HYBRID RYE

PRODUCTION GUIDE

SEEDING
THE FUTURE
SINCE 1856

KWS

KWS GROUP

Serving farmers for **over 165 years**

KWS sows the future. Our high-yielding seeds and extensive knowledge make us a trusted partner of farmers; and we have been for generations. In this way, we contribute to solutions for the nutrition of a steadily growing world population. We are constantly improving genetic potential through excellent research and breeding programs. We tailor our seeds to the needs and requirements of our customers to deliver the very best quality, and we are a strong partner throughout the value chain.

KWS Group is a leading breeder of hybrid rye, with a long-term hybrid breeding program established in the mid-1980s. Hybrid rye was first introduced to the United States in 2016, and since its arrival, has flourished across many parts of the country.

KWS Hybrid Rye is a highly efficient crop tailored to medium to light soils. High yield, quality, and agronomic characteristics such as winter hardiness, drought tolerance, standing ability, and disease resistance are a few of the key attributes of this crop. High importance has also been placed on selecting and breeding varieties of hybrid rye with ergot resistance through our PollenPLUS® technology. These attributes allow flexibility for farmers to rotate it with other crops, which helps in preventing soil depletion, managing pests and diseases, and improving soil health.

KWS offers Hybrid Rye varieties for both forage and grain production (for feed grain, flour, and distilling). This crop is taking the malting, milling, and livestock feeding industries by storm.

KWS believes this highly productive cereal offers new perspectives for farmers and end users alike!

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Why KWS Hybrid Rye?

"The highest yielding small grain with the service to stand behind it."

Hybridizing rye allowed for a rapid increase in yield potential by influencing the number of grains produced per ear and combining this advantage with robust hybrid vigor. Yield progression of KWS Hybrid Rye continues to outstrip that of conventionally bred cereals. The yield benefit of KWS Hybrid Rye over conventional rye has increased by almost 20% since the early 2000's and by over 45% since the 1980's when the KWS Hybrid Rye breeding activities first began.

Hybridization has also minimized the risk of ergot infection by allowing breeders to introduce our PollenPLUS® technology and by reducing the time required for pollination to occur.

Rye has a higher photoperiod response than other cereals, making it well adapted to northern regions of the US. KWS Hybrid Rye seeds germinate quickly because of their ability to imbibe or absorb moisture easily. In general, for germination to begin, a seed needs to achieve a moisture content of about 35 - 45% of its dry weight. Growers have noticed fast germination even in seemingly dry soil.

To view our current portfolio, scan the QR code or visit **www.kws.com/us**

Yield Potential
KWS Hybrid Rye has a very high yield potential. Yields have reached over 200 bu/acre in prime conditions, management, and regions. This makes KWS Hybrid Rye the highest yielding small grain on the market.

Uniformity
Compared to open-pollinated rye varieties, KWS Hybrid Rye has a uniform crop height and time to maturity.

Drought Tolerance
20% less water usage compared to winter wheat[1]. 18 gal/lb less than corn. 12 gal/lb less than wheat.

Ergot Protection and Disease Resistance
Built-in ergot protection with KWS' patented PollenPLUS® technology, high disease resistance to fusarium, strip rust, leaf blotch (scald), take-all (*gaeumannomyces graminis),* wheat streak mosaic, and triticum mosaic-virus.

Sustainability Qualities
Increased crop residue produced to reduce erosion. CO_2 efficient and lower greenhouse gas footprint than other small grains and corn. Produces 5 lbs less CO_2/bu than wheat and 6.7 lbs less than corn[2].

Lodging Tolerance
Better straw stiffness which provides excellent lodging tolerance. Excellent straw tonnage and quality. 1/3 more straw than wheat and barley. This can be an additional income stream if straw is not needed for livestock.

Lower Inputs
KWS Hybrid Rye is planted at a lower seeding rate than most cereals. It needs less fertilizer and chemicals and has minimal to no drying requirements resulting in lower crop input needs and costs.

Crop Rotation Benefits
Adding KWS Hybrid Rye into a crop rotation could result in: increases in yield in subsequent corn and soybean crops[3], increased soil organic matter, and breaking disease and pest cycles including mitigating the impact of corn rootworm resistance.

Manure Utilization
KWS Hybrid Rye utilizes excess manure well in the fall and spring, and reduces soil nitrate levels following fall-applied manure. Spreads seasonal workload and allows earlier manure application.

Forage Source
KWS Hybrid Rye is an excellent forage source of protein and highly digestible fiber.

Hybrid Vigor
Simply put, KWS Hybrid Rye has more growth above and below the soil surface. The more robust root system improves drought tolerance.

Winter Hardiness
KWS Hybrid Rye is the most winter hardy cereal crop. It can germinate in temperatures as low as 33°F in the fall. In the spring it will begin to grow at 38°F.

Adaptability
KWS Hybrid Rye can be established in a variety of soil types and qualities, including rich organic soils and poor sandier soils.

Weed Control
Trials have shown KWS Hybrid Rye competes intensely against weeds, reducing the viability of weed seed up to 60%. It exhibits an allelopathic effect on weeds. The hybrid vigor allows the KWS Hybrid Rye plant to move through stem elongation faster than any other cereal which outpaces and shades weed growth.

1) Sparing use of resources | Nitrogen requirements (draft Fertilizer Ordinance, Dec. 16, 2015, N uptake for wheat 2.51 kg/dt, N uptake for rye 1.96 kg/dt); Water requirements (Lower Saxony State Authority for Mining, Energy and Geology 2011); Need for pesticides (LfL contribution margins and calculation data, LfL Bavaria, 2016); CO2 footprint (averages for the German NUTS 2 regions (BMEL, 2009))
2) University of Netherlands http://webapplicaties.wur.nl/software/feedprintNL/index.asp
3) https://practicalfarmers.org/2024/09/crop-rotation-analyzer-case-study-hybrid-rye-pencils-out/?utm_source=sgn&utm_medium=email+#msdynttrid=cCtsjavNrcJ1tr1gKSMD07NxupOzZ5MFtm_kWgQ2ydE

Ergot

Ergot is a fungal disease affecting common cereals including rye and grasses during flowering. The mycotoxins that the fungus produces are highly toxic to humans and livestock.

The sclerotia (black ergot body) survives in the soil and produces a stalk that emerges at the same time as heading in most grasses and cereals. This stalk produces thousands of ascospores that spread by wind. When the cereals and grasses flower, their natural response is to receive pollen to produce a kernel. If there is little or no pollen available, but ergot spores are available, the ergot spores invade and replace the kernels with a hard, purple-black sclerotia or ergot body.

Ergot can also be a significant issue if there have been natural or man-made stresses on the plant which lead to poor pollen production or sterility.

Keep a good eye on the field during the last 3 weeks before harvest and observe if some areas of the field have more ergot presence than other areas. If so, leave the infected areas and harvest them separately, so as not to infect the whole grain lot.

Ergot Agronomic Risk Factors

- Unsynchronized flowering - caused by wide row spacing – greater than 10”-12”.
- Poor depth control which leads to uneven emergence.
- Excessive physical damage (like tire tracks) and travel on the crop after elongation.
- Unbalanced fertilizer program.
- Field drown outs and edges can create extended tillering times.
- No-till or minimum tillage can pose a higher risk for ergot because sclerotia that are present will readily germinate.
- Sclerotia can survive on and in the soil for up to 2 years.
- Misapplied growth regulator, fungicide, and herbicide.

