2021 Report

for the

Saskatchewan Ministry of Agriculture's

Agricultural Demonstration of Practices & Technologies (ADOPT) Program

Project Title: Influence of Potassium Fertilizer on Yield and Seed Quality of Malt Barley and Spring Wheat (Project #20200479)


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**Project Identification**

1. **Project Title:** Influence of Potassium Fertilizer on Yield and Seed Quality of Malt Barley and Spring Wheat
2. **Project Number:** 20200479
3. **Producer Group Sponsoring the Project:** Indian Head Agricultural Research Foundation (IIHARF)
4. **Project Location(s):**


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5. **Project start and end dates (month & year):** March 2, 2021 – February 15, 2022

6. **Project contact person & contact details (IHARF):**


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7. **Project objectives:**

The objectives of this project are to conduct trials with typical soil testing potassium (K) levels to:

1. Evaluate the effects of K fertilizer rate and placement on yield of malt barley and spring wheat;
2. Evaluate the influence of K fertilization on seed quality characteristics, and to;
3. Assess the impact of K fertilization on crop lodging.

8. **Project Rationale:**

Dozens of potassium (K) fertilizer field trials have been conducted in Saskatchewan since the 1960's, however, the majority failed to provide a grain yield response. In Saskatchewan, soils tend to have abundant soil available K, and therefore its application in cereals is typically restricted to the Grey soil zone or very light textured soils. Yield responses tend to be limited when K is applied to soils deemed adequate in soil test K (Karamanos et al., 2013; Holzapfel, C, 2016). However, yield responses can and have occurred. A summary of 124 barley trials conducted by Westco from 1989 to 1998 suggested that the probability of observing a yield response in barley to seed-placed K could be expected in 2 of 5 years. In wheat (52 sites) trials the probability of observing a yield response to seed-placed K was 1 year in 5 (data summary presentation in possession of G. Hnatowich). In yield responsive trials, the influence of K fertilizer additions may have been an indirect response to disease suppression and an overall healthier plant stand. Although yield responses can be variable on typical soils in western Canada, K fertilization may affect other agronomic and market-enhancing attributes.

Vasey & Soper (1966) found that K fertilization increased the plumpness of malting barley in soils high in available K. Similarly, low levels of K fertilization elevated the percentage of plump kernels in malt barley grown on soils testing from 248 to 1060 kg K/ha in North Dakota (Zubriski et.al., 1970). As 2-row malt barley varieties require $\geq$ 80% plump kernels to meet grading criteria, the potential to increase plumpness with K fertilizer additions is highly desirable and would provide a direct monetary benefit to producers. There may be other agronomic factors that respond to K fertilization (i.e., higher test weight in spring wheat) that could benefit producers and increase the profitability of either malt barley or spring wheat.

Lodging is a concern for high yielding varieties, particularly under irrigation. Lodging reduces yield, influences seed quality, and can create logistical challenges at harvest. Increased stem strength and enhanced lodging resistance is attributed to sufficient K availability (Yuan et. al., 2010). However, McKenzie et. al. (2005) conducted field trials in southern Alberta and failed to relate barley lodging resistance to K fertilization as lodging only occurred at one of fourteen sites over a three-year period. In high yielding or irrigated environments where lodging is more prevalent, additional K fertilizer supplementation might be beneficial.

9. **Methodology:**

Small plot trials were established at Indian Head (IHARF), Yorkton (ECRF), Redvers (SERF), Prince Albert (CLC), Swift Current (WCA) and Outlook (ICDC). Seven potassium (K) fertilizer treatments were established in a Randomized Complete Block Design with four replications. Both spring wheat and malt barley were evaluated as separate and individual trials. Plot size varied in accordance to seeding equipment at each site. Wheat variety selection was on a site-by-site preference to a regionally suitable variety. However, AAC Synergy or CDC Churchill were specified as preferred, high yielding malt varieties. K fertilizer rates and positional placement were:

1. 0 kg $K_2O$/ha – seed placed
2. 10 kg $K_2O$/ha – seed placed
3. 20 kg $K_2O$/ha – seed placed
4. 30 kg $K_2O$/ha – seed placed
5. 10 kg $K_2O$/ha – side banded
6. 20 kg $K_2O$/ha – side banded
7. 30 kg $K_2O$/ha – side banded
8. 20 kg $K_2O$/ha – seed placed + 40 kg $K_2O$/ha – side banded

Prior to seeding all sites obtained soil samples for nutrient analyses. Samples were sampled and submitted to Western Ag according to their sampling and shipping protocols for ion exchange resin membrane available K. Additionally, sites also obtained a conventional soil test as per standard testing procedures at each AgriArm location. Conventional soil testing measured ammonium acetate exchangeable K. As wheat and barley trials were adjacent, a single composite soil sample was obtained from the trialing area. Soil test results and recommendations are shown in Table 1. In general, Cropcaster recommendations were higher than conventional soil test procedures in the study. Operational dates and inputs applied at each site are shown in Table 2.

