



***Pulse Quality Evaluation  
2022-2024***

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Pea



## **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.

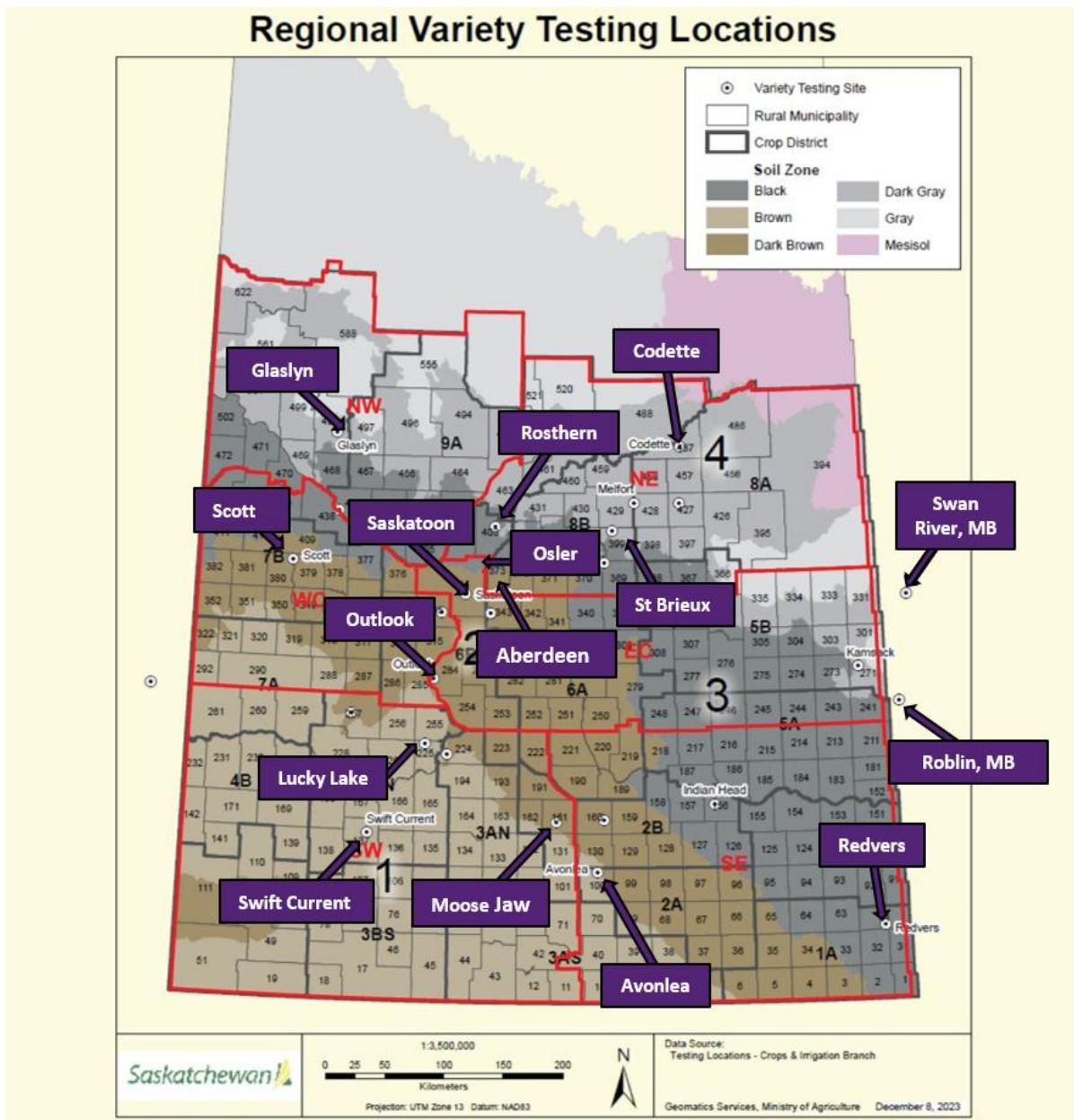


## 2022-24 Pea Quality Evaluation

There were twenty pea varieties (4 green and 16 yellow) that remained in the regional variety trials from 2022 to 2024. Samples acquired in 2022, 2023, and 2024 were harvested from 13, 12, and 13 locations, respectively. **Table A** provides detailed information about the samples.

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

Type	Variety	2022 Site	2023 Site	2024 Site	Region
Green	CDC Forest		Glaslyn	Glaslyn	Northwestern SK
	CDC Huskie				
	CDC Rider	Codette	Codette	Codette	Northeastern SK
	CDC Spruce	St Brieux	St Brieux	St Brieux	
Yellow		Rosthern	Rosthern		
		Aberdeen			
	AAC Beyond				
	AAC Julius				
	Caphorn	Scott		Scott	West-Central SK
	CDC 5791				
	CDC 5845	Saskatoon	Saskatoon	Saskatoon	East-Central SK
	CDC Amarillo	Outlook_Irrigation	Outlook_Irrigation	Outlook_Irrigation	
	CDC Boundless			Osler	
	CDC Citrine				
	CDC Engage	Lucky Lake	Lucky Lake	Lucky Lake	Southwestern SK
	CDC Hickie	Moose Jaw	Moose Jaw		
	CDC Inca	Swift Current		Swift Current	
	CDC Lewochko				
	CDC Spectrum	Avonlea	Avonlea	Avonlea	Southeastern SK
	CDC Tollefson	Redvers	Redvers	Redvers	
CS ProStar					
PS Boost	Swan River	Swan River Roblin	Swan River Roblin	Manitoba	
<b>Number of samples</b>		<b>780</b>	<b>720</b>	<b>780</b>	



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.

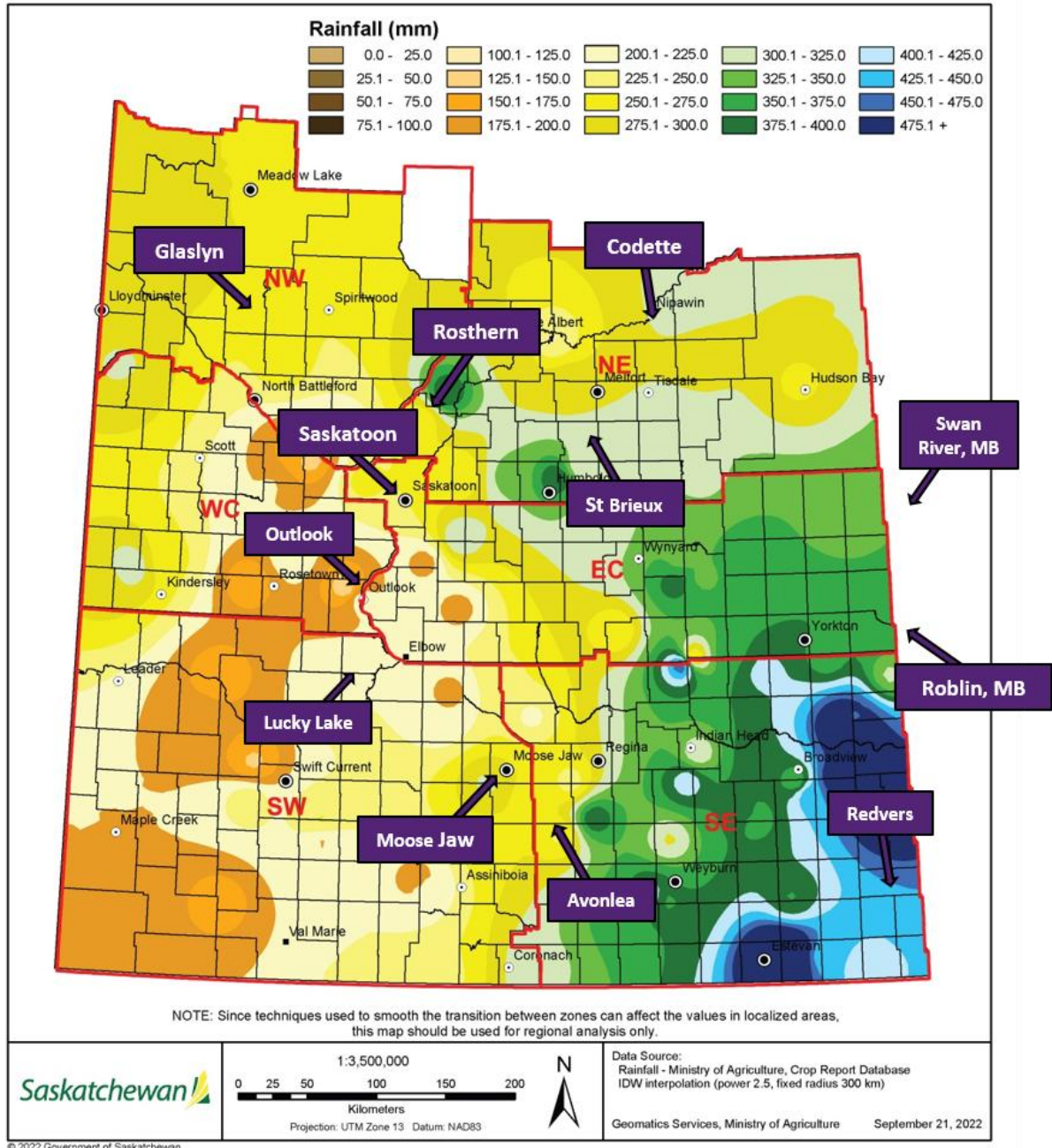
**Area 4:** Rainfall is usually adequate for crop production. However, early fall frosts and wet harvest conditions are frequent problems.

**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.

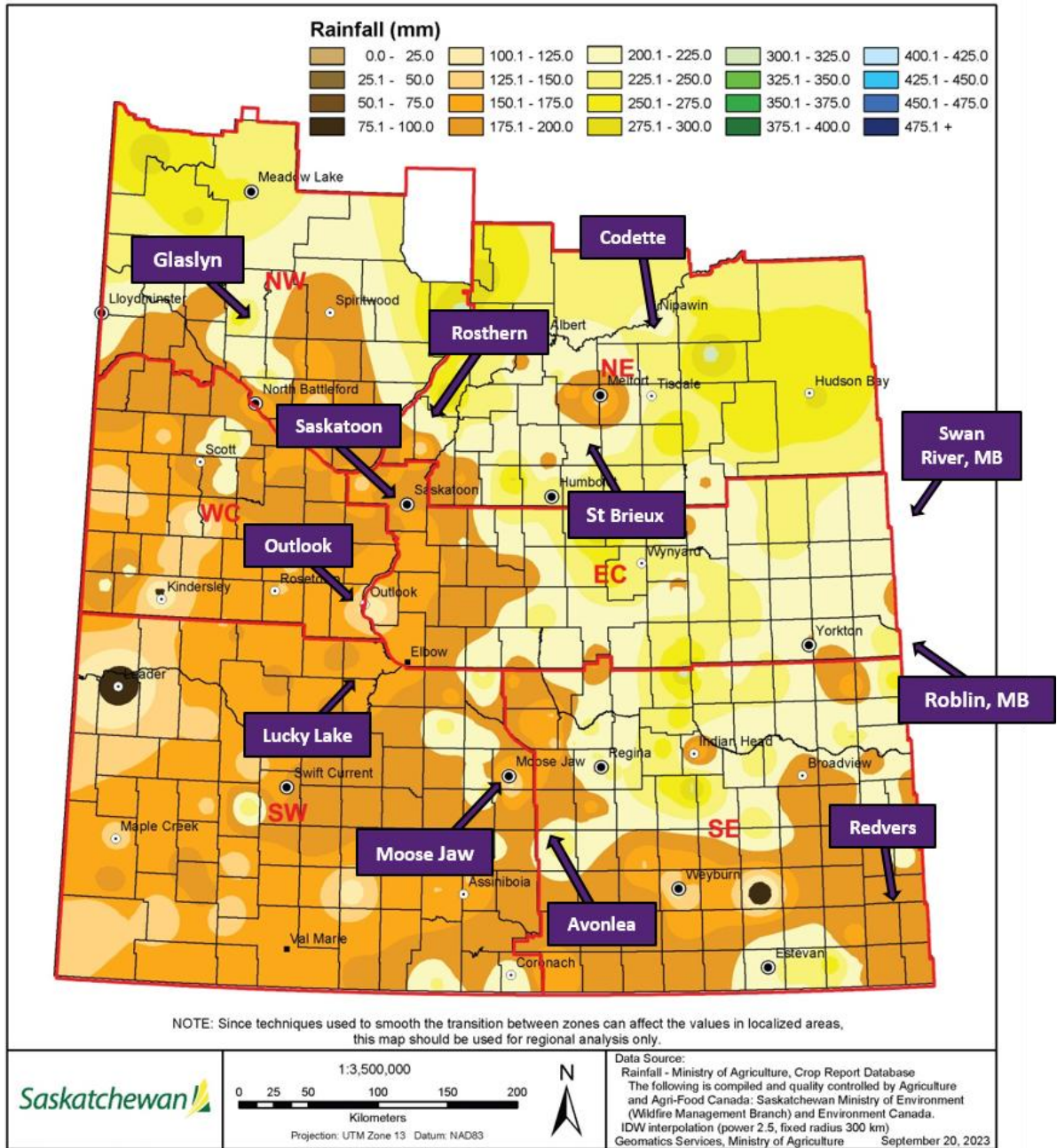
**Figure A.** Locations for pea quality testing during 2022 to 2024, along with the corresponding soil zones and crop regions. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

