

from the Far East that could be used to widen the genetic base for European varieties; but some of this is difficult to utilize, since it is inherited recessively and is oligogenic (12). Breeding with these exotic germplasms is also complicated because they are agronomically unsuited to the United Kingdom. Time-consuming backcross programs are needed to combine the resistance with an appropriate agronomic background. A transgenic approach to breeding would speed up these programs. It is particularly important at present to breed resistance to BaMMV into the malting varieties, and it may prove to be more feasible to do this by a transgenic than a conventional breeding program.

3.3. Rhizomania Disease of Sugar Beet

Rhizomania disease of sugar beet is caused by beet necrotic yellow vein virus (BNYVV), which is transmitted by the soil fungus, *Polymyxa betae*. The disease was first found in Italy in the 1950s but has since spread to most of the sugar-beet-growing areas of the world. The disease was first reported in the United Kingdom in 1987, and since then there have been an additional 76 outbreaks in the United Kingdom. Investigations of the yield effect of rhizomania in the United Kingdom have suggested that yield losses would be of the order of 53–75% or 3.6–4.9 tons of sugar per hectare if the disease continued to spread unchecked (13). This is in a crop with an annual farm gate value of about £300 million. The disease is currently restricted to certain areas in East Anglia; and the United Kingdom Ministry of Agriculture, Fisheries & Food (MAFF) pursue a statutory control policy to limit the spread of the disease. Control of the disease is possible by using methyl bromide soil sterilization (14), but this is too expensive for routine use on a field scale and is being phased out under the Montreal Protocol. This leaves the production of resistant cultivars the only practicable solution to its long-term control.

There are a limited number of sources of partial resistance to BNYVV in sugar beet itself; these have been used to produce some of the new sugar beet cultivars with partial resistance to the disease. Most of these cultivars have reduced sugar yield and root quality compared to susceptible cultivars. Also, they have undesirable agronomic attributes, such as increased bolting. Recently developed cultivars, such as Ballerina, are near to the acceptable quality for sugar beet cultivars with a 1–3% yield penalty and a reasonable level of resistance to the virus. These cultivars do however still become infected by BNYVV; and there are fears that they may build up inoculum levels in soils while masking disease spread, leading to widespread infection. The lack of immunity to the disease has recently posed a major problem for MAFF in that they are reluctant to deregulate the disease and allow partially resistant cultivars to be grown if there is any possibility that a breakdown of such resistance could take place in the near future. The development of a transgenic cultivar of