concerned with the reserve materials which are always found to be present in woody plants. The amount and nature of these reserves vary accord-

g to the season and character of the part under consideration, and these variations have sometimes been used as a basis to explain the phenomena observed. Thus, are recorded not only the observations of horticulturists but those of biologists and chemists as well.

The natural evolutionary development of the apple during the centuries that it has been under cultivation, has very likely had considerable influence upon the cultural practices of the succeeding periods. Therefore, it seems but natural to suppose that the management suitable for the apple as it was first known would be not at all applicable to the modern commercial high yielding varieties. Also, increasing knowledge of plant structure and function, in all probability, has been productive of improved methods of fruit growing. The recommendations, however, based upon either general observations or actual knowledge, have for their purpose an increase in the yield or an improvement in the character of the fruits borne.

One point upon which the majority of writers are in perfect accord is, that fruit bud formation is dependent upon a supply of reserve food material. With the better understanding of the sap flow in plants, this idea has become more and more prominent. Even the early writers seemed to appreciate that there is some connection between the food supply and the sap, and hence they devised methods which they thought they could modify the sap and thereby also influence the food supply. Particular methods were evolved for the various parts of the plant and changes in the character of the food supply, etc., were also suggested.

Since many of the writers have considered the effects of several methods or treatments upon fruitfulness, it seemed advisable to confer the literature in chronological order rather than by topics. This plan has been used in the following review:

One of the earliest records found of an interest being taken in the factors influencing fruitfulness is the statement of Lonicus (1587) quoted by Zacharias^{122*}. This early writer seems to have reached the conclusion that an excess of nourishment leads to a very marked extension of the vegetative branches, but that no fruit will be borne under these conditions. This same doctrine, that great vegetative growth is not compatible with great reproductive activity, has been subscribed to today.

According to Noehden¹⁰⁴, Van Oosten, (1711) the Dutch botanist, stated that a "moderate sap flow," secured by frequent transplanting or by summer pruning, will result in fruit production. While

*See bibliography for this and subsequent number references thruout.

he probably possessed very little knowledge concerning the sap flow, yet this writer suggested two methods which will encourage fruitfulness and these methods are even now sometimes used for this purpose.

The beneficial effects of ringing were observed by De la Baisse (1753), Bonnet (1754) and Duhamel (1758). These reports were recorded by Mobius¹⁰. Duhamel apparently seems also to have had some knowledge of the effects of pruning.

Knight¹¹ early in the nineteenth century published many papers dealing with horticultural subjects. Among his observations, Knight made note of the increased fruitfulness of horizontal branches as compared with upright ones. He explained this by the assumption that the decreased sap movement in the horizontal branches was the direct cause of their greater fruitfulness. He suspected that the heavy fruit crops borne immediately following a warm bright season when only a few fruits were matured, was due to the fact that the sap had not been expended in maturing an excessive crop. In some of his earlier papers he leaned to the belief that the bearing age of a tree is dependent to a large extent upon hereditary factors, but later, ringing is mentioned as a way of increasing fruitfulness, this being due to the accumulation of descending sap. Knight really had a much better knowledge of plant physiology than his predecessors and hence was enabled to give a more nearly correct interpretation of his results. It is interesting to note the close agreement between some of his ideas and those of the present day.

Forsyth¹² in a textbook on the general subject of fruit growing published in 1802 made the following statement, "Never shorten the young branches except they are very thin. . . . nor prune any of the young shoots the second year, as many of the eyes, almost at the end of the shoot, will, if it be strong, become fruit buds next year." Evidently, this writer had been making some very accurate observations upon the method of fruit spur formation.

That fruit bud formation may be stimulated by checking or diminishing the growth was the opinion of Noehden^{10a} (1818). Ringing was suggested as one means of accomplishing this end.

Prince¹³ (1830) believed that the amount of available moisture had a marked effect upon the fruitfulness of grapes.

Philips¹⁴ (1831) declared that, "Pruning is to be avoided as much as possible as it creates useless branches and prevents the fruiting." Cole¹⁵ (1849) mentioned the following factors as being conducive to fruitfulness and early bearing; root pruning, ringing,