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DISEASE IN TURNIPS AND RELATED CROPS

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Because they are integrated with our dominantly sheepfarming economy, the green fodder crops occupying three-quarter of a million acres are the most important field crop in New Zealand. Within this total, turnips and swedes comprising 425,000 acres are indispensable as winter feed for sheep in Canterbury, (126,000 acres), Otago (75,000 acres), Southland (105,000 acres). To avoid the losses in this crop that lead to difficulties in sheep management, farmers should take note of facts pertaining to the major diseases.

TURNIP MOSAIC

This virus infection starts off with vein-clearing, then yellowing, followed by stippling or necrosis of leaves. Ultimately leaves become twisted and mottled in colour and bulbs stunted. If the latter are well developed when the disease breaks out, the skin separates from the centre and black bacterial decay causes rotting. The virus is an infectious principle in the sap and the greater proportion of the disease in the South Island is caused by the Cauliflower mosaic strain of the virus. The grey cabbage aphid (*Brevicoryne brassicae*) is the primary agent of transmission. These insect vectors are adapted to the brassicas, multiply on these in summer and autumn, carrying virus-infected sap from plant to plant as they puncture leaf surfaces. The severe outbreaks of 1956-57 in the South Island have been attributed to favourable seasons for carry-over and multiplication of aphides on kale, choumoellier, regrowth rape. It appears that after maturity of these carrier hosts, the virus-laden aphides migrate to summer sown rape. They build up there until the rape dries off in December-January, whereupon they migrate to the next brassica sequence, turnips. This latter crop suffers disease effects more severely than any of the other carrier plants.

Trials by the Department of Agriculture have shown that all turnip varieties at present available are equally susceptible to Cauliflower mosaic. There are individual plants within varieties that appear to resist the disease and there is also other resistant material that may assist in a breeding programme aimed toward the development of resistant varieties. Meanwhile, the position among available swede varieties is better and Doon Spartan, Calder, Sensation are "very resistant", while Wilhelmsburger, Wye, Doon Major are in the grouping "resistant". Choumoellier is evidently the most mosaic-resistant of the cropping brassicas but that fact should not obscure the understanding that choumoellier, while unaffected in growth, in itself acts as a reservoir that keeps the virus alive throughout winter and pending the sowing of the summer crop of turnips.

To restrict losses from mosaic the working plan should be dominated by the following propositions:—(1) Lessen the dependence on turnips by exploring the possibility of suitable alternative feed crops; (2) Encourage the use and general distribution of aphid-resistant rape. In this connection there are hopes for the outcome of the work of Mr T. P. Palmer, Crop Research Division D.S.I.R. for when the aphid-resistant rape that he has developed becomes widely used the disease potential of the insect vectors should be curtailed. As matters are at present, transmission of the virus from infected rape is the chief menace to turnips in the vicinity. Time and again it has been shown that mosaic

outbreaks in turnip crops that started well have developed from old rape plants nearby—usually regrowth rape in a grass mixture established in the previous year; (3) Ascertain whether crop spraying can be performed at the critical time. Mr A. D. Lowe, Entomology Division D.S.I.R., has shown that aphides in Brassicas can be eradicated by the spray treatments, Lindane at a dosage equivalent to half-pound of 100 per cent Lindane per acre, and by the systemic material Metasystox suitably formulated and applied. (Refer to A. D. Lowe, N.Z.J. Agr. 93, 341-358, 1956 and N.Z.J. Agr. Res. 1, 37-43 1958).

It is important for the farmer to be given guidance as to when to spray, this information being derived from field observations on the incidence and build-up of aphids in relation to the seasonal conditions. Furthermore, in many areas it will be more effective to spray in order to eradicate aphides on old rape near to turnip sowings, than to defer treatment until the time the aphids have transferred to the turnips.

What of a solution through replacement of turnips by alternatives? Later sowings of turnips up to mid-February using the white globe purple top varieties may avoid the main aphid infestations and Italian, or short rotation, ryegrass can be sown in the mixture. The cereal green feeds have about half the winter-feeding capacity of turnips and Italian ryegrass, and are probably a better proposition if well established after good cultivation. Autumn saved grass likewise will not produce the same measure of winter-carrying capacity as turnips in Canterbury and Otago although autumn saved pasturage can be developed advantageously where lambs are quickly disposed of and so long as first class pasture is the source from which the autumn saved grass is obtained. Hay and/or silage, lucerne hay and lucerne; grass grazing mixtures are all being tried as alternatives to brassica fodder crops in winter feeding, and there are many claims that these have provided the solution. But all these possibilities that roots can be dispensed with and sheep wintered on such alternatives don't carry much support when one has to plan in terms of really high concentrations of sheep. On the available field evidence, it seems that swedes, kale and choumoellier are the best proposition. They certainly do better in higher rainfall areas on a good level of soil fertility, but fertility levels generally are now higher than 20 years ago, and it seems possible to grow swedes where formerly they did no good at all. The resistant varieties have been mentioned at 6oz. of seed per acre, plus 1 lb of choumoellier; they can be sown in alternating half-drill strips. The mixture must be sown early—mid-November in coastal areas, or late November, early December inland.

