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Nitrogen Fertilizers for Fruit Trees

H. D. Hooker

All cultivated plants require the same chemical elements for growth, but they do not all respond alike to fertilizer treatments. The difference between field crops and fruit crops in this respect is particularly striking. On Missouri farms, applications of phosphates usually bring larger profits for field crops than treatments with any other fertilizer, while applications of nitrogen are seldom profitable except where small quantities are used with other elements in a mixed fertilizer. For increasing the growth and yield of fruit trees, however, no other fertilizer is likely to be so effective as some quickly available form of nitrogen.

So-called complete fertilizers are sometimes recommended for orchard trees and especially for apples on the basis that nitrogen promotes growth, that phosphates increase fruit production and that potash improves color. Experimental evidence that either phosphates or potash have these desirable qualities or that they benefit fruit plants in any direct manner, is, however, entirely wanting. Phosphates may be of indirect value to orchard trees in an important way. The growth of inter-crops or of cover crops may often be benefited by some phosphorus-containing fertilizer, such as acid phosphate, and when these crops are turned under for green manuring they improve the tilth of the soil and the growth and production of the orchard trees. It may be that under some conditions or if applied at certain times, phosphates and potash benefit orchard trees, but no direct beneficial results have been obtained when these materials have been used in the usual way. Nitrogen, however, is all important in orchard fertilization, but of secondary importance for most other crops.

The effect of nitrogen on fruit trees demands some explanation. The roots of fruit trees in good fruit soil extend down into the subsoil, but the roots of annual crops are practically confined to the surface soil. Phosphates are distributed throughout both the top soil and the subsoil, so that fruit trees have a much larger supply on which they can draw than field crops or vegetables. In consequence the supply is rarely inadequate for trees, but repeated cropping exhausts the supply available to annual plants much more rapidly. The supply of available nitrogen, however, is practically confined to the surface soil. The subsoil contains little or none because nitrogen is made available by the action of soil bacteria that require air and so must work near the surface.

FRUITS FERTILIZED WITH NITROGEN

The use of fertilizers is practically restricted to three of the principal orchard fruits grown in Missouri, namely, to apples, peaches and cherries. Other fruits such as plums, persimmons and grapes, may be benefited by manure or commercial fertilizers high in nitrogen under certain conditions. However, the use of fertilizers for these fruits is not generally recommended until nearly every other cultural practice designed to increase growth has been exhausted. If after careful pruning, thorough spraying and cultivation with detailed attention to every other phase of orchard management, the plants do not give the yields that might be expected, it is possible that a fertilizer high in nitrogen may give the desired results. In the case of pears and quinces nitrogen fertilizer may be harmful by causing an excessive vegetative growth which increases susceptibility to fire blight.

KINDS OF NITROGEN USED

Manure.—Of the many kinds of fertilizers which supply nitrogen, only three are important for fruit. These three are manure, nitrate of soda and sulphate of ammonia. Probably no nitrogen-carrying fertilizer is quite equal to manure. When applied to an orchard soil, it not only acts as fertilizer supplying the fruit trees with nitrogen in an available form, but it improves the tilth of the soil by adding humus. The improved soil tilth increases water-holding capacity and reduces danger from drought in a dry season.

Chemical Fertilizers.—Nitrate of soda is a mineral mined in Chile from vast accumulations that represent the activity of innumerable soil bacteria through countless ages. It is called Chile saltpeter to distinguish it from true saltpeter which is nitrate of potash. Sulphate of ammonia is manufactured as a by-product from coke and gas ovens. Both nitrate of soda and sulphate of ammonia are essentially substitutes for manure. Both contain larger percentages of nitrogen than manure, which makes them cheaper to transport. Commercial sodium nitrate is about 15 per cent nitrogen depending upon the amount of moisture it contains. Commercial ammonium sulphate usually contains about 20 per cent nitrogen. Although these chemical fertilizers are more concentrated than manure, they do not contain humus and so lack other beneficial properties of manure. However, the supply of manure is practically always inadequate.

