



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

# Faba Bean



## **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 and particle size). 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.

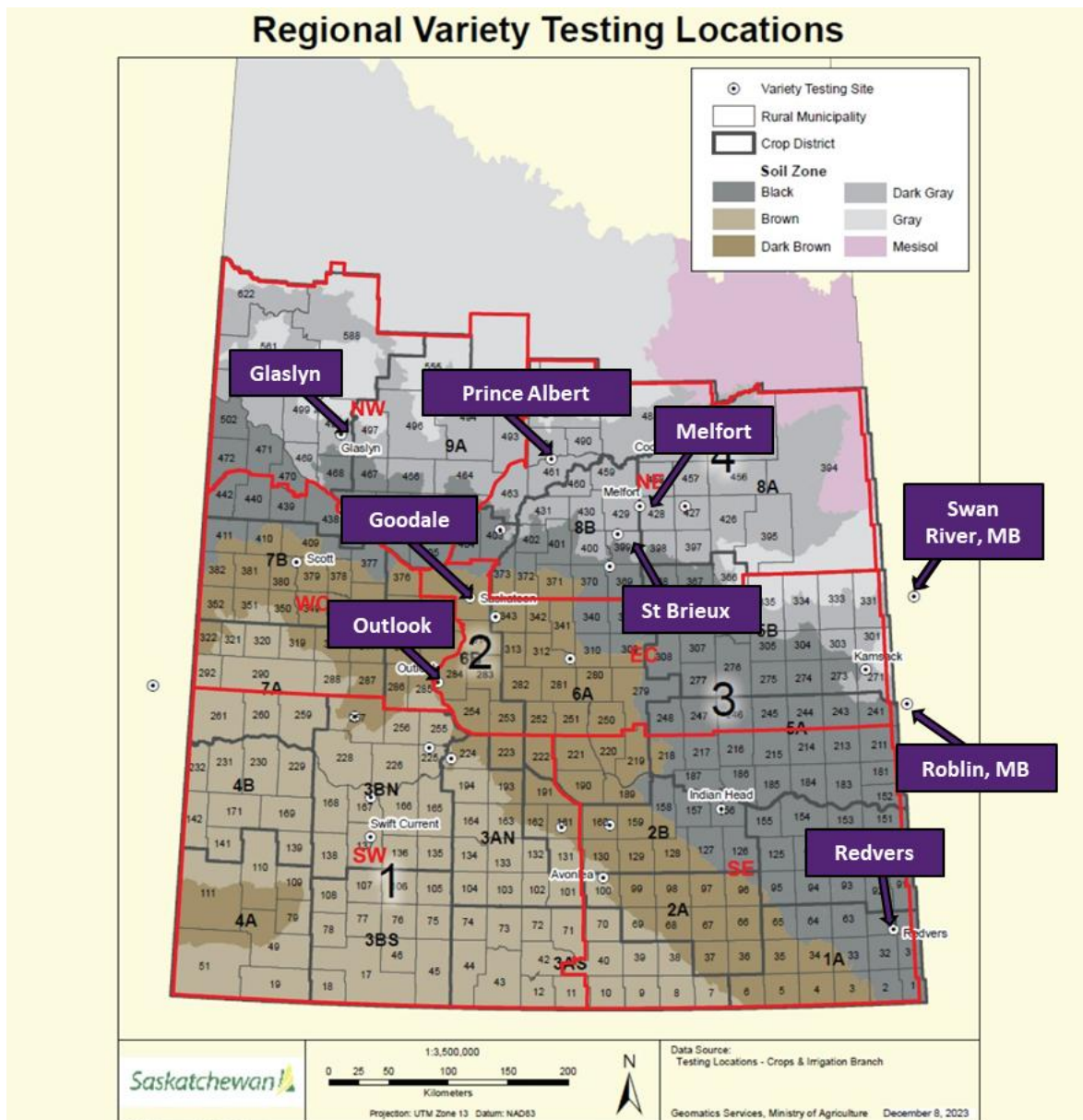
## 2022-24 Faba Bean Quality Evaluation

There were seven faba bean varieties (3 tannin and 4 zero tannin) stayed as the regional variety trails from 2022 to 2024. Samples acquired in 2022, 2023, and 2024 were harvested from 7, 8, and 8 locations, respectively. **Table A** provides the samples' information in detail.

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

Type	Variety	2022 Site	2023 Site	2024 Site	Region
Tannin	Allison Fabelle Victus	Glaslyn	Glaslyn	Glaslyn	<b>Northwestern SK</b>
		Melfort	Melfort	Melfort	<b>Northeastern SK</b>
		Prince Albert	Prince Albert		
		St Brieux	St Brieux	St Brieux	
					<b>West-Central SK</b>
Zero- Tannin	CDC 1089 CDC 1142 DL Nevado Navi	Goodale	Goodale	Goodale	<b>East-Central SK</b>
				Outlook_Irrigation	
					<b>Southwestern SK</b>
			Redvers	Redvers	<b>Southeastern SK</b>
		Swan River Roblin	Swan River Roblin	Swan River Roblin	<b>Manitoba</b>
<b>Number of samples</b>		<b>147</b>	<b>168</b>	<b>168</b>	

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.

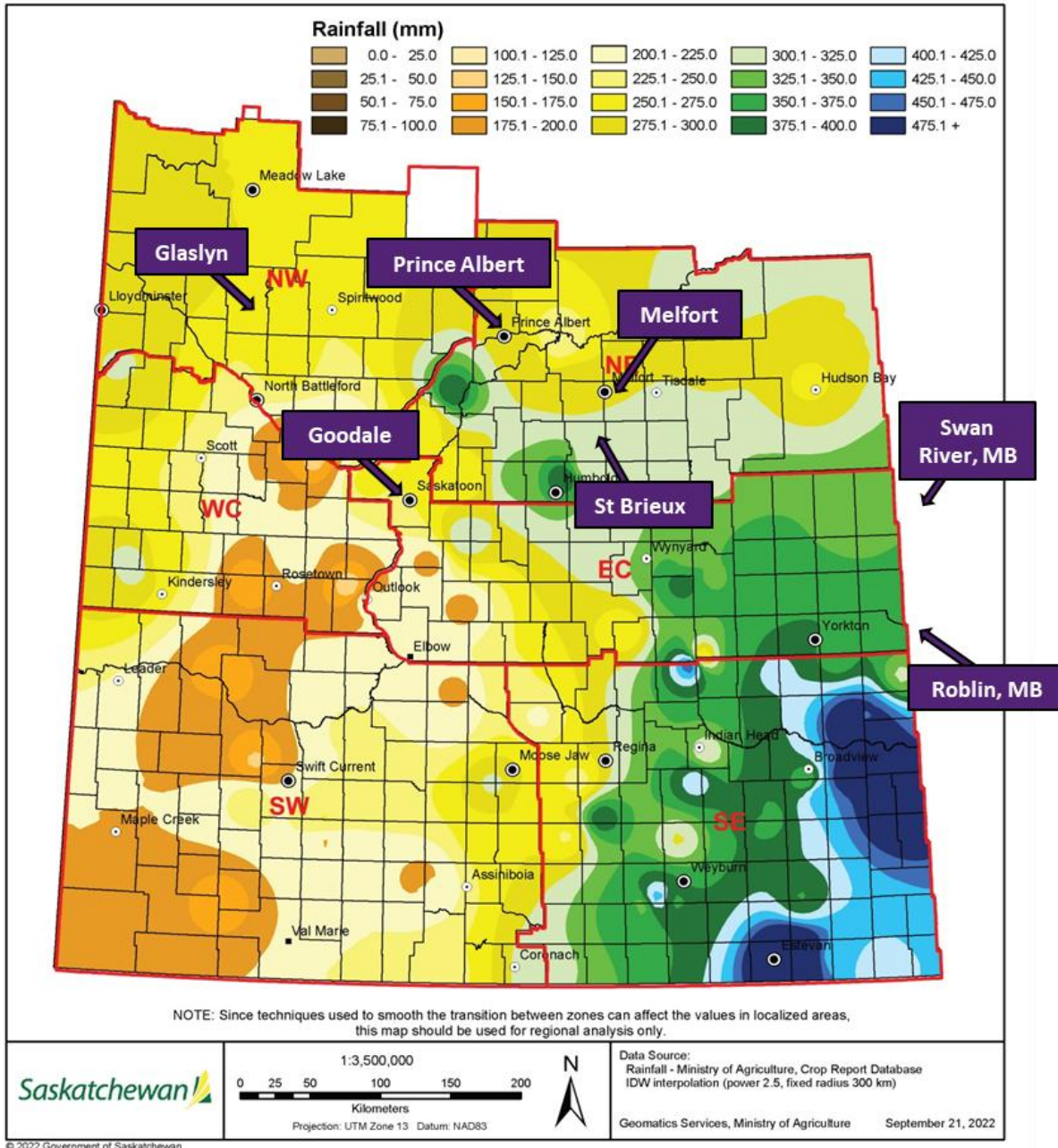
**Note About Dividing Lines:**

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 faba bean 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.

