Yellow Rust of Wheat - The UK Experience

R. A. BAYLES

Background

The total area of wheat currently grown in the UK is in the region of 2 million hectares, more than 70% of which is concentrated in the eastern counties of England. The risk of yellow rust (*Puccinia striiformis*) infection in wheat crops also tends to be greatest in the east of the country. One reason for this is obviously the high density of the host crop in this region, although environmental factors are also important. The cool and overcast summer conditions typical of coastal parts of Lincolnshire and North Norfolk favour the disease and contribute to the reputation of these areas as yellow rust 'hot spots'. The risk of yellow rust in wheat is in marked contrast to that of brown rust (*P. recondita*), which is found largely in the south of England, where summer temperatures are highest.

The incidence of wheat yellow rust fluctuates widely from year to year. Regular surveys of winter wheat crops have shown that, since 1970, epidemics have occurred approximately once in every three years (*Figure 1*). Brown rust showed a similar amount of variation from year to year, but with a different pattern of epidemic years. Survey data for winter barley did not become available until 1981. However, over the past twenty years brown rust of barley (*P. hordei*) appears to have been more common than either of the two wheat rusts, whereas yellow rust of *barley (P. striiformis*) has virtually disappeared since 1983.

Yellow rust epidemics in wheat

It is well known that plant disease epidemics occur when susceptible host varieties are widely grown, inoculum of virulent pathotypes is abundant and environmental conditions are favourable to disease development. The key role of susceptible varieties in UK epidemics of yellow rust on wheat is shown in *Table 1*. The main susceptible varieties (ratings of 5 or less on a 1-9 resistance scale) associated with each epidemic period are listed, together with their specific resistance genes.

In each case, more than 20% (and usually more than 30%) of the wheat acreage was made up of susceptible varieties at the time of the epidemic. Simultaneously, virulence corresponding to the resistances of these varieties was at a high frequency in the pathogen population.

Varieties are the driving force determining changes in virulence in the pathogen. *Figure 2* shows the recent example

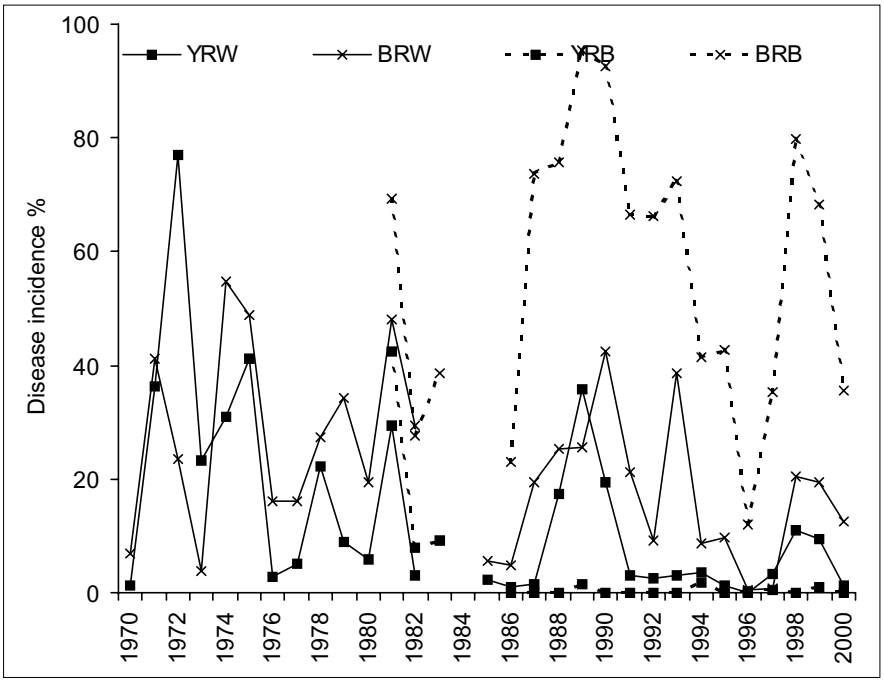

Figure 1: **Incidence of yellow rust and brown rust of wheat and barley in England and Wales (source: DEFRA surveys)**

