Factors Affecting Quantity and Quality in Citrus Fruits

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The interest of fruit growers must in the nature of the case be centered on the quality and quantity of the fruit produced. This interest has always been reflected in the previous meetings of this Society, and no doubt will continue to be a vital topic for discussion at future meetings for years to come. This paper is presented to the Society, not with the idea that anything new or startling has been discovered, but rather with the purpose of making a survey of the subject from a slightly different angle from that of previous discussions.

In the first place it must be emphasized that the factors affecting fruit quality are related to those affecting quantity both directly and indirectly; that conditions favoring quality tend to reduce quantity and vice versa; and that citrus fruit growing must be a compromise between these groups of two factors; for we can not make a profit if we produce a small amount of fruit of good quality or a large amount of fruit of poor quality.

Furthermore, in discussing the factors involved it may be pointed out that while any factor mentioned may be of importance no way has yet been found to measure its relative value. In consequence each grower must use his own judgment in evaluating the relative importance of these factors in handling his own grove. No attempt is being made to lay down rules for guidance; it is more desirable to discover fundamental principles which the grower may apply to his special needs and purposes.

Let us first take up the factors in the environment which affect quantity. In order to get a maximum crop it is necessary that the tree be situated in a favorable soil, that is, one which contains at all times sufficient water and plant food for full development. In order to contain at all times a large amount of plant food such a soil must have a heavy water holding capacity. It will also be well drained, with an abundant humus supply, a favorable soil reaction (neutral or slightly acid), the largest possible amount of favorable soil bacteria, sufficient plant food so no deficiency may act as a limiting factor, and there must be no toxic substances in the soil which might prevent absorption or injure tissues. In order to develop and maintain such soils in Florida attention must be paid to fertilization, cover crops, irrigation, drainage and cultivation. A further requisite
is the securing of protection from frost damage. This is best achieved by locating the tree where this type of damage is at a minimum. Frost protection by location is the cheapest and most satisfactory form of protection. Frost injury affects quantity by destroying bloom or by reducing the top. This second effect is similar to that produced by top pruning, which indirectly affects yields.

The tree should also be protected from injury by disease, insects and other pests. Any agency which reduces the size of the top or root system, or impairs their function, reduces in like proportion the quantity of fruit produced. There is no necessity to go into this question in detail as the pathologists and entomologists have shown you how to eradicate or control these troubles.

Another factor involved has to do with root stocks and root systems. In order to get maximum results it is necessary to have a vigorous, large root system suited to the type of soil in which it is planted. Not only should it be suited to the soil, but also to the type of cion which is top-worked upon it. It is not necessary to elaborate on this factor either, as citrus growers have had this phase of the subject thoroughly driven home to them. The root stock must be free from disease and insect damage, and to be long lived should be congenial to soil and cion.

The citrus tree producing the largest crops must have a vigorous healthy top adapted to the stock on which it is worked. There should be no interference with the flow of soil solutions from the root to the top, nor of plant food from the leaves to the roots. The foliage must be heavy, active, free from disease and insects. The growth of the previous season should have been sufficient to produce as many fruit buds as the tree requires and to carry as much fruit as the root system can supply with water and nutrients. All pruning of active healthy leaf areas must be avoided, as its effect is to reduce yield. The frame-work of the tree must be built up in such a form that it will carry maximum loads without injury either to the fruit or to the tree itself. In order to produce a sufficient quantity of marketable fruit it is necessary to see that the root system, trunk, leaves, buds, bloom and young fruit are not harmed in any way by disease, insects, or cold, or by mechanical injuries.