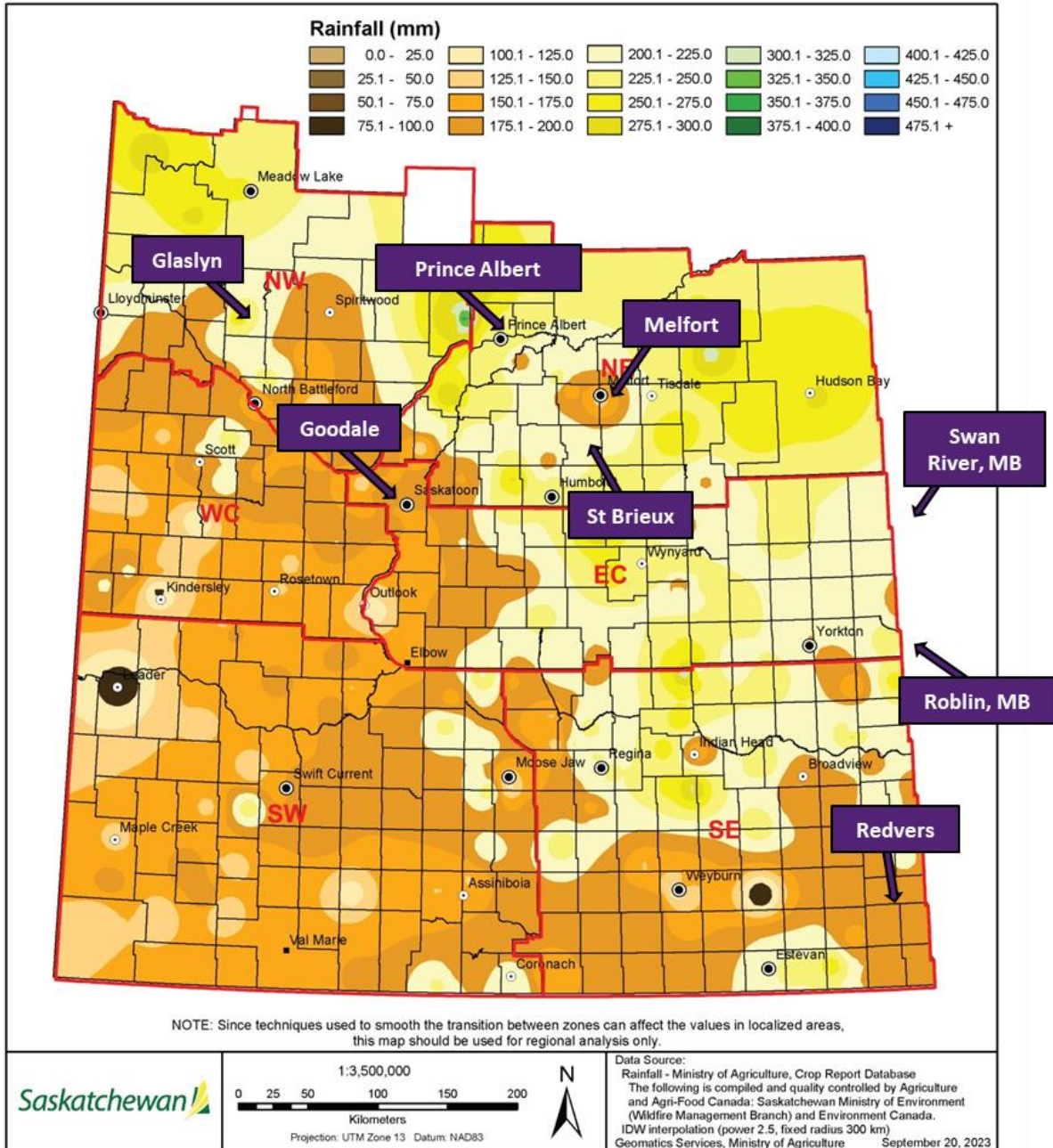
2335 SCHUYLER STREET, SASKATOON, SASKATCHEWAN, S7M 5V1,  
TEI: (306) 933-7555, FAX: (306) 933-7208

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



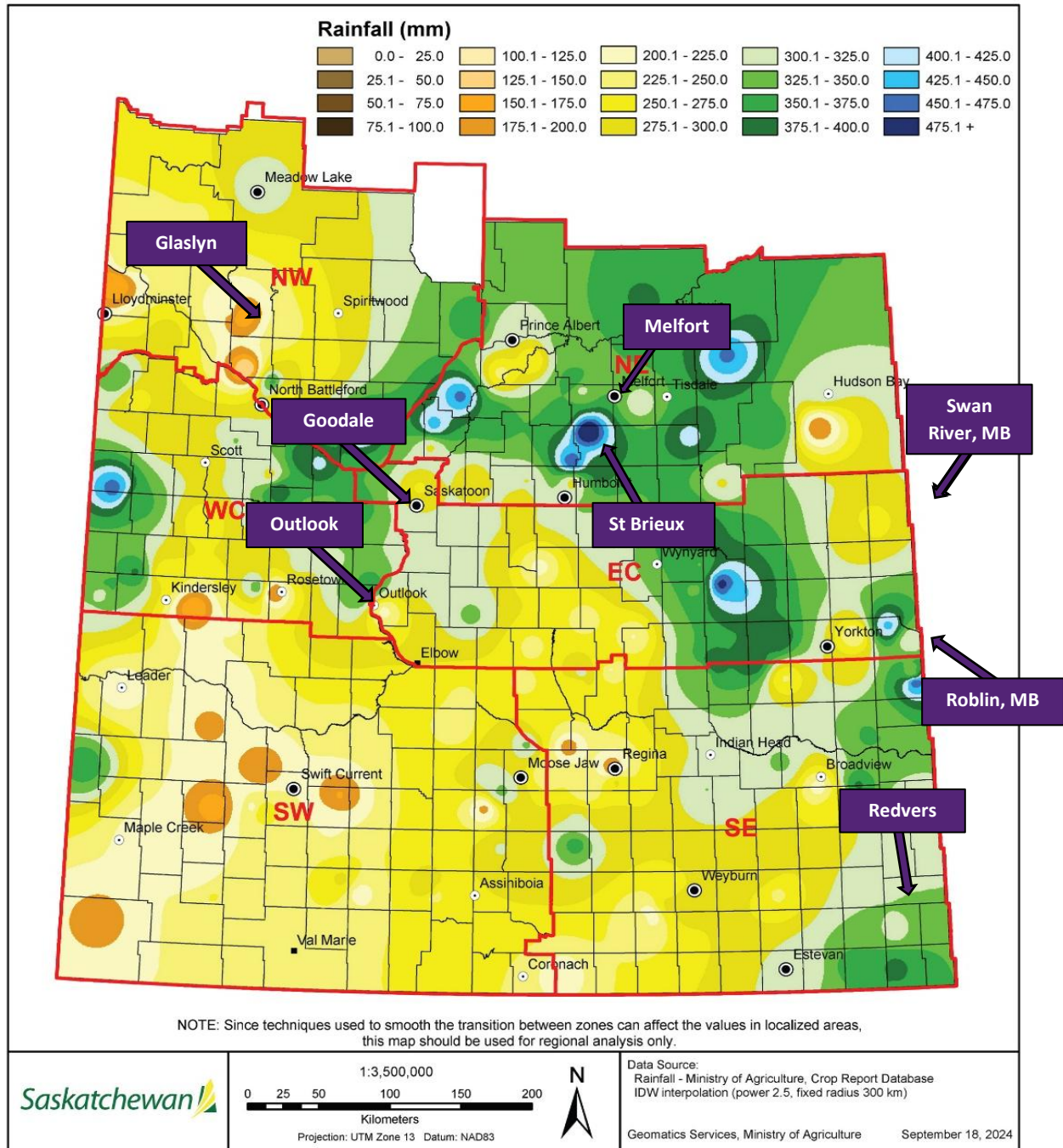
**Figure B.** Locations for faba bean quality testing and cumulative rainfall from April 1 to September 19, 2022. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

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



**Figure C.** Locations for faba bean quality testing and cumulative rainfall from April 1 to September 18, 2022. 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 faba bean 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 eleven subsections for the results of the following quality parameters:

1. Yield
2. Thousand kernel weight (TKW)
3. Seed size: length, width, thickness
4. Split amount
5. Hull perforation due to insects or disease
6. Other damage
7. Hardness of whole seed
8. Ash content
9. Protein content
10. Protein productivity
11. 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.

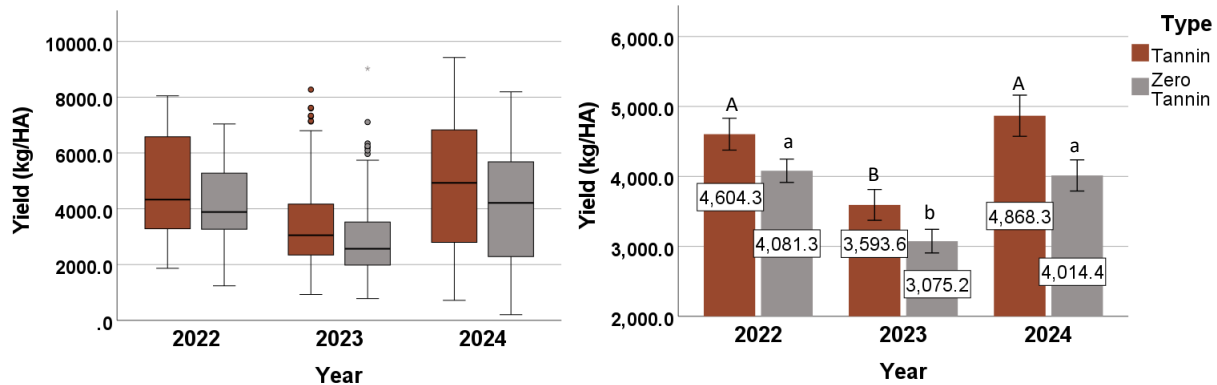
For **statistics**, a one-way analysis of variance (ANOVA) along with a post-hoc Tukey test (SPSS, Chicago, IL, USA) was performed to identify the differences in the quality parameters by variety and by year.

The Pearson Correlation was performed to measure the correlation between quality parameters (**Table B1&2**).