## Cumulative Rainfall from April 1 to September 19, 2022



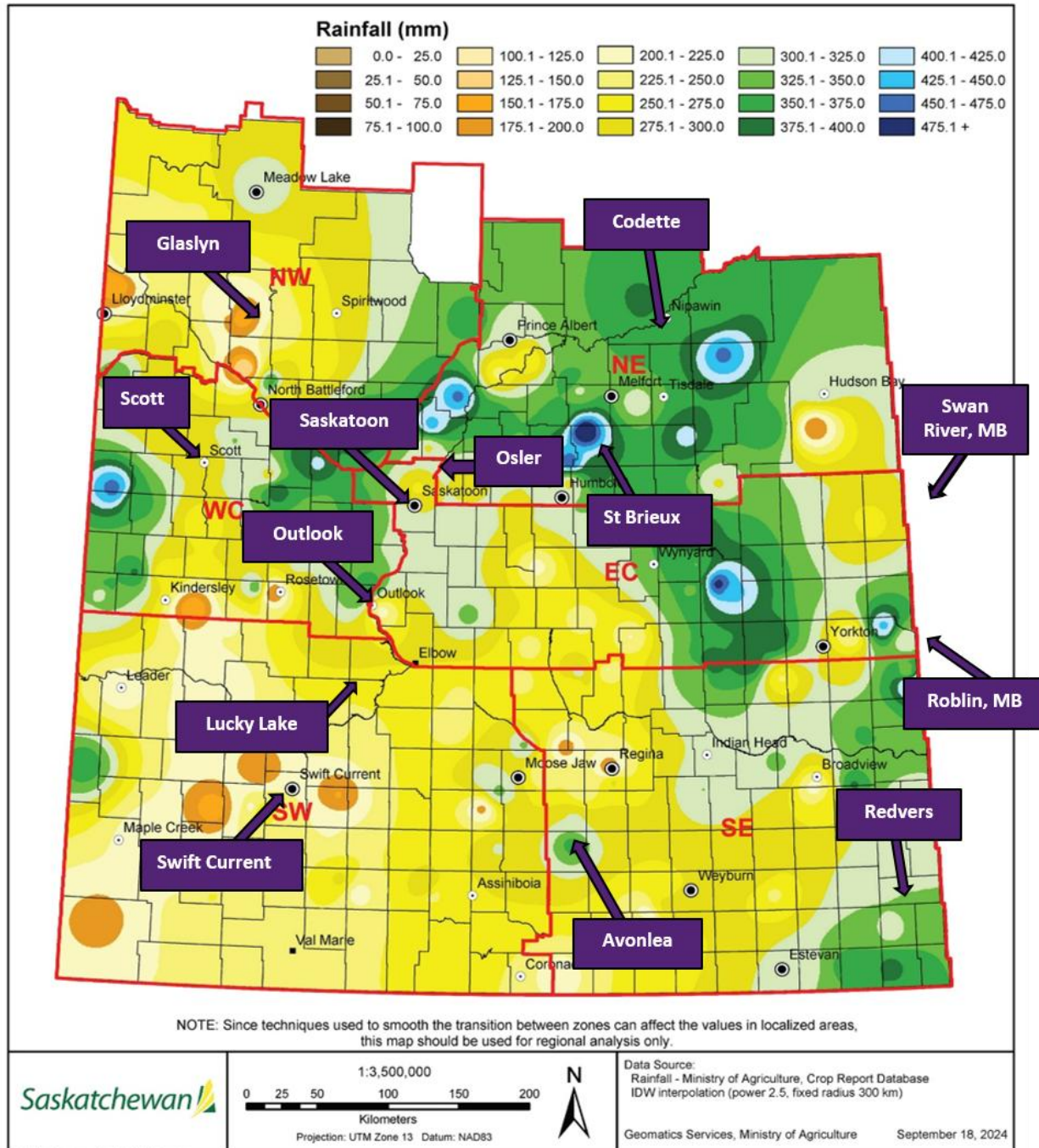
**Figure B.** Locations for pea quality testing and cumulative rainfall from April 1 to September 19, 2022. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

## Cumulative Rainfall from April 1 to September 18, 2023



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

## Cumulative Rainfall from April 1 to September 16, 2024



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

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

1. Yield
2. Thousand kernel weight (TKW)
3. Seed size distribution
4. Split
5. Seed coat breakage (SCB)
6. Bleaching (green peas)
7. Greenness (yellow peas)
8. Other damage
9. Hardness of whole seed
10. Ash content
11. Protein content
12. Protein productivity
13. 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.

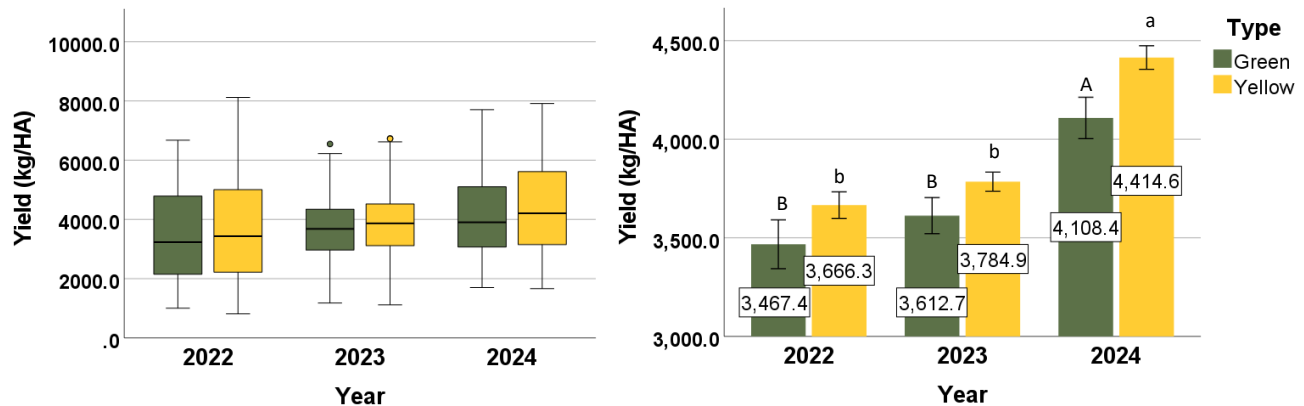
For **statistics**, a one-way analysis of variance (ANOVA) along with a post-hoc Tukey test (SPSS, Chicago, IL, USA) was performed to identify the differences in the quality parameters by variety and by year.

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

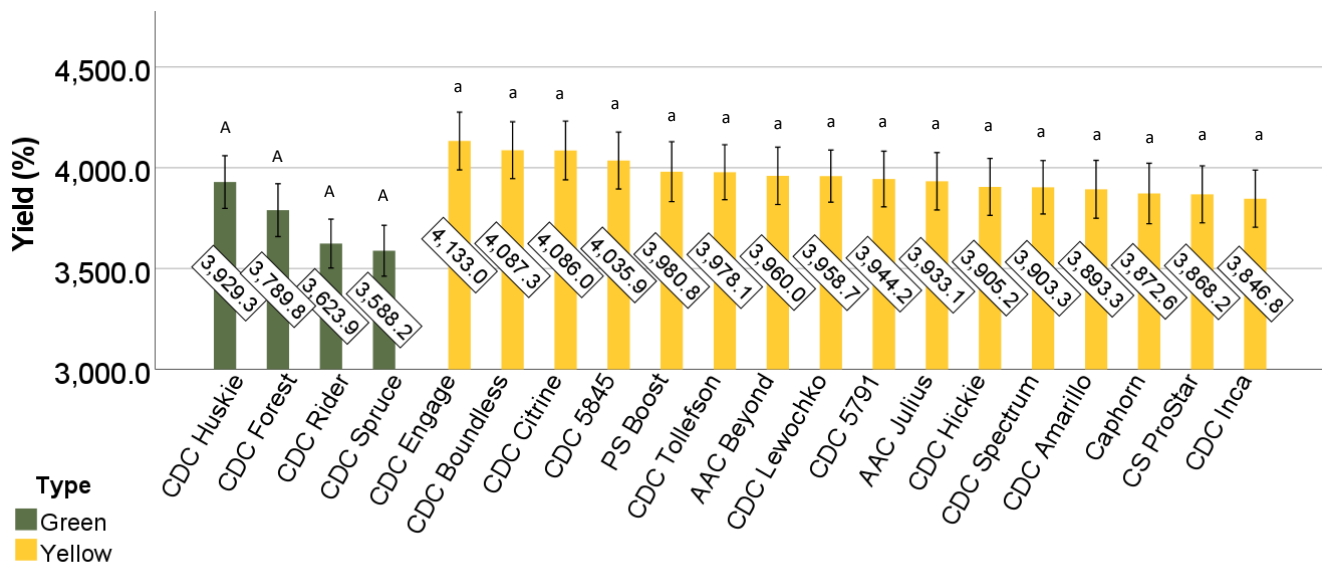
## 1. Yield

**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 plots (left) and mean yields (right) of peas in 2022, 2023, and 2024.



