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Crop production is very complex.

Your success as a farmer hinges on a solid understanding of the mechanical, biological and financial factors involved with crop production, along with the experience and knowledge to control these factors to the best of your ability. It is essential to understand the effects of each of the factors involved, in the present seeding conditions to make the most informed decisions to maximize both crop emergence and harvest yields.

The purpose of the *Bourgault Agronomy Handbook* is to focus on the factors involved with the important task of placing the seed in the ground in such a way as to ensure the greatest chances of germination and emergence in the given conditions. It also discusses the importance of fertilizer placement to create the optimum environment for the plant by consistently and accurately placing the seed and each required nutrient in a location that promotes even germination, uniform stand and optimum yield potential.
In the early 1990s, side-band openers were promoted as a practical method of placing all fertilizer requirements down safely in a single seeding pass. Just like other manufacturers of the day, Bourgault invested considerable time and money to develop a side-banding opener to offer customers a one-pass seeding system. Despite much research and testing, Bourgault could not achieve the seedbed quality, or the fertilizer separation that was so vitally important to crop

**THE EARLY YEARS**

**Inherent Issues of Side-Banding**

Tests performed in the late 1970’s by Harry Ukrainetz were conducted to determine the best placement for phosphate for sensitive crop access*. The report concluded that 1 inch to the side and 1 inch below was the best location for phosphate fertilizers. Unfortunately, this recommendation was assumed to be sufficient for all fertilizer forms and many companies released various side-banding systems based on this concept.

**1 Soil Disturbance**

It was soon realized that openers designed to band fertilizer beside the seed also had a tendency to produce a rough field finish. Greater soil disturbance, especially in dry conditions, causes seed and fertilizer to mix, uneven seed depth and accelerated evaporation of soil moisture. The wider profile of these side-banding openers made them very susceptible to residue bunching and plugging.

Manufacturers of these side-banding systems modified their existing side-band openers, released new openers, or suggested practices that would help reduce the risks and negative impact that was inherent to their systems. Minor improvements were made, but they typically only applied to localized conditions and with sacrifices to producer’s efficiency.

**2 Fertilizer Separation**

The ideal placement of seed and fertilizer at seeding will position the seed for optimal nutrient access without risk of damage from the fertilizer. Fertilizer placed too near a seed row can have two negative effects on the crop. Crops require nutrients in a salt form for root adsorption, so most fertilizer nutrients are applied in a salt form. However, too much fertilizer placed near a seed row will create a local ‘salt effect’, where seed germination is prevented or delayed or seedling roots are damaged. This is simply due to the fertilizer salts pulling soil moisture away from the seed. In addition, urea, UAN, and ammonia or ammonium based fertilizers may create a direct toxic effect if ammonia gas accumulates near the seedling. Historically, producers have blamed excessive soil disturbance for late or uneven germination, but in reality inadequate fertilizer/seed separation was also a contributing factor.

Side-banding suppliers have had to address the issues of fertilizer safety and soil disruption. In an attempt to provide a greater degree of separation, new approaches to side-banding came

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Fertilizer Management in One-Pass Seeding Systems

“Seedling damage occurred in canola with increasing rates of urea or UAN fertilizer applied as a side-band targeted to place the fertilizer placed 2.5 cm to the side and 2.5 cm below the seed row at the time of seeding.”

Nitrogen Fertilizer and Urease Inhibitor Effects on Canola Emergence and Yield in a One-Pass Seeding and Fertilizing System


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* Effect of Phosphate Placement on Yields of Different Crops in West-Central Saskatchewan—by H. Ukrainetz, Agriculture Canada Research Station, Saskatoon
The Development of Mid Row Banding Systems

In 1993, Bourgault’s designers teamed up with Garry and Glen Meier of Ridgedale, Saskatchewan, Canada to develop an innovative one-pass seeding system. Garry’s work as the northeast regional soil conservation specialist for the Saskatchewan Soil Conservation Association (SSCA) allowed him to see that the dual-shoot openers on the market did not work consistently in all soil types or conditions.

Development focused on a coulter-style bander that could supply the complete nitrogen requirements for the crop between every second seed row. Mid row placement also provided enough distance to prevent the nitrogen (of any formulation) from injuring the seed, but close enough for the seedling roots to quickly find the fertilizer. Coulters allowed for fertilizer placement with very little soil disruption, helping to preserve existing moisture and standing stubble. A narrow “seed-only” opener could now be used to minimize soil disturbance and maintain the integrity of the seedbed.

Initial prototypes and testing suggested that they had a winning concept on their hands. Bourgault entered the marketplace in 1996 with the first generation of Mid Row Banders. Designs were updated and perfected as the market became more aware of the Bourgault MRB® system.

Today, Bourgault Seeding Systems with Mid Row Banders® can be found in most of the small grain growing regions of the world.