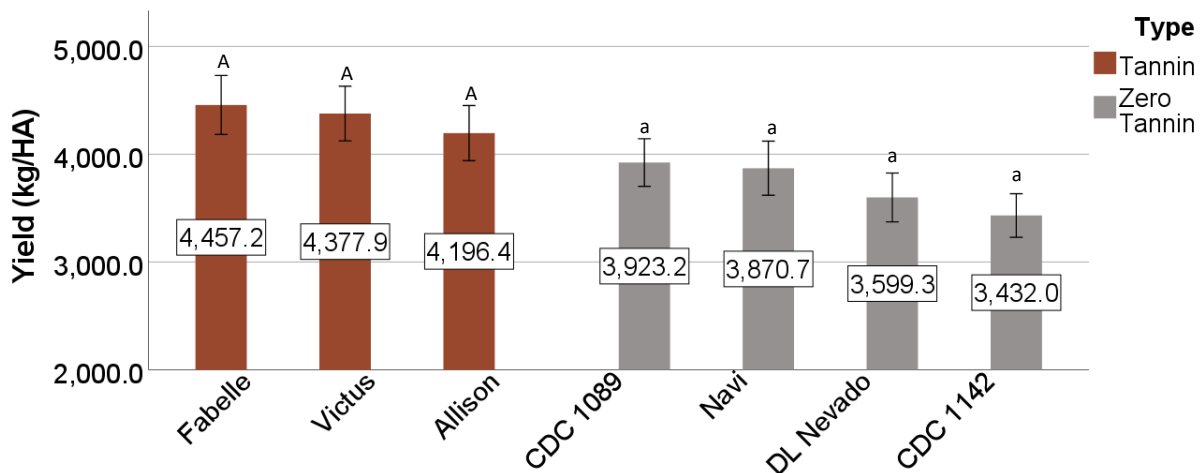
## 1. Yield

**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 faba bean’s yield in 2022, 2023, and 2024.



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



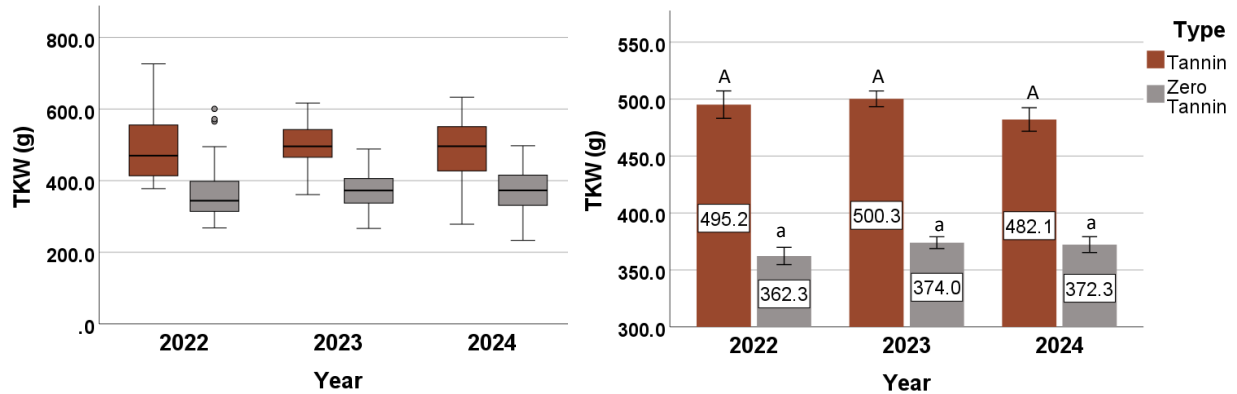
- Crop yield depends on the amount of moisture received. Rainfall was lowest in 2023, resulting in lower faba bean yields (Figure B, C, D).
- No significant differences in yield were observed among varieties within each type over the three years.

*Note: Small letters indicated significant differences ( $p < 0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p < 0.05$ ) by tannin faba beans.*

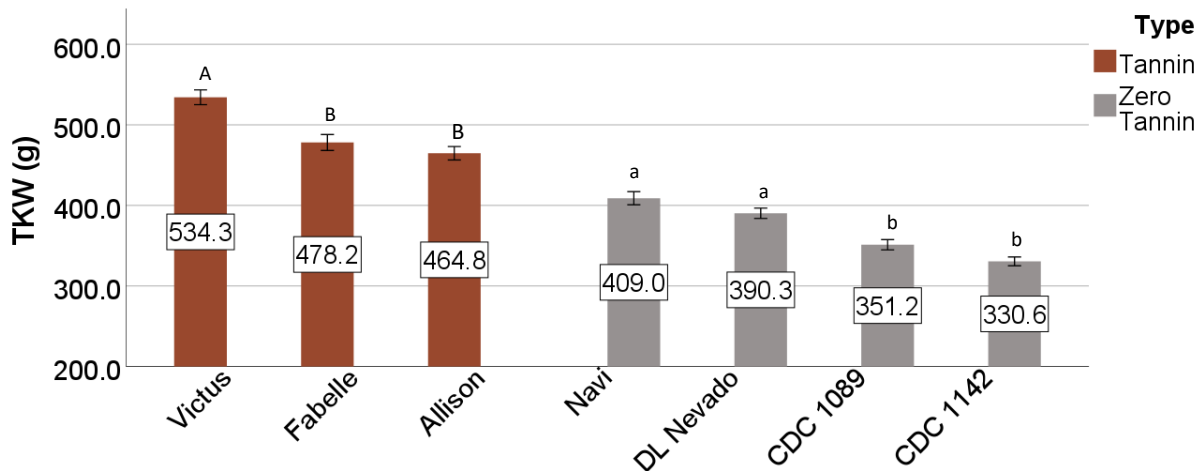
## 2. Thousand Kernel Weight (TKW)

**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 TKWs (right) of faba beans in 2022, 2023, and 2024.



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



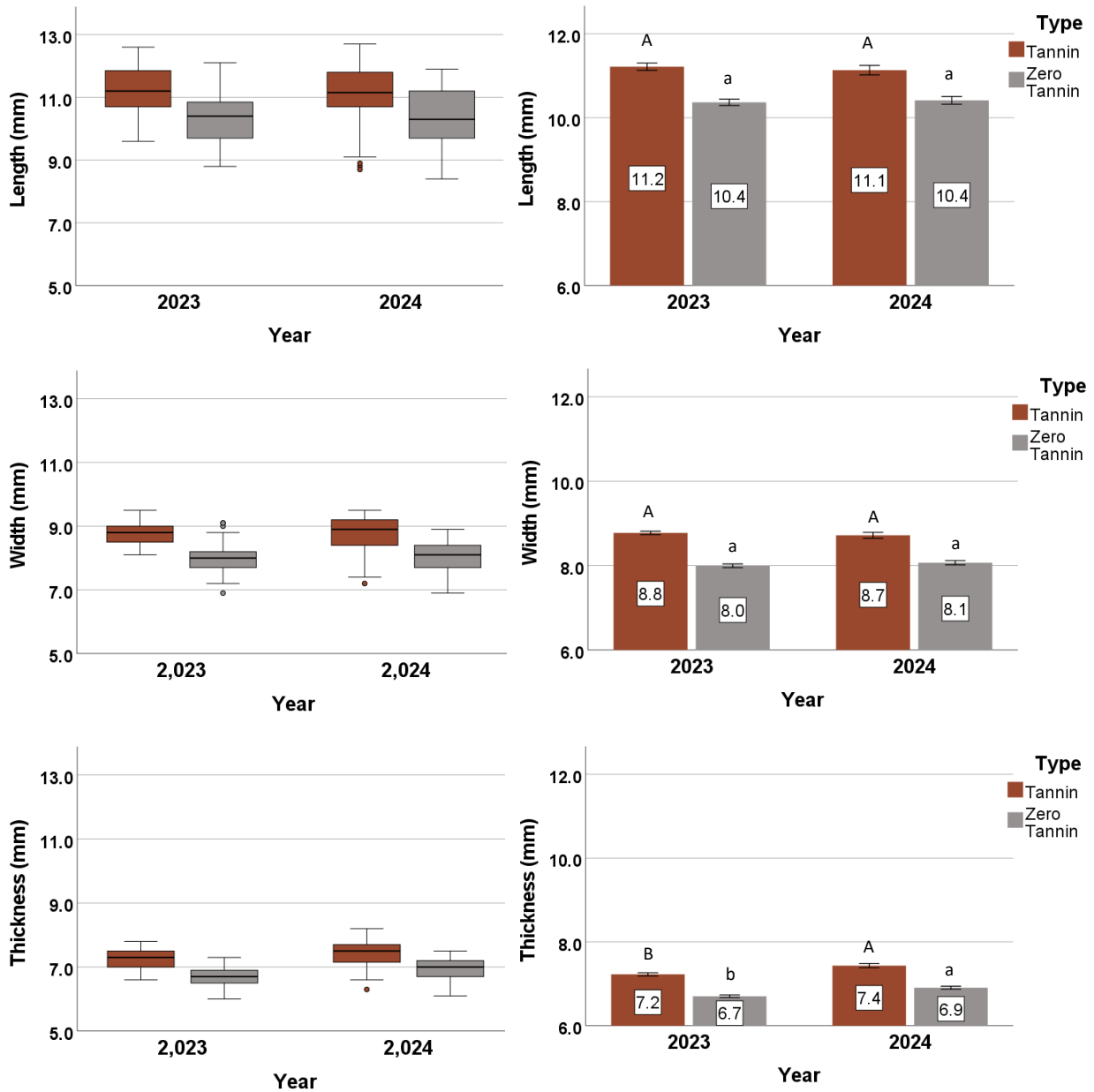
- No difference in TKW between years were observed.

