Pulse Quality Evaluation 2022-2024

Chickpea

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

Pulse Quality Program—*Mission*

The Pulse Quality Program launched in spring 2022 with a partnership between Saskatchewan Pulse Growers and the Saskatchewan Food Industry Development Centre with the mission to add in best management practices for pulses grown in Western Canada and to help the development of pulse-based ingredients/products in the food industry.

The program aims to develop a comprehensive database of composition, functionality, and nutrition for pulses that provides information to growers, agronomists, breeders, buyers, and end users to make more informed choices. This program implements a genotype by environment (G x E) evaluation of quality parameters of peas, faba beans, lentils, chickpeas, and dry beans.

Phase 1 of the program analyzes up to 3000 samples annually from regional variety trials. The main focus of parameters includes seed quality (i.e., 1000 seed weight, amount of damage, seed size, and seed hardness), nutritional composition (i.e., ash, moisture, and protein content), and physical properties (i.e., colour, particle size, and Hausner ratio). The generated data are compared across pulse varieties, locations, and years. Additional parameters will be considered in future years in Phase 2 and Phase 3.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

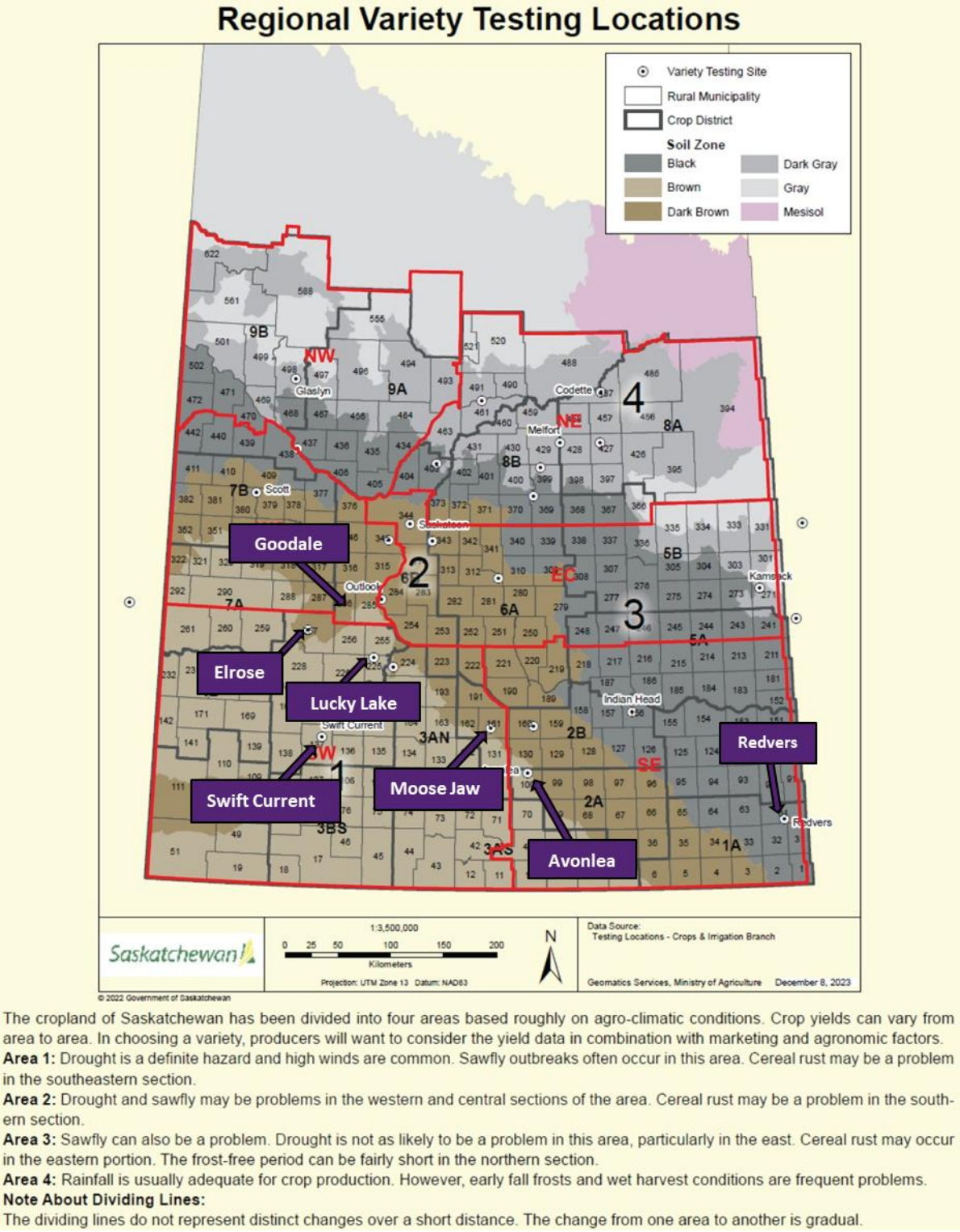
2022-24 Chickpea Quality Evaluation

There were ten chickpea varieties (1 black desi, 1 desi, and 8 kabuli) stayed as the regional variety trails from 2022 to 2024. Samples acquired in 2022, 2023, and 2024 were harvested from 6, 7, and 6 locations, respectively. **Table A** provides the samples' information in detail.

Table A. Description of chickpeas tested for the Pulse Quality Program from 2022 to 2024.

Type	Variety	2022 Site	2023 Site	2024 Site	Region
Black Desi	CDC Kala				**Northwestern SK**
					Northeastern SK
Desi	CDC Sunset				
		Goodale	Goodale	Goodale	**West-Central SK**
Kabuli	3315-6				**East-Central SK**
	CDC Climax CDC Hardy CDC Lancer CDC Leader CDC Orkney CDC Pasqua	Elrose Lucky Lake Moose Jaw Swift Current	Elrose Lucky Lake Moose Jaw Swift Current	Elrose Lucky Lake Moose Jaw Swift Current	**Southwestern SK**
	CDC Pearl	Avonlea	Avonlea Redvers	Avonlea	**Southeastern SK**
					Manitoba
Total sample size		**180**	**210**	**180**	

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208



The cropland of Saskatchewan has been divided into four areas based roughly on agro-climatic conditions. Crop yields can vary from area to area. In choosing a variety, producers will want to consider the yield data in combination with marketing and agronomic factors.

Area 1: Drought is a definite hazard and high winds are common. Sawfly outbreaks often occur in this area. Cereal rust may be a problem in the southeastern section.

Area 2: Drought and sawfly may be problems in the western and central sections of the area. Cereal rust may be a problem in the southern section.

Area 3: Sawfly can also be a problem. Drought is not as likely to be a problem in this area, particularly in the east. Cereal rust may occur in the eastern portion. The frost-free period can be fairly short in the northern section.

Area 4: Rainfall is usually adequate for crop production. However, early fall frosts and wet harvest conditions are frequent problems.

Note About Dividing Lines:

The dividing lines do not represent distinct changes over a short distance. The change from one area to another is gradual.

Figure A. Locations for chickpea quality testing in 2022-24, along with the corresponding soil zones and crop regions. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