**Table 1. Soil analysis results, 2021**

| Trial Location | Western Ag PRS Cropcaster | | Agvise | |
|---|---|---|---|---|
| | Soil $K_2O$ kg/ha | Fertilizer $K_2O$ Recommendation kg/ha | Soil $K_2O$ kg/ha | Fertilizer K2O Recommendation kg/ha |
| ICDC | 106.4 | 0 | 426 | 11 |
| ECRF | 58.2 | 29 | 764 | 11 |
| SERF | 29.8 Wheat<br>27.2 Barley | 40 Wheat<br>35 Barley | 364 Wheat<br>312 Barley | Not provided |
| IHARF | 26.9 | 56 | 1316 | 11 |
| WCA | 260.3 | 0 | 834 | 11 |
| CLC | 121.2 | 28 Wheat,<br>67 Barley | 490 | 10 |

**Table 2. Operational dates and inputs used in wheat/barley, 2021**.

| Activity | Location | | | | | |
|---|---|---|---|---|---|---|
| | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Pre-seed Herbicide | May 7 glyphosate | none | | May 11 glyphosate | May 3 glyphosate | none |
| Variety | Wheat – AAC Wheatland VB Barley – AAC Synergy | Wheat – AAC Brandon Barley – AAC Synergy | Wheat – AAC Brandon Barley – AAC Connect | Wheat – CDC Alida VB Barley – AAC Synergy | Wheat - Adamant Barley – AAC Synergy | Wheat – AAC Cameron VB Barley – CDC Churchill |
| Seeding | May 14 | Wheat – May 7 Barley – May 13 | May 6 | May 6 | May 11 | May 27 |
| N-P-S (kg nutrient/ha ) Fertilizer | Wheat 135-25-0 Barley 135-25-0 | Wheat 125-30-0 Barley 100-30-0 | Wheat 65-25-0 Barley 65-25-0 | Wheat 145-40-0 Barley 125-40-0 | Wheat 133-30-0 Barley 105-30-0 | Wheat 126-39-0 Barley 98-45-0 |
| In-crop Herbicide | June 18 Buctril M /Simplicity | June 7 Prestige June 16 Axial | | Wheat June 7 Prestige/Simplicity Barley June 16 Prestige /Axial | June 7 Buctril M / Achieve | June 15 Dyvel |
| In-crop Fungicide | none | Wheat July 9 Prosaro XTR Barley June 28 Trivepro | none | Wheat July 6 Prosaro XTR Barley July 1 Trivepro | none | July 13 Folicur |
| Harvest | Aug 26 | Wheat – Aug 13 Barley – Aug 27 | Wheat – Aug 14 Barley – Aug 10 | Wheat – Aug 30 Barley – Aug 15 | Wheat – Aug 31 Barley – Aug 30 | Wheat – Sept 22 Barley – Sept 9 |

## 10. Results

*Growing Season Weather*

Mean monthly temperatures and precipitation amounts for 6 locations are listed in Tables 3 and 4. The 2021 growing season was a historic event with temperatures higher than long-term averages and seasonal precipitation much below typical precipitation levels at most locations. The Outlook site received only 49.6% of historic precipitation but was irrigated. Irrigation applied at Outlook consisted of 15 mm in May, 110 mm in June, 110 mm in July and no applications in August, total irrigation applied was 235 mm. All other remaining trial locations were dryland production and adversely influenced by heat and or drought, particularly at Yorkton, Swift Current and Prince Albert where only 54%, 75% and 73% historic precipitation was received, respectively. Indian Head and

Redvers received precipitation close to long-term averages.

