Lincoln College

UNIVERSITY OF CANTERBURY

DEPARTMENT OF HORTICULTURE

FRUITGROWERS SHORT COURSE

May, 1967

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Although not the complete set of lectures presented at this course the papers and summaries included in this booklet are representative of those given.

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LINCOLN COLLEGE

SHORT COURSE IN FRUITGROWING

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FORMATION OF FLOWER BUDS

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It is quite common knowledge that flower bud formation in apples and pears starts only 6 or 7 weeks after blossoming and that by autumn leaf fall the flower buds for next season are fully developed. It is not so commonly realised that a wide range of other fruits also develop flower initials before winter although perhaps initiation does not take place as early as in the apple.

The shorter days and lower temperatures in March and April cause most berry fruit such as raspberries, gooseberries and blackcurrants to form flower initials. Sometimes cessation of growth of new canes during the summer may promote tip development of flower buds and an autumn raspberry crop. In peaches, nectarines, plums, cherries, apricots and many other fruits too, flower initials can be clearly seen in the autumn by cutting a longitudinal section of a bud and viewing it through a binocular microscope. On the other hand, fruits such as grapes, chinese gooseberries, passionfruit and tamarillos, show no evidence of flower initiation in the autumn. These develop flower buds as they grow away in the spring.

Flower bud differentiation theories:

If it were known which substance or substances promote the development of flowers it could be possible to apply them to a tree at the appropriate time and initiate all the flowering required. The only fruit with which this can be done so far on a commercial scale is the pineapple, where the application of a hormone such as 24D will cause promotion of flowering. All attempts to develop chemicals which will have a direct flower initiation effect on other fruits have so far failed.

However, we do know ways of indirectly promoting flower development and in order to partially understand how these might work, it is necessary first to look at the two main theories put forward for flower initiation:

(1) The carbon/nitrogen ratio: This has been discussed for many years. It revolves around the comparative levels of carbohydrate (the starches and sugars developed by the photosynthetic activity of leaves) and of nitrogen (mainly supplied through the roots, although sometimes by foliar application). Four groupings of carbon : nitrogen levels are commonly recognised and these will be related to growth and flowering in the apple:

(i) Very high nitrogen, very low carbohydrate. Growth very poor, no flowering or fruiting.

(ii) High nitrogen and low carbohydrate. Growth vigorous but soft, no flowering or fruiting.

(iii) Nitrogen low, carbohydrate high. Good growth, flowers initiated and good setting.

(iv) Very low nitrogen, very high carbohydrate. Poor growth, no flowering or fruiting.

It must be made clear that the nitrogen and carbohydrate levels are relative to one another and that in group (iii) the low nitrogen level stated, is only relative to the carbohydrate level. In this case, the nitrogen level is adequate for tree needs while not excessive in relation to carbohydrate formation. It should be understood also that other fruits may form flowers in all groups but under very low nitrogen conditions the set may be very poor. Apples as well will form a few flower buds even although growing very vigorously or very poorly but this only indicates that the C : N ratio varies over various parts of the tree and even over the length of individual shoots.

(2) The hormone theory: A number of experiments have shown the C : N ratio theory to be inadequate to describe all cases. It is well known that some plants exhibit a photoperiod effect in their formation of flowers. Notable amongst these are the chrysanthemum and the strawberry, which exhibit a short day effect. A strawberry for instance can be induced to form flower initials at any time of the year by subjecting it artificially to a short 8 - 10 hour day, particularly if low temperatures are maintained at the same time. Then the flower stalk can be induced to grow by long days (14 - 18 hours) even although the light intensity may be quite weak.

A common photoperiod-responsive test plant is the xanthium, which will not flower naturally on long days. A plant held in long days though can be made to flower by grafting on to it a section of another plant which has been held in short days. This indicates that some hormone-type substance, in only minute quantities, has been transferred during the grafting process and induced the plant held in long days to form flowers. Such a substance, although not chemically identified, has been given the name "Florigen".

Further evidence for the hormone theory has been gathered from fruiting plants. In the blackcurrant it has been shown that flower initials can be formed in a shorter period if the terminal leaf bud is removed but that at least one leaf must be left in order for the bud in its axil to form flowers. This suggests that the substance "florigen" may be produced in the leaves but that another substance inhibiting its action is produced in the growing point. Thus, if the growing point is removed or the growth of the shoot is stopped (possibly by ring barking or by natural slowing of growth in the autumn) then the inhibiting substnace is not formed and flower buds will develop if the leaves are functioning normally.

<u>The relation of theory to practice</u>:

(a) Many practical methods of inducing flower bud formation are aimed at slowing down growth. In the light of the suggested theories each method of growth reduction can now be explained briefly:

1. Root pruning. This old method is not commonly recommended nowadays due to the difficulty of doing this effectively in practice and the danger of disease entry and permanent root damage. It could though restrict the uptake of nitrogen thus increasing the C : N ratio or it could slow down growth, thus reducing the production of the inhibiting substance.

2. Bark ringing. In cases of uncontrollable vigour I believe this method may still be warranted. A single knife cut can be made through the bark to the cambium completely encircling the trunk in the spring. This will quickly heal and may not restrict growth sufficiently. Perhaps a more effective method is to remove about ¼ - ½" strip of bark half way around the trunk at one point and then several inches higher remove a similar strip of bark around the other half of the trunk.

3. Use of dwarfing rootstocks. Reduction in vigour at an earlier age is the usual explanation suggested for the earlier cropping habit of dwarfing or semi-dwarfing rootstocks.

4. It is commonly accepted that laterals nearer to the horizontal will initiate flowers more readily. The encouragement of lateral growth by pruning and the practice of bending or tying branches down to a lower level both help to reduce tree vigour and so theoretically restrict the production of any inhibiting substance in the tip.

5. Excessive nitrogen promotes excessive growth and the same arguments apply, but the C/N ratio theory has strong support in this case.

6. A more recent development in controlling flowering is the use of chemical growth retardents such as B995. Used on vigorous apples at 2000 - 3000 p.p.m. at about 14 - 28 days after full bloom it has induced quite a marked reduction in growth and an increase in flower bud formation for the following season. Much more testing work must be done on a range of fruits and varieties before it can be generally recommended for use.
Its effect on fruit quality and size in the season of its use and also any residual effect for the following seasons must be carefully assessed.

(b) Some practical methods of flower induction are aimed at the leaf :

1. Sunlight is necessary for adequate functioning of the leaf in the production of carbohydrates and if a tree is very dense its leaves are not effectively presented to the light. Careful pruning is important and should be aimed at thinning and spacing laterals so that light will effectively penetrate to most parts of the tree. It has been suggested that in a wet season, flower bud formation is reduced due to the effect of water but a more reasonable explanation is that in such a season total sunlight hours will be lower and leaf assimilation less.

2. Many growers prune fruit trees hard in the winter prior to an "on" season in an attempt to correct biennial bearing. Hard pruning, in effect, removes leaf area and reduces flower initiation. A more effective method is to prune fruiting spurs hard but leave young lateral growth uncut prior to an on year.

3. Any cultural factor resulting in reduced leaf efficiency will reduce flower initiation; a deficiency of nitrogen, a heavy mite infestation or mildew infection.

(c) The effect of crop on flower formation:

The importance of early fruit thinning in respect to flower formation will be dealt with in more detail in another paper. It has been proved many times that a low leaf to fruit ratio of say 15 leaves to 1 fruit will result in poor flower formation, that about 30 : 1 will give good initiation and that 60 : 1 will give excessive flower formation. It would be quite ridiculous for a grower to count leaf fruit ratios in detail as he is thinning and, of course, the ideal ratio would vary from fruit to fruit and variety to variety.

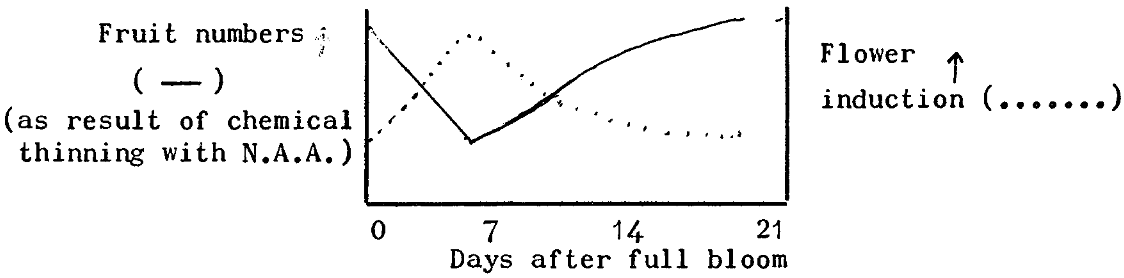
In a paper presented at the 17th International Horticultural Congress, J. Huat reported some interesting results from his work in France on Williams Bon Chretien pears.

Without fruit he obtained a flower induction rate of 11.5% with 3 leaves/bud and 100% with 8 leaves/bud. But with fruit, he obtained the following figures :

less than 5 leaves/bud	-	no floral induction
5 leaves/bud	-	12.5% induction
10 leaves/bud	-	50% induction

These figures show clearly a relationship between leaves and fruit, in flower bud induction. He also showed that any modification on floral induction rate was eliminated 75 days after full bloom thus emphasising the importance of early thinning.

A generalised graph demonstrates this timing effect very well:



FRUIT GROWTH

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Fruit growth begins at the time of fertilization and ends at maturity or at the stage when the fruit is harvested.

As a general rule, if there is no pollination followed by fertilization there is no stimulation of fruit development and the fruit will drop from the tree within a few weeks. A few fruits are capable of developing without the stimulation of fertilization in which case these are said to develop "parthenocarpically". Common in this group are the pineapple, banana, and citrus fruits.

Pollination and Fertilization

Although the setting of fruit is a subject worthy of separate detailed consideration, a few of the main aspects will be dealt with briefly here so that we can start fruit growth at the very beginning.

Pollination describes the transfer of pollen from the anthers of one flower to the stigma of the same or a different flower. Many factors can affect this: (a) the work of bees as determined by hive strength, weather, attractiveness of flower as a nectar source and many others, (b) the weather determining whether or not the pollen is ripe in sufficient density, whether it is viable or capable of germinating, whether it will be blown from male to female parent in the case of wind pollinated species such as chinese gooseberries and walnuts and whether it will remain on the stigma for a sufficient time before being damaged or washed off by rain, (c) the availability of pollinating varieties within a suitable distance of the variety to be pollinated.

Fertilisation describes the union of the male and female nuclei which occurs after the pollen grain has germinated on the stigma, grown down the style by the production of a pollen tube and entered the ovary. One of the key factors in growth of the pollen tube is whether or not the male and female parents are compatible. A number of plants are self incompatible, meaning that they must obtain pollen from another variety. This applies to almonds, cherries, European plums and most pears, to name a few. It is often stated that some plants have improved set with cross pollination, even although they are known to be self compatible. Some varieties of apples, notably Delicious and Gravenstein, have improved set with cross pollination. One explanation of this in the case of Gravenstein, is that it has poor pollen but in other instances the period of self compatibility may extend over only the first day or two of flowering and thereafter the flower requires pollen from another source.

Another factor in the case of setting is the time over which the stigma of a flower will be receptive to pollen. A notable example of a very short receptive period is a tropical fruit, the mango, whereby fertilization can take place only over a short 3 or 4 hour period. The avocado is another interesting example where the stigma is receptive one afternoon but the pollen is not ripe until the following morning by which time the stigma is no longer receptive. Under dull, cold weather, pollen germination and growth may be so slow that fertilisation cannot take place before the flower is spent.

Nutrient condition of the tree may also affect fertilization, although this has not been proven conclusively. It is generally accepted that high nitrogen levels aid fruit set, as evidenced by improved fruit set under poor weather conditions during blossoming when foliage applications of urea have been made just prior to flowering. It is also suggested that other elements may have some bearing on this, notably magnesium. Set is also invariably poor in weak and diseased trees, particularly those suffering from root troubles.

Seed number and fruit size:

Another aspect of fruit growth is the relationship of seed number. Malformed fruit such as pears are often found to contain seed on only the side of the fruit which has developed normally. Passion fruit, and chinese gooseberries, will size in proportion to seed number which, in turn, can often be related to pollen density in the air at the time of flowering. Invariably female chinese gooseberries in close proximity to the male plant will bear fruits of a larger average size. This has lead to the practice of having a male portion on each female plant.

Strawberries too will demonstrate this interesting relationship of seed number to size. If all the developing seeds are removed from a strawberry in the young stage, the fruit will not size. This explains why strawberry fruits are sometimes misshapen from uneven setting or damage to one side of the fruit.

Artificial parthenocarpy:

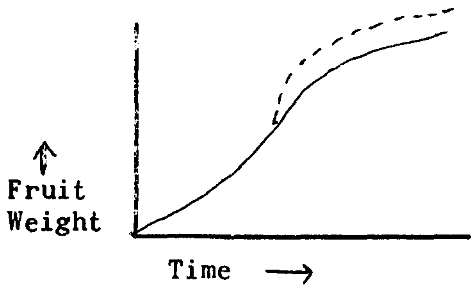
Some fruits can be made to grow without fertilisation by applying one of the growth regulating compounds in spray form. The three main groups of these compounds are the auxins, gibberellins and kinins. It seems clear that gibberellins usually dominate at about the stage of fruit set, that shortly after, when there is usually active cell division, the kinins dominate, and then subsequently, during the period of cell enlargement, the auxins are most important.

It is not surprising then to find that fruits can be developed without fertilisation, by the external application and uptake of gibberellins by the leaves of the plant. Varying degrees of success have been achieved with parthenocarpic development of apricots, peaches, cherries, almonds, grapes and even apples and pears, although, of course, it must be realised that the concentration and method of application are varied and difficult to determine in each case. A minority of fruits can also be stimulated in their growth by the application of auxin type compounds such as 24D, 245T, 245TP and N.A.A. Most of these fruits are many-seeded, such as strawberries, figs, tomatoes and melons. The use of "Fulset", a commercial preparation of N.A.A. is well known on out-of-season tomatoes.

Growth Curves:

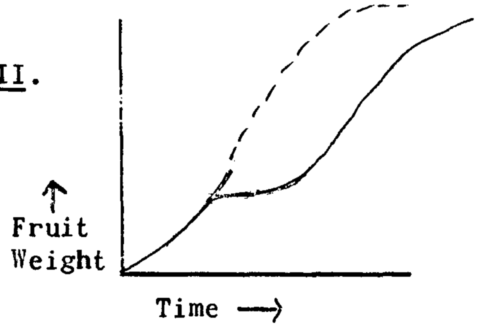
There are two distinct forms of growth curves formed by plotting fruit weight against time.

Fig. I.



Single sigmoid curve typical of that for apple, pear, strawberry and tomato.

Fig. II.



Double sigmoid curve commonly exhibited by all stone fruit, grapes, currants and figs.

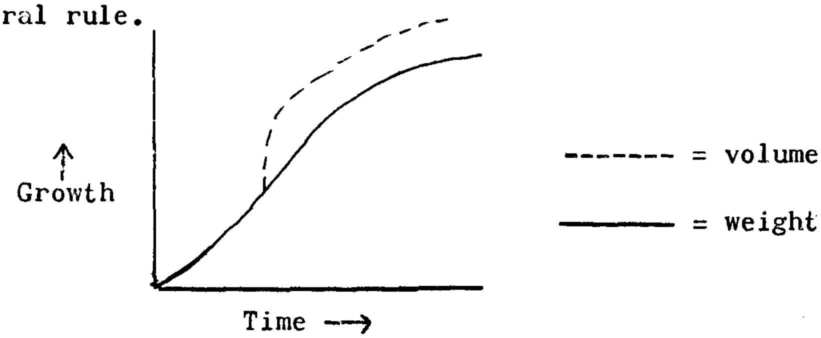
In most pip, stone and citrus fruits there is a brief period of cell division soon after pollination, followed by a prolonged period of cell enlargement. However, in the case of stone fruit, there is a pause in cell enlargement during which time the stone hardens.