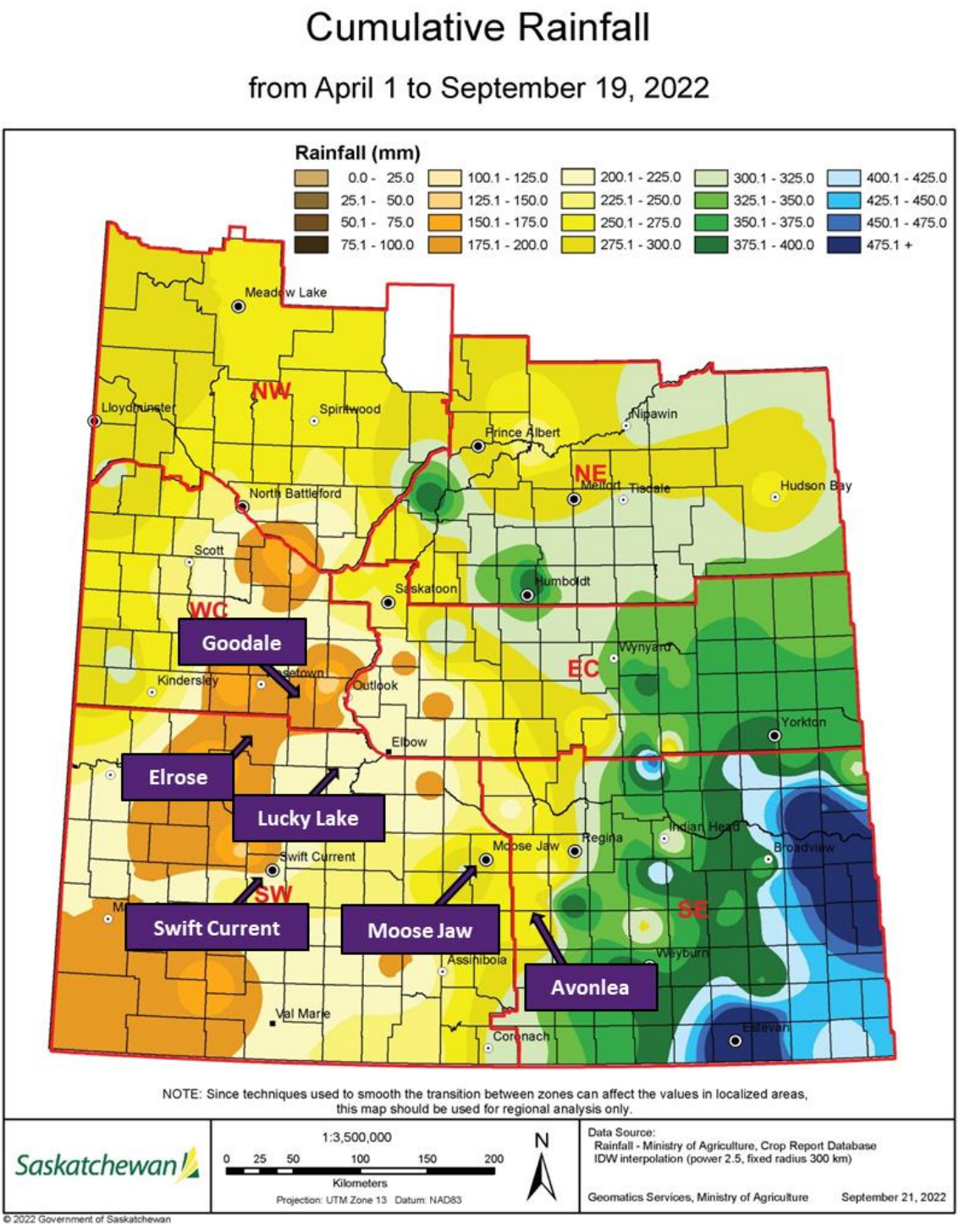


Figure B. Locations for chickpea quality testing and cumulative rainfall from April 1 to September 19, 2022. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

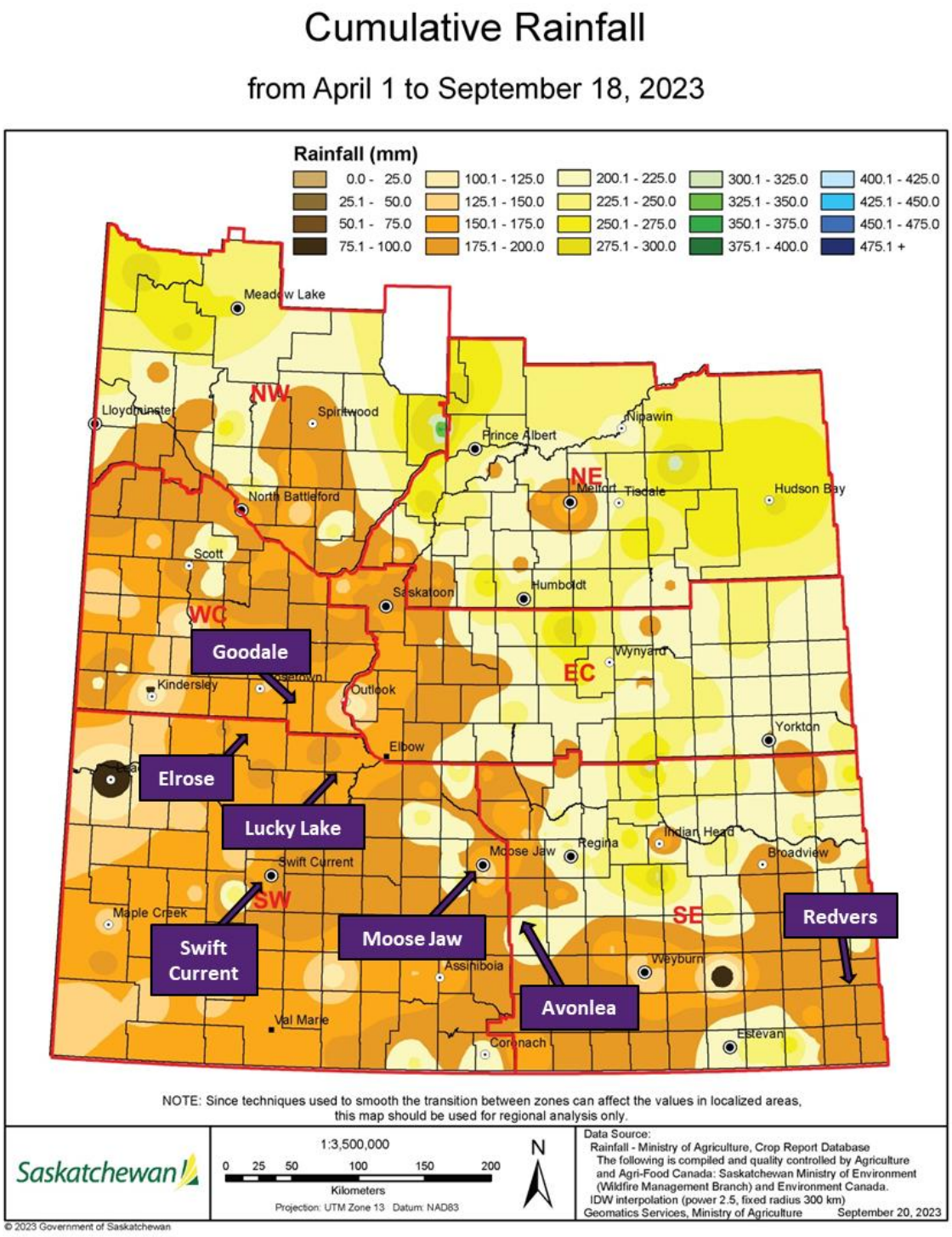


Figure C. Locations for chickpea quality testing and cumulative rainfall from April 1 to September 18, 2023. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

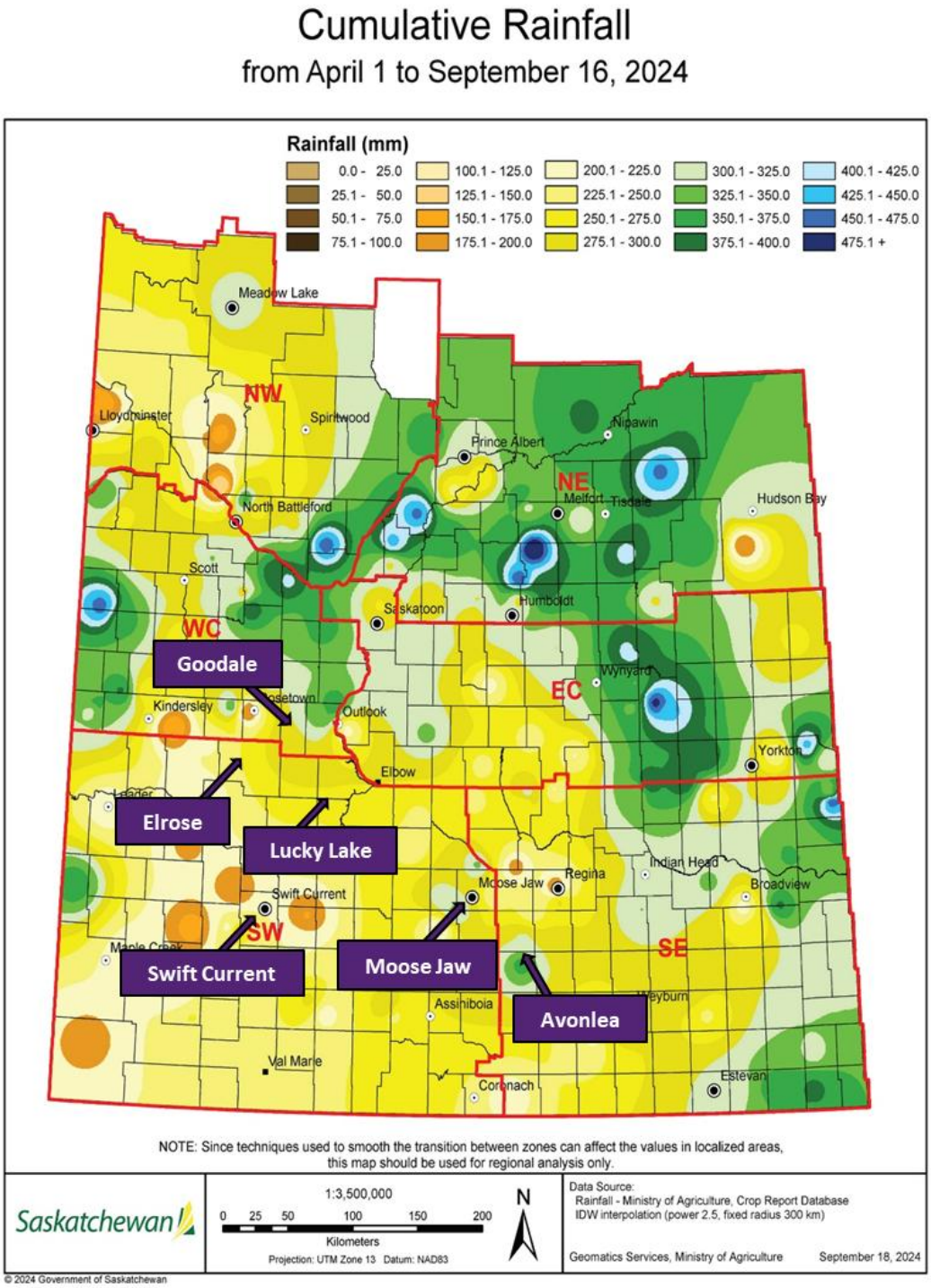


Figure D. Crop regions, locations for chickpea quality testing, and cumulative rainfall from April 1 to September 16, 2024. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

This report includes ten subsections for the results of the following quality parameters:

1. Yield
2. Thousand kernel weight (TKW)
3. Seed size distribution
4. Split
5. Other damage
6. Hardness of whole seed
7. Ash content
8. Protein content
9. Protein productivity
10. Colour (*L*, a*,* and *b**)

The **method** used to evaluate each quality parameter is provided at the beginning of each subsection.