Typical Side-Bander Warnings

**Dual-Shoot Opener:** “Warning—this opener system has the potential for creating seed burn due to fertilizer contact with the seed. The manufacturer assumes no responsibility for any crop loss caused by this opener.”

**Dual-Knife Opener:** “Many farmers have successfully seeded all crop types while using anhydrous ammonia, however, the manufacturer takes no responsibility if seeding damage is caused by anhydrous ammonia.”
Agronomic Study Leads the Way.

Understanding the Agronomy

Bourgault learned that improving its understanding of the agronomic requirements to growing successful crops would be crucial to the development of first class seeding equipment.

Key individuals, with strong agronomic training and experience, worked with Bourgault to spearhead the development of guidelines critical for successful crop establishment in a wide range of seeding conditions.

By studying relevant agronomic research, conducting original plot work and cooperating with third party agronomic research groups and independent agronomists, Bourgault has amassed an extensive and reliable database that is used to help design the most agronomically advanced seeding equipment available.

Key Factors

Each study confirmed that two key factors must be addressed by producers for long term success in one-pass seeding; 1/ establishing a root dominant environment, and 2/ maintaining seedbed integrity. The more that is done to encourage an extensive root system, the better the crop will take advantage of available nutrients and adapt to challenges through the growing season.

Key Factors:

1. Establish a Root Dominant Environment
2. Maintain Seedbed Integrity

Referenced Agronomic Research

- Seeding Management to Increase and Stabilize Canola Production in the Semiarid Prairie & Wide Row Spacings are Risky in the Semiarid Prairie - Semiarid Prairie Agricultural Research Centre in Swift Current, SK
- Investigation into Row Spacing with Direct Seeded Canola and Wheat - RL0498B - November 1999 - Alberta Farm Machinery Research Centre
- Optimizing Rate And Source Of N Fertilizer In No-till Canola - 2001 Report & Optimizing Rate And Source Of N Fertilizer In No-till Wheat - 2002 Report by C.A. Grant, D.A. Derksen and D.McLaren
- Seeding Rate, Nitrogen Rate, and Cultivar Effects on Malting Barley Production - J.T. O’Donovan et al.
Establishing A Root Dominant Environment

The ability to establish a root dominant environment is one of the most important factors in one-pass seeding. It is imperative that producers have a seeding tool that allows the placement of the crop’s nutrients in the ideal location to encourage the development of a strong and extensive root system.

There are two important factors to consider as nitrogen fertilizer changes in the soil and becomes useful to the crop. The better that you, as a producer, prepare for and set your seeding operation to account for these factors, the greater benefit you will realize from your nitrogen investment while minimizing risk. These factors are fertilizer toxicity and salt effect.

**Fertilizer Toxicity**—All fertilizer, in its initial form, can be harmful if placed too close to the seed and/or at too high of a rate. This is especially true of nitrogen fertilizers that release ammonia gas into the soil. Plants that experience fertilizer toxicity have difficulty developing a healthy root system.

Seeds placed at an optimum location from the fertilizer germinate in safety from the nitrogen undergoing the nitrification process (refer to page 10). The plant proliferates its root system to where it senses the nutrient radiating out from the band of fertilizer.

**Salt Effect**—Most fertilizers that are readily available to a crop are applied in a salt form. We know that salts are capable of rapidly absorbing water and that excess fertilizer near a seed or seedling can prevent germination of seed or desiccate the new root system. Again, optimal seed-to-fertilizer placement ensures roots can become established by keeping seeds away from the area of fertilizer salinity.

Your awareness of the effects of fertilizer toxicity and salt effect on root development can make the difference between having your fertilizer investment working for or against you.

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**Minot Canola Yields 2008**

<table>
<thead>
<tr>
<th>Fertilizer Placement</th>
<th>Yield (lb/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 N @ 1&quot;</td>
<td>400</td>
</tr>
<tr>
<td>100 N @ 2&quot;</td>
<td>600</td>
</tr>
<tr>
<td>100 N @ 3&quot;</td>
<td>800</td>
</tr>
</tbody>
</table>

**NOTES:**
- Phosphate seed placed
- Urea side-banded at distance noted
- Growing season was challenging

This chart highlights findings from a Bourgault plot study done in Minot, 2008 and recorded by the NDSU North Central Research Extension. Overall yields were low due to challenging conditions, but the interesting result from this study was that the application of nitrogen was actually reducing overall yields until 3" of separation from the seed row was achieved. All plots were seeded with a coulter plot drill.
Fertilizer Toxicity.

Understanding Fertilizer Toxicity

Poor emergence is typically blamed on bad seed, poor moisture conditions, weed pressure or other stresses. Producers may not suspect that poor emergence is a result of how they are placing their seed and fertilizer in one operation and the interaction between the two during germination and emergence. Producers must gain a good understanding of the benefits and dangers of seed and fertilizer placement to avoid producing an environment that is toxic to their crop (Refer to Ammonia Conversion, page 10).

