

NITROGEN EFFICIENCY

AN IMPORTANT TRAIT
FOR OILSEED RAPE
FARMERS

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N

Nitrogen

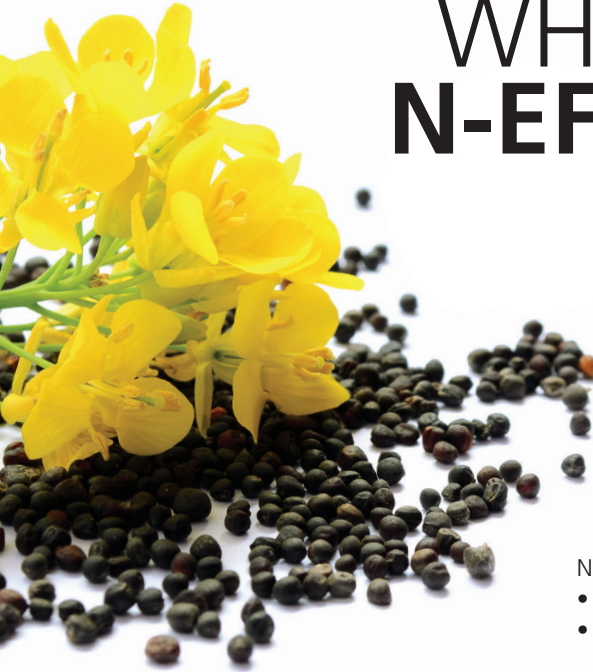
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WHAT DOES N-EFFICIENCY MEAN?



N-efficiency is the ability of a plant to generate more yield than average with the same amount of available N.

N-efficiency is impacted by two components:

- **N-UPTAKE** efficiency
- **N-USE** efficiency

N-UPTAKE efficiency

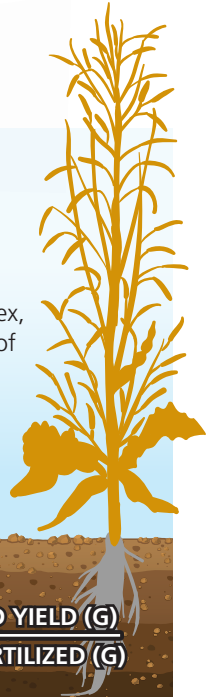
N-uptake efficiency describes the nitrogen use while the plant is actively growing:



$$\text{N-UPTAKE EFFICIENCY} = \frac{\text{N IN BIOMASS AT FLOWERING (G)}}{\text{N FERTILIZED (G)}}$$