**Table 3. Mean monthly temperatures at sites for 2021 compared to long-term (30 years) averages.**

| Location | Year | May | June | July | August | Avg. / Total |
|---|---|---|---|---|---|---|
| | | *-----------------------------Mean Temperature (°C) -------------------* | | | | |
| ICDC Outlook | 2021 | 10.1 | 18.8 | 21.6 | 17.9 | 17.1 |
| | ***Long-term*** | ***11.3*** | ***16.0*** | ***18.6*** | ***17.8*** | ***15.9*** |
| ECRF Yorkton | 2021 | 8.9 | 19.1 | 21.0 | 17.3 | 16.5 |
| | ***Long-term*** | ***10.4*** | ***15.5*** | ***17.9*** | ***17.1*** | ***15.2*** |
| SERF Redvers | 2021 | 10.0 | 18.7 | 20.8 | 17.5 | 16.8 |
| | ***Long-term*** | ***11.1*** | ***16.2*** | ***18.7*** | ***18.0*** | ***16.0*** |
| IHARF Indian Head | 2021 | 9.0 | 17.7 | 20.3 | 17.1 | 16.0 |
| | ***Long-term*** | ***10.8*** | ***15.8*** | ***18.2*** | ***17.4*** | ***15.6*** |
| WCA Swift Current | 2021 | *9.5* | *18.4* | *21.7* | *18.0* | *16.9* |
| | ***Long-term*** | ***10.9*** | ***15.3*** | ***18.2*** | ***17.6*** | ***15.5*** |
| CLC Prince Albert | 2021 | 10.1 | 18.3 | 20.3 | 17.0 | 16.4 |
| | ***Long-term*** | ***11.4*** | ***15.9*** | ***18.5*** | ***17.1*** | ***15.7*** |

**Table 4. Precipitation received at sites during 2021 compared to long-term (30 years) averages.**

| Location | Year | May | June | July | August | Avg. / Total |
|---|---|---|---|---|---|---|
| | | ------------------------------- *Precipitation (mm)* -------------------- | | | | |
| ICDC Outlook | 2021 | 44.5 | 10.3 | 13.8 | 37.7 | 106.3 |
| | ***Long-term*** | ***43.2*** | ***69.3*** | ***57.6*** | ***44.2*** | ***214.3*** |
| ECRF Yorkton | 2021 | 24.6 | 18.1 | 35.2 | 69.7 | 147.6 |
| | ***Long-term*** | ***51*** | ***80*** | ***78*** | ***62*** | ***272*** |
| SERF Redvers | 2021 | 41.4 | 95.2 | 38.4 | 72.1 | 247 |
| | ***Long-term*** | ***60.0*** | ***95.2*** | ***65.5*** | ***46.6*** | ***267*** |
| IHARF Indian Head | 2021 | 81.6 | 62.9 | 51.2 | 99.4 | 295.1 |
| | ***Long-term*** | ***51.7*** | ***77.4*** | ***63.8*** | ***51.2*** | ***244.1*** |
| WCA Swift Current | 2021 | 35.0 | 29.6 | 38.9 | 55.8 | 159.3 |
| | ***Long-term*** | ***44.1*** | ***74.5*** | ***51.9*** | ***43.2*** | ***213.7*** |
| CLC Prince Albert | 2021 | 29.8 | 84.0 | 9.6 | 57.0 | 180.4 |
| | ***Long-term*** | ***40.4*** | ***79.6*** | ***84.6*** | ***42.9*** | ***247.5*** |

Wheat Results

Results gathered for wheat seed yield, quality and other agronomic characteristics from all trial locations are shown in Tables 1 through 7. Potassium fertilization had little or no effect in wheat under the trial conditions. Results from the ECRF and WCA sites had higher than acceptable coefficients of variation with respect to yield. At both locations the high degree of variability within grain yield was attributed to drought conditions. Seed yield at the remaining four trial locations, while acceptable with respect to statistical analysis, where lower than might “normally” be expected. For example, under irrigation at ICDC average yield was 4412 kg/ha (65.6 bu/ac) where expected yields on this field are typically in the 6000-6200 kg/ha range (89.2-92.2 bu/ac) range. Therefore, although irrigated, the adverse environmental conditions experienced unquestionably had a negative influence on wheat growth and development. This probably may also apply to all dryland locations. Therefore, it is not possible to determine if spring wheat is nonresponsive to K fertilizer additions or if the absence of response is due to environmental conditions.

