2024 Pulse Quality Evaluation

Faba Bean

Saskatchewan Food Industry Development Centre Inc.
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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.

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2024 Faba Bean Quality

A total of **336** faba bean samples harvested in **2024** were acquired from **eight locations**, including Glaslyn, Goodale, Melfort, Outlook (Irrigation), Redvers, Roblin (MB), St Brieux, and Swan River (MB). Both **tannin-type** (7 varieties) and **zero-tannin type** (7 varieties) were harvested in each location, and three replicates of each variety were cultivated in each location. **Table A** and **Figure A** provide the samples' information and locations in detail.

Figure B provides the cumulative rainfall during the 2024 growing season. Adequate rainfall in May improved topsoil moisture conditions across the province. However, subsequent moisture and cooler temperatures delayed seeding. Seeding progress has been fastest in the southwest and southeast, while the central and northeast regions have experienced slower progress due to higher spring snowfall accumulations. Provincially, seeding is nearly complete by the end of May. In June, cooler temperatures and excessive moisture further delayed overall crop development. By July and early August, reduced precipitation and rising temperatures depleted topsoil moisture reserves in many regions, accelerating crop advancement and maturity. The development of crops in the southern and western regions was further ahead while the central and northern regions fell behind. Harvest began in August and was completed in September, reflecting variable yields across the province. Crop yields vary across the province, with some producers reporting higher-than-expected yields, while others—particularly in areas most affected by heat and drought—are seeing below-average yields.

Table A. Description of 2024 faba bean samples tested for the Pulse Quality Program.

Crop	Type	Variety		Location	Number of samples
Faba bean	Tannin	Allison Fabelle Victus	Dosis Futura Hammer Synergy	Glaslyn Goodale Melfort Outlook (Irrigation) Redvers Roblin, MB St Brieux Swan River, MB	336
	Zero-Tannin	CDC 1089 CDC 1142 DL Nevado Navi	CDC 1310 CDC 2235-2-29 Juno		

Note:

- Seven varieties that existed in 2022, 2023, and 2024, shown as black.
- Three varieties are in both 2023 and 2024, shown as blue.
- Four new varieties entered in 2024, shown in red.

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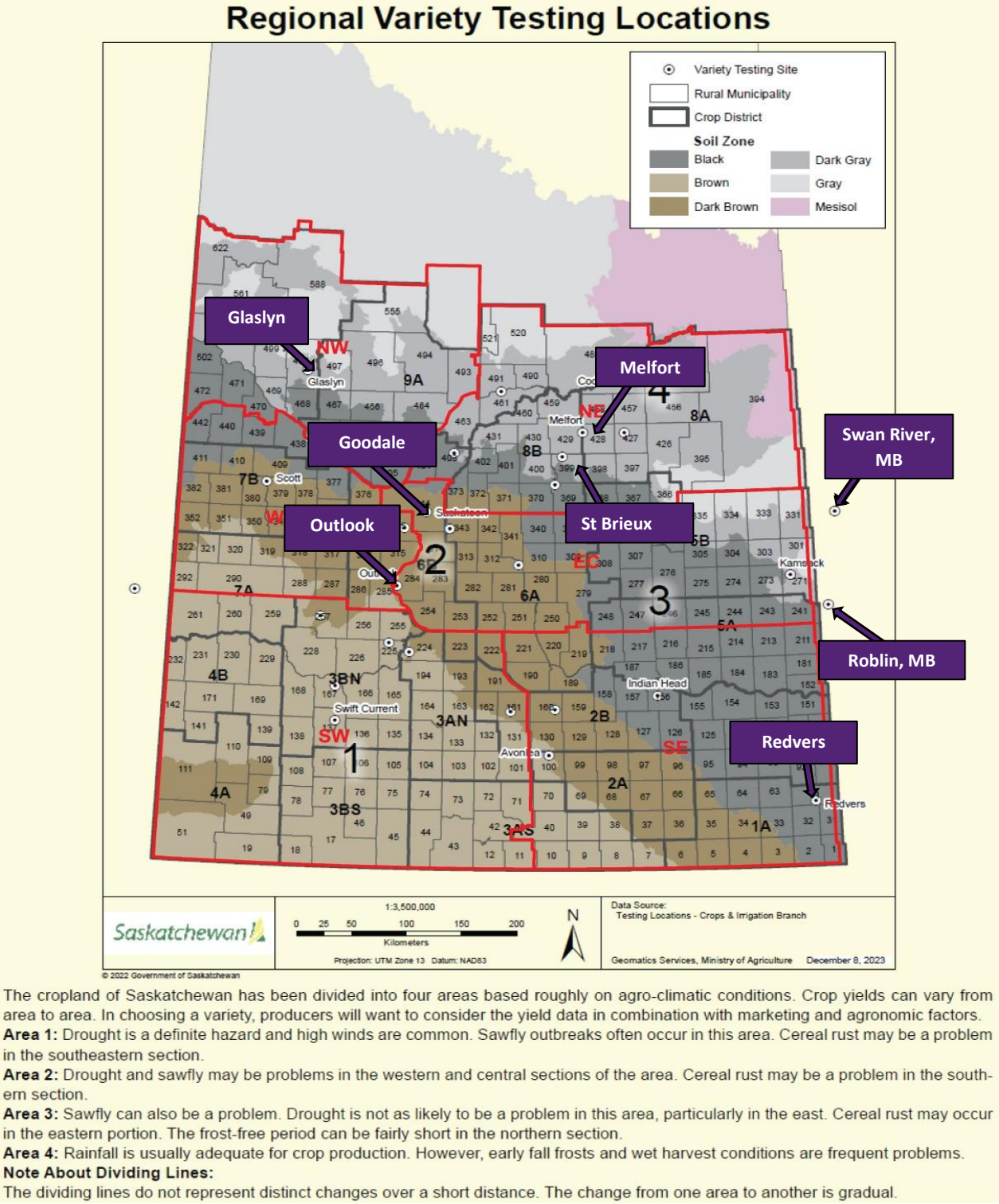

The cropland of Saskatchewan has been divided into four areas based roughly on agro-climatic conditions. Crop yields can vary from area to area. In choosing a variety, producers will want to consider the yield data in combination with marketing and agronomic factors.

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 2024, along with the corresponding soil zones and crop regions. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

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Cumulative Rainfall

from April 1 to September 16, 2024

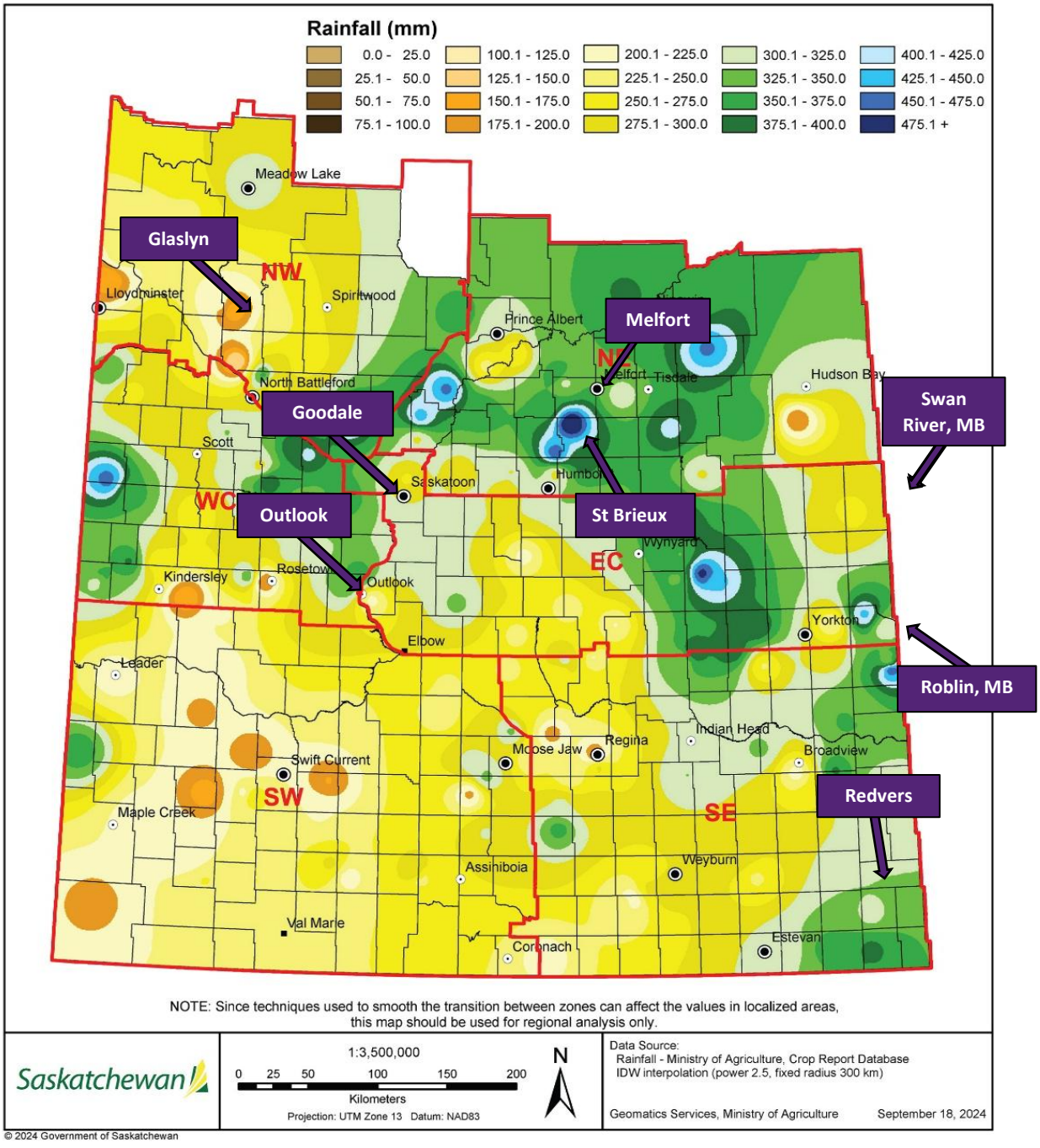


Figure B. Crop regions, locations for faba bean quality testing, and cumulative rainfall from April 1 to September 16, 2024. Figure was modified from material provided by the Saskatchewan Ministry of Agriculture.

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

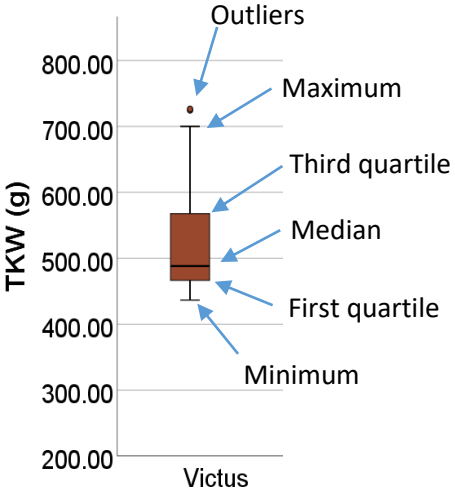
1. Yield
2. Thousand kernel weight (TKW)
3. Seed size: length, width, thickness
4. Split amount
5. Hull perforation due to insects or disease
6. Other damage
7. Hardness of whole seed
8. Ash content
9. Protein content
10. Protein productivity
11. Colour (*L*, a*,* and *b**)

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

For the **results**, a **Box and Whisker** plot is first provided to show the full dataset of each variety, 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).

In addition, a **Bar** graph is included to provide the mean values by variety to show the variety performance and by location to show how the locations differed.

Furthermore, the effects of variety, location, and variety x location on the characteristic are given in a **table**.



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, including yield, TKW, seed size, seed hardness, split, hull perforation, other damage, protein, protein productivity, ash, and colour by variety and by location.

A two-way analysis of variance (ANOVA) was conducted to determine the effects of variety, location, and their interaction on each parameter.