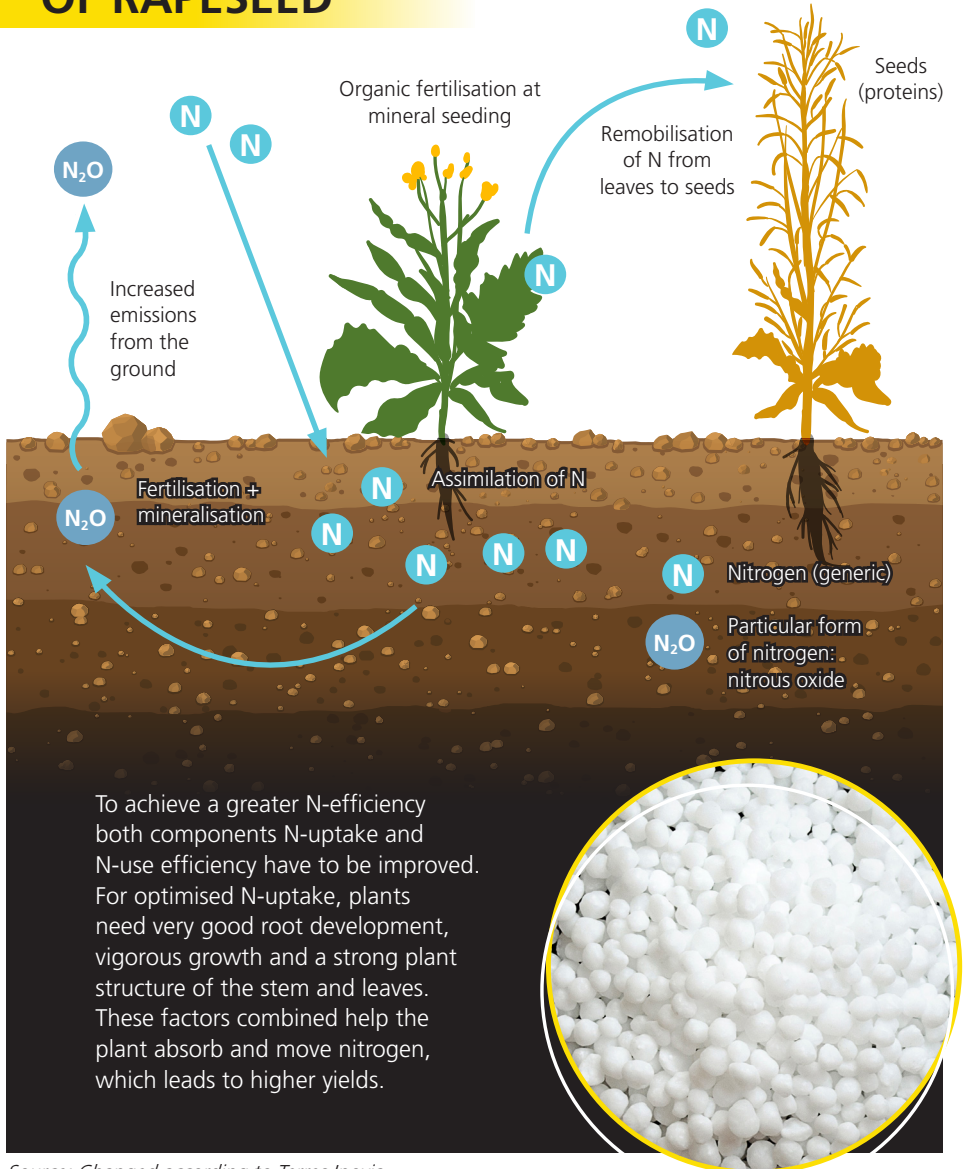
N-USE efficiency

N-use efficiency, also called the harvest index, describes how much of the available N in the field was used by the plant and transmitted to grain yield.



$$\text{N-USE EFFICIENCY} = \frac{\text{SEED YIELD (G)}}{\text{N FERTILIZED (G)}}$$

N USAGE OF RAPESEED



To achieve a greater N-efficiency both components N-uptake and N-use efficiency have to be improved. For optimised N-uptake, plants need very good root development, vigorous growth and a strong plant structure of the stem and leaves. These factors combined help the plant absorb and move nitrogen, which leads to higher yields.

BREEDING PROGRESS IN NITROGEN EFFICIENCY



In the wake of the Fertiliser Ordinance, the efficiency of varieties in terms of nitrogen use is increasingly coming to the forefront. N-efficiency has long been an important breeding goal at RAPOOL, not only since the Fertiliser Ordinance.

48 YEARS OF YIELD PROGRESS

In addition to good farm management, the seed placement and the root space that can be developed impact the variety performance. This makes the variety's breeding performance critical for nitrogen efficiency. Newer oilseed rape varieties are not only superior to older ones in terms of stress tolerance, they have been selected for enhanced root system, which enables them to better tap and use the nitrogen in deeper soil layers.

Multi-year cultivation trials on breeding progress with winter oilseed rape varieties of different approval years from 1970-2015 show that an annual yield progress of approx. 0.42 decitonnes per hectare has been achieved over the past 45 years.

New high-yielding varieties can also convert limited nitrogen fertilisation into grain yield more efficiently than older varieties. In the 2018 and 2019 crop years, winter oilseed rape from the 1970 approval year (Diamant) requires an average

of approximately 5.6 kg/ha of nitrogen per decitonne of grain yield, whereas the comparison variety (Bender) from the 2015 approval year requires only 3.1 kg/ha of nitrogen per decitonne of grain yield. Current top varieties from the RAPOOL range show even higher nitrogen efficiency. This clearly shows that the best N utilisation efficiency is also achieved with the highest-yielding variety.

Further cultivation trials from 2015-2019 with reduced nitrogen fertilisation showed that the grain yield decreases by about 1.4 decitonnes per hectare when nitrogen fertilisation is limited from 170 kg N/ha to 120 kg N/ha.