For the **results**, a box plot and a mean bar graph are first provided in each section to compare the overall yearly performance. The **Box and Whisker** plot shows the full dataset of each year, where the minimum, median, maximum, first quartile (the median of the lower half of the dataset), and third quartile (the median of the upper half of the dataset) are provided.

Additionally, the **mean** value of each variety over three years is provided to show the variety performance.

For **statistics**, a one-way analysis of variance (ANOVA) along with a post-hoc Tukey test (SPSS, Chicago, IL, USA) was performed to identify the differences in the quality parameters by variety and by year.

The Pearson Correlation was performed to measure the correlation between quality parameters (**Table B**).

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

1. Yield

Method: Yield refers to how much crops are produced and how efficiently land is used to produce food or agricultural commodities. The yield is provided as kilogram per hectare (kg/HA).

Results: Figure 1.1. Box plot (left) and mean (right) of chickpea's yield in 2022, 2023 and 2024.

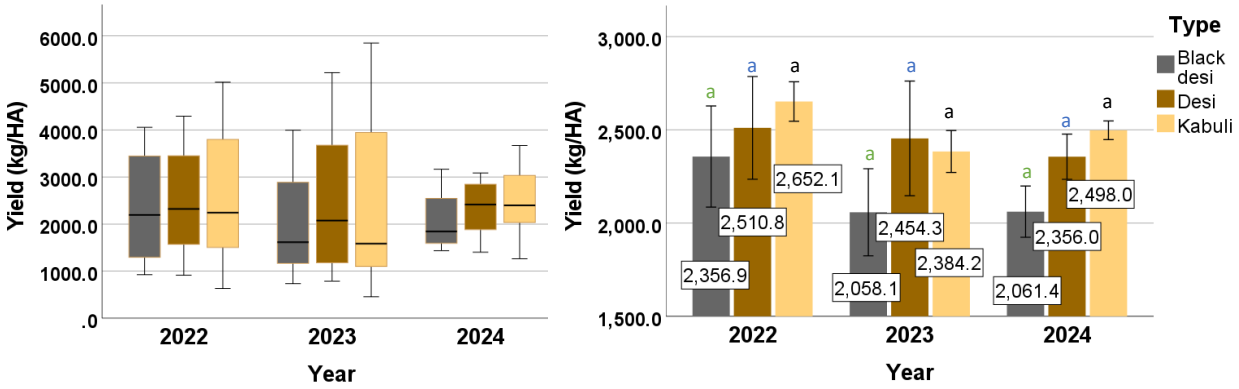
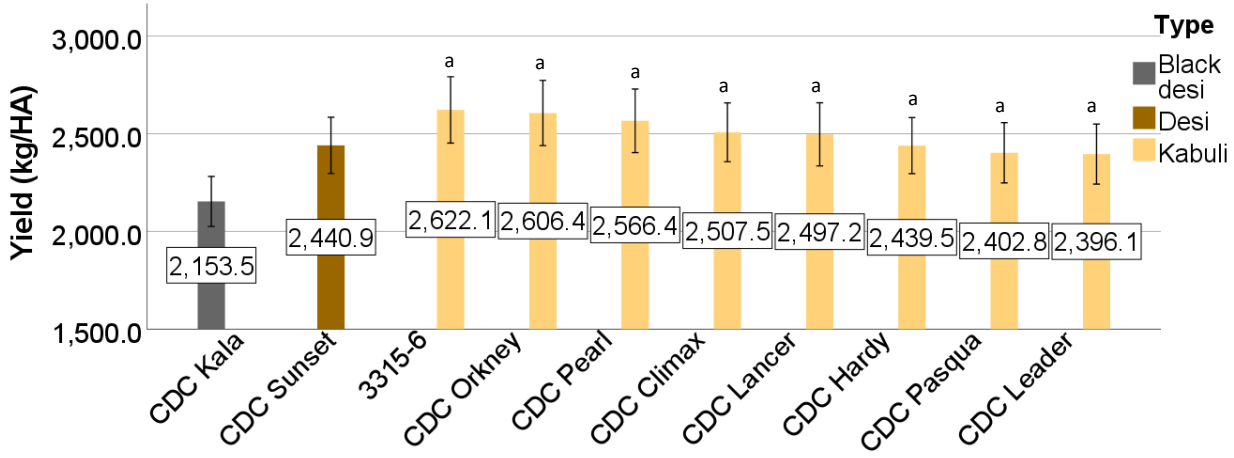


Figure 1.2. Mean yield of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Yield between years: no significant differences within each type.
- Yield between types: kabuli > desi > black desi
- Yield between kabuli varieties: no significant differences.

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

2. Thousand Kernel Weight (TKW)

Method: This test was conducted by weighing 300 seeds with duplicated measurements per sample, and TKW was reported.

Results: Figure 2.1. Box plot (left) and mean TKW (right) of chickpea in 2022, 2023 and 2024.

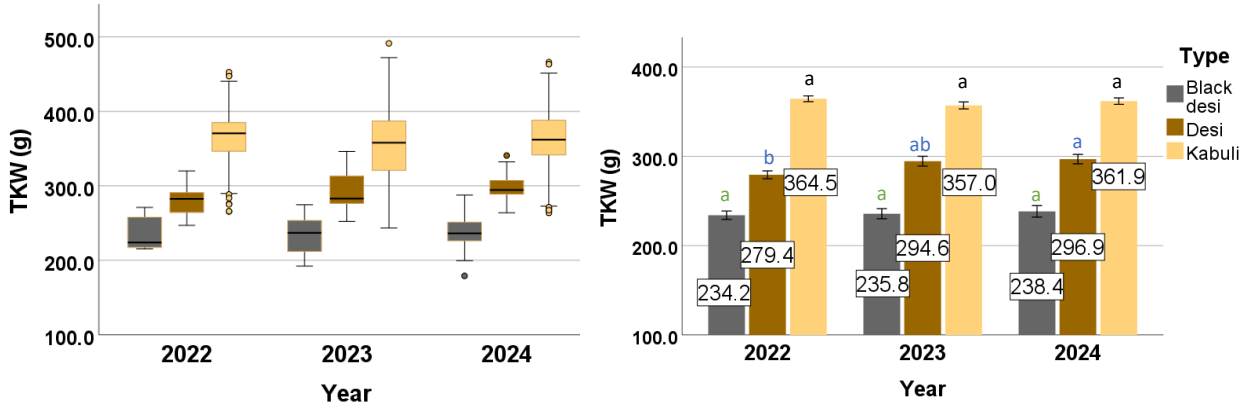
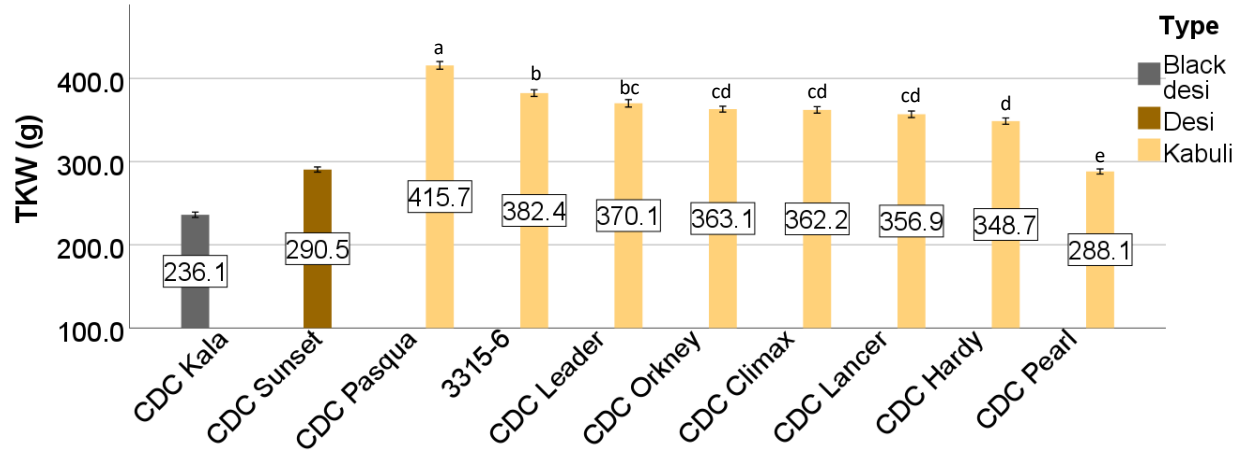


Figure 2.2. Mean TKW of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Yield between years: no significant differences for kabuli and black desi
- TKW between types: kabuli > desi > black desi
- TKW for kabuli: a 127 g difference of TKW was observed from highest to lowest.
- A positive correlation between TKW and yield was observed (r=0.3; p<0.01).