*Note: Small letters indicated significant differences ( $p < 0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p < 0.05$ ) by tannin faba beans.*

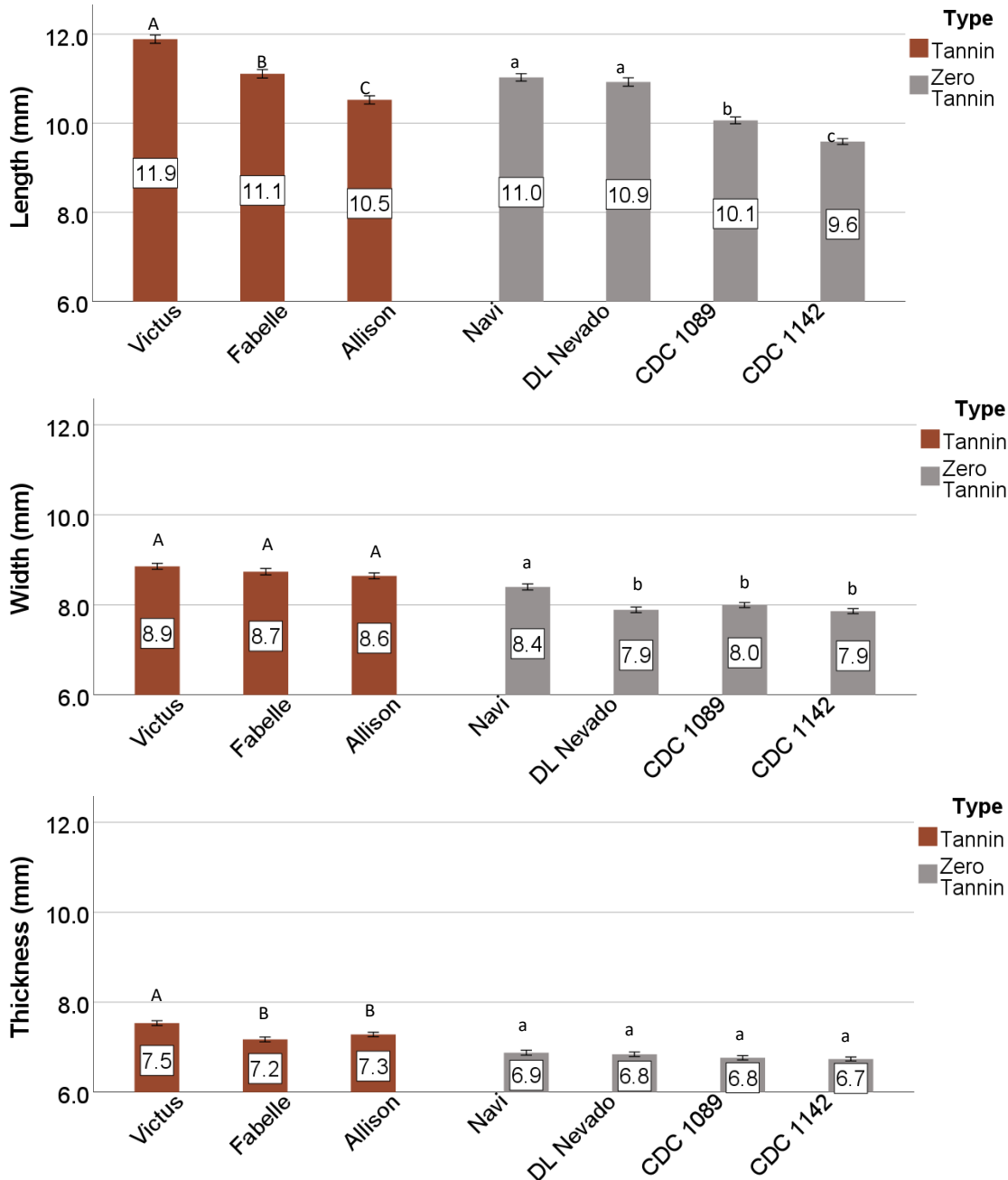
### 3. Seed Size

**Method:** The length, width, and thickness (mm) of the faba bean seed were measured with a caliper. The mean of twenty seeds was reported.

**Results: Figure 3.1.** Box plot (left) and mean (right) length, width, and thickness (mm) of faba beans in 2023 and 2024. Seed size in 2022 was measured using round-hole opening sieves and is thus not reported.



**Figure 3.2.** Mean length (mm), width (mm), thickness (mm) of faba beans based on trials in 2023 and 2024. Each bar represents mean  $\pm$  one standard error.



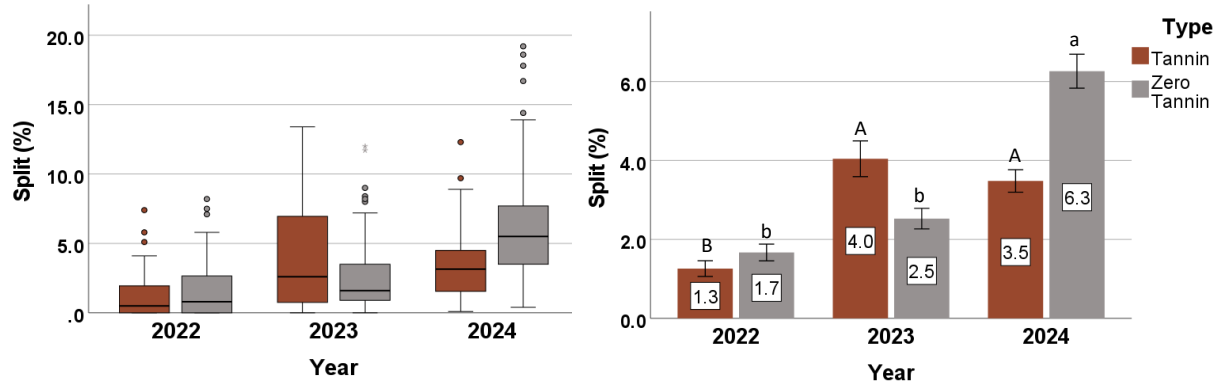
- For tannin type, length ( $r=0.89$ ;  $p<0.01$ ), width ( $r=0.87$ ;  $p<0.01$ ), and thickness ( $r=0.81$ ;  $p<0.01$ ) were positively correlated with TKW (Table B1).
- For zero tannin type, length ( $r=0.85$ ;  $p<0.01$ ), width ( $r=0.83$ ;  $p<0.01$ ), and thickness ( $r=0.75$ ;  $p<0.01$ ) were positively correlated with TKW (Table B2).

Note: Small letters indicated significant differences ( $p<0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p<0.05$ ) by tannin faba beans.

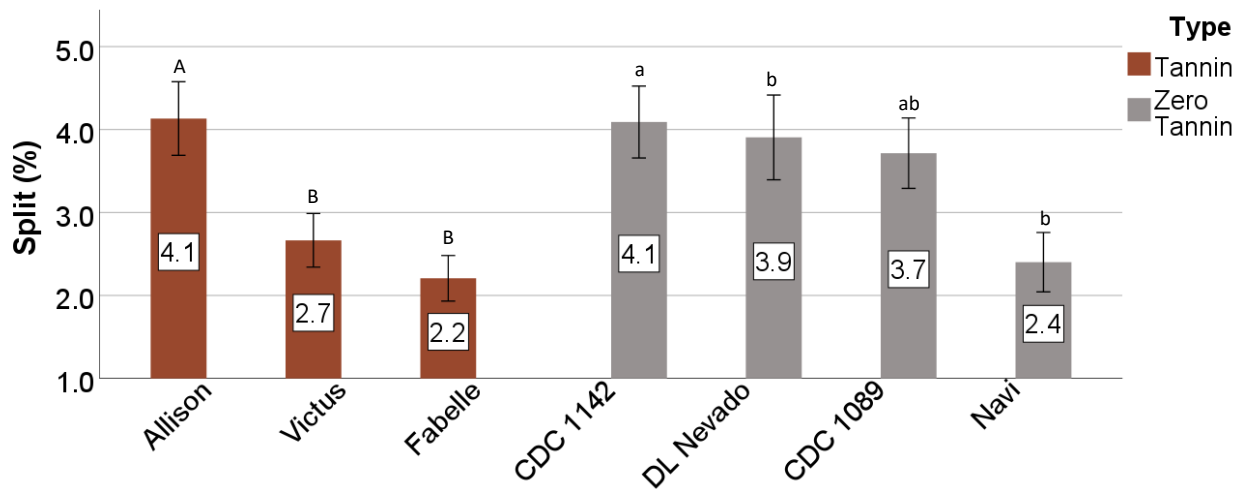
#### 4. Split

**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 (right) of faba beans for split in 2022, 2023, and 2024.



**Figure 4.2.** Mean split of each faba bean variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



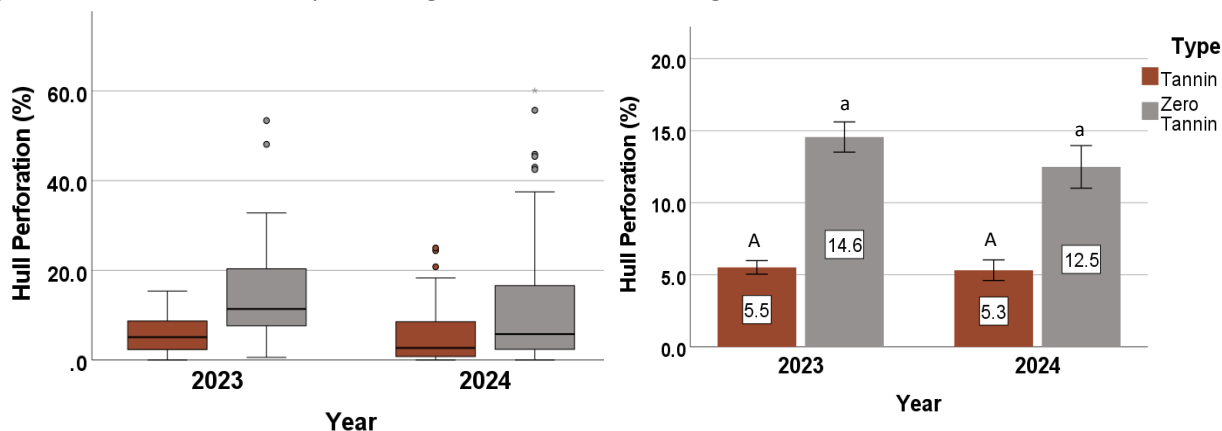
- Victus, Fabelle, and Navi had the lowest split amounts over the three years.

