


CHEMICAL THINNING OF APPLES

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Not thinned, this tree broke down
under heavy load of small apples

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Chemical Thinning of Apples

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Every commercial fruit grower knows that the best price is usually obtained from a crop consisting of apples of good size and attractive color. By and large, there seems to be scant profit, and frequently a loss, in growing low grade fruit. If apple consumption is to be maintained, the public must be provided with a product of high quality.

It would be difficult to mention any other major orchard operation that will directly do as much to improve the appearance and quality of fruit as judicious thinning.

Another, less appreciated, value of fruit thinning is its effect on the tree itself. Heavy fruit bearing is a devitalizing process, usually resulting in reduced flower bud formation for the following year's crop. Only exceptionally vigorous trees, well pruned and otherwise taken care of, are able to produce satisfactory yields with fair regularity. Biennially bearing varieties, as a rule, overload themselves in the "on" year with an extremely heavy crop of apples, which are often too small and of poor color, unless a large proportion of the fruit is removed by early and heavy thinning. As a result of excessive weight of the fruit, frequently there is a considerable injury to trees from breakage of limbs and loss from trunk splitting. Thus the tree may be half ruined because of a heavy load of small apples of poor quality that fetch a very low price.

Undoubtedly thinning of apples would be practiced more widely were it not for the time required and the high cost of labor. This certainly is true at present (1951). Whether thinning is done by hand, or possibly by means of a "pole" of some sort, the number of man-hours necessary for the work and the expense involved is indeed considerable. Hence there is a real need for a faster and less costly method of thinning apples and other fruits.

Chemical spray thinning, which has received much attention during the past few years, meets this requirement. It has now reached a stage of development where many commercial apple growers are trying it out and some are using it already on a considerable scale. It has been reported, for example, that chemical thinning of apples in Washington state alone has grown during the past 6 years from a few experimental trials to about 15,000 acres spray-thinned in 1950.

The main advantages of spray thinning of apples over hand thinning are lower costs, larger and better fruit, and higher yields due to heavier annual

production. According to a general estimate by a western horticulturist, the cost of spray thinning in many cases is reduced to as little as one-tenth that of hand thinning. Yields have been increased as much as 50% over a 2-year period, when, as a result of chemical thinning, biennial bearing has been overcome, and fruit size has been increased 22 to 40%.

The purpose of this publication is (a) to give the available information on the subject, (b) to indicate the advantages of this method of fruit thinning, (c) to consider the various major factors affecting the results and (d) to give recommendations for chemical thinning of apples.

GENERAL OBJECTIVES OF FRUIT THINNING

It may not be out of place to list here the general objectives or purposes of thinning fruit. Some of these, of course, will be of greater importance than others in considering specific varieties, relative vigor of the trees, relation to other orchards practices, and methods of marketing the crop.

Judicious thinning of apples usually will:

1. Increase the size of fruit.
2. Improve color and quality (flavor).
3. Reduce the number of defective specimens.
4. Decrease labor costs of harvesting and grading the crop.
5. Prevent breakage of limbs.
6. Preserve the vigor of trees.
7. Reduce or overcome biennial bearing.

Growers who may be interested in a more detailed discussion of any or all of the above points should obtain Missouri Agricultural Experiment Station Bulletins 252 and 428.

DEVELOPMENT OF CHEMICAL THINNING

Chemical spray thinning has come as an outgrowth of our interest in reduction or prevention of fruit set in the "on" year of biennially bearing varieties of apples and improvement of size, color and quality of the fruit of all commercial varieties. This work has been in progress during the past 14 years. It has involved hundreds of trees of all major varieties in two experimental and several commercial orchards.*

In the early investigations the chief chemicals used for this purpose were cresylic acid and tar oil distillates. In Missouri they were first tried experimentally at the Fruit Experiment Station in the southern part of the state. Beginning in 1939 work was started at the Agricultural Experiment Station, Columbia, on the use of the above two and other chemicals (Creosote oil,

*The writer is grateful for the kindly interest in this work of the many fruit growers of our state. Without their cooperation progress would have been slower and less would have been accomplished. Much of the experimental work was supported by the Dow Chemical Co., Midland, Michigan.



Fig. 1. Branches from adjoining Golden Delicious trees. Left: Not thinned. Right: Thinned by means of a chemical spray. Due to uncertainties of weather, chemical thinning sprays cannot be expected always to do that good a job.