Best Management Practices to Reduce Ergot

- Monitor other crop and weed sources of infective material like: barley, oats, fescue, triticale, perennial ryegrass, timothy, quackgrass, bromegrass, etc.
- Grass margins do pose a risk by providing a reservoir of secondary inoculum that could infect rye, particularly late tillers around the edge of the crop. Consider mowing unwanted grass in and around field before heading to limit infection. Continued use of cereal and grass cover crops can perpetuate ergot presence from year to year.
- In cases of heavy ergot sclerotia, use adaptive deep tillage to bury the sclerotia to avoid infections.
- Purchase new quality assured or certified seed each season.
- If irrigating, irrigate before flowering and then continue irrigation once flowering has completed. KWS Hybrid Rye completes flowering at a rapid pace, so irrigation timing should not be interrupted.

PollenPLUS®

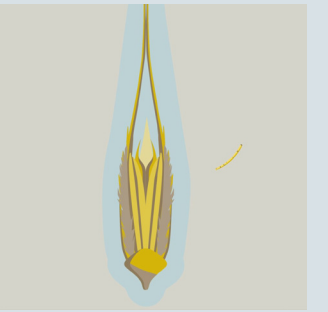
The innovative PollenPLUS® technology from KWS ensures significantly improved pollen formation in Hybrid Rye and effectively strengthens the plants’ resistance to ergot. In June 2017, KWS filed a patent for the Rfp1 gene. This patented enhanced restorer gene used in Hybrid Rye increases pollen shedding which prevents the fungus from penetrating the stigmas. The flowers are fertilized faster, and the glumes close sooner – meaning KWS Hybrid Rye has the best possible ergot protection.

With PollenPLUS®, ergot infestation is considerably reduced. KWS produces only 100% F1 PollenPLUS® hybrid seed to maximize ergot defense and yield performance, benefiting both farmers and end users now and in the future.

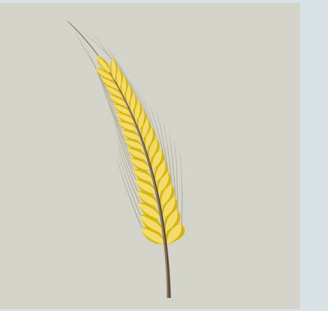
Minimal Ergot Risk with PollenPLUS®

If the pollen count is low, ergot spores can penetrate the stigmas of the rye.

This results in an ergot infestation, which can jeopardize the harvest.

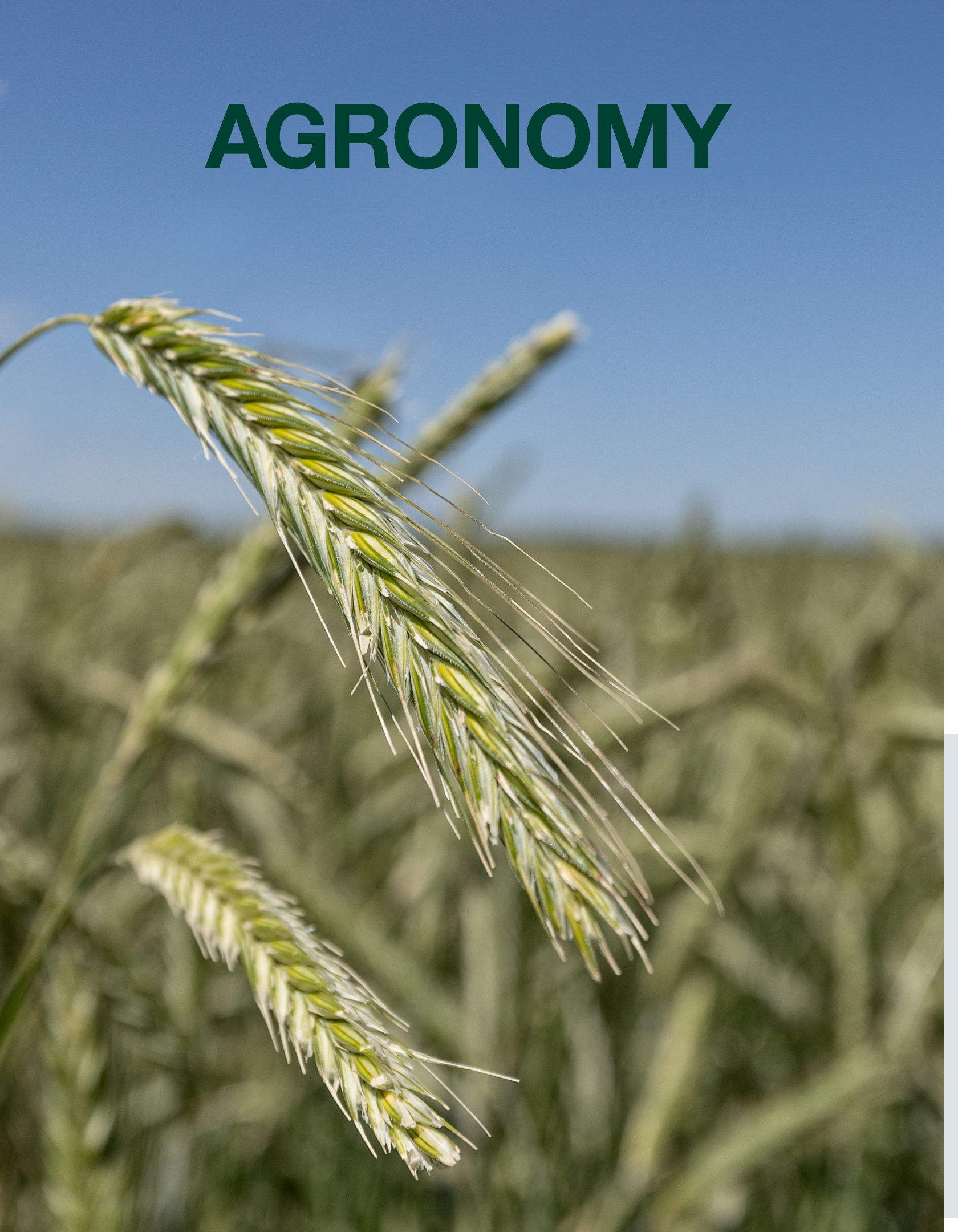


The PollenPLUS® technology ensures greater pollen counts that repel floating ergot spores.



The result: a strong and healthy KWS Hybrid Rye harvest!

AGRONOMY



Seeding

Maximize the potential of KWS Hybrid Rye with proper seedbed preparation, seeding rate, seeding depth, and a well calibrated planter.

Planter Calibration

Use the QR code found on the seed tag to utilize the KWS Hybrid Rye Seed Rate Calculator to find the number of seeds the planter should be laying down per foot of row. **Seed rate calculator can also be found on our website.*

Before going to the field, calibrate the planter to align with the seed rate calculator. Plant the precise amount needed for the field, at a rate that KWS Hybrid Rye will perform best.

KWS Hybrid Rye is packaged and sold in units. **1 unit of KWS Hybrid Rye seed is equivalent to 1 million viable seeds. **Our recommended seeding rate is 0.8 units or 800,000 viable seeds per acre.**

Depending on location, the ideal planting date is between mid-August and mid-October. However, southern regions have seen success at later planting dates. For optimal establishment, three weeks of good growing conditions are recommended. If considering late planting, there may be a need to increase seeding rate due to the risk of reduced emergence. Contact a local dealer or KWS team member with questions.

