BULLETINS FOR FRUIT GROWERS

BLACK CURRANT REVERSION DISEASE*

By J. M. THRESH

Early this century horticulturists in Britain and Holland reported that normal black currants gradually changed completely in character and became unproductive. Such bushes were said to ' revert ' to the character of a wild ancestral type and the condition became known as ' reversion '. Affected bushes became so common that the phenomenon was investigated in some of the earliest research at the Long Ashton and East Malling research stations, and this established that reversion was a virus disease.

The appearance and spread of reversion was closely associated with the distribution of the black currant gall mite, *Phytoptus ribis* Nal. Later work has confirmed that the gall mite is the natural vector of the disease. The mites also directly damage black currant buds, which become galled, fail to flower and frequently turn into ' big buds '.

Reversion remains the most important disease affecting black currants and is probably one of the major reasons for the poor national average yield of 30-40 cwt per acre. Infection is commo in nursery stocks and is widespread in plantations. Crop losses increase as infection spreads and whol plantations may have to be grubbed prematurely. Moreover, growers have additional expenses in finding, removing and replacing infected bushes and in attempting to control the black currant gall mite. These expenses become particularly important when market prices are low.

The symptoms of reversion

Many factors other than reversion can cause the black currant crop to fail and specific features affecting the flowers and leaves must be used in diagnosis.

The blossom symptoms

The sepals of the flowers of healthy black currants are magenta coloured, but they appear grey because of numerous hairs. By comparison, the sepals of flowers on reverted bushes show the magenta colour because the hairs are almost entirely absent (Fig. 1). The difference between normal and affected flowers is seen best at late grape stage, just before the first flowers open. Few leaves have developed then and the flowers are seen readily, even on the largest bushes. Similar symptoms develop in all varieties, but they are seen most clearly in hairy types such as Baldwin.

Diagnosing reversion at blossom is quick and reliable and has few limitations. With experience it is possible to distinguish bushes which are completely and incompletely invaded by reversion virus. Bushes should be examined only when dry and the flowers on damaged shoots should be ignored.

Vein pattern

A vein pattern symptom in the leaves of black currants (Fig. 2) has been known since 1940. Recent investigations have associated this with the earliest stages of reversion disease. The ve pattern symptom is difficult to find and is not produced by all infected bushes or in all localities and is therefore of limited diagnostic value.

Leaf shape

Reversion disease is sometimes called nettlehead because of its effects on leaf character, which are subtle and not easily appreciated or described. Attention must be given to leaves of the extension growth, which may be from the base or the tips of the previous year's wood. Reverted leaves are flatter than healthy ones, which have a fluted ' three-dimensional ' appearance. Other quantitative differences affect the marginal serrations and venation.

Healthy leaves of most varieties have many pointed serrations along the leaf margin. On one side of the central lobe there are usually thirteen or more serrations and five or more sub-main veins from the midrib. By comparison, the comparable serrations of a reverted leaf are broad, rounded and usually less than twelve, with less than five sub-main veins (Fig. 3).

A simple and precise method of diagnosing reversion on venation and serrations is complicated

* A brief summary of this bulletin was presented at the Members' Day on Soft Fruit, 26th June 1963.