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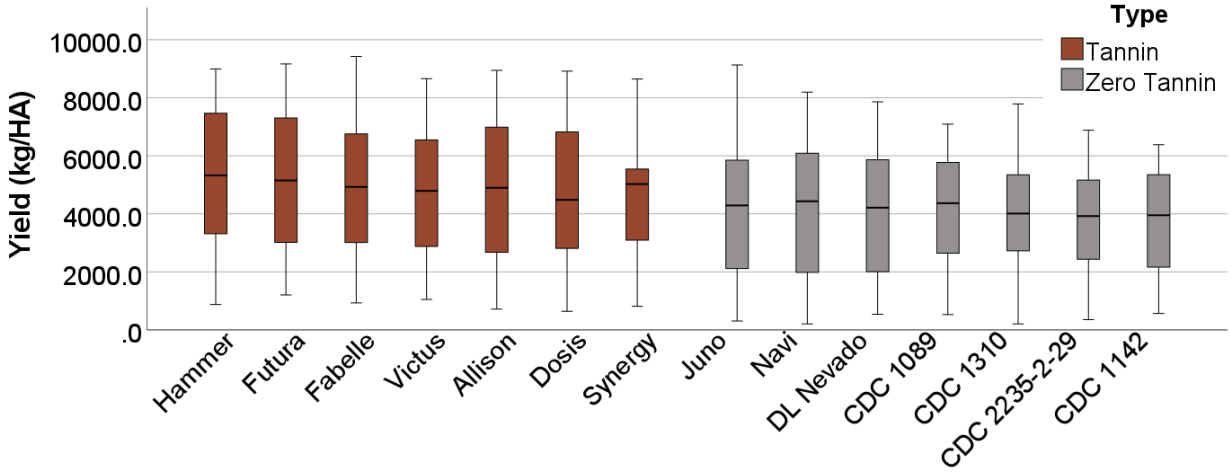
2024 Faba Bean Quality

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 of each variety from each location is provided as kilogram per hectare (kg/HA).

Results: Figure 1.1. Box and Whisker plot of 2024 faba beans for yield. Results by type were reported from highest to lowest.



- High yield viability was observed in all varieties.

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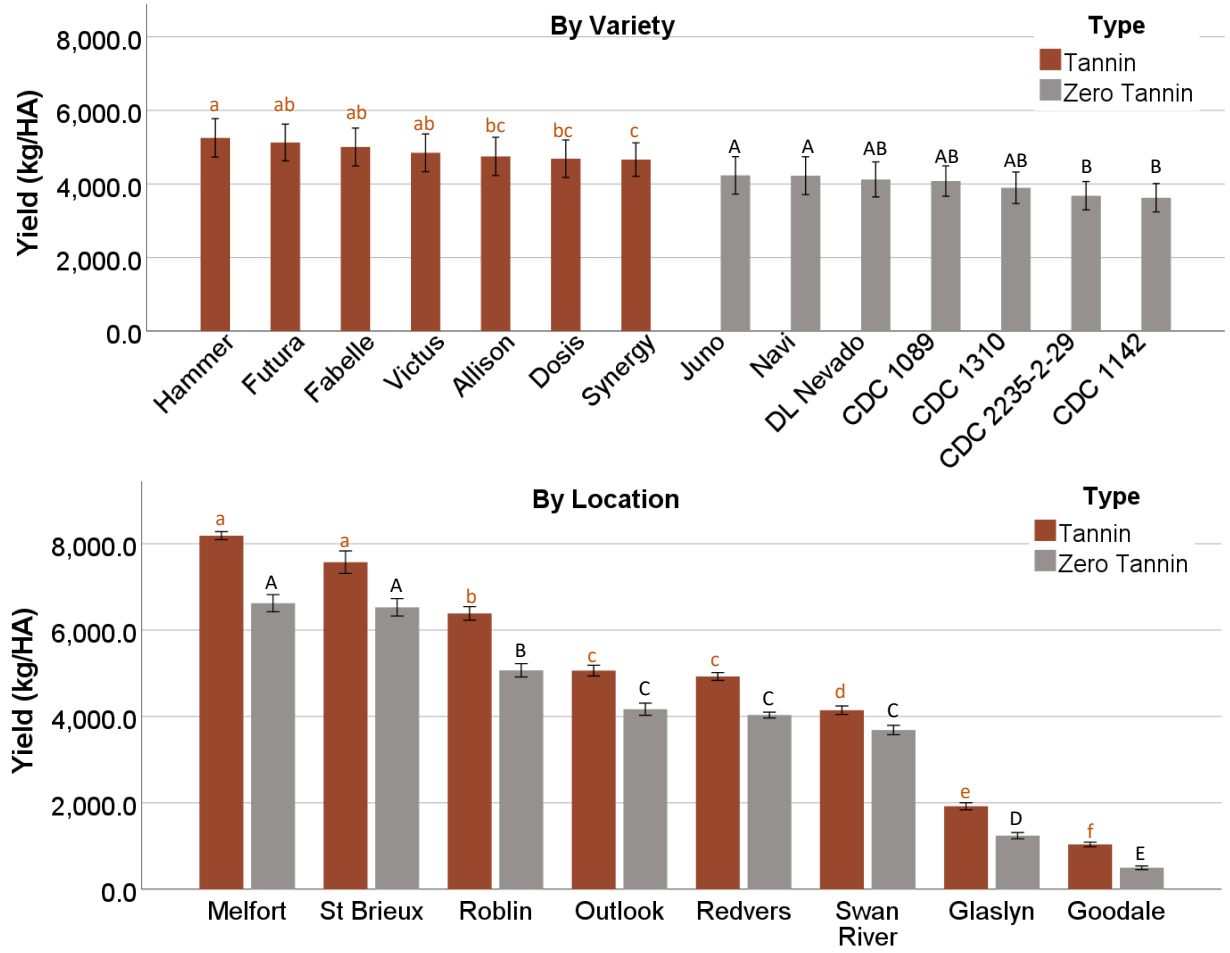
Figure 1.2. Mean yield of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** A difference of 792 kg/HA was found from highest to lowest.
  - **Zero Tannin:** A difference of 1160 kg/HA was found from highest to lowest.

- **By Location:** Yield varied significantly across locations.
  - **Tannin:** A difference of **7150** kg/HA was found from highest to lowest.
  - **Zero Tannin:** A difference of **6068** kg/HA was found from highest to lowest.

Table 1.1. Effects of variety and location in 2024.

	Tannin	Zero-Tannin
Variety	**	***
Location	***	***
Variety x Location	*NS*	**

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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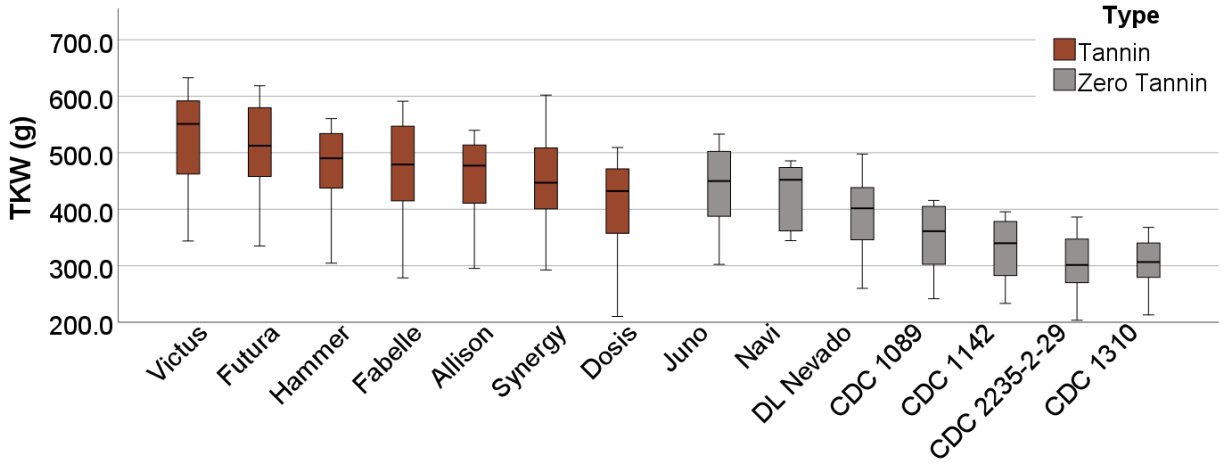
2. Thousand Kernel Weight

Method: Seed weight is an important parameter to indicate seed size and yield production. This test was conducted by weighing 300 seeds with duplicated measurements per sample, and the thousand kernel weight (TKW) was reported.

Results: Figure 2.1. Box and Whisker plot of 2024 faba beans for TKW. Results by type were reported from highest to lowest.



- TKW varied among the varieties.

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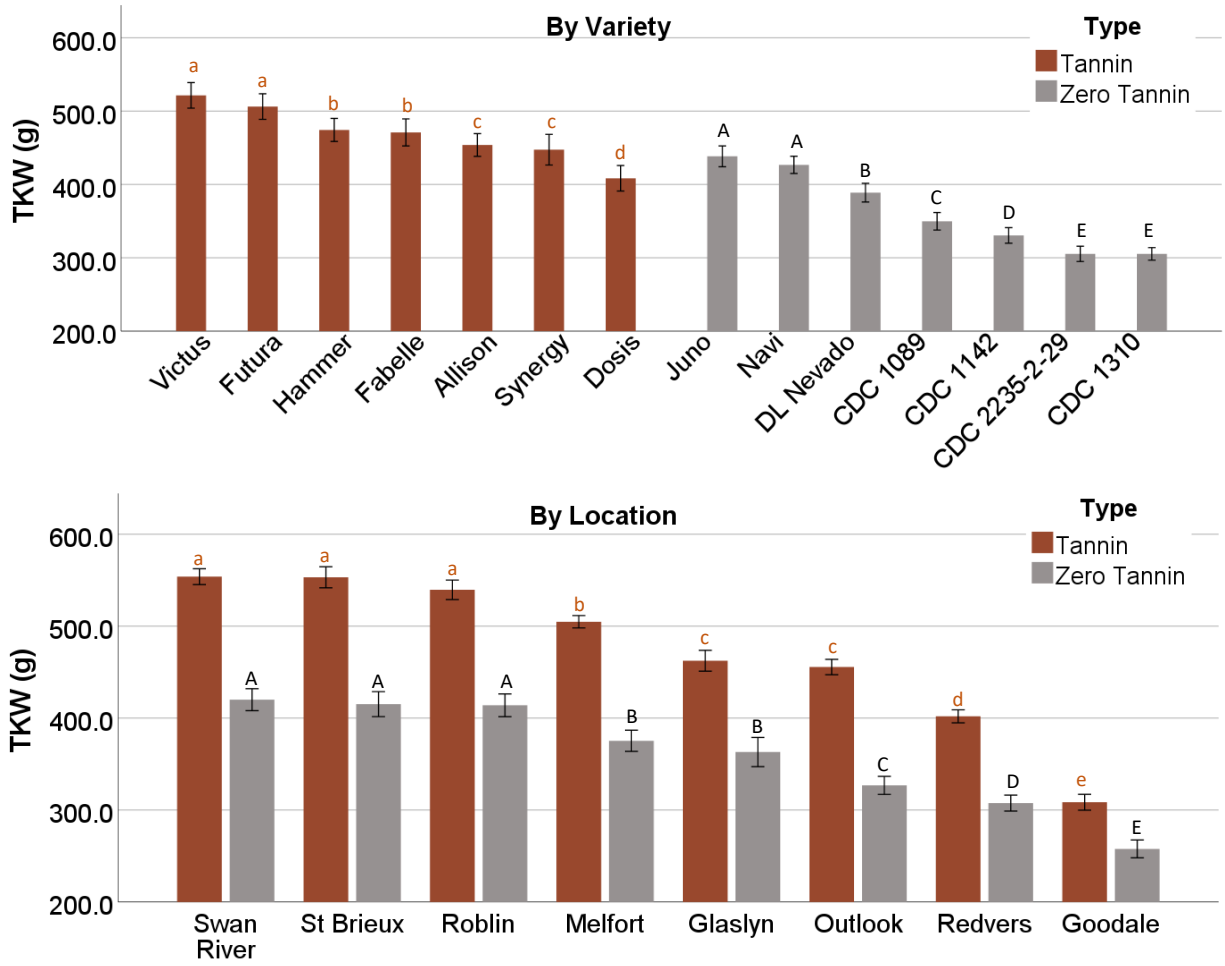
Figure 2.2. Mean TKW of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:** Variety effect played a significant role.
  - **Tannin:** Mean TKW of Victus was 114 g higher (p<0.05) than Dosis.
  - **Zero Tannin:** A difference of over 120g between the largest and the smallest.

