Influence of Organic Fertilizers on Container Grown Highbush Blueberries in High Tunnels

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Trends in the Blueberry market

Increase in demand

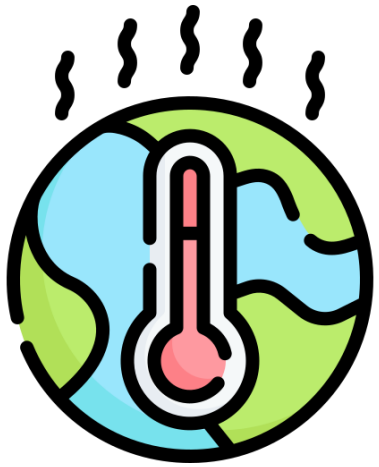
Health benefits associated with blueberries - richness in beneficial antioxidants

Growth of the global organic fruits markets driven by greater environmental awareness

(USDA, 2021. Yeh et al., 2023)

Cropping history : *Then and Now*

Open field

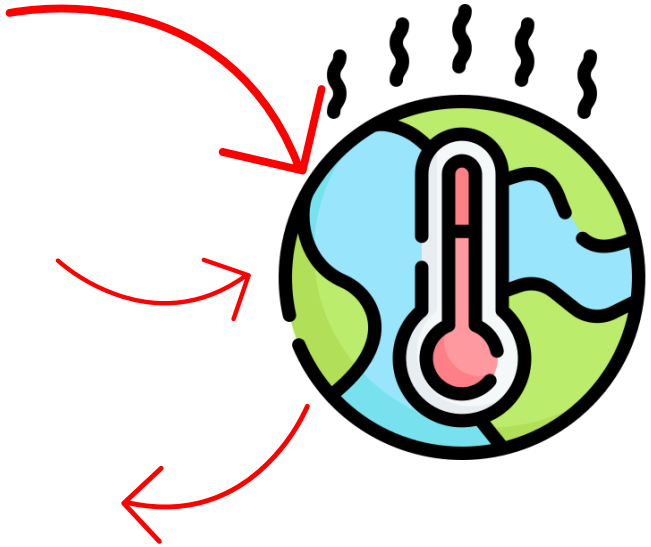


Container grown + protected environment

Cropping history : *Then and Now*

Open field

- **Sandy soils** that are more prone to **leaching of N and P** in the environment
- **Limited control on irrigation** and nutrient management plan
- **No protection** against **heavy rainfall, hail, and**



Container grown

- **Custom growing media** with low pH and high organic matter content
- **Better control on irrigation** and nutrient management plan
- **Protection** against hail, freeze and rainfall
- Early fruit ripening

Fang et al. 2020

Challenges of organic fertilizer management

- Research gap regarding organic blueberry production methods and fertilization
- Synchronizing plant nutrient demand with nutrient mineralization rates
- pH management

Organic production systems in northern highbush blueberry – Fertilizer review

Fish emulsion

Lower soil pH

Root mass

Feather meal

Higher soil pH

Root mass

Poultry manure

pH 3.5

Below optimal range

Strik et al. 2017

Goals

Study the impacts of three sources of organic fertilizers on:

(1) **Chemicals** and **biological properties** of the **growing media** compared to inorganic fertilizers.

(2) **Growth**, **yield** and **fruit quality parameters** compared to inorganic fertilizers.