Various fertilizers differ in toxicity. Ammonium nitrate (34-0-0), monoammonium phosphate (12-51-0) and ammonium sulphate (21-0-0) are similar in toxicity and are much safer than anhydrous ammonia or urea (46-0-0). More care should be taken with sensitive seeds such as canola, and in sandy or low organic matter soil.

Greater Risk in Challenging Conditions

Fertilizer toxicity becomes an even greater issue when seeding in dry conditions. Ammonia gas ($NH_3$) will quickly dissolve in soil moisture and form ammonium ($NH_4^+$), which is available for crop root uptake. In dry soil, more $NH_3$ remains in the soil and the dry soil pores allow easier movement of the $NH_3$. $NH_3$ can then be lost from the soil and also can damage seeds that are already struggling in dry conditions. If the spring remains dry and side-banding causes high soil disturbance, seedbed quality and germination may suffer.

Mid-row banding the N between every second row at seeding maintains the greatest degree of seed safety. Less soil disturbance and hence more moisture retention is achieved with a disk-type mid row bander unit compared to a side-banding opener. Wet conditions tend to protect the seeds deposited with a side-band opener from fertilizer damage, but can cause leaching or denitrification resulting in excessive loss of nutrients. A mid row band contains double the volume of fertilizer compared to a side-band. This higher concentration takes longer to go through the conversion process, thus acting as a nutrient stabilizing factor. When soil conditions improve, more fertilizer remains for the plant with a mid row band system.

> “If the entire N needs are to be applied, the side-band should be at least 2” from the seed row for solution or dry fertilizer and at least 2-3 inches from the seed row for anhydrous ammonia.

If the spring remains dry and side-banding causes high disturbance of the soil, seedbed quality and germination may suffer.

Mid-row banding the N between every second row at seeding maintains the greatest degree of seed safety. Less soil disturbance and hence more moisture retention would be achieved with a disk type mid-row bander unit compared to a shank-type.”

Recommendations for fertilizer spacing from seed taken from Soil Fertility Considerations When Dealing with Dry Seeding Conditions–Manitoba Agriculture, Food and Rural Initiative.
Growers must also be aware of the issue of salt effect that various fertilizers can place upon a developing plant. Virtually all fertilizer materials are salts. Injury is directly connected with the placement of too much soluble salt too close to the seed. The salt draws moisture away from the soil around the seedling, causing desiccation. The effects of salt effect vary depending on:

- the amount of moisture present in the soil;
- the type of fertilizer being applied;
- the rate of fertilizer application;
- the crop’s tolerance to salt;
- the proximity of the fertilizer to the seed.

Another factor is the composition of the soil itself. Generally, a sandy soil with reduced moisture will cause the salt concentration to remain high for a longer period of time after application. Clay soils with adequate moisture help mitigate desiccation. Overall, soil moisture is the key in the impact of the salt effect— a seeding system that may seem ‘safe’ in wet springs may cause significant crop injury in a dry spring. Crop tolerance to salt varies greatly; barley is moderately tolerant to high-salt conditions, whereas, crops like canola are much more susceptible.

### Salt Index Rating

The **Salt Index Rating** is a measurement of the relative strength of salt in a given fertilizer. It is important to note that the salt index does not predict the rate of fertilizer that will cause injury to crops in a particular soil, but rather it classifies fertilizer material relative to sodium nitrate (100). This gives growers a guide to which fertilizer is most likely to cause injury.

<table>
<thead>
<tr>
<th>Salt Index Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table Salt (Sodium Chloride)</td>
</tr>
<tr>
<td>Sodium Nitrate (NaNO₃)</td>
</tr>
<tr>
<td>Urea (46-0-0)</td>
</tr>
<tr>
<td>Ammonium Sulphate</td>
</tr>
<tr>
<td>Liquid UAN (28-0-0)</td>
</tr>
<tr>
<td>Anhydrous ammonia (82-0-0)</td>
</tr>
<tr>
<td>MAP - Monoammonium Phosphate (12-51-0)</td>
</tr>
<tr>
<td>DAP – Diammonium Phosphate (18-46-0)</td>
</tr>
</tbody>
</table>

Source: Calculating Salt Index by Dr. John J. Mortvedt (Sodium nitrate was chosen as the standard because it is 100% water soluble and was a commonly used nitrogen fertilizer when the SI concept was first introduced.
All urea based fertilizers (*46-0-0* and *28-0-0*) begin conversion to plant available forms in the presence of the urease enzyme, which first converts urea to $\text{NH}_3$. Bacteria then drive the process of *nitrification*, which ultimately leads to nitrate, which can be used for plant growth.

Mid row placement of the crop’s main nitrogen requirements is the optimum location for timely access through the season, yet avoids the risks involved with too close seed/fertilizer proximity.