Ensure Success in the Field with these Tips

- Drilling depth should be uniform at a depth of 1-1.5 inches. Adjust speed according to field conditions to maintain adequate down pressure for consistent planting depth.
- Seedbed preparation is essential to achieve good seed to soil contact.
- Seedbed should be firm, with minimal clods, and previous crop residue should be well distributed to ensure a uniform seeding depth for even germination.
- Yield can be suppressed by reduced stand / poor emergence at seeding depths > 2.0 inches.
- Seed to soil contact is essential for an optimal stand.

HELPFUL TOOLS FOR YOU

Yield Calculator

Get an estimate of your yield potential.

Take a few samples on your field and enter the resulting numbers into this helpful calculator.

Seeding Rate Calculator

Use this quick and easy tool to calculate how many lbs of seed per acre you should be planting and seeds / ft of row for planter calibration.

Stand Evaluation Calculator

Check your stand on your fields in fall and spring, and calculate the approximate plant population per acre and plant per square foot.

Evaluating the Stand

Field evaluations are key to check for final population, diseases, pests, and yield potential. Evaluation should take place starting in the fall, approximately 2 weeks after planting, or when 2 to 3 leaves are present. Use the KWS Hybrid Rye Stand Evaluation Calculator as a guide. A second round of evaluations should happen as plants start to green-up in the spring when temperatures start to stay above freezing. It is always a good idea to bring a shovel to dig up some plants and a measuring device to calculate plants/square foot. Use the chart below as a guide:

Plants / Acre	Plants / Sq. Ft.
350,000	8.0
400,000	9.2
450,000	10.3
500,000	11.5
550,000	12.6
600,000	13.8
650,000	14.9
700,000	16.1
750,000	17.2
800,000	18.4
850,000	19.5
900,000	20.7
950,000	21.8
1,000,000	23.0
1,050,000	24.1
1,100,000	25.3

The calculated stand is not acceptable. **Please contact your dealer.**

The calculated stand is **acceptable**.

The calculated stand is **ideal**. Congrats!

BTW, the key to an ideal or acceptable stand is uniform plant spacing.

Spring Stand Evaluation Process

1. **Start with the roots** - This is the first part of the plant to become active! If there is soil sticking to the roots and the roots are white, this means they are alive and healthy.
2. **Evaluate plants and mortality across the field in the spring** - The aim is to have 17 plants per square foot, but if you have 10 plants per square foot that are evenly spaced, this is adequate for good yields.
3. **Note thin areas in the field** - Spots with few plants could allow for additional late tillering which will be at risk for ergot because they will flower later than the main part of the field, when less pollen is available. Remember to re-check these thin areas before harvest to avoid contaminating clean grain.
4. **Evaluate tillering** - In a representative spot in the field dig up several plants. Make sure to separate plants that may be growing next to each other. Count the number of tillers (stems) with at least 3 leaves originating from the base of the plant. KWS Hybrid Rye usually has 10–20 tillers per plant by the time it reaches the jointing phase.

Fertility - What You Need to Know

Factors that will impact KWS Hybrid Rye fertility management

Soil Test
Soil testing is essential to determine soil fertility levels and make good nutrient management decisions. Appropriate nutrient application can increase yields, reduce production costs and prevent surface and groundwater pollution.

Use Your Resources
Rely on supporting businesses or experts to help with fertilizer recommendations and applications.

Nitrogen Credits
Apply Nitrogen Credits for % organic matter, soybeans, forage and cover crop legumes and manure before calculating additional N applications. An average 30 units or more of N credits can be claimed from previous legume crops like soybean, peas, clover and alfalfa.

Soil Type & Conditions
It is not recommended to plant KWS Hybrid Rye in water-logged soils. Heavy soils, where conditions are consistently wet in the spring, may limit machinery traffic for spring N applications. In these situations, apply all N in the fall.

Application Rates
When applying fertilizers in furrow, it is not recommended to exceed 15 lbs/acre of nitrogen.

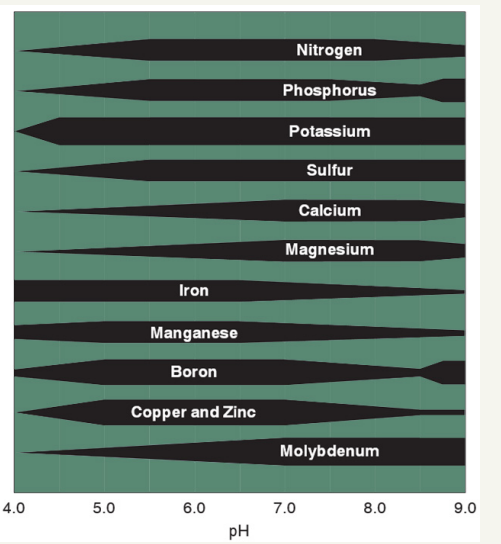
Manure
Remember that state and local manure application requirements may be different.

- It is critical to recognize the run-off risks associated with solid vs. liquid manures before making manure application decisions.
- Fall is the best time to inject or incorporate manure into the soil before planting KWS Hybrid Rye, especially if using manure as N source.
- Utilize the Approximate Manure Nutrient Credits by Animal Type[1] to help determine additional nutrient needs.
- Remember, the ammonium fraction of manure N is rapidly available, the organic form of N is slowly released and needs to interact with soil microbes both in the fall and very early spring, to ensure adequate mineralization and release. Use the University of Minnesota Manure Nitrogen chart[1] to examine availability and loss of Nitrogen by manure type.
- A spring application of solid manure is not recommended because it takes too long for the N to become available for the KWS Hybrid Rye to utilize. If spring manure application is necessary apply early.
- Applied spring solid manure should not cover more than 25% of the leaf surface and should not exceed 20% of total N as spring application.
- Dribble bars are recommended for spring liquid manure application to distribute manure close to the ground in between the rows. Apply at a rate of 20% of your Nitrogen needs.

[1] *https://extension.umn.edu/manure-management/manure-characteristics*

Utilize the pH and Nutrient Availability Chart for your soils
(See image to right) - High pH and dry soils can reduce phosphorous and manganese availability for early development of the crop. Foliar applications of manganese in the fall can increase winter hardiness by increasing sugar content in the plant. In the spring, manganese helps to increase root development to increase nutrient uptake.

pH and Nutrient Availability

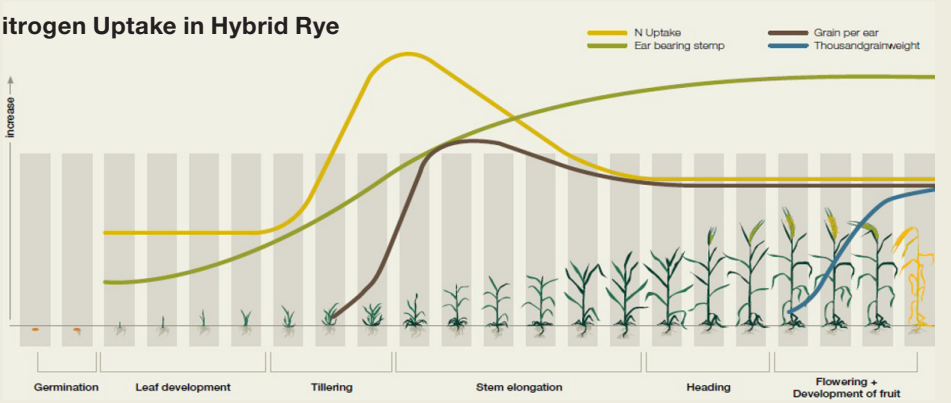


Above image from: Illinois Agronomy Handbook, University of Illinois Urbana-Champaign

Nutrient Requirements

Final spring application of fertilizer should occur before or at the beginning of spring growth. In the image to the right, the yellow N uptake curve shows that 90% of Nitrogen is taken up right after tillering and through stem elongation.