On the other hand, in raspberries, boysenberries, and blackcurrants, cell division is completed before pollination and fruit growth is all cell enlargement.

Conversely, in the strawberry, cell division may continue for over half the growth period of the fruit.

Stone fruit growers have long exploited the knowledge that auxin-like compounds such as 24D, 245T, and 245TP applied at the commencement of stone hardening will shorten the delay in fruit growth and produce increased size and hastened maturity, as indicated by the dotted line in Figure II. The dotted line in Figure I demonstrates that increase in fruit size is possible as well, although not commonly practised, in fruit exhibiting the single sigmoid curve.

Another interesting point about fruit growth is that much of the increase in fruit size is due to the development of air spaces as cells enlarge and that increase in fruit weight does not keep pace with fruit size as a general rule.



Sometimes 25% or more of a mature fruit may be occupied by air space.

Fruit Drop:

As fruit approaches maturity the level of auxin usually decreases. This initiates the development of the abscission layer and the fruit will fall or can be easily harvested. Sometimes this abscission will take place prematurely much to the dismay of the fruitgrower. Invariably this early abscission is associated with a low level of auxin, whether it be immediately after setting, during a "natural drop" period as often occurs with apples in December and stone fruit at or just after the stone hardening period, or just prior to normal maturity.

Overseas work has clearly demonstrated this fact in the blackcurrant for instance. Fruit drop may be quite high in the first 30 days after setting when the auxin content can be demonstrated as being **very low.** This is sometimes referred to as running out. Then, during about the 30-60 day period, fruit growth is practically nil when the auxin level is high, but then approaching full maturity, when the auxin level is falling rapidly, berry drop will increase again in direct proportion.

The commercial application of this knowledge on premature abscission has resulted in the use of stop drop sprays which commonly contain the auxin-like compounds N.A.A. or 24D. Commercial use of these sprays is probably most common in New Zealand on grapefruit and oranges (24D) although drop in pears (N.A.A.) and apricots (245T) is also effectively corrected on quite a number of orchards.

FRUIT THINNING

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There is no need to discuss in detail the reasons for thinning. In spite of improved cultural techniques, there are still occasions when the fruit set is in excess of normal, and adequate sizing and growth is not achieved. Under these conditions flower bud formation for the following year is likely to be inadequate.

Although hand thinning is more exact and safe, labour is the main cost in fruitgrowing today and there has been considerable interest in the economics of chemical thinning. Furthermore, it is evident that the beneficial effects of thinning are greater if the thinning is completed as soon as possible after full bloom. In one experiment on thinning of Redhaven Peach in the States, there was a steady gradation in size effect from 160 fruits per bushel when thinning was completed one week after blossom, to 220 per bushel when thinning was delayed until 12 weeks after blossom.

It is also possible to show a direct relationship between earliness of thinning and flowers initiated for the following year. Early thinning promotes greater flowering next year. Early hand thinning is not feasible, so that the rest of this discussion will be directed to a study of present-day knowledge on chemical thinning.

Scientific explanation of fruit thinning:

Three theories are commonly advanced for fruit thinning :

(a) prevention of pollination,

(b) inducement of embryo abortion,

(c) the alteration of the auxin gradient across the abscission zone.

(a) Prevention of pollination : Clearly the use of burning compounds such as cresols and phenols will damage parts of the flower and prevent fruit set. If the timing of spray during the blossom period is such that some fruits have set while other flowers are still opening, the open flowers will be damaged, while the fruit already set will be uninjured. An application at full bloom of 1 - 1½ pints/100 of 30% sodium dinitro ortho cresylate has been recommended in the past for apples but is seldom used now commercially.

Some people consider that N.A.A. causes inhibition of pollination as well but, in fact, most evidence points to the embryo abortion theory.

(b) Inducement of embryo abortion: It is clear that the use of auxins such as N.A.A. and Naphthalene acetamide will be gradually less effective in fruit thinning the longer the application is left after blossom. In other words, fruit embryos increase in resistance to abortion with increase in age.

This embryo abortion theory is further enhanced when one considers present day knowledge of growth substances and fruit growth. It seems clear that gibberellins dominate at the time of fruit set and that high levels of auxin (N.A.A.) could, in fact, interfere or be antagonistic with the action of gibberellins in promoting fruit growth. But three - four weeks after fruit set, the importance of auxins in preventing fruit abscission becomes important, and auxins dominate. Hence, later application of auxin could be beneficial in holding fruit on the tree as it is in "stop-dry" sprays.

(c) Promotion of abscission layer : The difference in auxin level in the fruit and spur resulting in the development of the abscission layer is unlikely to be the explanation of the way in which N.A.A. thins fruit. If this explanation were true then the thinning effect should last for a much longer period after flowering than it does. The explanation of the thinning effect of the insecticide carbamates such as Sevin and Mesurol is still in doubt but the time and way in which they act suggests that they could, in fact, fit into this "abscission layer" theory. It is known that Sevin is most effective between about 10 and 30 days after blossom. This is the stage when N.A.A. becomes less effective as a thinning agent and the young, developing embryo is producing related auxin compounds to prevent abscission taking place. Could not the action of the carbamate be an inhibitory one causing a temporary prevention of auxin synthesis by the fruit? Would this not also explain why the weaker and younger fruits absciss more readily and why a second application of Sevin 10-14 days after the first can cause a further mild thinning effect?

Practical considerations:

Growers are still understandably diffident about the widespread use of thinning chemicals. Fruit thinning with N.A.A. is very sensitive to only slight changes of concentration and its effect will often vary very markedly from district to district, tree to tree and season to season. However, our knowledge is now much improved on the factors affecting the degree of thinning and some of these factors warrant brief consideration.

(1) Fruit and Variety: N.A.A. and Naphthalene acetamide (N.A.D.) are effective on apples but their effectiveness is very limited on other fruits such as pears, peaches and grapes. One explanation suggested is that auxins are taken up by the leaf and translocated to the fruit and that apples having leaves at the time of flowering can take up more auxin than peach which is without leaves at the critical period. This could be so but it is not an effective explanation in all cases. Although high hopes were held for Sevin and Mesurol in thinning stone fruit, trials have not been very successful. Overseas reports suggest a material known as napthyl phthalamic acid as effectively thinning stone fruit. Another auxin 3 chlorophenoxypropionic acid (3 C.P.) is also reputed to thin peaches but results are very variable between varieties.

Naturally thinning agents are more dependable to use on varieties which tend to set heavy crops. It has been suggested that a reasonable commercial apple crop requires about 35 apples to every 100 blossoming spurs. As an example, Golden Delicious may set 80 - 100 fruits per 100 spurs but Delicious only about 50/100 spurs making the margin of safety with Delicious very much less.

There is no doubt that the main danger of overthinning is caused by set failure, which emphasises the value of the later applications possible with Sevin.

(2) Weather : As far as the "dinitro" materials are concerned rain will cause rewetting and an additional thinning effect. Dinitros will also render the flowers more susceptible to low temperature and can double or triple the loss of young fruit by frosts.

The absorption of N.A.A. can also be markedly affected by weather. Any conditions causing slower drying and greater spread over the leaf will increase absorption. Cool temperatures, high humidity, low sunshine, rainfall, will all increase thinning. But conditions favouring growth and leaf activity prior to spraying such as high humidity, temperature and light will also favour increased uptake.

On the other hand, Sevin is absorbed by the fruit and is therefore not subject to the same marked fluctuations.

An effective method of reducing the fluctuation of N.A.A. thinning is to use a surfactant or wetting agent. Glycerine has been commonly recommended as an additive in New Zealand and proprietary compounds such as Tween 80 appear in Australia and U.S.A. literature. Only about one third the quantity of N.A.A. is required when a surfactant is used. For instance, 50 percent of Golden Delicious fruit may be thinned with 15 p.p.m. N.A.A. alone but with the addition of a surfactant only about 5-7½ p.p.m. would be needed for a similar effect. An effective method, if there is a worry of overthinning, is to spray just the tops of trees with N.A.A. about late petal fall and to follow this about two weeks later with Sevin, if further thinning is required.

The concentration of Sevin is not as critical as with N.A.A. and a surfactant is not necessary. Varieties such as Dougherty and Golden Delicious will be thinned by about 1½ lbs of Sevin 80% per 100 gals. but it would be best to reduce the strength to about 1 - 1¼ lb with varieties such as C.O.P. Sturmer, Jonathan and Delicious. Take care with Sevin under low temperature conditions as it is liable to russet fruit.

(3) Tree vigour: Individual trees vary in their response to thinning sprays, particularly to N.A.A. and for this reason some growers prefer to apply these sprays by hand lance, so that they can be selective in application. Trees suffering in growth from root injury, wet feet, low nitrogen and from inadequate light will all have weaker flowers and will therefore be more susceptible to the effects of thinning sprays. Young trees are also more easily thinned but there is a tendency for the king blossoms to resist thinning.

For pip fruit, chemical thinning is becoming an effective tool and being used increasingly by growers who are prepared to gradually develop experience in its use. The advent of Seven as a thinning agent has brought further confidence in the method, but much work remains to be done on other than pip fruit.

FRUIT QUALITY

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Much emphasis has been placed on fruit quality in recent years with the increasing competition to sell on World markets. People closely associated with marketing may look on the term "quality" as meaning solely "storage quality" or perhaps solely "appearance" at time of sale. Fruit quality, in my opinion, embraces appearance, texture and flavour.

(a) Appearance:

It is taken for granted nowadays that fancy grade fruit is free from serious insect and disease damage and that it is not badly disfigured in any way by pit, deficiency symptoms, limb rub or similar damage. It is perhaps not so commonly accepted by growers that fruit damaged during harvesting and packing will sometimes appear very badly bruised on arrival at its destination and that disease rotting organisms can enter through the damaged skin. Much may be done on correct storage, on correct wrapping with D.P.A. or oil or copper wraps and on growing the fruit but the need for and importance of carefully avoiding all forms of damage during handling cannot be overemphasised.

Colour is another facet of appearance which seems to be assuming more and more importance. Obviously one of the best ways of assuring good colour is to select a variety which inherently produces a well coloured fruit. But, given a certain variety what can be done to improve colour? There is little doubt that a heavy attack of red mite will result in dull colour and that powdery mildew will also affect the appearance of the fruit particularly from the russet point of view. There is also no doubt that vigorous, dense trees generally produce poorer coloured fruit than an open, less vigorous tree. This reflects low light intensity falling on the fruit. A simple way to prove this is to cover a portion of the fruit with adhesive tape before the main colouring period. At maturity, you will find that the covered portion is still quite green. Some American orchardists have produced a small stencil of their name, or the name of their orchard, and covered a number of fruits with the stencil, in order to outline their name in red on the green background of the fruit. They then place one of these fruits in a prominent position in the top layer of a packed case. There are obvious ways of improving light - by training and pruning for a more open tree (central leader type) or by summer removal of vigorous shoots, and by reducing growth by controlling nitrogen level, by heavier cropping or by more drastic growth-reducing means such as ring barking.

You may have wondered why oranges from the tropics are a perfect flavour but green and unattractive in appearance. This is because lower temperatures are required for the chlorophyll to be broken down and to allow the masked orange colour to dominate. This is one reason why North Island apples are invariably of poorer colour than in the South where colder, dewy nights result in better colour development. Warm countries will go to considerable trouble to colour citrus by holding them in special humidity, temperature and gas controlled rooms.

(b) Texture:

While fruits are growing they remain firm, mainly due to the insoluble protopectin contained in the cell walls. As the fruit matures, the insoluble protopectin is converted to soluble pectin and the fruit softens. In a pear for instance, most of the insoluble protopectin is still present at the stage when the pear is still firm and green but ready to be harvested. As the pear ripens, the level of soluble pectin increases in direct proportion to the decrease in firmness, as measured by a pressure tester. When fully ripe the cells rupture easily and the fruit is soft and juicy.

If, on the other hand, a fruit is harvested too soon the conversion of protopectin to pectin may not proceed and the fruit will remain hard until it will eventually shrivel and become rubbery.

Large fruits, perhaps resulting from high levels of nitrogen or a small number of fruits on the tree, will invariably have large, thin-walled cells and a high percentage (25%) of air space in each fruit. Fruits of this type have a lower percentage of pectin in relation to their size and will invariably be soft and damage easily. Fruit from young trees is usually of this type and will collapse very quickly in storage. It is commonly recognised too that comparatively high levels of potash are necessary for firm, good quality fruit.

An interesting development, still in its infancy, is the discovery of the importance of growth substances, the kinins, in promoting cell division. Should it be possible in the future to apply kinens economically to trees to promote cell division, then it could have an important effect on quality.

Juice content could also be considered under this general heading of texture although it can be argued that juice is more closely connected with flavour. The percentage juice content of fruit in the citrus industry has been developed as one of the means of measuring fruit quality and to group them for payment purposes. A reading of sugar content is also taken. In oranges for instance, groupings are as follows:

	Soluble Solids (Sugar)	Juice Percentage
Group 1	11° Brix	35
2	9° "	30
3	8° "	25

Generally, percentage juice content is lower under conditions which produce large soft-celled fruit, namely vigorous trees, on vigorous root-stocks, promoted in growth by high levels of nitrogen. Unfortunately, many of these factors leading to poor quality also lead to heavier crops. However, the trend towards semi-dwarfing stocks such as MM106 for apples and Poncirus trifoliata for citrus, together with closer planting in the row, can give both high yields and high quality.

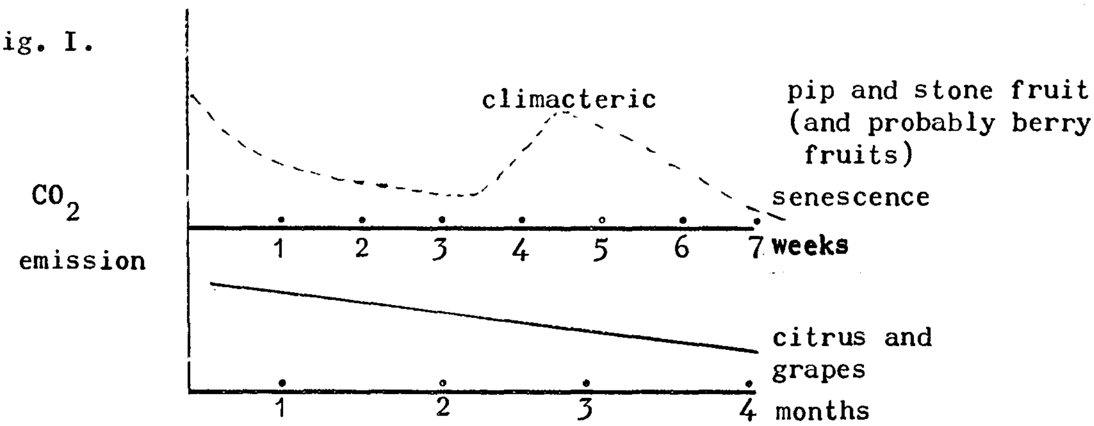
(c) Flavour:

Large numbers of chemical compounds, sometimes in only minute quantities, contribute to the wide range of fruit tartar. Basically though, we say a fruit is either sweet or sour and that it is well flavoured or watery. What we are analysing in fact is the amount of sugars in relation to the amount of acids in a fruit and the actual level of these in relation to the overall weight of the fruit.

To understand the development of flavour it is necessary first to understand the ripening process of fruits. During the growth of the fruit, much of the food manufactured in the leaves is transported to the fruit and stored in the form of starch, or used to build other more complicated compounds. But, as the fruit approaches maturity, much of this starch is converted to sugars and the fruit becomes sweeter. At the same time the acid percentage usually decreases. The ascorbic acid or Vitamin C content on the other hand, which has no marked effect on flavour but is important in quality, generally increases as the fruit matures.

Fruits fall into two main categories as far as their pattern of ripening is concerned as shown in Fig I.

Fig. I.