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**Nitrification.**

### Stage 1

*Ammonia* ($\text{NH}_3\ -\ red$) is initially released by ammonia and urea-based fertilizer after it is applied. In this form, the fertilizer is toxic to the germinating seed and can be mobile in dry soil. Adequate nutrients for germination and early seedling growth are contained in the seed, nearby soil and with fertilizer placed in the seedrow.

### Stage 2

Ionic hydrogen transfer from water and clay particles convert ammonia to *ammonium* ($\text{NH}_4^+\ -\ orange$). Ammonium dissolves in soil water and can be absorbed by roots for plant growth. Ammonium is not very mobile in the soil, as it can be attracted to clay and organic matter. The rate of conversion to plant available nitrogen occurs very quickly, with access from the mid row band to the seedling roots within 2 days. *(Refer to Fertilizer Form & Mobility, page 13).*

### Stage 3

Certain bacteria in the soil will convert ammonium ($\text{NH}_4^+$) to *nitrate* ($\text{NO}_3^-$). Nitrate is very mobile in the soil and is also susceptible to denitrification *(loss as a nitrous oxide gas)* or to leaching losses. Farmers want to select fertilizer banding systems that minimize the amount of time that nitrate resides in the soil before the developing crop utilizes it. With mid row bands, the developing root system will access the nitrate as it moves away from the surface of the nitrogen band. The plant’s roots detect the nitrate and begin to proliferate its root system towards the source. Research has shown that by the time the plant is in the 1 to 2 leaf stage, roots often extend outwardly 4 to 6 inches in a mid row banding environment.
Multi-Year/Multi-Location Agronomic Study

Beginning in 2008, Bourgault conducted an ambitious multi-year/multi-location study aimed to confirm existing studies and to improve its knowledge of fertilizer placement relative to the seed in a one-pass seeding environment. This study involved the application of nitrogen, phosphorous and sulphur at various distances from the seed row, with different crops and documented the effects throughout the season. The goal of the study is to determine the benefits and risks involved with fertilizer placement from a producer’s point of view. In order to isolate soil disturbance from the test studies, a disk-style plot seeder was used for the studies.

Over 3500 plots have been seeded in Pierre, South Dakota, Minot, North Dakota, Odessa, Saskatchewan, and St. Brieux, Saskatchewan to gather data representative of crop production in the varying conditions that can be found on the Upper Great Plains of North America.

A Pattern Emerges

Results have been consistent across all of the locations, crops and growing conditions. Issues including reduced emergence, delayed emergence and reduced yields were more common as nitrogen rates increase, and/or minimum separation between the nitrogen row and seed row decreases.

From this data, a chart was developed specifically for canola at 10” seedrow spacing to provide a guideline on nitrogen spacing requirements to ensure reliable seed safety, commonly referred to as the Danger Zone chart.

The Danger Zone

The Danger Zone is based on average conditions throughout the growing season. If there are additional plant stresses present, (such as too much or too little moisture, extreme heat, disease, insects or an early frost) this would in effect increase the nitrogen rate Danger Zone value from the amount applied.

For example, under average conditions, the seedrow should be at least 3” from the fertilizer band at a rate of 100 lb N per acre. Under less than ideal conditions, plant vigor and yield could be negatively impacted with nitrogen fertilizer placement 3” or closer in canola.

The Minimum Separation Required would need to increase:

- as seed row spacing increases,
- as growing conditions deteriorate,
- if the seedbed integrity is lost.
Manage Nutrient Supply to the Plant.

Right Form, Place, Time and Amount

Crops do not need all of their nitrogen fertilizer right away! Not only is placing the entire season’s supply of nutrients right beside the seed a high risk practice; it is not required by the plant!

The goal of fertilizer application is to deliver balanced nutrition to the developing plant throughout its growing cycle; plants need an appropriate and timely supply of nutrients, with none in excess and none being deficient. Other than by applying fertilizer in multiple passes, Bourgault Mid Row Banders® most closely replicate this ideal situation in a single-pass. The conversion process and location from the seed row ensure that plants have access to adequate nitrate nitrogen at the right time in their growth cycle, yet minimize the risk of injury to the crop early in the season. Plants benefit from season long access to fertilizer requirements from doubly concentrated mid row band.

Optimum canola development up to the 5 leaf stage, (typically after 4 weeks), requires that only 20 lb of nitrogen be available to the canola plant. After this point, nitrogen is very rapidly taken up by the plant, so that about two thirds of the nitrogen is taken up in the first third of the growing season. Nitrogen does not need to be available either very early or very late in the growing season.

This schematic representation shows the effects of increasing levels of nitrogen supply to the roots during early growth stages on the root and shoot development of cereal plants. Too little early nitrogen access causes reduced shoot growth while root development continues to search for nutrients. Too much early nitrogen access may show extensive shoot growth, but discourages root development, leaving the plant in danger in summer dry spells and poor access to soil born nutrients.