- **By Location:** TKW was similar in Swan River, St Brieux, and Roblin (p>0.05). TKW of Goodale was the lowest (p<0.05).

Table 2.1. Effects of variety and location in 2024.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	**	***

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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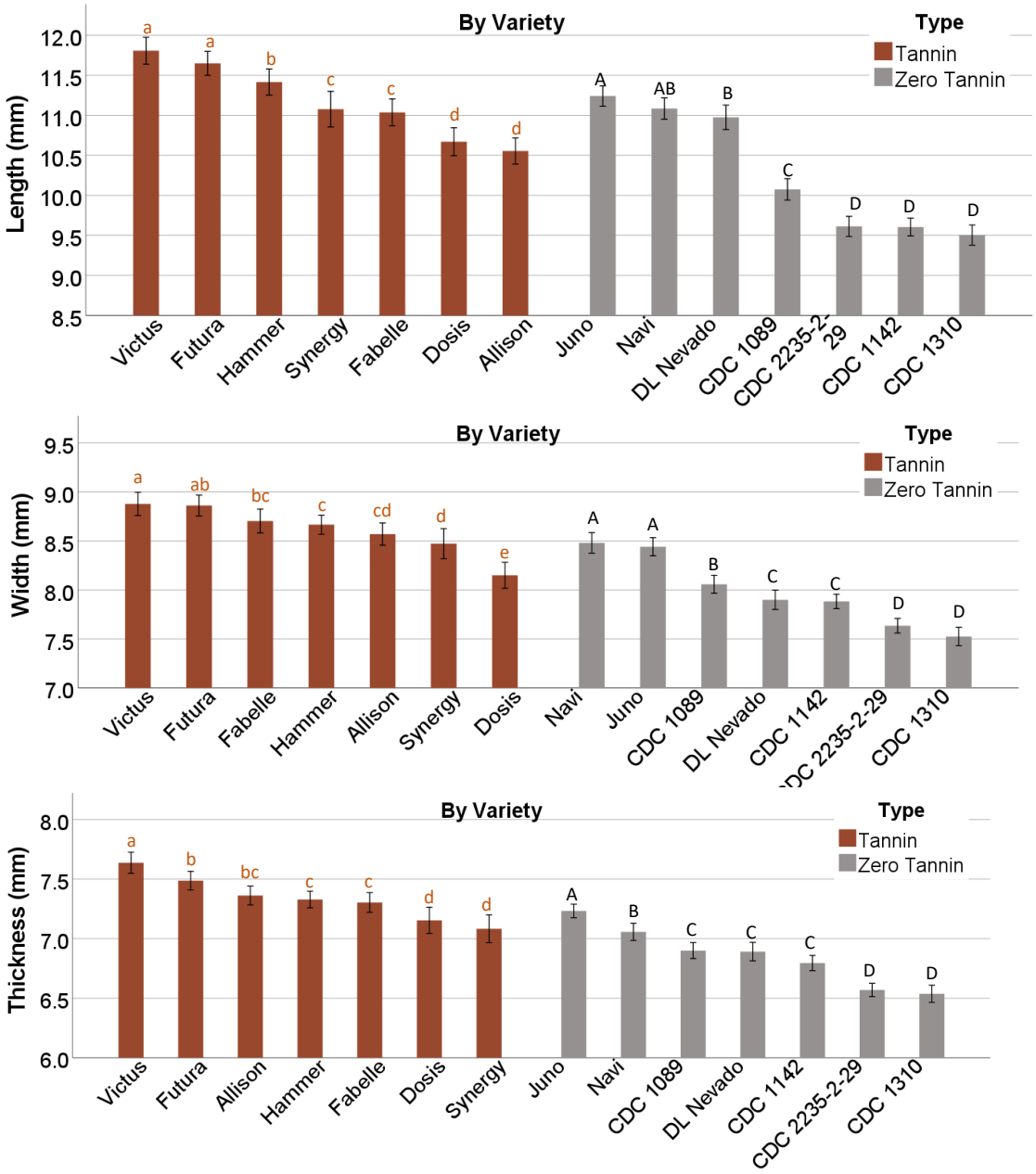
3. Seed Size

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

Figure 3.1. Mean length (mm), width (mm), thickness (mm) of 2024 faba beans by variety.



- Victus had the largest length, width, and thickness, corresponding to the largest TKW. In contrast, CDC 1310 had the smallest length, width, and thickness, contributing to the smallest TKW.

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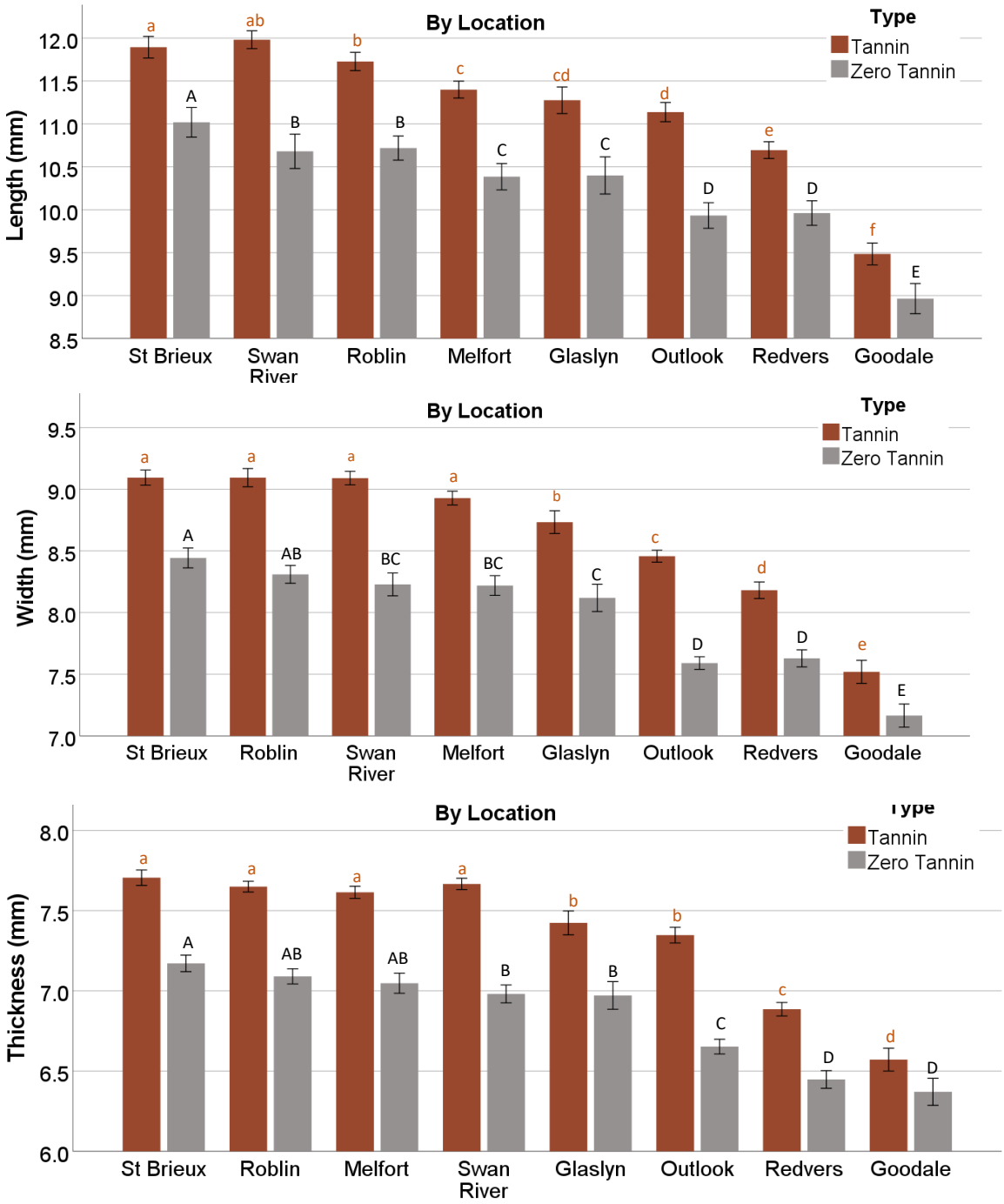
Figure 3.2. Mean length (mm), width (mm), thickness (mm) of 2024 faba beans by location.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- The largest seeds were found in St Brieux and Roblin, while Goodale had the smallest seed size.

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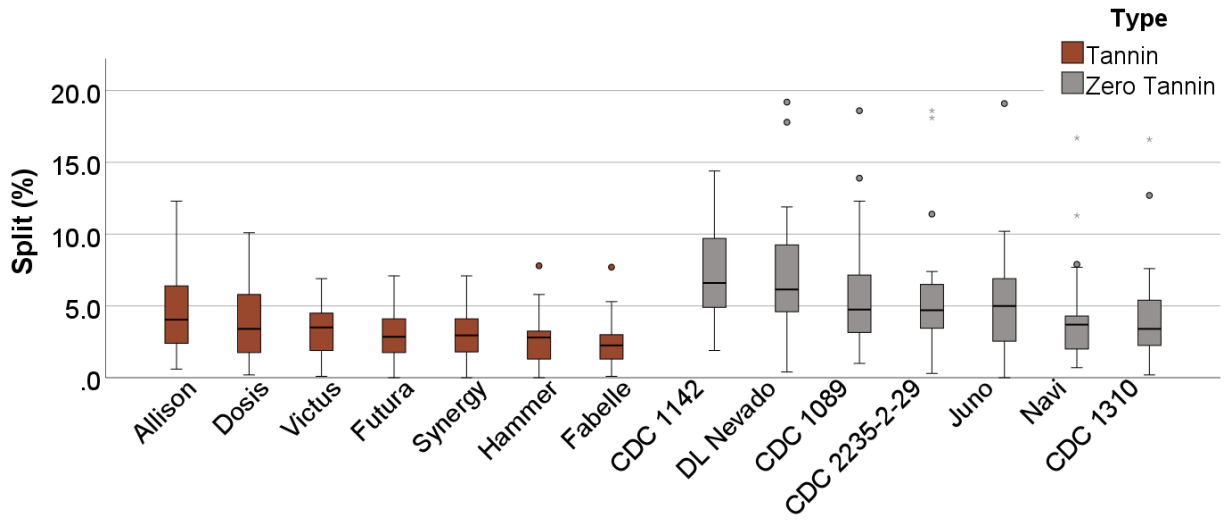
4. Split

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

Results: Figure 4.1. Box and Whisker plot of faba beans for the split in 2024. Results by type were reported from highest to lowest.



- A large variability was observed in all faba beans, especially in the zero tannin type.
- Fabelle and Hammer had the lowest split amounts in all varieties.