*Note: Small letters indicated significant differences ( $p < 0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p < 0.05$ ) by tannin faba beans.*

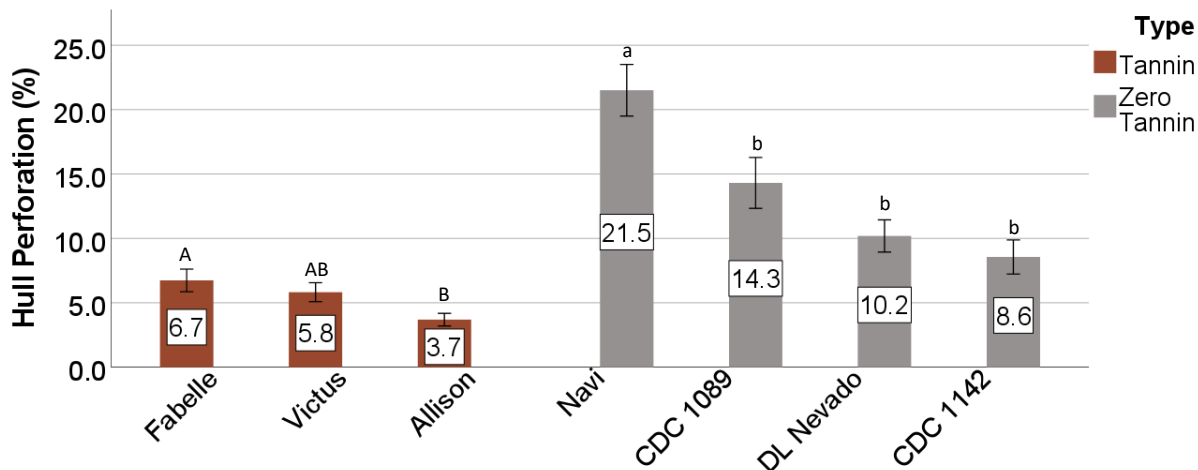
## 5. Hull perforation

**Method:** 100 grams of each sample was used for evaluation, and seeds with hull perforation due to disease or insects were selected by hand.

**Results: Figure 5.1.** Box plots (left) and mean (right) hull perforation of faba beans in 2023 and 2024. Hull perforation in 2022 was reported together with other damage and is thus not included in this section.



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



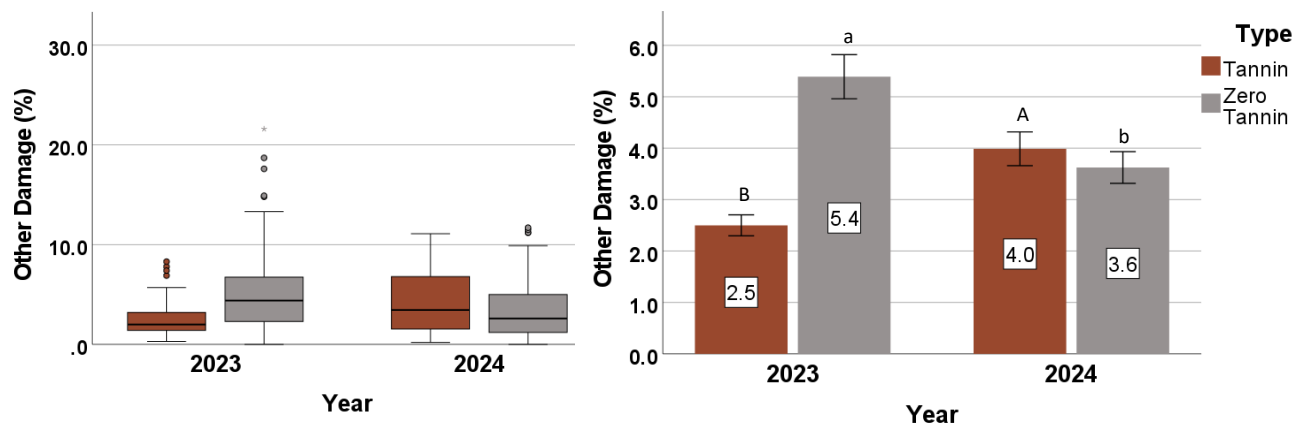
- The zero tannin type exhibited greater hull perforation damage.
- Hull perforation was negatively correlated with yield ( $r=-0.43$  for tannin,  $r=-0.37$  for zero tannin;  $p<0.01$ ) (Table B1& 2).

*Note: Small letters indicated significant differences ( $p<0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p<0.05$ ) by tannin faba beans.*

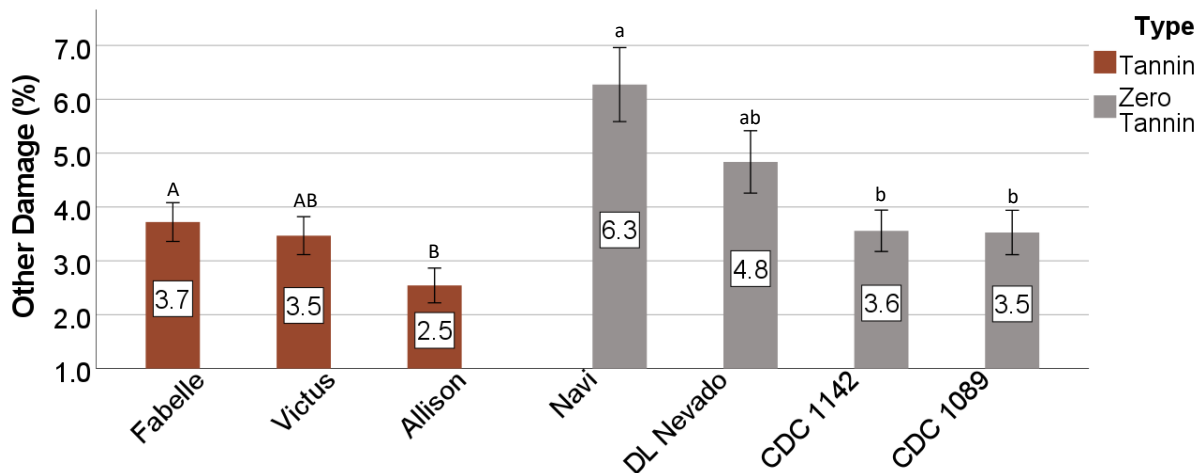
## 6. Other Damage

**Method:** 100 grams of each sample was used for evaluation, and damaged seeds were selected by hand. Other damage included sprouting, distinct immaturity, distinct deterioration or discolouration by weather or disease, insect damage, heat damage, and any other damage that affects appearance.

**Results: Figure 6.1.** Box plots (left) and mean other damage (right) of peas in 2023 and 2024. Other damage in 2022 also included the hull perforation data and is thus not reported in this section.



**Figure 6.2.** Mean other damage of each faba bean variety based on trials from 2023 to 2024. Each bar represents mean  $\pm$  one standard error.

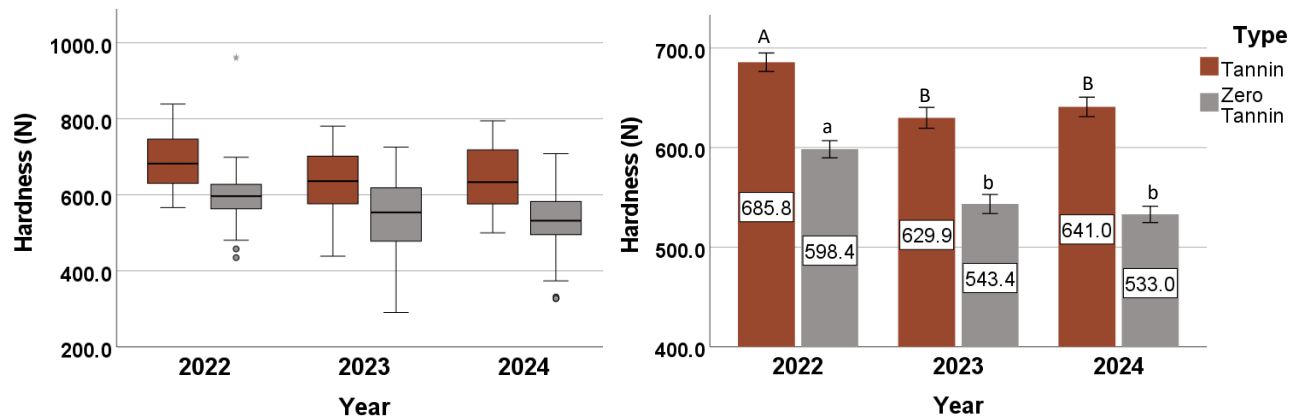


*Note: Small letters indicated significant differences ( $p < 0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p < 0.05$ ) by tannin faba beans.*