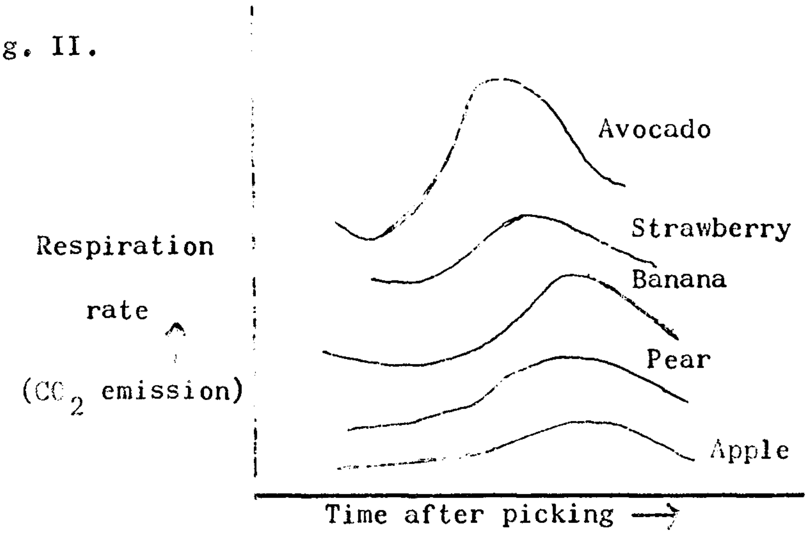


The carbon dioxide emission is used as a measure of respiration rate, that is the speed at which the fruit breaks down its sugars to carbon dioxide and water. It is also a measure of the speed with which a fruit ripens to peak condition and then gradually uses up all its sugar reserves, becomes flavourless and collapses.

In most cases of climacteric fruits the ideal stage of eating maturity is about at the climacteric stage or just after. Obviously, if we can harvest fruit before the climacteric rise starts and as long as the fruit has converted most of its starch to sugars and developed a good juice content, then we have a much better chance of keeping it in good condition for a longer period.

The period over which the fruit may be held in good condition depends very much on the natural respiration rate of the fruit and the conditions under which it is stored.

Fig. II.



An avocado has a very high natural respiration rate and might last in good condition only for 6 or 7 days. The apple, on the other hand, has a much lower rate of respiration and could remain in good condition for months. The variety also has a marked effect, with early varieties having a much higher rate than late varieties, as evidenced by the storage qualities of Wilson's Early compared with George Wilson Plum, Mayflower compared with Golden Queen peach and Irish peach apple compared with Granny Smith.

It is well known that reducing the temperature of fruit reduces its respiration rate and this is the principle of cool storage. One can make many generalised statements to emphasise the importance of removing the field heat from fruit as soon as possible and certainly for not allowing fruit to sit in the sun. For instance, for every 1½-2 hrs that fruit is held in the sun its life may be reduced by 1-2 days. Another expression commonly used is, that if the storage temperature is raised 10°F then the respiration rate will double. This means that fruit held at 60°F will last only one-quarter of the time of fruit held at 40°F. These statements of course vary according to the type of fruit.

A higher than normal level of carbon dioxide and a lower than normal level of oxygen will also slow down respiration rate and lengthen the period of good quality. This is the principle of controlled atmosphere storage.

It must be made clear that a fruit off the tree is still a living entity and as such, its quality can still be affected. Too low a relative humidity can cause loss of water, resulting in dry, shrivelled fruit. Too low a temperature in store can cause freezing injury and off flavours. Too low a level of oxygen can cause anaerobic respiration and the development of off flavours. Too high a level of carbon dioxide can be toxic. High levels of ethylene, another volatile substance given off by fruit during ripening, can, in fact, accelerate ripening if the air is not changed regularly or if various fruits are mixed together. Extended storage life has been claimed by sterilizing fruit with irradiation but an overdose can completely interfere with the physiological processes within the fruit and cause loss of flavour and keeping quality.

I have not yet referred to the non-climacteric fruit, notably grapes and citrus, which have a gradually declining rate of respiration, generally over a long period of time. In the same way as climacteric fruits, the rate varies between varieties (compare Washington Navels with the slower rate of Valencia oranges) and between fruits (compare oranges with the slower rate of lemons). The change in sugar content in grapes and citrus is much more marked than in apples and pears for instance, and this change can readily be measured with a refractometer to determine harvesting time and quality.

This section mentioned at the start insipid fruit. It is appropriate to give a reminder at the end that leaves manufacture food and any cultural detail resulting in improved health of the leaves and maximum presentation to the light will, if the climate is right, result in improved fruit quality.

THEORETICAL ASPECTS OF SPRAY APPLICATION

G.F. Thiele,
Lincoln College.

The application of therapeutants today ranges from the aerosol concentrate of minute droplets commonly used in a closed glasshouse, through concentrate and semi-concentrate orchard machines, to various methods of dilute application. Concentrate and semi-concentrate machinery covers motorised knapsacks to fixed wing and helicopter aerial application. Dilute application ranges from the common home garden double action hand pump or the hand knapsack through boom spraying in its various forms to the high capacity 40-50,000 cubic feet of air displacement per minute air blast orchard sprayers.

Droplet size:

Droplet size varies very markedly between these different methods and it is useful to make a comparison with fog, mist and rain sizes with which we are reasonably familiar by experience. Droplets are usually expressed in terms of microns.

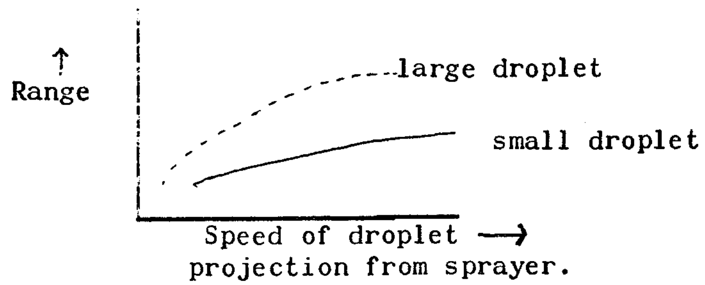
Rain is usually in the 500-1000 microns range and equivalent to a normal irrigation sprinkler. Clouds about 20-30 microns, mist 40-90, and drizzle 100-300 microns cover the range equivalent to normal concentrate, semi-concentrate and dilute spraying (1 millimetre is equivalent to 1000 microns). Below this, at about the sea fog level of 5 microns, and lower still in the oil fog .1 - 1.0 microns range, falls the common aerosol droplet size.

In order to understand some of the practical aspects of various forms of spray application, it is necessary first to understand some of the physical principles of droplet behaviour.

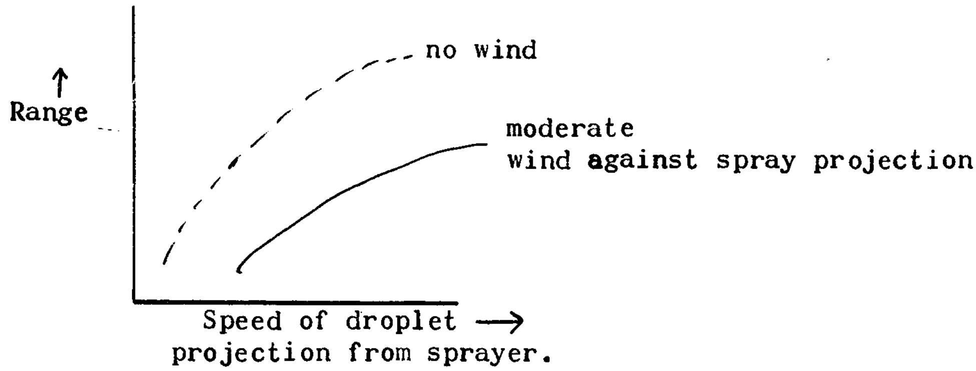
Physical principles of droplets:

(a) Droplet size :

If we were to allow a large droplet to fall a set distance at the same time as a small droplet which droplet would fall faster? Naturally it would be the larger one. The same principle apples when projecting spray droplets toward a tree, the range attainable is dependent on the droplet size and the speed with which it is projected.



That is, the larger droplet can be forced further than the small one by the same machine. If we now introduce a wind blowing against the force of the machine the small droplet will have a smaller range still.



The droplets can be projected towards the target in two ways :

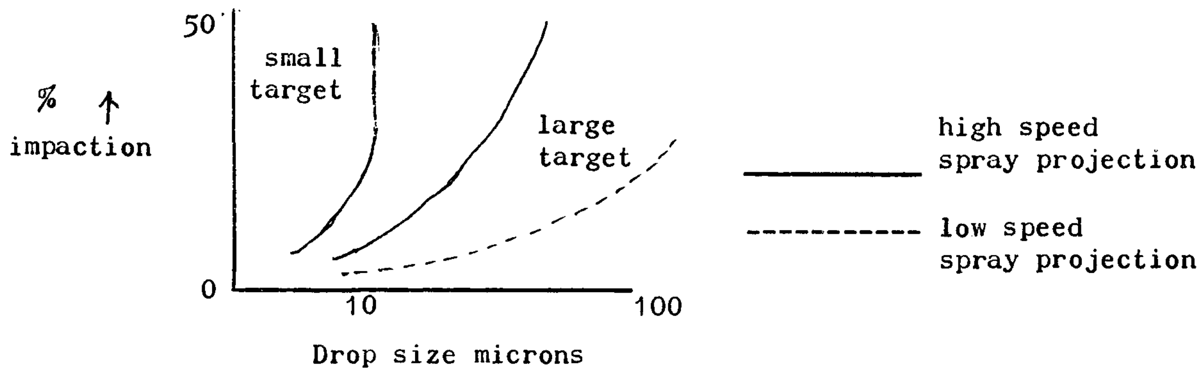
(i) by direct pressure through the nozzle which is the common method of most of the older sprayers.

(ii) by airblast which is the method of most modern machines

It is easy to see that insufficient projection could be brought about by insufficient air displacement capacity of the machine, too rapid forward movement of the machine, very small droplet size and strong wind against the projection.

(b) Impaction efficiency:

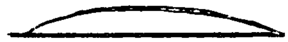
Droplets not only vary in their speed of movement but they also vary in their ability to land on a surface. Small droplets moving in a slow air stream tend to by-pass objects, particularly if the obstacle is large. This means that a very small droplet could conceivably move right through a tree without landing on a leaf or fruit and be carried away with the airstream on the other side. If a tree is very dense, fine droplets may be carried by a slow air stream around the outsides of a tree and be lost in this way. At the same time, with careful selection of droplet size and with the spray carried by a strong or turbulent air stream, as is typical of a turbo-mist machine, the small droplets could penetrate more efficiently into a reasonably dense tree and result in good coverage of all surfaces and even impaction on insects resting in sheltered places.



(c) Coverage in relation to surface tension and volume:

Large drops of high surface tension (that is with no wetting agent added) tend to bounce off a leaf or fruit in much the same way as a rubber ball would rebound from a solid surface. This is accentuated by shiny surfaced leaves such as cabbages, onions and citrus.

high surface tension of droplet



low surface tension of droplet

A droplet can, of course, have a surface tension which is too low, in which case the deposit of spray material may be too thin. This happens if too much wetting agent is added to the spray.

The practical decision on whether or not to add wetting agents sometimes causes concern to growers. Proprietary preparations of most therapeutants contain spreader stickers and, generally, there is no need to add additional wetting agent when there are two or more wettable powders in the mix or when an emulsifiable concentrate is being used.

One of the best methods of judging whether more wetting agent is needed is to look at the foam on the top of the spray tank. With the agitator running, if the foam is stable, then there should be no need for further wetting agent but if the foam breaks up almost straight away, then additional Triton B or similar agent is needed.

If after spraying you notice that the majority of spray has collected at the drip point, then it is a sure sign that too much spreader has been used. If, on the other hand, quite large congregated drops have deposited thick areas of spray material irregularly over the whole surface of leaves and fruit, then more spreader would be needed.

Materials such as Triton and Agral assist with sticking as well as spreading. On the other hand, anionic "detergent-type" preparations may spread effectively and are cheap but they may allow the spray material to be washed off easily by rain.

However, coverage is not always the most important part about spraying. As long as distribution is even and there is a sufficient level of spray material deposited, then even only 15 - 20% coverage can give effective control. When spraying with a high volume of liquid, the object is to saturate the crop surface to the run-off stage so that the crop retains as much as possible by complete coverage and the rest drains off. In this case the amount of spray material retained is in direct proportion to the concentration of therapeutant in the spray mixture and not directly related to the volume of liquid used.

On the other hand, with concentrate and semi-concentrate spraying, the amount of therapeutant actually deposited is proportional to the volume applied as well as the concentration of the material in the mixture. This means that a grower can lower the volume applied and increase the concentration, provided the machine can be adjusted to produce fine droplets and that the machine has the power to carry the finer droplets to the target and deposit them efficiently. The reverse is also the case, whereby semi-concentrate machines could be converted to dilute spraying, where smother control of insects is required, provided pump capacity and air stream is adequate.

If Captan was applied through a Turbo Mist machine to cover only 20% of leaf and fruit surface, how could this control black spot? There are several answers to this; spore and leaf exudates may help with redistribution; dew and even rain can help spread; and in the case of contact insecticides, the movement of the insect over the leaf allows contact at some point. It should be made clear that this refers to coverage only and that uneven distribution of deposit over a leaf surface or over the tree itself would not be efficiently redistributed.

Terms used about spray mixtures:

Dispersion - A dispersion is the scattering of one substance throughout another.

In the case of a dispersion of a substance through a liquid, as is the case in normal spraying, if the substance is soluble in the liquid it is a solution. Very few spray materials are of this nature. Bluestone, urea and epsom salts would be examples.

If a solid substance (spray particles) are not soluble and dispersed in a liquid then this is known as a suspension. Most wettable powders are of this type and need effective agitation to keep the concentration even throughout the spray tank.

The dispersion of a non-soluble liquid in a liquid is an emulsion. These usually require stable emulsifying agents but an emulsion can become unstable and break down if mixed with some other materials notably those which are alkaline or lime based. Emulsions may also react one with the other and this is why it is commonly recommended not to have more than one emulsion in a spray mixture.

A dispersion of a liquid in a gas is known as an aerosol.

Interesting figures:

Some careful overseas work has brought to light some interesting figures in regard to droplets which may leave food for thought.

(a) A 100 micron droplet of pure water falling through air at a temperature of 86°F and 50 percent relative humidity would fall only 6' before it completely evaporates in a time of 14 seconds. A 200 micron droplet under the same conditions falls 69' in evaporating in a time of 56 seconds.

(b) A 100 micron droplet from a fine aircraft spray would be carried 48' by a 3 m.p.h. wind while falling 10'.

A 50 micron droplet from a normal ground sprayer would be carried 178' while falling the same distance.

A fine dust would be carried between one-fifth and four-fifths of a mile.

Disease and Pest Control

D.A. Slade,
N.Z. Fruitgrowers Federation,
Hastings.

Mr D.A. Slade outlined the life cycles of the more important insects, mite, fungi and bacteria and highlighted the stages in the life cycle when control measures were most successful.

In discussing control of European red mite he advised that semi dormant oils should be applied at the green tip period. The trend from New York State in America is to apply lower rates of oil at periods up to the tight cluster stage. This has been made possible by the use of 60 and 70 second oils. These base oil sprays form the foundation for good mite and scale control for the remainder of the season.

Materials available for the control of mite were discussed. Eight groups of materials were described and it was suggested that if resistance occurred to members of any one of these groups it was best to change to a material in another group. The eight groups were I, organophosphates and carbamates II. Kelthane, the Dimite component of Spidex and Rospin, III. Omite, Chlorocide, Mitex and Tedion, IV. the Azo-sulphide component of Spidex, V. Morocide and Karathane group, VI. Morestan and Eradex group, VII. the Formanidine group and VIII, Oils. The correct choice of material is important. Members of group III are mainly ovicide or larvacidal. Ovicides are not effective when applied to high mite populations.