Dinitro phenols and cresols, etc) with the object of either reducing or eliminating the fruit set of alternately bearing varieties in the "on" year.

All of the chemicals tested in those years were of highly caustic nature. They were usually applied during the cluster bud or early pink stage of flower development. This was *flower bud thinning*. At the most effective concentrations all the flowers and young leaves were killed, while at weaker concentrations many of the less advanced buds escaped injury thus giving a reduced fruit set.

Because of the "burning effect", the sprayed trees looked terrible, as if fire had scorched them. In due time, however, new foliage developed and the appearance of the sprayed trees eventually became quite normal. This destruction of the young leaves early in the season undoubtedly gave a severe shock to the trees in the spring. As a result they did not always produce flower buds for the "off" year's crop, as was expected.

A real advance in chemical fruit thinning came with the use of the milder forms and concentrations of the dinitro chemicals for this purpose (Sodium dinitro-ortho-cresylate and dinitro-ortho-cyclo-hexylphenol). The most popular trade names for these are Elgetol, DN No. 1 and Krenite. At the same time our interest changed from eliminating the crop entirely to "bloom" thinning in the "on" year of biennially bearing varieties of apples. The Dinitros are applied from full bloom to not later than 3 days past it. This is *blossom thinning*.

Another, probably more important step forward in development of chemical thinning was the discovery that a "hormone spray" (Naphthaleneacetic acid, a popular pre-harvest spray material) will thin apples successfully up to 2 weeks, possibly even longer, after the fruit has set. This is real *fruit thinning*. At present both the dinitro flower thinning and the hormone fruit thinning sprays are popular, the latter often being preferred.

ADVANTAGES OF SPRAY THINNING OF APPLES

Chemical thinning of fruit has the following advantages over hand or pole thinning:

1. **It Is Fast.** Instead of 1-2 hours being required to thin a large tree by hand, a chemical spray may thin it in that many minutes or less time. Even when some hand thinning is done, supplementary to spray thinning, the work is speeded up 3-5 or more times.

2. **It Is Less Expensive.** Only one or at most two sprays are required and the material is not costly. When a hormone spray is used for this purpose, it is possible to combine it with the calyx or early cover spray, thereby saving extra labor. Hand or even pole thinning is a slow operation and requires much labor at a time when other farm or orchard activities are in full swing. Said a grower at the recent state horticultural meeting: "In our 14-year-old Golden Delicious orchard, the best we could do in hand thinning was about 5 trees per man per day. This is about \$1 per tree. Thinning by hand simply costs too much. I can't afford it."

3. **It Permits Trees To Carry a Heavier Load of Good Fruit.** Estimates made in Washington state, where spray thinning of apples has become quite popular, indicates that chemically thinned trees can carry and mature 10-20% more fruit than hand thinned trees because the excess fruit is removed early, before the multitude of young apples have used up all the available food supply. During the first few weeks of their development the fruit have to obtain and live upon food reserves stored in the tree during the preceding season. Moreover, shoot and leaf growth early in the spring is also at the expense of reserve foods. Thus, soon after the fruit is set, demand and competition for available food supplies may be great indeed.

4. **It Preserves the Trees' Vigor.** Chemical thinning is done early in the spring. At the usual time of hand thinning the vitality of the tree already