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

3. Seed Size Distribution

Method: 250 g of seeds were placed on a series of round-hole opening sieves. The weight of seeds retained on each sieve was determined and reported as % of seeds retained. Duplicated measurements were performed.

Sieves used for chickpea varieties:

a. #24R: 9.52 mm
b. #22R: 8.73 mm
c. #20R: 7.94mm
d. #18R: 7.14 mm
e. #16R: 6.35 mm

Results: Table 3.1. Seed size distribution (%) of each chickpea variety. Data represent mean ± one standard deviation.

Variety	> 9.52 mm (%)	> 8.73 mm (%)	> 7.94 mm (%)	> 7.14 mm (%)	> 6.35 mm (%)	Below 6.35 mm (%)
CDC Kala	0.0 ± 0.0	0.2 ± 0.4	18.8 ± 12.1	56.4 ± 8.0	21.9 ± 10.4	2.7 ± 3.1
CDC Sunset	0.0 ± 0.0	2.6 ± 2.7	36.9 ± 12.7	45.7 ±10.0	13.2 ± 6.7	2.0 ± 1.8
CDC Pasqua	9.1 ± 6.5^{a}	45.5 ± 12.5^{a}	34.3 ± 11.6^{d}	8.6 ± 6.4^{d}	1.9 ± 2.5^{bc}	0.6 ± 1.0^{b}
3315-6	4.7 ± 5.5^{b}	38.6 ± 13.3^{b}	44.1 ± 12.7^{c}	10.6 ± 6.3^{cd}	1.6 ± 1.6^{c}	0.4 ± 0.4^{b}
CDC Leader	2.6 ± 3.7^{c}	29.5 ± 13.1^{c}	47.8 ± 10.7^{bc}	15.9 ± 9.3^{b}	3.1 ± 3.6^{bc}	1.0 ± 1.7^{b}
CDC Orkney	1.2 ± 1.5^{cd}	25.0 ± 12.5^{cd}	55.1 ± 9.7^{a}	15.6 ± 8.6^{bc}	2.5 ± 2.6^{bc}	0.6 ± 0.8^{b}
CDC Climax	1.5 ± 1.5^{cd}	24.2 ± 12.8^{cde}	50.7 ± 8.4^{ab}	19.6 ± 10.9^{b}	3.4 ± 3.4^{bc}	0.7 ± 0.7^{b}
CDC Hardy	0.4 ± 0.6^{d}	21.4 ± 13.7^{de}	54.9 ± 9.6^{a}	19.9 ± 12.5^{b}	2.9 ± 2.9^{bc}	0.5 ± 0.5^{b}
CDC Lancer	0.5 ± 0.5^{d}	18.0 ± 9.2^{e}	56.1 ± 10.3^{a}	20.7 ± 10.9^{b}	3.9 ± 4.4^{b}	0.9 ± 1.5^{b}
CDC Pearl	0.0 ± 0.0^{d}	1.5 ± 2.7^{f}	28.6 ± 13.7^{d}	51.5 ± 10.0^{a}	15.9 ± 8.7^{a}	2.4 ± 2.4^{a}

Note: Means within a column followed by different lowercase letters are significantly different (p<0.05).

- Seed size distribution results were consistent with TKW.
- CDC Pasqua had the largest seed size, with over 50% of seeds larger than 8.73 mm.
- In contrast, CDC Pearl was the smallest kabuli chickpea, with less than 2% of seeds larger than 8.73 mm.
- CDC Kala was the smallest among all varieties.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

4. Split

Method: 100 grams of each sample was used for evaluation, and damaged seeds were selected by hand. Results included splits, cracks, partially missing hull, and partially missing cotyledon.

Results: Figure 4.1. Box plot (left) and mean split (right) of chickpea in 2022, 2023 and 2024.

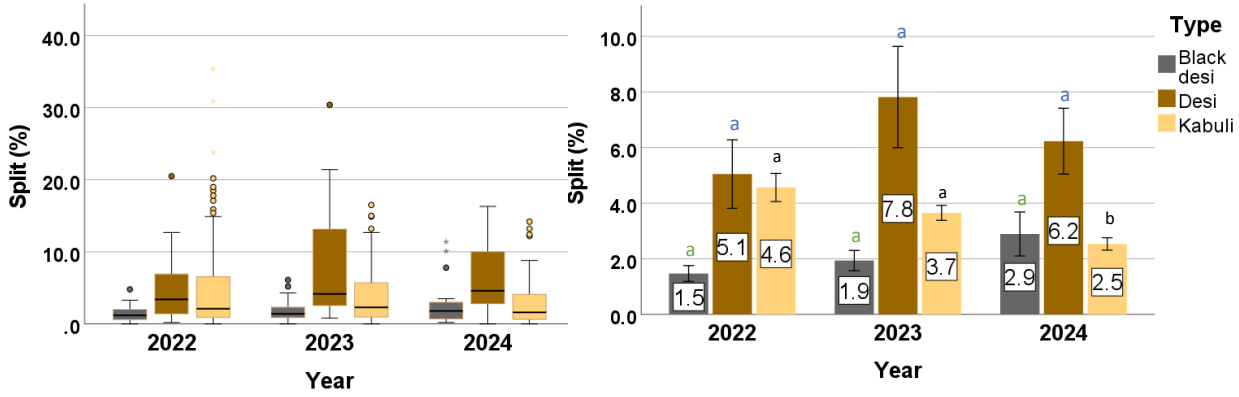
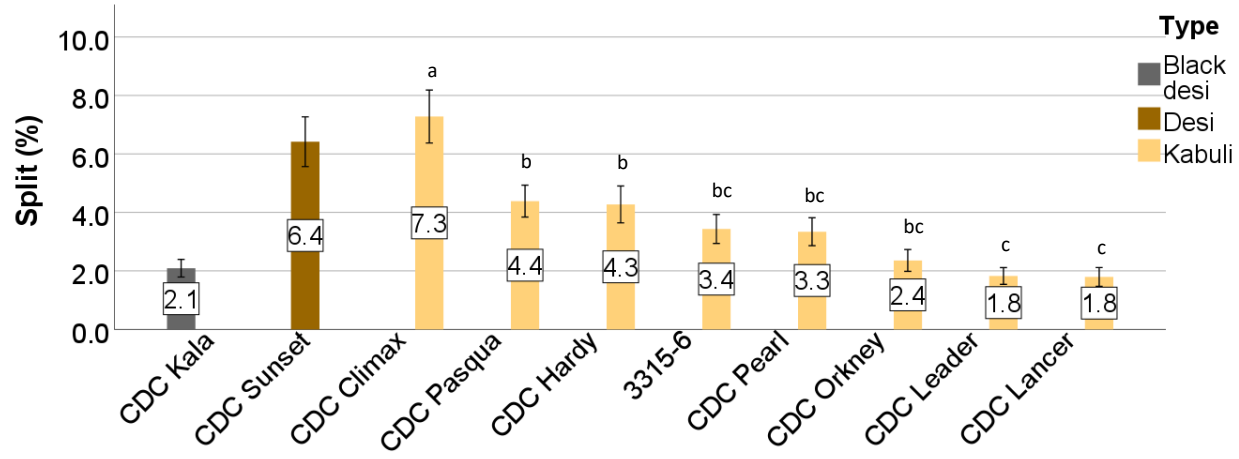


Figure 4.2. Mean split of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Split between types: desi was the largest.
- Split between kabuli chickpeas: a 5.5% difference was observed from highest to lowest.

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

5. Other Damage

Method: 100 grams of each sample was used for evaluation, and damaged seeds were selected by hand. Other damage included pink, sprouted, shrivelled, heated, frost, and insect damage.

Results: Figure 5.1. Box plot (left) and mean other damage (right) of chickpea in 2022, 2023 and 2024.