For controlling two-spotted mite an ovicide was suggested about first cover. This should be repeated later in the early season to prevent further development. Knockdown materials are applied during the summer period and if after harvest it is found that a high population builds up, it is desirable to apply oils at that stage. Since this mite overwinters on the vegetation under the trees, high populations are not completely controlled by green tip oils.

Control of citrus red mite was also discussed. There is no over-wintering egg stage with citrus red mite, all stages surviving during periods of low temperature. Kelthane MF is a highly effective material for use on citrus. There is very limited use of Spidex on citrus, but this could contribute in future if it proves safe on this crop. Trithion has been recommended overseas and could contribute to mite control in citrus in future.

Reference was made to the pear leaf blister mite because this mite has occurred in some areas after lime sulphurs at bud movement have been omitted. Lime sulphur at bud movement is the best spray but if it is noticed that the young mite are causing injury inside leaves, Septan sprays applied from petal fall will penetrate the leaves and will kill the majority of young mite. They have no thinning effect on pears.

Control of leaf roller was discussed. In some districts several species are present and are responsible for the extended injuries which are found in the early harvest period. In most districts it is now necessary to maintain a cover of insecticide right up to two weeks before harvest. This can be done by using Gusathion in the last spray. Effective materials included DDD, in districts where it is still effective, Gusathion and Matacil. Lead arsenate is of use in the Nelson area where it is usually not necessary to combine it with lime.

Codling moth has not been a problem in recent years and is adequately controlled by the normal Nelson leaf roller programme. DDT is used normally in other districts. Gusathion and Matacil gave outstanding control of codling moth. Parathion and Septan are also effective and have a limited use in some programmes.

The differences between the life histories of our two most important mealy bug species were briefly discussed. The Nelson mealy bug (Phenacoccus sp.) does not feed on the tree. It lives on grasses and other vegetation under the tree and moves up the tree from mid November. To reduce the numbers of mealy bug overwintering on the tree it is desirable to clean up all vegetation under the tree, particularly during periods when the branches are laden with fruit and may touch the ground. Mealy bugs of Pseudococcus sp. occur commonly in Auckland, Gisborne and Hawkes Bay. These live on the tree and must be controlled with Parathion or Matacil programmes.

Matacil is a new carbamate insecticide which will be used commercially this season. It has been tested extensively and has been found to give an outstanding fruit finish and excellent control of mealy bug and caterpillars. This material is related to Septan and while it cannot be considered a thinning agent it may under some conditions give a slight thinning effect. If trees are carrying a light crop it may be desirable not to use Matacil until six weeks after full bloom. Under normal conditions the slight thinning effect will be of no concern.

Other insecticides mentioned include Kilval, the systemic insecticide applied during late November or early December for controlling woolly aphis. This material replaces the green tip Lindane or Trithion recommended previously, but it was suggested only for use on heavily infested orchards. In areas where organophosphate resistance in mite is not widespread, Kilval may act as an efficient miticide. In areas where Gusathion has been used extensively, Kilval will have a limited effect as an acaracide. Trithion was briefly described and it was suggested that this material should not be applied until after December and then it should not be used on Golden Delicious under high temperature conditions, because it can cause heavy leaf fall. Morestan is to be introduced into the spray programme, particularly in the Nelson area, and will be available for orchardists who have resistance to Trithion. Under some conditions severe phytotoxicity has occurred and all label warnings should be observed. Avoid particularly excessive spray accumulation at the drip point of fruit and keep mixtures as simple as possible. Severe phytotoxicity has not occurred since Gusathion 25 was replaced by Gusathion 50.

Powdery mildew was discussed in some detail at both courses. The incidence of mildew has been increasing in New Zealand. Some of the increased incidence is due to the adoption of long pruning by most districts. Despite this, every endeavour should be made to cut out all infected tips. We have recently had an improved formulation of Karathane introduced on to the New Zealand market. This material is far easier to mix with water and it is suggested that no additional wetting agent is required when it is combined with other materials. To control powdery mildew it is essential to adequately wet the mass of fungal mycelium. It may be necessary in most districts to add a small quantity of wetting agent such as Triton B1956 when Karathane is used by itself or with one other material. Morocide is also an effective material for controlling powdery mildew and when Morestan is used in the mite control programme no other powdery mildew fungicide is required in that spray.

The life history of black spot was discussed. Strong mercury sprays using 5 lbs. 2.5% PMC (Ascospray) just prior to leaf fall were suggested to prevent parithesia developing in dead leaves. Promise was also being shown by 40 lbs. per 100 gallons sprays of Urea applied at the same time. Bordeaux is not a satisfactory clean up spray. Protective sprays suggested in the green tip period include Bordeaux applied with the green tip oil followed by captan, thiram or one of the recommended protectants. Melprex was one of the best protectants discussed. Difolatan, a good protectant, should not be applied until after mid November. Eradicant type sprays include Melprex and phenyl mercury chlorides. Melprex will eradicate infections established 48 hours prior to application while mercuries will eradicate up to 72 hours prior to application. A valuable property of Melprex was the manner in which a programme suppressed the production of conidia from black spot lesions.

Life cycles of glomerella and ripe spot were described. Sprays which assist to reduce the overwintering stages of a fungus include Bordeaux applied at the green tip period followed by up to three mercury sprays in the early spring. Fruit infections may be prevented by using a suitable cover spray from mid December. Suitable sprays include Captan, Flit 407 and Difolatan. Nelson use copper sprays to a limited extent on Sturmers. Sturmers tolerate these sprays but they should not be applied to other varieties. Too much irritation has been experienced with Difolatan to enable a simple recommendation to be made. On orchards however, where it is known that it can be used without the risk of irritation, it is one of the best materials available.

Brown rot on stone fruit was described and control measures recommended included the application of Dichlone 50W during the blossom period followed with a protectant programme. The one preferred is based on Captan. Rust control may be obtained by substituting zineb at monthly intervals from early November. Difolatan has given outstanding brown rot control during the summer and pre-harvest period. It is unsatisfactory during the blossom period and its future development is limited by its unpredictable irritant nature. Ways of avoiding irritation were outlined.

They include avoiding all contact with the body by wearing light clothes including long sleeved shirts. Clothes should be changed frequently and washed in soap, not detergents. Wash the hands and face as often as possible. Do not use barrier creams of the wet and dry types, use only water soluble creams. If irritation occurs avoid further contact until it is relieved.

Stone fruit blast control was discussed. One of the most important methods for the control of both blast and bacterial spot was to obtain clean trees from the nursery and to keep them clean, during the period their framework was establishing, by applying a very full protectant programme of bordeaux or streptomycin as recommended in the programmes printed in the Federation's spray diaries or recommended by the Department of Agriculture. Once the tree's framework was established a reduced programme prevents serious infection of trees.

Shothole disorders of leaves were briefly discussed and the control recommendations for dieback and peach scab were described. Dieback may be controlled by the application of 10.8.100 bordeaux in autumn. This prevents twig infections. Other fungicides are effective but bordeaux is preferred since it is effective against bacteria. Bordeaux sprays should also be applied at bud movement to prevent further spore production. Post blossom fungicide sprays used to protect foliage and fruit include Thirospray 1½ lbs. plus ½ gallon oil, Thirospray 2 lbs. or Difolatan 1 lb. per 100 gallons. Application should commence at petal fall on smooth skinned stone fruit but with hairy fruits it may be delayed until shuck fall. Some instances of peach scab were noted last season. The fungus responsible for this disorder, which appears more like black spot of pip fruit, survives from season to season as dormant mycelium in infected shoots. Infection of fruits and leaves occurs in spring when most fungicides will give an adequate control. Symptoms are not normally seen until many weeks after infection has occurred.

The life cycle and control of some of the more important diseases of citrus was also described. The current sprays recommended by the Department of Agriculture were suggested for control.

The factors influencing the integration of control recommendations in a programme were outlined briefly, mention being made of compatibility, fruit injury, waiting periods and their effect on the choice of materials.

MITES (ACARINA)

Dr Elsie Collyer,
D.S.I.R., Nelson.

Mites are small animals, many are less than 1mm in length. Typically they have four pairs of legs, the body is not divided by a "waist", nor is it segmented. The life history consists of eggs → larva (three pairs of legs) → one or more, usually two, nymphal stages (four pairs of legs) → male and female adult. The eggs may be of two types, one hatching normally, the other a diapause or resistant egg that will overcome unfavourable winter or summer (dry) conditions. Some species have no males stage, the females lay eggs which are unfertilised, this is parthenogenesis.

Mites are a large group and live in a wide diversity of habitat. A few examples are taken from the field of horticulture.

HARMFUL MITES

Family TETRANYCHIDAE, Plant feeding mites, over 200 spp. known.

Tetranychus telarius (= urticae): glasshouse, or two-spotted red spider (mite). Three colour variations of adult female: green, with two dark spots, an outdoor feeding form; carmine red, a glasshouse feeding form; orange, a winter non-feeding form. Long hairs over body, live in a mass of webbing usually on lower leaf surface. Breeds rapidly with many successive generations. Very wide host plant list, in glasshouses, gardens and orchards.

Panonychus ulmi: European red mite. Deep red colour in all stages, long white hairs. Five to seven generations in summer, eggs laid on leaves; in winter, a dormant egg laid on branches of apple, plum, peach, pear.

Panonychus citri: citrus red mite. Very similar to P. ulmi except plant host restricted to citrus, and lays no dormant winter egg as host is evergreen.

Bryobia spp.: brown mite. A dark reddish-brown colour, larger than foregoing spp., with very long front legs. Small flat setae on body. Is parthenogenetic (females only) and therefore variable and likely to develop "races" or "subspecies". One form lives on apple and plum foliage, lays winter eggs on twigs and branches; another feeds on grass, clover etc, and lays winter eggs low down on tree trunks. Three summer generations on apples.

Petrobia latens: similar in appearance to Bryobia; lives under stones and feeds on grass, cereals, onions etc.

Family PHYTOPTIPALPIDAE

Brevipalpus spp. Smaller than Tetranychids. Flat, bright scarlet mites; not hairy. Occur on Citrus, ornamentals and in glasshouses. Slow moving.

Family TARSONEMIDAE

Small, colourless, inconspicuous mites. Hind pair of legs modified as setae in female, and claws in male for carrying female nymphs to new leaves. Feed on young tissue of buds and leaves, distort growth and turns foliage silver.

Hemitarsonemus latus: broad mite. Common glasshouse pest, also outdoors, on flowers, tomatoes, beans, ornamentals etc.

Steneotarsonemus pallidus: strawberry, or cyclamen mite, these two main host plants. Less common than broad mites.

Family ERIOPHYIDAE

Gall mites. Many form galls, many are free-living on leaf surface. Minute cryptic, mites, worm-like in shape, with only two pairs tiny legs at head end.

Of the free-living forms, tomato russet mite feeds on leaves and fruits. Vine leaf blister mite and pear leaf blister mite cause blister galls on leaves. Blackcurrant gall mite causes large distorted "big buds".

Family EUPODIDAE

Red-legged earth mite: black mite with red legs, live in soil, fast-moving. Lays eggs resistant to drought to survive summer, lives in drier areas. Feeds on grasses, cereals and other field crops.

Family ACARIDAE

Stored products mites, common scavengers, feed on fungi. White, slow-moving, with long hairs.

BENEFICIAL MITES

Many mites are predators and therefore beneficial and these belong to many families. Two main groups feed on Tetranychids.

Family PHYTOSEIIDAE

Typhlodromus spp. Pale, cream coloured, shiny mites, move rapidly. Similar in size to Tetranychids. Several generations a year, feed on active stages of other mites. Hibernate as adults under bark and on dead leaves.

Family STIGMAEIDAE

Agistemus spp. Bright red-orange mites, resemble Tetranychids. Eggs bright orange. Breed throughout year on evergreens.

Family ACARIDAE

Hemisarcoptes malus, related to stored products mites which are fungal feeders. White, soft-bodied, slow-moving. Feeds on scale insects, lives beneath scales. (A species being introduced from overseas).

There are many other predators among the mites, some of them large, active and red in colour.

FRUIT VIRUSES

G.F. Thiele, Lincoln College.

Virus disease symptoms are well known amongst most forms of life.

The common cold and chicken pox are viruses of man, dog distemper, feline enteritis and cow pox are examples in animals. Polyhedrosis virus is known to be fatal to the white butterfly caterpillar and, of course, we have a wide range of plant viruses, tobacco mosaic, daphne virus, cucumber mosaic, stony pit of pears, to name a few.

What are viruses?

Sometimes viruses are described as being closely related to bacteria but this is not so. They are, in fact, very similar to the materials which make up cytoplasm and the chromosomes responsible for inherited characteristics in normal cells. Like these cell materials viruses are composed of protein and nucleic acids, usually a core of nucleic acid surrounded by a protein sheath.

The question has been asked - "Are viruses living or non-living"? The common consensus of opinion is that they are living but that they can only reproduce within a living cell. A virus depends on the cell for its food and the manufacture of its whole substance. It is the cell plus the virus which is the living unit. The presence of the virus means the presence of a new nucleic acid which will permanently influence the function of the cell. The virus proteins may also have an influence by dissolving cell walls for instance.

How do viruses express symptoms?

The exact way in which viruses produce symptoms in plants is not clear. Sometimes viruses kill but more often they debilitate or distort, sometimes very severely. Often symptoms are severe to start with and then later become masked. Sometimes symptoms will be more severe in some seasons than in others, such as with stony pit of pears. Sometimes trees which appear to have recovered from a virus will show severe or 'shock' symptoms when infected with another virus. Sometimes two unrelated viruses give more severe and often quite different symptoms from either alone. A good example of this is bootlace virus of tamarillos, a combination of cucumber mosaic and potato virus Y. A cumulative or interaction effect can sometimes be noted in strawberries where a decline in cropping of clonal varieties is thought to be due to the effect of additional or widespread virus infection.

What effect do viruses have on a plant?

The following is a useful classification of symptoms:

Malformed fruit - stony pit of pears, green crinkle of apples, apple ring spot, tamarillo mosaic, plum fruit crinkle, woodiness in passionfruit.

Small fruit - chat fruit of apples.

Loss of rigidity - rubbery wood of apples.

Disfigured or stunted stems - Gravenstein gnarl (or flat limb), scaly butt of citrus, peach rosette, prune dwarf.

Leaf symptoms - Strawberry yellow edge, strawberry crinkle, apple mosaic, cherry ring spot, oak leaf virus of plums, plum mosaic, Moorpark mottle (fruit distortion as well), cucumber mosaic, and bootlace virus of tamarillos.

How do viruses spread?

It is most unusual for viruses to spread by seed and, in fact, one of the ways to produce virus free plants in most instances is to grow them from seed. The reason why viruses do not enter egg and pollen cells is not known. Even young meristematic, undifferentiated cells at the growing point of a shoot will not have virus particles either. This has been used to produce virus free plants by excising apical meristems and growing them on a suitable nutrient medium.

Fruit trees are not commonly propagated by seed because of the variability which may result in the progeny. Instead they are vegetatively propagated usually by budding or grafting. It is quite certain that this is the most important method of virus spread and it emphasises the importance of selection of virus free propagating material. Some viruses such as those of tamarillos, strawberries and some viruses of citrus such as tristeza and stem pitting can be spread by aphis. In this case control of the vector helps to reduce spread, but most of the fruit viruses are not spread in this way. Nor are they spread by touch or by secateurs.

However, many growers argue that they have areas of trees where viruses are spreading in an ever increasing block. One explanation of this is that viruses sometimes do not show up in a tree until it reaches maturity and is in full cropping. This though cannot be the explanation in all cases and it seems clear that a process such as root grafting must play some part in the spread of infection in a mature orchard.

Methods of control:

Once a tree is infected with virus there is no known effective cure. The only measure which could be suggested is to change the variety by grafting on a less susceptible one. An example of this would be green crinkle of apples where red varieties are less prone to show severe symptoms than are green varieties. Another example is the Williams Bon Chretien pear which is less susceptible to stony pit than other common pear varieties.