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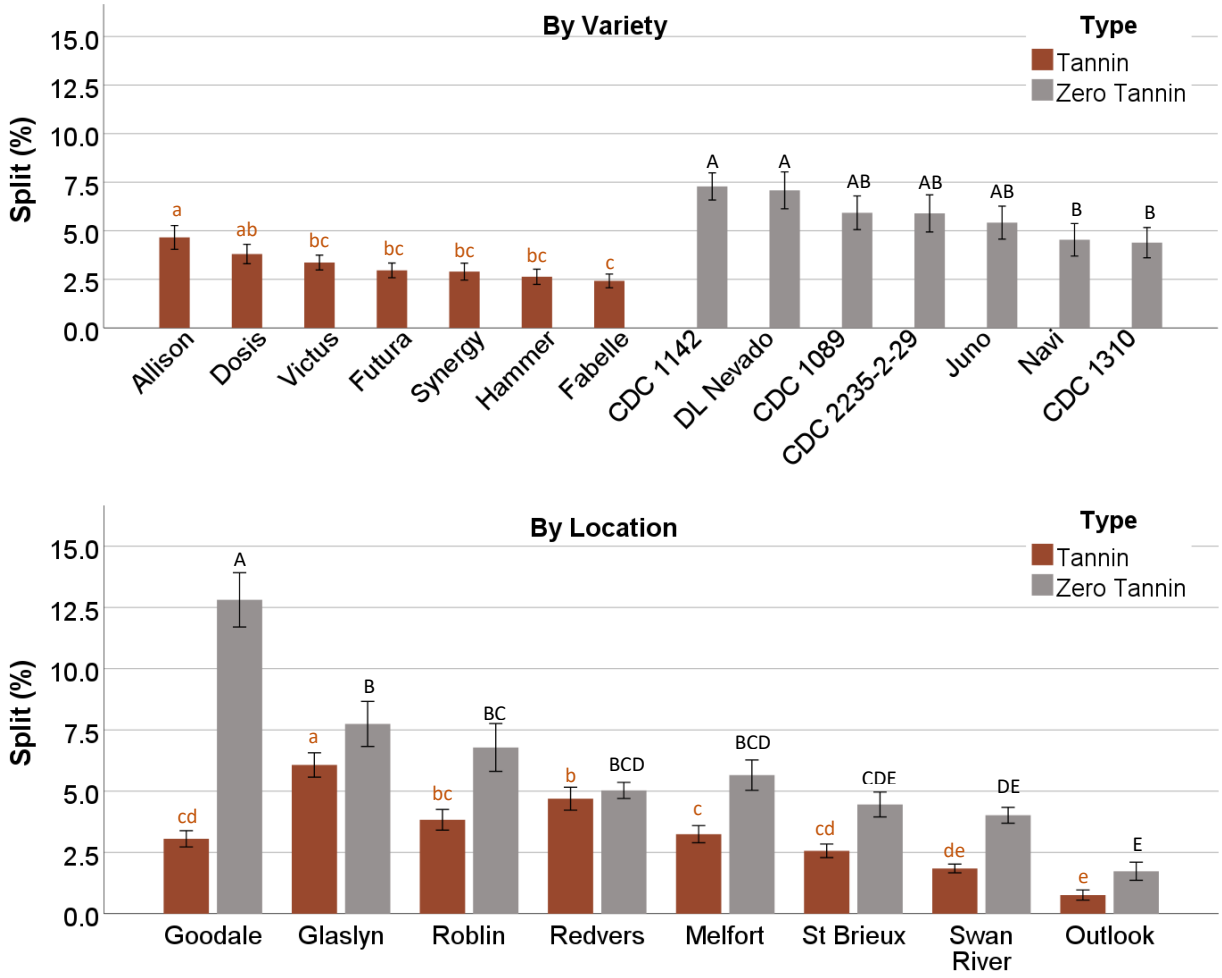
Figure 4.2. Mean split of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:** The tannin type had a lower split amount.
  - **Tannin:** Fabelle was 2.2% lower than Allison.
  - **Zero Tannin:** CDC 1310 and Navi was 1% lower than all others.

- **By Location:** Location effect played an significant role. Split was low (less than 2%) in Outlook for both types. However, it was extremely high (over 12%) in Goodale for zero tannin. Post-harvest processing is an important factor in split amount.

Table 4.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	*
Location	***	***
Variety x Location	*NS*	*NS*

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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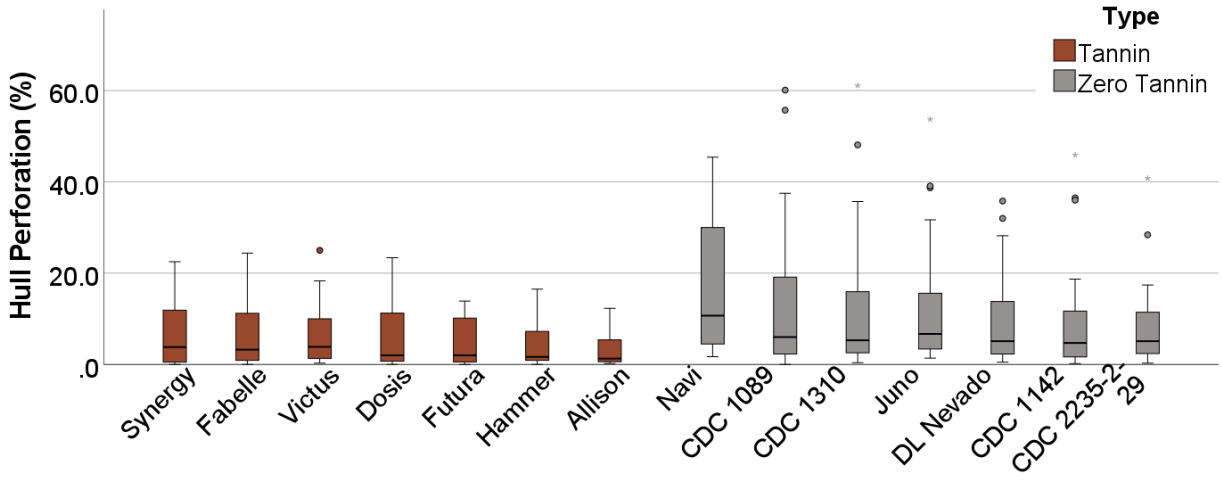
5. Hull Perforation

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 and Whisker plot of faba beans for the hull perforation in 2024. Results by type were reported from highest to lowest.



- Zero-tannin faba beans had a higher rate of hull perforation due to disease or insects.
- Among the tannin types, Allison had the lowest hull perforation.

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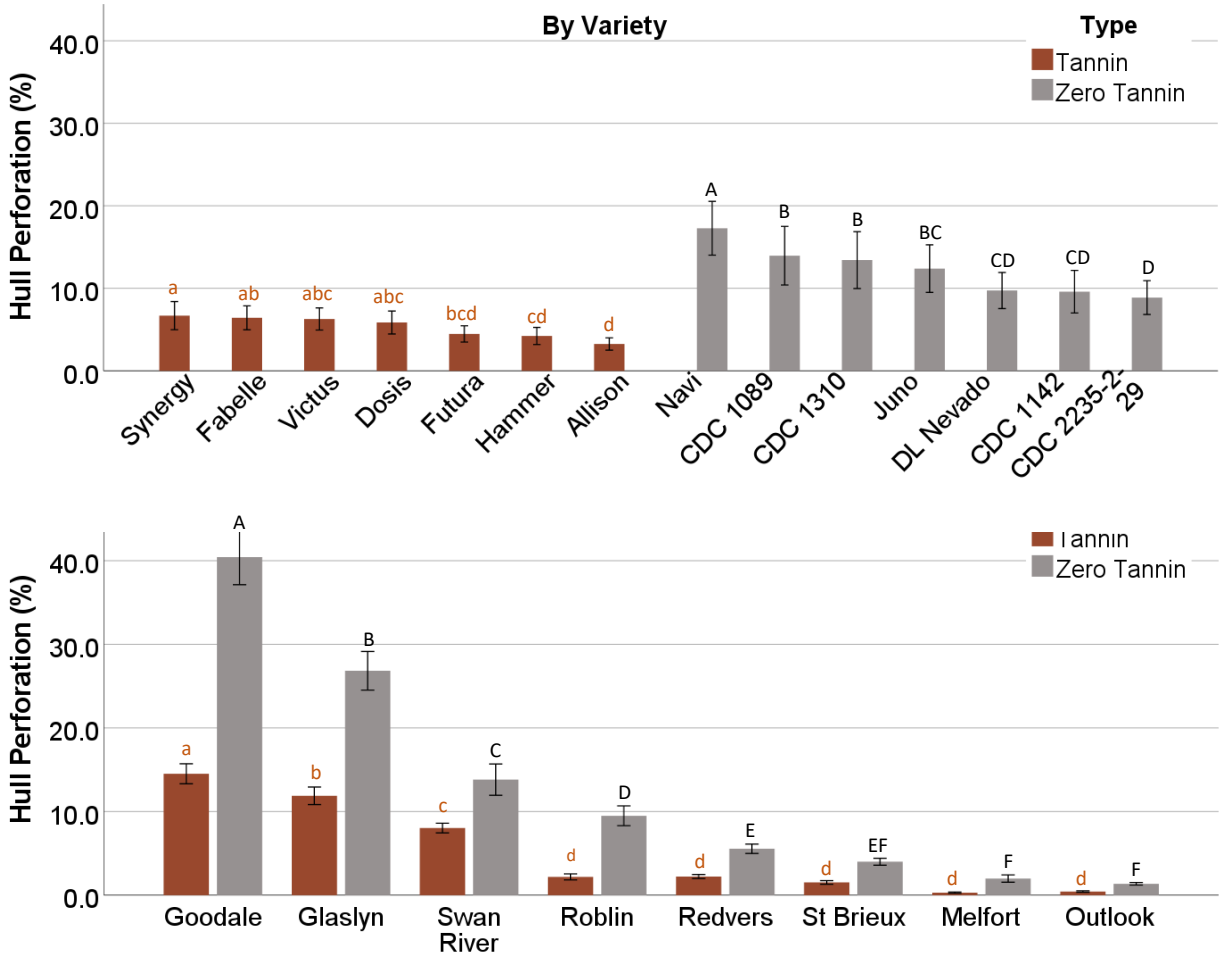
Figure 5.2. Mean hull perforation of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:** Overall, zero tannin is more susceptible to hull perforation due to disease and insects.
  - **Tannin:** A 3.4% difference is observed from highest to lowest.
  - **Zero Tannin:** A 8% difference is observed from highest to lowest.

- **By Location:** Outlook and Melfort had the lowest hull perforation damage.

Table 5.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	**	***

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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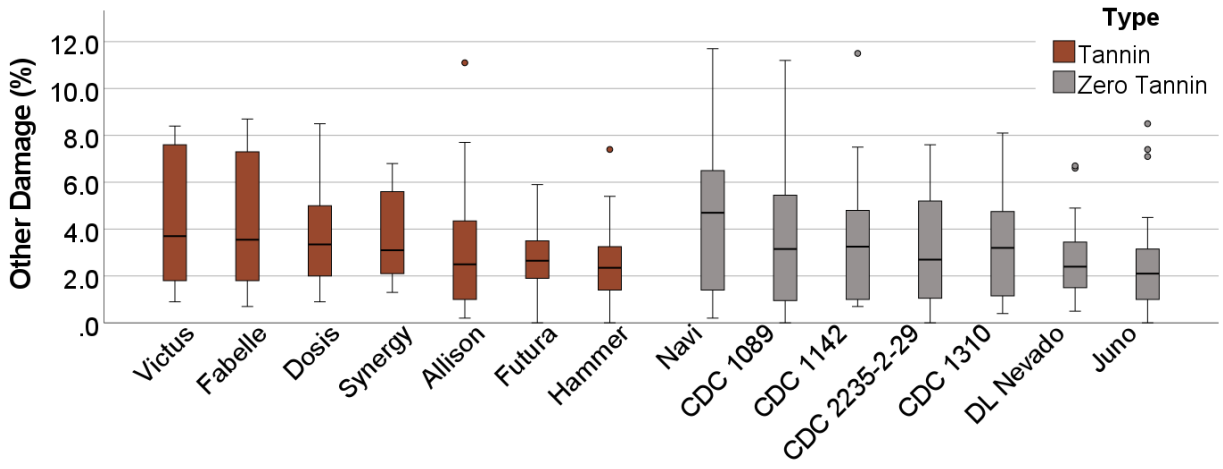
6. Other Damage

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 and Whisker plot of faba beans for other damage in 2024. Results by type were reported from highest to lowest.



- Navi and CDC 1089 had the highest other damage with very large variability.
- Significant heat and water damage was found in Outlook, Roblin, and St Brieux (data not shown).