Nitrogen Uptake by Canola Growth Stage

Source: Mineral Nutrition of Higher Plants, 2nd edition, Horst Marschner

Source: Potash and Phosphate Institute
Nitrogen Fertilizer Form and Mobility

There is not an agronomic requirement to place all of the crop’s nitrogen requirements in close proximity to the seed row. Mid row placement ensures adequate conversion to the beneficial form at the right time in the plant’s development.

### Net Nitrate (NO₃⁻) Supply Rates to the Seed-Row

<table>
<thead>
<tr>
<th></th>
<th>After 2 days</th>
<th>After 6 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea Side-band</td>
<td>35.2</td>
<td>76.1</td>
</tr>
<tr>
<td>Urea mid-row</td>
<td>33.2</td>
<td>61.5</td>
</tr>
</tbody>
</table>

### Net Ammonium (NH₄⁺) Supply Rates to the Seed-Row

<table>
<thead>
<tr>
<th></th>
<th>After 2 days</th>
<th>After 6 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea Side-band</td>
<td>35.6</td>
<td>48.1</td>
</tr>
<tr>
<td>Urea mid-row</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Units in micrograms (µg) of N per 10 cm²*


Evidence of a negative impact on side-banded ammonia based fertilizer is documented in continuous multiple third party studies. One such study titled Seeding Rate, Nitrogen Rate, and Cultivar Effects on Malting Barley Production—J.T. O’Donovan, Agronomy Journal, Volume 103, Issue 3, 2011 was conducted using a dual-shank side-band opener with urea as the nitrogen source.

The results of this study showed that though yields tended to increase as nitrogen rates increased, negative effects included reduced plant density, greater lodging problems and longer time to maturity. These negative effects put the crop at risk of attaining a malt grade and actually reduce the profitability of the field, even with an increased yield.

### Impaired Root Development

Traditionally, side-banding systems were designed to place the crop’s requirements for the whole season in close proximity to the seed. This close proximity may promote above ground vegetative growth, but may also discourage the plant from establishing an extensive network of roots, thus missing out on other nutrients and moisture present in the soil and endangering it to late season droughts.

The close proximity promotes early season top growth; however, nitrogen availability may not be present in the later seed production state. The early season top growth may also lead to increased crop lodging.
Small Scale Demonstrations.

Agronomist, Mike Dolinski, MSc., conducted a series of observations on the effects of fertilizer placement on germination and root development in a controlled environment. Factors such as light, temperature, soil and moisture were controlled so the effects documented were attributable only to fertilizer placement and rate. His observations were captured by close up, highly detailed digital photography documenting the fertilizer’s effects on the plants’ root system.

This photo was taken of canola without any urea, 66 hours after setup. Notice the healthy start of the main root and the abundance of fine root hairs developing from the root. It is the establishment of these fine root hairs that is critical for nutrient and moisture uptake for the plant.

The above photo was also taken 66 hours after setup. The left set of canola seeds had 2 urea prills placed within \( \frac{1}{4} \)", and the right set had 1 urea prill placed within \( \frac{1}{4} \)" of the seeds. The prills had dissolved prior to the photo being taken. The subsequent release of free ammonia and ammonium in proximity to the seed appears to be interfering with germination and normal root development when compared to the control on the left.
The results of the demonstrations show a clear difference in root development where roots are exposed to *free ammonia* and *ammonium nitrate* and roots developing in the absence of fertilizer toxicity. The issue of root thinning or “pruning” caused by *free ammonia* and *ammonium nitrate* become more severe as the rate of fertilizer increases. It is clear to see from the photos how proper fertilizer placement is key for establishing a root dominant environment and achieving strong and even crop establishment.

This photo is of a wheat seedling 13 days after setup. One urea prill was placed 1” below and 1” to the side of the seed, the equivalent of approximately 45 lb/acre. Most of the primary root stems still look healthy, but this close up photo reveals the root tips near the urea prill are browning off and root hair development is not as extensive.

This example shows a higher magnification of wheat root tips where two urea prills were positioned 1” below and 1” to the side of the seed, the equivalent of approximately 90 lb/acre. Notice how the root tips have browned off and the fine root hairs are pruned as they get closer to urea concentration.
Mid Row Banding Promotes Root Development.

Shortly after germination, the roots of the emerging plant sense the source of the mobile nitrate and sulphate as well as immobile phosphate and potassium. This encourages the proliferation of roots towards the source resulting in the establishment of a strong root base.

Bourgault Mid Row Banders® are the best tool available to provide plants access to nitrate nitrogen at the right time at all times during their growth cycle. Since plants use the fertilizer in a more timely manner, more of their energy is directed to grain production and less to early season above ground growth, making the most of your fertilizer dollars.