The use of mild or symptomless strains of a virus has also been successful. In the case of apple mosaic for instance it is possible to graft a symptomless or mild strain of the disease onto a severely infected tree and the resulting growth will remain symptomless or mild.

It cannot be stressed too strongly the importance of disease free propagating material. A number of countries have Government fruit certification schemes whereby growers can obtain trees and plants produced from virus tested propagating material. New Zealand does not yet have Government controlled schemes of this nature but it is continually developing improved fruit propagating material.

The Horticultural Research Centre at Levin is indexing for strawberry viruses using an indicator variety such as *Fragaria vesca*.

Similarly, D.S.I.R. in Auckland are indexing tree fruits for viruses and using heat treatment in the order of 100°F for up to about 35 - 40 days to free nucleus material of viruses. The rootstock Quince A has been treated in this way for instance together with a number of scion varieties.

The Fruitgrowers' Federation are also playing their part by producing fruit trees with bud wood taken from carefully selected, apparently virus-free, trees.

It has been suggested in some quarters that our quarantine regulations restricting the importation of new varieties of fruit are too stringent but, in fact, we are extremely fortunate to be free of a wide range of serious fruit viruses reported overseas and any measure which will improve the disease free quality of our planting material cannot be given enough emphasis.

INTEGRATED CONTROL

Dr Elsie Collyer,
D.S.I.R., Nelson.

Integrated control is applied pest control, which combines biological and chemical controls, the latter to be used as necessary and in a manner least disruptive to biological control.

In the D.S.I.R. experiment at Appleby Research Orchard, Nelson, five years records have been taken to assess levels of biological control and pest damage to fruit. The only insecticide used on the integrated control block, ryania, has given some but not adequate control of codling moth. Leafhopper has been controlled by ryania. Damage to fruit by leafroller has been high. Amount of San Jose scale on the fruit has been small but this pest is increasing. Mites have been no problem since the first year, and no acaricides have been used, biological control by predacious mites and ladybirds is adequate. Woolly aphid and mealybugs are less abundant than on the fully-sprayed trees, at present, introductions of overseas beneficial species are being made to improve biological control:

(1) Several predacious bugs which are general predators and will feed on a variety of hosts including mites, aphids, and caterpillars or codling moth and leafrollers.

(2) A predacious mite that feeds on various scale insects.

(3) A number of parasites of leafrollers.

On the fully sprayed trees, the normally recommended spray programme has been effective, except for the development of European red mite populations that are now resistant to most of the acaricides on the market.

Powdery Mildew of Apples

D.W. Wilson
Department of Agriculture,
Auckland.

Summary

Powdery mildew of apples is now a disease requiring specific control measures in all fruitgrowing districts. The symptoms of the disease were briefly described, but the life cycle was discussed in detail. The overwintering of the disease only in live but infected buds was stressed, together with the fact that buds or shoots killed by the fungus were of no importance in the carryover of powdery mildew from season to season. The terms "primary" and "secondary" infection, terms which often cause confusion in trying to obtain a full appreciation of the life cycle, were explained in detail.

The amount of infection observed early in the season is often attributed to a deficiency of the current season's spray programme. This is incorrect because the growths and buds that "break" mildewed in the spring indicate the inadequacy of control secured in the previous season.

Powdery mildew spores can only become established on young foliage. A good spray programme should therefore be designed for close ratio spraying over the period of most rapid foliage development.

Experiments for the control of powdery mildew in Central Otago, were then described. These experiments not only covered comparisons of different materials, but were also designed to prove when the first mildew spray for the season need to be applied. Of the materials compared Morocide, Sulfane, Karathane as well as wettable sulphur, a material in common use many years ago, can all be confidently recommended. Morocide, however, should not be used late in the season, because of the possibility of skin bleaching at the drip point and the application of wettable sulphur under high temperatures could accentuate sun-scald.

Experiments over three seasons conclusively showed that under Central Otago conditions the first powdery mildew spray for the season could be safely delayed to full bloom. This may not be the case in other districts. Full bloom is considered a very critical period and sprays at this stage should never be omitted.

Overseas reports often stress and we have accepted the importance of cutting out infection during the winter pruning. The Otago series of experiments demonstrated, however, that pruning is only complementary to a good spray programme and of little importance on its own. If good spray programmes are adopted there should be little if any need (other than the tipping of annual growths in severe mildew areas) to cut out visible infection during the winter pruning.

Good mildew control is impossible if early sprays at critical stages are omitted. The critical timing of sprays is equally if not more important than the mildew spray used.

Frost Protection

D.W. Wilson
Department of Agriculture
Auckland.

Summary

The conditions under which damaging spring frosts in orchards can occur and the use of low precipitation water sprinklers for orchard frost protection were fully covered.

Frosts that affect the fruitgrower are fortunately mostly of the radiation type. "Freeze" type frosts which result from the movement of cold air into an area from polar regions have occurred in Central Otago and are virtually impossible to combat.

Before understanding how radiation frosts occur an understanding of heat transferance is necessary. Heat can be transferred in three ways, conduction, convection and radiation, and were fully explained.

Conditions conducive to late spring frosts include, clear sky, cool preceding day temperatures, overcast preceding day, low humidity and still air. On the other hand, the possibility of a damaging frost developing is lessened or obviated by warm day temperatures, definite air movement and cloud at night.

Soil conditions can influence frost severity. Grassing down or cover crops, loose and dry soil increase the risk of frost while clean cultivated and compacted soil as well as irrigated soil can be expected to lessen frost risk.

Like cold water, cold air flows downhill, so the avoidance of areas where cold air can accumulate is necessary for susceptible crops. The importance of shelter layout in relation to air drainage was stressed.

Frost protection with water sprinklers, although used in Central Otago for strawberries for many years, has only been used for tree fruits for a comparatively short time. Although this form of frost protection has many distinct advantages, there are still many unknown factors, and research on this subject is continuing. The latent heat principle on which frost protection with water sprinklers is based, was explained.

HARVESTING EQUIPMENT

M. Baumgart,
Department of Agriculture,
Nelson.

Two Subdivisions: 1. For loose fruit supply or gate sales.

2. For immediate grading and packing.

Loose Fruit: To Apple and Pear Board or factory straight from tree. At the moment this involves use of bushel case. Mechanisation can only be to the extent of palletisation.

Gate Sales: Most gate sellers still use bushel case as the basic unit and tend to harvest into this and where they have cool storage still use these units. However, I believe these growers too could profitably employ a 20 - 25 bushel bin and use a hand operated winch lift stacking truck in the cool store, very cheaply increasing storage capacity by about 30% and reducing handling costs and effort very considerably. Modifications to the door may be needed to allow the tractor to place the bin on the stacker.

Bins: May be used as bulk containers in the back of the shop and fruit sold in paper sacks - easier work and no mess.

For these methods a fork lift of some sort is needed. For truck loading a high lift operating up to 5' 6" is needed to load 2 bins high.

The heavy duty lift priced at approximately £220 is a better investment than the lighter one at about £150. You can lift and cart 2 bins totalling about 50 bushels.

Providing distances do not exceed 300 yards no provision should be made to use trailers to carry bins as it is possible to fit the high lift to the front of the tractor by using heavy duty front wheels, and fitting a cheap unit on the tractor's own 3 point linkage to carry a third bin.

Without a trailer, loading at the shed or on the truck is that much quicker.

Importance of standard bin for Board or Co-operative Supply - This is not so important where bins stay on grower's property.

Bulk Handling for Immediate Packing:

Bushel case handling is right out in this field as even when palletized it is far too slow - hence expensive. It is slow for the pickers, the carter in and the shed staff and overall, more expensive in actual container costs over a 10 year period.

For this type of handling a bulk container of some type is used. As these units stay on the property there has been little attempt to standardise, although this is preferable as it should reduce costs of each unit. It is essential where there are co-operative packing houses or where a factory takes in fruit.

There are two main types of containers -

(a) The pallet bin.
(b) The trailer bin.

(a) Pallet Bins:

These may be handled solely by fork lifts on the tractor, or on trailers where lifting in the shed is by fork-lift, travelling overhead hoist, or in one case we know of by horse on a Konaki and a conveyor skid delivery to the grader!

Bins vary considerably from about 18 loose bushels up to 40 bushels.

If too small you lose some of the benefits of reduced numbers of handlings - if too large they become cumbersome.

A bushel is approximately 1.25 cubic feet. It appears unwise with pip fruit or peaches to have bins capable of carrying more than 21" depth of fruit.

Hence each square foot of bin area will carry approximately 1.4 bushels.

∴ a 4 x 4 bin will carry 22½ bushels
and a 30 bushel bin could be 5' x 4' or 3' 6" x 6'.

Anything over 6 feet long becomes awkward in the orchard and in the shed, so that the greatest capacity which appears practical = 6' x 4' with a capacity of 34 bushels.

Bins vary in price according to the materials used and whether they are made by the grower or bought as complete units, and how much steel framing is used for them. Where they remain on the orchard no steel appears necessary, provided strong corner posts and drive in screws are used. An end binding of No 10 S.W.G. galvanized wire also improves their life. Dressed timber completely free of all knots with properly chamferred corners is essential.

The finishing surface varies a lot. I am in favour of an enamelled finish, but a bottom liner of heavy clear polythene is desirable. Raw linseed oil alone, applied each year at the end of harvest preserves the timber adequately and splinters stay soft.

It must not be used close to harvest or fruit may be affected by the oil.

Dressed Pinus radiata, preferably T and G with edges planed, makes the cheapest bins as in this country marine ply is very expensive.

The number of bins a grower should have depends on his methods of handling, climate etc. With the normal good harvesting weather in Nelson growers should aim to have sufficient bins to hold 1½ days actual shed output. If their through-put is 400 cases per day then they need 600 case equivalent in bins i.e. 20 bins of 30 bushel capacity or 6 x 100 bushel trailers.

Methods of Handling Pallet Bins:

Where orchards are reasonably level and only reasonably short distances are involved between tree and shed, forks, either single or double are all that is needed. This method also reduces the number of tractors needed as bins may be placed on the ground for pickers while the tractor is carting in or outloading packed fruit. Whereas with trailers and pallet bins or with trailer bins the tractor must stay with the unit at all times, although older and cheaper tractors may be used.

The fork lift tractor can place the bins in position in the shed either to feed the grader or in a stock pile.

Pallet bins or trailers may be handled by fork lift at the shed or by overhead travelling hoist. As a motorised hoist with the required steel rails and gantry works out to very much the same price as fork lifts fitted on the tractor and has no other use we favour the use of fork lifts. Bins on trailers too are getting rather high for pickers to fill without some damage to fruit. Therefore we favour a fork lift attachment even where bins are carried to the shed on a trailer.

I intend leaving costs until later as the whole operation, including inside the shed must be considered.

(b) Trailer Bins:

I need say little on these as all of you must have seen them. These were the first units used for bulk handling and have some advantages yet several disadvantages.

Their size varies from about 60 bushels to 100 bushels.

There is no doubt that in the orchard, and for carting in they are the easiest units to operate but they are initially expensive, do tie up at least one tractor and require quite extensive and expensive shed alterations. They also do not assist any other operations on the farm.

Before having a short break, I consider you must take in the problems of feeding fruit to the sorting table, under the heading of bulk harvesting rather than packing and grading so I'll spend a few minutes on this.

There are three main types of feeds:

1. Simple tipping of the bin - fruit flow to the grader being controlled solely by the degree of tip or the extent of the opening.

2. Tipping of the bin - and use of a pivotted hopper to start and stop the feed belt or fruit conveyor.

3. Trailer bins with a wide flat belt in a pit - the belt travel being controlled by a pivotted hopper.

Feeds above ground level are simple and cheap and require little if any shed alterations.

The pit type of feed frequently requires extensive alterations and concrete works and considerable storage space for empty and full trailers. The equipment in itself is also expensive.

What of Costs of Conversion and Actual Savings:

If I take savings first as these can be only general comments and there are variations between systems:

The savings over bushel case handling:

Increased picking rates - this can be as high as 25%.
Less carting in labour - approximately one-third of normal.
Less labour in feeding grader - approximately half of normal.
A big saving in time and effort by the grower himself in after-hours work, carting in full cases and carting out empties. (This is incalculable!).

Less fruit damage and less maintenance time.

Costs:

(a) For Pallet Bins and Fork Lift Operations:

20 bins @ £10 each	=	£ 200	
Front high lift fork	=	220	
Rear low level fork	=	12	
Shed high level conveyor with tipping feed to sorting table	=	100	
Total		£ 532	
Less other uses for fork lift	=	60	
	=	470	for an orchard producing 15,000 bushels

(b) Pallet Bins, Trailers and Chain Hoist:

20 bins @ £10	= £	200
4 trailers @ £40	=	160
Motorised hoist and rails etc	=	140
Frames to hold bins etc	=	25
	£	525

(c) Pallet Bins, Trailers and Fork Lift:

20 bins @ £10	= £	200
3 trailers @ £40	=	120
High lift fork	=	220
High level conveyor	=	100
		640
Less other uses for fork	=	60
	£	580

(d) Trailer Bins:

6 trailer bins @ £100	= £	600
Pit feed, elevator etc	=	300
Shed alterations	=	200
	£	1100

It can be seen from these approximate figures that the cheapest method to handle a crop of 15,000 bushels on a reasonably flat and compact orchard is the one using forks on the tractor.

The second most economic method and one suitable for hilly orchards or where some distance is involved is the use of trailers and a high lift on the tractor. As this also assists in outloading of packed fruit, handling case timber or fertilisers this method is preferable to the chain hoist and gantry.

Now we'll have a five minute break, then I intend to talk for a short time on shed layouts, types of grading machines and a word or two on other shed equipment. Then we will have the slides for both these lectures.

Shed Layouts:

In most sheds over 90% of the fruit is fancy grade so that a very high proportion of the fruit goes over one section of the grader and most of the new graders being installed use a Benseman or Lightning section for the lower grade fruit. This has resulted in most machines being built as single sided machines with a feed belt leading to an old section.

This change has encouraged a change in siting from the centre of the shed to placing the units against walls.

With the various containers most orchards are having to use today, the placement against the wall simplifies the supply of containers to the packers and leaves much more free space in the shed for assembly of cartons, making cases and storage of packing materials.

A word or two on our assessment of grading machines.

The Screw Type Benseman:

This is still the grader in general use and when maintained in clean condition and good mechanical order is capable of doing a very good job of sizing. It does require some method of speed adjustment as it is sometimes necessary to operate it at slow speeds as low as 96 revs per minute to grade fruit without bruising. It should never be operated above 125 revs per minute.

A limiting feature of this grader is its relatively low capacity at speeds recommended. A section can carefully size approximately 250 cases per day and this is not high enough for many medium sized sheds.

The Lightning:

Quite a lot of these graders are in use and operating reasonably. Too frequently they can cause a band of very deep bruising and because of this, which doesn't seem able to be cured, we cannot recommend it.

The capacity is high, our estimates being 600 bushels per day.

The Ansa;

Many variations of this grader have been produced. It is gentle to the fruit and has a high capacity but is difficult to operate to produce really accurate sizing.

Our estimate is 1,000 bushels per day per section.

The Boyd:

The principle is rather like a cross between the Ansa and a Lightning. It does a fairly good job of sizing and is generally easy on the fruit and has reasonably high capacity. It appears as if service is a problem.

Our estimate of capacity is 800 bushels per section per day.

At the moment in Nelson, two new types of graders are under test. While they use a similar principle in sizing they apply this principle quite differently.

This principle is deepening grooves in parallel rollers which turn through 180° or so produce a gradually increasing opening through which the fruit finally falls.

This type should result in no fruit damage during sizing.

Further trials this coming season of these machines should assist in their evaluation and prove whether production is warranted and likely to be economic.

Now a word or two on sorting tables. Generally these are far too small, being a unit manufacturers tend to shorten to keep the total grader length as short as possible.

There are four main types in use:

1. <u>The Benseman Shuffle-board Type</u>:

This is hard on the graders eyes and unless very well maintained can cause fruit damage. Its capacity is quite limited.

