



“ We can predict the probability of success with a hybrid before we actually sow it. ”

The genome tones the traits

Innovation **OSR** hybrid breeding

Using genome-wide selection, breeders at Dekalb's research facility in France are taking a whole new approach to variety progression. *CPM* visits to gain an insight.

By Tom Allen-Stevens

In amongst the large white tents that dot around the field there's a single row of plants. These are clearly oilseed rape, but bear little resemblance to the mighty hybrids that festoon the surrounding trial plots — small, stunted, distorted, they cling to the vining wire they've been carefully attached to, while some of their pods have been bagged up like surgical mittens.

"These are our F1 parents, sown by hand," explains Dekalb breeder Gonzague de Gassart. "They're weak because they're isolated — each plant represents an individual line and will yield 5-15g of seed. But they should have the phenotypes we're after and some of them will go on to become the parents of the next generation of Dekalb hybrids."

Around 8000 lines are assessed every year across this 60ha facility at Boissay, near Orléans, France, of which around 1200 are taken out to the field. It then takes about seven years to develop a line, to ensure it's stable, before it's crossed to produce an F1 hybrid. Dekalb's dihaploid programme cuts this down to just two years — a process whereby an embryo from the initial cross with half the genetic make-up (the haploid) is doubled up in the lab to produce a pure and stable cross.

But it's the traits breeder Matthew Clarke is

after. He's responsible for the DK lines that come to the UK. The parents of some of these now sit enclosed in large white tents across this 8ha field. A male line occupies the central third of each tent, flanked on either side by the female counterpart, with a box of bees busily employed to transfer pollen from one to the other.

Testing stations

Each tent produces enough of the hybrid to send out to trial plots and testing stations across Europe and further afield. In the UK that translates to a total of around 7000 plots that Matthew oversees to hone in on the particular lines of interest. As at all Dekalb sites, these are tested without fungicides and at high seed rates (70/m² in the UK) to identify the more robust types.

"The Boissay site has a good track record of producing some of Europe's leading OSR lines, ever since the beginning of the '00' story over 40 years ago," says Matthew. "We were the first in the market to start talking about traits, and the team at Boissay have used marker-assisted selection over the past 20 years. This has helped introduce and fix major gene traits like RLM7 phoma and pod shatter resistance as well as characters like Clearfield and the semi-dwarf habit into the crop."

The breeding programme aims to combine these traits both with one another and with steady improvements in yield and quality as well as polygenic disease resistance, vigorous establishment, environmental stress tolerance and differing rates of autumn and spring development.

But progress in improving these complex traits has been limited, Matthew admits. "They're governed by many genes, each with a relatively small effect. This makes them far less responsive to traditional marker-assisted selection."

So the team has somewhat turned the whole product concept on its head. "These days we're following hundreds of genes, rather than just one or two. Instead of working towards incremental advances, we can move the whole breeding programme on as one — new traits will simply add to the existing suite of traits we already have."

The concept is known as genome-wide selection, explains Dr Pauline Bansept-Basler, a senior breeder at Boissay. "Starting with our most successful hybrids, we genetically profile them, identifying whole blocks of their genomes that are distinctively associated with the high performance package they are carrying, including the hybrid vigour effect unique to them."

This links the phenotypic information — what the breeder sees in the field — with genotypic data. Clever algorithms and machine learning are then brought in to sift through the massive resulting datasets.

"Knowing what we are looking for, we then actively seek these blocks of genes in our parent lines. Indeed, with the genetic mapping and data processing capacities we have today we have models that allow us to estimate with considerable accuracy the overall breeding value of parents for the ▶



Gonzague de Gassart is looking to fix the desired phenotypes into the parents of the next generation of Dekalb hybrids.



Dekalb's dihaploid programme, run from its recently expanded facility at Boissay, cuts the time taken to develop a line from seven years to just two.

► outcomes we desire — we can predict the probability of success with a hybrid before we actually sow it.”

Expect to see the fruits of these developments come through in around four to five years' time in commercial lines, says Matthew. And now, as a subsidiary of Bayer, the Dekalb breeding programme may be set for further advances.