Table 1: **Yellow rust epidemic years in the UK - principle susceptible varieties**

Year(s)	Varieties	Resistance rating	*Yr* genes	% wheat acreage
1971/72/73	Joss Cambier	1	2, 11	15%
	Maris Ranger	2	2, 6	18%
	Cappelle Desprez	4	3	33%
	Cama	2	3	9%
1974/75	Maris Huntsman	4	2, 3, 13	31%
1978	Maris Huntsman	4	2, 3, 13	38%
	Hobbit	2	14	19%
1981	Maris Huntsman	4	2, 3, 13	16%
	Mardler	5	1, 2, 3, 13	10%
	Hustler	3	1, 2, 3, 13	6%
1883/84	Norman	4	2, 6	19%
	Longbow	3	1, 2, 6	8%
1988/89/90	Slejpner	2	9	16%
	Hornet	2	6, 9	8%
1998/99	Brigadier	1	9, 17	6%
	Others	4.4	17+	27%

Autor: Rosemary A. BAYLES, NIAB, Huntingdon Road, Cambridge CB3 0LE, UK

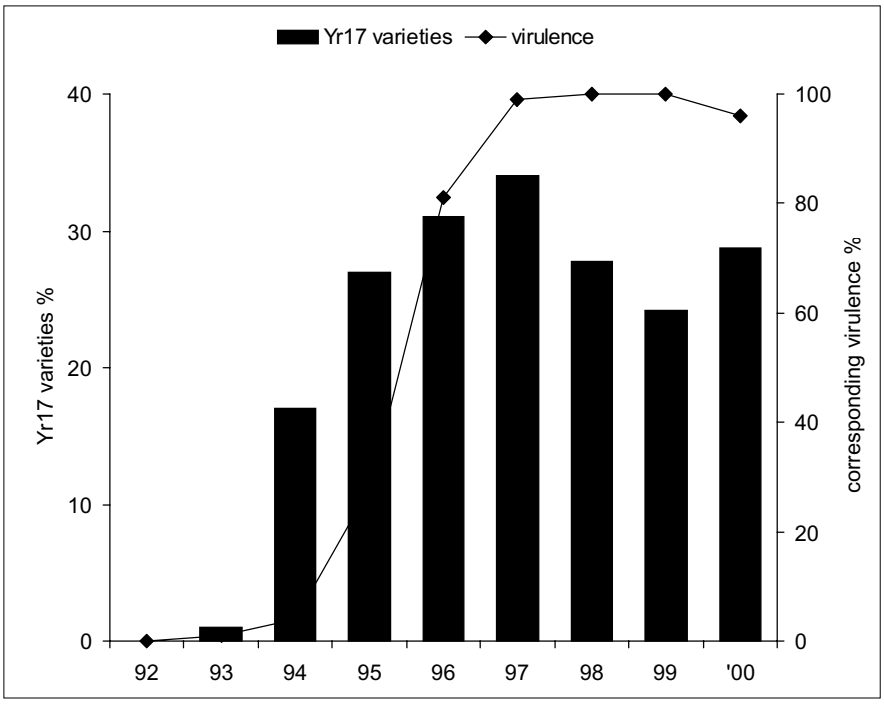

Figure 2: **Increasing virulence for *Yr17* in the pathogen population in relation to the increased popularity of varieties possessing the *Yr17* resistance in the UK**

of increasing frequency of virulence for the yellow rust resistance *Yr17* in response to increasing exploitation of this resistance in UK wheat varieties. *Yr17* was first introduced into UK wheat varieties with the variety Rendezvous during the late 1980s. However, this variety was never grown on a large scale and it was not until 1994, with the arrival of the high yielding variety Brigadier, that *Yr17* varieties started to achieve a significant share of the national acreage. By 1997, *Yr17* varieties occupied around 34% of the UK wheat acreage and the frequency of the corresponding virulence in the yellow rust population had risen to almost 100%. The increase in virulence for *Yr17* in the UK was mirrored in Denmark and was followed two years later by similar increases in France and Germany (BAYLES *et al*. 2000). There are clear indications that long distance migration of yellow rust spores around northern Europe plays an important role in determining the composition of local populations.