All the above factors are well known and understood by the citrus grower and do not need elaboration or further discussion, but there are many other factors which are little known although they may affect the quantity of fruit produced to an equal extent. Suppose we have a vigorous orange tree with healthy root, trunk and leaf systems, a favorable soil, adequate water and food; in other words everything mentioned above which favors the production of a large quantity of fruit, yet many times there is a short crop. The conditions which bring this about may be within the control of the grower; yet because of imperfect knowledge his remedy for it may be entirely inadequate. Most citrus growers know that the blooming period is a critical time in the life of the crop, yet few realize that it is possible to partially con-
control the amount of the bloom produced and of fruit set. The citrus flower is usually self-pollinated, in other words does not require the assistance of bees in order to set a crop. The fact that this is true saves the citrus grower much trouble. Other factors, however, may affect fruit setting if overlooked. For example, while there may be an adequate supply of water to favor growth throughout the entire season, yet a temporary deficiency at or preceding the blooming period may cause a short crop. In the same way a temporary deficiency of important food elements, particularly nitrogen, may produce a like result. An attempt to protect trees against cold damage by nitrogen starvation may cause the loss of a considerable portion of the bloom. The effect on the nitrogen reserve brought about by the heavy yields of the preceding year is also underestimated. While the color of the leaves is usually a good indication as to whether the tree is getting sufficient nitrogen during the growing season, yet the fact should not be overlooked that a tree which has had an adequate supply of nitrogen all winter may be suffering from nitrogen starvation by the time it is in full bloom, due to the fact that the nitrogen reserve is used up in building new tissue and conditions have been unfavorable for renewing it. Generally a liberal application of nitrogen in a soluble form to the tree several weeks before the blooming period is one of the most effective means of increasing the crop.

Assuming that we have supplied all the conditions necessary to bring out a heavy bloom, yet there will be times when bloom does not show up on the spring flush. If the grower is observant this condition will be accounted for by a previous unfavorable growing season but this is only a partial explanation. Let us look farther and see if we may find the reason. In the citrus groves of California it has been found that there is a direct relation between the character of the growth of the previous season and the subsequent bloom. There is no doubt in my mind that this relation holds true also in Florida. The orange tree grows by a series of flushes which are responses to the tree’s environment. Normally there is a spring flush which tends to check during the dry months of April and May; then the summer flush beginning with the rainy season and diminishing again with a lack of water or plant food; and sometimes there is a fall flush if conditions are favorable. In young, well-fed trees with a constant water supply there may be no break between these flushes, but each flush tends to become shorter as the age of the tree increases. In young trees where the growth is nearly continuous, conditions are unfavorable for fruit bud differentiation. Consequently conditions tending to check young trees favor early bearing. When the growth is upright and vigorous in young trees they will usually be unproductive and only as the summer growth becomes less will the trees come into bearing. An abundance of nitrogen and water and a capacity in the stock and cion enabling them to use raw materials to best advantage are not conducive to early bearing. Certain com-
Combinations of stock and scion, however, particularly those showing unequal unions, tend to differentiate their bloom when very young and are heavy, consistent producers during the life of such combination. On the other hand these trees are more or less short-lived. Even a vigorous type of tree with perfect union which would normally not produce when young may be thrown into bearing by any factor or combination of factors which tend to check growth between May and August. Root pruning, heavy potash fertilization, lessened supplies of water, girdling, bending of limbs, are all agencies which tend to increase the carbohydrate-nitrogen ratio and consequently to stimulate fruit bud differentiation. Top pruning, heavy nitrogen fertilization, shortage of potash and frequent shallow cultivation tend to lessen this ratio and thus delay fruiting. In mature trees well supplied with foliage fruit bud differentiation normally occurs if the trees are well fed, but if they are carrying a heavy crop the burden on the trees may be such that they may suffer from nitrogen starvation as shown by a loss of color in the leaves. If a nitrogen reserve is not built up there will usually be a short crop. If these statements are correct, and I believe them to be thoroughly sound, then quantity production on mature trees will require liberal feeding of all nutrients up to capacity in spring and early summer. In young trees just coming into bearing a formula high in potash and low in nitrogen would be indicated for summer fertilizing, and the application of an abundant supply of soluble nitrogen two or three weeks before blooming would be found desirable on both young and mature trees. Unfortunately some of the more common forms of soluble nitrogen, such as sulfate of ammonia and nitrate of soda, have often given undesirable results; probably due either to their unfavorable effect on soil reaction, to a lack of humus in the soil, the loss of too much nitrogen by leaching, or undesirable residues. An application of one of the newer forms of soluble nitrogen such as urea or calcium nitrate will usually give better results. Urea in particular seems to be well suited to this purpose and I believe that as it becomes more easily obtainable it will be a very valuable agent in the hands of the citrus grower who learns how to use it properly. It seems to leach much less readily than the other forms of soluble nitrogen, to injure the plant less when fairly high concentrations are used, and to leave no harmful residues.