However, these trials also showed that oilseed rape can compensate for the reduction in nitrogen fertilisation by about 50 kg/ha with up to 0.6 % higher oil content on the market. This clearly shows that rape is a real alternative for sites in nitrate-polluted areas in the future.





ENVIRONMENTAL FACTORS THAT INFLUENCE N-EFFICIENCY

Environmental factors influence varieties with the same intensity, but some of the varieties can adapt to this biotic and abiotic stress better than others. This shows our breeders the genetic prerequisites of the different varieties. The main characteristic to select for a higher N-efficiency is the grain yield. Varieties, which are all at the same location with the same treatments of plant protection and fertiliser, have

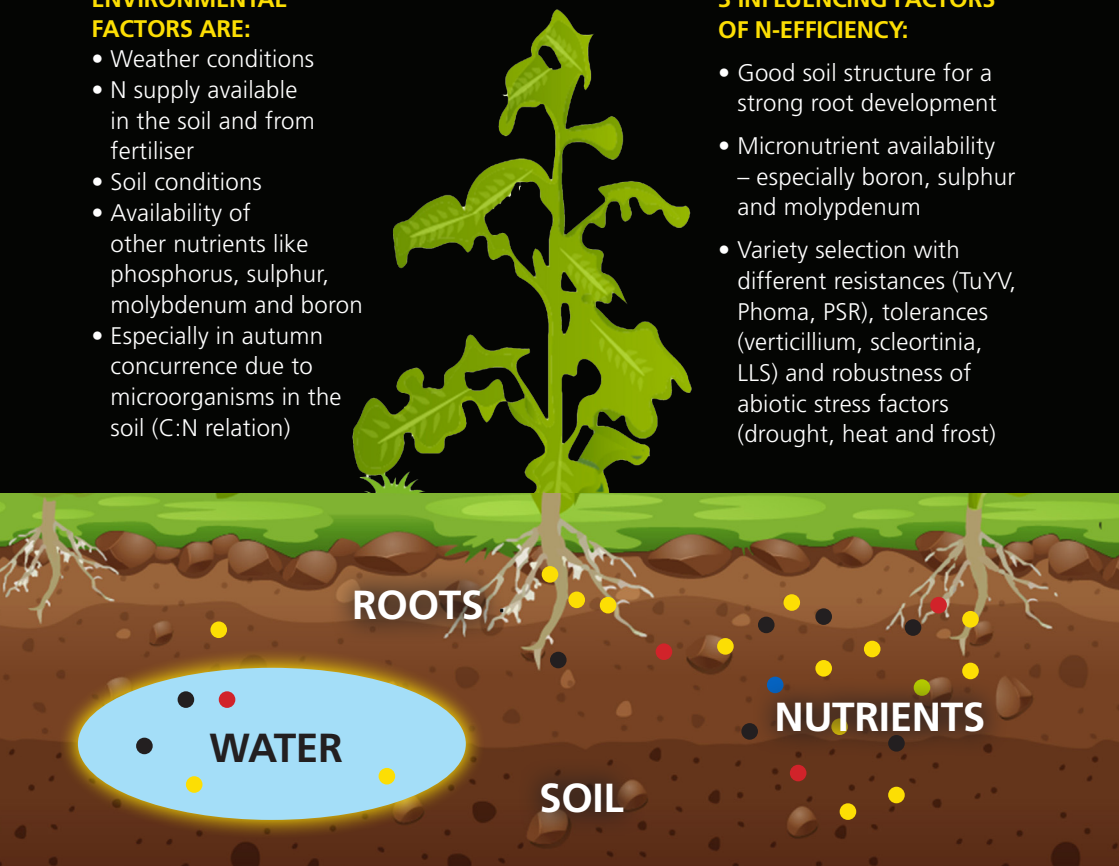
the same environmental factors to cope with. The highest yielding varieties have a stronger genetic package to generate more yield with the same amount of nutrients, which means they have a better N- efficiency. These hybrids will be chosen to go further in the breeding process. All hybrids that yield lower than the check variety, are automatically removed from further testing.