**Table 1. Wheat Grain Yield Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Yield kg/ha | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 4436 a | 3822 a | 3795 a | 3965 a | 1414 a | 3715 a |
| 10 | | 4409 a | 3735 a | 3578 a | 3905 a | 1431 a | 3246 a |
| 20 | | 4325 a | 3312 a | 3714 a | 3910 a | 1428 a | 3559 a |
| 30 | | 4344 a | 3398 a | 3847 a | 3956 a | 1311 a | 3405 a |
| | 10 | 4413 a | 3029 a | 3313 a | 3917 a | 1429 a | 3239 a |
| | 20 | 4362 a | 3087 a | 3679 a | 3931 a | 1520 a | 3449 a |
| | 30 | 4522 a | 2985 a | 3438 a | 3949 a | 1603 a | 3425 a |
| 20 | 40 | 4489 a | 3049 a | 3789 a | 3882 a | 1543 a | 3545 a |
| | LSD (0.05) | NS | NS | NS | NS | NS | NS |
| | CV (%) | 5.2 | 21.7 | 7.7 | 1.9 | 15.6 | 13.5 |

NS = not significant

**Table 2. Wheat Grain Protein Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Protein % | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 10.7 a | 15.9 a | 14.1 a | 15.03 ab | 17.3 a | ND |
| 10 | | 10.8 a | 16.1 a | 14.6 a | 15.05 a | 17.2 a | ND |
| 20 | | 10.6 a | 16.4 a | 14.3 a | 14.85 cd | 17.1 a | ND |
| 30 | | 10.8 a | 16.1 a | 14.6 a | 14.95 abc | 17.1 a | ND |
| | 10 | 10.8 a | 16.4 a | 14.8 a | 14.93 abc | 17.3 a | ND |
| | 20 | 10.6 a | 16.4 a | 14.4 a | 14.75 de | 17.1 a | ND |
| | 30 | 10.9 a | 16.6 a | 15.2 a | 14.90 bc | 17.0 a | ND |
| 20 | 40 | 10.5 a | 16.5 a | 14.6 a | 14.70 e | 17.3 a | ND |
| | LSD (0.05) | NS | NS | NS | 0.15 | NS | |
| | CV (%) | 4.4 | 2.8 | 4.5 | 0.7 | 1.2 | |

NS = not significant
ND = not determined

**Table 3. Wheat Grain Test Weight Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Test Weight (kg/hL) | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 78.5 a | 78.6 a | 81.0 a | 78.1 a | 77.9 a | 74.9 a |
| 10 | | 78.3 a | 78.5 a | 81.0 a | 78.3 a | 78.6 a | 75.4 a |
| 20 | | 78.5 a | 77.6 a | 81.4 a | 78.3 a | 78.0 a | 75.6 a |
| 30 | | 78.9 a | 78.7 a | 81.4 a | 78.3 a | 78.0 a | 75.5 a |
| | 10 | 78.4 a | 78.5 a | 81.5 a | 78.3 a | 78.0 a | 75.4 a |
| | 20 | 78.0 a | 77.9 a | 81.8 a | 77.9 a | 78.5 a | 75.3 a |
| | 30 | 77.9 a | 77.6 a | 81.5 a | 78.2 a | 78.2 a | 75.2 a |
| 20 | 40 | 78.2 a | 78.4 a | 81.9 a | 78.2 a | 77.5 a | 76.0 a |
| | LSD (0.05) | NS | NS | NS | NS | NS | NS |
| | CV (%) | 0.8 | 1.1 | 0.8 | 0.4 | 0.9 | 1.0 |

NS = not significant

**Table 4. Wheat Seed Weight Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Seed Weight (TKW) | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA*** | **CLC** |
| Control - 0 | | 37.2 a | 34.4 a | 33.3 a | 35.1 a | 27.38 c | 31.0 a |
| 10 | | 37.5 a | 31.6 a | 32.4 a | 35.4 a | 29.38 a | 32.4 a |
| 20 | | 37.6 a | 32.7 a | 32.8 a | 35.1 a | 27.70 bc | 31.6 a |
| 30 | | 37.7 a | 33.8 a | 33.9 a | 35.6 a | 27.93 abc | 30.9 a |
| | 10 | 38.1 a | 33.2 a | 32.3 a | 35.2 a | 27.45 c | 31.3 a |
| | 20 | 37.9 a | 32.1 a | 33.8 a | 35.7 a | 29.03 ab | 31.0 a |
| | 30 | 37.2 a | 31.6 a | 33.4 a | 34.8 a | 28.45 abc | 31.3 a |
| 20 | 40 | 37.7 a | 33.7 a | 33.6 a | 34.1 a | 27.53 bc | 32.7 a |
| | LSD (0.05) | NS | NS | NS | NS | 1.55 | NS |
| | CV (%) | 2.4 | 4.7 | 3.9 | 2.7 | 3.8 | 4.2 |