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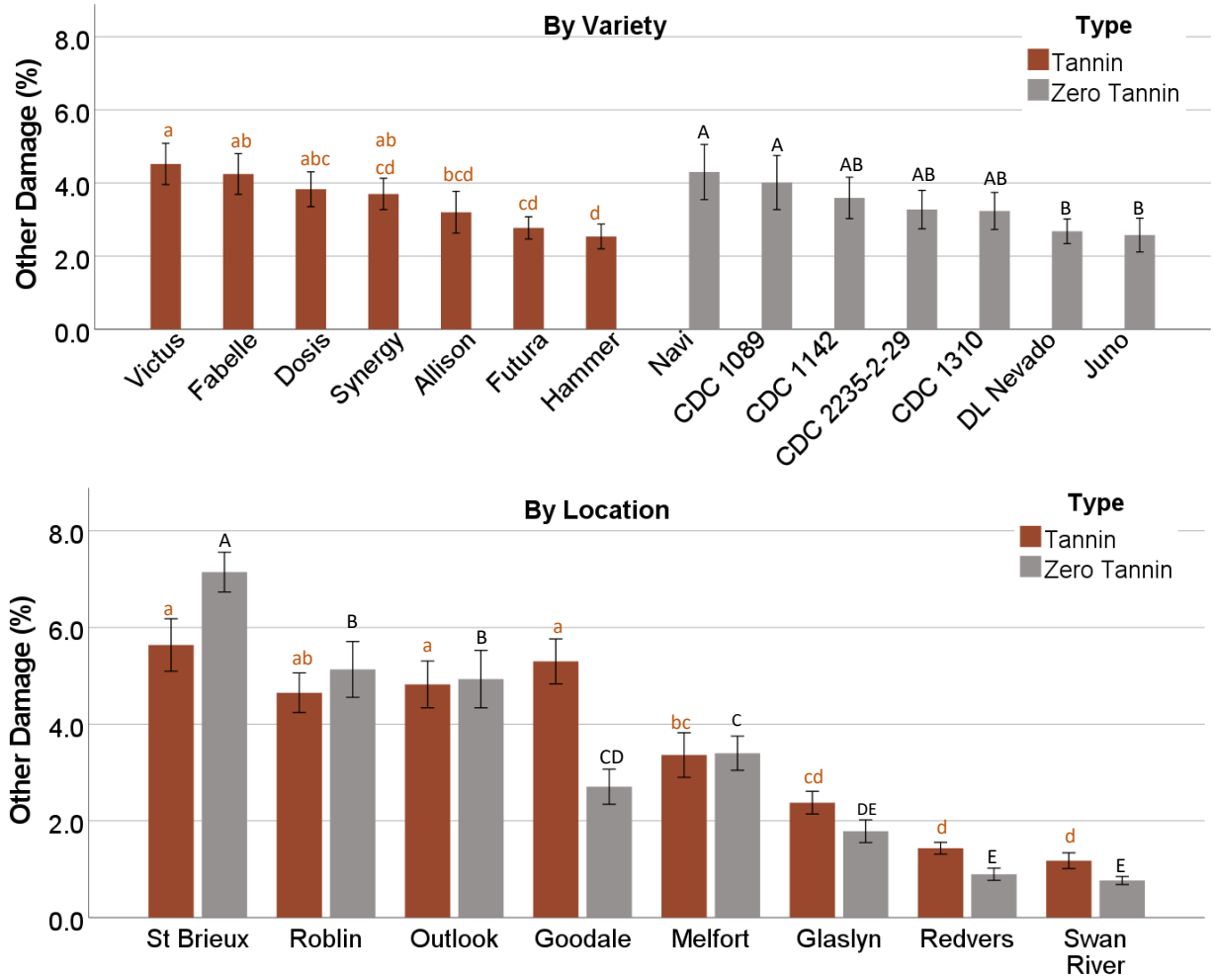
Figure 6.2. Mean other damage of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:** Zero tannin seeds in general had higher other damage than tannin seeds.
  - **Tannin:** A 2% difference is observed from highest to lowest.
  - **Zero Tannin:** A 1.8% difference is observed from highest to lowest.
- **By Location:** Redvers and Swan River had the lowest other damage for both types.

Table 6.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	***	***

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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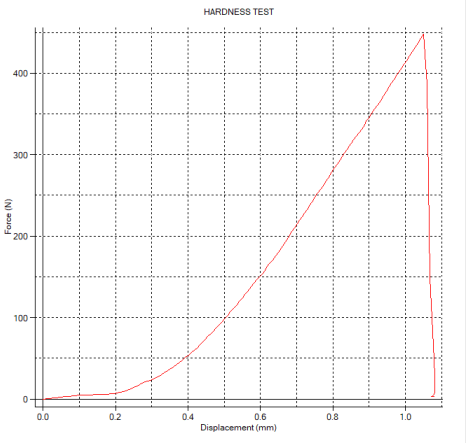
7. Hardness of Whole Seed

Seed hardness is an important parameter to indicate milling yield and cooking quality. Seed hardness is affected by seed size, shape, density, composition, etc.

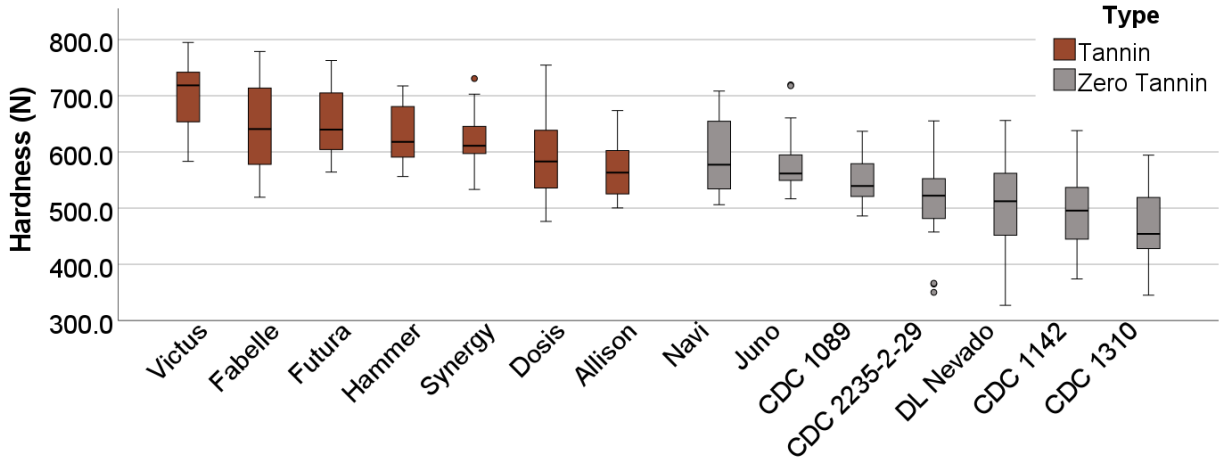


Method:

Seed hardness was determined by measuring the force of breaking a seed using a texture analyzer (TMS-Pro, Food Technology Corporation, USA) equipped with a 2500 N load cell with a modified method from Karami et al. (2017) and Lovas-Kiss (2020)[1].

In brief, a seed was placed under the 10 mm cylinder probe that was lowered with a speed of 50 mm/min. The forces to lower the probe till a seed was broken were monitored. The mean peak force (N) of 10 seeds was reported.

Results: Figure 7.1. Box and Whisker plot of faba beans for seed hardness (N) in 2024. Results by type were reported from highest to lowest.



- For tannin types, Victus had the greatest hardness, while Allison and Dosis had the lowest.
- For zero-tannin types, Navi had the highest hardness.

[1] Karami, S., Sabzalian, M. R., Rahimmalek, M., Saeidi, G., & Ghasemi, S. (2017). Interaction of seed coat color and seed hardness: An effective relationship which can be exploited to enhance resistance to the safflower fly (Acanthiophilus helianthi) in Carthamus spp. Crop Protection, 98, 267-275.

Lovas-Kiss, Á., Vincze, O., Kleyheeg, E., Sramkó, G., Laczkó, L., Fekete, R., ... & Green, A. J. (2020). Seed mass, hardness, and phylogeny explain the potential for endozoochory by granivorous waterbirds. Ecology and Evolution, 10(3), 1413-1424.

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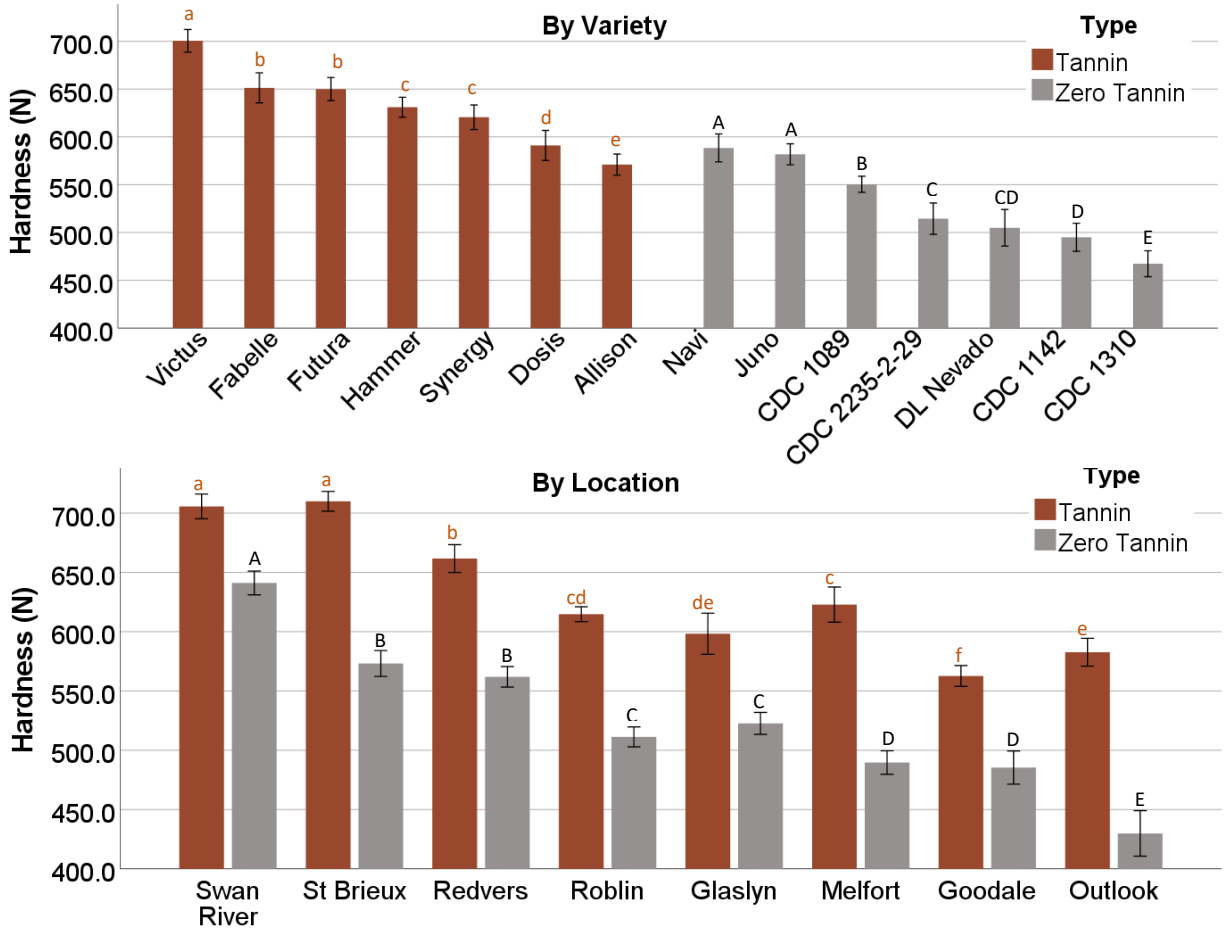
Figure 7.2. Mean seed hardness of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

By Variety:

- **Tannin:** Hardness of Victus was 130 N higher than Allison.
- **Zero Tannin:** Navi and Juno were ~115 N higher than CDC 1310.

By Location: Location also impacted the hardness of faba beans.

- **Tannin:** Hardness of St Brieux and Swan River was 145 N higher than Goodale.
- **Zero Tannin:** Swan River was 210 N higher than Outlook.

