FULL SPEED AHEAD FOR DISEASE RESISTANCE BREEDING

CREATING MODERN VARIETIES DEMANDS FORESIGHT AND PERSISTENCE

The German government's Arable Farming Strategy 2035 sets out the clear direction of future agricultural development: The use of pesticides is being reduced and restrictions will be placed on the use of fertilisers. The spotlight is turning to biodiversity and special recognition is given to soil fertility.

In view of these changes, agriculture has to remain economically viable. In this context, there is also a growing appreciation of the role of plant breeders, as it becomes clear that robust, tolerant, resistant and productive varieties will pave the way to sustainable agriculture. However, what is less well understood is that plant breeding, and disease resistance breeding in particular, is a very long game.

The active ingredients in crop protection products are running short after the new EU Pesticides Regulation introduced new cut-off criteria as early as in 2009. The knock-on effect of this legislation is that certain active ingredients are no longer being reapproved, and we are now in the position where more pesticides have lost their approval than have had their approval renewed. This affects all crop types, although some more than others or sooner rather than later. In short, there will be fewer fungicides and insecticides available in future. At the same time, pest and disease pressure is rising due to climate change (Fig. 3). Plant breeding can help by establishing resistances to viruses and fungal diseases, for example, and has already achieved very successful results in recent years.

OILSEED RAPE: TUYV

90s

The TuYV-resistance gene is identified with the assistance of German plant breeders (GFP*) and is made available for breeding.

Since then, internal DSV projects among others have combined the resistance gene with other favourable traits such as improved early development.

2001

The first TuYV-resistant variety CALETTA is approved, yet yield performance is still low.

2007

DSV increases the proportion of TuYV-resistant breeding material in its programme.

2008

First BaYMV-1, BaYMV-2 and BaYMM-resistant variety YOKOHAMA.

BARLEY: BAYMV 1,2; BAMMV, BYDV

Resistances to the BaYMV complex are identified in a range of GFP* projects and made available to breeders.

A tolerance to BYDV is introduced into cultivated barley and described in detail.

Resistance to BaYMV-1 and BaYMM become part of the standard genetic toolkit.

*Association for the Promotion of Private Plant Breeding in Germany (now GFPi (German Federation for Plant Innovation))

The long road to resistant varieties

Plant breeding is an extremely lengthy undertaking, and resistance breeding even more so. Many agronomic plant traits are improved during the normal, ongoing breeding process. But this is not the case with resistance breeding. Here, breeders must be prepared to play the long game; first finding sources of resistance and then making them usable.

For small to medium-sized breeders like the Deutsche Saatveredelung (DSV), the key is to interpret agricultural trends and set the right course in good time; it takes 10 to 12 years to develop a market-ready variety and as a general rule, a variety is approved only if in addition to conferring a novel resistance, it

FIGURE 3: REASONS WHY VIRUSES ARE BECOMING MORE PREVALENT.

1. Global warming

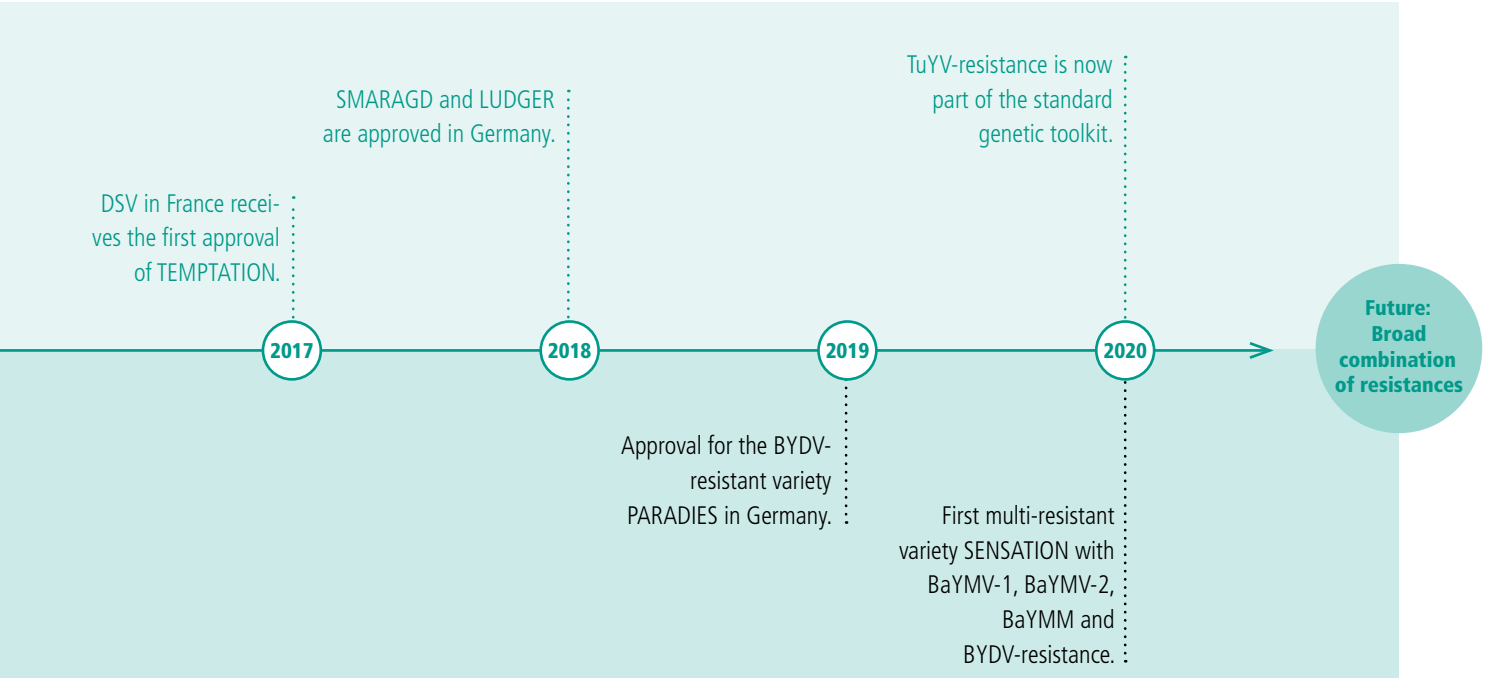
- The migration and feeding activity of aphids as vectors for viruses now extends over a longer period
- The aphid population is increasing
- Infected aphids survive the winter

