TAKE-ALL AND EYESPOT OF WHEAT

B.J. Arnst

Plant Diseases Division,
DSIR, Lincoln.

Take-all and eyespot are diseases of the foot-rot, root-rot complex occurring in most temperate countries where cereals are intensively grown and being more serious on wheat crops. Take-all is a disease of the root system and crown while eyespot is often referred to as a true foot-rot affecting only the lower part of the stem. Of the two, take-all is more widespread and probably is the most important disease of wheat in New Zealand at the present time. A recent survey of wheat root diseases showed take-all to be present in 73% of all crops sampled throughout New Zealand.

TAKE-ALL

The disease is caused by the fungal pathogen *Gaeumannomyces graminis* which is found within the soil, on debris of cereals and grasses where it lives saprophytically or as a parasite on the living tissue of the roots and crowns of these plants. It is important to note that this pathogen will not survive in soil alone.

Symptoms

Infection occurs when dark runner hyphae produced by the pathogen grow along the surface of wheat roots branching

out to invade the tissue and eventually block off the vascular system. The direct result of this infection is a reduction of nutrient flow to the growing plant. Wheat plants may be attacked at any stage of growth. If young seedlings are severely infected some may be killed while others, showing no obvious damage, will become stunted and produce fewer tillers. It is the symptoms of disease at this early stage which are responsible for the name take-all as a thinning out of the wheat crop occurs. Plants attacked at a later stage of growth show up as whiteheads with shrivelled grain and very often no grain at all. This type of infection produces symptoms referred to as 'haydie' where premature ripening would appear to be taking place. The wet spring in 1979 favourable to take-all infection followed by hot dry conditions during December resulted in many crops showing 'haydie' symptoms in Canterbury. Other obvious symptoms of infection by *G. graminis* are blackened and rotting roots and blackened stem bases. The sexual fruiting bodies of the pathogen are often observed on this dark area as small dark spots protruding through the sheath. Although ascospores are readily produced in late autumn they are not considered important as a source of infection. It is the mycelium in roots and stubble of infected crops and other host grasses which is important in spreading the disease.

Conditions for build-up

Conditions which favour the build-up of take-all are

* continuous cropping with wheat and barley

* wet seasons which prevent stubble burning and break-down

* presence of volunteer cereals and other weed grasses

in fallows preceding wheat crops,

* high nitrogen levels in the soil.

The severity of take-all disease of wheat is often variable because of its patchy nature within a crop, variations in climatic conditions and variation in soil types. It is well known that take-all can be more severe where wheat is grown in light, alkaline soils where moisture is abundant. In trial plots last season at Lincoln 100% infection with *G. graminis* gave a yield reduction of 47% over uninfected control plots while a similar infection level in Southland trials gave a yield reduction of 78%. Under spring sown conditions at Lincoln a reduction of only 24% was measured. The results from the Lincoln autumn sown trial are similar to observations made in farmers paddocks throughout the season. Near Methven two fields showed almost 100% of plants carrying some infection and they yielded 2.3 and 2.6 tonnes per hectare on a farm where uninfected paddocks yielded 4.6 tonnes per hectare.

Control

What then can be done to control take-all? No chemical control is available and no worthwhile resistance has been detected in wheat varieties. Take-all must therefore be managed in such a way as to obtain minimum infection levels. This can be done through a combination of cultural measures, including rotations, application of fertilisers, weed control and early ploughing of stubble to allow maximum time for breakdown in warm autumn soils.

Introduction of a break crop into a continuous wheat rotation may reduce the incidence of take-all, but where conditions of wet autumn and spring prevail such as in Canterbury during the past three seasons, the break between wheat crops

needs to be much greater as stubble breakdown in the soil may still be continuing after several years. The wheat - white clover rotation commonly practised does not encourage quick stubble breakdown and a wheat crop following a pea crop planted after the white clover may become infected with take-all. Incorporating oats into the rotation may be useful as the species of *G. graminis* on wheat and barley will not attack oats, thus take-all levels in the soil will decline rapidly.

Burning of stubble will not necessarily reduce take-all as it is mainly in the roots where the mycelium survives but it will reduce the amount of trash incorporated into the soil and therefore lessen the number of survival sites for the pathogen.

Direct drilling of cereals has been shown to reduce the incidence of take-all as there is limited spread of the pathogen in the undisturbed soil. Recently in Canterbury many people have associated this cultivation practice with take-all where twitch (*Agropyron repens*) has been involved. The real problem here is that twitch is one of the best hosts for *G. graminis* and is present in many cropping systems. Although the use of herbicides prior to drilling may have killed the twitch the fungus in the dead rhizomes is still viable and capable of infecting wheat roots. Previous practice for twitch control involved continually bringing the rhizomes to the surface throughout the summer allowing them to dry up and blow away taking the fungal mycelium with them.