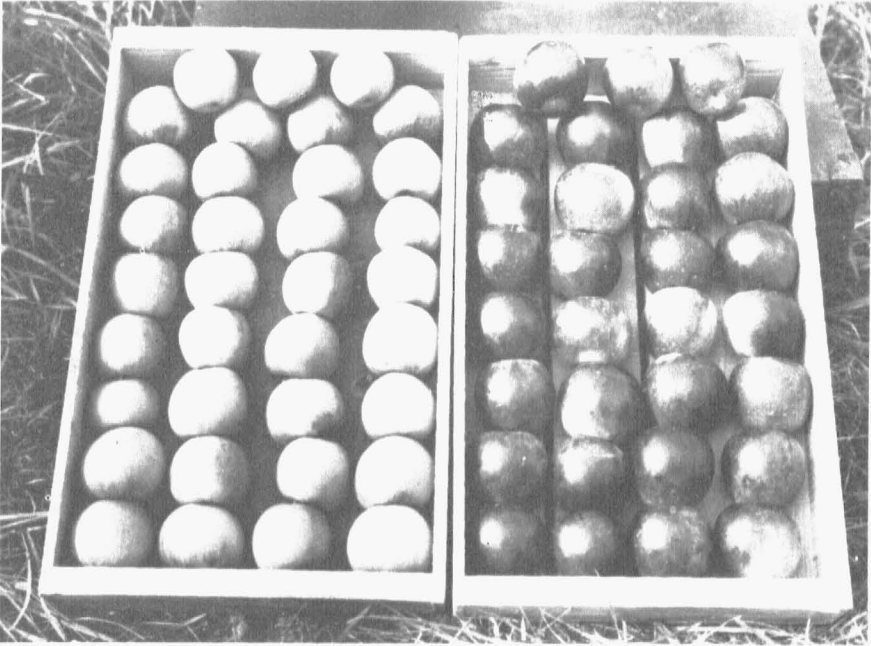


Fig. 2. Jonathan apples. Left: Picked from shaded inside branches. Right: Picked from outside branches of the same tree. Fruit thinning improves color and size of "inside" fruit.

has been sapped by several weeks' growth of fruit, most of which are discarded in thinning. Thus the food reserves and the functional activities of the tree, instead of being used for fruit development and vegetative growth, are unnecessarily wasted.

5. **It Will Help To Break Alternate Bearing.** Experimental work has shown that in most, though not all, cases a heavy thinning of flowers or very young fruit, up to 3 or 4 weeks after setting, will help to maintain annual bearing of apples. This is not possible when fruit is thinned by hand, which is done much later. By that time the excessive load of fruit usually will have prevented flower bud formation for next year's crop. This is an important consideration with all biennially bearing varieties and will be discussed in more detail further on.

FACTORS DETERMINING EFFICIENCY AND ECONOMY OF SPRAY THINNING OF FRUIT

It should be emphasized that chemical spray thinning of fruit is still to a large extent in the "experimental stage". It is, therefore, still "on trial". Considering this fact, growers should exercise considerable judgment in its use and limit the practice to relatively small blocks till experience is gained and they have appraised the practice on specific varieties in their own orchards.

In general, chemical thinning of apples seems to be feasible and practicable only when conditions are favorable for good pollination and a heavy fruit set is expected. Before the work is undertaken one should be reasonably sure whether thinning would be desirable or not and on what varieties or blocks of trees. Satisfactory results cannot always be predicted nor expected. The efficiency of such sprays depends upon many factors, some of which are beyond the control of the fruit grower.

The following factors have a bearing on the results of chemical thinning of apples:

1. Variety and fruit bearing habit.
2. Material, concentration and amount of spray applied.
3. Time of spraying.
4. Pollination and the weather.
5. Vigor of trees, nitrogen supply and pruning.
6. Type of marketing of crop or sales practice.

(1) Apple varieties differ considerably in their response to both dinitro and hormone fruit thinning sprays. Personal experience with variety behavior in his orchard is a great asset to the grower who wishes to use fruit thinning sprays. The biennially bearing varieties of apples normally require a higher concentration of spray material, sometimes two applications, and a more thorough spraying than the annual bearers for they are apt to over-set in the "on" year. Among the latter there seem to be differences also in respect to susceptibility to such sprays. The Jonathan, Winesap, Delicious and probably Grimes, for example, are especially sensitive and one should "go easy" with these varieties.

It is probable that in any annually bearing variety, the size of the crop in the preceding year determines to a considerable extent the "vigor of flowers" and their capacity to set fruit and to respond to fruit thinning sprays. The "weakest" flowers are largely on the shaded and lowest branches.

(2) Of the many chemicals that have been tried for thinning of fruit, only two kinds are used to any extent at present. They are: (a) Dinitro compounds either in liquid or powder forms and (b) a plant "hormone", naphthaleneacetic acid, the popular pre-harvest spray material. The dinitro preparations are used as flower thinning sprays at concentrations, in the case of Elgetol (20%) of .125% to .5% and DN No. 1 (Dow's) at $\frac{1}{2}$ to 1 lb. per 100 gallons, depending on the variety and amount of thinning required. The hormone spray seems to be more adaptable for *fruit thinning*. Desirable concentrations have not been fully established for specific fruits and times of application, but the usual range is 10 to 20 parts per million. Higher strengths appear to be necessary for late spraying of some apples. Certain biennially bearing varieties, in the "on" year, may require 2 applications of the spray, at 5-10-day intervals.