If the discussion of the factors affecting quantity of fruit seems to you inadequate, the following on those factors affecting quality will appear still more vague.

In the first place no type of grove handling will make a variety which is naturally of poor quality into a first class fruit. In some seasons and under some circumstances it may be better than at others, but in the long run there will be little profit in handling such fruit.

The question of quality is not always well defined by either the grower, the shipper or the consumer. The grower considers a fruit of high quality if he can enjoy it on his own table; the shipper
recommends its quality if it tops the market for its season; while the consumer selects it for its appearance, flavor, and keeping qualities when he buys it from the retailer. In consequence we must differentiate between fruit quality and commercial fruit quality. A fruit may be very pleasing both to the eye and to the palate and yet be entirely unsatisfactory when placed at the mercy of the assembling, transporting and distributing agencies. All of you know of varieties which are fine fruits when grown at their best, yet which reach the consumer in the north in a state unfit for human consumption. In fact certain varieties can only be enjoyed in the state, as they are unfit for transportation. Such varieties should not be planted extensively or if already planted should be top-worked as soon as their faults are discovered. How can we define a fruit of first class commercial quality? To my mind an orange should be well shaped, have a thin, smooth rind, well and evenly colored, with no defects or injuries. The pulp should be juicy with a minimum of rag, practically seedless, and with an even blending of acidity, sweetness and flavor. It should have these characteristics not only when picked from the tree but when it reaches the consumer. Otherwise it is not a satisfactory commercial fruit. It is easy enough to define such a fruit but not to produce it. It requires a climate with adequate moisture and heat, a soil lacking neither humus, water nor plant food, a root-stock which can supply water and nutrients to the top slowly and evenly, with no tendency to force excessive growth and consequent coarseness, or to dry out the fruit before maturity; and a top with healthy foliage lacking the deep green of vigorous growth. It implies proper choice of variety, proper protection of the surface of the fruit from diseases, insects and other injuries which may mar its appearance, moderate or even scanty fertilization and cultivation, particularly in summer and fall. In fact from the tree standpoint the best fruit is produced where there is a slow, even and regular development of the fruit from the time of blooming until it is harvested.

This gradual growth is more easily achieved on old trees than on young ones; with Pineapples rather than Valencias; with trees on sour orange or trifoliate rather than those on rough lemon; on hammock soils with moderate fertilization rather than on high pine land heavily fertilized; with a minimum of cultivation rather than with a maximum; with soils which have carried leguminous cover crops for several years rather than those without such treatment; on irrigated areas rather than unirrigated; on well drained areas rather than poorly drained ones; with trees pruned lightly rather than severely; on trees with normal foliage rather than on defoliated trees; in groves that are protected by spraying and dusting rather than in neglected ones; on soils which are fertilized moderately rather than heavily; on soils high in potash rather than low; those low in soluble nitrogen rather than high. Some of these factors are the exact opposites of those favoring the quantity of fruit and there
is no doubt that treatment which tends to produce fruit of high quality often lessens the amount. Is it possible to effect a compromise? I believe that it is; yet it is the job of each grower to find the middle point best suited to his conditions. To a certain extent the grower can furnish treatments which favor quantity production. After the fruit has set and reached a certain size the soil and fertilizer may be modified to such an extent as to favor more gradual increase in the size of the developing fruit. The grower who harvests his fruit before the spring blooming period is especially fortunate because with the late fruit, Valencias in particular, conditions favoring the set of fruit also favor the drying out of that already on the tree. Even if the grower follows a definite compromise which has been successful in the past, adverse weather conditions may throw the whole mechanism out of joint and he may neither have a heavy set of new fruit nor marketable fruit of the current season. The Valencia grower is often like the dog who sees the reflection of the bone in the water, and in snatching at the pictured one loses the one in his mouth.

No one knows better than the writer of this paper that our knowledge of the internal mechanism of the tree is still deficient. It is practically impossible to measure the relative value of these factors in the production of quality and quantity in fruit. However, it is possible to avoid the extremes which have been indicated and which are liable to bring disaster.