Application of nitrogen to crops can be beneficial where take-all occurs. It should be made clear however, that the pathogen is also benefitted by the presence of nitrogen and will increase its activity along with the increased growth of the wheat plant. Providing the wheat plants are

not stressed by moisture deficiency then the added nitrogen should enable the plant to reduce the effect of *G. graminis* infection. The use of slow release forms of nitrogen in early spring would be preferable to autumn application.

In some countries a phenomenon called 'take-all decline' exists where levels of take-all are reduced following a period of continuous wheat growing. This is brought about by a corresponding build-up of soil micro-organisms which are antagonistic to *G. graminis*. This takes several years and considerable yield reduction is likely to occur before yields will begin to improve. It is not known if this phenomenon exists in New Zealand where little continuous wheat cropping occurs. In Southland however, some farmers have grown crops of wheat for up to ten consecutive years and appear to have reached a level where take-all is not increasing.

Research is currently underway to study the effect of rotations on take-all in Canterbury but in the meantime farmers will have to consider the past and present seasonal weather conditions and possibilities of take-all infection in the future, before deciding to plant a first or second wheat crop.

EYESPOT

Eyespot of cereals caused by a fungus *Pseudocercosporella herpotrichoides*, and, while not as widespread in New Zealand as take-all, does have a serious effect on wheat yields in several cropping regions.

Infection and symptoms

Infection can occur throughout the growing season although initial crop infection occurs in late winter or early spring

when spores of the pathogen are dispersed to the seedling coleoptile, germinate and infect the sheath tissue and often that of the leaves developing underneath. Seedling death is unusual and in most cases as the plant grows the eyespot lesions increase in number and size until when fully grown the plants are weakened at the infection point so that they break off or bend resulting in lodging. Stems may break completely resulting in loss of all grain while in those that are lodged shrivelling of the grain will occur. The disease obtains its name from the oval grey to yellowish brown eyespot type lesions. When infected stems are split open at the lesion the smoke-grey mycelium of the fungus is clearly seen. Infected stems often lodge in a straggling manner distinguishing them from the more uniform lodging of heavy crops in bad weather. Spores produced on infected seedlings and young plants are readily dispersed by rain to other wheat plants. Spores produced on diseased lesions are abundant after harvest on stubble and trash and may survive up to three years on wheat debris in the soil.

Factors predisposing plants to eyespot are, low soil temperature, humidity within the crop, high nitrogen levels and a ready source of inoculum on stubble. Prolonged moist periods with temperatures of 3-14^{o}C represent optimum infection conditions.

Humidity within a crop canopy can be encouraged by high sowing rates, the use of nitrogen, presence of weeds and particularly undersowing with white clover. The latter condition is especially important in a wheat - white clover rotation and under direct drilling where clovers are not killed by herbicides. Eyespot would seem to be the most serious disease problem where direct drilling of wheat is being practiced.

Control

Source of inoculum is however, the most important factor responsible for disease outbreaks. As with take-all it is the presence of stubble acting as a reservoir for the pathogen which is important. Complete stubble removal by burning will reduce eyespot to insignificant levels. Where this is not possible deep ploughing will reduce the disease, but infected stubble can be exposed during later cultivation. During last season eyespot was observed in many Canterbury wheat crops and as with take-all this can be attributed to poor stubble hygiene and lack of decomposition during past wet seasons together with reasonably intensive wheat usage in rotations.

Rotations are effective in reducing eyespot but complete elimination of the disease may be reached only after several seasons away from cereals.

Differences in varietal reaction of wheat to *P. herpotrichoides* have been recorded and some research is currently underway to investigate this point in New Zealand. This is however, a long-term project.

Eyespot is readily controlled by fungicides. Both overseas and in New Zealand the use of carbendazim products has proven successful in preventing the disease. Application of these products, of which Benlate is the only one fully registered for this use in New Zealand, should be made at early stem extension (Feekes Growth Stage 6-7). It is common practice in Southland where the disease is often widespread to apply this fungicide with a herbicide application. If weather conditions at a later growth stage are continuously bad a second spray application would probably be needed. Some use has also been made of a product known as Cycocel a plant growth regulator which shortens

wheat plants and strengthens their stems to resist lodging. This practice creates a thickening of the canopy which has the disadvantage of encouraging foliage diseases.