**Figure 1.2.** Mean yield of each pea variety based on trials conducted from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



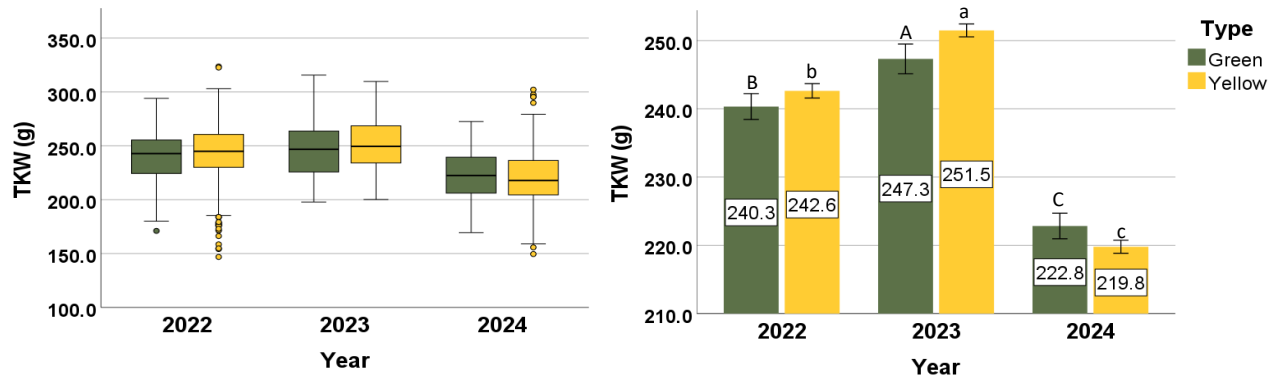
- Crop yield depends on the amount of moisture received. Rainfall was most adequate in 2024, resulting in the highest yield for both green and yellow peas (**Figure B, C, D**).
- No significant differences in yield were observed among varieties over the three years.

*Note: Small letters indicated significant differences ( $p < 0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.*

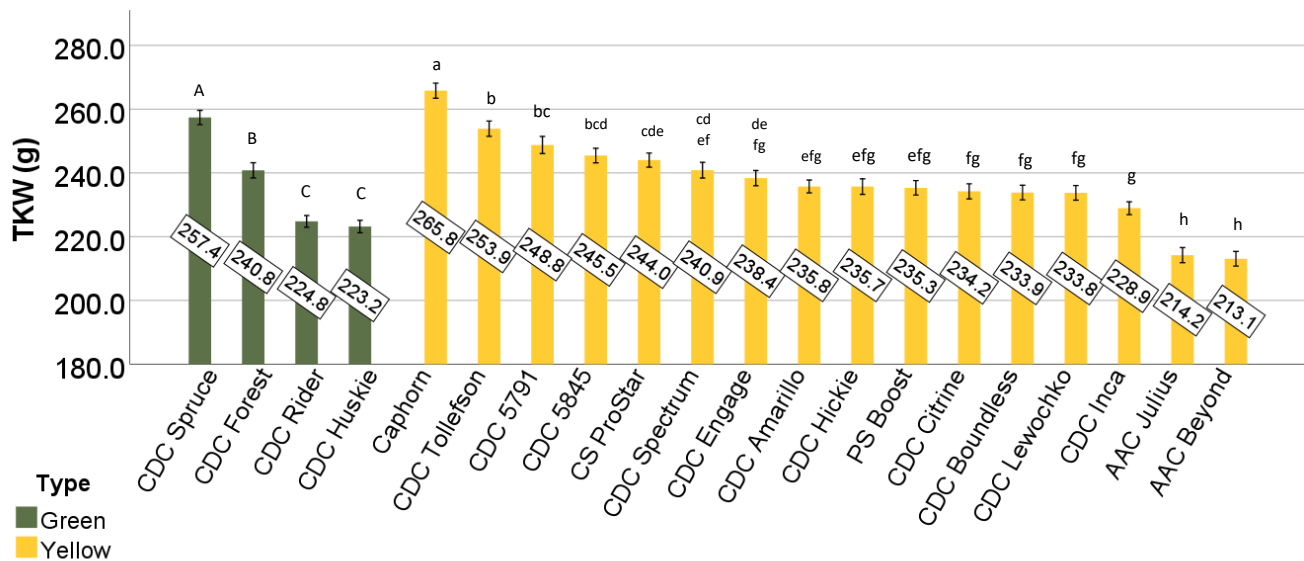
## 2. Thousand Kernel Weight (TKW)

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

**Results: Figure 2.1.** Box plots (left) and mean TKWs (right) of peas in 2022, 2023, and 2024.



**Figure 2.2.** Mean TKW of each pea variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



- The TKW of 2024 was significantly lower than in 2022 and 2023.
- TKW was positively correlated with yield ( $r=0.18$ ;  $p<0.01$ ) (Table B).

*Note: Small letters indicated significant differences ( $p<0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p<0.05$ ) by green peas.*

### 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 yellow pea varieties:

- |                  |                  |
|------------------|------------------|
| a. #20R: 7.94 mm | c. #16R: 6.35 mm |
| b. #18R: 7.14 mm | d. #14R: 5.56 mm |

**Results: Table 3.1.** Seed size distribution (%) of each pea variety based on trials from 2022 to 2024. Data represent mean  $\pm$  one standard deviation.

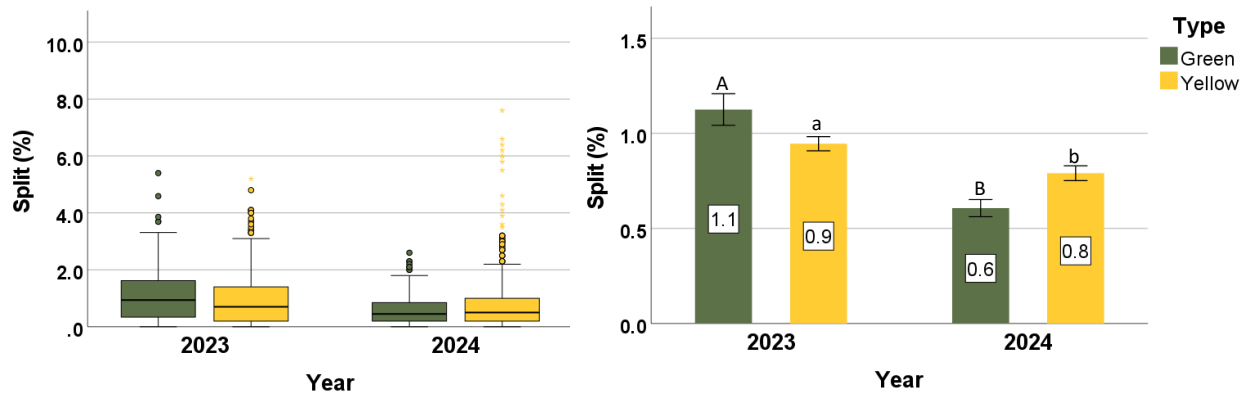
Variety	> 7.94 mm (%)	> 7.14 mm (%)	> 6.35 mm (%)	> 5.56 mm (%)	$\leq$ 5.56 mm (%)
CDC Spruce	3.4 $\pm$ 3.6 <sup>A</sup>	42.8 $\pm$ 18.1 <sup>A</sup>	49.4 $\pm$ 17.8 <sup>B</sup>	4.1 $\pm$ 4.4 <sup>C</sup>	0.3 $\pm$ 0.4 <sup>C</sup>
CDC Forest	1.9 $\pm$ 2.4 <sup>B</sup>	35.7 $\pm$ 19.9 <sup>B</sup>	54.8 $\pm$ 16.6 <sup>B</sup>	7.1 $\pm$ 9.1 <sup>B</sup>	0.5 $\pm$ 0.6 <sup>BC</sup>
CDC Rider	0.6 $\pm$ 0.7 <sup>C</sup>	21.1 $\pm$ 14.3 <sup>C</sup>	65.6 $\pm$ 10.0 <sup>A</sup>	11.9 $\pm$ 10.3 <sup>A</sup>	0.7 $\pm$ 0.8 <sup>AB</sup>
CDC Huskie	0.6 $\pm$ 0.9 <sup>C</sup>	18.6 $\pm$ 12.6 <sup>C</sup>	66.3 $\pm$ 9.5 <sup>A</sup>	13.7 $\pm$ 12.2 <sup>A</sup>	0.8 $\pm$ 1.0 <sup>A</sup>
Caphorn	8.9 $\pm$ 8.8 <sup>a</sup>	52.2 $\pm$ 15.1 <sup>a</sup>	34.8 $\pm$ 16.9 <sup>g</sup>	3.3 $\pm$ 4.1 <sup>f</sup>	0.4 $\pm$ 0.6 <sup>b</sup>
CDC Tollefson	3.8 $\pm$ 4.4 <sup>b</sup>	41.5 $\pm$ 19.3 <sup>b</sup>	49.2 $\pm$ 18.8 <sup>f</sup>	5.1 $\pm$ 5.7 <sup>ef</sup>	0.4 $\pm$ 0.5 <sup>b</sup>
CDC 5791	2.5 $\pm$ 2.7 <sup>bcde</sup>	38.5 $\pm$ 20.1 <sup>b</sup>	50.8 $\pm$ 15.8 <sup>f</sup>	7.7 $\pm$ 8.6 <sup>cdef</sup>	0.6 $\pm$ 0.8 <sup>b</sup>
CS ProStar	3.1 $\pm$ 4.1 <sup>bc</sup>	35.3 $\pm$ 16.7 <sup>bc</sup>	53.7 $\pm$ 14.9 <sup>ef</sup>	7.2 $\pm$ 8.1 <sup>def</sup>	0.6 $\pm$ 0.8 <sup>b</sup>
CDC 5845	2.3 $\pm$ 2.3 <sup>cdef</sup>	35.4 $\pm$ 17.7 <sup>bc</sup>	54.7 $\pm$ 15.2 <sup>ef</sup>	7.0 $\pm$ 8.7 <sup>def</sup>	0.6 $\pm$ 0.9 <sup>b</sup>
PS Boost	2.7 $\pm$ 4.1 <sup>bcd</sup>	28.2 $\pm$ 15.6 <sup>de</sup>	58.8 $\pm$ 15.0 <sup>cde</sup>	9.4 $\pm$ 10.1 <sup>bcde</sup>	0.9 $\pm$ 1.2 <sup>ab</sup>
CDC Engage	1.5 $\pm$ 2.1 <sup>defg</sup>	29.2 $\pm$ 17.4 <sup>cd</sup>	59.1 $\pm$ 13.6 <sup>cde</sup>	9.4 $\pm$ 10.5 <sup>bcde</sup>	0.6 $\pm$ 0.9 <sup>b</sup>
CDC Hickie	1.5 $\pm$ 1.7 <sup>defg</sup>	29.4 $\pm$ 18.5 <sup>cd</sup>	57.9 $\pm$ 14.2 <sup>de</sup>	10.4 $\pm$ 11.1 <sup>bcd</sup>	0.9 $\pm$ 1.4 <sup>ab</sup>
CDC Amarillo	1.1 $\pm$ 1.3 <sup>efg</sup>	26.3 $\pm$ 17.4 <sup>def</sup>	62.6 $\pm$ 13.7 <sup>abcd</sup>	9.4 $\pm$ 9.9 <sup>cde</sup>	0.5 $\pm$ 0.7 <sup>b</sup>
CDC Spectrum	1.1 $\pm$ 1.4 <sup>efg</sup>	26.1 $\pm$ 18.5 <sup>def</sup>	61.2 $\pm$ 14.4 <sup>bcd</sup>	10.6 $\pm$ 11.5 <sup>bcd</sup>	0.9 $\pm$ 1.3 <sup>ab</sup>
CDC Lewochko	1.4 $\pm$ 2.0 <sup>defg</sup>	24.9 $\pm$ 15.5 <sup>def</sup>	61.0 $\pm$ 12.5 <sup>bcd</sup>	11.9 $\pm$ 12.3 <sup>bc</sup>	0.8 $\pm$ 1.3 <sup>ab</sup>
CDC Boundless	0.8 $\pm$ 1.2 <sup>g</sup>	22.6 $\pm$ 15.4 <sup>ef</sup>	64.5 $\pm$ 11.0 <sup>abc</sup>	11.4 $\pm$ 10.4 <sup>bcd</sup>	0.6 $\pm$ 0.8 <sup>b</sup>
CDC Citrine	0.6 $\pm$ 1.1 <sup>g</sup>	20.9 $\pm$ 16.6 <sup>f</sup>	64.2 $\pm$ 13.2 <sup>abc</sup>	13.4 $\pm$ 13.5 <sup>b</sup>	0.8 $\pm$ 1.2 <sup>ab</sup>
CDC Inca	0.8 $\pm$ 1.1 <sup>g</sup>	20.2 $\pm$ 13.1 <sup>fg</sup>	67.5 $\pm$ 9.9 <sup>a</sup>	10.9 $\pm$ 9.5 <sup>bcd</sup>	0.6 $\pm$ 0.9 <sup>b</sup>
AAC Julius	0.9 $\pm$ 2.4 <sup>fg</sup>	14.0 $\pm$ 13.6 <sup>gh</sup>	61.7 $\pm$ 15.3 <sup>abcd</sup>	22.1 $\pm$ 17.9 <sup>a</sup>	1.3 $\pm$ 1.9 <sup>a</sup>
AAC Beyond	0.7 $\pm$ 2.0 <sup>g</sup>	11.6 $\pm$ 11.0 <sup>h</sup>	66.6 $\pm$ 16.4 <sup>ab</sup>	19.9 $\pm$ 17.7 <sup>a</sup>	1.3 $\pm$ 2.1 <sup>a</sup>

Note: Small letters indicated significant differences ( $p < 0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.