The relative scarcity of manure and the high cost of transportation makes the expense prohibitive in many localities. Fruit growers who have a local supply or who are so situated that they can obtain stockyard refuse from Kansas City or St. Louis at a reasonable cost may take advantage of the double benefits to be derived from manure. Others are forced to resort to chemical substitutes. These have compensating properties. In addition to the lower cost of transportation per pound of nitrogen, both nitrate of soda and sulphate of ammonia are more quickly available sources of nitrogen than manure and can be used to produce certain results more effectively. For example, early spring applications of either sodium nitrate or ammonium sulphate are much more effective in increasing the set of fruit on apple trees than manure applied at the same time.

Under ordinary circumstances there is no choice between nitrate of soda and sulphate of ammonia. Experiments with both apples and peaches show that a pound of nitrogen in the form of nitrate of soda is exactly equivalent to a pound of nitrogen in the form of sulphate of ammonia. It should be borne in mind, however, that 6⅔ pounds of nitrate of soda contain one pound of

nitrogen while 5 pounds of sulphate of ammonia contain an equal amount. In applying these substances to fruit trees, therefore, only ¾ as much sulphate of ammonia as sodium nitrate should be applied.

In purchasing fertilizer, the same relation applies. Nitrate of soda at $60 a ton is roughly equivalent to sulphate of ammonium at $80 a ton. If the sulphate of ammonia costs less than a third more than nitrate of soda, it is cheaper.

TABLE 1.—EQUIVALENT COST OF SODIUM NITRATE AND AMMONIUM SULPHATE.

Price per pound of nitrogen	One ton nitrate of soda	One ton of sulphate of ammonia
$0.27	$81.00	$108.00
0.26	78.00	104.00
0.25	75.00	100.00
0.24	72.00	96.00
0.23	69.00	92.00
0.22	66.00	88.00
0.21	63.00	84.00
0.20	60.00	80.00
0.19	57.00	76.00

In general the deciding factor between nitrate of soda and sulphate of ammonia will be the price figured in terms of nitrogen content, because nitrogen in these two forms is of equal value under average conditions. There are extreme conditions, however, where one kind of fertilizer may be preferable to the other.

Orchard soils that are strongly acid are not uncommon in Missouri and nitrate of soda should be used on them rather than sulphate of ammonia. In weakly acid or basic soils fruit trees would be expected to respond more favorably to ammonium sulphate than to the same amount of nitrogen in the form of nitrate of soda. Wherever lime has been used to counteract soil acidity, ammonium sulphate may be preferred to nitrate of soda.

GENERAL EFFECTS OF NITROGEN FERTILIZERS

It is important to understand exactly what can be accomplished by the use of nitrogen fertilizers in the orchard. Some of the effects produced by nitrogen applications are highly beneficial, but there are other effects that are distinctly harmful. Under one set of conditions a certain change produced by nitrogen treatment may be most desirable and under other circumstances the same effect may be decidedly injurious. The grower must determine whether the beneficial effects will outweigh the harmful under the conditions existing in his orchard.

Growth.—Of all the effects produced by nitrogen, the stimulation of growth is usually the most striking. Growth will not be increased unless there is a deficiency of nitrogen in the soil. Applications of nitrogen fertilizers to soils that already contain adequate supplies will have very little effect on growth or in any other respect. However, poor growth is usually the first sign of a nitrogen deficiency and the value of nitrogen treatment can be measured most readily by the effect produced on growth.

Associated with the increased vigor of rapidly growing trees are secondary effects that fertilizer treatments may induce. The more important of these secondary effects are disease resistance, hardiness and an increased moisture requirement.

Disease Resistance.—Vigorously growing apple trees are more resistant to blister canker and rapidly growing peach trees are more resistant to bacterial shot hole than trees making a poor growth. In fact, the stimulation of growth with nitrogen fertilizer is one of the most serviceable means the grower has of combating these two diseases.