Nitrogen Uptake in Hybrid Rye



Fertilize based on yield goals, taking into account the nutrient availability determined by soil tests. This approach will ensure the crop receives necessary nutrients without over fertilizing.

Nitrogen (N) & Sulfur (S):

Fall apply 20-40 lbs of N/Acre
Spring apply remaining Nitrogen based on expected yield potential
Spring apply Sulfur

- Typical S Needs 15-20 lbs/acre in the Sulphate form

Phosphorus (P) & Potassium (K):

Fall apply 50-100% of total Phosphorus and Potassium needs
Spring apply remaining Phosphorus and Potassium

Hybrid Rye Nutrient Removal Table: (Per Bushel)*

	Phosphorus (P205)	Potassium (K20)	Sulfur (S)
Grain	0.45	0.30	0.10
Straw	0.20	1.50	0.15
Total	0.65	1.80	0.25

* Use the nutrient removal table, available soil test, previous crop and manure nutrient credits to aid in your determination of how much additional fertilizer should be applied to reach the expected yield goal.

**For rate adjustments based on soil test levels and yield goals, see the University of Minnesota Rye Fertilizer Recommendations or Fertilizer Recommendations Guide from South Dakota State University.*

IMPORTANT: **Avoid driving on the crop after stem elongation as this increases the risk of damaging developing plants. Damaged plants will be delayed in flowering which may result in higher incidence of ergot infection.**

Micronutrients:

Manganese (Mn) is not a common micronutrient problem, but small grains like KWS Hybrid Rye are more sensitive to Mn deficiency. Deficiencies in KWS Hybrid Rye can occur on high pH soils (8.0 – 8.5) or recently limed soils. Dry soil conditions reduce availability of Mn and cold and wet soil reduce mineralization from organic matter (OM) and reduce root growth and root metabolism. Other nutrients in high amounts like Copper (Cu), Iron (Fe), and Zinc (Zn) can inhibit uptake also.

Manganese deficiency symptoms occur on the younger leaves, and it looks like a diffuse interveinal chlorosis. Use soil and tissue tests to evaluate if the above parameters fit the soils in the area. Check with a local advisor to see if a foliar application of Manganese Sulfate at 1 – 2 lbs / acre can be applied or combined with an insecticide or fungicide application. This is the recommended rate for Manganese deficiency. There are Mn seed treatments on the market that help root elongation in cool soil and are usually combined with Zinc.

Hybrid Rye for Grain

Total N Application =

expected yield in bushels x 1.2 lbs/bu - soil credits

Hybrid Rye for Forage

Total N Application =

~30-35 lbs of N per dry ton or ~10-12 lbs of N per wet ton

KWS HYBRID RYE MANAGEMENT TIPS

Feekes Growth Scale	Feekes Growth Description	Fall Fertility	Planting	Seeding	Spring Fertility	Herbicide	Fungicide	Growth Regulator	Irrigation	Harvest
Fall Planning	*Soil testing recommended *Utilize Manure and Previous Crop Credits when determining nutrient availability in field	50-100% P & K + 20-40 lbs of N	North - Early Sept. Midwest - Mid Sept. - Oct. South - Mid. Sept. - Late Oct.	0.8 unit/Acre (800,000 seeds) depth 1 to 1.5"						
Seedling Growth										
1	First leaf through the coleoptile, up to 3 leaves								✓	
Tillering										
2	Beginning of tilering, main shoot with 1 tiller				Remaining NPK plus 15-20 lbs of Sulfur as Sulfate	✓		!	✓	
3	Tillers formed, leaves often twisted, plants prostrate					✓		!	✓	
4	Leaves begin to lenghten					✓		✓	✓	
5	Leaf sheaths strongly upright					!		✓	✓	
Stem Elongation										
6 Jointing	First node of stem visible at base of shoot							✓	✓	
7 Jointing	Second node of stem formed; next to last leaf just visible							✓	✓	
8 Jointing	Flag leaf visible, but still rolled up, head beginning to swell							!	✓	
9 Boot	Ligule of flag leaf just visible, swollen head							!	✓	
10 Boot	Boot Stage - head swollen but not yet visible						!	!	✓	
Heading										
10.1	First heads just visible, awns visible, head escaping sheath						!		✓	
10.2	25% of heading						!		✓	
10.3	50% of heading						✓		✓	
10.4	75% of heading						✓		✓	
10.5	All heads exposed						✓		✓	
Flowering										
10.5.1	Beginning of flowering in middle of head						✓		!	
10.5.2	Flowering complete to top of head						✓		!	
10.5.3	Flowering over at base of head						✓		✓	
10.5.4	Flowering over, kernel watery ripe						✓		✓	
Ripening										
11.1	Milky ripe						!		✓	
11.2	Soft dough, contents of kernel soft but dry								✓	
11.3	Hard kernel (25-35% moisture)									
11.4	Ripe for cutting									Test @ 18% moisture Harvest between 13-16% Storage between 12-13%

Nutrient Products

Phosphate and Potassium containing fertilizers:

- Monoammonium Phosphate (MAP) a granular product, (11-52-0) /water soluble P_{2O5} = 82%
- Diammonium Phosphate (DAP) a granular product, (18-46-0) / water soluble P_{2O5} = 85%
- Ammonium Polyphosphate (APP) a liquid product, (10-34-0) / water soluble P_{2O5} = 100%
- Potassium Chloride (KCL) a granular product, (0-0-60)
- Potassium Sulfate (SOP) a granular product, (0-0-50-17S)

Nitrogen containing fertilizers:

- Urea, a prill or granular product, (46-0-0). The key to most efficiently using urea is to incorporate it into the soil during a tillage operation prior to planting. However, during spring application, it can also be blended into the soil with irrigation water, or **0.25 inches of rainfall** is sufficient, so ammonia losses won't occur. Avoid urea applications on snow covered, frozen soil in the spring.
- Urea-Ammonium Nitrate (UAN) is a liquid fertilizer, (28-0-0) or (32-0-0).

Limit Nitrogen Fertilizer Stabilizer use, as nitrogen release may be too slow for adequate uptake during critical stages of KWS Hybrid Rye growth.

Caution - Anhydrous Ammonia (NH3), (82-0-0) is a liquid under pressure and a gas once released. **KWS Hybrid Rye is highly sensitive to NH3 in the seed zone. If using NH3, apply well below the seed zone, in adequate soil moisture, a minimum of 2 weeks before planting.**

Sulphate (SO_4^{-2}) containing fertilizers:

Supply Sulfur that is immediately available for plant uptake.

- Ammonium Sulphate (AMS) a granular product (21-0-0-24S) is the most popular and readily available.
- Ammonium Thiosulphate solution (ATS) a liquid product (12-0-0-26S) can be fall applied directly.
- Potassium Sulfate (SOP) a granular product, (0-0-50-17S)

Streamer-bars or stream jets are a preferred application method for liquid nitrogen sources after crop establishment. Streamer-bar or stream jet applied UAN and ATS, used alone or mixed, are excellent N sources for spring application. It is not recommended to broadcast UAN or ATS due to leaf burn and yield reduction.