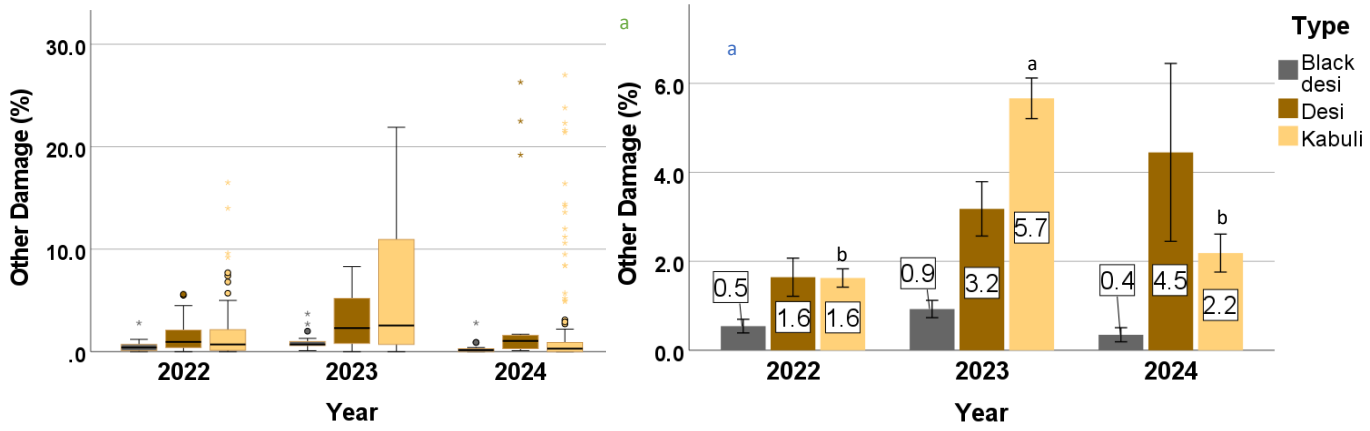
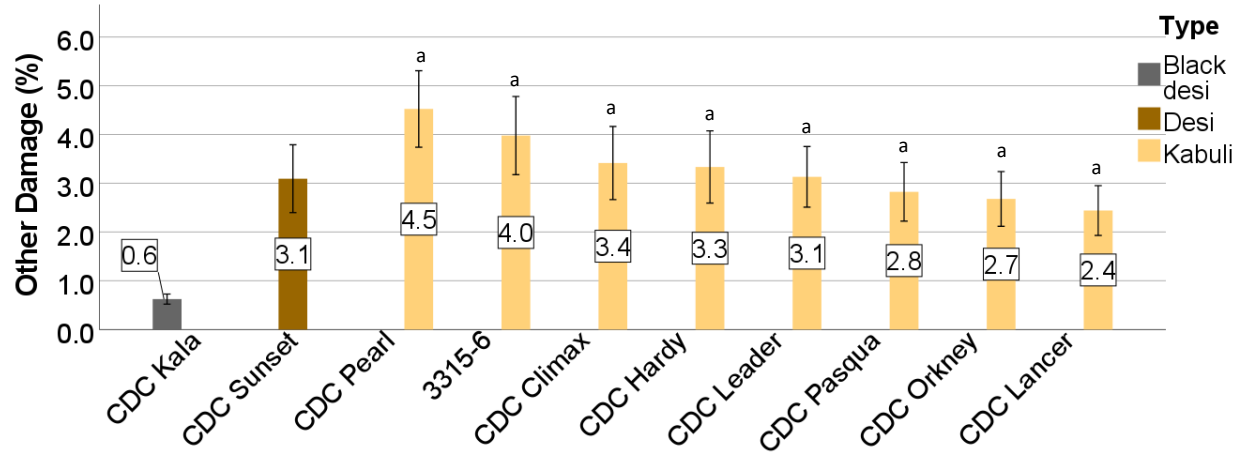


Figure 5.2. Mean other damage of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Green seeds, frost damage, and mouldy seeds were observed in the 2023 samples, and mouldy seeds, water damage, and sprouted seeds was observed in the 2024 samples. More details regarding different locations can be found in the 2023 and 2024 Chickpea Quality Evaluation reports.

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

6. Hardness of Whole Seed

Method: Seed hardness is an important parameter to indicate milling yield and cooking quality. Seed hardness is affected by seed size, shape, density, composition, etc. Seed hardness was determined by measuring the force of breaking a seed using a texture analyzer (TMS-Pro, Food Technology Corporation, USA). The detailed procedure is outlined in the hardness section for green peas (pg. 19).

Results: Figure 6.1. Box plot (left) and mean (right) of chickpea hardness in 2022, 2023 and 2024.

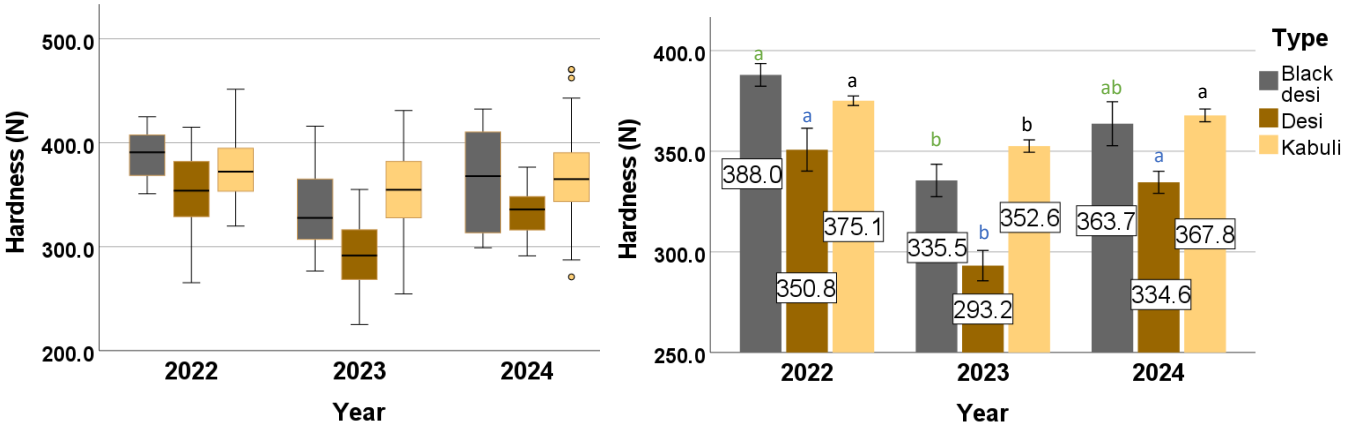
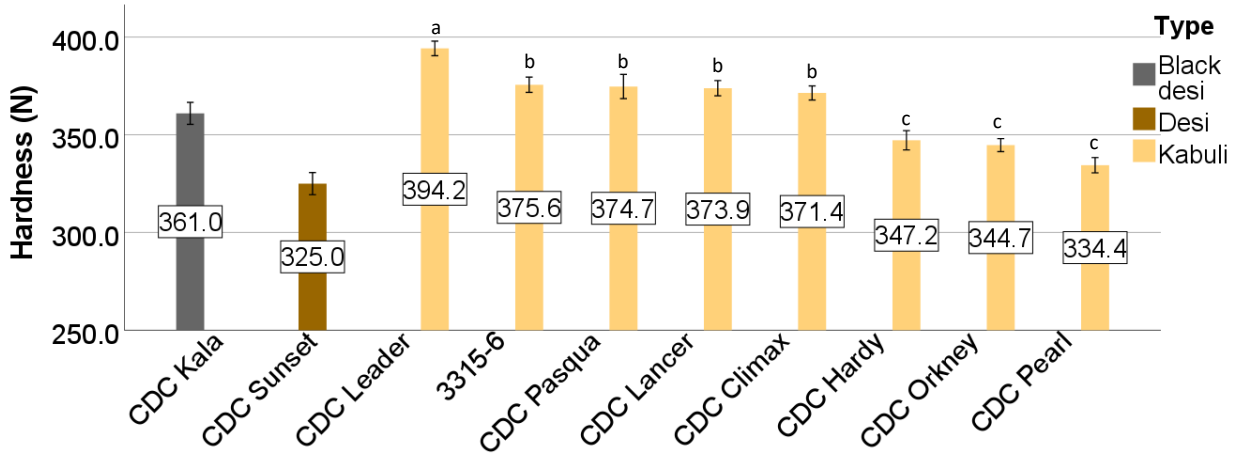


Figure 6.2. Mean hardness of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Hardness was positively correlated with TKW (r=0.45; p<0.01) and negatively correlated to Split (r=-0.15; p<0.01) and other damage (r=-0.37, p<0.01).

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

7. Ash Content

Method: Ash content (%) was determined using AACC 08-01.01[1] with modification. Samples were heated at 560°C till they turned white. Duplicated measurements were performed for each sample, and the average was reported on a dry basis (d.b.).

Results: Figure 7.1. Box plot (left) and mean (right) of chickpea for ash content in 2022, 2023 and 2024.