Mid row banding encourages an extensive root system that not only draws in moisture but also the nutrients contained in the soil. If a dry spell sets in after the seedlings initial growth, these plants would be much better equipped for survival than those that have been compromised by close fertilizer application.

In all other fertilizer application methods, plants that survive or are not affected by the initial toxicity of the fertilizer find the full source of nutrients close by; this close placement promotes early season, above ground vegetative production and discourages extensive root development.
Phosphate Strategies

Safe rates of phosphorus fertilizer still need to be considered when applied in the seedrow. High rates of phosphorus fertilizer can delay germination in some conditions through the salt effect. Although phosphorus fertilizers do have a low salt index, the factor should still be considered in some cases. If higher rates are required, another approach to minimizing the risk of fertilizer damage in a one-pass operation is side-banding phosphate fertilizer while mid row banding the nitrogen fertilizer. Phosphate banded safely to the side and below the seed row allows producers to place all of the season’s phosphate requirement in a single band without placing undue risk to the crop. This also eliminates stranding of the phosphate from the plant.

If side-banding phosphate is a consideration, it is critical to select an opener that will not compromise seedbed integrity. Excessive soil disruption could negate any benefits that would have been realized.

Phosphate Access.

Unlike nitrogen, phosphates are not very mobile in the soil. This is important to consider when applying fertilizer in blends.

_Avoid Hot Zone Application_ – If phosphate fertilizer is applied in a band with a high rate of nitrogen fertilizer, it may become stranded. If roots do not penetrate to the center of the band, they may not encounter the phosphorus fertilizer in time for efficient uptake for plant growth.

From the Bourgault nutrient study, phosphorus response was best if placed in the seedrow, while the nitrogen fertilizer was placed in a separate band.

Benefit of Phosphate Access

This photo documents a root box test where corn was grown with access to phosphate (P₂O₅) on the right side and none on the left. Once all the soil was washed away, it was clear to see the benefit of phosphate for root development.

Both nitrogen and starter nutrients are positioned at the optimum location.

Owners of MRB systems can also employ wider seed-only openers to increase the spread, thereby increasing the safety factor for higher rates of phosphate.
Maintaining Seedbed Integrity.

Never Compromise Seedbed Quality.

Never compromise seedbed quality for a one-pass seeding operation. Seeding systems that disturb the seedbed and leave a rough field finish typically struggle to place seed uniformly at the depth set by the operator. The quality of the seedbed is paramount to ensuring the best start for the crop. It is crucial for optimizing yields to ensure that a one-pass seeding system maintains a high quality seedbed in a wide range of conditions. Factors to consider when evaluating a seeding system are:

**Excessive Moisture Loss**—In dry seeding conditions, one-pass systems that fracture the soil and leave a rough seedbed finish greatly increase the soil’s surface area, which in turn accelerates the evaporation process and robs moisture from the seed.

**Uneven Seed Placement**—A rough seedbed typically indicates that soil is mixing with the seed; this results in erratic seed placement (*seeds can be found on the soil surface to the bottom of the furrow*). Emergence varies greatly resulting in variations in crop maturity.

**Soil Throw (Stepping)**—Seeding systems that cause excessive soil fracturing tend to throw soil from the openers on the front row on to the next row causing an uneven seed depth. Farmers must reduce their seeding speed in order to minimize this issue.

**Fertilizer Damage**—Systems that leave a rough field finish typically struggle to maintain adequate seed-to-fertilizer separation. Seeds in close proximity with nitrogen or sulphur are in danger of experiencing fertilizer toxicity and salt effect.

**Deep Furrows**—Seeding equipment that leaves deep furrows produce undue stress on the operator and equipment during later operations such as spraying, swathing and harvesting. In dry years, these deep furrows expose more of the soil’s surface to evaporation. In wet years, the furrows tend to slump to the bottom of the trench depositing excessive soil over the seed.

**Straw Piles**—Systems that tend to collect and drop field residue cause uneven germination and dead spots. Straw piles also interfere with swathing and harvest operations.

**Soil Sticking**—Systems that are prone to mud build-up in wet conditions can alter the profile of the opener causing excessive soil disturbance.

**Seeding Efficiency**—It is important to achieve the optimum seeding speed; the maximum speed before seedbed integrity starts to breakdown, seeding depth becomes inconsistent and soil throw occurs.

### Seedbed Integrity and Nitrogen Immobilization

Farmers are aware that nitrogen fertilizer can be ‘tied up’ in the soil during the decay of crop residue. This occurs when bacteria in the soil use some of the soil or fertilizer nitrogen while they decompose the crop residue of the previous year. This is often called *immobilization*. The best strategy to reduce immobilization is to isolate the nitrogen fertilizer in a band under the crop residue—a placement that favours the fertilizer use by the crop rather than soil bacteria. The most effective nitrogen fertilizer placement will be completely under the crop residue with minimal soil mixing in a narrow and concentrated band. Mid row bands are very well designed to reduce nitrogen fertilizer immobilization—the bands have high rates of fertilizer in a very narrow band with almost no mixing of crop residue into the soil. The residue remains near the surface to protect and mulch the soil, while the band is placed for ideal crop use.
Mixing Causes Mortality.