* = significant at P<0.10

NS = not significant

**Table 5. Wheat Days to Maturity Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Days to Mature | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 94 a | 88 a | 87 a | 93.0 b | 87 a | ND |
| 10 | | 94 a | 88 a | 88 a | 93.3 ab | 86 a | ND |
| 20 | | 94 a | 87 a | 88 a | 93.0 b | 86 a | ND |
| 30 | | 94 a | 88 a | 88 a | 93.4 a | 87 a | ND |
| | 10 | 94 a | 87 a | 87 a | 93.3 ab | 87 a | ND |
| | 20 | 94 a | 87 a | 88 a | 93.0 b | 86 a | ND |
| | 30 | 94 a | 86 a | 86 a | 93.1 ab | 88 a | ND |
| 20 | 40 | 94 a | 88 a | 88 a | 93.0 b | 87 a | ND |
| | LSD (0.05) | NS | NS | NS | 0.27 | NS | |
| | CV (%) | - | 1.4 | 1.3 | 0.2 | 1.2 | |

NS = not significant
ND = not determined

**Table 6. Wheat Plant Height Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Plant Height (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 79 a | 71 a | 76 a | 77 a | 46 a | ND |
| 10 | | 79 a | 71 a | 79 a | 76 a | 44 a | ND |
| 20 | | 79 a | 71 a | 73 a | 75 a | 48 a | ND |
| 30 | | 79 a | 70 a | 77 a | 77 a | 45 a | ND |
| | 10 | 81 a | 68 a | 72 a | 74 a | 47 a | ND |
| | 20 | 79 a | 67 a | 76 a | 75 a | 46 a | ND |
| | 30 | 80 a | 70 a | 76 a | 75 a | 46 a | ND |
| 20 | 40 | 79 a | 66 a | 73 a | 74 a | 47 a | ND |
| | LSD (0.05) | NS | NS | NS | NS | NS | |
| | CV (%) | 2.4 | 6.5 | 4.2 | 2.5 | 7.4 | |

NS = not significant
ND = not determined

**Table 7. Wheat Plant Lodging Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Lodging (Belgian Scale) | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 0.2 a | 0.5 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| 10 | | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| 20 | | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| 30 | | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| | 10 | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| | 20 | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| | 30 | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| 20 | 40 | 0.2 a | 0.3 a | 0.2 a | 0.2 a | 0.2 a | 0.2 a |
| | LSD (0.05) | NS | NS | NS | NS | NS | NS |
| | CV (%) | - | 38.6 | - | 71.0 | - | - |

NS = not significant

Barley

Results gathered for barley seed yield, quality and other agronomic characteristics from all trial locations are shown in Tables 1 through 7. Like wheat, dryland barley trials failed to respond in any meaningful manner to fertilizer K additions. Correspondingly, unfavorable environmental conditions may have adversely influenced findings. However, results for the irrigated barley trial differed. At ICDC all fertilizer K applications resulted in numerically higher grain yield compared to the unfertilized control treatment. Mean yield response to K application was 17%. Seed-placed K additions were highest with the 10 kg $K_2O$/ha rate and declined with additional seed-placed K rates. This suggests that though the K fertilizer was beneficial, the higher rates may have caused some seedling damage from fertilizer salt, particularly in the dry seed bed conditions prevalent in 2021. Once fertilizer K was positioned away from the seed, in a side band application, all treatment rates produced statistically higher grain yield compared to the control treatment. Protein at ICDC decreased with K fertilizer applications, this is attributed to a dilution effect because of higher yields obtained. Generally, it appears that at ICDC the 10 kg $K_2O$/ha rate provided optimal barley yield, aligning with the conventional soil test K fertilizer recommendation for this location. At IHARF, some K additions did tend to increase the % plump seed fraction, thought results were variable both within K rates and between K fertilizer positional placement. No other results from K fertilizer treatments were obtained.