Spraying must be thorough. A mist spray seems to be preferable to a drenching one. Bear in mind that a heavy application of a weaker concentra-



Fig. 3. Branch of tree, hormone-thinned. Very large high quality fruit. On the left an adjoining tree, not thinned, with extremely heavy set of small fruit.

tion may supply just as much or even more of the active material as a light application of a spray of high concentration.

Avoid overspraying the lower limbs and inside branches, unless fruit is not desired there. This applies especially when a speed sprayer is used and when there is a tendency for the spray to overlap in the center of the tree.

(3) Blossom spraying with dinitro compounds has to be timed right. The spray must be applied on the first or second and not later than the third day of full bloom. This is easier said than done, considering the great variability of weather in the central states. The reason upon which this exact timing is based is that the first and usually strongest blossoms are allowed to be pollinated and will set while the others are prevented from setting by the caustic chemical. In the case of some varieties of apples, a second application seems to be desirable at the time when most of the late flowers on the terminal shoots have opened.

The exact or best time to apply a hormone spray for fruit thinning has not yet been fully established. Close timing does not seem to be as important as in the case of the dinitro sprays. Experimentally naphthaleneacetic acid has been used all the way from full bloom to a few weeks later. The present recommendation, as given in detail further on, is that it be used for apples 1-2 weeks after bloom. If spraying with hormone is done late enough, it may

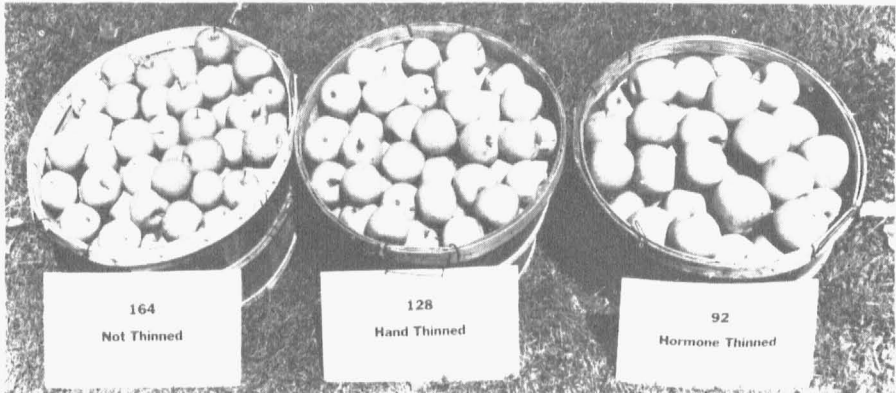


Fig. 4. Golden Delicious apples picked from adjoining trees in a commercial orchard. Note the relative number of apples per bushel basket, as given on cards. The hormone-thinned apples were not only larger in size but had a better color and higher sugar content—better flavor.

be combined with the calyx or early cover spray. Commercial hormone preparations do not burn the foliage, although at the higher concentrations, if sprayed very early, there may be a temporary flagging of leaves and sometimes a modification and dwarfing in development. The later the spraying is done the less the foliage is affected.

(4) All orchardists know that the weather has an important bearing on pollination and fruit setting of his trees. Heavy blooming does not necessarily mean a heavy crop. For the same variety, the amount of thinning required may vary from year to year depending largely on the weather. Cool and rainy weather frequently results in poor pollination, overthinning and reduced fruit production. The set may be limited likewise by winter freezes, spring frosts, excessive spur blight of some varieties of apples and other plant diseases. Then, too, what slight injury to the foliage may occur from the use of either a dinitro (burning of leaf margins) or a hormone (temporary flagging or wilting) thinning spray is usually a little worse when cool and cloudy weather precedes the time of full bloom. However, trees soon outgrow such temporary "leaf injury" and, with proper fruit thinning, the foliage is apt to be even better by mid-summer than on unthinned trees.

One should mention here the likelihood that certain sulfur-containing fungicides and chlorinated hydrocarbon insecticides probably have also an effect on fruit setting and early drops of the apple, though exact information on this subject is still meager.