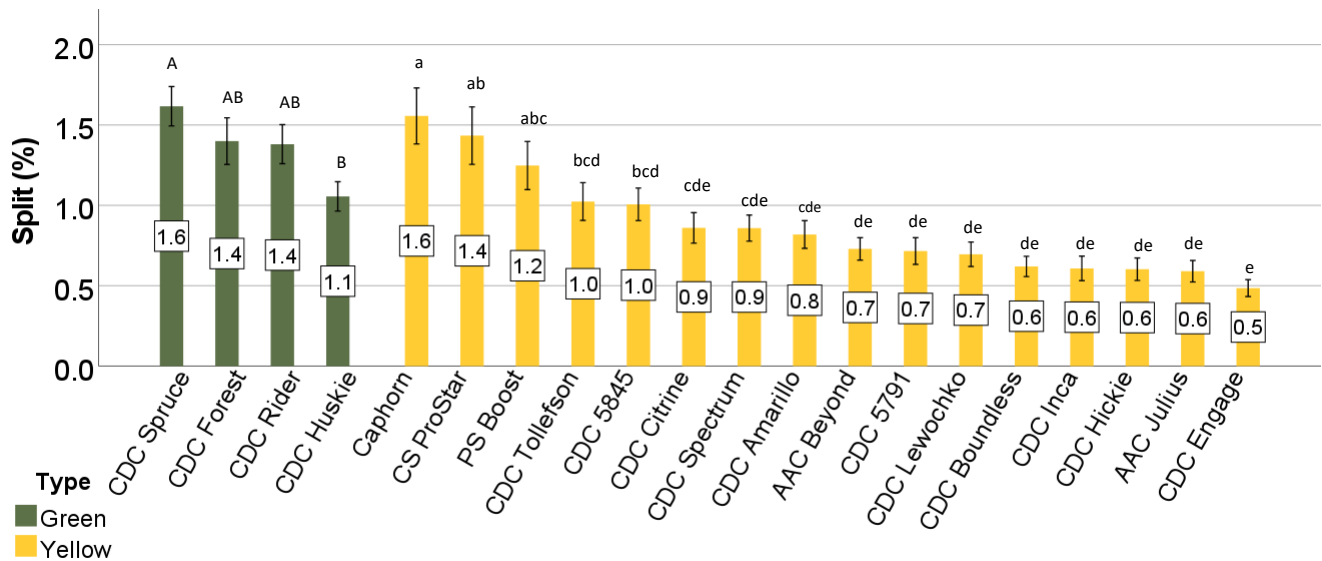
## 4. Split

**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 plots (left) and mean (right) splits of peas in 2023 and 2024. Split results for 2022 were reported together with seed coat breakage; therefore, the average is not included in this section.



**Figure 4.2.** Mean split of each pea variety based on trials from 2023 to 2024. Each bar represents mean  $\pm$  one standard error.



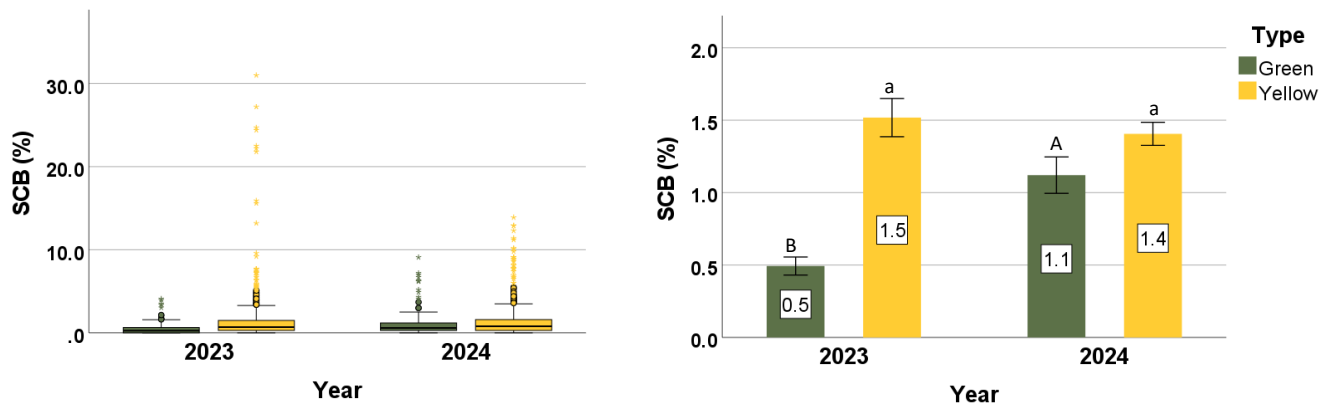
- Split was found to be positively correlated with TKW ( $r=0.13$ ;  $p<0.01$ ) and negatively correlated with hardness ( $r=-0.17$ ;  $p<0.01$ ) (**Table B**).

*Note: Small letters indicated significant differences ( $p<0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p<0.05$ ) by green peas.*

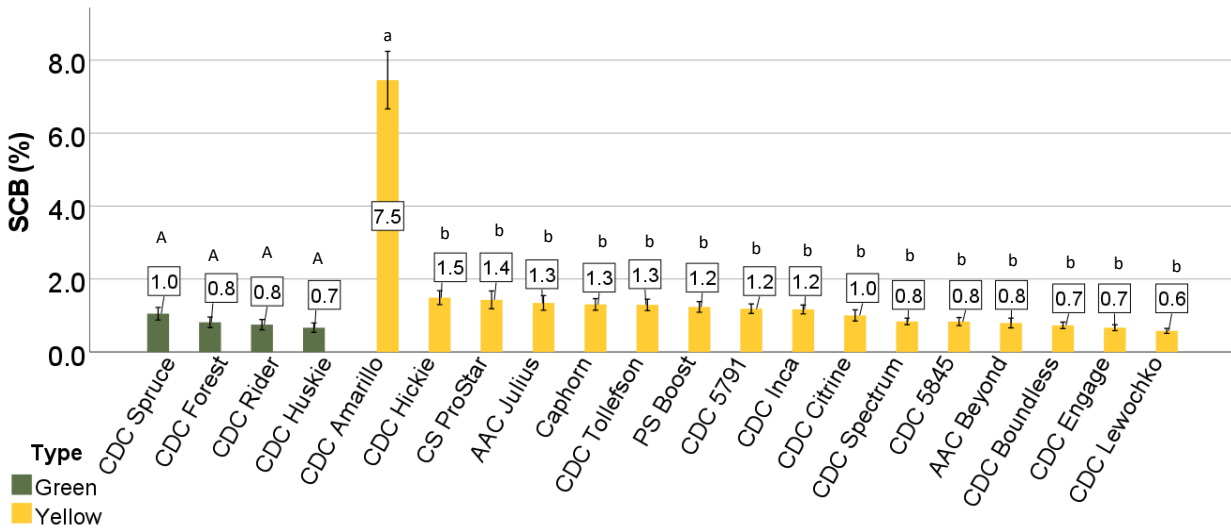
## 5. Seed Coat Breakage (SCB)

**Method:** 100 grams of each sample was used for evaluation, and seeds with seed coat damage were selected by hand. Seed coat breakage occurs during harvesting and handling, reducing seed quality. It is recommended to combine peas at around 18-20% moisture content to reduce the risk of seed cracking or peeling. Using lower speeds with the combine and auger is also preferred (Saskatchewan Pulse Growers, 2024<sup>1</sup>).

**Results: Figure 5.1.** Box plots (left) and mean SCBs (right) of peas in 2023 and 2024. SCB results for 2022 were reported together with the split amount; therefore, the average is not included in this section.



**Figure 5.2.** Mean SCB of each pea variety based on trials from 2023 to 2024. Each bar represents mean  $\pm$  one standard error.



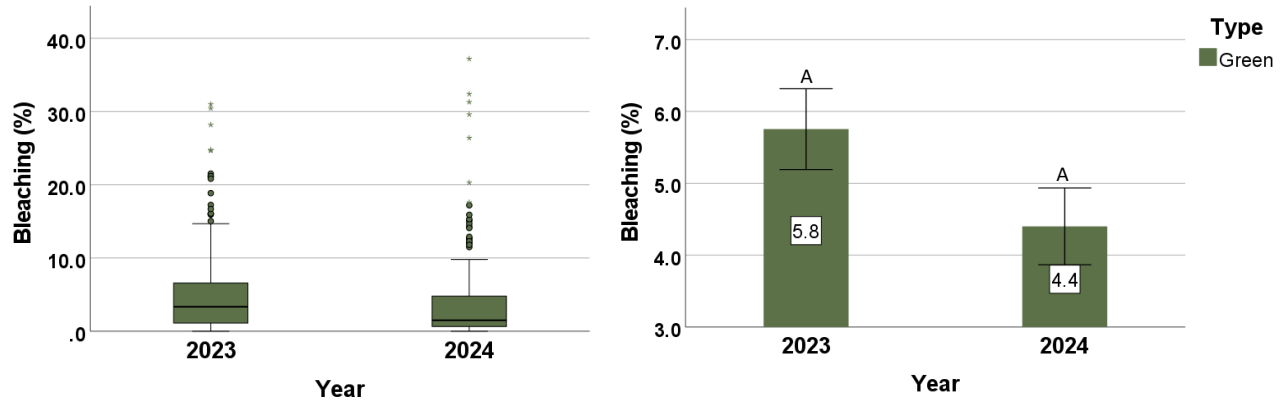
Note: Small letters indicated significant differences ( $p < 0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.