2. <u>The Cutler Type</u>:

Table with parallel, spirally wound rollers. Provided enough rollers are fitted this type of table seems to turn the fruit completely in the shortest distance of travel and is easy on the operator, drops leaves, spurs etc straight through.

3. <u>The Lightning Large Wooden Rollers</u>:

This is a good table turning the fruit quite well but fruit travels rather far before completing its turn.

4. <u>The Ansa and Boyd Tables</u>:

Small rollers about 8" apart, not particularly good at turning fruit, particularly flat apples and pears. Tends to accumulate rubbish and drag fruit through it. Fruit does travel rather far before completing the turn.

For general purposes the Cutler, if of four or more rollers, and the Lightning appear to be the best sorting tables.

<u>Packing Stands</u>:

The totally independent Boyd and Ansa stands appear quite satisfactory and it appears to be only individual preference which type is used.

Conveyors:

With the large long Ansa grader motorised conveyors appear desirable in the larger sheds to keep cases up to the lidder. An innovation in the prototype Benseman is to use packing stands which lower and the case can be pushed onto a conveyor sited below the bins. This leaves the rest of the shed free - saves at least 6' of width on each side, and makes the supply of packing supplies very much easier.

To summarise the effects of mechanisation and improvements to equipment, the main factors are :

Previously the labour requirements to pick and pack a crop of fruit was based on one person per 1,000 bushels production. The harvesting season was longer then by approximately 20 percent.

Today with full mechanisation, the labour requirement is one person to approximately 1,400 bushels.

In total this represents a saving of approximately 40% of the harvesting and packing labour bill.

On an orchard of 15,000 bushels this represents an annual saving of £1,000 which makes the investment in capital equipment a very attractive one.

15 people for 14 weeks (male and female)

= 210 man weeks = £2,300

becomes

11 people for 11 weeks

= 121 man weeks = £1,300

Other factors are also involved but these largely cancel each other out. The higher standards demanded and the multiplicity of packs are offset by a generally larger fruit size and increased crop per acre, and generally cleaner crops.

On top of all this is the major reduction of physical exertion. So much of the carting in and out and handling cases in the shed and carting out empties always fell to the grower outside the working hours of employees, that the season became a severe physical as well as mental strain.

These changes have considerably shortened and eased physically the growers working day. Such factors can hardly be measured in terms of money but are invaluable.

STORAGE OF APPLES AND PEARS

C.H.S. Padfield,
D.S.I.R.,
Havelock North.

We may assume that your course has reached the stage at which you have harvested a good, clean crop, without signs of obvious blemish. This crop has to be either shipped overseas or disposed of to the best advantage on the local market.

New Zealand is almost the only country in the world, where the grower's responsibility for his crop ceases at harvest. Nevertheless we all have a responsibility to the Apple and Pear Board to submit apples and pears that will keep in the best possible condition, for as long as the Board may with to store them.

The apple and pear industry in this or any other country, would be a very small affair, if these two fruits could not be cool stored for reasonably long periods. Without storage facilities only a small quantity of fruit could be economically disposed of, and it would have to be eaten in a short space of time.

The first important point is that fruits are alive at all times, whether attached to or detached from the parent tree. This can be demonstrated, because like all other living organisms, fruit respires. It uses up the oxygen (O_2) in the atmosphere, and produces carbon dioxide (CO_2) as the main product of respiration. We shall discuss this process in greater detail at a later stage in this paper.

Most of our apples and pears reach optimum harvest maturity within four to five months after blossoming. We expect to store some of our long-keeping varieties for six or seven months, sometimes a limited quantity may be held for as long as eight months. So you can see that more than half the life of an apple or pear has to be accounted for after it has been picked from the tree. We therefore expect a lot from these fruits, for, during the whole of their storage life, they exist solely on the reserves which were built up during the shorter growing period.

Fruit progressively deteriorates during storage, and eventually it dies. We can delay but we cannot prevent ultimate death. Good storage procedures retard the life processes, and so enable us to maintain fruit quality for long periods.

MATURITY:

To obtain fruit of maximum storage potential, it must be picked at optimum maturity. Because we have no precise method of measuring maturity, we have to rely on experience and a knowledge concerning local conditions in our district, and ultimately of each individual variety of apple or pear that we grow on our orchards.

The person who can devise a simple objective method of measuring harvest maturity will be a great benefactor to the fruit industry.

During storage fruit may develop a number of physiological disorders, as well as fungal and bacterial rots. If fruit is picked in an immature condition, it tends to wilt and will untimately shrivel. This wilting occurs because the skin cuticle has not been properly formed to provide an adequate transpiration barrier. Fruit picked too early will not have a good flavour or develop full juiciness, and it will never fully develop these qualities, however long you may store it. Storage should not be considered to be a ripening procedure. Other disorders that develop more readily in prematurely harvested fruit are, bitter pit, coreflush, and superficial scald.

On the other hand, if harvesting is delayed until the fruit is past its prime, another group of disorders may develop. These are internal breakdown, fungal and bacterial rots, Jonathan Spot, Deep or Soft Scald and Lentical Spot. Late picked fruit also is likely to develop Water Core. Water Core develops while the fruit is still on the tree. Most of it disappears soon after the fruit is put in store; but affected apples are more liable to develop breakdown in storage. In the case of the Delicious variety and its red spots, water core affected apples develop a mealy texture in the early stages of storage life.

Over-mature fruit softens more readily in storage, which results in a shortening of useful storage life.

For practical purposes optimum harvest maturity for most varieties probably extends over a period of several weeks. Nevertheless, each year, too much of our fruit is harvested either in an immature or over-mature condition. If harvesting operations are well planned, there is ample time to harvest each variety, so as to ensure a reasonable period of storage life.

DELAY BETWEEN HARVEST AND STORAGE:

Fruit must be delivered into storage as quickly as possible after harvest. This is a particularly important requisite for pears. A rough guide can be given about this. If apples are delayed from storage by one week, the potential storage life of such fruit will be reduced by one month. For pears <u>a delay of one day</u> can cause the same loss of storage potential, as a week's delay may cause to apples. Pears should never be delayed from storage for longer than 48 hours after harvest.

In addition to shortening storage potential, fruit delayed from storage, is more liable to develop breakdown, Superficial Scald, Deep Scald, Jonathan Spot and Fungal Rots. The effects of delay are similar to those obtained by harvesting the fruit in an over-mature condition.

FREEZING POINT AND FREEZING INJURY:

The juice of apples and pears contains organic acids and sugars in solution. These soluble solids depress the freezing point of the fruit below that of water (32°F). Most varieties have a freezing point somewhere between 28.5°F and 31°F. In order to avoid freezing injury the minimum storage temperature generally recommended for apples is 32°F and for pears 30-31°F.

It has been demonstrated that the freezing point of pears is not constant for all varieties. The freezing point of a single variety may vary according to the district in which it is grown. Seasonal conditions may also affect freezing points. For example, it has been found that the freezing point of a variety may be as low as 28.5°F in one year, but in another it may be just under 31°F. Both apples and pears showing freezing injury are generally quite unmarketable. Because of the greater risk involving pears; the Apple and Pear Board each year measures the freezing points of representative samples of all major varieties from each district. From these measurements it is possible to set a safe minimum storage temperature for the particular season.

STORAGE TEMPERATURE:

Maximum storage life can be obtained only if the fruit is cooled as rapidly as possible to the holding temperature. Again this is particularly important when handling pears. Some authorities consider the rapid cooling of pears to be more important than the elimination of the period of delay between harvesting and storage.

The rate of respiration is a measure of the life processes of fruit, and this is primarily controlled by temperature. As a general guide, the respiration rate is doubled each time the temperature rises 20°F. Thus chemical changes and vital activities proceed twice as fast at 50°F, as they do at 32°F; while a week at 90°F is equivalent to 12 weeks at 32°F. To put this in its simplest form; the higher the temperature, the shorter the storage life.

Unfortunately the reverse is not true at temperatures below 32°F. Because of the risk of freezing injury, we cannot progressively reduce the storage temperature, in the hope of indefinitely prolonging storage life.

At this point we encounter a major hazard in fruit storage practice. Some varieties of apples are more subject to injury by cold than others. This injury can be triggered off by storing a variety two degrees Fahrenheit lower than the recommended temperature. Injury can take two forms. The most important is Low Temperature Breakdown, which affects the fruit internally. The other is an external injury known as Deep Scald. This latter disorder affects only a few varieties, of which, Jonathan is the most susceptible. Because of this difference in cold susceptibility, individual apple varieties are stored at temperatures ranging from 38°F to 32°F.

The varieties which are most susceptible to low temperature breakdown are:- Ballarat, Cox's Orange, Gravenstein, Jonathan, Kidd's Orange, Statesman and Sturmer. These should not be stored below 36°F. The next group which are only moderately cold shy are:- Cleopatra, Dunn's Seedling, both Frimley and Rome Beauty and Worcester Permain if it is still grown. The optimum temperature range for this group is 34°F - 36°F. More resistant still are:- Dougherty, Golden Delicious, Lord Wolesley, Rokewood and Stayman's Winesap. For them the recommended temperature is 32°F - 34°F. It is worthy of note that Golden Delicious apples can sometimes develop severe Deep Scald when stored at 31°F., particularly if they have to withstand this temperature during the early part of the storage period.

The varieties most resistant to cold injury are Delicious and the coloured Delicious types, Democrat and Granny Smith. Recent experimental results have shown that Delicious types can be stored with pears, provided they are subjected to regular inspection from September onwards. Granny Smith can be stored at 31°F.

COMPROMISE BETWEEN TEMPERATURE AND VARIETY:

You may ask how the numerous varieties of apples can be successfully stored according to their temperature requirements in the two-chamber cool stores, which the Apple and Pear Board operate? Even more pertinent, how can the orchardist, with only one cool room, successfully store the wide range of varieties that he grows on this orchard? The temperatures that have been given are those considered to be optimum for each variety. If more than one variety is stored, a compromise must be made. Storage temperature should always favour the most cold susceptible variety that has to be stored. Storing the more hardy varieties at a slightly higher temperature may cause more rapid softening of the flesh, and yellowing of the skin ground-colour. The storage life of these varieties may also be shortened. This is preferable to the probably total loss of the more cold susceptible variety from low temperature breakdown. Such disasters have happened.

HUMIDITY:

Humidity conditions in the store can also affect the out turn of fruit. Ideal conditions of humidity are generally harder to achieve than those of temperature. The two factors are of course inter-related. Once a store is operating there is little that can be done to alter conditions of humidity. The degree of humidification achieved in a fruit store, is a direct reflection of the quality of storage construction and of the refrigeration installation.

A humidity of 85 to 90 per cent is desirable. Humidity is governed by the type and size of the cooling unit. Where low humidities prevail, insufficient evaporating surface has been provided. In such chambers there will be big temperature differences between the cooling coils and the fruit. This results in excessive moisture being deposited on the coils in the form of ice. The situation becomes worse the longer the fruit is stored under such conditions. In such cases, the evaporation needs defrosting more often, causing considerable and undesirable fluctuations of storage temperature. This ice which is water extracted from your fruit can cause considerable shrivelling and loss of fruit weight. It is well to remember that when you defrost the evaporator, you can literally see money flowing down the drain.

It is imperative that you obtain the best possible engineering advice before you build a fruit cool store. In D.S.I.R. we have Mr Foster of the Auckland Industrial Development Division, who can give independant advice on this matter.

Really high humidities, that is those over 90 per cent, can also be hazardous to fruit. Fortunately such conditions are less frequently encountered than are those of low humidity. Excessively high humidity can increase the liability of the fruit to develop break-down. High humidity can also cause fruit splitting, by creating conditions of high turgidity within the fruit. It also favours rapid development of fungal rots.

CONTROLLED ATMOSPHERE STORAGE (C.A.):

The remaining factor that can be controlled in the store is the composition of the atmosphere. When this is done, the fruit can be held in almost tree-fresh condition for very long periods. Such fruit also has a longer shelf-life after storage, than fruit held in a conventional cool store.

Controlled atmosphere stores are generally lined with sheet metal, with all joints and seams made suitably gas-tight. When the door is closed, the chamber contains a constant volume of atmosphere. This can then be manipulated to obtain the required levels of CO_2 and O_2.

Mention was made earlier that each fruit is a living entity, and that it respires. We can use respiration to control the composition of the storage atmosphere.

Normal air contains 79 per cent of nitrogen. As this does not support life, it need concern us no further. The remaining 21 per cent is Oxygen (O_2). During respiration the quantity of carbon dioxide (CO_2) produced, is equal to the volume of O_2 respired. For example if fruit in a gas-tight chamber respires 5 per cent of the O_2, contained in the room, 5 per cent of CO_2 is produced. The atmosphere would then contain 5 per cent of CO_2 and 16 per cent of O_2. This is the basis of controlled atmosphere storage (C.A.).

If the respiration of the fruit is allowed to continue without interference, we shall eventually have an atmosphere that contains no O_2 and 21 per cent of CO_2. This must never be allowed to happen. If it does the fruit will undergo anaerobic respiration, which will cause undesirable physiological changes, and it will soon die. Before death occurs the fruit will develop both an offensive odour and flavour. The flesh will turn brown and large interior cracks may develop. Sometimes unusual depressions or undulations may appear on the skin. These areas either remain a darker green than the rest of the apple or they may turn dark-brown.

There are a few varieties of apples and pears that can tolerate 10 per cent of CO_2. Some will tolerate between seven and eight per cent. The majority can only tolerate between 2.5 and 5 per cent.

In the most simple type of C.A. Store, the conditions are modified by periodic ventilation. If an atmosphere of 5 per cent of CO_2 is required, the concentration is allowed to build up until it reaches about 5.5 per cent. The chamber is then ventilated with air, by opening a port in the wall of the chamber. Ventilation continues until the CO_2 content is reduced to 4.5 per cent, when the port is closed. This procedure is repeated as required throughout the storage period. Replacement oxygen to enable respiration to continue is automatically replenished during periods of ventilation.

Ventilation is not required until the O_2 level falls slightly below the specified requirement for the variety being stored. This initial pull-down period may take several weeks. The shorter this period is and the sooner conditions are stabilised the better the ultimate out-turn of the fruit will be. Quick pull-down of O_2 ensures the longest possible storage period. Once the storage atmosphere becomes stabilised, daily ventilation will probably be required. As time progresses and the rate of respiration falls off, ventilation will be required less frequently. No hard and fast rule can be applied. The performance of every C.A. store differs, therefore the operator must be guided by local conditions.

The CO_2 and O_2 content of the storage atmosphere is obtained by regular analyses. These analyses decide the ventilation programme. Various types of apparatus are available for conducting these analyses. Some are highly sophisticated, automatic instruments. The hand operated ovsat gas analyser will do the job quite satisfactorily. Running a controlled atmosphere store is as binding as a cow farm. You must be on deck for part of each day, seven days a week, over the whole period during which the fruit is stored. The fruit will tolerate slight fluctuations in the storage atmosphere, but for best results both CO_2 and O_2 levels must be rigidly controlled.

Simple ventilated atmospheres similar to the one described are seldom used these days. Every year millions of bushels of apples and a lesser quantity of pears are stored in Europe and North America in very low levels of CO_2 and O_2. It has been found that if O_2 can be reduced to the lowest possible level at which normal respiration can proceed, storage life can be prolonged and fruit quality maintained for even longer periods. O_2 levels must never fall below 2 per cent, otherwise severe fruit damage may occur. CO_2 is generally maintained at between 2 and 3 per cent. Recommendations originating in America and Australia suggest that some varieties store best in an atmosphere containing three per cent of O_2, and from which CO_2 has been completely eliminated.

It is inevitable that when these low O_2 levels are stipulated, CO_2 in excess of requirements will be produced. This excess has to be removed from the atmosphere by chemical means. The procedure is known as "scrubbing". There are several methods of carrying out this operation.