Highbush blueberries grown in containers under high tunnels

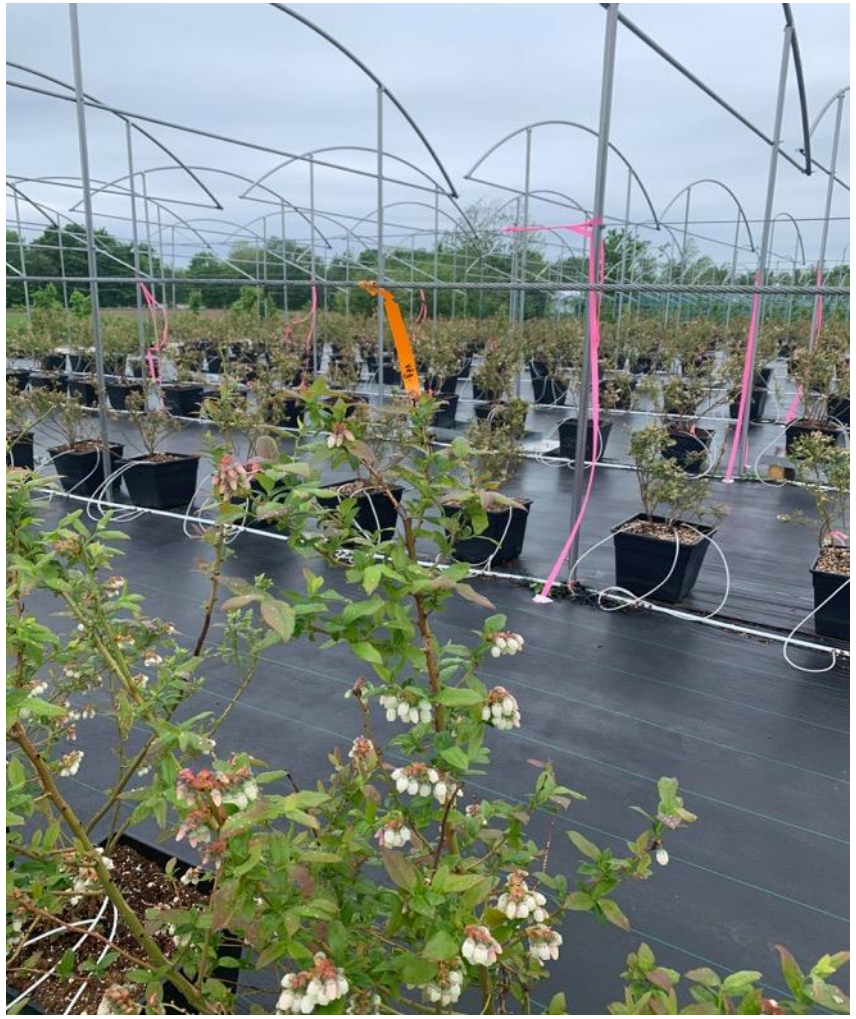
Hypotheses

(1) **Animal** and **plant-based fertilizers** are **as effective as inorganic fertilizers** to maintain an **optimal soil pH** as well as **soil microbial activity** and **adequate level of nutrients**.

(2) It is possible to **obtain similar growth, productivity and fruit quality** under organic management compared to inorganic fertilizers.

Experimental design

- 2-years trial
- Split-plot design
- 4 repetitions – 288 highbush blueberry plants
- ANOVA (SAS v. 9.4) with a significance level of $P \leq 0.05$ (protected Fisher'S LSD test)
- PCA using Prinqual procedure (SAS v. 9.4)



Treatments structure Main Plot

3 highbush blueberry cultivars

REKA – early harvest

Bluecrop - midseason

Liberty - late season

Treatments structure Sub Plot

Fertilizer sources	Composition	N-P-K Content (%)	N-P-K Content (ppm)
Animal	*Actisol* (Poultry pellets)	5-3-8	
	Feather meal	11-0-0	
	K_2SO_4	0-0-52	30
Vegan	*Ez-grow* (Rock phosphate, soy protein hydrolyzate, ferrous sulfate)	9-1.5-7	
	K_2SO_4	0-0-52	30
Mix	*Selectus* (Alfalfa meal, feather meal, bone meal, mined potassium sulfate, rock phosphate, shellfish meal, seaweed extract, gypsum)	4-2-5	
	K_2SO_4	0-0-52	30
Inorganic (Standard)	Nutrient solution	-	42-12-60