Table 7.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	***	***

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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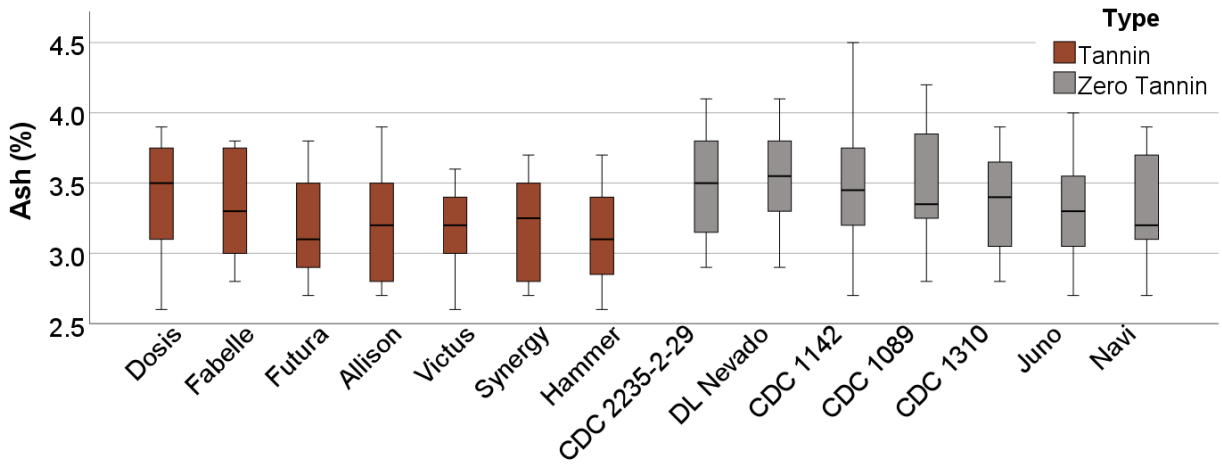
8. Ash Content

Method: Ash content (%) was determined using AACC 08-01.01[2] 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.).

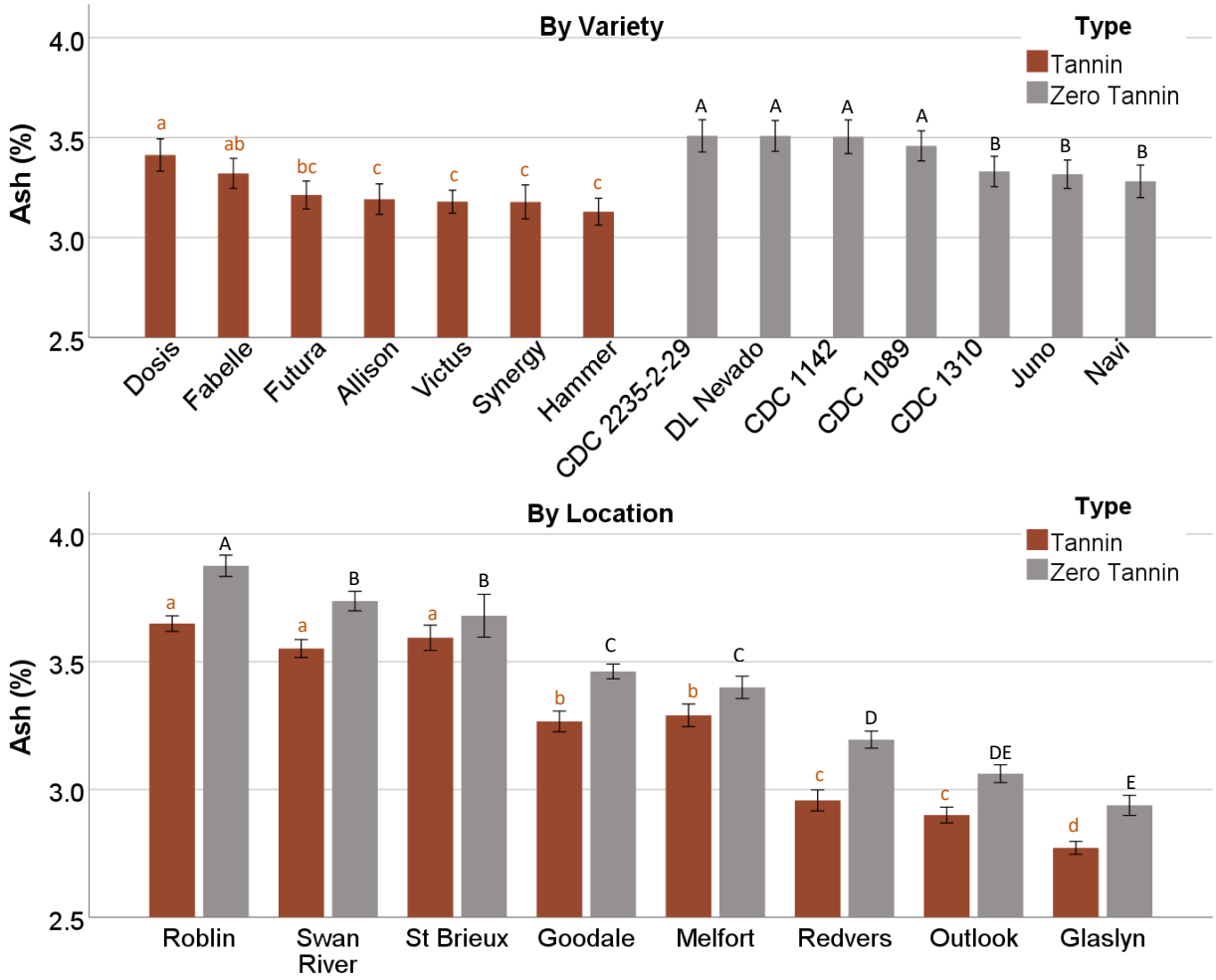
Results: Figure 8.1. Box and Whisker plot of faba beans for ash content in 2024. Results by type were reported from highest to lowest.



- Overall, the zero-tannin types had a higher ash content than the tannin types.

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

Figure 8.2. Mean ash of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** A 0.3% difference was found from highest to lowest.
  - **Zero Tannin:** A 0.2% difference was found from highest to lowest.
- **By Location:** Location effect played a role. A 0.9% difference was found from highest to lowest for both types.

Table 8.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	***	***

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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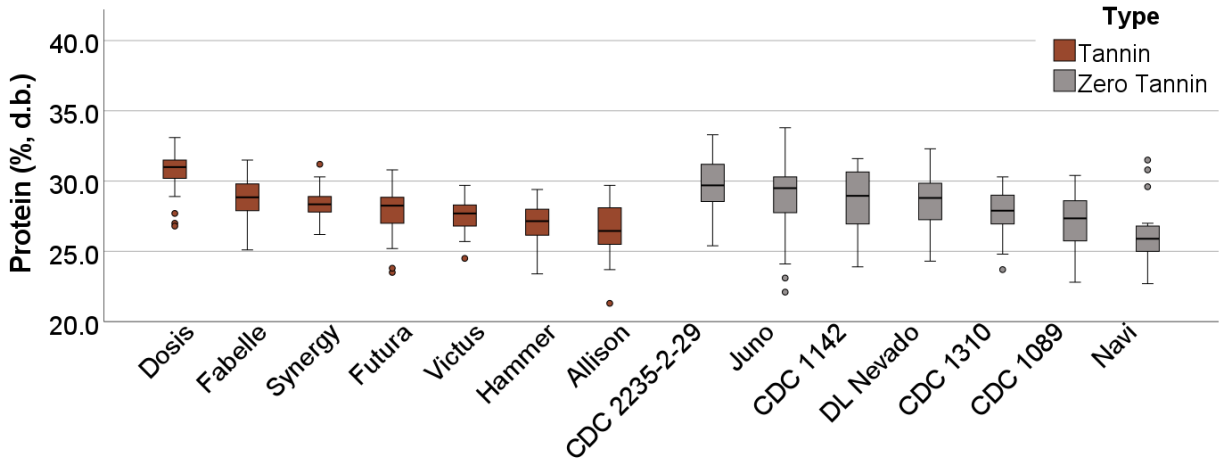
9. Protein Content

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 9.1. Box and Whisker plot of faba beans for protein content in 2024. Results by type were reported from highest to lowest.



- A large variability in protein content was found across all varieties.

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

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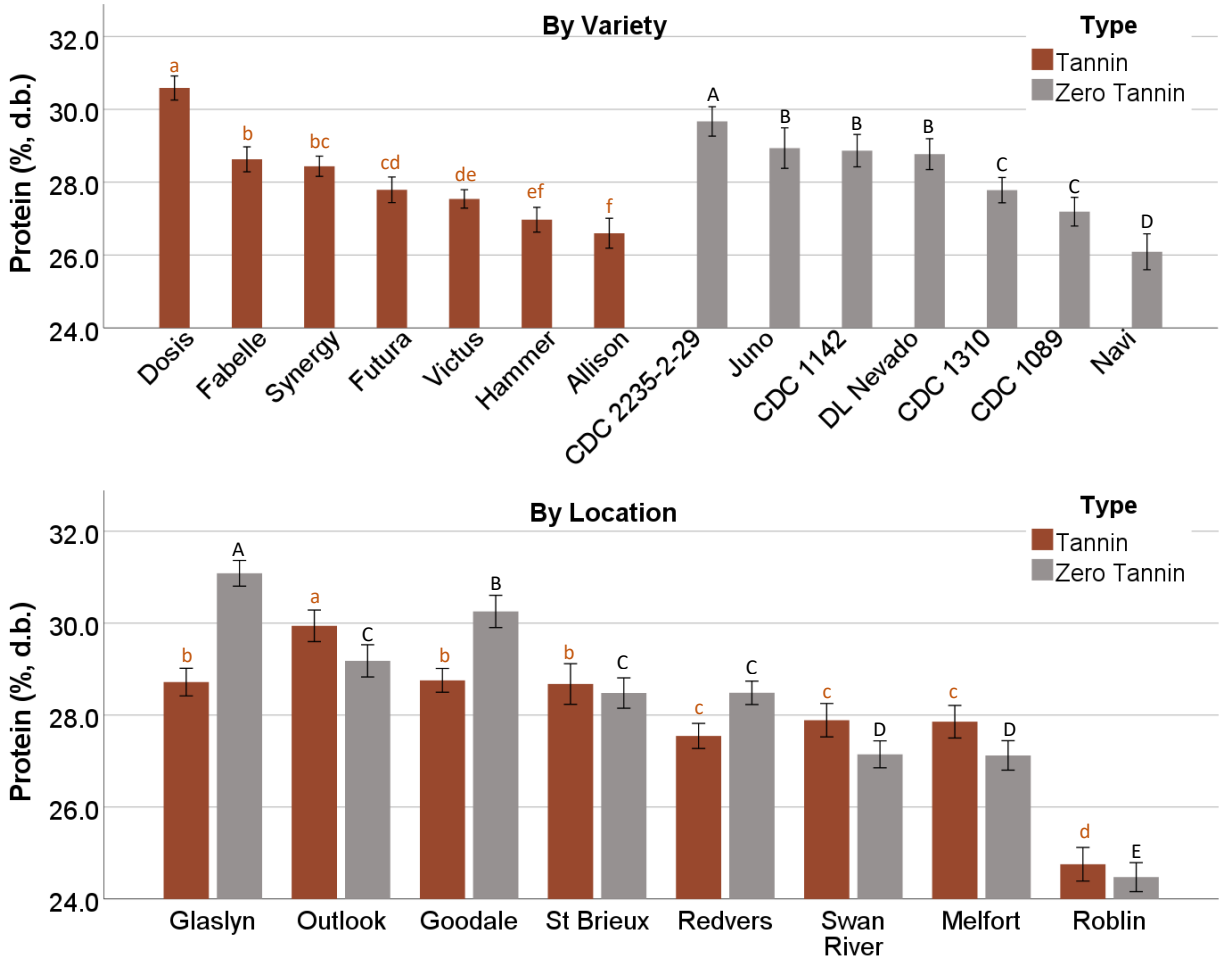
Figure 9.2. Mean protein of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** Dosis (highest) was 4% higher than Allison (lowest).
  - **Zero Tannin:** A 3.6% difference was found from highest to lowest.

- **By Location:** Location effect played a significant role.
  - **Tannin:** Outlook (highest) was 5.2% higher than Roblin (lowest).
  - **Zero Tannin:** A 6.5% difference was found from highest to lowest.