ENVIRONMENTAL FACTORS ARE:

- Weather conditions
- N supply available in the soil and from fertiliser
- Soil conditions
- Availability of other nutrients like phosphorus, sulphur, molybdenum and boron
- Especially in autumn concurrence due to microorganisms in the soil (C:N relation)

3 INFLUENCING FACTORS OF N-EFFICIENCY:

- Good soil structure for a strong root development
- Micronutrient availability – especially boron, sulphur and molybdenum
- Variety selection with different resistances (TuYV, Phoma, PSR), tolerances (verticillium, sclerotinia, LLS) and robustness of abiotic stress factors (drought, heat and frost)



HOW ARE RAPOOL BREEDERS SELECTING VARIETIES FOR INCREASED N-EFFICIENCY?

N-efficiency is not a trait like the resistance against Phoma or TuYV. N-efficiency is influenced by different genetic and environmental factors.

GENETIC FACTORS INCLUDE:

- Development of the root system
- Development of the stem and leaves
- Healthiness of the plant
- Vigour and yield potential


Infection of plants with *Phoma lingam* or Turnip Yellow Virus (TuYV), which is transmitted by aphids in the autumn. The aphids cause leaf blight in autumn, which damages surface and blocks the phloem. This leads to a yield reduction by at least 5-15% for TuYV and up to 100% for Phoma (with complete plant death).

Nitrogen is a source of 'energy' for plants. Its deficiency leads to stunted growth, reduced leaf surface, and yellowing of the plant – especially on the older leaves. If rapeseed plants are deficient their development is retarded. All of these factors have an effect on the yield, because it reduces the possibility of realising the yield potential of the plant.


The soil fungi *Verticillium longisporum* has become increasingly more and more evident in crop rotations where rapeseed is grown more intensely (up to 33%). The typical signs are stripes on the stems. The disease causes partial or complete wilting and in extreme years, it can reduce yields by up to 1.5 t/ha.




RAPOOL



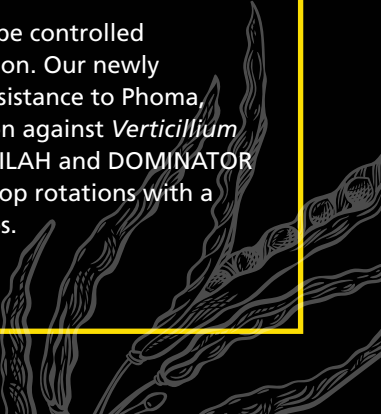
Our new hybrids, such as MANHATTAN and JANOSH are resistant to Phoma and TuYV. Disease resistance helps guarantee strong plant health in autumn and spring. This comprehensive protection ensures high tolerance to stress under changing climate conditions and offers greater flexibility in crop management.



Hybrids with TuYV resistance also offer better nitrogen use efficiency. Hybrids such as JUREK, MANHATTAN, TEXAS and JANOSH have stronger root growth biomass accumulation, which allows nitrogen consumption in the autumn period. This is an advantage which allows a more productive use of nitrogen in the spring and ensures better profitability.



Verticillium longisporum can be controlled effectively by breeding selection. Our newly developed RImS system for resistance to Phoma, also provides strong protection against *Verticillium longisporum*. The hybrids AKILAH and DOMINATOR are the perfect solution for crop rotations with a short cycle of cruciferous crops.



JUREK

A RELIABLE CHOICE FOR YOUR FARM



Jeanne Geißler
Product Management
RAPOOL International

- **Highest usage of limited nitrogen**
 - **Very good tolerance against verticillium**
 - **Very fast autumn development**
- JUREK shows a strong vigour and has a fast development in autumn, which is underlined in our results of the late sowing trials in 2020/21. With this vigour JUREK is able to use the available N already in autumn from deeper soil layers.
- In spring time JUREK starts right away very quick and shows the same vigorousness as in autumn. More over the development is very quick as well and JUREK starts early with flowering with a medium maturity for a comfortable timeline of grain filling for high yields.
- At maturity JUREK has a very good lodging resistance due to the medium plant height. Also a good plant health at maturity as shown in the official trials in CZ for Verticillium, Phoma (RLM7) and Sclerotinia.
- The package of JUREK is completed with the resistance to TuYV. All these characteristics and traits lead JUREK to a very N efficient variety also at lower N levels shown in internal N trials.