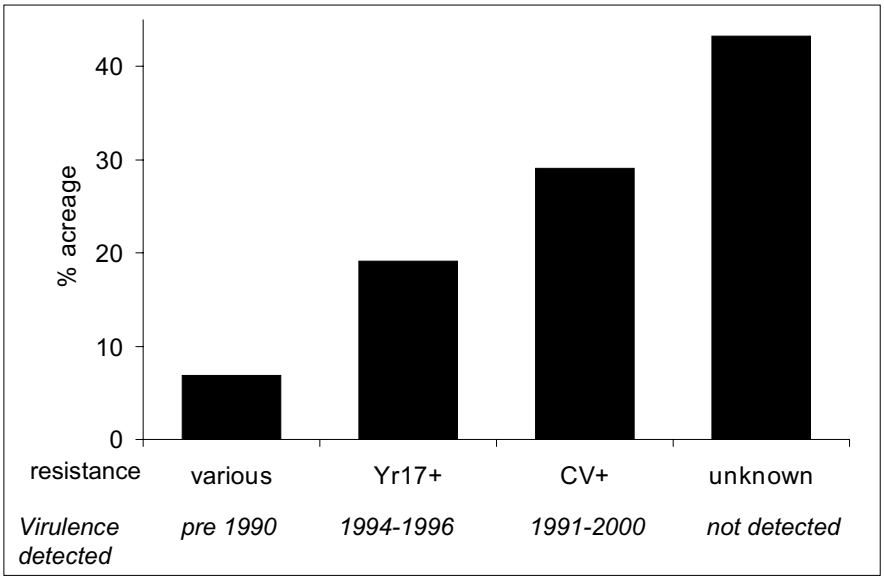

Figure 3: **Specific yellow rust resistances of UK wheat varieties harvest 2001**

Current situation

Figure 3 summarises the the yellow rust resistance of UK wheat varieties grown for harvest 2001. 32 varieties achieved a minimum of 0.1% of the national acreage. Of these, only 8 reached as much as of 3% of the acreage each. The varieties can be divided into four main groups on the basis of their yellow rust resistance. The smallest group, making up around 7% of the acreage, comprised a number of varieties with specific resistances that were overcome by the pathogen prior to 1990 and remain ineffective against the current pathogen population. The next group, making up just under 20% of the acreage, included varieties carrying the *Yr17* resistance, either alone, or in combination with *Yr9* or *Yr6*. The principle varieties in this group were Savannah, Equinox and Napier. Virulence for the resistance of these varieties emerged in the UK between 1994 and 1996 and is now at a high level in the pathogen population. A further 30% of the acreage was made up of varieties possessing resistance derived from Carstens V (*YrCV*). This group of varieties was dominated by the widely grown variety Consort, which occupied around 22% of the acreage. The resistance of varieties in this group was matched by virulence in the pathogen at various points during the period 1991 to 2000. The fourth group, accounting for over 40% of the acreage, was made up of varieties with resistance that was fully effective at adult plant growth stages i.e. varieties with the best available resistance rating equal to 9 on a 1-9 scale. Two varieties, Claire and Malacca, dominated this group, accounting for nearly 30% of the acreage between them. The genetic basis of the resistance of varieties in this group is uncertain, as is the diversity of resistance represented by different varieties within the group.