Table 9.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	*	**

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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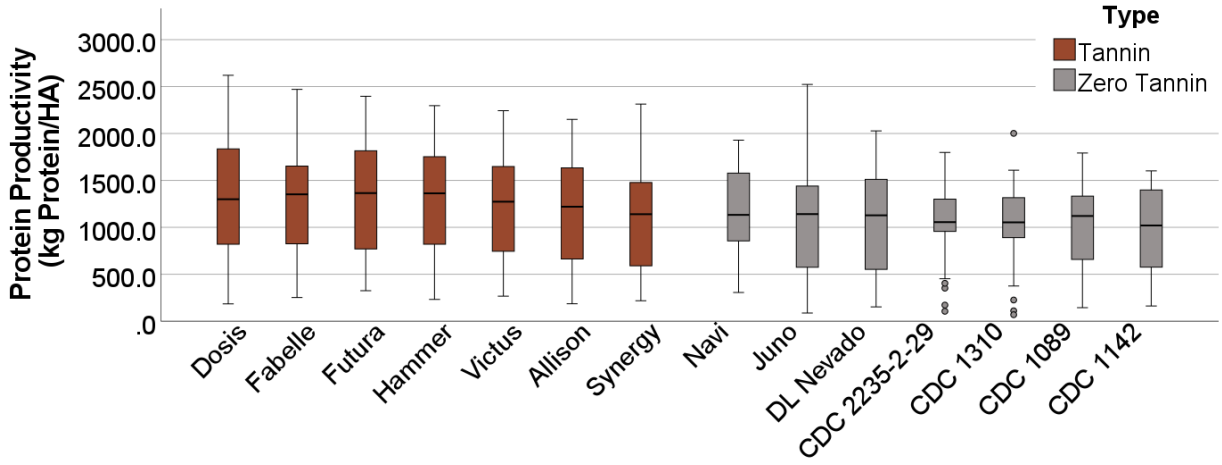
10.Protein Productivity

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 and Whisker plot of faba beans for protein productivity in 2024. Results by type were reported from highest to lowest.



- A large variability in protein productivity was found across all varieties.

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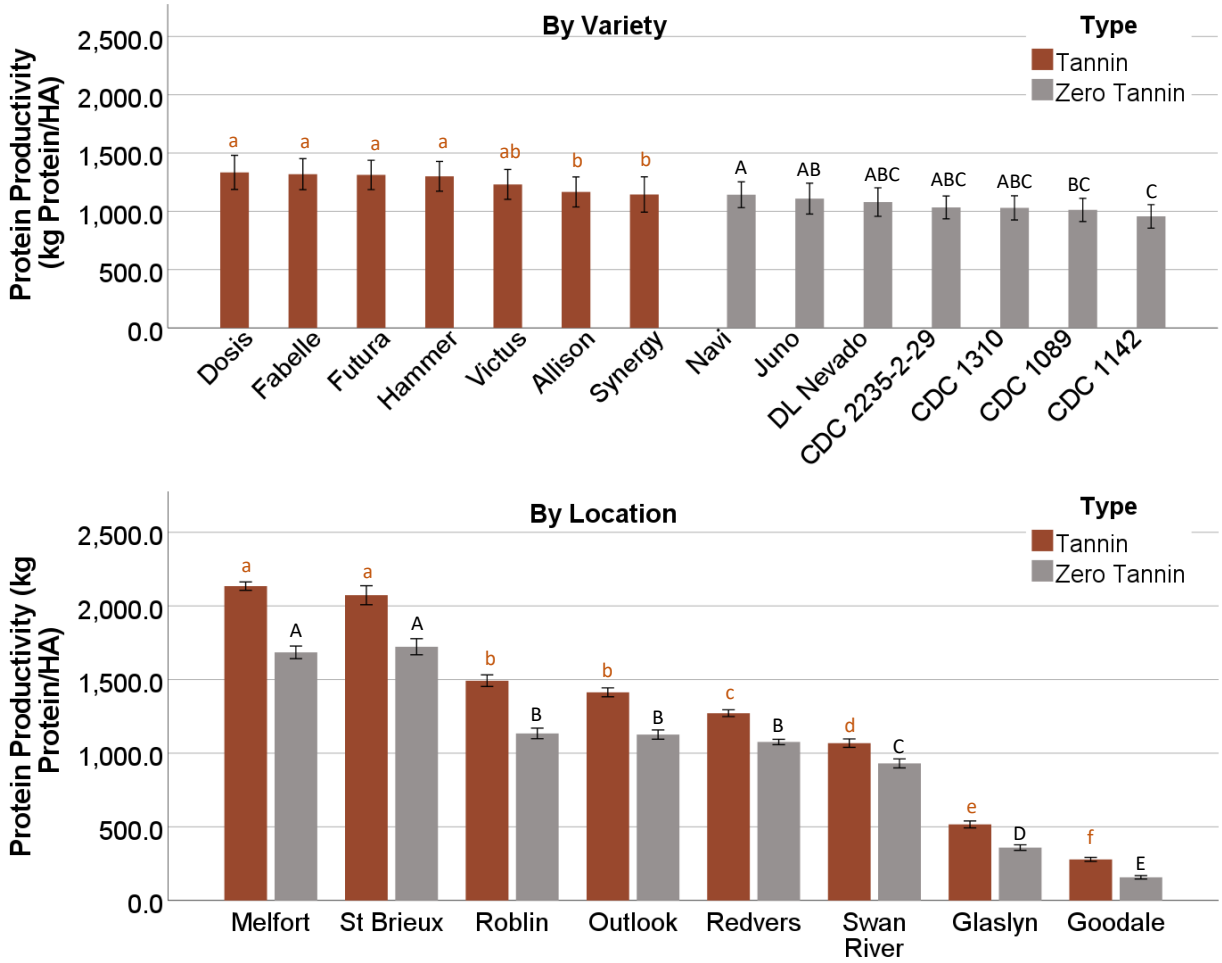
Figure 10.2. Mean protein productivity of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** A 190 kg protein/HA difference was found from highest to lowest.
  - **Zero Tannin:** A 185 kg protein/HA difference was found from highest to lowest.

- **By Location:** Location effect played a significant role.
  - Melfort and St Brieux had high protein productivity due to their high yield.
  - In contrast, Goodale had the lowest yield, resulting in the lowest protein productivity.

Table 10.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	**
Location	***	***
Variety x Location	*NS*	*NS*

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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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. Three measurements were made for each sample, and the mean value was reported.

- ***L* (lightness):*** white (100) to black (0)
- ***a*:*** red (+) to green (-)
- ***b*:*** yellow (+) to blue (-)

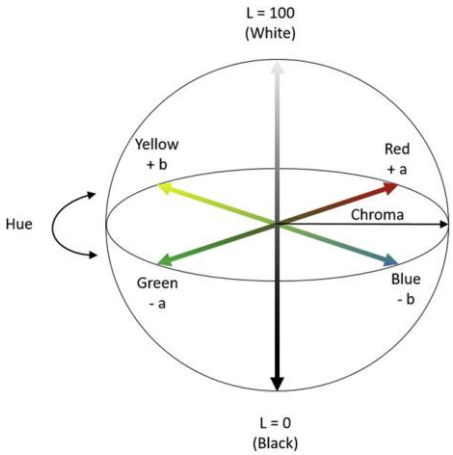
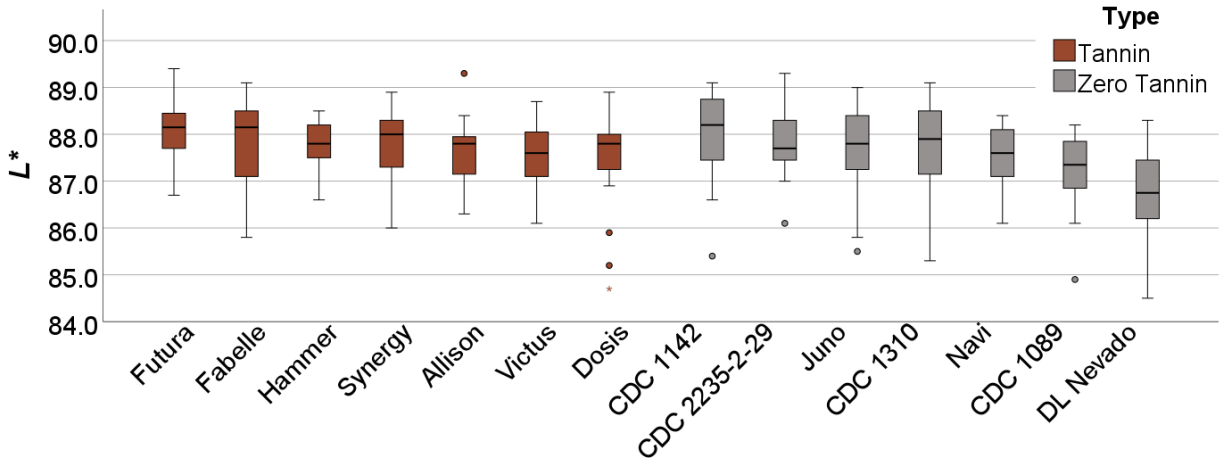


Figure 11.1. The CIELAB color spacediagram[3].

Results:

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

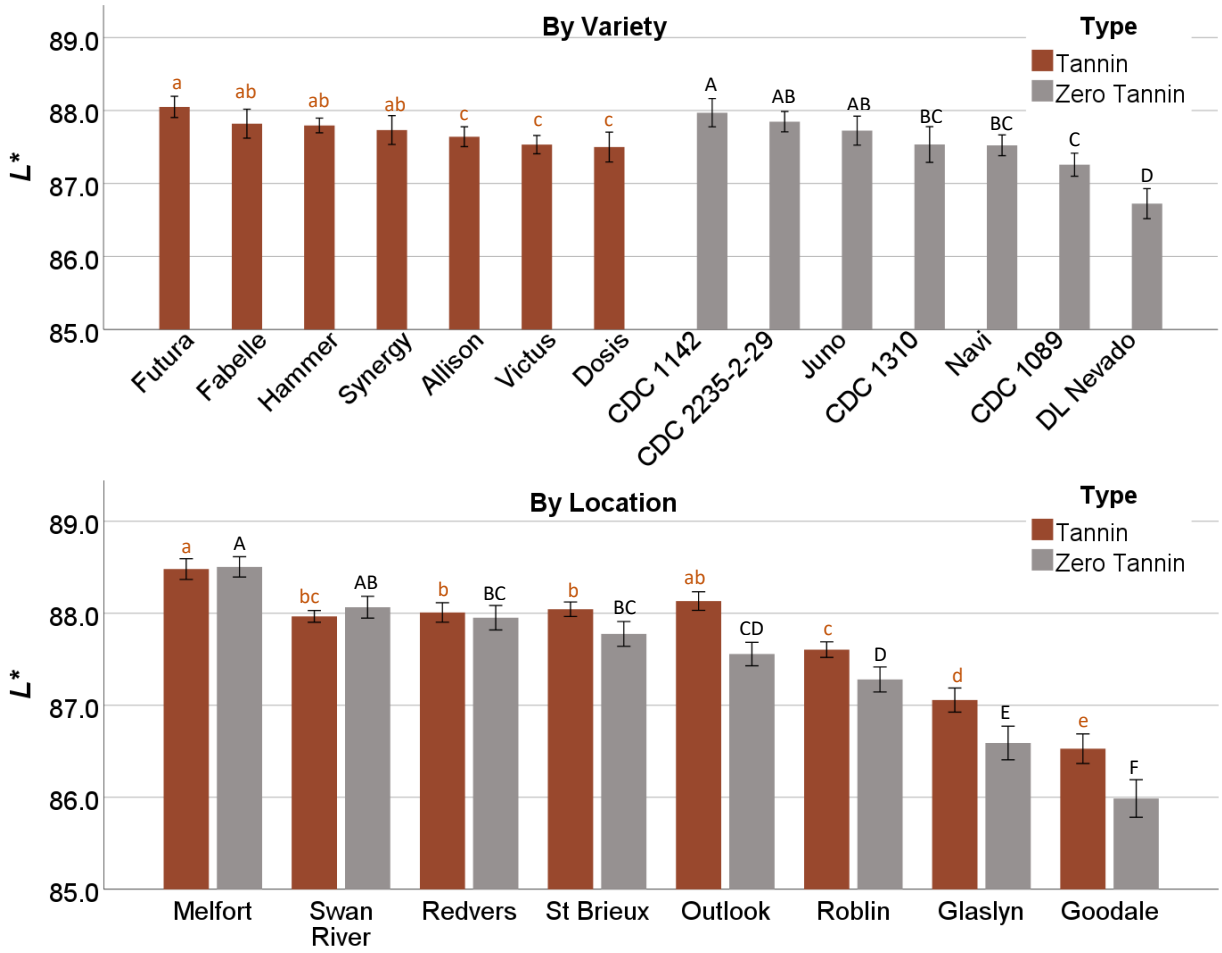
Figure 11.2. Box and Whisker plot of 2024 faba beans for lightness. Results by type were reported from highest to lowest.