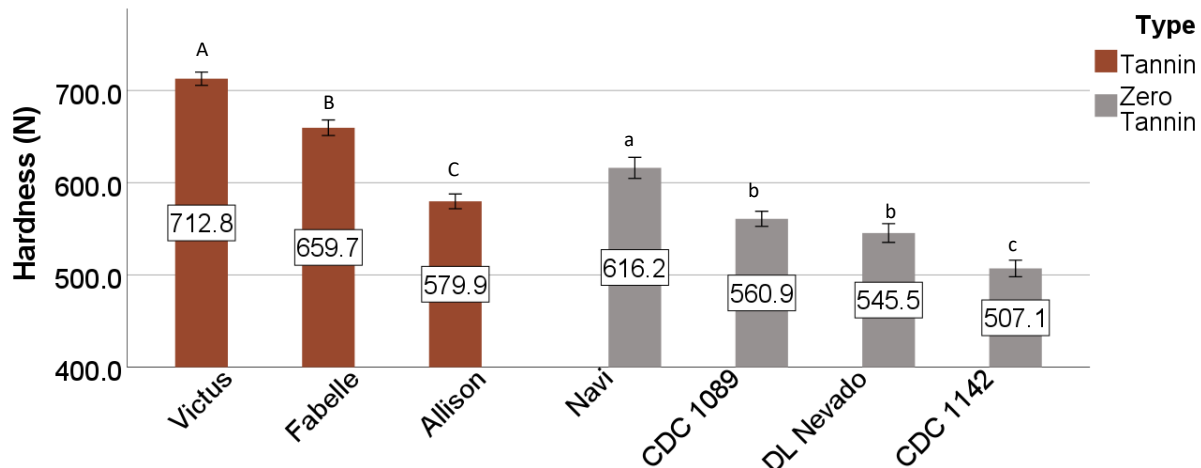
## 7. Hardness of Whole Seed

**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).

**Results: Figure 7.1.** Box plot (left) and mean (right) of faba bean hardness in 2022, 2023, and 2024.



**Figure 7.2.** Mean hardness of each faba bean variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



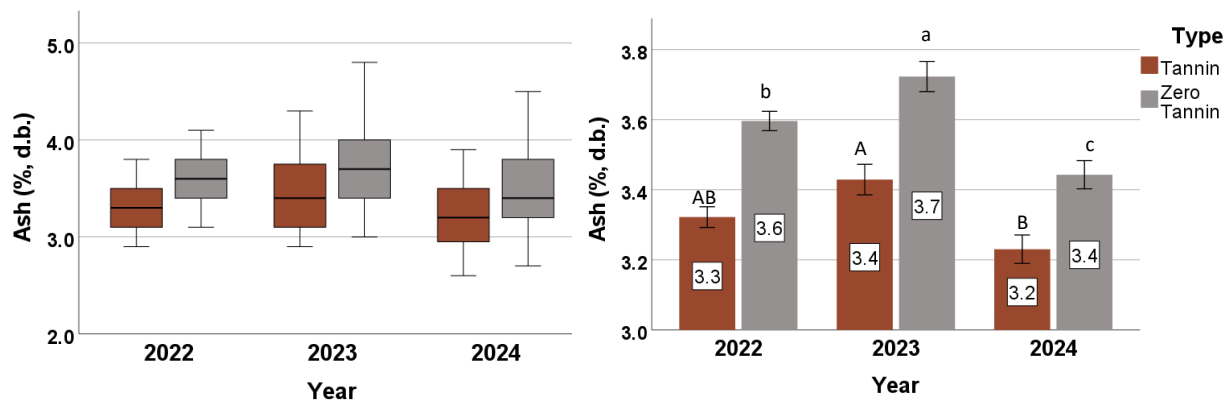
- For tannin type, hardness was positively correlated with TKW ( $r=0.54$ ;  $p<0.01$ ), length( $r=0.67$ ;  $p<0.01$ ), width( $r=0.42$ ;  $p<0.01$ ), thickness ( $r=0.38$ ;  $p<0.01$ ), and protein ( $r=0.32$ ;  $p<0.01$ ) (**Table B1**).
- For zero tannin type, hardness was positively correlated with TKW ( $r=0.34$ ;  $p<0.01$ ), length( $r=0.45$ ;  $p<0.01$ ), width( $r=0.46$ ;  $p<0.01$ ), and ash ( $r=0.24$ ;  $p<0.01$ ) (**Table B2**).

*Note: Small letters indicated significant differences ( $p<0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p<0.05$ ) by tannin faba beans.*

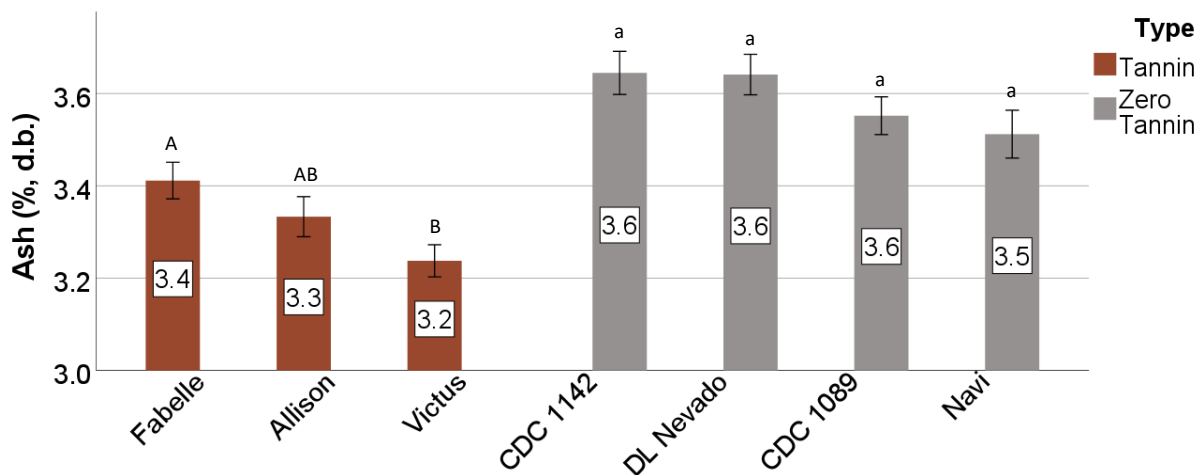
## 8. Ash Content

**Method:** Ash content (%) was determined using AACC 08-01.01<sup>1</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 8.1.** Box plot (left) and mean ash contents (right) of faba beans in 2022, 2023 and 2024.



**Figure 8.2.** Mean ash content of each faba bean variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



- The zero tannin type had a higher ash content than the tannin type.

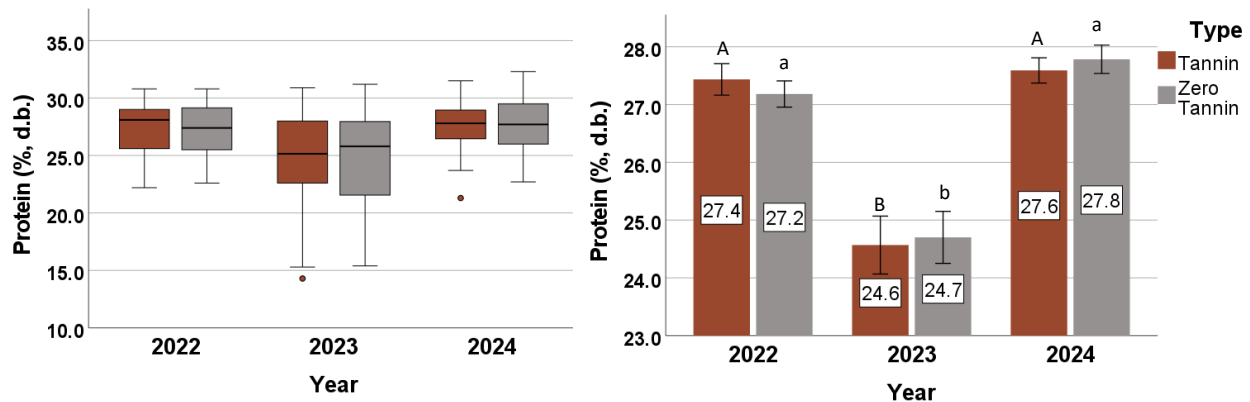
*Note: Small letters indicated significant differences ( $p < 0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p < 0.05$ ) by tannin faba beans.*

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

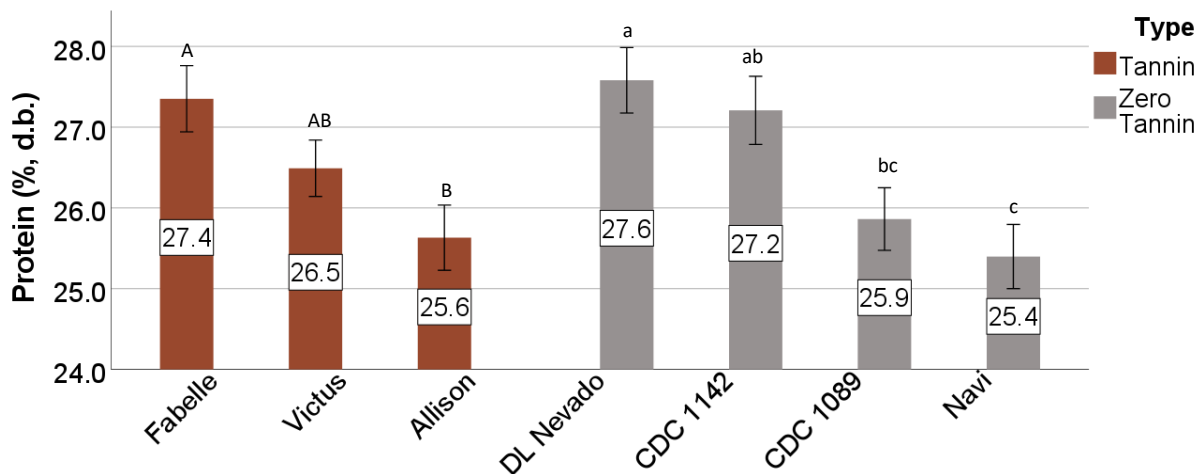
## 9. Protein Content

**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 9.1.** Box plot (left) and mean proteins (right) of faba bean in 2022, 2023 and 2024.



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



- Protein content in 2023 was significantly lower than in 2022 and 2024.
- Protein was negatively correlated with ash ( $r=-0.49$  for tannin;  $r=-0.57$  for zero tannin  $p<0.01$ ) (Table B1&2).