Increasing the rate of growth does not increase disease resistance in all cases. In some cases it may decrease it. Apples, pears and quinces, for example, are more susceptible to fire blight when they are growing vigorously than when growth is slow. Since fire blight is so prevalent in and about Missouri, nitrogen fertilizers are not recommended for use on pears or quince trees. In fact, it is usually advisable to grow pears in sod, so that growth will be slow and susceptibility to the blight will be at a minimum.

Hardiness.—The ability of plants to survive the extreme cold of winter is also connected with vigor of growth. Actively growing tissue is usually susceptible to winter injury, and does not acquire any marked degree of resistance to cold until it has ceased to grow and has gone through a process of hardening. If plants are forced to grow late in the season, as when nitrogen fertilizers are applied liberally or at repeated intervals during the season, their tissues may be unable to go through a process of hardening before the severe cold of winter comes on. Thus an injudicious use of nitrogen fertilizers may cause serious and often permanent injury to peach trees and even to young apple trees in the northern part of Missouri where the temperature is often dangerously low early in the winter or late in the fall.

Though the prolongation of the season of growth by applications of nitrogen may cause trees to enter the winter in an immature condition and so render them susceptible to one type of winter injury, the same treatment under other conditions may be used to protect the trees from another type of winter injury. Nearly all hardy plants pass through a period of rest during which they are unable to grow. When growth is prolonged late in the season, peach trees are late in entering this period of rest. It has been found that peach trees which are late in starting the rest period are also late in breaking it. As a result, such trees do not respond so readily to brief warm spells in the winter and their buds develop more slowly. In consequence they are less likely to be caught by early spring frosts.

Drought Injury.—When the rate of growth has been increased to any extent, the immediate effect is the production of a larger top—longer shoots and more leaves. This increased leaf area presents a larger surface from which water may be lost. If for any reason the roots are unable to obtain this water from the soil, drought injury follows. Wherever trees are using nearly all the available supply of water, the danger of drought injury should be considered before nitrogen fertilizers are used. In case the margin of safety with respect to moisture is small, manure is the only nitrogen fertilizer that should be used, for manure increases the moisture-holding capacity of the soil at the same time that it supplies nitrogen. This applies particularly to parts of Missouri where danger from summer drought is threatened.

Leaf Color.—Next to the effect on growth, the most noticeable result following the use of nitrogen fertilizer is to be seen in the color of the leaves. The leaves acquire a deep green color that is usually associated with health and vigor. A pale, sickly greenish-yellow color is generally a sign of trouble and is often an indication of a lack of nitrogen in the soil, but not invariably so. The leaves become pale green for many other reasons, as when the supply of moisture is poor or when the plant is suffering from a lack of iron. Nevertheless nitrogen is probably responsible unless the paleness of the leaves is obviously caused by drought, because the other possibilities are of rare occurrence.

A pale green color of the leaves is not, however at all times a sign of trouble. In early fall, the leaves of a healthy apple tree, for example, naturally lose their brightness. This is accompanied by the accumulation of food products that are stored in the tree over winter. At such a time bright green foliage is more often a sign of the absence of these stored foods and not infrequently presages an off year to come the next season.

Set of Fruit.—The orchardist is primarily concerned in growing fruit, and the effects of nitrogen fertilizers on the crop are therefore of particular interest. No effect of nitrogen fertilizer is so rapid as that produced on the set of fruit by nitrate of soda or sulphate of ammonia applied ten days or two weeks before the trees come into bloom. Manure applied in this way does not have as marked an effect as the chemical fertilizers.

Old apple trees that are suffering from an insufficiency of nitrogen often bloom profusely every spring but set little or no crop. A small amount of sodium nitrate, 3 to 5 pounds, or an equivalent amount of ammonium sulphate applied to such trees usually produces striking results. It can turn a crop failure into a record crop. Even trees that are bearing fairly good yields will often respond to such nitrogen treatment with an increased set and a larger crop. This action of nitrogen fertilizers of increasing the set of fruit has also been observed on peaches and cherries.

Regularity of Bearing.—Many varieties of apple trees that ordinarily bear good crops every year, sometimes develop a tendency to bear a full crop every other year or at irregular intervals. This is usually associated with a deficiency of nitrogen and is most likely to occur sooner or later in sod orchards. Treatment with a nitrogen fertilizer usually corrects this tendency and is an aid in bringing alternately bearing trees back to regular bearing.