- A greater difference within the zero tanin type was found.

[3] Ly, B. C. K., Dyer, E. B., Feig, J. L., Chien, A. L., & Del Bino, S. (2020). Research techniques made simple: cutaneous colorimetry: a reliable technique for objective skin color measurement. *Journal of Investigative Dermatology*, *140*(1), 3-12.

Figure 11.3. Mean lightness of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** Only a 0.45-unit difference was found from highest to lowest.
  - **Zero Tannin:** DL Nevado had the lowest lightness, which might be attributed to the darker seed coat color.

- **By Location:** Lightness also varied between locations, where the lowest lightness was found in Goodale for both types.

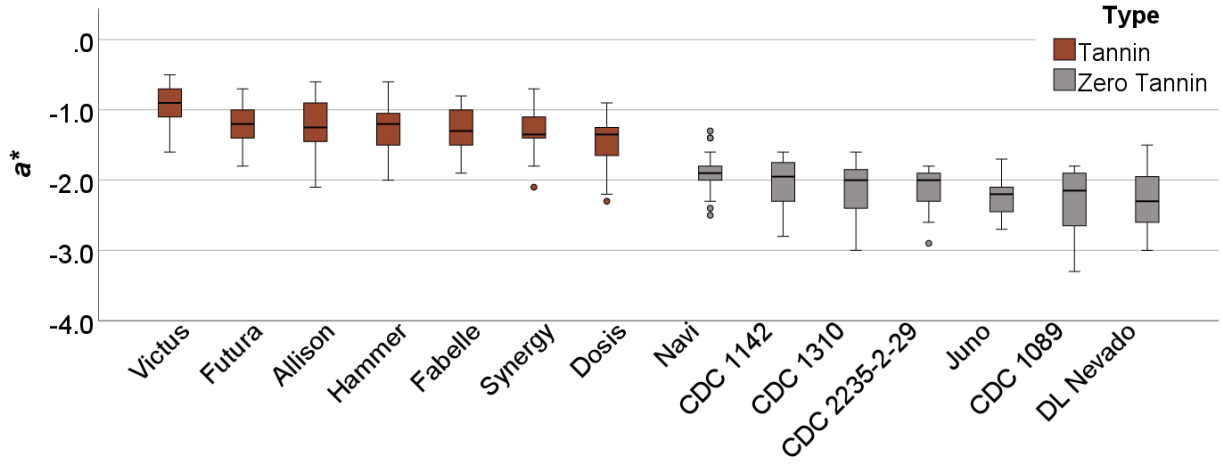
Table 11.1. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	***	**

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

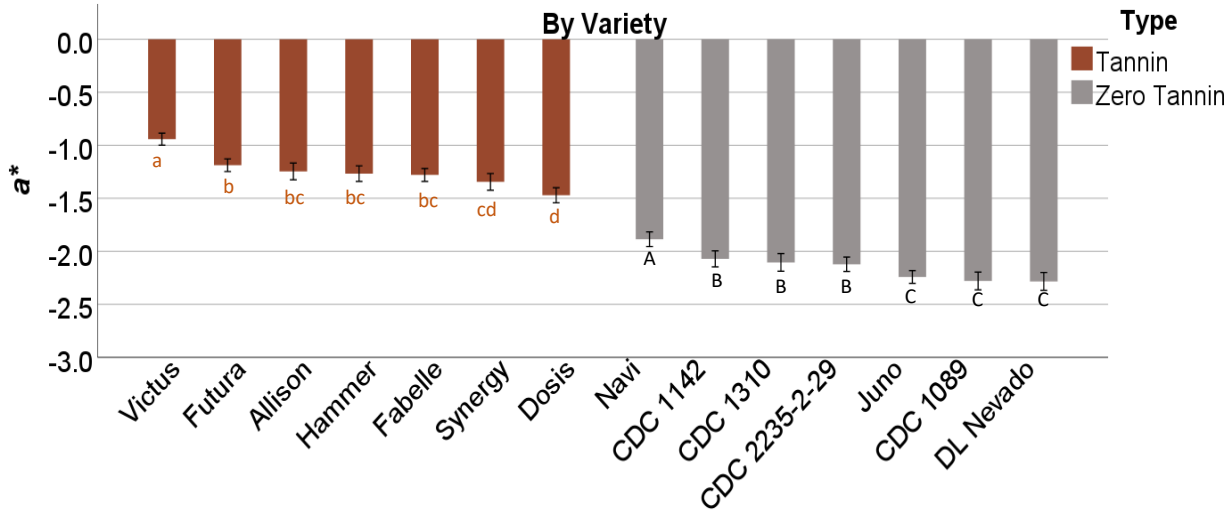
2) ***a*:*** red (+) to green (-)

Figure 11.4. Box and Whisker plot of 2024 faba beans for *a** values. Results by type were reported from highest to lowest.



- The zero-tannin type had greater greenness than the tannin type.

Figure 11.5. Mean *a** of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** ranged from -1.5 to -0.9.
  - **Zero Tannin:** ranged from -2.3 to -1.9.

- **By Location:** Location played a role in both tannin and zero tannin types.

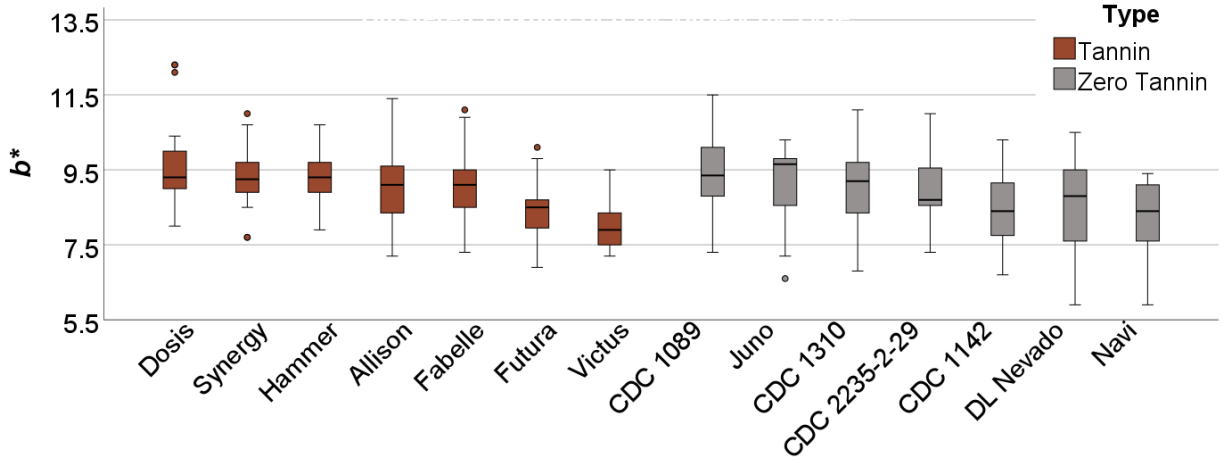
Table 11.2. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	*NS*	***

Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant*

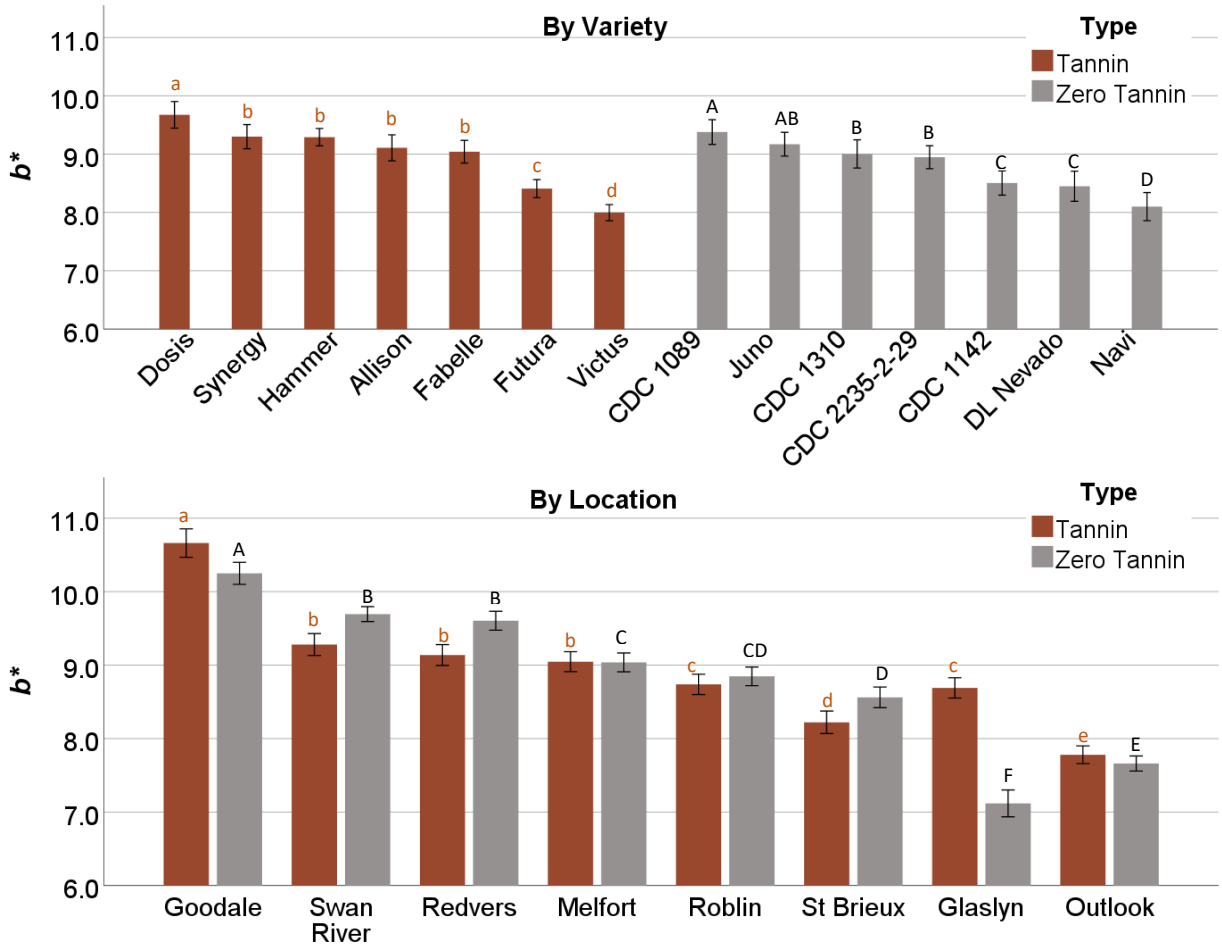
3) ***b*:*** yellow (+) to blue (-)

Figure 11.6. Box and Whisker plot of 2024 faba beans for *b** values. Results by type were reported from highest to lowest.



- Outliers and extreme outliers were present in the 2023 samples.

Figure 11.7. Mean *b** of 2024 faba beans by variety (top) and by location (bottom). Each bar represents mean ± one standard error.



Note: Small letters indicated significant differences (p<0.05) between tannin varieties. Capital letters indicated significant differences (p<0.05) between zero-tannin varieties.

- **By Variety:**
  - **Tannin:** A difference of 1.7 units was found from highest to lowest.
  - **Zero Tannin:** CDC 1089 was about 1.3 units higher than Navi.

- **By Location:** Location played a role in both tannin and zero tannin types. Yellowness of both seed types from Goodale was 3 units higher than the lowest.

Table 11.3. Effects of variety and location.

	Tannin	Zero-Tannin
Variety	***	***
Location	***	***
Variety x Location	***	***

*Note: ***p<0.001; **p<0.01; *p<0.05; NS not significant.*

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