Fungicide

Fungicide

Fungicide applications may be necessary under certain conditions and disease pressure. KWS Hybrid Rye is more tolerant to many diseases that affect other cereals like fusarium, stripe rust, karnal bunt, and scald. Fungicidal measures should aim at keeping the upper three leaves and the stalk free from infection up to milk stage.

IMPORTANT: KWS advises to always read and follow product labels. All applications and safety precautions should be made according to the use label directions. KWS Cereals and its affiliates, distributors and employees disclaim any liability and responsibility in connection with these estimates and projections.

Irrigation

Irrigation Timing Observations for KWS Hybrid Rye

1. Deficit Irrigation and New Tillers:

- A significant deficit of irrigation during the tillering and jointing stages may cause late tillers to develop.
- These tillers mature unevenly, produce less pollen, and are more susceptible to ergot.

2. Consistent Water Availability:

- Maintain a good water account from the beginning of the growing season.
- Ensure 0.15 to 0.18 inch of water is available per day (15-18 inches per season).

3. Overhead Irrigation Scheduling:

- Schedule and apply extra overhead irrigation before the flowering stage and again when grains can be felt in the center of the head.
- Heavy irrigation at flowering can reduce pollen shed, causing poor pollination, seed set, and potential ergot issues.
- KWS Hybrid Rye is a super pollinater, pollinating twice a day (early morning/evening), so irrigation timing adjustment is minimal.

Growth Stage	Approx. Dates	~Days	~Water Use (in)
Emergence Fall Growth	Sept. 15 - Oct. 15	30	0.5
Dormancy			0.0
Spring growth-tillering	March 20 - April 20	30	3.5
Jointing stage	April 20 - May 10	20	3.5
Boot/Heading stage	May 10 - May 25	20	2.5
Flowering Stage	May 25 - June 1	10	1.0
Grain fill	June 1 - July 10	40	7.0
Maturity	July 20 - July 25	10	Total 18.0

4. Critical Irrigation Scheduling:

- Reduce stress between early flag leaf stage (Feekes 8.0) and milky stage (Feekes 11.1).
- The most critical period is 10 days prior to bloom through the late milk stage.
- Continue irrigation through the grain fill period.
- Deficit irrigation during these stages will lead to yield reduction.

Timing of last irrigation

The timing of the last irrigation depends on various factors, including soil type, irrigation system, time of year, and growth stage. Water stress towards the end of the season may reduce kernel size, test weight, and yield. No water is needed once the heads have completely matured and turned from green to brown.

- **Sandy to sandy loam soils:** May require irrigation through the soft dough stage
- **Heavy soils:** Last irrigation could be before the soft dough stage

Weed Control

Hybrid Rye has 4 natural mechanisms to out-compete weeds for moisture, nutrients, and sunlight.

Heavy root growth helps KWS Hybrid Rye lessen weed pressure in the field.

1. **Cold Tolerance:** KWS Hybrid Rye can grow and add biomass at temperatures near the freezing point.
2. **Extensive Root System:** It produces a wide and deep root system.
3. **Rapid Stem Elongation:** It quickly moves through stem elongation to produce large above-ground biomass. KWS Hybrid Rye can produce up to 20 tillers per plant, compared to open-pollinated rye and wheat, which only produce 4 or 5 tillers.
4. **Allelopathic Properties:** KWS Hybrid Rye releases natural bio-chemicals.

Herbicide Weed Control

"Spray Early, Spray Small"

In many situations a herbicide application is not necessary for KWS Hybrid Rye, In the event that a herbicide application is required it is recommended to spray early, before stem elongation when the weeds are small, but actively growing.

Avoid letting weeds grow too big, as they become harder to control and have already competed for nutrients, water, and sunlight. Some weed species are more aggressive and problematic, requiring early control during crop growth.

Plant Growth Regulators

Plant Growth Regulators (PGRs)

PGRs are not usually necessary unless the crop is in a high yielding environment. High nitrogen manure applications and high seeding rates can create thin stems and increase the risk of lodging. PGRs enhance stem thickness, strengthening the stem and reducing lodging. This helps avoid harvest delays, yield loss, and reduced grain quality.

Avoid applying PGRs if the crop is stressed by drought, disease, or high temperatures.

Timings for foliar applied PGRs:

Feekes Growth Stages:

Stage 4: Leaves begin to elevate
Stage 5: Leaf sheaths strongly upright
Stage 6: First node visible above the soil surface
Stage 7: Second node visible

Harvest Tips

Harvesting for Grain

KWS Hybrid Rye harvest occurs from mid-July to mid-August. Direct harvesting is preferred for optimal grain quality. KWS Hybrid Rye is uniform in height, has stiff straw, and excellent standability, which helps control header height and reduces the amount of straw processed through the combine.

Prepare for harvest when grain moisture approaches 18%, as it dries down quickly, though the straw may still be green.

To avoid broken kernels:

- Ensure gentle threshing by slowing down the cylinder/rotor speed.
- Harvest at around 13-16% moisture.
- If needed, use an air bin to dry the grain immediately after harvest, ensuring the air front blows through the bin to maintain quality.
    - An air floor bin can reduce moisture by 1-2%. Beyond 2% reduction in moisture, consider drying at temperatures below 120 degrees.
- For long-term storage, ensure the grain is between 12-13% moisture.

Harvest Residue Management

KWS Hybrid Rye produces about one-third more straw than wheat. If leaving the straw on the field, make adjustments to ensure header cut height and chopper spreader are set correctly. Properly dispersed residue will break down more easily and facilitate the establishment of the following crop.

To avoid volunteer rye in the next crop, it's important to have a strategy for handling the straw and stubble after harvest. Lightly work the stubble after harvest at an angle to the combine direction. This will help kernels fall onto the soil surface and germinate. Use deeper tillage if necessary after most of the rye has germinated.

If planning to bale the straw, consider cutting high instead of running everything through the combine, then re-cutting after harvest. Adjustments may need to be done to the chopper for longer straw lengths.

Harvesting for Silage

KWS Hybrid Rye is an excellent forage choice for silage, offering high yields and nutritional value. The timing of the harvest is crucial to maximize the quality and quantity of the silage. There are two main cutting options: early cutting and late cutting, each with its own benefits and considerations.

General Recommendations for Silage Harvest

- **Field Conditions:** Check field conditions to avoid harvesting in wet or muddy areas, which can affect the quality of the silage.
- **Storage:** Properly store the silage in airtight silos or bags to prevent spoilage and maintain quality.
- **Quality Control:** Regularly monitor the silage for any signs of spoilage or nutrient loss and take corrective actions as needed.

Proper facing of the pile, no different than other ensiled forages, is key long-term silage preservation.

Early Cutting

Early cutting typically occurs when the rye is in the boot stage, just before the heads emerge. This stage is characterized by high protein content and digestibility, making it ideal for high-quality silage. Here are some tips for early cutting:

- **Monitor Growth:** Keep a close eye on the rye's growth stages to ensure timely cutting. The boot stage is the optimal time for early cutting.
- **Moisture Content:** Aim for a moisture content of around 65% for the best fermentation and preservation of nutrients.
- **Alternative Methods:** If the rye is too wet for direct chopping, consider using alternative methods such as wilting the rye before chopping. This involves cutting the rye and allowing it to dry in the field for a short period before chopping.

Late Cutting

Late cutting occurs when the rye is in the milk ripe to soft dough stage, where the grains are more mature. This stage offers higher yields, but slightly lower protein content compared to early cutting. Here are some tips for late cutting:

- **Monitor Grain Development**: Ensure the rye has reached the milk ripe to soft dough stage, where the grains are soft and not fully hardened.
- **Moisture Content**: Aim for a moisture content of around 65% to ensure proper fermentation and preservation.