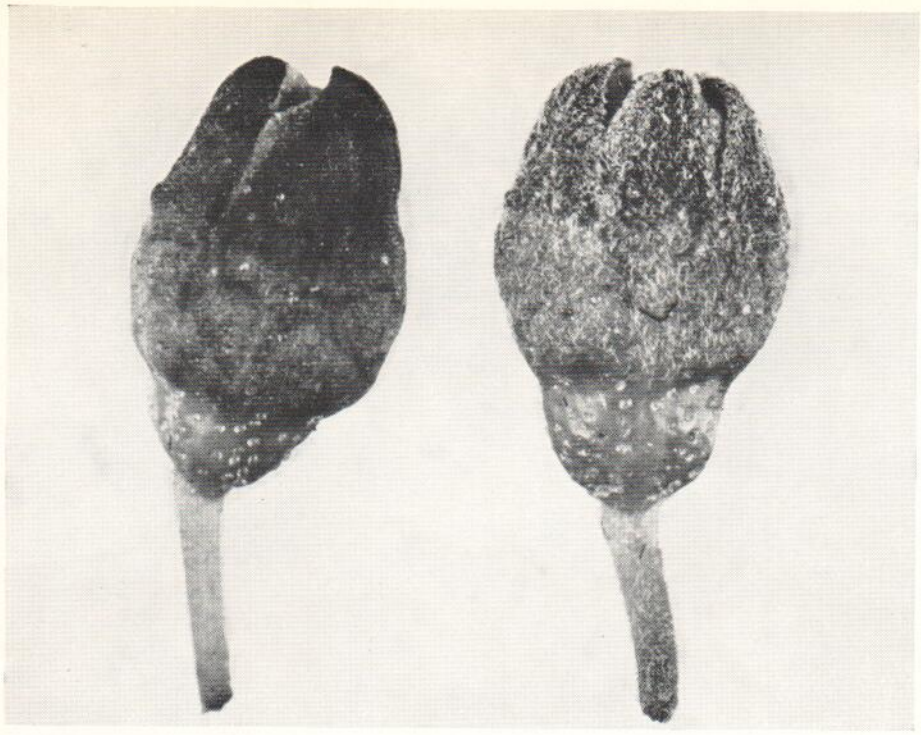

Fig. 1

Flower buds of the variety Baldwin at late grape stage.
Left, from reverted bush. *Right*, from healthy bush.

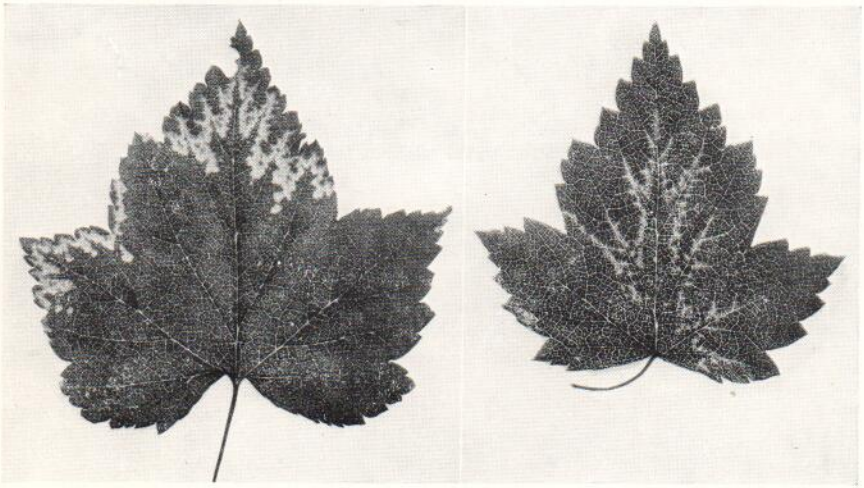

Fig. 2

The vein pattern phase of reversion in Wellington XXX (*left*) and Baldwin (*right*).