Color of Fruit.—One of the most serious disadvantages attendant on the use of nitrogen fertilizers for apples and peaches is the effect on the color of the fruit. Red apples may fail to develop the depth of color that is such a great asset in marketing this kind of fruit. This undesirable tendency may be more marked in some cases than in others, but it is always a powerful argument against the use of more fertilizer than is actually required. This detrimental effect may, however, be largely overcome by judicious pruning. The color of cherries is not affected by the use of fertilizers.

Ripening.—Another effect of the use of nitrogen is found in the delayed ripening of the fruit. This is most likely to occur in peaches. Apples and cherries are not particularly affected in this respect. A liberal use of nitrogen fertilizer may delay the ripening of peaches as much as two weeks. Whether this is desirable or not depends largely on market conditions.

TIME TO APPLY NITROGEN

The action of fertilizer can be controlled to some extent by making the application at the proper time. Manure is usually applied late in the winter, chiefly because the grower is not occupied with other orchard operations at that time. Nitrate of soda and sulphate of ammonia contain nitrogen in a more soluble and more quickly available form. They should be applied to apples and cherries about two weeks before the trees commence to bloom. Applied at this time, they produce the greatest effect on the set of fruit. If applied much sooner these chemical fertilizers may be washed out of the soil before the roots have an opportunity to absorb them and if applied later the flowers open and drop before the nitrogen has an opportunity to reach them and affect their set.

For the Peach.—It is recommended that peach trees be not fertilized until danger from late, killing frosts is past. Peach trees in moderately good condition will not ordinarily require fertilizer treatment unless they bear a crop and if a crop is borne the increased set produced by an early application of nitrogen merely increases the work and cost of crop thinning that must be done later. By waiting until danger from late frosts is past, the proper amount of fertilizer to be used can be determined by the prospects of a crop, and in case late frosts have killed all the blossoms, the fertilizer can be saved until it is needed. If peach trees are weak and are making poor growth, application of nitrogen should be made whether a crop is produced or not and the application may be made at any time in the spring.

For the Apple.—Several varieties of apple trees have a marked tendency to bear in alternate years. The York apple, for example, tends to bear excessive crops one year and little or no fruit the next. Such trees should be given early spring applications of nitrogen two weeks before bloom in the off year only. If nitrogen is applied at this time in the spring of the bearing year when large yields may be expected anyway, the tendency of the variety to overbear will be accentuated. This is dangerous because the tree may break down and be partly or completely destroyed by the great weight of its fruit. It is inadvisable because it favors the natural tendency of the variety to bear crops in alternate years. In case applications of nitrogen in the spring of the off years prove inadequate to keep the trees in a good growing condition, nitrate of soda or sulphate of ammonia may be applied after the bloom the spring of the bearing year or else the previous fall, that is the fall of the off year. Fall applications should be made sometime in September about a month before killing frosts may be expected. Applied at this time nitrogen fertilizers have no effect on maturity and do not induce winter injury.

METHOD OF APPLICATION

The application of manure requires no discussion. The chemical fertilizesr must be broadcasted by hand or else drilled in between the rows of trees. In broadcasting fertilizer, care should be taken to keep it away from the trunk as there is some danger of burning the bark. It should be distributed as far as the branches reach or even a little farther, as the root system of the tree usually extends a greater distance from the trunk than the branches.

If a large number of trees are to be treated, it is advisable to haul the fertilizer in a wagon through the orchard so that it will not have to be carried

by hand further than necessary. Sulphate of ammonia is much easier to handle than nitrate of soda which absorbs moisture readily and usually contains coarse lumps after standing for any length of time. For this reason particular care should be taken to keep sodium nitrate in a dry place. The coarse lumps must be broken up before being applied. The easiest way to accomplish this is to dump the contents of a sack on the floor of the wagon and pound it to a fine powder.