JANOSH

- **Leading yield level and stability proven by official trials in Europe**
- **Advanced plant health with (Rlm7 & TuYV) for long-term protection**
- **Modern N-efficiency and lodging resistance offer more flexibility in spring management**

- JANOSH has a balanced development before and after winter to ensure a good winterhardiness. The beginning of flowering is mid to late to be aware of late frost. In case of N fertilization JANOSH is very flexible regarding the dosage and the timing of N due to the balanced start also after winter.
- JANOSH provides the whole package of health traits and characteristics like TuYV, RLM7 and Verticillium tolerance.
- The balanced to strong development in autumn insures a good winterhardiness and root development for a very good N uptake already in autumn.
- The healthiness during autumn and spring until harvest allows JANOSH a very efficient transmission of N into grain yield at harvest time. This is very good visible in internal trials on different N levels.

A HIGH PERFORMER WITH VIRUS-RESISTANCE



Rene Brand
Product Management
RAPOOL International



IN A WORLD AFFECTED BY CLIMATE CHANGE, **RAPOOL-RING PARTNERS WITH RESEARCHERS** TO ENSURE GROWERS CAN RETAIN AND EVEN BOLSTER YIELDS



CLIMATE CHANGE BRINGS new challenges to growers' doorsteps, not least among them rising temperatures which bring new pest and disease threats to their fields. The Government has also responded with new regulations concerning fertilisers. There are new restrictions on how much fertiliser growers can use.

Key to solving this challenge, as RAPOOL-RING has discovered, is partnerships. That's just what Artur Kozera, now a product manager for RAPOOL Polska, did when he recruited his university mate, Dr. Witold Szczepaniak, to devise the best fertilization systems for individual oilseed rape varieties.

Szczepaniak is a professor in the Department of Agricultural Chemistry and Environmental Biogeochemistry at the University of Life Sciences in Poznan.

"More environmental protection legislation can be expected in many European countries in the near future. This

will result in both the withdrawal of some crop protection products (active substances) and limitation of the level of nitrogen and phosphorus fertilization, the nutrients which constitute the biggest burden for the environment," says Szczepaniak.

Thankfully, companies like RAPOOL-RING are thinking ahead and partnering to breed new rapeseed varieties with climate change in mind. Enter researchers like Szczepaniak, who has worked with the RAPOOL-RING team for more than 20 years.

During that time, they have organized a number of seminars, training sessions and field workshops for oilseed rape producers, showing growers how to not only select the right varieties, but also how to properly prepare their fields and also design their fertiliser and crop protection schedule.

In plot trials conducted by RAPOOL-RING and their research partners in the academic world, it was observed that RAPOOL-RING's new oilseed rape varieties are hardier,



We are constantly searching for genetics that have resistance to disease, as well as tolerance to environmental stress factors caused by a changing climate.

**Artur Kozera, Product Manager
Oilseed rape RAPOOL Poland**



**Dr. Witold
Szczepaniak,
University of Life Sciences**

resistant to disease and better converted nitrogen absorbed from soil into high yield — just what farmers want.

“We are constantly searching for genetics that have resistance to disease, as well as tolerance to environmental stress factors caused by a changing climate,” says Kozera.

IMPORTANCE OF RESEARCH

Oilseed rape, like other crops, needs access to plenty of key nutrients to reach its yield potential. Nitrogen is primary among those nutrients, notes Szczepaniak. Researchers have discovered over the years that while each plant needs nitrogen to thrive, nitrogen is also a substance which constitutes the biggest threat to the natural environment.

Growers help protect the environment and also save money when they use less fertiliser. They also make their life easier by not having to worry as much about constantly changing regulations around the use of fertiliser products.

“Our research work accelerates not only breeding progress but also broadly defined oilseed rape agronomics. As a result of this — despite variable weather conditions and a resulting rise in disease and pest pressure — it’s possible to retain or even increase oilseed rape yields,” adds Szczepaniak.

USING THE RIGHT VARIETY

The key to success, of course, is using a rapeseed variety that will thrive and yield well when less fertiliser is used.

RAPOOL’s rapeseed varieties are very efficient at using nitrogen which is already present in the soil, notes Szczepaniak.