[*face page 184*

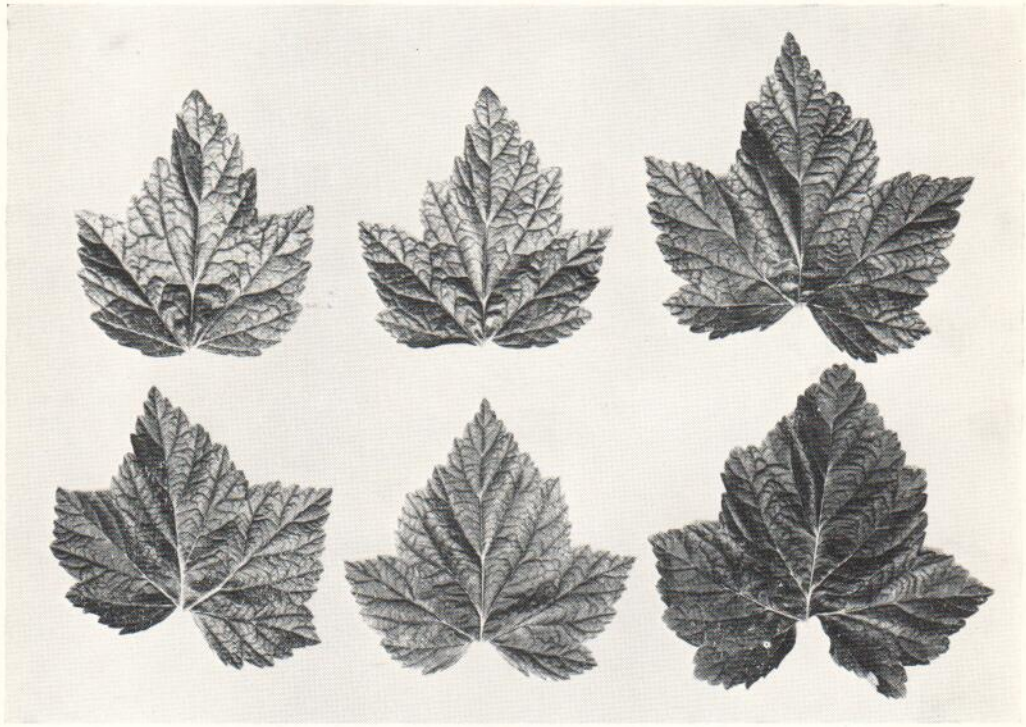

FIG. 3

Leaves of extension growth from Wellington XXX.
Above, from reverted bush. *Below*, from healthy bush.

by varietal differences. For example, the ' French ' varieties including Seabrook's Black have few submain veins and Westwick Choice has leaves with a very small number of large, coarse serrations. Raven is also atypical, with flat leaves which resemble the reverted leaves of other varieties.

It is impossible to inspect many bushes for reversion by actually counting the serrations or submain veins of suspect leaves. However, after practice with an experienced inspector it becomes possible to discriminate readily between reverted and healthy shoots, although several important limitations on diagnosing leaf symptoms remain. Thus, bushes should be growing well and be free from weeds, pests and diseases. Aphids, capsids, midges, spider mites, leaf spot and mildew can destroy or obscure the symptoms. Severe distortion may be caused also by herbicides from a contaminated spray machine or by drift. Damaged shoots which fork or develop many axillary branches produce atypical leaves of reverted appearance which must be ignored during inspection.

Ministry of Agriculture inspectors usually examine bushes for the leaf symptoms of reversion in late June or July, when varietal features can be checked. Preliminary inspections for reversion in late May and June are advantageous and efficiency is increased by examining large bushes from each side.

The sequence of symptom expression

Fruiting bushes

The sequence of symptoms has been followed in young fruiting bushes inoculated with reversion by mites or by graft patches. Symptoms were not produced in the year of inoculation, but a small proportion of the bushes developed affected blossom the following year. Symptoms always were restricted to the inoculated branches and usually only one or two trusses of flowers were affected near the inoculation point. A few weeks later and throughout the growing season, leaf symptoms appeared on all bushes which had carried affected flowers and on many others. Often the vein pattern symptom was noted first and later leaves on the same shoots had fewer serrations. Throughout the year symptoms were restricted to shoots developing from or near the inoculated branch and affected bushes carried a normal crop.

Infected bushes were still incompletely affected two years after inoculation. Blossom symptoms were found on about a third of the branches and these set few fruits. Most of the branches were carrying leaves of the reverted type by the end of the growing season. However, the vein pattern symptom was seen infrequently and was usually restricted to previously healthy branches.

Three years after inoculation, whole bushes showed the flower and leaf symptoms of reversion, but the vein pattern symptom was virtually absent. Fully affected bushes produced few fruits.