**Table 8. Barley Grain Yield Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Yield kg/ha | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC*** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 4706 b | 2737 a | 4000 a | 4162 a | 1554 a | 3581 a |
| 10 | | 5425 a | 2116 a | 3890 a | 4258 a | 1448 a | 4392 a |
| 20 | | 5360 ab | 2988 a | 3786 a | 4226 a | 1675 a | 4178 a |
| 30 | | 5266 ab | 2305 a | 3959 a | 4199 a | 1471 a | 4221 a |
| | 10 | 5555 a | 2417 a | 4058 a | 4270 a | 1555 a | 3785 a |
| | 20 | 5446 a | 2984 a | 4221 a | 4185 a | 1706 a | 4118 a |
| | 30 | 5821 a | 2589 a | 4089 a | 4264 a | 1483 a | 3902 a |
| 20 | 40 | 5760 a | 2280 a | 4048 a | 4241 a | 1651 a | 3532 a |
| | LSD (0.05) | 695 | NS | NS | NS | NS | NS |
| | CV (%) | 8.7 | 27.0 | 6.3 | 3.4 | 10.9 | 16.4 |

* = significant at P<0.10
NS = not significant

**Table 9. Barley Grain Protein Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Protein % | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC*** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 9.2 a | 15.9 a | 13.9 a | 12.3 a | 16.38 ab | ND |
| 10 | | 8.8 ab | 15.8 a | 13.6 a | 12.2 a | 16.43 ab | ND |
| 20 | | 9.0 ab | 14.7 a | 14.2 a | 12..3 a | 16.00 c | ND |
| 30 | | 9.0 ab | 16.0 a | 14.1 a | 12.3 a | 16.45 a | ND |
| | 10 | 8.6 b | 15.3 a | 14.1 a | 12.4 a | 16.43 ab | ND |
| | 20 | 8.8 ab | 14.8 a | 13.7 a | 12.2 a | 16.18 bc | ND |
| | 30 | 8.6 b | 15.8 a | 13.6 a | 12.3 a | 16.28 ab | ND |
| 20 | 40 | 8.6 b | 15.7 a | 13.9 a | 12.4 a | 16.20 abc | ND |
| | LSD (0.05) | 0.4 | NS | NS | NS | 0.26 | |
| | CV (%) | 3.4 | 5.5 | 3.7 | 1.0 | 1.1 | |

* = significant at P<0.10
NS = not significant
ND = not determined

**Table 10. Barley Grain Test Weight Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Test Weight (kg/hL) | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 68.4 a | 55.3 a | 55.3 a | 60.8 a | 64.9 a | 57.2 a |
| 10 | | 64.8 a | 55.0 a | 55.8 a | 61.3 a | 65.1 a | 57.5 a |
| 20 | | 63.8 a | 55.2 a | 54.4 a | 61.6 a | 64.5 a | 56.7 a |
| 30 | | 64.0 a | 55.3 a | 54.8 a | 61.2 a | 65.2 a | 56.4 a |
| | 10 | 64.7 a | 55.6 a | 54.3 a | 60.9 a | 65.4 a | 58.9 a |
| | 20 | 63.7 a | 55.1 a | 55.2 a | 60.7 a | 65.1 a | 57.2 a |
| | 30 | 64.8 a | 55.6 a | 55.4 a | 60.9 a | 64.8 a | 57.2 a |
| 20 | 40 | 64.6 a | 55.3 a | 55.5 a | 61.2 a | 64.7 a | 56.9 a |
| | LSD (0.05) | NS | NS | NS | NS | NS | NS |
| | CV (%) | 5.2 | 1.4 | 2.7 | 1.0 | 0.9 | 2.0 |

NS = not significant

**Table 11. Barley Seed Weight Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).**

| K Placement & Rate (kg/ha) | | Seed Weight (TKW) | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF*** | **WCA** | **CLC** |
| Control - 0 | | 47.6 a | 43.3 a | 41.3 a | 41.7 c | 64.9 a | 43.0 a |
| 10 | | 47.1 a | 44.1 a | 41.3 a | 42.3 abc | 65.1 a | 42.1 a |
| 20 | | 47.7 a | 45.0 a | 42.0 a | 42.8 a | 64.5 a | 42.4 a |
| 30 | | 47.4 a | 43.3 a | 41.3 a | 42.4 abc | 65.2 a | 40.9 a |
| | 10 | 47.4 a | 44.4 a | 41.1 a | 42.5 ab | 65.4 a | 41.7 a |
| | 20 | 47.0 a | 43.5 a | 41.9 a | 41.8 bc | 65.1 a | 42.0 a |
| | 30 | 47.6 a | 44.3 a | 41.6 a | 42.1 abc | 65.1 a | 42.3 a |
| 20 | 40 | 47.2 a | 44.7 a | 42.1 a | 42.8 a | 64.7 a | 42.9 a |
| | LSD (0.05) | NS | NS | NS | 0.8 | NS | NS |
| | CV (%) | 2.1 | 5.0 | 6.8 | 1.3 | 2.2 | 5.4 |