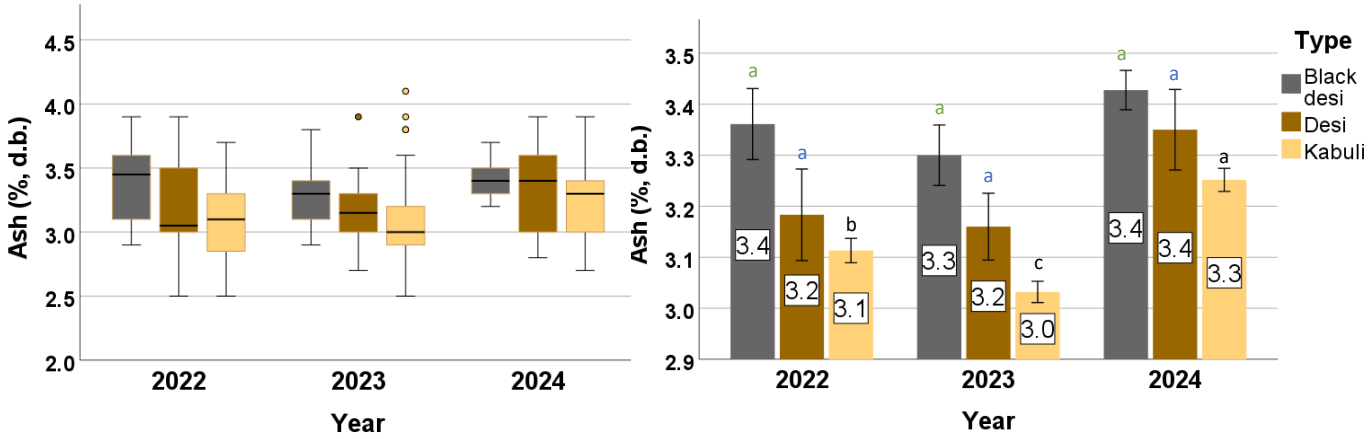
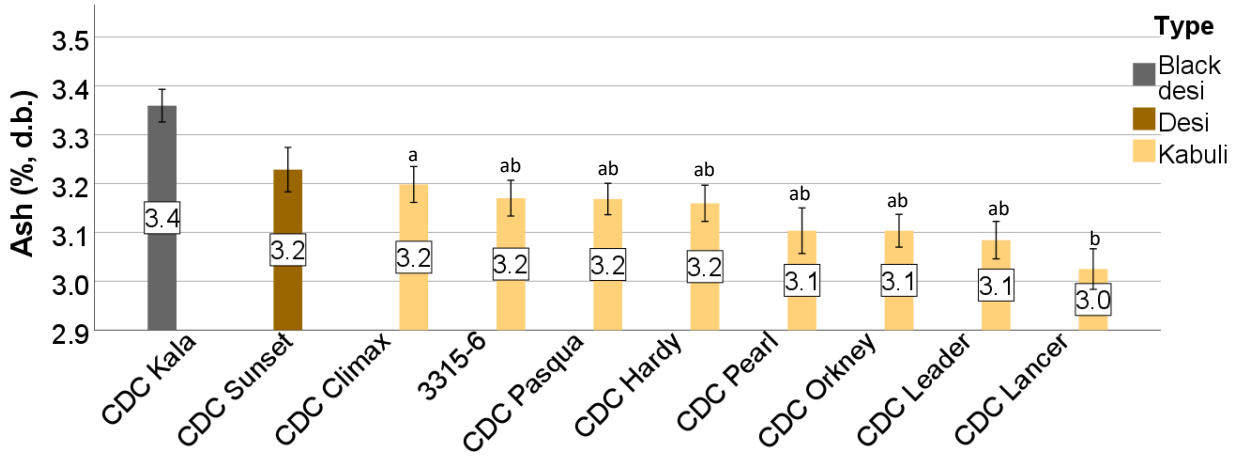


Figure 7.2. Mean ash content of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Ash by type: black desi > desi > kabuli.

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

[1] AACC (1999). American Association of Cereal Chemists International. Approved methods of analysis (11th ed.). The Saint Pauls Association: Saint Paul, MN.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

8. Protein Content

Method: The protein content (%) of each flour was determined through AACC 46-30[2] using the combustion method through a Rapid N Exceed (Elementar, USA). Duplicated measurements were performed for each sample, and the average was reported on a dry basis (d.b.).

Results: Figure 8.1. Box plot (left) and mean (right) of chickpea for protein content in 2022, 2023 and 2024.

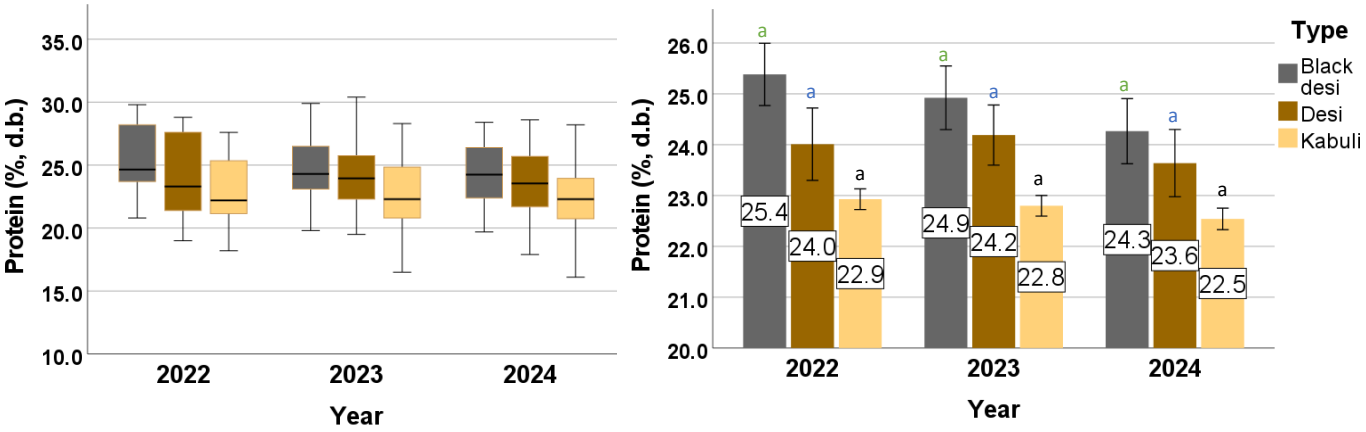
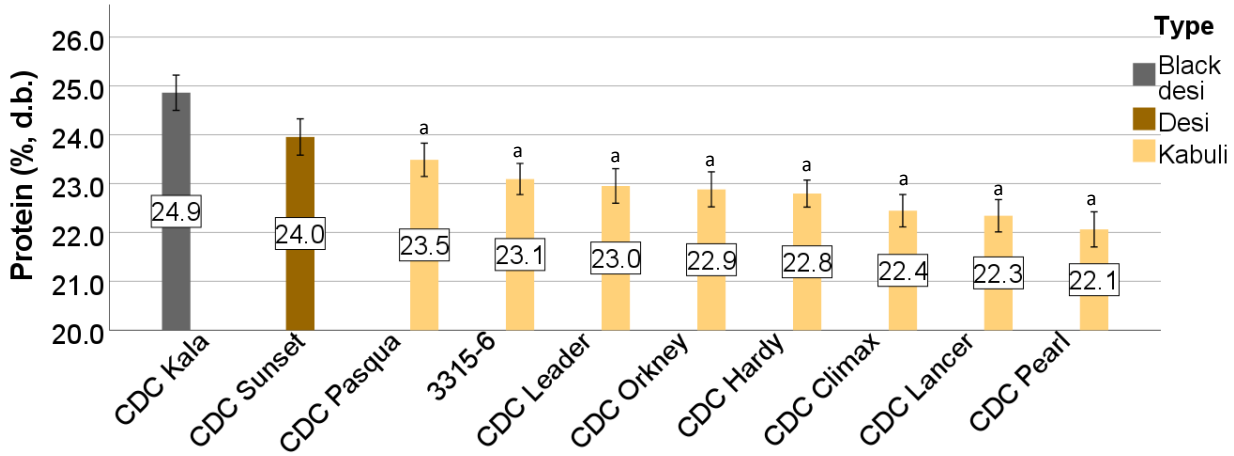


Figure 8.2. Mean protein content of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

[2] AACC (1999). American Association of Cereal Chemists International. Approved methods of analysis (11th ed.). The Saint Pauls Association: Saint Paul, MN.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

9. Protein Productivity

Method: Protein productivity (kg protein/HA), which is calculated using yield (kg/HA) multiplied by protein content (%), refers to the amount of protein produced per unit of land. It evaluates how much protein is being harvested from a given area.

Results: Figure 9.1. Box plot (left) and mean (right) of chickpea for protein productivity in 2022, 2023 and 2024.