Stool bushes

Stool bushes which are cut back annually to provide cuttings may produce fifty or more shoots. Of these, only two or three are likely to show symptoms the year after infection. Bushes affected in this way are easily overlooked, but if used for cuttings in the autumn only the shoots which showed symptoms and a few others will be infected.

Virus is still incompletely systemic two years after infection. Symptoms are then usually obvious on a third to half the shoots and most of the cuttings propagated in the autumn are affected. By the third year reversion is usually present throughout affected bushes and all cuttings show obvious symptoms.

The diagnosis of reversion in stools is difficult and ideally they should be examined at least three times each season, in May, June and July. Even then, diagnosis may be complicated by the atypical leaves produced by some very vigorous bushes. Consequently, some growers leave a few shoots on the bushes each winter to carry blossom for examination in the spring. This practice is valueless, as the likelihood of the flowers being affected is small unless the bushes have been infected for so long that the leaf symptoms are obvious.

Nursery bushes

Current nursery practice is to plant cuttings in the autumn or winter and these may be used to establish fruiting plantations a year later. Alternatively, the rooted cuttings are cut back in the winter and sometimes transplanted in the nursery and then grown for a second year. At least some of the cuttings collected from infected bushes show reversion symptoms during the first year in the nursery. However, inspections then are very unreliable and only two-year-old nursery bushes are certified under the Ministry of Agriculture scheme. This is because cuttings often produce atypical leaves or develop late and grow slowly.

Two-year-old bushes present fewer problems. Rooted cuttings from an infected source which are cut back usually produce several shoots, all of which bear obviously affected leaves. Bushes that are

infected the previous year produce much less obvious symptoms, which are usually restricted to one or two shoots. An early inspection in late May before the shoots and foliage have begun to intermingle in the row is advisable, with later inspections in June and July when varieties can be identified.

To facilitate diagnosis in the second year in the nursery, it is possible to delay cutting back rooted cuttings until the flowers have been inspected for reversion at late grape stage. Affected flowers are obvious on the shoots of reverted cuttings, which can be removed before much more spread occurs. Few of the bushes which develop normal flowers later produce reverted leaves. However, the practice of cutting back late cannot be recommended generally until it is known how much this affects later growth.

Strains of reversion virus

The virus causing reversion disease is not exactly the same in all localities. Differences have been noted in the sequence of symptom expression and in the effect on crop. For example, one strain at first produces conspicuous vein pattern symptoms, but later has a barely detectable effect on the hairiness of the flowers and on leaf shape. Infected bushes produce annually about two-thirds the weight of fruit on comparable healthy bushes. Strains having mild effects may be detected only by the most experienced inspectors. The occurrence of such mild strains could account for the satisfactory yields obtained from some heavily infected plantations.

Strains also differ in their ability to cause the preliminary vein pattern symptom which is produced by viruses from Kent, Herefordshire and Norfolk. The vein pattern symptom has not been reported elsewhere.

The spread of mites and reversion

The gall mite, vector of reversion virus, can infest the buds of all black currants and spread virus into and within nurseries and plantations. Spread occurs early in the growing season, when the mites move from buds infested the previous year into the new buds. Some mites disperse locally by walking or leaping and others are carried by rain. They may also be wind-borne and have been found clinging to winged insects, including aphids.

The relative importance of the different methods of spread has not been evaluated and probably varies with season and site. At East Malling in 1962, mites spread unchecked from a row of large heavily infested fruiting bushes to two-year-old mite-free bushes planted the previous winter and cut back. Some spread occurred as far as the edge of the plot which was 50 feet from the nearest infestor, but most spread was restricted, and on plants only 10 feet from the infested bushes, the number of galled buds had fallen to half the maximum level recorded on those alongside the infestors.