Market Opportunities

KWS Hybrid Rye offers diverse market opportunities due to its versatility and high nutritional value. Here are some key end use markets:

Forage Market

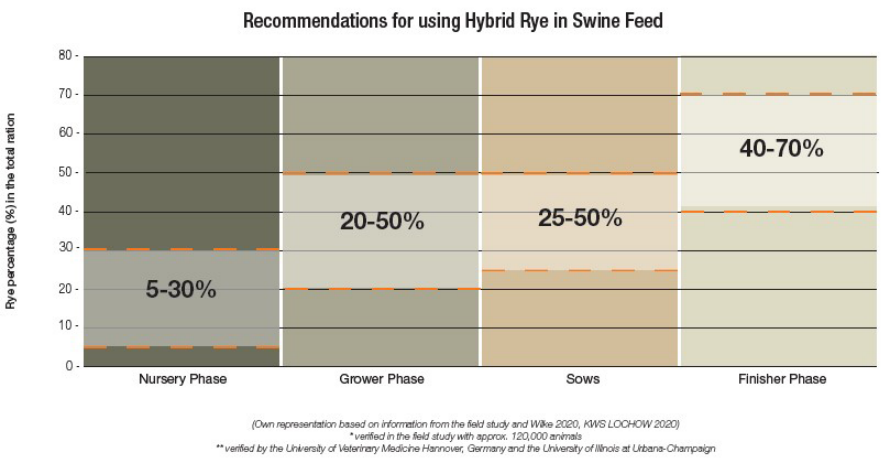
KWS Hybrid Rye can be used as forage for livestock. It offers high yield and nutritional value, making it an excellent choice for silage and other forage applications.

Feed Market

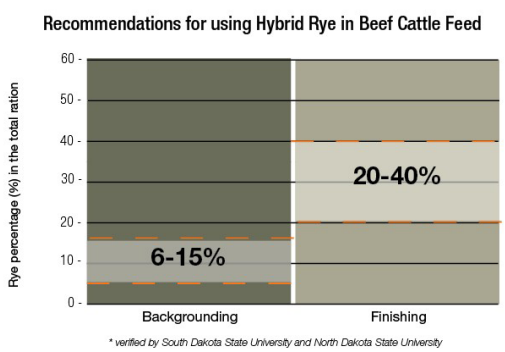
KWS Hybrid Rye grain is increasingly used in animal feed, particularly for swine and cattle. Its high digestibility and nutritional profile make it an excellent choice for livestock diets. Feeding hybrid rye to livestock improves animal health and welfare while maintaining performance.

Swine Feeding Recommendations

KWS Hybrid Rye can be incorporated into most stages of swine production. In the nursery phase, it can be introduced in phase 2 at a rate of 5-7%. Gradually increase the inclusion rate to 30% by the end of the nursery period. During the grower phase, Hybrid Rye can be increased in each phase, reaching a maximum of 70% inclusion in the finisher phases. For sows, Hybrid Rye provides an ideal fiber profile and can be fed at an inclusion rate of 25-50% to maximize feed efficiency, milk yield, and litter performance.



(Own representation based on information from the field study and Wilke 2020, KWS LOCHOW 2020)
* verified in the field study with approx. 120,000 animals
** verified by the University of Veterinary Medicine Hannover, Germany and the University of Illinois at Urbana-Champaign



* verified by South Dakota State University and North Dakota State University

Beef Cattle Feeding Recommendations

KWS Hybrid Rye can be included in backgrounding diets for beef cattle at a rate of 6-15% to achieve maximum growth performance. During the finishing period, the inclusion rate can be increased to 20-40% in the ration to optimize feed efficiency.

Food Market

KWS Hybrid Rye grain is also gaining popularity in the food industry. It can be used in baking and milling to produce various food products such as bread, pastries, and cereals. The grain's unique flavor and nutritional benefits make it a valuable ingredient in human nutrition.

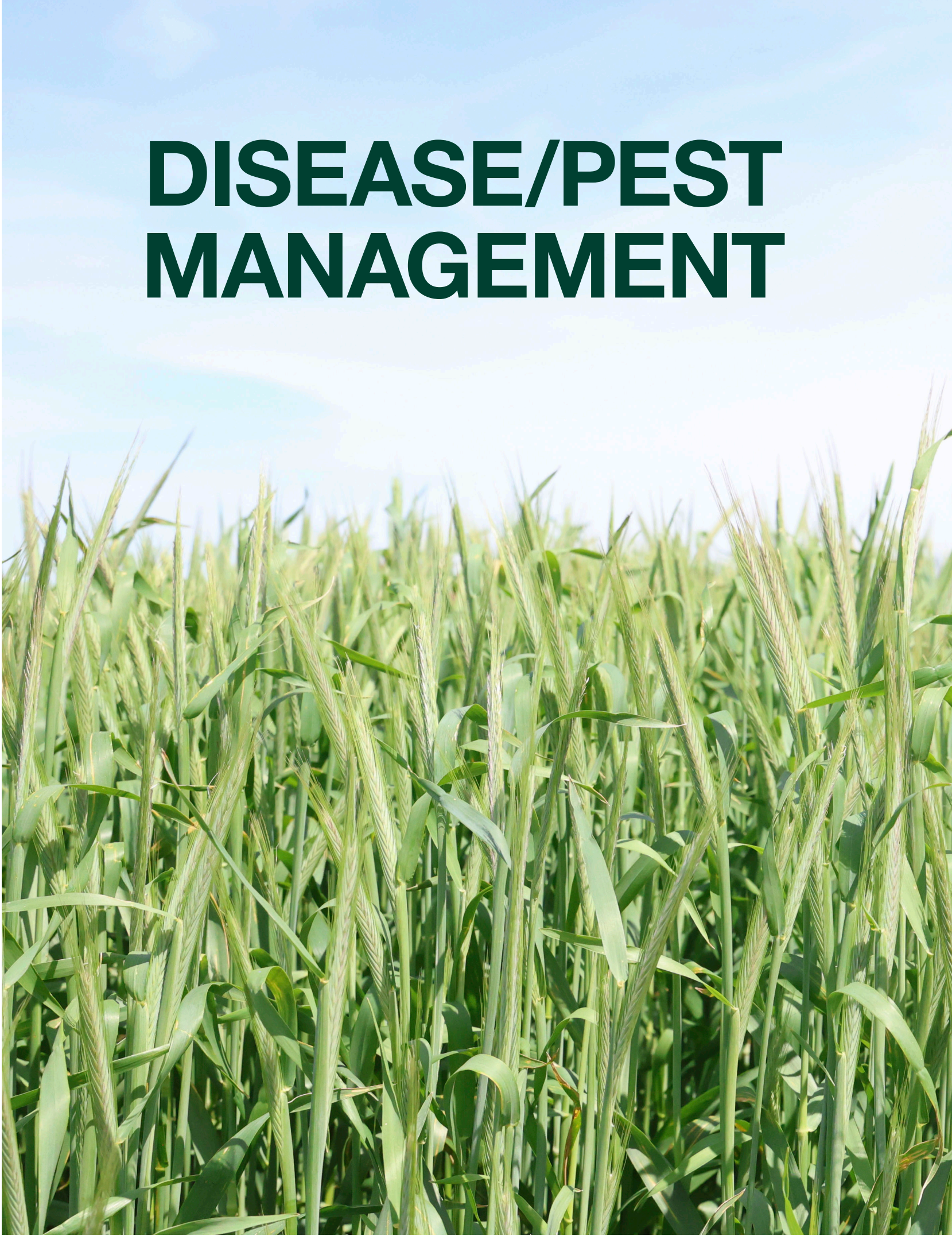
Distilling Market

In the distilling industry KWS Hybrid Rye grain is used to produce high-quality spirits. Its unique characteristics contribute to the flavor and quality of the final product, making it a preferred choice for distillers.