<sup>1</sup> Saskatchewan Pulse Growers. 2024. Accessed June 03, 2024. <https://saskpulse.com/resources/pea-harvest-management/>

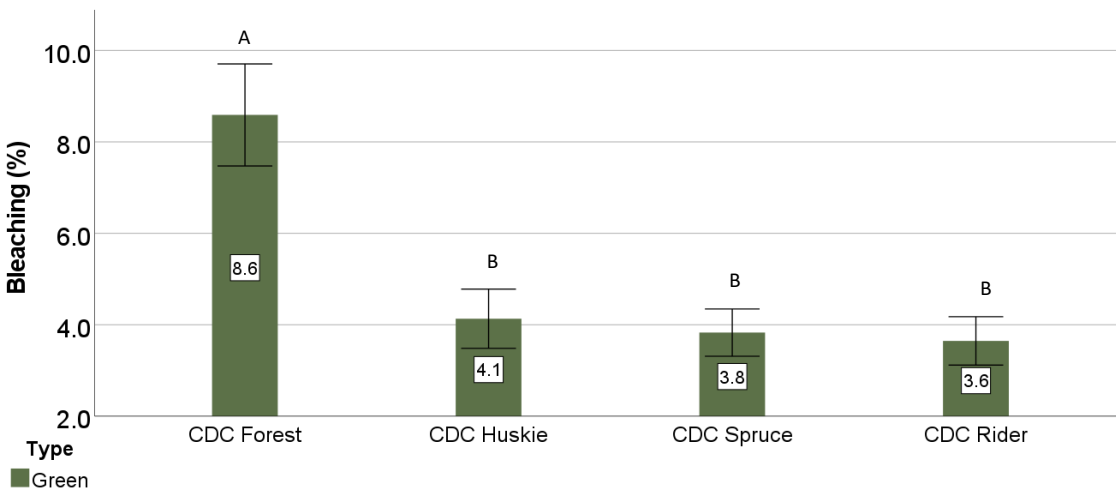
## 6. Bleaching

**Method:** 100 grams of each sample was used for evaluation, and bleached seeds were selected by hand. Green peas are bleached when one-eighth or more of the surface of the cotyledon has a distinct yellow color. Bleached green peas in general do not affect seed quality but the appearance, thereby reducing the market price. Bleaching occurs when the chlorophyll is enzymatically degraded under a combination of bright sunlight and moisture. Choosing varieties that have better tolerance to bleaching is a good idea to minimize bleaching. In addition, it is also recommended to harvest green peas as soon as possible to reduce the time of green peas in the field.

**Results: Figure 6.1.** Box plot (left) and mean (right) of green peas for bleaching in 2023 and 2024. Bleaching was not reported in 2022.



**Figure 6.2.** Mean of bleached green peas based on trials from 2023 to 2024. Each bar represents mean  $\pm$  one standard error.

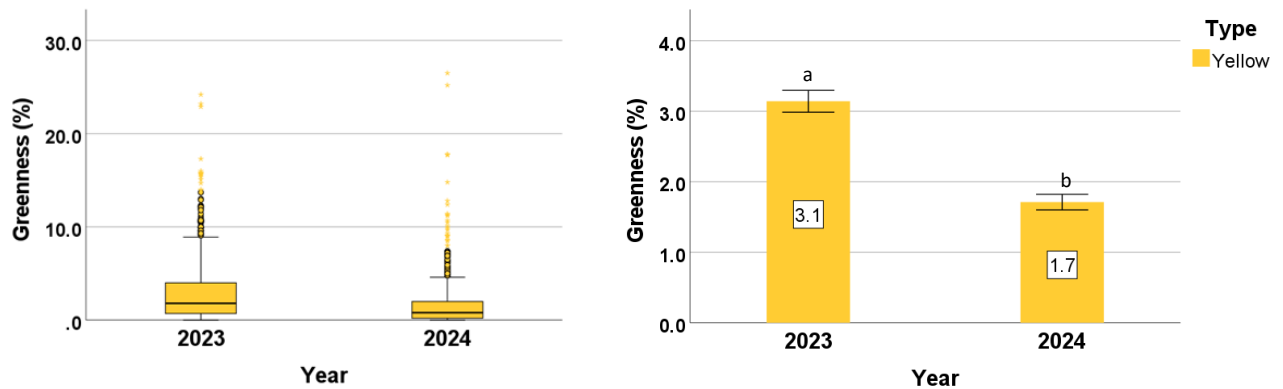


Note: Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.

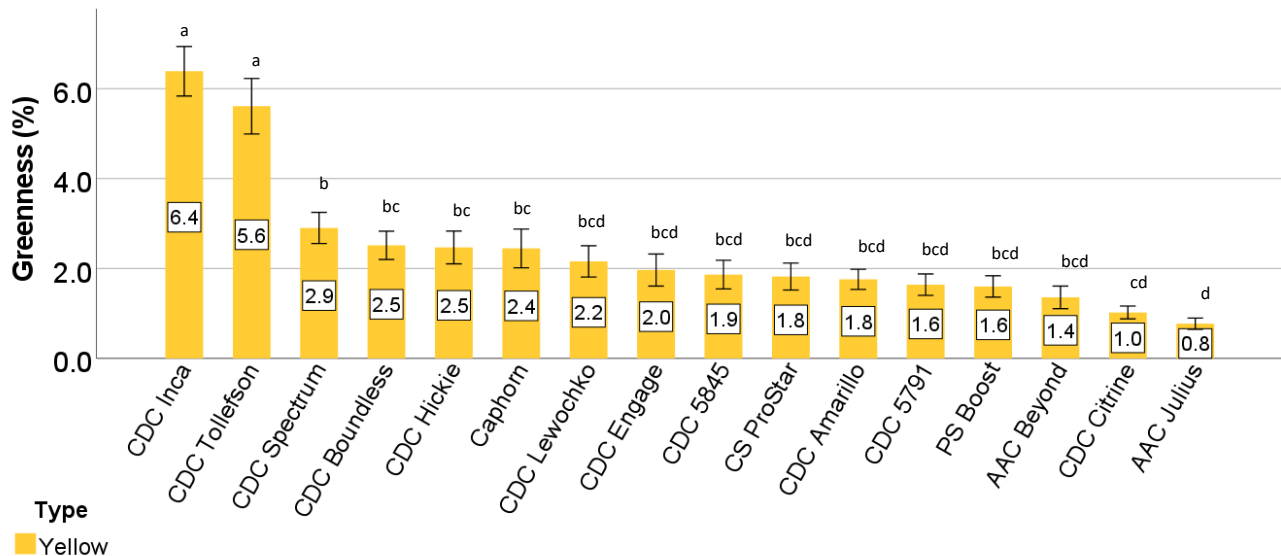
## 7. Greenness

**Method:** 100 grams of each sample was used for evaluation. The results included yellow peas with distinct greenness due to immaturity or because certain varieties remain green even after reaching maturity.

**Results: Figure 7.1.** Box plot (left) and mean (right) of yellow peas for greenness in 2023 and 2024. Greenness was not reported in 2022.



**Figure 7.2.** Mean greenness of yellow peas based on trials from 2023 to 2024. Each bar represents mean  $\pm$  one standard error.

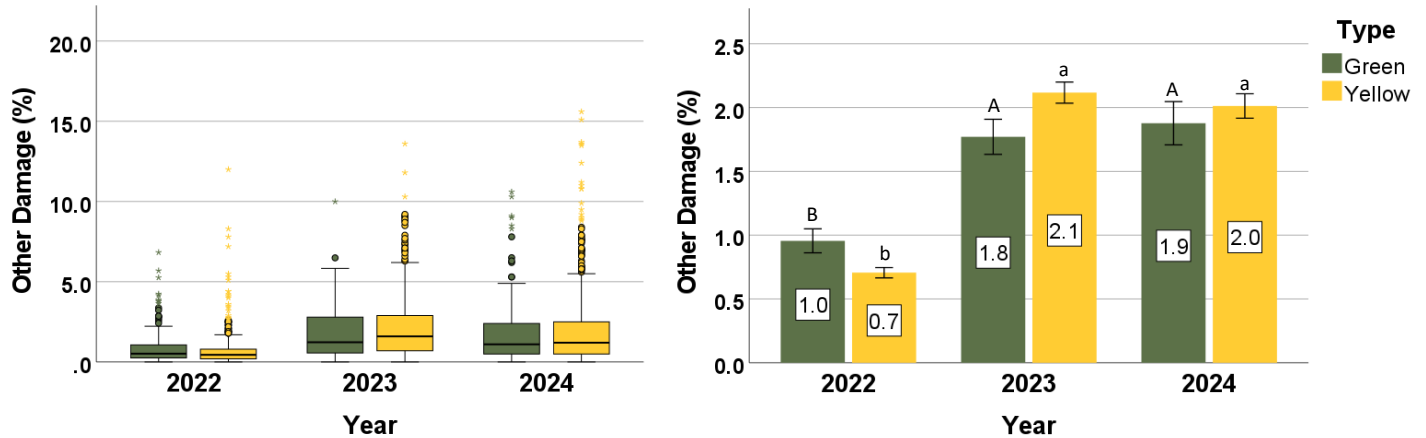


Note: Small letters indicated significant differences ( $p < 0.05$ ) by variety.

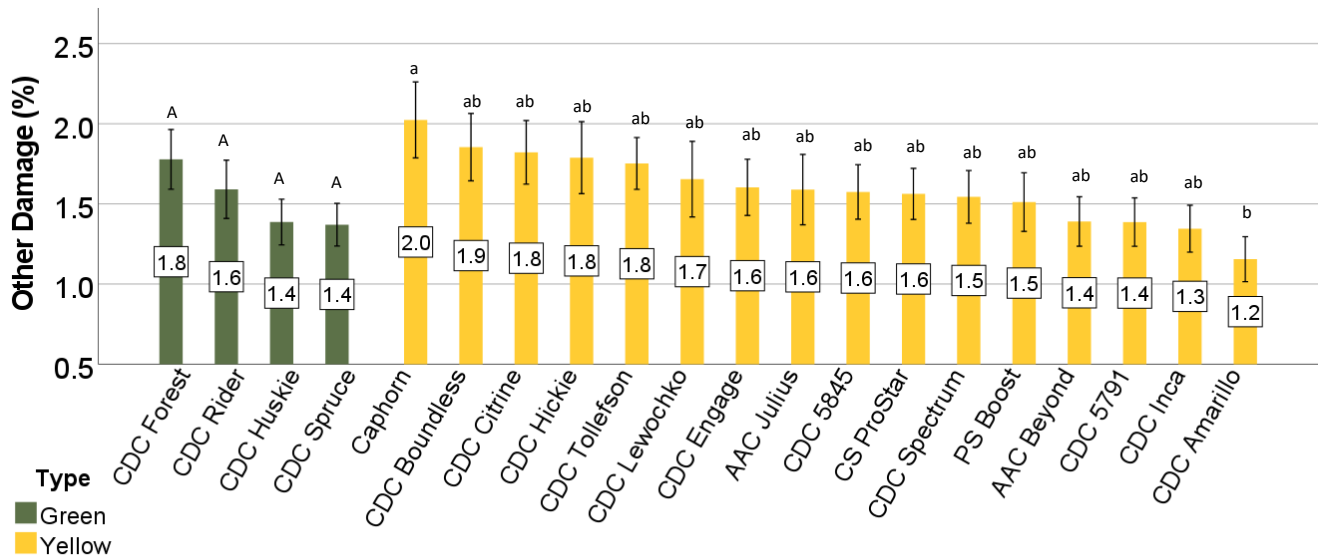
### 8. Other Damage

**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 8.1.** Box plots (left) and mean other damage (right) of peas in 2022, 2023, and 2024.



**Figure 8.2.** Mean other damage of each pea variety based on trials from 2022 to 2024. Each bar represents mean ± one standard error.