Spread into healthy bushes

More extensive experiments should indicate the likelihood of mites spreading into previously uninfested currants and make possible definite recommendations concerning isolation. Meanwhile, bushes should be at least 100 yards away from any others if they are to be eligible for certification. This arbitrary distance seems to give satisfactory results, although the risk of infestation obviously decreases with distance and greater isolation is desirable, particularly for nursery rows and stool bushes. The common practice of establishing new plantations immediately alongside older contaminated bushes, even if these are to be retained only until the new bushes begin to crop, often has devastating results. This situation should be avoided, even if it means careful planning and some inconvenience in having bushes in several different fields.

Spread within nursery and fruiting bushes

Most spread occurs locally from existing foci of infection within nurseries or plantations. Spread between stool bushes is usually restricted by routine sprays and also by annual cutting back. Thus the only infested buds which remain until the spring dispersal are the small proportion near ground level. These galls are often very small and unrecognizable, but they are responsible for infestations persisting and sometimes increasing annually.

The practice of growing cuttings 6-9 in. apart in rows not more than 4 ft apart favours the spread of mites from galled buds present at planting. Usually only two or three buds are left above soil level and so the likelihood of such spread is small if cuttings are selected carefully from bushes free from obvious galled buds. However, infested buds may be overlooked if they are very small or of normal shape. To eliminate mites completely, it has been suggested that cuttings should be immersed for ten minutes in 0·2% fluoroacetamide. This chemical eliminates mites, but it is phytotoxic and some damage and failure or delay in rooting have been reported. Warm water treatments are effective alternatives and mites were killed without any evidence of damage to several varieties, by immersing

cuttings in water at 40° C for 40 minutes, 42·5° C for 30 minutes, or 45·0° C for 15 minutes. Any one of these treatments is recommended for use where facilities are available for accurate temperature control.

Most of the buds infested during the first year in the nursery are removed during the winter, when rooted cuttings are cut back. Some nurserymen cut to ground level, but most cut to buds at the base of the previous season's growth, so that some infested buds may remain and further spread occurs the following season. Although this may be restricted by routine sprays, quite frequently nursery bushes are infested when lifted. Such bushes should be destroyed as they are likely to develop reversion symptoms, and the sale of bushes 'substantially affected' by black currant gall mite is an offence against the Sale of Diseased Plants Orders of 1927 and 1936. Sometimes, however, affected bushes are sold and they often lead to the early appearance of mites and reversion in fruiting plantations.

In fruiting plantations, bushes that are free from mites and reversion and are established in isolation may remain healthy for many years. Elsewhere, the early appearance of reversion is usually due to spread from adjacent plantations or to planting contaminated stock.

Several factors contribute to the poor standard of much planting material. Many bushes are sold as yearlings before they can be inspected adequately for reversion and some two-year-old bushes are never entered for official inspection, or are sold after they have been rejected. At present there is no inspection of certified bushes in the winter to check that they are free from galled buds. This situation may be improved by the release of virus-tested material which has been inspected frequently and which has been propagated in isolated localities with an intensive spray programme and winter inspections to eliminate mites.

Galled buds which are present on planting material near ground level remain after the shoots are cut back. Such buds are important foci for subsequent spread and others arise when mites enter the crop from other plantations. Spread during the first year should be checked by the intensive spray programme discussed later and if the bushes make poor growth they may be cut back again. Spread is also restricted because the bushes do not meet for some years, at the conventional spacing of approximately 9 ft × 4 ft. Observations on fruiting plantations in Kent have shown that the incidence of galled buds and reversion increases several fold each season, the rate of spread accelerating as the bushes intermingle and as they become difficult to spray.

Reversion and propagation

Some growers propagate from special stool bushes which are cut back annually. Other growers buy in cuttings, collect shoots from fruiting plantations, or use the tops of yearling and two-year-old bushes. Excellent growth may be achieved with each type of material, although dissimilar problems are encountered in controlling mites and reversion.

Propagation from stool bushes

Isolated stool bushes which are inspected adequately for reversion symptoms are the most convenient source of many cuttings. Moreover, stools can be sprayed intensively to control any mites which overwinter near ground level.