In conclusion, if the mosaic disease is ruining soft turnip crops we must under a dominantly grass economy strive to retain some form of root or brassica crop, both for their winter feeding capacity and for the preparation it gives in pasture renewals. The swede-choumoellier mixture seems to be the best proposition on medium to good land. On very light upland areas where the prospects of alternatives to soft turnips are not good, spraying of the turnip crop at the time coinciding with aphid build-up is the recommended preventive treatment.

DRY ROT

This disease caused by a fungus (*Phoma lingam*) continues to be of major concern in the swede-growing areas of Otago and Southland. When plants are in full leaf small grey-brown lesions appear, within which pin-point spots occur that are the spore containing sacs (pycnidia) of the fungus. The spores are washed from leaves down the stems of the bulbous lower stem where in time cracked areas of dry rot decay develop. This canker of the lower stem is generally followed by a secondary soft rot, brought about by the entry of soil bacteria. In a damp season complete crop loss may occur.

Until an important discovery was made in 1956 by Dr H. C. Smith, Plant Diseases Division D.S.I.R., the disease was deemed to originate only from the *Phoma Lingam* stage of the fungus persisting from earlier infection beneath the seed coat. Infected seed was then considered the primary source of disease. Strenuous efforts have been made by the Department of Agriculture in New Zealand and elsewhere to procure and maintain lines of seed free from infection by this fungus. Despite these efforts, regular reports were received of Dry Rot disease

breaking out in swede crops grown from approved seed. Dr Smith's discovery was that choumoellier so often grown with swedes also was a carrier of the disease organism. It is now clear that infected choumoellier stems left on the ground after paddock feeding his been completed constitute a medium on which the fungus survives and develops a survival spore stage (*Leptosphaeria*). This produces wind blown infective spores that are spread to the leaves of swede plants subsequently growing in the vicinity.

The prevention of this disease, therefore, must first be based on the knowledge that infection can come from residues of choumoellier (and kale) left in the vicinity, including neighbouring farms. Farmers who have suffered losses have sought to alleviate the effects by sowing choumoellier with the swedes—the former providing valuable sheep feed in the event of swede failure. This has advantages in terms of yield of stock food, but in regard to Dry Rot, a problem is created. Whereas soft swede tissue readily decays and disappears during the cleaning up cultivation, fragments of woody choumoellier stem persist on the surface for years, even after the area concerned has been sown down in grass. The recently demonstrated fact that on these woody fragments the Dry Rot fungus survives indefinitely calls for particular effort to eliminate stem residues of choumoellier or kale after feeding of these has been completed. They should not be left on the soil surface to act as sources of infection for succeeding crops of swedes.

Choice of and preparation of the area is very important. After the current crop is fed off, cultivation must be performed in such a way as to destroy and bury residual material, especially old stems of choumoellier, upon which the fungus would otherwise develop. Even where a grass field is ploughed up for swedes, the precaution should be taken of choosing an area well separated from any of the residue material of a preceding crop. The earlier insistence on disease-free seed is still revelant and only lines approved and grown under supervision by the Department of Agriculture should be considered. The New Zealand Wilhelmsburger is clearly the best variety for use in districts where Dry Rot disease is prevalent. It has a distinct measure of resistance. The Crimson King variety is the only other one with a fair record of resistance to the disease. But again only lines of this variety that have been through the Department's approval scheme are recommended.

The evidence of many trials makes it clear that spraying swede crops with fungicides to protect against wind-borne infection is of little avail. The all-important principle is to eradicate the ground or carryover phase, not only from any one farm but from a district as a whole. Success in the campaign against the disease therefore, must be dependent on the rotational planning and of the efficacy of cultivation in securing destruction of the infected residues upon which survival of the organism depends.