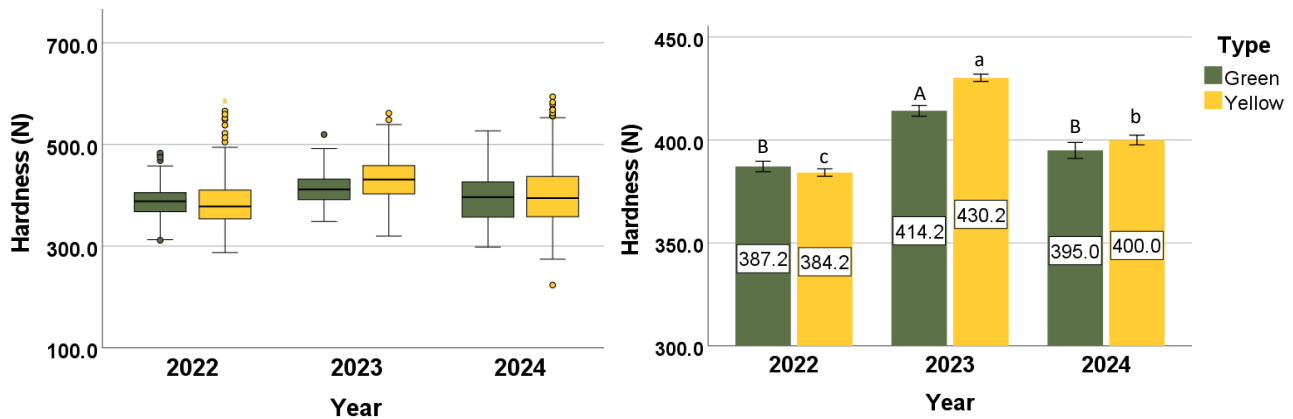


*Note: Small letters indicated significant differences ( $p < 0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.*

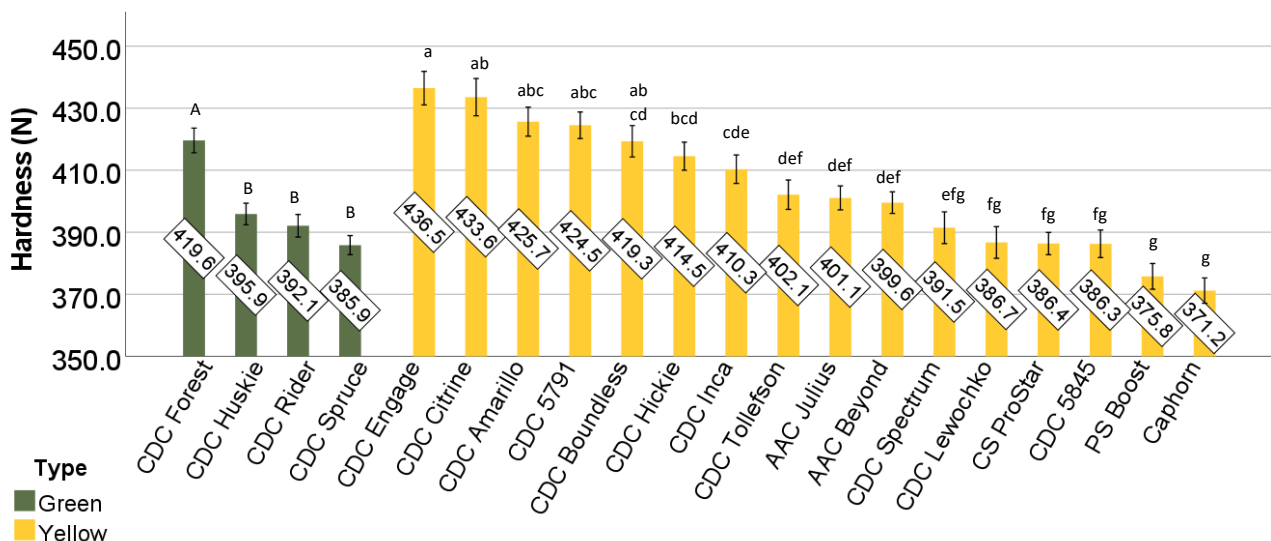
## 9. Hardness of Whole Seed

**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 9.1.** Box plots (left) and mean hardness (right) of peas in 2022, 2023, and 2024.



**Figure 9.2.** Mean hardness of each pea variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



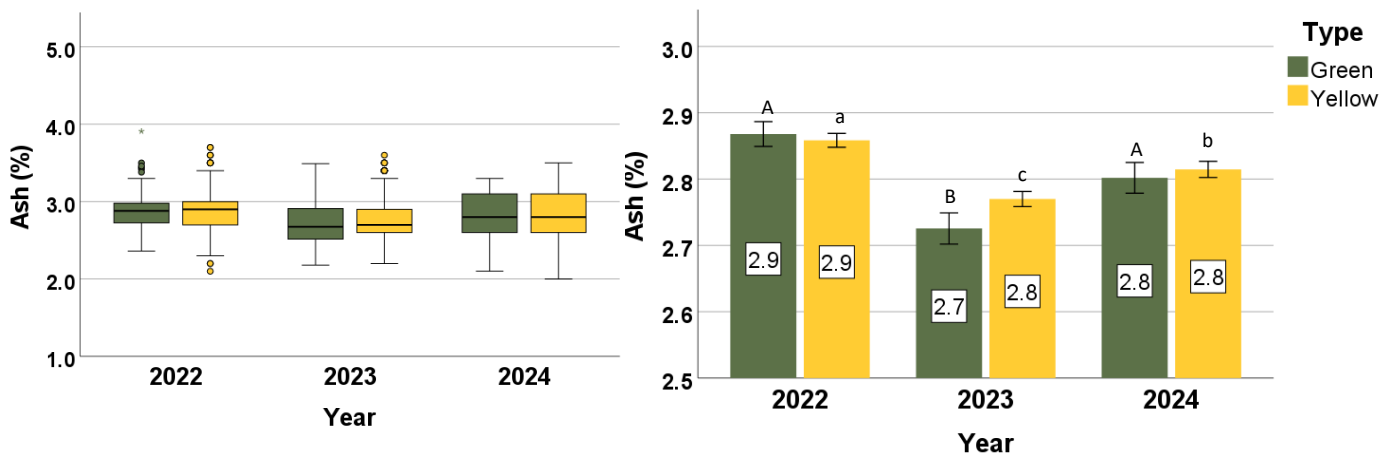
- The average hardness of peas in 2023 was higher than in 2022 and 2024.
- Hardness was positively correlated with TKW ( $r=0.16$ ;  $p<0.01$ ), and negatively correlated with moisture ( $r=-0.24$ ;  $p<0.01$ ), ash ( $r=-0.19$ ;  $p<0.01$ ), and protein ( $r=-0.07$ ;  $p<0.01$ ) (**Table B**).

Note: Small letters indicated significant differences ( $p<0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p<0.05$ ) by green peas.

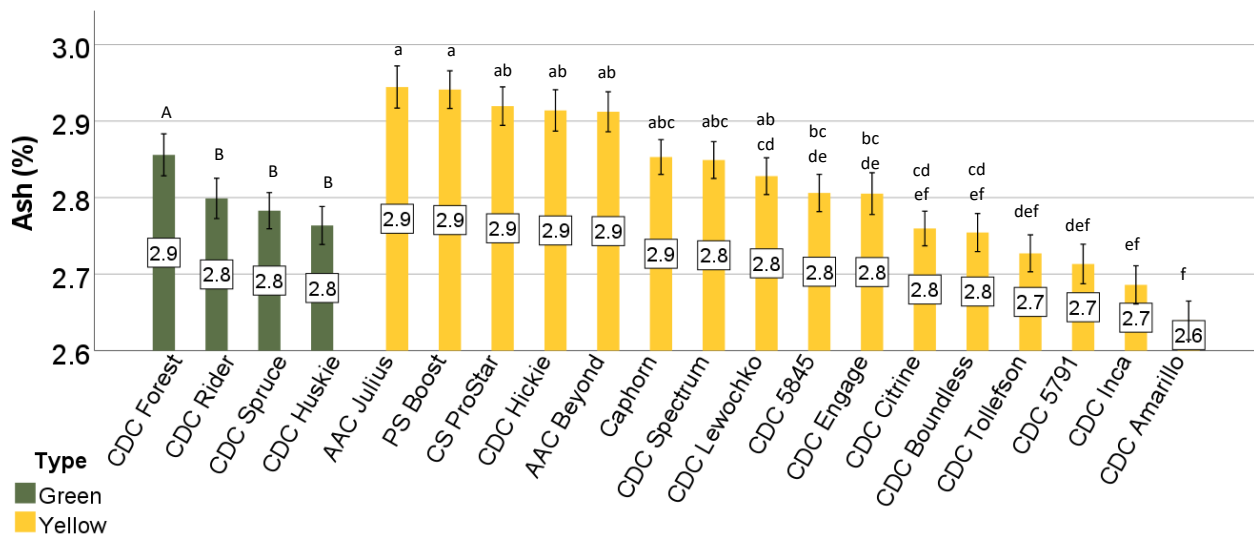
## 10. Ash Content

**Method:** Ash content (%) was determined using AACC 08-01.01<sup>2</sup> 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 10.1.** Box plots (left) and mean ash contents (right) of peas in 2022, 2023, and 2024.



**Figure 10.2.** Mean ash content of each pea variety based on trials from 2022 to 2024. Each bar represents mean ± one standard error.



- The average ash content of peas in 2023 and 2024 was lower than that in 2022.

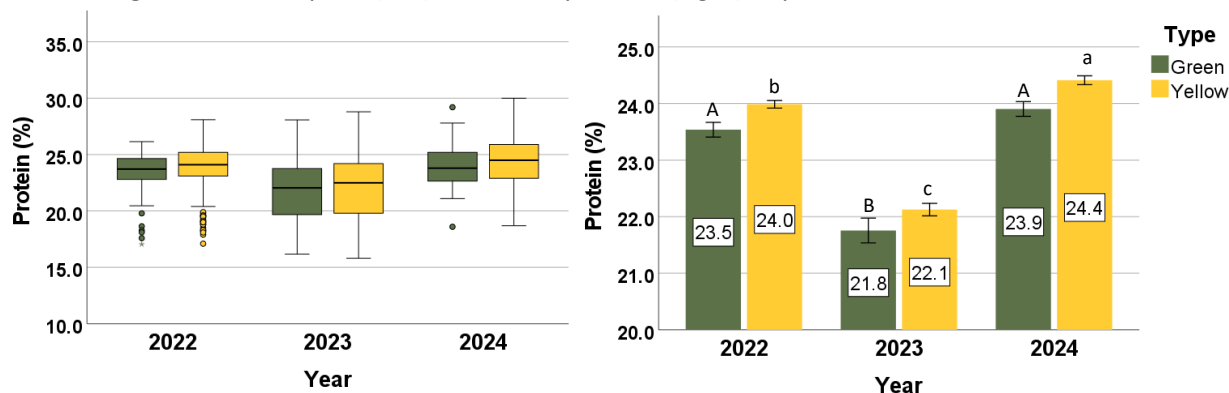
Note: Small letters indicated significant differences ( $p < 0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.