Against stools it may be argued that frequent cutting-back may lead to bud sports or aberrant fruiting types which could not be detected in the nursery. Moreover, flowers are not available for inspection and if reversion appears it is likely to affect many cuttings. These problems may be overcome by labelling each stool and growing the cuttings in separate numbered batches. Thus the stools and their progeny can be cross-checked if reversion or other problems arise. This procedure has been tried successfully. It is desirable to make a permanent written record and plan of the numbering system and also to use labels in the field. Thick galvanized wires bearing printed metal or plastic labels may be thrust into stools so as to be undisturbed by spraying or cultivation. A less permanent and expensive system for use with cuttings is to leave a gap of 2-3 ft between each batch and place a cheap, numbered metal label on the first cutting, which is left a full 3 ft long and not cut back. If reversion symptoms appear in the parent stool one or two years after cuttings have been collected, it should then be easy to destroy the progeny. The technique is particularly valuable if yearlings are to be sold, as they cannot be rogued efficiently.

Propagation from fruiting bushes

Fruiting bushes which are inspected thoroughly for reversion symptoms at and after blossom provide a reliable source of cuttings. However, the limited number available from each bush makes it impracticable to label individual batches of cuttings. This is an important limitation because the spread of mites in fruiting plantations is not arrested by frequent cutting back and the possibilities

of chemical control are limited. Fruiting bushes are also checked less readily for galled buds and isolation and management may be less satisfactory than that of stool or nursery bushes.

Propagation from nursery bushes

The shoots of well-grown yearling bushes are convenient for further propagation. Two-year-old bushes also are a satisfactory source but the shoots may have to be bought back after sale, with some risk of damage and adulteration or mixing. Galled buds can be recognized readily on nursery bushes and should be few as a result of cutting back, isolation and effective chemical control. The main disadvantages of nursery material are that they are not fruited, so that they cannot be checked for blossom symptoms and fruit characters and it is impracticable to label individual progenies.

The chemical control of black currant gall mite and reversion

The chemical control of black currant gall mite and reversion has proved difficult, because none of the numerous acaricides now available has a satisfactory systemic action. However, some success has been achieved with chemicals to protect the new growth during the spring when the mites are dispersing. Complete control is difficult to achieve then, because mites continue to leave the old buds for a period of 12 weeks or more, at a time when the bushes are growing rapidly and it is very difficult to maintain an adequate spray cover.

Six materials are effective in killing mites : lime-sulphur, wettable sulphur, colloidal sulphur, endrin, endosulfan (Thiodan) and fluoroacetamide, but all of them are subject to one or more limitations, particularly for use on fruiting plantations. Fluoroacetamide is so phytotoxic that it cannot be recommended ; with the other materials satisfactory control can be achieved only on non-fruiting bushes. It is important, therefore, that thorough spraying should be practised in the nursery and in the early non-fruiting years of a plantation.

Nursery material and young plantations

Stool bushes, nursery rows of cuttings and established bushes which have been cut back, do not crop and consequently there is no restriction on the type or frequency of application. Endrin at 0·04% with wetting agent is recommended as the most effective and persistent material available, and thorough high-volume spraying should start when growth begins. At East Malling this is usually the week after flowers of the same variety start to open. Five applications at 10- or 14-day intervals were effective under the most extreme conditions and are recommended.

It may be undesirable or hazardous to use several endrin sprays, and endosulfan at 0·05% with a wetting agent is a slightly less toxic and less effective alternative. Lime-sulphur at 1·0%, 0·75% or 0·5% with dinonyl sodium sulphosuccinate wetter is even safer, but may damage the leaves and reduce growth. Consequently, the lowest concentration is advised for sensitive varieties such as Goliath, Wellington XXX and Westwick Choice.

Fruiting plantations not under contract

Endrin can be used only once on fruiting bushes and then must be applied before the first flowers open, which is too early for maximum effectiveness. Endosulfan, lime-sulphur, or wettable sulphur can be used later, but not at full blossom, because of possible effects on pollination and fruit set. Consequently if endosulfan is used it should be applied at 0·05% three weeks after first blossom.