The emergence of virulence matching the specific resistance of a variety exposes the partial, or 'background' resistance of that variety. The degree of partial resistance is reflected in the variety's 'resistance rating' expressed on a 1-9 scale (ANON. 2001). Ratings of 6 and above indicate moderate to good partial resistance and ratings of 5 or below poor

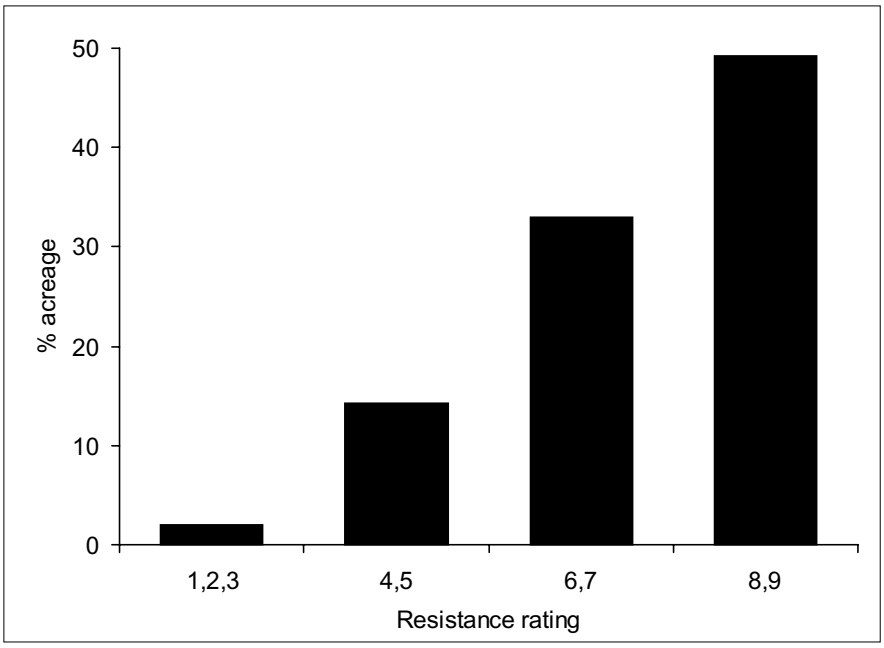

Figure 4: **Yellow rust resistance ratings of UK wheat varieties harvest 2001**

to very poor resistance. The resistance rating has practical significance for farmers as it gives a guide to the risk of damaging infection and the probability of fungicide being required to control the disease. In general, ratings of 5 or below indicate varieties that are at moderate to high risk from yellow rust infection, depending on disease pressure, and are likely to require fungicidal control. With ratings of 6 or above, the risk diminishes and the probability of fungicide being required is slight. *Figure 4* shows the harvest 2001 varieties grouped according their resistance ratings. Only about 16% of the UK wheat acreage was sown with varieties in the high or very high risk categories, with resistance ratings of 5 or below. The comparable figure for 1972 was 75%, showing a dramatically improved position in 2001.

The future

The yellow rust resistance of the UK wheat crop is probably in as good, or better, position in 2001 than at any time during the past 30 years. This has been achieved by a combination of plant breeding and independent variety evaluation, backed up by a national pathogen virulence survey (BAYLES *et al*. 1997).

However, it is important to remember that we are only looking at a snapshot in time. The genetic composition of the host population is constantly changing as plant breeders respond to the requirements of end users and growers. Changes in the host population are the driving force for change in the pathogen population. It is impossible to predict the durability of the resistance of current resistant varieties, nor to be certain of the diversity of resistance amongst them. The critical question is whether a single adaptation in the pathogen would overcome the resistance of one or several of the currently important resistant varieties.

There is still ambivalence in attitudes towards disease resistance. Despite the publicity given to concepts such as sustainability and reduction of pesticide inputs, UK cereal production remains a high input / high output operation. Fungicides are used liberally, with 100% of wheat crops receiving a treatment and the average number of sprays per crop being 2.5. It still appears to make good economic sense to most growers to choose their varieties for high yield and to rely on fungicides for disease control.

Against this background it is especially important to emphasise that the problem of yellow rust has not gone away and that resistance breeding and pathogen monitoring are as important as ever if we are to maintain, or improve upon, the current, relatively favourable, situation.

References

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