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

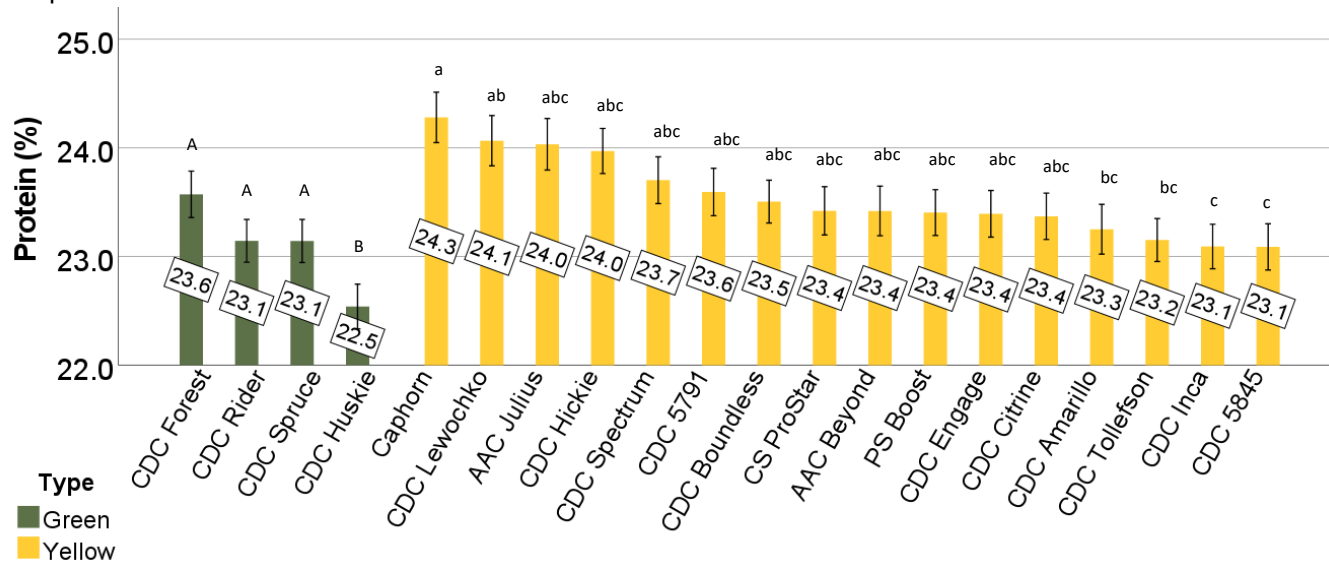
## 11. Protein Content

**Method:** The protein content (%) of each flour was determined through AACC 46-30<sup>2</sup> 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 11.1.** Box plots (left) and mean proteins (right) of peas in 2022, 2023 and 2024.



**Figure 11.2.** Mean protein content of each pea variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



- The mean pea protein content in 2023 was significantly lower than in 2022 and 2024.
- Protein was negatively correlated with other damage ( $r=-0.32$ ;  $p<0.01$ ) and ash ( $r=-0.23$ ;  $p<0.01$ ) (Table B).

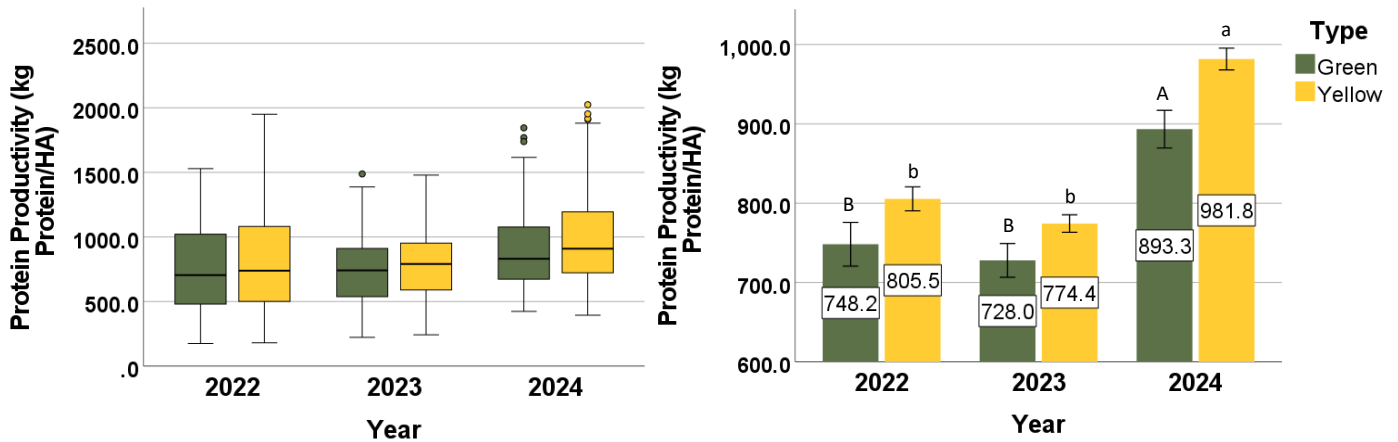
Note: Small letters indicated significant differences ( $p<0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p<0.05$ ) by green peas.

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

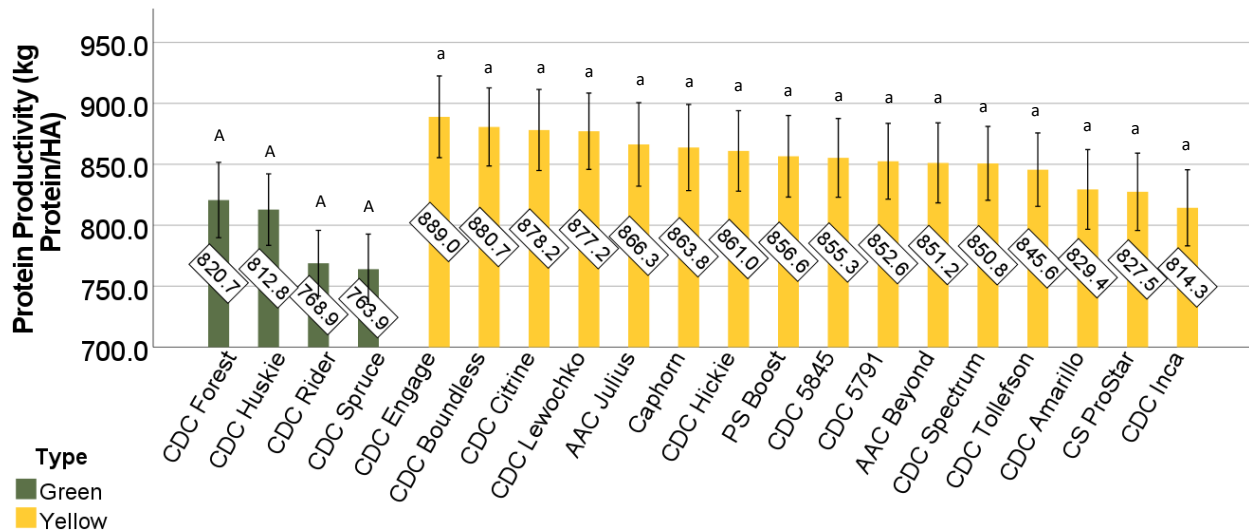
## 12. Protein Productivity

**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 12.1.** Box plots (left) and mean protein productivity (right) of peas in 2022, 2023 and 2024.



**Figure 12.2.** Mean protein productivity of each pea variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



- Protein productivity in 2024 was significantly higher than in 2022 and 2023.
- Protein productivity was positively correlated with yield ( $r=0.97$ ;  $p<0.01$ ) and protein content ( $r=0.27$ ;  $p<0.01$ ) (**Table B**).

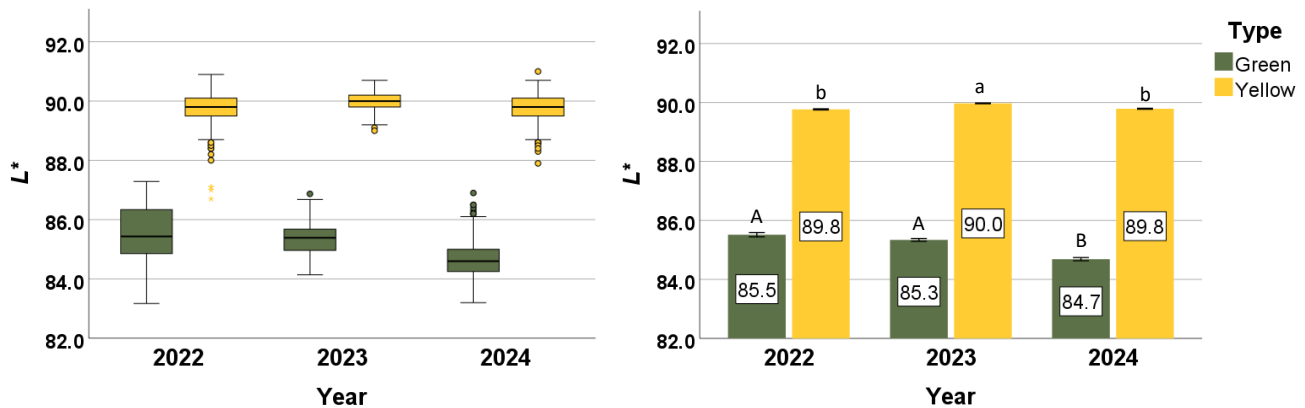
*Note: Small letters indicated significant differences ( $p<0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p<0.05$ ) by green peas.*

### 13. Colour

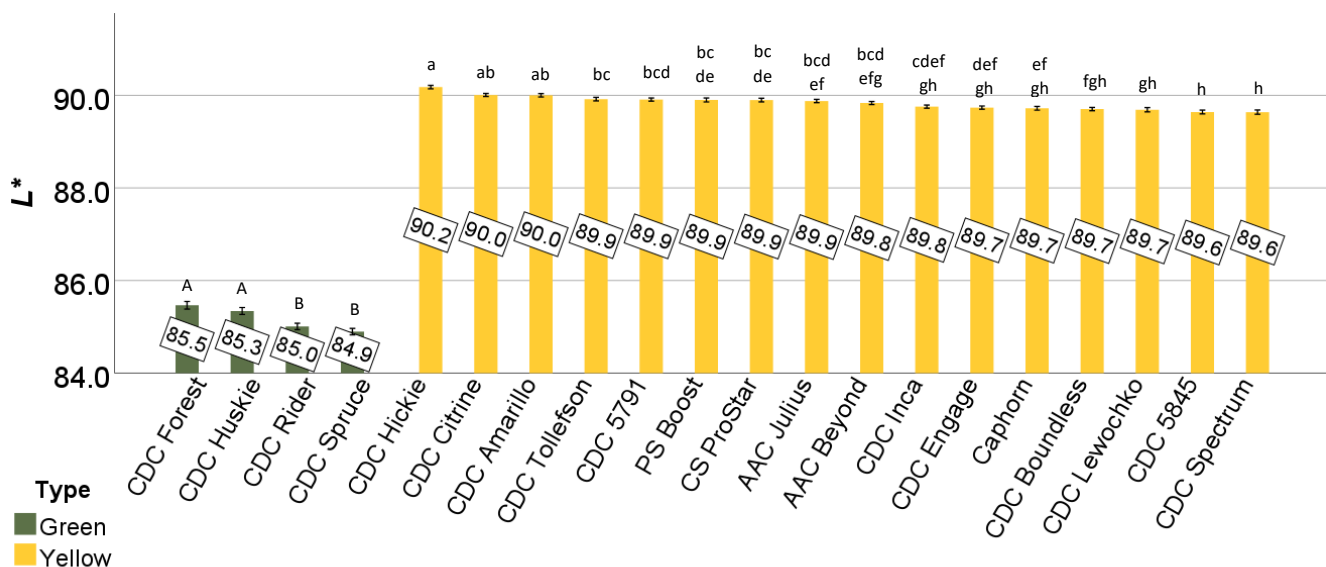
**Method:** The absolute colour of each flour was determined using the Konica Minolta CR-400 Chroma meter, where  $L^*$ ,  $a^*$ , and  $b^*$  values were reported.