Lime-sulphur, according to Dr. B. D. Smith of Long Ashton Research Station, should be applied at 1% with wetter when the last flowers on the strig are opening and again two weeks later. In severely infested plantations he suggests three sprays, 2, 4 and 6 weeks after flowering starts. Some leaf damage and decreased growth and crop may occur with lime-sulphur and a concentration of 0·5% is advised, if an application coincides with heavy flowering or if sensitive varieties are to be sprayed in areas where damage has been experienced previously.

Wettable or colloidal sulphur used with a wetting agent have been suggested as less phytotoxic alternatives to the equivalent quantity of lime-sulphur. However, there is only limited evidence of their effectiveness in controlling black currant gall mite, and in one experiment at East Malling a preparation of colloidal sulphur damaged the leaves and growth of young bushes as much as lime-sulphur.

Fruiting plantations under contract

Endrin cannot be used at all and endosulfan can be used only twice on most currants grown on contract for processors. The choice is therefore between lime-sulphur or wettable sulphur and a modified endosulfan programme. The accepted recommendations for endosulfan are that it should be applied at 0·05% at first blossom and three weeks later. It may also be advantageous to apply a

third spray, of 1·0% or 0·5% lime-sulphur with wetter, two weeks later, if the risk of some damage is accepted.

The Long Ashton lime-sulphur recommendations are that applications of 1·0% or 0·5% with wetter should be made at first flower, when the last flowers are opening, and again two weeks later. Four sprays should not be applied because of the risk of tainting processed fruit.

Summary of control measures

The present prevalence of reversion disease can be decreased greatly by the application of existing information in nursery and plantation practice.

In the nursery, cuttings should be propagated only from sources that were free from galled buds and that failed to show reversion symptoms in several thorough inspections during the growing season. The cuttings may be treated in warm water as an extra precaution against mites and whenever possible should be planted in batches labelled according to the particular source plant. The cuttings should be planted far away from any currants affected by reversion and gall mite, and should be sprayed thoroughly several times with acaricide during the period of mite dispersal in the spring. Nursery bushes should be inspected for reversion at the end of July in the first year and in May, June, and July in the second, with an inspection for galled buds during the first winter and on lifting. Where reversion is suspected the pruning of yearling bushes may be delayed until they have been inspected for blossom symptoms early in the second year.

Fruiting plantations established with bushes of a reliable certified stock should be planted away from sources of infection. They should be sprayed intensively to eliminate mites, particularly before the bushes start to crop. Inspections for galled buds should be made each winter and reverted bushes should be rogued at blossom time and on the leaf symptoms in late May or June, and again in late June or July.

TABLE I

SUMMARY OF SPRAY RECOMMENDATIONS*

Nursery material	Fruiting plantations	
	Not under contract	Under contract
1. Endrin or endosulfan or lime-sulphur when growth starts	1. Endrin immediately before flowering or endosulfan at first flower or lime-sulphur at first flower	1. Endosulfan at first flower or lime-sulphur at first flower
2. Similar application 10-14 days later	2. Endosulfan three weeks after first flower or lime-sulphur as last flowers open	2. Endosulfan three weeks after first flower or lime-sulphur as last flowers open
3. Similar application 10-14 days later	3. Lime-sulphur two weeks after last flowers open or	3. Lime-sulphur two weeks after last flowers open
4. Similar application 10-14 days later	2, 3, 4. Lime-sulphur two, four and six weeks after first flower	
5. Similar application 10-14 days later		

* Throughout these recommendations ' endrin ' implies 0·04% active ingredient with wetter in formulation or added later. ' Endosulfan ' implies 0·05% active ingredient with wetter in formulation or added later. ' Lime-sulphur ' implies 1·0, 0·75 or 0·50% with 0·0125% active ingredient dinonyl sodium sulphosuccinate wetter. Later work may show that wettable or colloidal sulphur provides a less phytotoxic and equally effective alternative to lime-sulphur.