In this example, fertilizer has been side-banded with the seed. Some seeds are on the soil shelf created by the opener. Some seeds have mixed with the fertilizer in the lower levels of the fertilizer furrow.

As soon as the seed is in the soil, it begins absorbing moisture. Soon after application, depending on the fertilizer form, the band of ammonia \((NH_3 - \text{red})\) and ammonium \((NH_4^+ - \text{orange})\) grows to typically 3" in diameter in normal conditions and larger in dry, highly fractured or sandy soil. Seed in the presence of ammonium \((NH_4^+)\) can suffer from impaired development and reduced plant vigor, while exposure to ammonia \((NH_3)\) can result in severe injury or mortality.

Mid Row Banders® Provide a Superior Seedbed Environment.

The preservation of the previous crop’s stubble demonstrates how well the Bourgault seeding system can place seed and fertilizer without excessive disruption of the seedbed, with or across last season’s seed rows. The preserved stubble itself also provides several advantages:

- **standing stubble protects the seedlings during initial emergence**;
- **the old root system binds the soil together to prevent erosion**.

A side-by-side demonstration conducted in Churchbridge (near Langenburg, Saskatchewan) in the Spring of 2005, showed how different one-pass seeding systems can perform. In the photo below, the left side of the field was seeded with a Bourgault 5710 air hoe drill equipped with Mid Row Banders. The right side of the field was seeded with a dual-knife side-banding system. This demonstration highlighted a number of advantages that the Bourgault MRB system has over side-banding systems, including seedbed integrity.

Bourgault offers a choice of seeding systems that work for your conditions, each one available with Mid Row Banders: so you can seed directly into managed residue, preserve standing stubble and minimize the risk of fertilizer damage.
Evaluating Wide Row Spacing.

Residue Clearance
Residue clearance is a major reason why some seed drill manufacturers have gone to wider row spacings. Double-shoot openers present a much wider profile through the soil compared to single shank seed-only openers. By increasing the seed row spacing, mats of straw have a lower tendency to catch on the openers on the next row.

Soil Disturbance
Wide row implement spacing may be a benefit in traditionally dry regions to reduce soil disturbance, if the opener itself minimizes soil disruption. Openers with a wider profile, such as dual-knife or double-shoot side-banding systems create more disturbance than a narrow single-shoot opener. The moisture loss resulting from these systems can be detrimental to the emerging plants, especially when short of rainfall.

In regions with excessive spring moisture, there can be a benefit of systems which “blacken” the seed row, promoting evaporation. However, wide double-shoot openers may build up mud in clay based soils, widening their profile even more causing even greater seedbed disruption, poor seed placement and draft loading.

Variable Rate Fertilizer Technology
Variable Rate Technology brings another element of risk for wider row spacing. Fertilizer must be applied in fewer rows, yet maintain the prescribed rate per acre. It is not unusual to see prescription maps call for over 150 lb/acre of N in specific zones. Widening the row spacing on a side-banding unit will increase the concentration of fertilizer and thereby increase the risk of seedling damage.

Cost vs. Investment
A system with less openers per foot reduces the initial price of the seeding system. However, the majority of studies have shown that one-pass systems with wider row spacing typically produce lower yields than narrow spacing. Systems with a lower initial cost may reduce the producer’s profits over the long run. To date, over 85% of Bourgault seeding systems are sold on 10” spaced systems.

In-Row Competition
Systems with wider row spacings must concentrate more seed in the fewer rows to maintain the same seeding rate per acre. This leads to increased competition between the germinating seeds, which can lead to reduced emergence and slower development, especially in dryer conditions.

Below: Even field finish and excellent emergence Bourgault seeding systems on 10” row spacing, equipped with Mid Row Bander® fertilizer applicators.
Seed Bed Utilization

Narrow row spacings make more of the seedbed available to the growing plants. Plant roots absorb not only the applied nutrients, but also the available nutrients and micro-nutrients in the soil. Wider row spacings increase the challenge for crops to take up what is available in the soil.

The Semiarid Prairie Agricultural Research Centre in Swift Current published a research newsletter (#34, December 6th, 1996) titled “Wide Row Spacings are Risky in the Semiarid Prairie” by Brian McConkey and Perry Miller. Their tests compared 8” to 12” row spacing with a paired row opener. “The results for 1995 and 1996 showed that there was a high risk of obtaining more than a 10% yield loss when a narrow seed spread is used on a 12” spacing (compared to the 8” spacing).” It is crucial to understand that as the row spacing increases, the concentration of fertilizer also increases resulting in a higher risk of seedling damage.