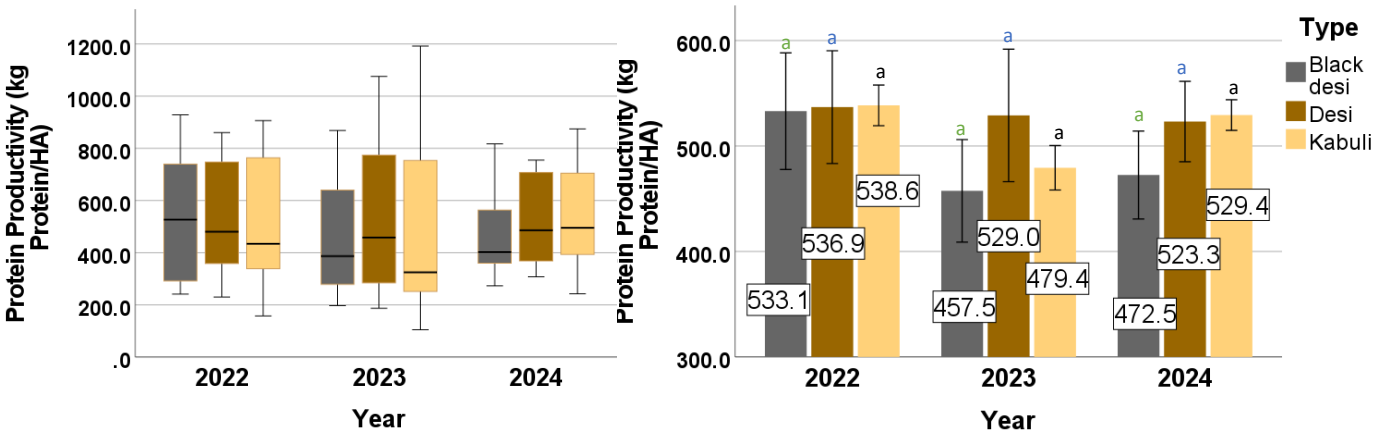
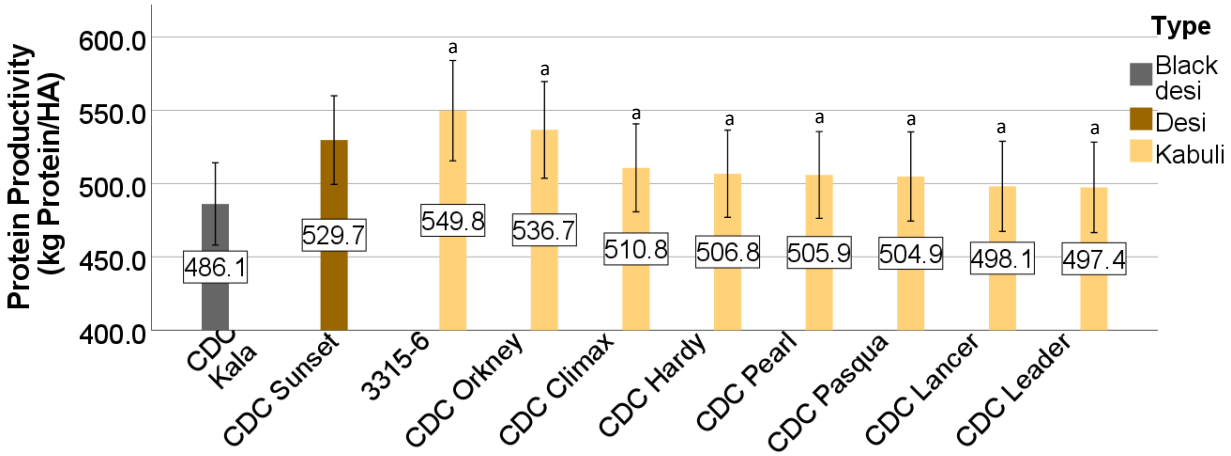


Figure 9.2. Mean protein productivity content of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

10. Colour

Method: The absolute colour of each flour was determined using the Konica Minolta CR-400 Chroma meter, where *L*, a*,* and *b** values were reported.

a) ***L* (lightness):*** white (100) to black (0)

Results: Figure 10.1. Box plot (left) and mean (right) of chickpea for *L** values in 2022, 2023 and 2024.

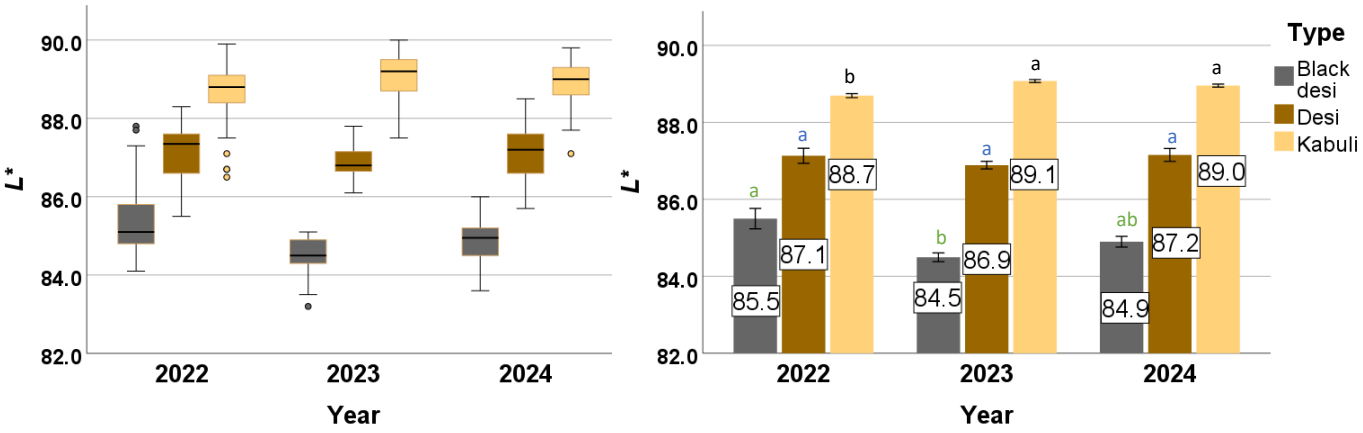
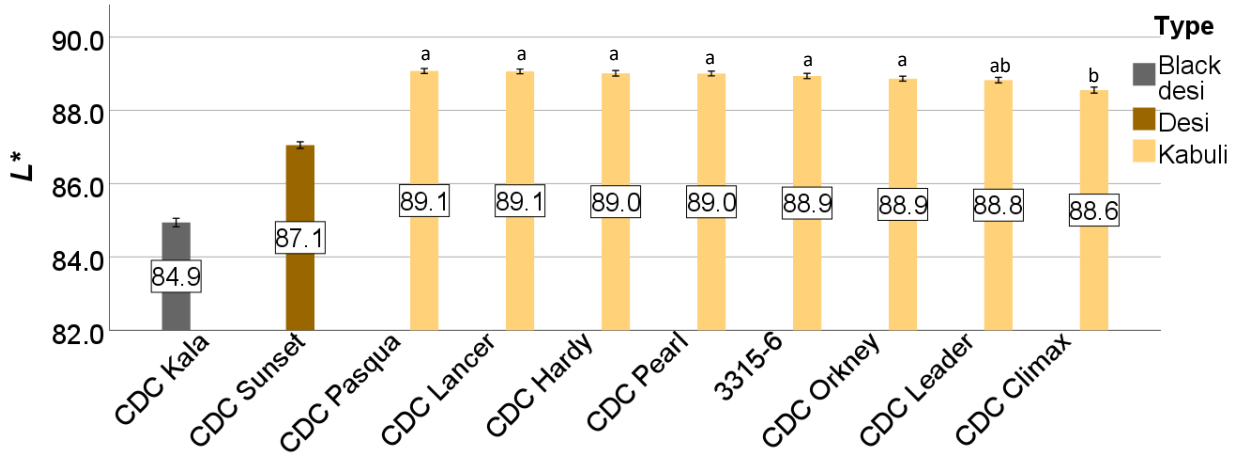


Figure 10.2. Mean *L** values of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Lightness by type: Kabuli > desi > black desi
- Lightness of kabuli chickpeas was positively correlated with protein (r=0.35; p<0.01) and negatively correlated with split (r=-0.14; p<0.01), other damage (r=-0.32; p<0.01), moisture (r=-0.42; p<0.01), and ash (r=-0.43; p<0.01).

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

b) ***a*:*** red (+) to green (-)

Results: Figure 10.3. Box plot (left) and mean (right) of chickpea for *a** values in 2022, 2023 and 2024.