Considering this uncertainty, due mainly to weather, it becomes highly desirable to have a fruit thinning spray that would be applied and would work *after* the fruit set is fairly well established and one can estimate with some degree of accuracy the amount of thinning needed. Moreover, the foliage is much less affected than by the thinning spray. The hormone material appears

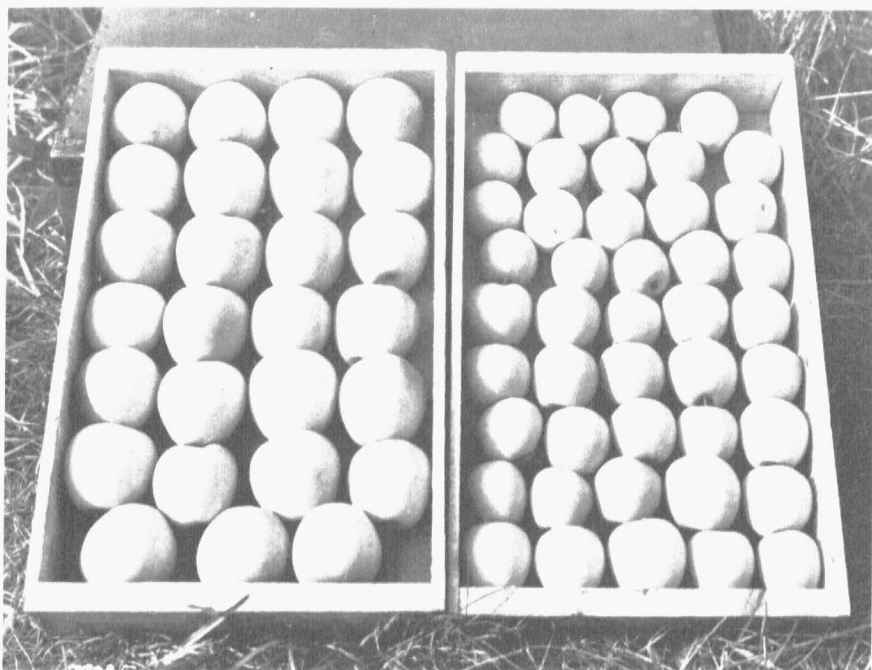


Fig. 5. Golden Delicious apples. Left: From hormone-thinned half of a tree. Right: From not-thinned half of the same tree.

to be most promising for this purpose. One of the important values of the hormone spray is that it can be used as a second or follow-up spray, if an earlier dinitro or first hormone spray has not thinned sufficiently a heavily setting variety of apples.

(5) Not only the variety but the vigor of the tree, too, seems to have a bearing on the efficiency of chemical fruit thinning. Young and very vigorous trees, as well as extremely weak ones, may be more sensitive than trees of moderate vigor and high fruit setting capacity. The accumulated food reserves, the quantity of nitrogen supplied and available in the spring and possibly the amount of some as yet unidentified naturally occurring "hormones" in the tree most likely affect fruit setting response to thinning sprays. It is known also that trees that have received fairly heavy pruning the preceding winter are apt to set fruit better than unpruned trees.

Trees weakened because of poor soil drainage, root injury, sunscald and other stem injuries seem to be more sensitive than healthy and vigorous trees. Relatively toxic fungicidal and insecticidal sprays, used early in the season, may also have a bearing on the results of chemical fruit thinning.

(6) Whether fruit should be thinned or not will depend a great deal on the kind of crop the grower wishes to produce in relation to his marketing practice. The raising and handling of a smaller crop of high quality may or