Research on Seed Row Spacing.

A number of agronomic studies have documented that there is a greater benefit to crop production with narrow seed row spacing as compared to wide.

“Investigation into Row Spacing with Direct Seeded Barley, Canola and Wheat - RL0498B - November 1999” conducted by the Alberta Farm Machinery Research Centre showed that an increase in row spacing demonstrated a decrease in emergence and yield for both canola and wheat.

The graph shows the results of a study done to determine the effect of row spacing on the emergence of wheat in High River, Provost, and Edmonton Alberta. An increase in row spacing resulted in a decrease of wheat emergence. At all three sites the differences in emergence between the row spacings were significant.
Crop Stressors.

Although small grains are adapted to a wide range of climates and soils, they are sensitive to various agronomic and environmental conditions including temperature, rainfall, humidity, sunlight, fertility, herbicide carryover, insects and diseases. When considering the factors we can control, there is an opportunity to boost soil fertility for maximum yield potential when moisture is not the limiting factor. Caution must be given to the placement strategies for that fertilizer when targeting maximum yield.

Bourgault’s 2010 plot trials supported this observation. The canola yield trial at test plots near Odessa, Saskatchewan, (which also experienced significantly above average moisture conditions) showed that as nitrogen placement moved away from the seed row, yield steadily improved. This plot study, as with all Bourgault studies, was recorded and verified by an independent agronomist.

The negative effects of nitrogen fertilizer toxicity and subsequent damage on an emerging crop being amplified by excessive heat and drought are fairly well documented and understood. However, 2010 revealed that even in wet conditions, fertilizer placement still plays a significant impact on crop development and ultimately, yield.

Mother Nature continues to throw stressors our way, but by managing your fertility program with Mid Row Banders you can minimize the cumulative effect of stress under dry or wet conditions to produce the highest possible yield in all growing conditions.

Image: Odessa Canola 2010

All trials included 14 lb of actual sulphur with N in the side-band, and 20 lb of phosphate with the seed. The Odessa canola results indicate that a MRB seeding system would be beneficial to maximize yield with nitrogen rates of 100 lb/acre or greater. Similar results have been observed in 70 lb/acre trials as well.

These results are an average of 4 plots for each trial.
Myths about MRBs.

Myth #1—Mid Row Banding Feeds the Weeds

A myth about mid row nitrogen application is that it promotes weed growth over the nitrogen band, showing up as heavier weed density in every second row spacing.

In mid row banded fields, it is possible to find one inter-row space almost devoid of weeds and the next inter-row more populated with weeds. However, the weedy space between the seed rows is the non-fertilized inter-row, and the inter-row space with little to no weeds is the location of the banded nitrogen.

Demonstration plots were established with flax at three separate locations in 2012; Pierre, South Dakota, Regina, Saskatchewan, and St. Brieux, Saskatchewan. Flax was broadcasted and incorporated into the soil, after which, various rates of fertilizer were banded into the plots and a control with no fertilizer applied. In all cases, it was found that where fertilizer was applied, the seeds perished overtop the fertilizer row, then flourished on either side of the band.

**MRB Fact — The weeds will actually perish overtop of the concentrated mid row fertilizer band. MRBs do not feed the weeds!**

Myth #2—Mid Row Banding Strands the Nitrogen

Another myth about mid row banding is that in dry years, Mid Row Banders will strand the nitrogen so that the plant cannot access it.

In reality, plants at the two leaf stage can often have root systems that extend up to 6 inches.

Also, the nitrate from the mid row band diffuses outwardly 4 to 5 inches typically within 2 weeks. Independent research has shown that nitrate originating from the mid row band can be detected at the seed row in as little as 2 days. (Reference: *Journal of Plant Nutrition*, Vol. 26, No. 3, 2003)

**MRB Fact** The growing plant roots easily locate and tap into the nitrate radiating out from the mid row band.

Plants will continue to proliferate or expand the size of their roots towards the source of nitrate, helping to establish larger and extensive root systems.

With the mid row fertilizer band being 5 inches from the seed row, it is easy to see that even in dry conditions, the nitrogen fertilizer in the nitrate form will easily reach the radiating root system.

If there is insufficient moisture to facilitate the nitrification of fertilizer, there will be insufficient moisture to support plant growth past germination and the one leaf stage.

This photo clearly shows the travel of the 4 disk openers when placing nitrogen into broadcasted flax. It is difficult to see the bands with nitrogen turned off. There is a clear band of zero growth directly over the location of nitrogen. **70 lb N - Side-banded.**
Bourgault extends its appreciation to Lyle Cowell, regional agronomist with Viterra in Tisdale, (Saskatchewan), for reviewing the material in this document.

Every effort has been made to produce this handbook with the most current information possible.

Visit www.bourgault.com for additional agronomic information.