“New breeding technologies such as CRISPR are in use in the US. This makes it possible to edit a gene of interest to bring about a particular trait. We're not using these

techniques in Europe, but once we know the desired outcome, we can reverse engineer a variety through more traditional techniques.”

The digital farming platform, FieldView, may bring further insight into this interaction between plant performance and environmental conditions. Developed and delivered by Bayer subsidiary, The Climate Corporation, it's a platform that's claimed to help farmers gain a deeper understanding of their fields through tools that collect and store data. Real time localised environmental data is related to the actual crop and its management to provide a personalised field insight.

Although mainly a platform for corn and soya growers, FieldView's feeding data through from more than 25M paid ha across the US, Canada, Brazil and Europe, and Bayer claims this is set to rise to 36M ha in 2019. “Increasingly we're feeding the trials data through into the FieldView platform to provide the link between climate and genetics,” notes Matthew. “It's about providing the right hybrid in the right place at the right time.”

This could even lead to breeding assistance with problems such as cabbage



Pauline Bansept-Basler (left) inspects some of the latest Dekalb hybrids in the plots at Boissay with Matthew Clarke.

stem flea beetle, he indicates. “With our advanced material, we are seeing some lines that are more interesting than others. This big change in data-processing capacity will help us bring such traits forward.”

But for now he insists that marker-assisted selection will continue to remain an important route for introducing and fixing new traits involving relatively few genes into the Dekalb portfolio, pointing out that the team are adding new markers to their library the whole time.

Turnip yellows virus resistance (TuYV) is a trait Dekalb will bring through in a ►

Top of the plots

The visit to Boissay is a valuable opportunity to review the latest varieties from Dekalb, that are lined up at one area of the site. Agrii's David Leaper is on hand to give his view of how they've fared, alongside Matthew's.

Newly recommended for the North on the AHDB Recommended List is DK Exsteel. With a gross output of 104% of controls, it has disease scores of 7 for light leaf spot and 8 for stem canker. “It was the highest yielding in our trials, but has sold out,” reports David.

“Its only downside is it grows a bit tall — it's a big beast,” says Matthew. “In terms of establishment, it's mid-range — it's out as fast as DK Expedient and close to DK Exalte. It performs similarly in the spring, not as early to flower as DK Extrovert.”

DK Exstar is the new variety on offer this autumn, although you won't see it on the RL. “Some issues with an early seed production field meant we had problems with supplying RL trials,” says Matthew.

“But it's the most disease-resistant variety I've ever bred, with an 8 for both LLS and phoma. It's considerably shorter than Exsteel and stiff although doesn't quite have its top end yield.”

David confirms there's a higher commercial volume of Exstar seed available. “It's our first year with the variety, but we're sharing the risk of establishment with the grower and Dekalb through their pilot Establishment Support

Scheme (see panel on p88).”

DK Exclaim has a yield score on the 2017/18 RL of 105, with a 9 for phoma and 6 for LLS. “It's the highest yielding variety in the DK network, but it's not had as much take up as others. It's later to develop through the year.”

The variety's been on the market for two years, reveals David. “It's a solid performer, producing plenty of biomass, but it's been somewhat eclipsed by DK Exalte — it's the one that got away.”

Matthew picks out DK Expedient for its speed of development. “It's faster than Extrovert, stiffer than DK Expower and very early.”

David agrees. “There was a high infestation of cabbage stem flea beetle at our trial site in Trumpington. An assessment of early recovery in the spring showed Expedient suffered the least amount of larval damage.”

DK Extremus (code CWH391) could be set to be the next pan-European blockbuster, suggests Matthew. “It's very predictable in yield, coming top in both the UK and the Nordics. It also has good disease resistance and is shorter than DK Exsteel, with a good resistance to lodging.” The variety's listed in France, making it available across Europe, although it's only in NL1 trials in the UK, with limited seed availability.

The two varieties with TuYV resistance closest to market are DMH432 and WRH539. “Both are in NL2 in the UK and we're hoping for



DK Exsteel is a big beast, highest yielding in Agrii trials.

registration this autumn,” reports Matthew. “They're quite short and in NL1 scored 105 and 102 respectively for gross output, with an 8 or 9 for phoma and 6 or 7 for LLS, so they're strong contenders.”