Soil Protection Market

The KWS Cover+™ soil protection program is an innovative opportunity that allows hybrid rye grain to be sold to authorized licensed partners and utilized as a terminal cover crop. This program enhances soil and environmental protection, opening new avenues for selling hybrid rye grain.

DISEASE/PEST MANAGEMENT



Common Pests/Diseases

Hessian Fly

Hessian flies prefer wheat but will also choose rye. Adult flies emerge in the fall and live for only a few days, during which they can lay up to 300 eggs per female on young leaves. The larvae are the most damaging, stunting and lodging the plant by feeding on the lower leaves and stems. They overwinter as flax seed-like pupae, emerging as adults again in the spring.

Above: Hessian fly damage to wheat plants. Courtesy: John C. French Sr., Bugwood.org

Control Tactics:

- **Delay Planting:** To avoid fall infestations, delay planting until the "Fly-Free Date", which is the first predicted frost date when Hessian flies are no longer active due to cold temperatures.
- **Remove Hosts:** Remove volunteer cereals and grassy weed hosts before planting. Avoid planting near volunteer or cover crop wheat, barley, or rye, which are hosts for the fly.
- **Seed Treatment:** Consider using a systemic seed treatment containing Thiamethoxam, Imidacloprid, or Clothianidin at planting to protect young seedlings from Hessian fly larvae. However, the effective period is short, lasting only two to three weeks after planting.
- **Foliar Insecticide:** The use of fall foliar insecticide depends on correctly predicting Hessian fly adults and larval hatching before they penetrate the stem. This is difficult to predict, so spraying is not normally recommended.

Right: Fall armyworm feeding damage. Photo by James Morris, Ohio State University Extension.

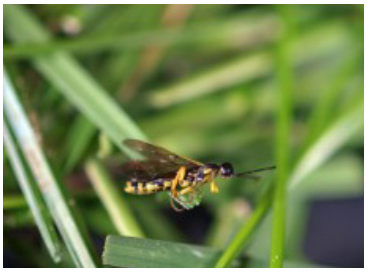
Fall Armyworms and Aphids

To minimize the risk of fall armyworm and aphid feeding, plant within the fly-free date window. Aphids can transmit the Barley Yellow Dwarf Virus (BYDV). Using fall foliar insecticides can also help control or suppress aphids, Hessian fly, and fall armyworm.

Wheat Stem Sawfly

KWS Hybrid Rye has great resistance to Wheat Stem Sawfly. While KWS Hybrid Rye can host sawfly egg laying, the larvae rarely mature or survive in this crop. This makes KWS Hybrid Rye a good alternative to wheat in sawfly-prone areas. Diversifying with KWS Hybrid Rye in the rotation helps reduce sawfly infestations.

To minimize risk of sawfly, avoid planting near previous wheat fields, especially if there were noticeable cut stems from the previous year. Be aware of other weedy grasses near new wheat seeding, as they can host sawfly and increase infections. Tillage and insecticide treatments have minimal effect on sawfly control.



Above: Adult wheat stem sawfly, Photo from ©Colorado State University Extension. 6/11. Revised 10/14. www.ext.colostate.edu

Leaf Rust or Brown Rust

Hybrid rye can be affected by leaf rust fungus, which is widespread across U.S. growing regions. It can cause yield losses and reduce grain quality. Moderate nights (60°F) with dew and warm days (60-75°F) create ideal conditions for rust. Reddish-brown, powdery pustules appear on the upper side of leaves and sometimes on stems. Yield loss usually occurs before flowering, so monitor fields to protect upper leaves. Effective fungicides are available, some with curative properties. If no symptoms are visible 10-12 days after flowering, applications are generally not needed.

Above: Close-up of leaf rust on leaf. Photo courtesy of KWS.

Powdery Mildew

Hybrid rye is susceptible to powdery mildew, causing yield loss. However, KWS Hybrid Rye varieties have strong resistance to mildew. Powdery mildew usually appears on leaf blades as whitish, cotton-like growths, which later turn brown with small black necrosis and eventually black spore pustules. Temperatures between 50-60°F with high relative humidity are ideal for spore formation, which can occur as early as 5 days after infection. Mildew spores are vulnerable and can only survive for 2-3 days if favorable conditions disappear.

Powdery mildew affects rye in the fall after early planting, especially if the foliage is dense. Early infection can reduce the number of tillers. In early spring, infection is often seen on older leaves, but Hybrid Rye grows quickly, and the disease rarely spreads to new leaves.

Above: Powdery Mildew on wheat. Photo courtesy of University of Tennessee Crops - guide.utcrops.com

Control Measures:

- Use effective fungicides for powdery mildew.
- Implement preventive agronomic measures.
- Avoid excess populations and nitrogen application.
- Optimize phosphorus and potash fertility.
- Timely planting: too early creates a dense canopy for the disease to thrive, too late reduces tillers.
- Practice crop rotation (avoid back-to-back rotations of other winter small grains).
- Avoid planting in rich soils sheltered from the wind, which creates a favorable microclimate for the disease.

Fusarium Head Blight (FHB)

KWS Hybrid Rye has strong tolerance to FHB, maintaining yield despite infection. FHB affects major small grains like wheat, barley, and rye. No cultivar is completely resistant.

Yield losses occur due to floret sterility, shrunken kernels, and lower test weight. FHB thrives in 90%+ humidity and temperatures between 60-85ºF during flowering. Early infections produce airborne spores, leading to secondary infections. Severe losses happen with ample inoculum, dampness, and high humidity during flowering and kernel formation.

Symptoms include bleached sections of the head and brown/purple streaking on the stem. Infected kernels are shriveled and off-color. Corn stubble is a common source of fusarium, so avoid planting hybrid rye after grain corn.

Above: FHB in open pollinated rye. Photo courtesy of Carolyn King, 2018, Alberta Seed Guide

Control measures:

- Use effective fungicides during flowering (Feekes 10.5.1 to 10.5.4).
- Implement crop rotation with non-host broadleaf crops.
- Practice tillage to bury residue and reduce inoculum.
- Adjust the combine at harvest to remove lightweight FHB kernels.

Barley Yellow Dwarf Virus (BYDV)

BYDV affects wheat and rye in many U.S. growing regions. It is transmitted by cereal aphids through their saliva during feeding. Early monitoring is essential, as aphids migrate in the wind. Damp, mild conditions (50-65°F) favor fall aphid infestation. Symptoms may appear in 3-4 weeks, often under-developed until spring. Visual symptoms include leaf discoloration in yellow and purple tints from the tip down to the mid-rib. BYDV cannot be controlled once it occurs.