AMOUNTS TO BE USED

The amount of fertilizer to be used will depend on the poverty of the soil, and the condition and size of the trees. A moderate application of manure for large apple trees would be ⅕ ton to a tree. A bearing apple tree of average size would receive about 5 pounds of nitrate of soda or 3¾ pounds of ammonium sulphate. The average peach or sour cherry tree of bearing age might be given 3 pounds of sodium nitrate or 2¼ pounds of ammonium sulphate. Young trees two or three years old would not ordinarily require more than half a pound of nitrate or a third of a pound of ammonium sulphate. A fairly good rule for apple trees is one pound of nitrate of soda or the equivalent amount of ammonium sulphate for every two inches of trunk diameter. These figures give a general idea of the amounts that are ordinarily used. The exact amount to be used in any special case must be determined by the grower on the basis of judgment and experience. If the trees are large and the soil very poor as much as 10 to 15 pounds of nitrate of soda, or a corresponding amount of ammonium sulphate may be called for. In any case the amount to be used in the orchard and hence the amounts to be purchased for orchard use should be calculated in terms of individual trees and not in terms of acres.

It is of course out of the question for the grower to weigh out the exact amount of fertilizer he has decided to apply to each tree. The simplest procedure is to measure the amount by bulk rather than by weight. Fill some cans with the amount of fertilizer to be applied to each tree, say 5 pounds, carefully weighed out. Then cut the tops of the cans off so that they will just hold the required weight when filled even to the top. It will be found that nitrate of soda and the corresponding amount of ammonium sulphate occupy approximately the same bulk so that the same cans can be used for either fertilizer.

HARMFUL AND BENEFICIAL EFFECTS

Many growers are tempted to believe that if a little fertilizer is good, more is better. It is well to remember that there can be too much of a good thing. Fertilizers should be used in moderation, because their effects are not always beneficial. Fertilizers are not cure-alls. The use of fertilizer in too great quantities or at times when it is unnecessary may lead to decided injury. Whether an orchard will be benefited or injured depends on many circumstances which the grower must take into consideration and weigh before making an application. Some of the injurious effects that must be expected have already been mentioned—decreased color of apples and peaches, increased susceptibility of apple, pear, and quince trees to blight, increased loss of water and danger from drought, immaturity and danger of winter injury to peach and young apple trees.

Other effects may be very desirable under some conditions and distinctly harmful under others. Increased growth and set of fruit, for example, are usually the chief benefits expected from fertilizer treatment. It is possible,

however, to stimulate growth to such an extent that the tree ceases to bear. This occasionally happens with peach trees and more rarely with apples. Similarly, an increased set may be a source of danger and expense. The York apple may be induced to set such large crops by fertilizer treatment the spring of the bearing year that the tree is split open by the weight of the fruit. The treatment may also tend to increase the alternate bearing habit. Increasing the set of peaches usually involves extra labor and expense in thinning.

These instances show the necessity of using judgment in applying fertilizers and the impossibility of making general recommendations. Each orchard is a special problem that the owner must work out for himself. The most that can be done by way of recommendation is to make some suggestions that may serve as a guide to the solution of particular problems.

Under average conditions, fruit trees will receive enough nitrogen for good growth and yields if the soil is cultivated and if legume cover crops are grown occasionally and turned under to maintain the supply of nitrogen. It frequently happens, however, that cultivation is inconvenient or impossible because of soil washing and that the orchard must be grown in sod. Sooner or later a sod orchard will generally suffer from a lack of nitrogen, unless it is located on very rich land, and nitrogen in some form must be applied regularly to maintain growth and fruit production.

Orchard soils that have been tilled continuously for many years become exhausted unless legume cover crops are grown and turned under as green manuring from time to time. Failing this, nitrogen fertilizers must be used. Poor growth and a pale green color of the leaves are the best signs suggesting the need of nitrogen fertilizers. In older trees, a profusion of bloom followed by a poor set and irregularity of bearing in varieties that should bear regularly are usually good indications of a lack of nitrogen. Fertilizers are not usually needed for young trees about to come into bearing. Over-producing trees should not be given nitrogen the spring of the year of over-production.