1. The atmosphere may be blown through or caused to come in contact with a solution of caustic soda. This is a very messy method. It is likely to create corrosion problems with the metal parts of the store. There is always a risk of personal injury to the operator. Large quantities of caustic soda are required, making for high operating costs. Disposal of the spent caustic soda solution can also be a problem.

2. Another method is to blow the atmosphere through a water spray inside the storage chamber. It so happens that CO_2 is more readily dissolved in cold water. The conditions in the cool-store help this situation. After "scrubbing", the CO_2 saturated water is aerated at atmospheric temperature, when the dissolved CO_2 will be released to the atmosphere. The water can then be recirculated and recooled in the store.

   Under this system "scrubbing" can be organised as a continuous process. This method has become popular in the eastern U.S.A.

3. More recently hydrated lime has been used for "scrubbing". CO_2 and hydrated lime have great affinity for each other. So great in fact, that when bags of hydrated lime are placed in the "scrubber", there is no need to open them. A few holes punched in a multi-wall paper bag is all that is required. The "scrubber" is a separate airtight container, through which the atmosphere is allowed to diffuse, and then return to the fruit chamber. Rate of diffusion can be controlled by a valve in one of the connecting pipes between store and "scrubber". One pound of hydrated lime is required for each bushel of apples stored over a six-month period.

   This last method has the advantage that the "scrubber" can be easily isolated from the store. If the lime becomes "spent" the scrubber can be recharged with fresh material. The operator knows when replacement is required because the CO_2 content of the storage atmosphere starts to rise. This becomes evident from the log of the daily analyses of the storage atmosphere. This is the most simple, as well as the cheapest and cleanest method of "scrubbing" devised to date.

4. In North America several types of chemical engineering systems have been developed for producing "instant" C.A. These employ burners that lower the level of O_2, by combustion. Patented "scrubbing" devices are included to maintain the correct CO_2 level. As the main product of combustion is CO_2, some of this can be used to maintain the CO_2 level in the chamber. When these machines are used, the natural respiration of the fruit plays practically no part in the creation of the storage atmosphere. These machines are generally leased to the storage operator, and the rentals are high. Running costs, particularly in fuel and electricity are not cheap. Propane is the fuel most generally used in the burners.

   The advantages claimed for these devices are :

1. The chamber does not need to be as gas-tight as when the natural respiration of the fruit is used to develop the atmosphere.

2. The required atmosphere can be imposed on the fruit almost immediately after closure of the chamber. There is no extended period of pull-down of oxygen, which is inevitable when the natural respiration of the fruit is used to regulate the atmosphere.

3. The system can be stopped and the chamber entered at any time during the storage period, for the removal of fruit and to conduct servicing operations. This is not possible when the atmosphere is controlled by fruit respiration. It is, however, recommended that chambers should not be opened more frequently than once a month.

4. After a store has been opened, the required atmosphere can be re-imposed within a few hours after re-starting the machine.

5. A stricter control of atmosphere can be maintained.

6. The required atmosphere can be maintained in a partially filled room. This is virtually impossible to achieve, when natural respiration is used to maintain the atmosphere. However, it must be realised that it will be necessary to run the machine for longer periods, as the volume of free air in the chamber increases. Thus running costs will increase after each removal of fruit, if the correct atmosphere is to be maintained.

The first experiments with C.A. Storage in New Zealand were undertaken in 1937. Several attempts have been made in the last 30 years to interest the fruit industry in this method of storage. This year the Apple and Pear Board is holding the first commercial quantity of apples under C.A. storage. There are between two and three thousand bushels of Golden Delicious enjoying a controlled atmosphere in Hastings. At present there are no permanent C.A. chambers in the country. We have built a gas-tight, plastic, film tent, which is connected to a hydrated-lime "scrubber" unit. We hope that these apples will remain in good condition, in this tent, until early December, when they will be released for the pre-Christmas market. Golden Delicious stored in a conventional cool store are generally not available after August.

As a result of our experimental work in New Zealand, several apple varieties have been shown to be suitable for holding in C.A. storage. Those that can be recommended are Dougherty, Golden Delicious, Sturmer, Rome and Frimley Beauty, and with certain reservations, Jonathan. Unfortunately, we have had no success in our efforts to store either Delicious or Granny Smith in C.A. storage. A lot more experimental work is necessary. None is currently being undertaken.

POLYETHYLENE FILM:

Although C.A. storage has not yet found a permanent place in the New Zealand fruit industry, we have been able to employ a modification of this process in our storage procedure. This has been achieved by the use of case liners, in the form of sealed polyethylene bags. These can be used in both wooden boxes and cardboard cartons. The film is one and a half thousandth of an inch thick. (1.5 ml). Several firms manufacture these bags. The Fruitgrowers' Federation stock them.

The value of these bags depends on their differential permeability to CO_2 and O_2. They are more permeable to CO_2 than to O_2. Also they prevent loss of moisture from the fruit. They can be used for two purposes; the prevention of wilt and for the creation of an individual modified atmosphere in each package of fruit. These bags are being extensively used in the storage of both Golden Delicious and Sturmer. You will have noted that both these varieties are recommended for C.A. storage. Both are also highly wilt susceptible.

People who own their own cool stores and have an extensive private trade, will find that they can market a superior article by using these film-bags for both these varieties. Storage life can be prolonged until late in the year, with the result that a juicier, crisper apple can be offered to the customer. Best results are obtained if the fruit is pre-cooled before it is packed into the bags, which should be done as soon as possible after harvest. Sturmers stored in sealed polyethylene bags have been known to develop "brownheart". One pound of fresh hydrated lime can be inserted in each bag before it is sealed, as an insurance against "brownheart" development. To avoid mess the hydrated lime can be sealed into an ordinary brown paper retail bag. "Brownheart" is caused by the accumulation of CO_2 in the storage atmosphere.

Closure of the film bags can be made in three ways:-

1. By heat-sealing the open edges of the bag. This operation is difficult, unless a special hot-iron sealing machine is used.

2. By means of a tight rubber ring. The thick insulating ring is ideal for this purpose.

3. By folding the over-laps of the bag in an envelope pattern. The loose folds are held in place by pressure when the box is lidded.

One precaution must be taken. Immediately the package is removed from the cool store to air temperature, a hole must be made in the bag.

As explained earlier, the respiration rate increases as the temperature rises. The hole prevents the accumulation of CO_2 which might cause fruit browning, as well as "off" flavour and odours.

<u>CONCLUSION</u>:

Finally, I would like to stress, that the final quality of the fruit you sell, will be governed by its original quality prior to storage. Also, it will reflect the care or neglect with which it was treated during storage. Remember that all stored fruit deteriorates to a greater or lesser degree. A poor apple can never become a better apple, even when stored under the best possible conditions.

Apples showing visible defects such as abrasions, severe bruising, insect damage, stem and finger-nail punctures and excess russet should never be considered for long-storage. Immature and over-mature fruit must be watched for the development of storage disorders and disposed of immediately these start to appear. From time to time remove small inspection samples of each lot of fruit held in storage. Hold these at air temperature for about 7 to 10 days, before inspecting them for signs of the development of physiological disorders and general deterioration. At the first sign of any deterioration, market the fruit immediately. All forms of senescent deterioration will only increase with passage of time. Only good quality fruit stored while taking all the necessary precautions, can be expected to retain reasonable quality after prolonged storage.

Weed Control in Orchards and Berry Fruit Plantings

F. Allen,
Department of Agriculture,
Lincoln,

With judicious use of chemicals unwanted vegetation in pip, stone, citrus, berry and small fruit orchards can be controlled or eliminated with minimal use of cultivation or hand weeding. Long-term overseas work indicates that fruit yield is maintained or increased by these methods.

Several chemicals of differing properties are available. They may be used alone or in combination to produce desired effects.

Paraquat burns off all top growth and is particularly effective for killing small annual weeds and non-twitching grasses. Perennial weeds will regrow from crowns and rhizomes. It is inactivated on the soil surface and thus cannot affect later germinating weeds or be absorbed by tree roots. It can damage soft, green bark so that care is needed in application.

Diquat is similar in action to paraquat, is cheaper but much less effective against grassy weeds.

Weedazol TL is absorbed into the plant and moves through the sap stream. Pimatos is very suitable for perennial weeds such as twitch grasses, Californian thistle and docks. It will kill or damage most plants at the rates of application recommended, so must be applied carefully at the time and rates recommended. It must not be used in raspberry or related fruit plantings.

Simazine is root absorbed, will persist in the soil for a varying length of time and at low rates will kill seedlings as they germinate without harming established perennials. At recommended rates of application, which vary with the soil type, breakdown of simazine in the soil prevents the build-up following repeat applications, of levels harmful to the fruit plants.

When initiating a chemical control programme obtain all available information and be certain to read the product's label, with particular reference to precautions, before commencing operations.

Principles of Orchard Fertilising

E.G. Bollard, Fruit Research Division, D.S.I.R.

There are certain factors which must always be kept in mind when considering orchard fertilising:

(a) The soil always supplies some nutrients. The function of fertilisers is simply to augment the supply from the soil.

(b) The same crop is in the ground year after year. No rotation of crops is possible and this may tend to accentuate natural deficiencies.

(c) Cover crops or permanent grass are usually grown in the orchard and these will affect nutrient availability. Use of legumes will result in significant nitrogen fixation.

(d) Fruit trees are perennial plants and substantial amounts of nutrients are carried over in the tissues from one year till the next.

(e) Young trees making vegetative growth may have different nutrient requirements from mature trees in full cropping.

The practical questions which must always be answered are :

(i) What particular nutrients are required? Different methods are available but the one with greatest application is leaf analysis carried out on leaf samples collected in a quite specific way.

(ii) What particular fertilisers will be used to supply these requirements? The commercially available fertilisers were discussed.

(iii) How should these be applied? There is no evidence that particular placement of fertilisers is preferable to general broadcasting.

(iv) When should fertilisers be applied? The traditional time of application is in the spring but recent ideas on summer and autumn applications were discussed with reference to New Zealand conditions.

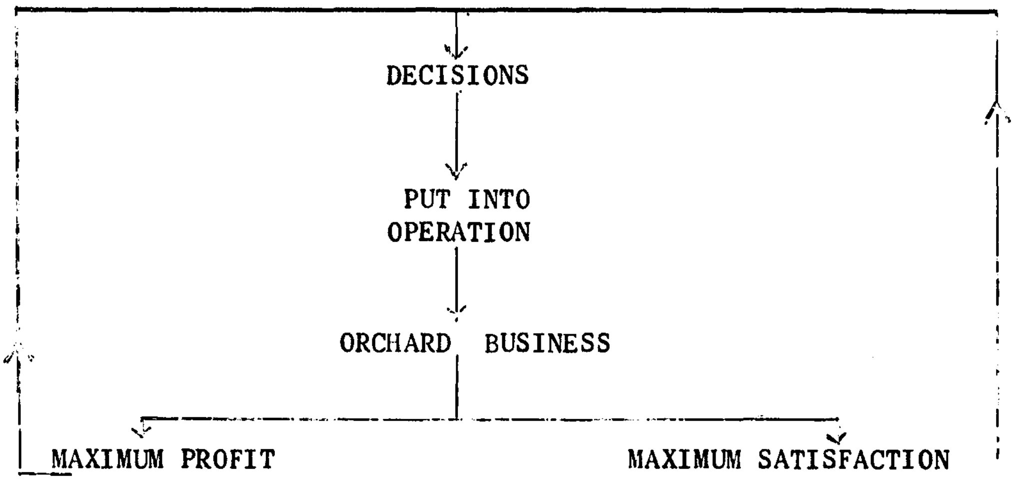
As a conclusion the basis of our present understanding of the causes of bitter pit were discussed, with particular reference to the natural supply of calcium in the tree and the ability of sprays of calcium nitrate to reduce the incidence of this disorder.

Orchard Management

W. Foster,
Department of Agriculture,
Wellington.

Orchard management can be defined as the decision-making involved in the operation of the orchard business using economics in its broadest sense and aimed at maximising satisfaction. Or more simply - the orchardist's job is to decide how to use what he has to get what he wants and to give him the greatest return.

Both definitions have similar key words - "decisions" - "to decide"; "operation" - "to use"; "orchard business" - "what he has"; "economics" - "greatest return"; "satisfaction" - "what he wants". The management process can therefore be summarised as -



The orchard business consists of resources - land, labour and capital. The resources are used by the producer in such a way as to cope with problems of risk and uncertainty, technicality, the ability and objectives of the producer to produce a maximum net return or in other words economic principles.

Management is nothing new - primary producers have been doing it for years and doing it successfully. What is new is that it has emerged as an entity into itself and in the course of doing so we have been able to get a better grasp of all the facets of production. Through doing this plus the development of management techniques we can make better decisions - the all important part of management.

In order to achieve better management we must have facts - both technical and financial. There is no question that technical facts - and new technical ideas affecting orcharding are well catered for. However, some physical facts - particularly those concerning labour imports are not so well established. Similarly financial facts are neglected. In order to assist with the decision-making or planning in orchard management we must have these facts.

To assist this the orchardist must be prepared to reward information - both physical and financial. Once we have this we can use it to assist the producer to make better decisions more easily. By doing this we will increase his satisfaction and his profits.

Dams in Orchards

T. Heiler,
Agricultural Engineering Institute,
Lincoln College.

An introductory period was spent describing various types of earth dams and dam terminology. This lead on to the concept of a "good" storage site and the storage - excavation ratio. Soil types suitable for dam construction.

The problem of catchment area - how big to provide enough yield to justify a storage of a certain size, but an introduction to the problems of large catchment areas and associated spillway problems.

Purposes of an earth storage - stock, irrigation, domestic and special purposes. The order of demands for various types of application was explained with a view to establishing the right ideas on storage magnitudes. The use of a storage capacity curve to take account of evaporation losses in relation to withdrawals was introduced.

Brief discussion on special requirements of dams in orchards.

Finally, a last look at dam failures and what causes them. Prevention of seepage losses and evaporation.

Genetics and Plant Breeding

L. Watts,
D.S.I.R.,
Lincoln.

Genetic principles

A knowledge of genetics is essential for the successful breeding of plants; the basic techniques are similar whether one is breeding improved varieties of strawberries, cabbage, apples or chrysanthemums.

All organisms are composed of cells which contain the hereditary materials, chromosomes and genes. Genes control the expression of characters e.g. whether a peach is furry or smooth. The basic chromosome number of each cell is the same throughout the plant or variety although most species and some varieties possess different numbers from one another. Thus, peaches and sweet cherries have 16 chromosomes, while apples have 34, 51 or 68.

In order to maintain the basic number of chromosomes from generation to generation the pollen grains and immature seeds (or ovules) are formed with only half the normal complement. When fertilisation takes place the resulting seed is of the correct chromosome constitution.

So, in a 34 chromosome apple variety there is a reduction division at flowering to give 17 chromosomes per pollen grain and ovule. These combine to restore the number to 34. It is evident that varieties must have an even number of chromosomes to be able to produce fertile seed and ovules so that apple varieties with 51 chromosomes for example are unsuitable for breeding work. Gravenstein is of this type.

Fruit breeding

Apples

About 85 per cent of the common varieties have 34 chromosomes (diploid constitution) while 15 per cent have 51 (triploid constitution). Triploids will set seed if pollinated by other triploids but seedlings from 'pips' will show very poor growth. Triploid varieties set seed and fruit better if inter-planted with diploids for pollinators. For all varieties a 5 percent set of the great number of flowers produced gives a reasonable fruit yield. When the fruit crop is heavy, those with less than three seeds tend to fall off.

Peaches and apricots

Peach crosses readily with nectarine to give fertile progeny.

Peach crosses readily with almond but gives sterile progeny.

Peach x Apricot and Apricot x Almond have been made but are not easy.

Apricot crosses readily with plum but is most successful when the plum is used as female parent.

Early varieties of peaches produce few good seeds (although the fruit is good) and should only be used as male parents in crosses.

Blackcurrants

This crop has very high export potential, particularly as juice, and increased areas should be grown. Harvesting can be carried out by machine by removing the fruiting wood in part of the plantation in alternate years and bushes would need to be replanted every eight years or so.