Above: BYDV in wheat. Photo courtesy of extension.okstate.edu

Fall BYDV Management:

- **Seeding Dates:** Avoid planting before the Hessian fly-free date to minimize aphid populations and BYDV risk.
- **Genetic Resistance:** Hybrid rye is moderately susceptible to BYDV; susceptibility by variety is not well documented in the U.S.
- **Cultural Practices:** Control volunteer small grains at least 2 weeks prior to planting.
- **Chemical Control:** Seed treatments can reduce aphid populations and primary infections. These treatments also offer some control of Hessian Fly and underground insects. Fall foliar insecticide can reduce aphid populations and BYDV incidence, especially if planted early and didn‘t use seed treatments. Scout fields 2-3 weeks after emergence for rising aphid populations. Check state threshold levels before application.
- **Biological Control:** Heavy rainfall, cool temperatures, frost, and natural parasitism can significantly reduce aphid populations. Consider these factors before making insecticide applications.

Snow Mold

Snow mold is most easily identified after snowmelt, particularly in winter cereals such as rye. It develops under conditions of high humidity and near-freezing temperatures. Fields covered by snow on non-frozen soil for extended periods are especially prone to infection.

Affected rye stands often show large, scattered, oval-shaped patches. Living and dead plants lie flattened to the ground, covered in a whitish to pink fungal mycelium. Leaves may appear rotten and necrotic. If the crown is infected, the entire plant may die. However, if the crown remains healthy, the crop can recover—even after extensive leaf damage.

Above: Snow mold in rye. Photo courtesy of Ryan Higginbotham.

Control Measures:

To reduce the risk and severity of snow mold, the following agronomic practices are recommended:

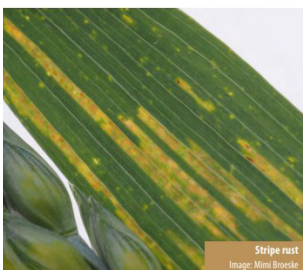
- **Residue Management**: Incorporate harvest residues of cereals and grasses into the soil.
- **Sowing Time**: Avoid early planting to prevent excessive fall biomass.
- **Crop Rotation**: Avoid cereal-after-cereal or cereal-after-grass rotations in high-risk areas.
- **Fertilization:** Ensure fertilization is timely and appropriate to avoid excessive fall growth.

Stripe Rust

Stripe rust (Puccinia striiformis), also known as yellow rust, is a fungal disease affecting wheat, rye, and barley. It appears as yellow-orange pustules that form stripes along leaf veins, typically after stem elongation.

Stripe rust thrives in cool (50–60°F), damp weather. It can overwinter in volunteer grains and grasses and spreads long distances via wind. Early infection poses a greater risk of yield and grain quality loss.

KWS Hybrid Rye varieties are rated as resistant to stripe rust, offering a strong defense through durable genetic resistance. Timely scouting and well-informed fungicide decisions will help optimize crop performance and grain quality.



Above: Stripe rust in wheat. Photo courtesy of https://cropprotectionnetwork.s3.amazonaws.com/cpn3002_fungicideefficacywheatdisease_final.pdf

Control Measures:

- **Scout early and often**: Early detection is key to effective control.
- **Fungicide timing:** Apply protectively, ideally before or at flag leaf emergence.
- **Decision-making factors**: Crop color change, visible spore levels, weather forecast, and awareness of the ~7-day spore cycle.
- **Cultural control:** Manage volunteer cereals and grasses that can harbor the disease.

Wheat Streak Mosaic Virus

Wheat Streak Mosaic Virus (WSMV), Triticum Mosaic Virus (TriMV), and High Plains Wheat Mosaic Virus (HPWMoV) are significant viral threats in cereal crops, particularly in the central and northern high plains of the U.S. and Canada. These viruses are transmitted by the wheat curl mite, which can carry one or multiple viruses simultaneously, resulting in co-infections that can intensify crop damage. Infection will vary based on many factors including plant stage and environment.

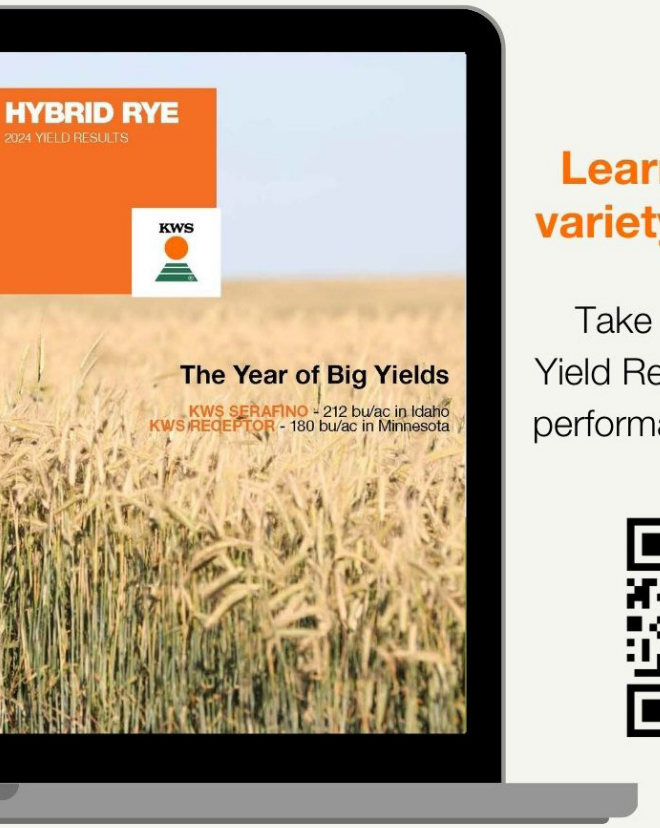
Symptoms of WSMV and TirMV are similar and start with yellowish green discoloration running parallel to the leaf veins extending to the leaf base and turns the leaf completely yellow as the virus spreads. Symptoms of HPWMoV appear as spots on the leaves. These spots eventually turn into a yellowish chlorotic mass.

Right: Wheat Streak Mosaic Virus in Colorado in 2024. winter wheat on the left, KWS Hybrid Rye on the right. Photo from Jim Diamond.

Control Measures:

- Remove volunteer cereals and grassy weeds well before planting. Plants should be dry and dead for at least 2 weeks before planting new crop.
- Delay fall planting until after the Hessian Fly-Free Date for your region, which will avoid peak mite activity and limit early infections.
- Choose varieties with moderate to high resistance to virus infection.
- Make note there is no effective chemical control for the wheat curl mites.

Getting started with **KWS Cereal varieties** is easy...



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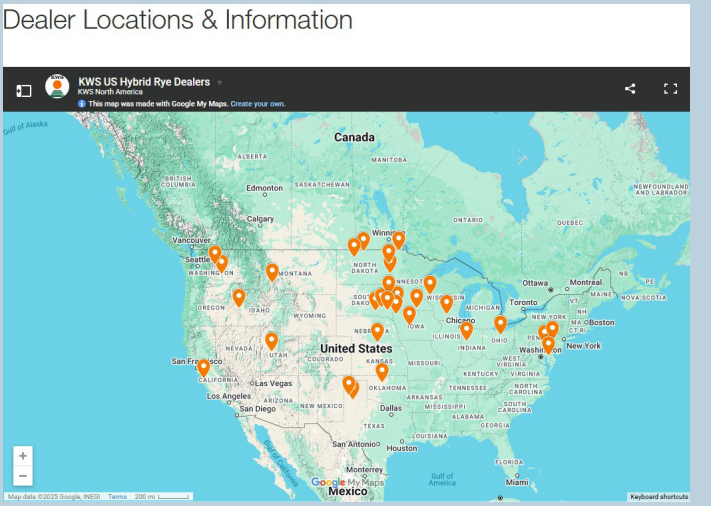

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