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

**Results: Figure 13.1.** Box plots (left) and mean  $L^*$  (right) of peas in 2022, 2023, and 2024.



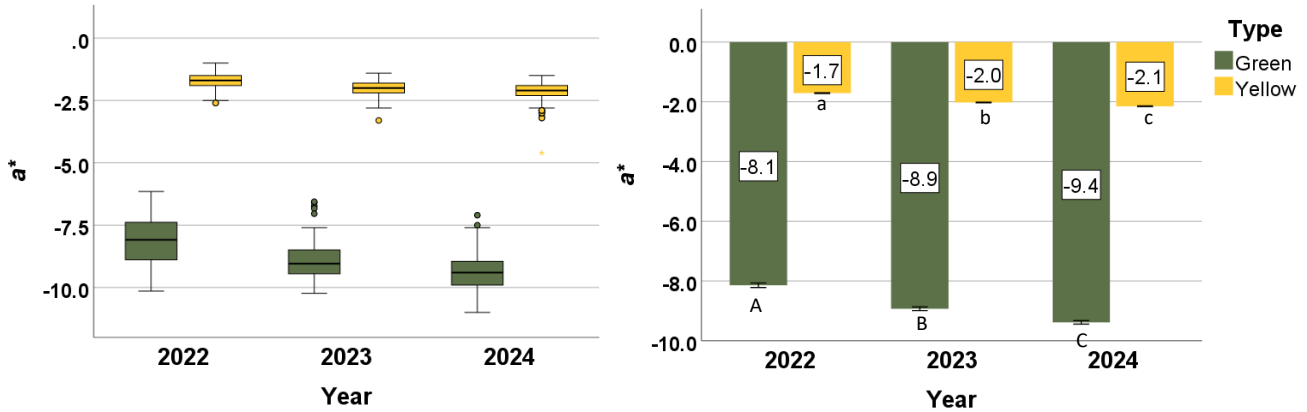
**Figure 13.2.** Mean  $L^*$  values of each pea variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



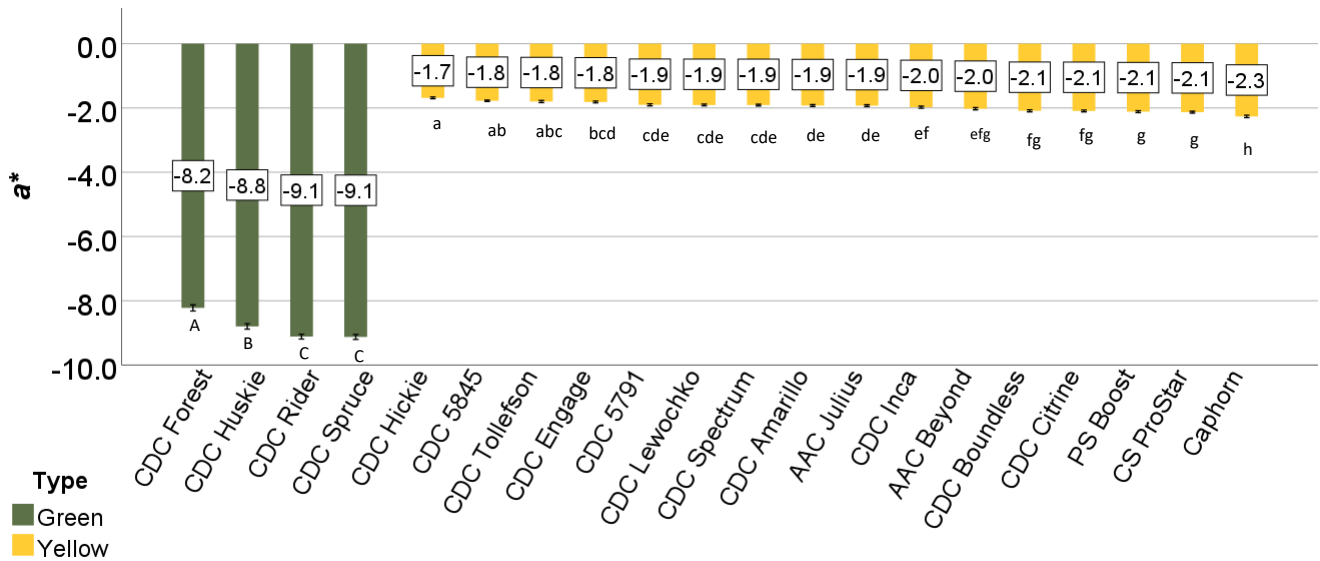
Note: Small letters indicated significant differences ( $p < 0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.

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

**Results: Figure 13.3.** Box plots (left) and mean  $a^*$  values (right) of peas in 2022, 2023, and 2024.



**Figure 13.4.** Mean  $a^*$  values of each pea variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



Note: Small letters indicated significant differences ( $p < 0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p < 0.05$ ) by green peas.

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

Results: Figure 13.5. Box plots (left) and mean  $b^*$  values (right) of peas in 2022, 2023, and 2024.

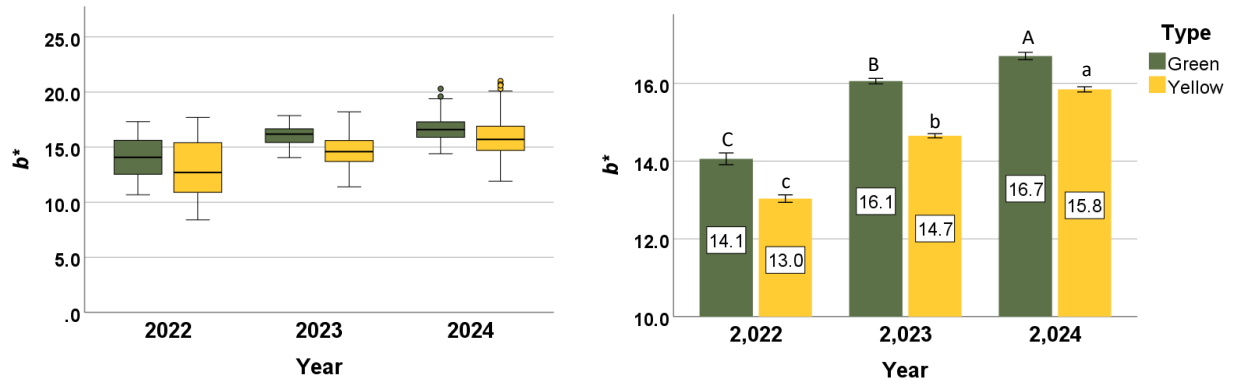
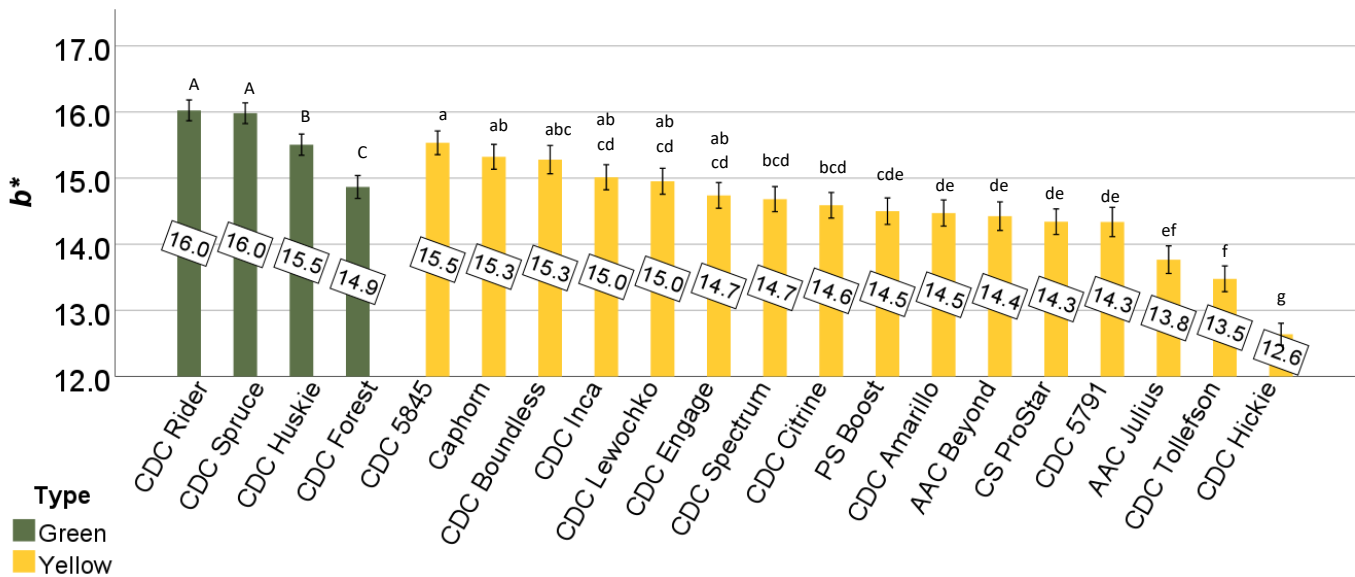


Figure 13.6. Mean  $b^*$  values of each pea variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



- For green peas:  $L^*$  ( $r=0.62$ ;  $p<0.01$ ) and  $a^*$  ( $r=0.71$ ;  $p<0.01$ ) were positively correlated with bleaching, while  $b^*$  was negatively correlated ( $r=-0.50$ ;  $p<0.01$ ).
- For yellow peas,  $L^*$  ( $r=-0.19$ ;  $p<0.01$ ),  $a^*$  ( $r=-0.07$ ;  $p<0.05$ ), and  $b^*$  ( $r=-0.08$ ;  $p<0.01$ ) were all negatively correlated with greenness (Table B).

Note: Small letters indicated significant differences ( $p<0.05$ ) by yellow peas. Capital letters indicated significant differences ( $p<0.05$ ) by green peas.

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

	Yield	TKW	Split	SCB	Bleaching (G)	Greenness (Y)	Other Damage	Hardness	Moisture	Ash	Protein	Protein Productivity	L*	a*	b*
<b>Yield</b>	1														
<b>TKW</b>	.18**	1													
<b>Split</b>	-.07**	.13**	1												
<b>SCB</b>	NS	.12**	.07*	1											
<b>Bleaching</b>	NS	.25**	.15*	NS	1										
<b>Greenness</b>	-.07*	NS	-.12**	NS	na	1									
<b>Other Damage</b>	.07*	.09**	-.14**	NS	.23**	-.07*	1								
<b>Hardness</b>	.14**	.16**	-.17**	NS	NS	NS	-.05*	1							
<b>Moisture</b>	.23**	.14**	NS	NS	.19**	-.19**	.34**	-.24**	1						
<b>Ash</b>	-.06**	-.06**	-.05*	NS	NS	NS	.24**	-.19**	.26**	1					
<b>Protein</b>	.04*	-.08**	.18**	.09**	-.18**	-.15**	-.32**	-.07**	-.16**	-.23**	1				
<b>Protein Productivity</b>	.97**	.14**	NS	NS	-.15*	-.10**	NS	.14**	.15**	-.12**	.27**	1			
<b>L*</b>	.10**	.05*	.09**	.14**	.62**	-.19**	NS	.09**	-.12**	NS	.04*	.11**	1		
<b>a*</b>	.09**	.05*	.11**	.11**	.71**	-.07*	NS	.04*	-.06**	NS	NS	.10**	.97**	1	
<b>b*</b>	-.31**	-.22*	-.29**	-.13**	-.50**	-.08**	.05*	NS	NS	-.05*	.18**	-.26**	-.31**	-.33**	1

\*Pearson correlations coefficients significant at  $p < 0.05$ ; \*\* Pearson correlations coefficients significant at  $p < 0.01$ ; NS not significant; na not applied.

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