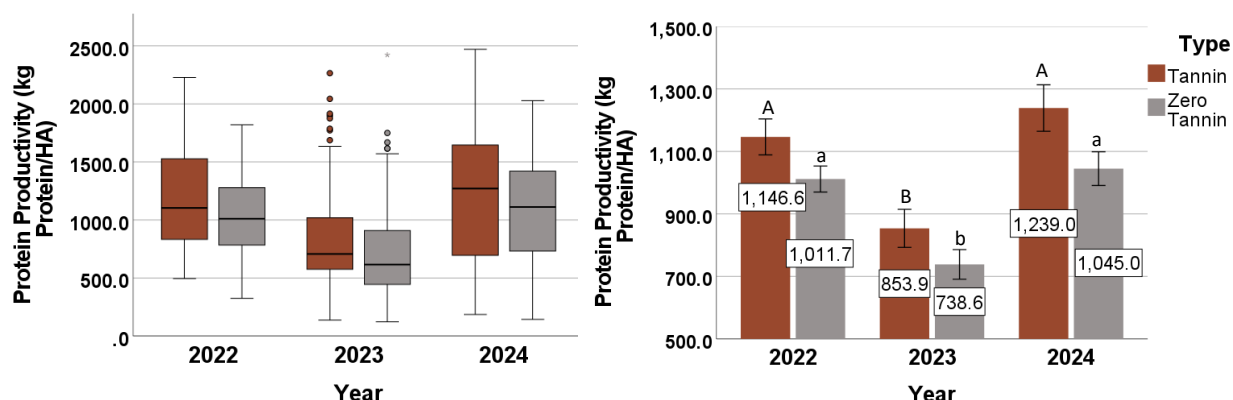
Note: Small letters indicated significant differences ( $p<0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p<0.05$ ) by tannin faba beans.

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

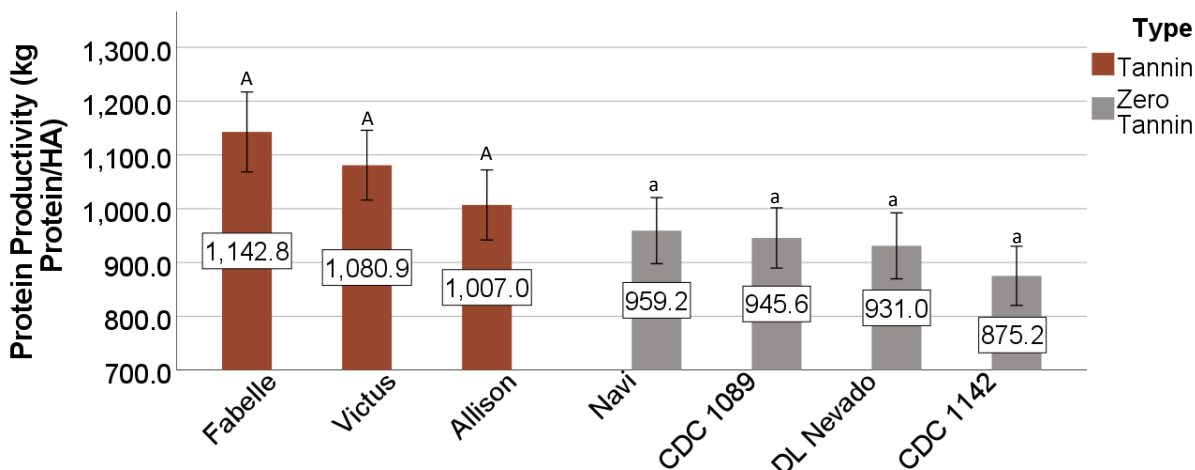
## 10. Protein Productivity

**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 10.1.** Box plot (left) and mean protein productivity (right) of faba beans in 2022, 2023 and 2024.



**Figure 10.2.** Mean protein productivity content of each faba bean variety from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



- Protein productivity in 2023 was significantly lower due to lower yield ( $r=0.99$  for tannin;  $r=0.98$  for zero tannin;  $p<0.01$ ).
- Protein productivity was positively correlated with protein content ( $r=0.38$  for tannin;  $r=0.29$  for zero tannin;  $p<0.01$ ) (Table B1&2).

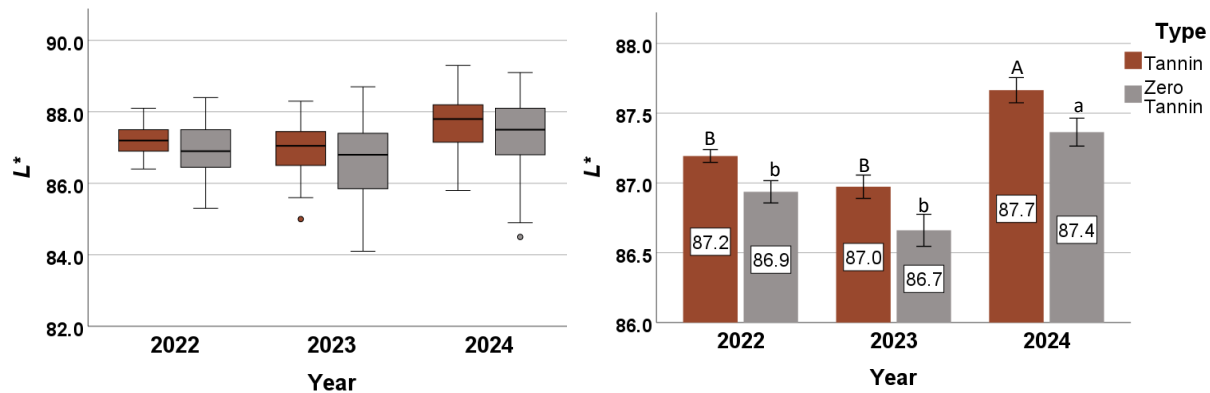
*Note: Small letters indicated significant differences ( $p<0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p<0.05$ ) by tannin faba beans.*

## 11. Colour

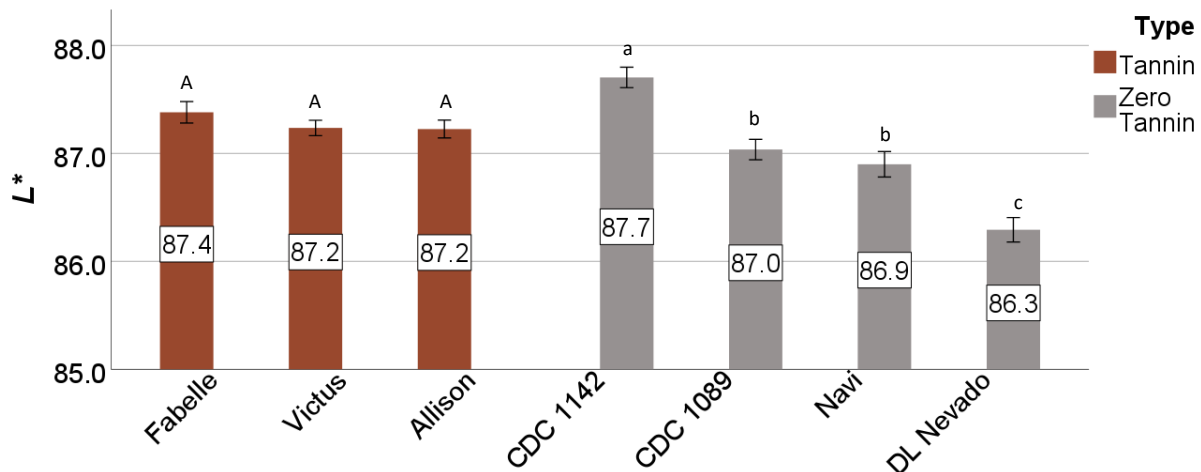
**Method:** The absolute colour of each flour was determined using the Konica Minolta CR-400 Chroma meter, where  $L^*$ ,  $a^*$ , and  $b^*$  values were reported.

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

**Results: Figure 11.1.** Box plot (left) and mean  $L^*$  (right) of faba beans in 2022, 2023 and 2024.



**Figure 11.2.** Mean  $L^*$  values of each faba bean variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error

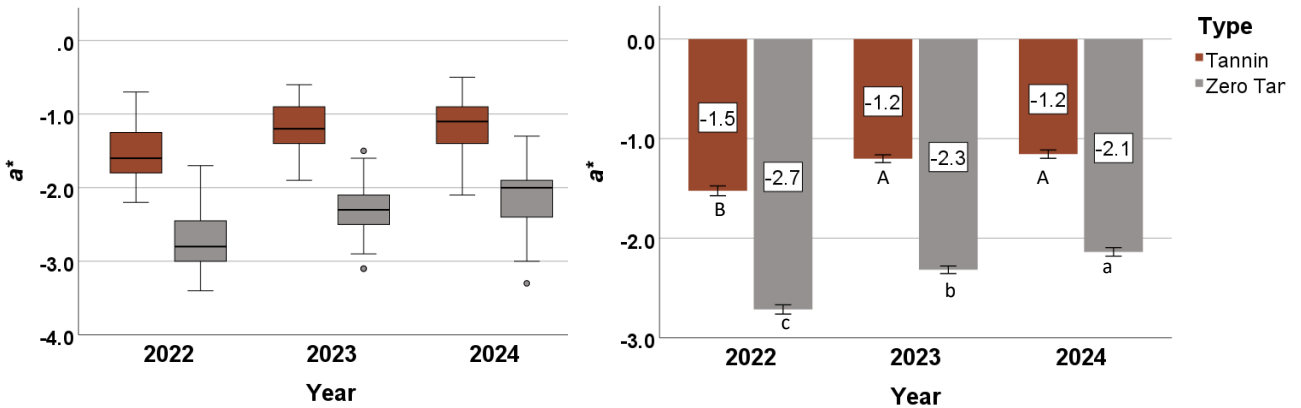


- $L^*$  was negatively correlated with hull perforation ( $r=-0.48$  for tannin;  $r=-0.38$  for zero tannin;  $p<0.01$ ), moisture ( $r=-0.46$  for tannin;  $r=-0.33$  for zero tannin;  $p<0.01$ ), and ash ( $r=-0.26$  for tannin;  $r=-0.26$  for zero tannin;  $p<0.01$ ).
- $L^*$  was positively correlated with protein content ( $r=0.45$  for tannin;  $r=0.27$  for zero tannin;  $p<0.01$ ) (**Table B1&2**).