CLUB ROOT

This disease, with a wider host range than dry-rot, still occurs in severe form in some districts, especially in Otago and Southland. The casual organism *Plasmodiophora brassicae* differs from the dry -rot fungus in the ability of the former to persist for long periods in soil. Infection develops from soil, not usually from seed, and in early stages seedlings may wilt and die when the fungus penetrates seedling roots. On older plants the infection of roots stimulates plant cell formation leading to characteristic malformations. Later, these "club-roots" may rupture, providing bacteria with points of entry and consequent soft decay. Severe curtailment of growth is the usual outcome of club-root disease.

Among other features, it is to be noted that weeds included in the Crucifer family such as hedge mustard, shepherd's purse, the cresses, act as carriers. The disease also becomes well established on acid soils, where drainage is poor and the water holding capacity high.

Club-root spores are carried in soil adhering to dray wheels, implements, feet of animals and men. They pass unimpaired through animals which feed on diseased roots, thus an infected crop must not be fed out on fields intended within five years for club-root susceptible crops. Some striking examples have been recorded where the disease has been introduced into

formerly clean country, as a result of the purchase and transfer of sheep from other areas where such sheep were fed on clubroot-infected swedes or turnips prior to sale. Likewise in commercial horticulture, the disease has been introduced into soil through the purchase or transplants of cabbage or cauliflower that had been raised in soil contaminated by the clubroot fungus. Where the disease is known to exist, choice of cropping area is important and a susceptible crop should preferably be sown after grass or on an area one year removed from grass. It is advisable to sow swedes, cabbages, choumoellier, etc., on a field in good heart. Provided no serious climatic check to growth occurs, a fast-growing crop on good soil is able to withstand severe attacks. If soil is acid, heavy lime applications are required, from 2-4 tons per acre of carbonate of lime, or ½-2 tons per acre of burnt or hydrated lime. Under garden conditions, 1 lb hydrated lime per square yard is recommended. Heavy applications at sowing or planting are ineffective. The lime must be applied three months before sowing and well worked into the soil.

This requirement serves to illustrate how necessary it is in preventing disease to plan sufficiently early to ensure that proven preventive measures can be put into practice.

Few crop diseases can be controlled once they become severe, but early attention to preventive measures is helpful—in the case of club-root—choice of a field of high fertility with supplementary early liming where necessary. In club-root districts such as Southland, choice of variety is particularly important. New Zealand Resistant swede derived from the Wilhelmsburger variety is recommended. Of the turnips, N.Z. Green Resistant (Wallace) and N.Z. Purple Resistant (Bruce) are rarely severely affected.

Choice of area and liming are of equal concern to market gardeners producing cabbage and cauliflower. Where the disease has been prevalent, seedlings for transplanting must be raised free from initial infection. Seedling box or bed soil should be chemically sterilised using mercuric chloride solution (1 part in 1000 of water) at the rate of 2 gallons per square yard of soil, applied 10 days before seeding. The disinfectant should be prepared in a non-metallic container using 1 lb mercuric chloride in 1 gallon cencentrated hydrochloric acid. For use add 2 pints of this stock solution to 25 gallons of water in a barrel.

BROWN OR MOTTLED-HEART

This disease seems to be increasing in prevalence as is usually the case where "deficiency diseases" develop under continuous crop production. Affected swedes and turnips show no striking outward evidence of disease, but when bulbs are cut across irregular areas of brown woody tissue may be seen grouped around the centre. Among the leafy Crucifers, cauliflowers seem particularly susceptible, showing an internal stem cracking and browning. Affected cauliflowers remain stunted, producing small curds with areas of brown discolouration. Brown hearted swedes and turnips will not store well but if used before they begin to decay, stock consume them readily. Analyses show, however, that diseased roots are appreciably poorer in stock food value.

The disease is physiological in nature, meaning that it is associated with a breakdown in cell development, in this instance initiated by deficiency of the minor element, boron.

Prevention is sometimes complicated by the fact that ability of plants to obtain boron from soil may be reduced by alkaline conditions. Thus heavy liming may prevent club-root but, conversely, encourage brown-heart. But it has been shown that applications of boron in the form of borax or boracic acid prevent brown-heart. Seed germination injury is likely if borax is in direct contact with seed and Department of Agriculture trials have established the value of broadcasting the borax before or shortly after sowing. 40 lb per acre are required. Borated phosphate is less effective than straight applications of borax, although the latter, up to 40 lb per acre, can be mixed and broadcast with fertiliser. Should heavy rain fall soon after, the good effects of the treatment will be reduced. Seeding of turnips and swedes should not be less than 1 1-4 pounds per acre where borax is being used and as with club-root, the N.Z. Resistant variety types are less susceptible to the disease.