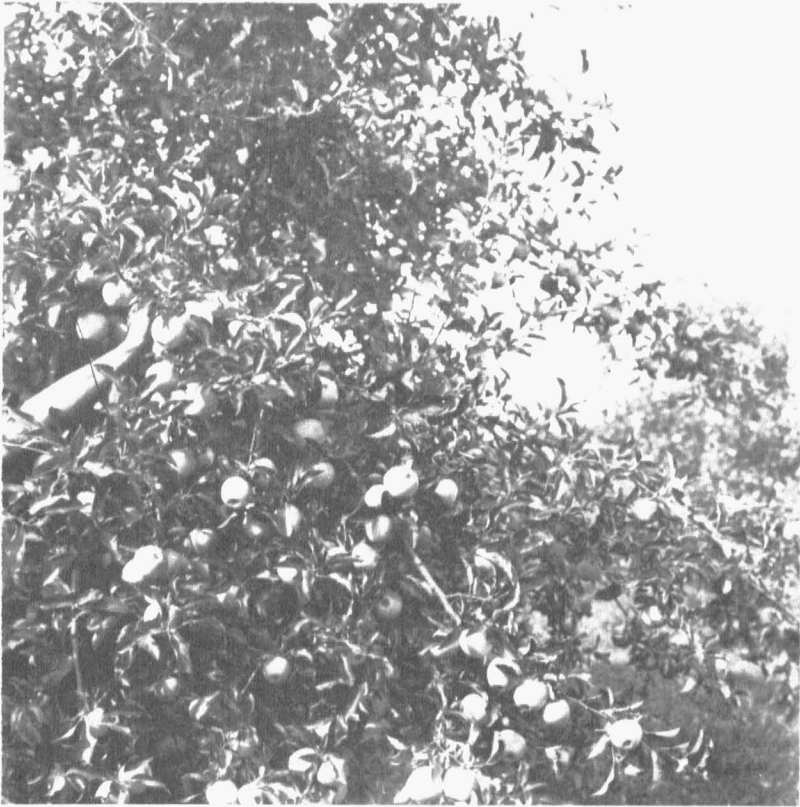


Fig. 6. This tree, spray-thinned heavily in the "on" year (1949), produced a good crop of apples in the "off" year (1950).

may not be more profitable than a large crop of more average fruit. Thinning is apt to increase the size and usually improves the color of apples both of which are assets in selling. There must be a satisfactory price differential to justify heavy fruit thinning. Usually apples of large size and good color fetch the best price.

RELATION TO BIENNIAL BEARING

Growers, who are interested in chemical thinning of apples, frequently ask whether this type of thinning will change the alternate year bearing habit of some varieties. Usually they refer to such pronounced biennial bearers as the Yellow Transparent, Duchess, Wealthy, York and Golden Delicious. The answer is *yes* if the expected heavy crop in the "on" year is reduced to an average, but preferably below average, size by early chemical thinning. By "early" is meant not later than 2 weeks, and at most 3 weeks after full bloom. Moreover, in order to get the desired results, thinning must be so heavy that the fruit set in the "on" year will not be much more than 1 apple per 10 flower

clusters on heavily blooming trees. Hence, to bring about annual bearing of well established biennial bearers, one must sacrifice to some extent the crop in the "on" year in order to get fruit in the "off" year and thus break a well established alternate year bearing habit.

But, unless the trees are maintained in good vigor, there is no assurance that when a blossom or post-bloom thinning spray is used in the "on" year biennially bearing trees will snap into heavy production in the following year. When trees are devitalized due to overbearing, lack of soil fertility and poor pruning or spraying, then fruit production may be meager in the "off" year and not much will be gained.

The writer has in mind a block of closely planted York trees growing on a very light soil and consequently of low vigor. When practically all the flowers were removed from these trees in the "on" year by a caustic spray, there was very light to no bloom the following year. While in another block of Yorks of the same age, but vigorous, a similar bloom spray resulted in a satisfactory crop in the following "off" year. These differences from the same treatment were very striking indeed. Several other observations point to similar effects and results with other varieties.

It should be emphasized, however, that in most cases, as a result of timely and heavy chemical thinning, apple trees have produced satisfactory crops in the "off" year when no fruit was normally expected. But insufficient spray thinning, followed by hand thinning at the usual time, when all the drops are over, absolutely will not do the job of breaking an established biennial bearing habit.

RECOMMENDATIONS FOR CHEMICAL THINNING OF APPLES

The recommendations as to material, concentration and time of application are tentative and probably will be changed somewhat as the results of more experimental work accumulate and additional experience is gained by growers. In light of the above discussion it is apparent that desirable results cannot always be predicted or expected.