DK Impressario CL could be the variety to wrestle the Clearfield crown from DK Imperial CL, Matthew suggests. “Introduced last year, it has an edge in terms of outright yield potential.”

Currently around 20% of the UK certified seed market is grown with Clearfield varieties, by growers with specific broadleaf or volunteer OSR contamination issues, notes David. “Impressario is a variety we're quite excited about because it's probably the fastest autumn developer of the Clearfield line-up. But I'd advise to only grow Clearfield if you have a problem as there's still a yield lag from the leading hybrids. Also, grow one that's been well tested in the UK, so you know how it will perform.”

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OSR hybrid breeding



Genome-wide selection involves genetically profiling the most successful hybrids and using this information to actively seek blocks of genes in the parent lines.

► commercial line in the near future, Matthew confirms. “We have material in the second year of National List trials (NL2), and it’s present in much of our pipeline.”

The trait is encouraged in France where there are tax credits available for more

Refund scheme for establishment failures

DK Exstar is the first variety to come under Dekalb’s Establishment Support Scheme, refunding growers fully 50% of their seed costs for crops failing to establish this autumn.

Those wishing to take advantage of the scheme do so by opting into it with their merchant when buying their seed — which comes complete with the new seed treatment, Acceleron — and registering their participation at www.dekalb.co.uk

The seed has to be sown by 15 Sept and any parts of the crop failing to establish by 15 Oct automatically qualify for a 50% seed cost refund from the merchant who will, in

turn, be refunded by Dekalb.

“Through the scheme we’re sharing the risk of establishment failure 50/50 with our growers,” points out Dekalb marketing manager, Mark Shaw. “We believe it’s the fairest thing to do, and also offers good value.

“We’ve also striven to make it as simple as possible and linked to what we believe to be the strongest genetics on the market supported with the best available seed treatment. This is all part of our commitment to helping growers make the very most of their OSR at the least risk.”

sustainable forms of pest management. “But I’m not convinced it’s adding that much

to our varieties — I was expecting to see a marked difference in yield performance that hasn’t come through in trials, so I suspect our material has a certain amount of background resistance built in.”

Clubroot resistance is proving a very complex trait to bring in. “Most breeders work with the same source material, but come out with different products. The disease itself is not straightforward and genetic resistance should not be relied on. In the meantime, we’re constantly looking for new forms of resistance.”

Matthew’s seeing some interesting progress on resistance to verticillium wilt, however. “We’re seeing big differences within our material and are digging through the data to determine the genetic markers. I suspect we’re seeing tolerance as well as resistance, though, and it can be difficult to identify in the field what interaction we’re actually seeing.”

Sclerotinia, however, is one disease with very limited potential for genetic resistance, he notes. But genome-wide selection is now helping bring on other, less specific traits that have until now seemed beyond the reach of breeders.

“Rooting is an area in which we’re particularly interested in moving forward, to bring improvements in drought tolerance. We’re beginning to realise that we’ve been accidentally selecting for rooting ability in many of our lines, although it’s a difficult trait to pinpoint and measure. That’s where management of big data can provide more certainty.

“We’re also bringing on improvements in oil quality, although if you actively select for it, oil yield can drop off. Our driving force has always been to produce robust varieties that deliver continual improvements in all-round strength for growers rather than improvements in particular areas at the expense of others,” concludes Matthew. ■

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EARLINESS AT FLOWERING	1 2 3 4 5 6 7 8 9
EARLINESS AT MATURITY	1 2 3 4 5 6 7 8 9
PLANT HEIGHT	1 2 3 4 5 6 7 8 9
LODGING RESISTANCE	1 2 3 4 5 6 7 8 9
STEM STIFFNESS	1 2 3 4 5 6 7 8 9
POD SHATTERING RESISTANCE	YES
PHOMA RESISTANCE	1 2 3 4 5 6 7 8 9
LIGHT LEAF SPOT RESISTANCE	1 2 3 4 5 6 7 8 9

All UK Recommended List 2018/19 Table 10 - Varieties not added to the RL:
<https://cecmex.ukrb.org.uk/varieties/ukrb-recommended-list.aspx>

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