* = significant at P<0.10

NS = not significant

**Table 12. Barley Plump Seed Percentage Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).**

| K Placement & Rate (kg/ha) | | % Plump Seed | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 98.5 a | 97.0 a | ND | 97.2 cd | ND | ND |
| 10 | | 98.2 a | 97.9 a | ND | 97.2 bcd | ND | ND |
| 20 | | 98.4 a | 98.2 a | ND | 97.8 a | ND | ND |
| 30 | | 98.1 a | 97.7 a | ND | 97.2 bcd | ND | ND |
| | 10 | 98.0 a | 98.7 a | ND | 97.0 d | ND | ND |
| | 20 | 98.1 a | 97.4 a | ND | 97.4 abcd | ND | ND |
| | 30 | 98.0 a | 98.4 a | ND | 97.6 abc | ND | ND |
| 20 | 40 | 98.2 a | 98.2 a | ND | 97.7 ab | ND | ND |
| | LSD (0.05) | NS | NS | | 0.48 | | |
| | CV (%) | 0.3 | 1.2 | | 0.3 | | |

NS = not significant
ND = not determined

**Table 13. Barley Thin Seed Percentage Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).**

| K Placement & Rate (kg/ha) | | % Thin Seed | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 1.6 a | 0.3 a | ND | 0.12 a | ND | ND |
| 10 | | 1.8 a | 0.2 a | ND | 0.15 a | ND | ND |
| 20 | | 1.6 a | 0.2 a | ND | 0.10 a | ND | ND |
| 30 | | 1.9 a | 0.2 a | ND | 0.11 a | ND | ND |
| | 10 | 2.0 a | 0.2 a | ND | 0.14 a | ND | ND |
| | 20 | 1.9 a | 0.3 a | ND | 0.11 a | ND | ND |
| | 30 | 2.0 a | 0.2 a | ND | 0.10 a | ND | ND |
| 20 | 40 | 1.8 a | 0.2 a | ND | 0.09 a | ND | ND |
| | LSD (0.05) | | NS | | NS | | |
| | CV (%) | | 48.9 | | 24.8 | | |

NS = not significant
ND = not determined

**Table 14. Barley Days to Maturity Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).**

| K Placement & Rate (kg/ha) | | Days to Mature | | | | | |
|---|---|---|---|---|---|---|---|
| Seed | Side band | ICDC | ECRF | SERF | IHARF | WCA | CLC |
| Control - 0 | | 83 a | 77 a | 80 a | 87 a | 87 a | ND |
| 10 | | 83 a | 78 a | 81 a | 87 a | 87 a | ND |
| 20 | | 83 a | 78 a | 81 a | 87 a | 87 a | ND |
| 30 | | 83 a | 77 a | 81 a | 87 a | 87 a | ND |
| | 10 | 83 a | 77 a | 81 a | 87 a | 86 a | ND |
| | 20 | 83 a | 77 a | 82 a | 87 a | 87 a | ND |
| | 30 | 83 a | 78 a | 81 a | 87 a | 87 a | ND |
| 20 | 40 | 83 a | 78 a | 82 a | 87 a | 87 a | ND |
| | LSD (0.05) | NS | NS | NS | NS | NS | |
| | CV (%) | - | 1.8 | 1.2 | 0.3 | 1.6 | |

NS = not significant
ND = not determined

**Table 15. Barley Plant Height Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).**

| K Placement & Rate (kg/ha) | | Plant Height (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| Seed | Side band | ICDC | ECRF | SERF | IHARF | WCA | CLC |
| Control - 0 | | 72 a | 69 a | 63 a | 60 a | 55 a | ND |
| 10 | | 70 a | 66 a | 63 a | 60 a | 53 a | ND |
| 20 | | 69 a | 73 a | 65 a | 59 a | 55 a | ND |
| 30 | | 69 a | 66 a | 64 a | 59 a | 54 a | ND |
| | 10 | 71 a | 65 a | 67 a | 59 a | 52 a | ND |
| | 20 | 70 a | 71 a | 66 a | 60 a | 56 a | ND |
| | 30 | 71 a | 67 a | 64 a | 60 a | 53 a | ND |
| 20 | 40 | 72 a | 66 a | 66 a | 59 a | 52 a | ND |
| | LSD (0.05) | NS | NS | NS | NS | NS | |
| | CV (%) | 3.1 | 7.5 | 3.4 | 3.0 | 7.2 | |