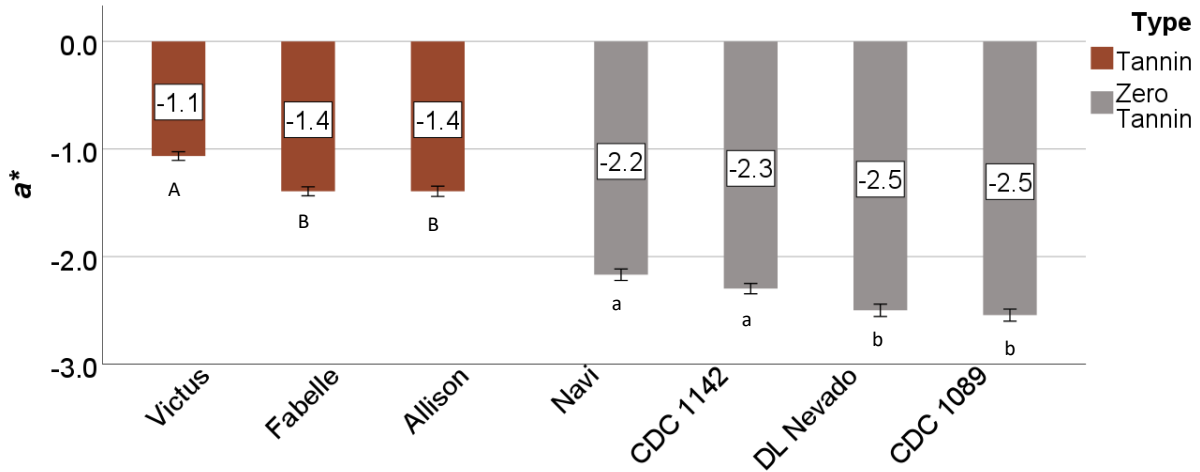
Note: Small letters indicated significant differences ( $p<0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p<0.05$ ) by tannin faba beans.

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

**Figure 11.3.** Box plot (left) and mean  $a^*$  values (right) of faba beans in 2022, 2023 and 2024.



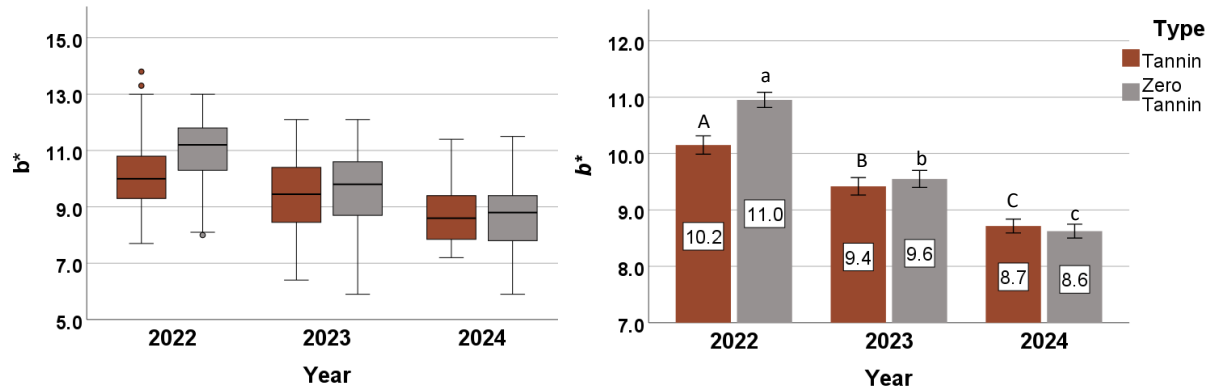
**Figure 11.4.** Mean  $a^*$  values of each faba bean variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



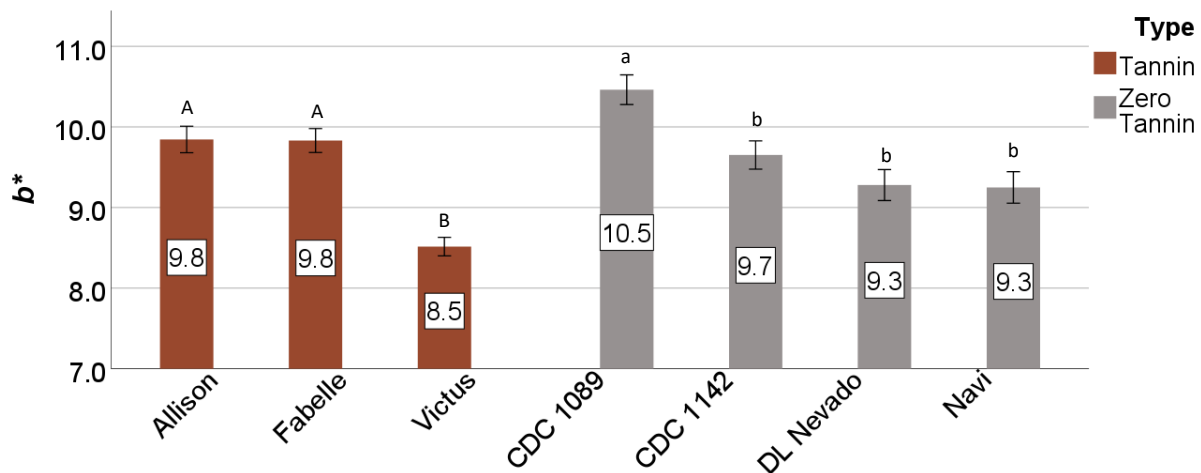
Note: Small letters indicated significant differences ( $p < 0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p < 0.05$ ) by tannin faba beans.

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

**Figure 11.5.** Box plot (left) and mean  $b^*$  values (right) of faba beans in 2022, 2023 and 2024.



**Figure 11.6.** Mean  $b^*$  values of each faba bean variety based on trials from 2022 to 2024. Each bar represents mean  $\pm$  one standard error.



- For tannin type,  $b^*$  were negatively correlated with  $L^*$  ( $r=-0.38$ ;  $p<0.01$ ) and  $a^*$  ( $r=-0.86$ ;  $p<0.01$ ) (**Table B1**).
- For zero tannin type, tannin,  $b^*$  were negatively correlated with  $a^*$  ( $r=-0.87$ ;  $p<0.01$ ) (**Table B2**).

*Note: Small letters indicated significant differences ( $p<0.05$ ) by zero tannin faba beans. Capital letters indicated significant differences ( $p<0.05$ ) by tannin faba beans.*

**Table B1.** Correlation coefficients between quality attributes based on **tannin faba bean trials** from 2022 to 2024.

	Yield	TKW	Length	Width	Thickness	Split	Hull Perforation	Other Damage	Hardness	Moisture	Ash	Protein	Protein Productivity	L*	a*	b*
Yield	1															
TKW	.43**	1														
Length	.36**	.89**	1													
Width	.45**	.87**	.79**	1												
Thickness	.53**	.81**	.74**	.83**	1											
Split	-.33**	NS	NS	NS	NS	1										
Hull Perforation	-.43**	-.18*	NS	NS	NS	NS	1									
Other Damage	.21*	NS	NS	NS	NS	NS	NS	1								
Hardness	.19**	.54**	.67**	.42**	.38**	-.35**	NS	NS	1							
Moisture	-.32**	.2*	.2*	.33**	NS	.24**	NS	NS	NS	1						
Ash	-.16*	NS	NS	NS	-.19*	NS	NS	NS	NS	.43**	1					
Protein	.25**	.23**	NS	NS	.31**	-.27**	NS	.28**	.32**	-.45**	-.49**	1				
Protein Productivity	.99**	.45**	.35**	.42**	.53**	-.35**	-.41**	.23**	.22**	-.37**	-.22**	.38**	1			
L*	.57**	.25**	.17*	.24**	.36**	NS	-.48**	.22**	.23**	-.46**	-.26**	.45**	.6**	1		
a*	.29**	.56**	.6**	.47**	.59**	NS	NS	NS	NS	NS	-.2**	NS	.29**	NS	1	
b*	-.37**	-.56**	-.57**	-.43**	-.66*	NS	NS	-.18*	-.18**	.35**	.38**	-.29**	-.4**	-.38**	-.86**	1

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

**Table B2.** Correlation coefficients between quality attributes based on **zero tannin faba bean trials** from 2022 to 2024.

	Yield	TKW	Length	Width	Thickness	Split	Hull Perforation	Other Damage	Hardness	Moisture	Ash	Protein	Protein Productivity	L*	a*	b*
Yield	1															
TKW	.44**	1														
Length	.36**	.85**	1													
Width	.48**	.83**	.72**	1												
Thickness	.53**	.75**	.6**	.81**	1											
Split	-.26**	NS	-.15*	NS	.15*	1										
Hull Perforation	-.37**	NS	NS	NS	NS	.16*	1									
Other Damage	NS	.3**	.19**	.16*	NS	NS	NS	1								
Hardness	NS	.35**	.45**	.46**	NS	-.22**	NS	NS	1							
Moisture	-.23**	NS	NS	NS	NS	-.28**	NS	NS	.24**	1						
Ash	-.16*	NS	NS	NS	-.18*	-.19**	NS	NS	.24**	.45**	1					
Protein	.15*	NS	NS	NS	.32**	-.21**	NS	NS	NS	-.38**	-.57**	1				
Protein Productivity	.98**	.42**	.34**	.44**	.53**	-.23**	-.38**	NS	NS	-.28**	-.23**	.29**	1			
L*	.43**	NS	.16*	.19**	.24**	NS	-.38**	NS	NS	-.33**	-.26**	.27**	.45**	1		
a*	.18**	.35**	.28**	.37**	.45**	.15*	NS	NS	-.38**	-.17*	-.28**	NS	.2**	NS	1	
b*	-.12*	-.35**	-.33**	-.26**	-.45*	-.27**	NS	NS	.42**	.5**	.35**	-.29**	-.17**	NS	-.87**	1

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

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