1. For biennially bearing varieties in "on" year:
 - a. *Elgetol*—20% grade (On "first day" of full bloom)
 - .25% (2 pints to 100 gallons) for York and Golden Delicious
 - .37% (3 pints to 100 gallons) for Duchess and Wealthy
 - b. *DN No. 1* (Dow's) (On "first day" of full bloom)
 - $\frac{3}{4}$ to 1 lb. to 100 gallons. For all biennially bearing varieties.
 - c. "Hormone" spray (1 to 2 weeks after full bloom)
 - 20 parts per million (twice usual pre-harvest spray concentration)
 - Respraying sometimes necessary.
2. For annual bearers: (Go "easy" with Jonathans, Delicious and Winesap.)
 - a. *Elgetol* (20%) (2 to 3 days after full bloom)
 - .125% to .187% (1 to 1½ pints to 100 gallons) for most varieties.

- b. *DN No. 1* (Dow's) (2 to 3 days after full bloom) $\frac{1}{2}$ to $\frac{3}{4}$ lbs. to 100 gallons.
- c. "*Hormone*" spray (1-2 weeks after full bloom)
10 parts per million (usual pre-harvest spray concentration)

Attention is called to the higher concentrations of all spray materials recommended for biennially bearing varieties of apples. This is based on wide experience and considerable experimental work. Such varieties usually set way too much in the "on" year and are more difficult to thin than annual bearers. Frequently 2 sprays may be desirable for the heavy setters: Either a dinitro (Elgetol or *DN No. 1*) followed by a second hormone spray, or two hormone sprays about 5-7 days apart.

It must be pointed out that for biennial bearers the dinitro sprays should be applied on the first day of full bloom, while for the annual bearers the application should be made 2-3 days later. This will assure the necessary amount of fruit setting before the flowers are thinned by the spray, thereby making overthinning less likely.

Remember that Elgetol settles out on standing in the containers, like paint does. Stir well, and keep stirring, while measuring out the required amount. Still better, prepare a stock solution before using it. The recommendations are for 20% Elgetol. If a 30% preparation is used, as in some parts of the country, reduce all amounts by $\frac{1}{3}$.

IMPORTANT GENERAL CONSIDERATIONS

Chemical spray thinning of apples, as an orchard practice, is gaining in popularity in Missouri and elsewhere. This despite the fact that the results cannot always be definitely predicted because of the many factors involved that have a bearing on fruit set and extent of the natural drops. It would seem to be quite practicable to thin chemically biennially bearing varieties of apples in the "on" year when an extremely heavy fruit set is expected, likewise any other variety that consistently bears too heavily.

Vigorous trees or branches can produce and mature more and better apples than weak ones. Both very young and very old trees are more easily overthinned than trees of average vigor. Of special consideration is the current epidemic, in some orchards or districts, of fire blight on Jonathans and a few other varieties. Though blooming heavily, blighted trees often do not set fruit well and, therefore, do not require thinning.

The fruit grower, knowing the behavior of his trees, the anticipated crop and his marketing practices, is the only and best person to make a decision in this matter. If the grower has had no first-hand experience with chemical thinning sprays, he should limit their use to small blocks of trees of specific varieties, observe the results carefully and be guided accordingly in the future. Leave some trees unsprayed.

By and large, the hormone (pre-harvest spray material) is to be preferred

to a dinitro compound. This, as discussed before, is due to the fact that it is less toxic to foliage, is compatible with usual spray materials, the application does not have to be timed very exactly, and it can be used late enough after bloom, when the fruit set can be foretold better. Generally, the later, counting from full bloom, a hormone spray is used the higher should be the concentration. The range for biennially bearing varieties is 15 to 30 parts per million, for the annual bearers 5 to 15 parts per million.

It should be remembered that a lower concentration of a hormone spray, if the gallonage per tree is higher, may have the same effect as a higher concentration of a lighter spray. Then, too, if a speed sprayer is used, there may be too much thinning of the lower portions of the trees and considerable overlapping of the spray material in some parts, with consequently greater effects on thinning. If the required amount of thinning varies from variety to variety or tree to tree, it is advisable to apply the hormone spray independently of general spraying and to use a gun or broom for distributing it. Carelessness in using a fruit thinning spray may be as costly as that of any other spray.

To be on the safe side, some growers seem to prefer to underthin the crop by means of a chemical spray. This procedure requires a follow-up thinning by hand of the excess fruit later on. Even then the cost is reduced considerably in comparison to complete hand thinning. Such a practice, however, will have little if any effect on changing the established "off" and "on" year fruiting cycle. As regards continuous production of trees, benefits from thinning decreased rapidly as the date of spraying is delayed. Trees that are overthinned by a chemical spray one year usually bear more fruit the following year.