NS = not significant
ND = not determined

**Table 16. Barley Plant Lodging Response to Fertilizer K Applications. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).**

| K Placement & Rate (kg/ha) | | Lodging (Belgian Scale) | | | | | |
|---|---|---|---|---|---|---|---|
| **Seed** | **Side band** | **ICDC** | **ECRF** | **SERF** | **IHARF** | **WCA** | **CLC** |
| Control - 0 | | 0.2 a | 1.0 a | 0.2 a | 0.4 a | 0.2 a | 0.2 a |
| 10 | | 0.2 a | 0.5 a | 0.2 a | 0.5 a | 0.2 a | 0.2 a |
| 20 | | 0.2 a | 0.6 a | 0.2 a | 0.5 a | 0.2 a | 0.2 a |
| 30 | | 0.2 a | 0.4 a | 0.2 a | 0.7 a | 0.2 a | 0.2 a |
| | 10 | 0.2 a | 0.6 a | 0.2 a | 0.4 a | 0.2 a | 0.2 a |
| | 20 | 0.2 a | 0.9 a | 0.2 a | 0.4 a | 0.2 a | 0.2 a |
| | 30 | 0.2 a | 0.7 a | 0.2 a | 0.4 a | 0.2 a | 0.2 a |
| 20 | 40 | 0.2 a | 0.8 a | 0.2 a | 0.8 a | 0.2 a | 0.2 a |
| | LSD (0.05) | NS | NS | NS | NS | NS | NS |
| | CV (%) | - | 51.2 | - | 63.3 | - | - |

NS = not significant

### 11. Conclusions and Recommendations

K fertilizer additions failed to influence seed yield, seed quality or any measured agronomic parameter measured for both wheat and barley grown under dryland conditions in 2021. Irrigated spring wheat also did not respond to K fertilizer additions. Irrigated barley responded to K fertilizer additions with increased grain yield to all K applications. Mean yield response to all K applications was 17%. K fertilizer yield response was greatest where K fertilizer was side banded. Fertilizer salt damage may have reduced the seed placed K fertilizer yield response. Optimal rate of K fertilizer for irrigated barley was 10 kg $K_2O$/ha.

## Supporting Information

### 12. Acknowledgements

Financial support was provided by the ADOPT initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement and by Fertilizer Canada. All funding is gratefully acknowledged.

### 13. Abstract/Summary

Field studies were conducted at six different locations in 2021 to determine the influence of potassium (K) fertilizer additions on spring wheat and barley. All sites conducted soil testing procedures to analyze soil for both ion exchange resin membrane available K and ammonium acetate exchangeable K. Potassium fertilizer as 0-0-60 was applied at 10, 20 and 30 kg $K_2O$/ha either in the seed row or in a side band position at seeding. An additional treatment of 20 kg $K_2O$/ha seed row + 40 kg $K_2O$/ha side band along with an unfertilized control treatment were included. Of the six trial sites, five were established under natural rain fed conditions (dryland) while one trial was irrigated. Dryland trials did not respond to K fertilization with respect to any measured agronomic parameter. The 2021 growing season was characterized by a historic drought. The reason for the lack of K fertilizer responses cannot be positively determined. It may be that barley and wheat do not require additional K nutrition on most Saskatchewan soils; however, the lack of response could also have been due to the adverse environmental conditions experienced at most trial locations. Under irrigated production, wheat failed to respond to fertilizer K applications; however, irrigated barley did respond to K fertilizer applications. All K treatments under irrigation resulted in numerically higher

barley yields compared to the unfertilized control, and most differences between treatments were statistically significant. Yields were higher when the K fertilizer was moved away from the seed row, indicating that fertilizer salt damage might have been occurring when seed placed. An application of 10 kg $K_2O$/ha appeared optimal. Ideally this trial should be repeated in a more “normal” growing season for proper evaluation. Barley may be more responsive than wheat to K fertilization in higher yielding environments.