Parameters measured

Growing Media Evolution

- Characterization of drainage waters
- Mineral analysis: SME
- Microbial activity: FDA

Photosynthesis & plant growth

- Chlorophyll fluorescence (Handy PEA)
- Chlorophyll content (SPAD)
- Growth measurements: stem nb and diameter, height
- Leaf mineral content

Productivity

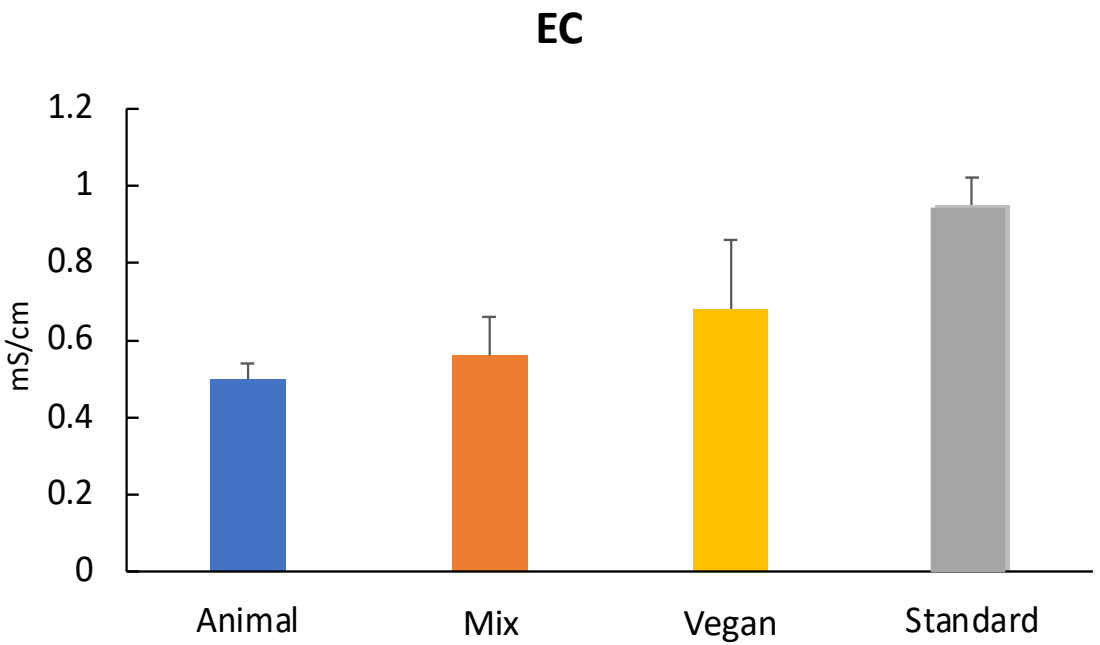
- Yield and fruit size

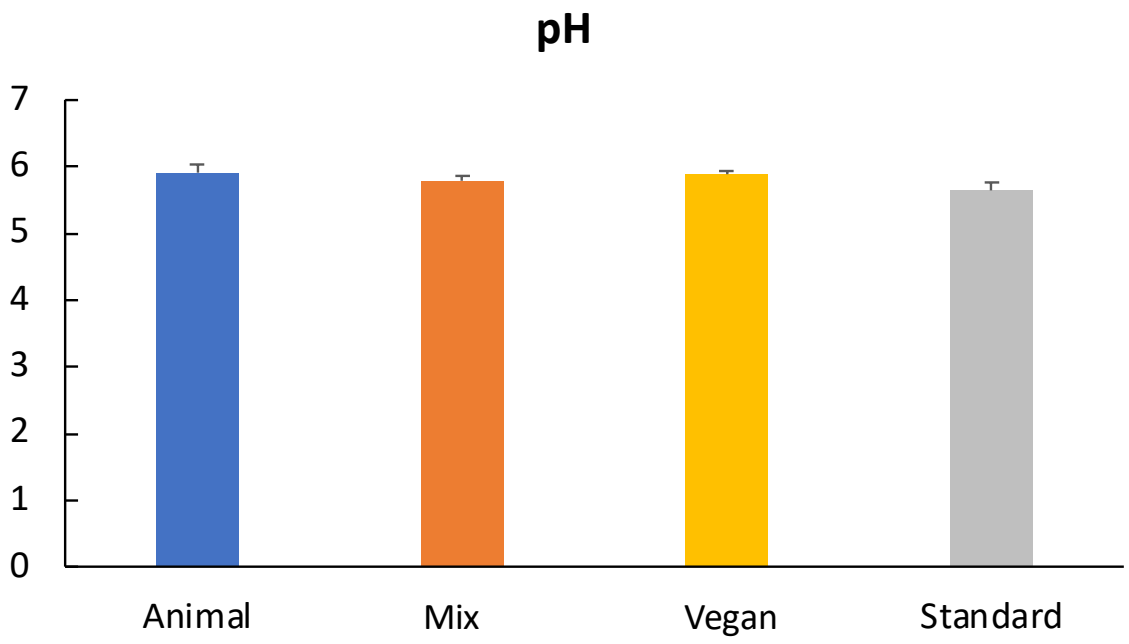
Fruit quality attributes

- Soluble sugar content
- Anthocyanin and polyphenol contents

Results – Drainage waters

EC of Inorganic (Standard) > Organic fertilizers
Similar pH for all four fertilizers sources
Irrigation water : EC Inorganic: 0.7 mS cm^{-1} ; EC Organic : 0.35 mS cm^{-1}