“Only plants properly provided with nutrients are able to develop normally and give high yield. It’s not only important to plan and implement fertilization, but also to correctly match varieties to farming conditions,” he says.

The right variety should not only have high yielding potential but also high tolerance to abiotic stress factors (low and high temperatures, periodical droughts) and biotic ones (pest and diseases), he adds.

“That is why RAPOOL-RING breeders should continue their work on varieties with new resistance to pathogens, and also on introducing varieties which would be very flexible in adjusting to variable weather conditions, which in consequence will increase the efficiency of both managing nitrogen and other nutrients.”

Kozera adds that RAPOOL-RING stands out among other breeders as it constantly searches for such varieties which will have resistance to fungal, viral diseases or tolerance towards environmental stress factors caused by the changing climate.

“As a result of our works on trial plots, we see that new varieties more efficiently convert nitrogen absorbed from soil into yield. Such varieties include TEMPTATION and JUREK. These varieties result from long-term work of our breeders,” Kozera says.

“Farmers need to optimize production costs. We should remember that oilseed rape stays in the field for 11 months. During this time, it is exposed to diseases and pests and also abiotic stresses. Only the best, healthiest and also best-yielding varieties may face such a challenge.



NITROGEN-EFFICIENT VARIETIES ARE HELPING CHANGE THE GAME IN OILSEED RAPE

Research backs up what farmers who grow RAPOOL-RING oilseed rape already know — these varieties are more nitrogen efficient and can help save farmers money on fertiliser.

WHEN UNIVERSITY OF GIESSEN plant breeding researcher Andreas Stahl looked at modern varieties of rapeseed (among them varieties created by RAPOOL-RING) and compared them to older varieties of oilseed rape, he discovered something important: modern varieties are significantly more efficient at using nitrogen.

Nitrogen is among the most important plant nutrients farmers apply to achieve a high yield and high productivity, notes Stahl. On the other hand, unused nitrogen can escape from the agricultural production system as it is not always completely taken up by the plant, and nitrogen residues can cause severe damage to ecosystems.

“That means we need higher nitrogen use efficiency in oilseed rape varieties,” says Stahl.

Modern genetics allow the plants to better take up

the needed nutrients, and Stahl believes these improvements will only gather speed in the future as breeders become even better at doing their work.

“Modern genetics will contribute to a more environmentally friendly production of crops in general, but especially in oilseed rape, where growers are challenged to use less fertiliser due to new regulations and an overall concern for the environment,” adds Stahl.

WINNING COMBINATION

Higher nitrogen use efficiency offers growers the potential to cut their fertiliser costs, saving money and helping the environment at the same time — a winning combination in the world of farming, especially at a time when farmers are having to decrease fertiliser use, says Jeanne Geissler, product manager international for RAPOOL-RING.

“Growers who use these varieties tell us the plants are healthier and are better able to withstand weather and climate challenges, even when fertiliser use is reduced,” says Geissler.



Prof. Dr. Andreas Stahl, Julius Kühn Institute - Federal Research Centre for Cultivated Plants

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Growers who use these varieties tell us the plants are healthier and are better able to withstand weather and climate challenges, even when fertiliser use is reduced.

Jeanne Geissler, Product Manager International



RAPOOL-RING's oilseed rape varieties provide the whole package in a modern hybrid. The biggest step RAPOOL recently made toward nitrogen efficiency was the introduction of the new standard trait turnip yellows virus (TuYV) resistance. The resistance to TuYV has a positive influence on plant vigour and root development.

TuYV resistance is now standard in RAPOOL varieties, as are tolerances to other diseases like light leaf spot, verticillium and sclerotinia. Resistance to pod shatter and winter hardiness are built in as well. TEMPTATION, one of the standout hybrids in the RAPOOL portfolio and the most popular one in eastern Europe, is an example.

“Newcomers like JUREK, MANHATTAN and JANOSH are more efficient with nitrogen because they are better able to withstand environmental stress, much of it due to climate change. The plants do not expend excess energy coping with those

environmental stresses, and are able to put their energy towards yield,” Geissler says.

As oilseed rape farmers look for new tools to help them cope with climate change and reduce their fertiliser use, modern breeders like those at RAPOOL-RING are showing through extensive research that their groundbreaking new varieties are the real deal to help growers deal with the consequences of climate change.