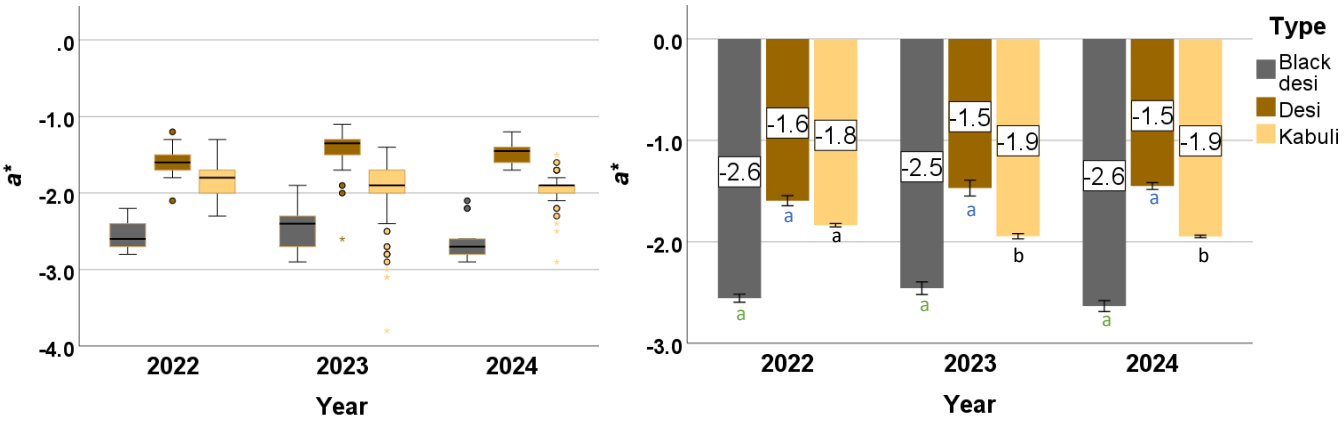
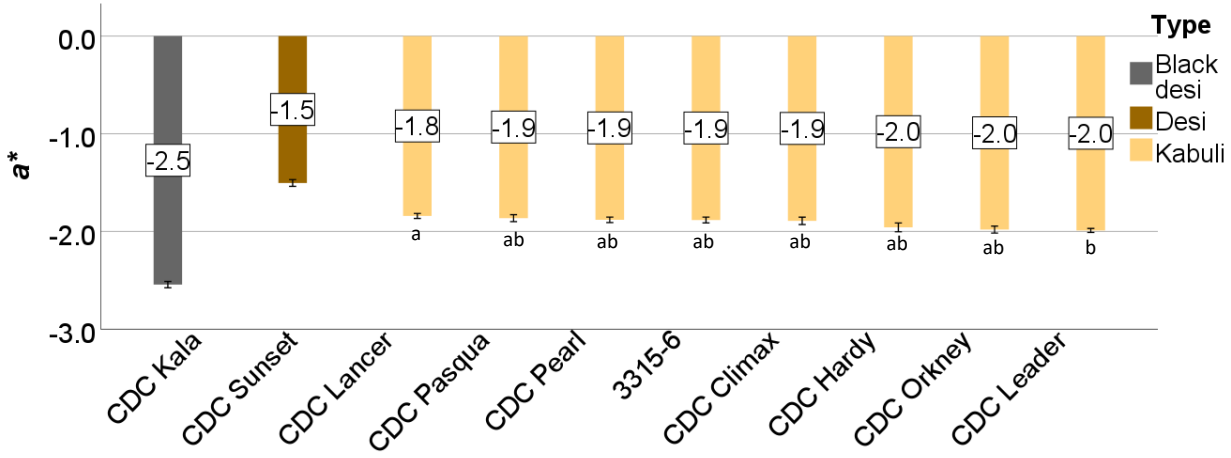


Figure 10.4. Mean *a** values of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

c) ***b*:*** yellow (+) to blue (-)

Results: Figure 10.5. Box plot (left) and mean (right) of chickpea for *b** values in 2022, 2023 and 2024.

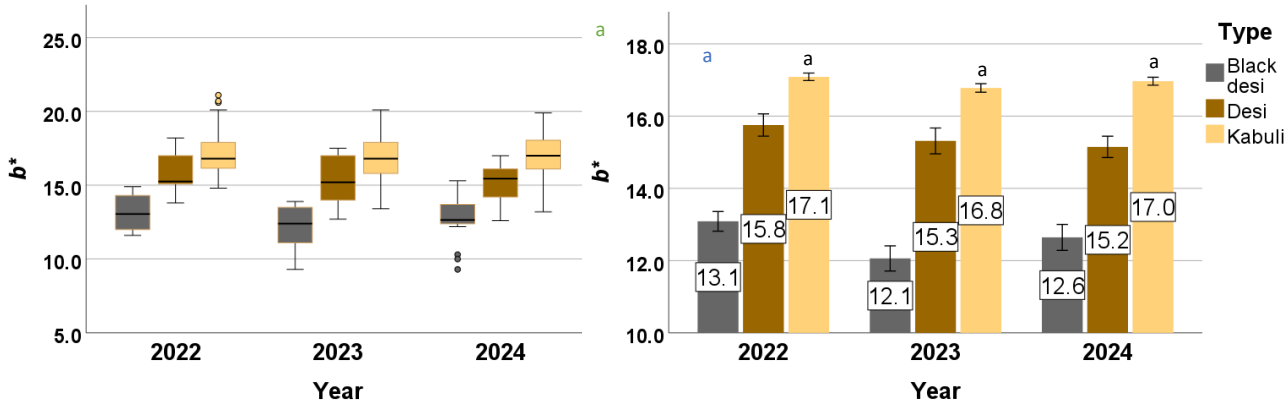
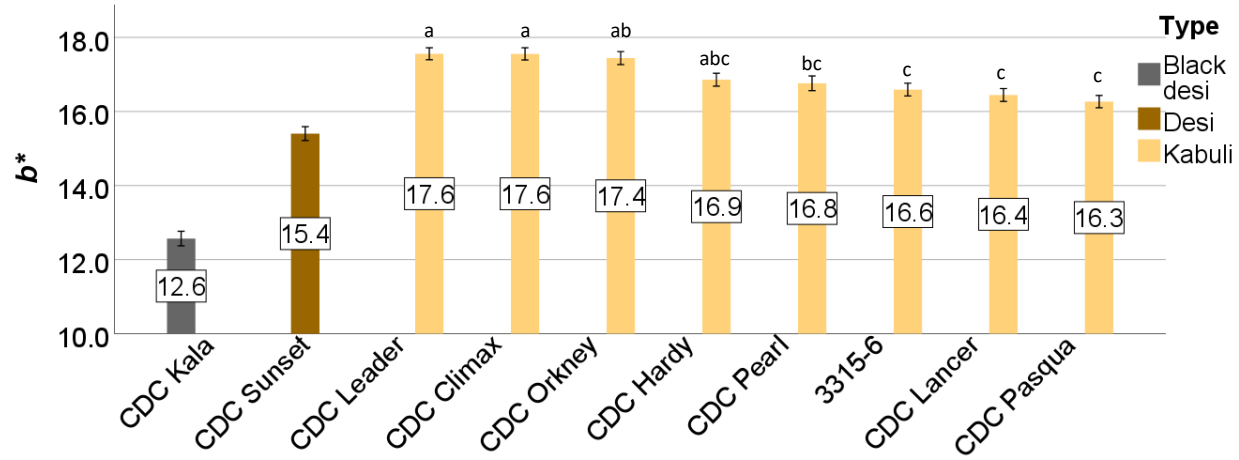


Figure 10.6. Mean *b** values of each chickpea variety based on trials conducted from 2022 to 2024. Each bar represents mean ± one standard error.



- Yellowness of kabuli chickpeas was positively correlated with moisture (r=0.46; p<0.01) and negatively correlated with protein (r=-0.33; p<0.01), lightness (r=-0.55; p<0.01), and *a** value (r=-0.43; p<0.01).

Note: Small letters in black indicated significant differences (p<0.05) by kabuli chickpeas. Small letters in green indicated significant differences (p<0.05) by black desi type. Small letters in blue indicated significant differences (p<0.05) by desi chickpeas.

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

Table B. Correlation coefficients between quality attributes based on kabuli chickpea trials from 2022 to 2024.

	Yield	TKW	Split	Other Damage	Hardness	Moisture	Ash	Protein	Protein Productivity	*L**	*a**	*b**
Yield	1											
TKW	.3**	1										
Split	-.22**	*NS*	1									
Other Damage	-.1*	-.22**	.09**	1								
Hardness	.23**	.45**	-.15**	-.37**	1							
Moisture	.11*	*NS*	*NS*	.09*	*NS*	1						
Ash	*NS*	*NS*	.12*	.22**	*NS*	*NS*	1					
Protein	-.4**	-.11*	.15**	*NS*	-.12*	-.22**	-.29**	1				
Protein Productivity	**.97****	.35**	-.23**	-.13**	.23**	*NS*	*NS*	.21**	1			
L*	*NS*	*NS*	-.14**	-.32**	*NS*	-.42**	-.43**	.35**	*NS*	1		
a*	.21**	*NS*	-.12*	.34**	*NS*	-.1*	-.16**	-.17**	.21**	-.27**	1	
b*	*NS*	-.13**	*NS*	-.11*	-.18**	.46**	.14**	-.33**	*NS*	**-.55****	-.43**	1

**Pearson correlations coefficients significant at p<0.05; ** Pearson correlations coefficients significant at p<0.01; NS not significant.*

Saskatchewan Food Industry Development Centre Inc.
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,
TEI: (306) 933-7555, FAX: (306) 933-7208

ACKNOWLEDGEMENTS

We would like to express our sincere thanks to the Saskatchewan Pulse Growers for financially supporting this program.

Contact information:

Lindsay (Yingxin) Wang, Ph.D.

Manager, Food Crop Quality
Saskatchewan Food Industry Development Centre Inc. (Food Centre)
2335 Schuyler Street, Saskatoon, SK, S7M 5V1, Canada
Direct: (306) 964-1819
E-mail: lwang@foodcentre.sk.ca

Mehmet Tulbek, Ph.D.

President
Saskatchewan Food Industry Development Centre Inc. (Food Centre)
2335 Schuyler Street, Saskatoon, SK, S7M 5V1, Canada
Direct: (306) 933-7175
Fax: (306) 933-7208
Main office: (306) 933-7555
E-mail: mtulbek@foodcentre.sk.ca