2. Stronger population dynamics

- Greening measures create larger refuges
- Biodiversity creates more host plants
- No spraying during juvenile development

3. Fewer available insecticides

- With only a few active ingredients currently approved, the risk of developing resistance increases



also scores more highly for all other traits. In other words, a variety that is resistant to the yellow mosaic virus must also produce higher yields. Consequently, these processes take a long time.

Resistance breeding forms the basis for future crop protection strategies

Breeding a resistant variety begins with the search for and evaluation of resistance sources. This calls for the creation and harnessing of genetic variation, which may also involve crossings with wild species. The resistance genes against barley yellow dwarf virus (BYDV) were discovered in exotic barley landraces from Ethiopia and in the wild barley Hordeum bulbosum, which belongs to the secondary gene pool of barley. To ensure that the resistance is stable, selected candidates are being tested at multiple locations over several years (see Fig. 4). In some cases targeted testing has been carried out by artificially infecting the material with infected virus vectors in isolation tents. In the case of soil-born barley yellow mosaic viruses (BaYMV-1, BaYMV-2 and BaYMMV), BaYMV-infected sites were chosen as trial fields to ensure that the varieties had the greatest possible degree of environmental stability. The selection of the resistant phenotype is supported by the establishment of suitable molecular markers. All in all, it’s an extremely laborious process for a breeding company.

Breeding is an intensive process.

This explains why the DSV has always sought to work in partnership with other organisations, for example on the Turnip Yellows Virus (TuYV) in oilseed rape, or the barley yellow mosaic and barley yellow dwarf viruses. Partnerships with the Julius Kühn Institute (JKI) and other academic institutions have laid the foundations for resistance breeding and opened the doors to public funding. Without such funding initiatives, the small and medium-sized breeder would be unable to raise the capital to conduct this basic research.

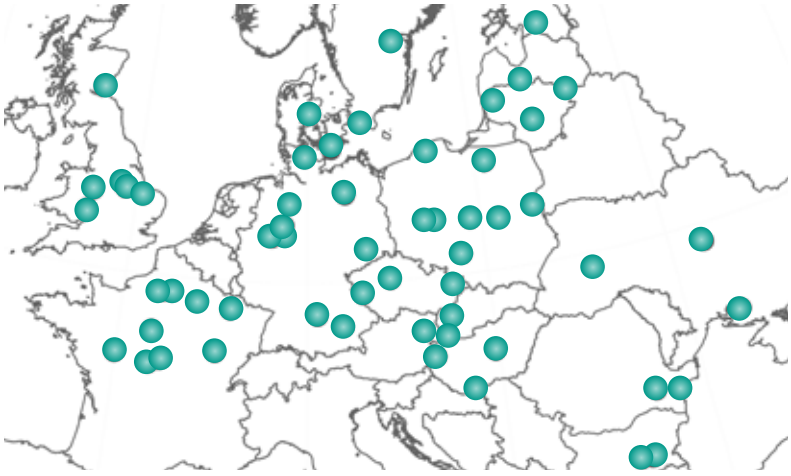
The results are subsequently made available to the entire plant breeding community, enabling every breeder to make use of the findings in their own breeding programs.

Pioneering work has already given rise to a new generation of varieties with resistance traits that form the basis for further developments. LUDGER and SMARAGD are two high yielding TuYV-resistant oilseed rape varieties on the market, while SENSATION is the first multi-resistant barley –a good starting point for overcoming the restrictions on the use of pesticides.

Summary

Breeding is set to become increasingly important in future. We are constantly battling with climate change, the associated pest and disease pressure, extreme weather events and constantly changing framework conditions. It must also be borne in mind that the timeframe from preliminary trials to varietal approval is around 12 years. Through our modern breeding methods, associations with project partners, different breeding programmes, extensive network of testing and selection stations and decades of experience, the DSV is well aware of the special responsibility of plant breeders and is constantly striving to further develop varieties that are fit for the future. —

FIGURE 4: TESTING NETWORK: DSV BREEDING AND TESTING STATIONS FOR OILSEED RAPE



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