MAXIMISE NITROGEN IN AUTUMN AND **CONSIDER GROWING MODERN HYBRIDS**

CONSIDERING OILSEED RAPE farmers face new challenges like climate change and restrictions on nitrogen, we consulted two agronomy experts for some tips on how to be successful in the field this season. Albin Gunnarson is a Swedish agronomist and member of the Global Council for Innovation in Rapeseed and Canola. Ferenc Kornis serves as managing director for N.U.

Agrar in Germany, a private plant production consultancy.

Together, they have advised countless farmers over the years when it comes to variety

selection, fertiliser application and seeding. They had the following tips for success.

Select a winter hardy variety. Sweden is about the most northern part in Europe where winter oilseed rape can be grown. Winter hardiness is an important issue, especially in the age of climate change where many areas are experiencing extreme cold events in winter. Rapeseed plants that are healthier and in better shape can stand and survive winter much better than others. Winter hardy varieties are strong and stay in healthy shape despite adverse conditions.

Put in more nitrogen in the autumn. In many parts of the EU including Sweden and Germany, 60 kilos of nitrogen per hectare is the maximum level allowed in the autumn months. The experts recommend putting more nitrogen down late in the year and



Ferenc Kornis,
Managing Director for N.U. Agrar



less in the spring. This is to help the plant to grow big enough to survive the winter with eight to 10 leaves. Considering high fertiliser prices and supply chain difficulties, farmers are advised to apply the maximum allowable amount in autumn in order to give the plants a healthy start and get them through the winter — yield can even increase up to 20%. After a poor harvest of the previous crop, the surplus nitrogen must be taken into account and can be saved in the total demand.

Optimise your total nitrogen rate in spring. Going by the experience of Swedish farmers, one kilo of nitrogen uptake in autumn is worth 1.7 kg in the spring. Applying more nitrogen during autumn allows you to save nitrogen in spring.

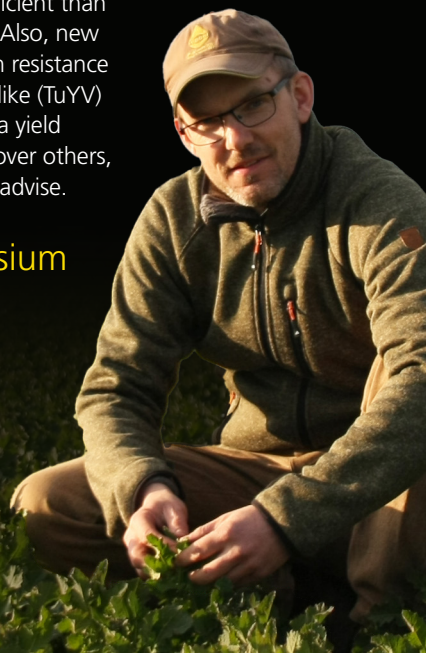
Pay attention to other nutrients besides nitrogen. Plants don't only need nitrogen; potassium and phosphorus are also a key to success. Putting these nutrients in the deeper soil layers in high concentration (in depot), can result in plant roots being better able to take up nutrients. Using nitrogen, phosphorus and potassium along with nutrients like manganese, magnesium

and boron results in significantly better winter hardiness. Using fertiliser with sulphur is also ideal to maximise the nitrogen efficiency.

Pay attention to seeding rate. Reducing seeding rate in the fall can be hugely helpful in saving on fertiliser without impacting yield. The seeder that offers the fastest emergence will generally be the best. Never seed more than 50 plants per square meter. If you plant more than this, the plants begin to compete with one another. 25-45 plants per square meter in spring is ideal. The bigger the individual plant, the fewer are necessary.

Modern hybrids have an advantage. Varieties released over the past five years are fast-growing in autumn, meaning they tend to be hardier and more nitrogen efficient than older ones. Also, new hybrids with resistance to diseases like (TuYV) could have a yield advantage over others, the experts advise.

Using nitrogen, phosphorus and potassium along with nutrients like manganese, magnesium and boron results in significantly better winter hardiness.



Albin Gunnarson, Global Council for Innovation in Rapeseed and Canola



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