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Wheat rust epidemics

By A. G. P. Brown, Plant Pathologist and J. T. Reeves, Plant Breeder

Stem rust of wheat is probably the most damaging plant disease in the world. The rust fungus attacks stems, leaves and heads, producing characteristic red-brown pustules which affect the plant's ability to fill out the grain. Yield loss is directly related to the amount of rust in the crop and the length of time the crop is infected.

Measurements have shown that only a trace of rust at the boot stage can build up to cover 65 per cent of the plant's surface at maturity, resulting in a 50 per cent drop in yield. With 10 per cent of the crop rusted at the boot stage total loss of yield can occur.

In Western Australia it is not uncommon to find rust on crops in mid-October, but usually there is negligible loss of yield. In fact this pattern is quite normal throughout the world: In general, rust arrives too late to cause an epidemic.

Why is this?

Rust spreads by means of spores produced in millions in the red-brown pustules, and dispersed on the wind. Fortunately most do not survive to cause a fresh infection even with favourable warm, moist weather for germination of the spore and infection of the host. This means that the build-up of rust starts very slowly at first and gradually gathers speed.

In most years under average weather conditions rust builds up slowly and the epidemic occurs too late to affect the crop seriously, except at the focal points where the disease began.

Conditions that favour rust

In the Eastern States summer rainfall ensures that volunteer plants are common but in Western Australia abnormally high summer rainfall is necessary for build-up of sufficient rust on the self-sown cereals which appear.

If such plants were removed from the scene rust would cease to be a problem, but unfortunately complete control of volunteers is impractical. Even if it were possible, it is also possible that suitable grasses might serve as hosts, though evidence to date indicates that they have not played any major part in our epidemics.

Fortunately, heavy summer rain is not the only pre-condition for a rust epidemic. It also appears that there must be enough rust at the close of the previous season to initiate the autumn build-up, and following this a warm winter with well distributed rain.

The optimum temperature range for rust is 24 to 28°C when rust will go from initial infection to release of more spores in 10 days. Although temperatures in this range are very seldom maintained in winter, any increase over average will speed the cycle.

Since a wet plant surface and several hours of high humidity (associated with cloud) are also necessary for germination of rust spores and infection of the host, an exceptionally warm winter with rain every two to three weeks would be ideal. Conditions in Western Australia are nearest to ideal in the Geraldton and Esperance areas.

In the last epidemic, in 1963, rust began in both areas and was widespread in the wheatbelt by September. Losses in that epidemic were estimated at $20 million.

New rust strains

What appears to happen is that mutants arise by chance at spore formation extremely rarely on a susceptible crop. In most cases these mutant spores will fail to infect (since most spores are lost anyway) but even more rarely one will succeed. However, most mutations are deleterious for the fungus—that is, the alteration caused by the mutation will more usually be a handicap rather than an attribute.

![Graph 1](image1.png)

**Fig. 1.**—January to April rainfall at Chapman Research Station in rust epidemic years. Epidemics are associated with above-average summer rainfall.

![Graph 2](image2.png)

**Fig. 2.**—Records of summer rainfall (Geraldton) and rust collections in northern wheat-growing districts indicate that summer rainfall is not the only factor involved in rust development.
Severe rust on mature wheat stems.

Only once in an almost infinite number will a spore with a changed virulence successfully infect and reproduce. For the new race to persist it must quickly gain in numbers and adjacent fields of (previously) resistant varieties will provide a starting point where the new virulent race has a competitive advantage over the old race. Plantings of resistant varieties in areas where most crops are infected thus act as "filters" for mutants blowing in from rust epidemics in the surrounding susceptible crops.

It is also possible for new rust races to arise by hybridisation of two or more old races where these races are infecting a common host. This is more likely to occur on hosts with few resistance genes (which can thus be infected by a large range of races) such as wild grasses.

Because rust is comparatively rare and short-lived in W.A. it follows that new mutants and hybrids will also be rare. By the laws of chance, resistant crop varieties here should enjoy a more extended life than in eastern Australia. Unfortunately, however, rust spores can be blown into W.A. from the east and probably also from Africa.

**Monitoring rust races**

Western Australia assists in an Australasian scheme to monitor changes in the population of rust races, organised by Prof. I. A. Watson of Sydney University.

The virulence of a particular strain is assessed by its ability to attack a series of wheat varieties of varying resistance.

The system employs two groups of testers: an international set which divides Australasian rust isolates into broad groups and an Australasian set which further divides the broad international groups. The resistance in the varieties used can be related to specific genes for resistance which in the rust are associated with complementary genes for virulence.

The varieties are numbered so that a rust race acquires a code according to its virulence. Rust race 34 ANZ 2,3,7 shows a pattern of virulence on an international set of 12 differentials which gives it the code 34, and it attacks varieties 2, 3 and 7 in the local group.

Samples from as wide an area as possible are tested every year.

**Preparation for rust in 1976**

Significant build-up of rust on wheat crops in the 1975 growing season should put many growers on their guard against a serious epidemic in 1976. However, the risk of an epidemic is not necessarily increased because much will depend on summer rains enabling rust to survive the summer on growing plants.

In case rust does carry over growers throughout the wheatbelt have been advised to either save or obtain at least some seed of the resistant variety Madden for sowing in 1976.

For the rust-liable south coastal areas only Madden should be sown, as this variety is amongst the top yielders in the area even in the absence of rust.

In the central wheatbelt Madden is only slightly lower yielding than Gamenya and some should be sown as part of the crop in 1976. Northern wheatbelt growers should save enough Madden to sow a substantial part, if not the whole, of their wheat area, in addition to saving seed of their normal variety.

The Department of Agriculture is keeping a close watch for rust over the summer; reports and samples from farmers will also be welcomed at the Department's district offices.

If rust is widespread in April the increased risk for next season will be widely publicised.

Madden is the highest-yielding, rust-resistant variety available for W.A. at present, and is one of the few varieties that has maintained resistance to all strains of rust found in Australia. Some small rust pustules have been found on Madden over the past two years but this does not indicate a breakdown of resistance.

Other rust-resistant varieties available are Eagle, Gamut, Timgalen, Gatcher, Kite and Mendos. Small reserve areas of Eagle should be grown in both northern and southern areas, and some Gamut should be grown in the southern mallee to provide nucleus seed for build-up should the need arise.

If seed supplies of resistant varieties are limited they can be put to best use by reducing seed rate to enable sowing over a larger area.

In cases where only part of the crop will be sown to susceptible varieties it would be best to sow these first, finishing off with resistant varieties. By doing this susceptible varieties have a better chance of maturing before rust build-up in the spring.