High yields of fruit appear to be related to high yields of seed.

Crosses between red and blackcurrant are being made overseas to give longer, better filled strigs.

Hybrids of black x red or black x gooseberry do not have the characteristic foliage smell.

Rootstocks

All plants within a top fruit variety are genetically identical because they have been propagated on to root stocks from a single plant. Rootstocks are used for rapid multiplication of good material and because they can control the performance of the scion to some extent. For example, pear on pear gives large, vigorous trees but pear on quince gives smaller and earlier fruiting trees. In general, fruit from the former is drier and more gritty than that from the latter.

Seed of triploid apples is quite unsuitable for rootstock production.

Peach grows best on a peach rootstock.

Apricot on apricot forms large trees with good unions.

Apricot on Peach makes smaller trees with earlier maturing fruit.

Weather Forecasting

J. Hunter,
Meteorological Service,
Christchurch.

With the object of encouraging an informed use by fruitgrowers of the published weather maps and forecasts, the lectures in Meteorology concentrated on a description of the method used to produce a forecast, under the four headings :

(i) Making, receiving and plotting simultaneous weather observations,

(ii) Analysing the weather map to obtain a picture of the present state of the atmosphere and its motion.

(iii) Projecting the analysis into the future, and the methods used to do this, including numerical methods with the aid of a computer.

(iv) Translation of the expected situation into a simple statement of expected weather.

Other topics touched on briefly were extended-range forecasting, frost forecasting, the incidence of thunderstorms and hail, etc.

INTRODUCTION AND ASSESSMENT OF BERRY FRUIT VARIETIES

L.A. Porter,
Department of Agriculture,
Levin.

Source of New Varieties

New Zealand: Some local amateurs produce new varieties and odd seedlings appear. There is no systematic breeding and it is doubtful whether an area of 1200 really warrants it.

Overseas: U.S.A. (especially California, Oregon, Washington)
Canada (especially British Columbia)
Britain (others Germany, Holland, Australia)

Method of Selection of Overseas Varieties:

Descriptions in literature are followed up by making contact with authors, who are usually very co-operative. The contacts and others are made through visitors to New Zealand or New Zealand people going overseas, usually keeping in contact and provide prior information on up and coming varieties. The biggest difficulty here is that very little reciprocal trading is possible.

Process of Introduction:

1. Requests made to overseas breeders and research establishments.

2. Plant quarantine permit obtained.

3. Post-entry receipt - *Rubus* and *Ribes* to P.D.D., *Fragaria* to Levin HRC direct.

4. Post-entry establishment, virus indexing and observations for other diseases and pests.

5. Post-quarantine propagation.

Evaluation Trials:

1. Initial Trials: small numbers involved to enable sorting out those for bulking up and yield trials.

2. Yield Trials: replicated, and large enough to supply fruit for more detailed examination, and possibly for evaluation for processing.

3. Re-evaluation Trials: sometimes a variety may need a further evaluation e.g. a variety may be susceptible to a disease for which an easy control is recently found.

Evaluation of Berry fruit varieties:

Yields: 1st season : 2nd season

1. Plant characteristics: habit size : disease and pest susceptibility.

2. Fruiting characteristics: yields, presentation of fruit, season, ease of harvesting, evenness of ripening, holding on plant.

Fruit: shape, firmness, disease susceptibility, colour of skin, colour of flesh, susceptibility to rain, suitability for processing, size of fruit, seediness, vitamin C content, soluble solids, acidity, flavour.

Difficulties in Evaluation:

1. Seasons vary.

2. Conditions for occurrence of pests and diseases vary.

3. Different cultural methods can have large effects differently on different varieties e.g. mulching materials, deblossoming fertilizers, setting dates, pruning, training, spacing.

4. Readiness-for-harvesting varies between some varieties e.g. culinary gooseberries, and strawberries.

Evaluation for Districts:

New Zealand has a surprising range of climate and latitude. District trials have been run but it seems that the best method is to try and have an early release to growers of those showing some promise at Levin HRC.

VARIETIES EVALUATED OR BEING EVALUATED OVER THE PAST DECADE

Strawberries: Auchincruive Climax; Shasta; Lassen; Klondike; Klonmore; Talisman; Redstar; Armore; Robinson (Scarlet Beauty); Merton Princess; Cambridge Favourite; Blakemore; Midland; Sure Crop; Cambridge Vigour; Early Cambridge; Catskill; Redgauntlet; Sparkle (Paymaster); Earlidawn; Missionary; Tennesse Beauty; Empire; Orland; Vermillion: Fairfax; Pocahontas; Solana; Florida Ninety; Redglow; Stewarts; Chapmans; Siletz; North West; Senga Sengana; Trumpeter; Marshall; Captain Cook; Bedford; New York 386; Fletcher; Molalla; Wiltguard; Dixieland; Lihama; Midway; Geneva; Vola; Gorella; Cascade; Columbia; Jerseybelle; Kendal; Torrey; Fresno; Fortune Regina; Cyclone; Christopher York; Frontenac; Cavalier; Grenadier; Guardsman; Templar; Tioga; Hood; Crusader.

Raspberry: Marcy; Taylor; Lloyd George; Malling Promise; M. Exploit; M. Enterprise; M. Jewel; Norfolk Giant; Boyne Killarney; Fairview; Bunnetholm Seedling; Clyde (purple); Munger (black cap); Willamette; Canby; Sumner. Oregan S.U. Seedlings (3).

Bramble: Various New Zealand strains of boysenberry and loganberry, L.Y. 59 loganberry; Darrow; Raven; Aurora Marion.

Blackcurrant: Goliath; Cotswald Cross; Climax; Magnus; Lantons Giant; Wellington XXX; Westwick Triumph; Bayliss Late; Kentish Hero; Amos Black; Tor Cross; Silvergeiters Black; Late Goliath; Harrows; Daniels; September Black.

Redcurrant: Southwell; Amgot; La Versailles; Redlake.

Whitecurrant: Davidsons; Gondouin.

Gooseberry: Farmers Glory *

Roaring Lion * Crown Bob* Green Overall; Gregories Perfection* Yorkshire Champion; Billy Dean; Levin Early (originally an early Farmers Glory); Leveller.

* Selected from various strains collected in New Zealand

Blueberry: Seedlings (seed from Michigan)
Atlantic, Burlington, Jersey, Stanley, Walker.

MAINTENANCE OF NUCLEAR BERRYFRUIT STOCK

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Department of Agriculture,
Levin.

NUCLEAR STOCK

Nuclear stock plants of a particular variety are the few plants from which are made the initial propagations of a series in a bulking up programme.

Because successive propagations in such a programme involve progressively larger populations of plants, the chances of disease and pest incidence must increase. It thus follows that Nuclear Stock must be as near as possible to completely healthy if the ultimate fruiting plants are to have a chance of being reasonably healthy. Nuclear Stock plants must be free of insects, mites, nematodes, fungus diseases and virus diseases. Of these, virus diseases, because of their nature, are the most difficult to control.

DEVELOPMENT OF THE NUCLEAR STOCK UNIT AT LEVIN HRC.

Some nine years ago the need for a source of reliable propagation stock of berry fruits in New Zealand was realised.

Shortly after this a small glasshouse and screenhouse were erected at Levin HRC to initiate the project of obtaining and maintaining Nuclear Stock, particularly of strawberries. Since then work has commenced on Rubus and Ribes varieties.

ESSENTIALS OF THE NUCLEAR STOCK UNIT

The design of the Unit was dictated mainly by the rather elaborate measures needed for prevention of viruses. As aphides are the main vectors, and certainly the most mobile, the unit must be insect proof.

Basically the Unit is an insect-proof enclosure with provision for the introduction holding, propagating and improvement of Nuclear Stock.

The simplest need is a screenhouse in which plants are grown under conditions very much the same as outdoors. The addition of glasshouse space allows virus indexing and propagation to proceed throughout the year.

A heat cabinet and room for this is needed to produce virus-free plants.

A service shed is also necessary to allow room for many of the operations involved with virus indexing and plant production.

DESCRIPTION OF THE LEVIN HRC NUCLEAR STOCK UNIT

Glasshouse: insect proofed with "Tygan" gauge (24 x 24); complete with heating, manual and automatic fan ventilation, supplementary lighting, propagation facilities, electricity and water.

Screenhouses: simple construction and covered with insect proof "Tygan" gauge.

Service Shed: also insect proof, with benches, sink etc. and facilities for storage of soil, pots etc. and keeping records.

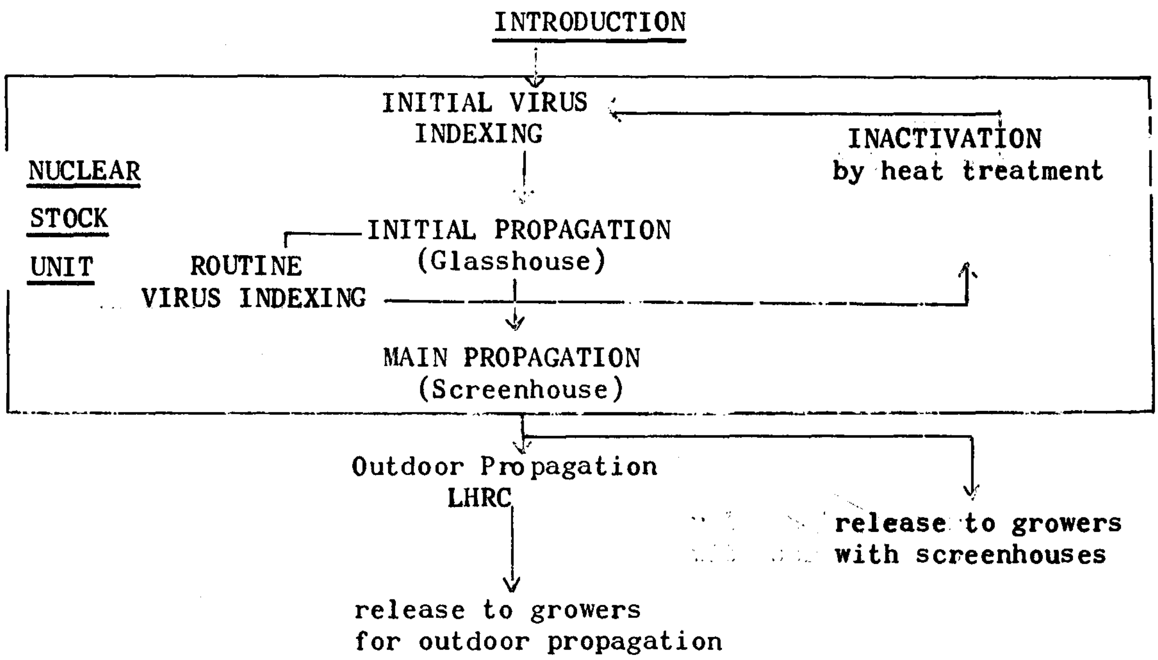
Insect lock: essential to aid in keeping out insects.

General: spraying gear, is essential; semi automatic watering and misting aids maintenance of plants.

Heat Cabinet: this is a box which is double glazed on top and sides and heated by incandescent electric light globes and illuminated by fluorescent tubes. It is situated in a heat insulated room which is heated to a few degrees below that in the cabinet so as to buffer it from outside temperature changes.

OUTLINE OF MAINTENANCE OF VIRUS FREE STOCK:

In general this is as follows :



VIRUS INDEXING METHODS:

Basically the various techniques are simply methods of transferring viruses from a donor (variety) to an indicator plant which shows the virus symptoms in a constant manner.

Strawberry Indicators: Fragaria vesea clones

e.g. Alpine (non-runnering);
EMC (has latent-A;
Shows mottle, and veinbanding and latent -C);
U.C.I. (shows crinkle and mild yellow edge);
EMK (No latent -A);

Methods: Grafting by inserted leaf (or excused leaf petiole); inserted petiole sliver; stolons; stolon plants.

Rubus (Raspberry and Bramble)

Indicators: Rubus henryi
Rubus occidentalis
Varieties "Munger" and "Plum Farmer"
Selected variety seedlings, and varieties.

Methods: approach grafting; bottle grafting.

Ribes (Gooseberry and Currant)

Indicators: Selected seedlings

Method: approach grafting; bottle grafting; tip grafting.

Aphid transmission - not yet tried at Levin HRC as facilities to date have not been available.

Transmission to herbaceous indicators - such as Chenopodium guinoa and C. amaranticolor will be used when facilities are improved.

Difficulties:

1. Uncertainty of virus transmission. Though a graft may take we can never be sure that the virus has been transmitted. Repeated indexing is needed.

2. Complicating pseudo - virus - symptoms such as chlorotic and necrotic spots and discolourings and distortion following some applications of therapeutants.

3. Heat spot.

4. Tip burn from previous water stress and heat.

5. The difficulty of reading symptoms.

The Main Viruses Expected

Strawberries
1. Mottle
2. Mild Yellow Edge
3. Crinkle
4. Vein chlrosis
5. Leaf curl (i.e. virus latent -A + vein banding)

Rubus	1. Mosaic	2. Leaf mottle
	3. Stunt	4. Vein chlorosis
Ribes	1. Reversion	2. Yellowing
	3. Vein banding	

HEAT TREATMENT

Not all viruses can be eliminated by heat but as techniques improve more virus are being inactivated. The general theory is that if a virus is inactivated by heat it recovers from it slower than the plant.

Technique.

The plants are submitted for as long as possible without killing them, to a temperature of $37^{\circ} \pm 1^{\circ}C$. Mottle (strawberry) is inactivated in between 2 and 3 weeks. Other viruses may require months. The difficulty is to keep the plant alive, while this inactivation is going on.

Heat Cabinet: the cabinet room is kept at about $34^{\circ}C$ while the cabinet is at $36.5 \pm .3^{\circ}C$. Heating via light globes has enabled us to hold temperatures very steady while the heated room has considerably reduced differential across the cabinet.

Propagation Following Heat Treatment:

Following heat treatment the plants are encouraged to produce new growths from axilliary buds as soon as possible. These growths are removed when large enough to handle, and set in a mist propagation box. Subsequent plants are indexed with the hope that at least some are free from virus.

OTHER DISEASES OF SPECIAL CONCERN

Redcore - (always a potential trouble). Verticillium wilt Transient or June Yellows, Mildew.

PESTS OF SPECIAL CONCERN

Aphides (virus vectors), mites (two spotted), eriophyd mites, foliage nematodes, soil nematodes, weevils.

THERAPEUTANTS

Disyston and dematon-s-methyl (against mites and aphides) and endrin (against general insects) are used regularly. Sulphane or karathane or pipron are used against mildew in spring, summer and autumn, while thiram is used against botrytis in the winter.

SCHEME FOR SPECIAL RELEASE OF STRAWBERRY STOCK TO GROWERS:

We are now prepared to release up to five foundation plants of any variety we have to growers who have screenhouse facilities and who are prepared to maintain adequate precautions against re-infection by virus.

It is hoped that these nurserymen will eventually grow and sell healthier plants with resultant benefit to the industry.

The Commercial Firm

G.N. Paulin,
Ivon Watkins-Dow Ltd.,
New Plymouth.

G.N. Paulin, Technical Officer Horticulture of Ivon Watkins-Dow explained the profit motive of a chemical company as the incentive, common to all efficient businesses, to provide the customer with high quality products with a competitive price, to give technical service and allow reserves for efficient research and development. The search for new chemicals to improve the effectiveness and range of established ones and to tackle unsolved problems is always on. This means long-term planning and budgeting not only for finance, plant and buildings, but highly trained staff.

For users of agricultural chemicals, especially specialized growers such as orchardists, technical advice is considered necessary and is always available to supplement bulletins and label instructions, which have to meet Agricultural Chemical Board requirements. Chemical companies, he indicated, are not likely to risk the success of a modern product which takes five years to get to the market and cost $2m in the process to be misused in the want of expert advice.

Mr Paulin also discussed and demonstrated the good and bad points of wettable powders and emulsifiable concentrates.