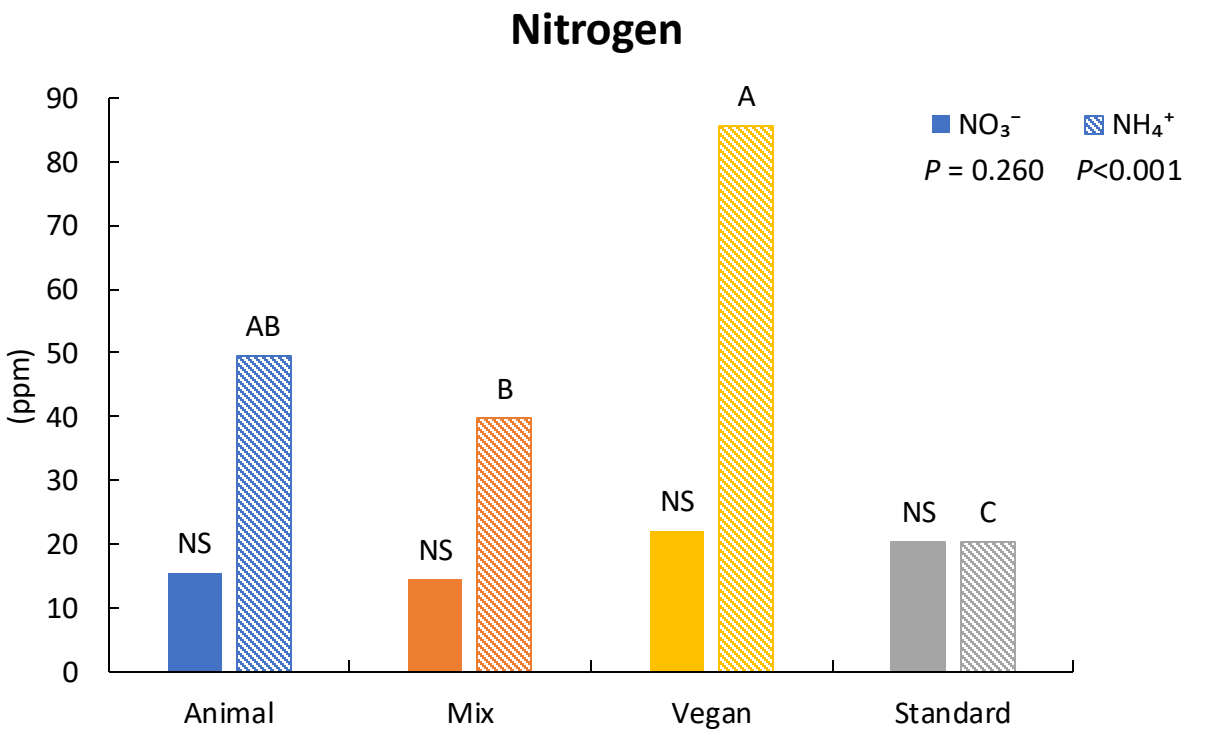
Results – SME analysis

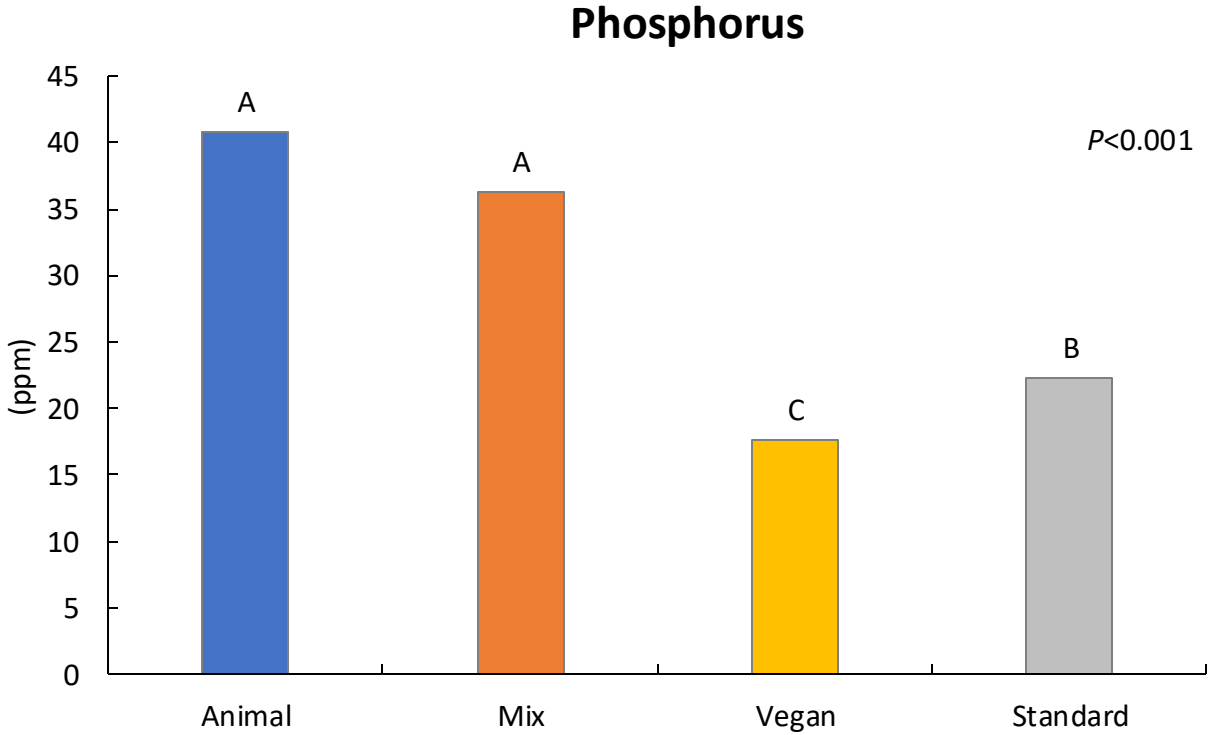
Vegan : Higher **NH_4^+** content when compared to standard (Inorganic)

Preferred nitrogen form by blueberries

Highest phosphorus content in **animal** and **mix** fertilizers

No significant difference for NO_3^- and Potassium

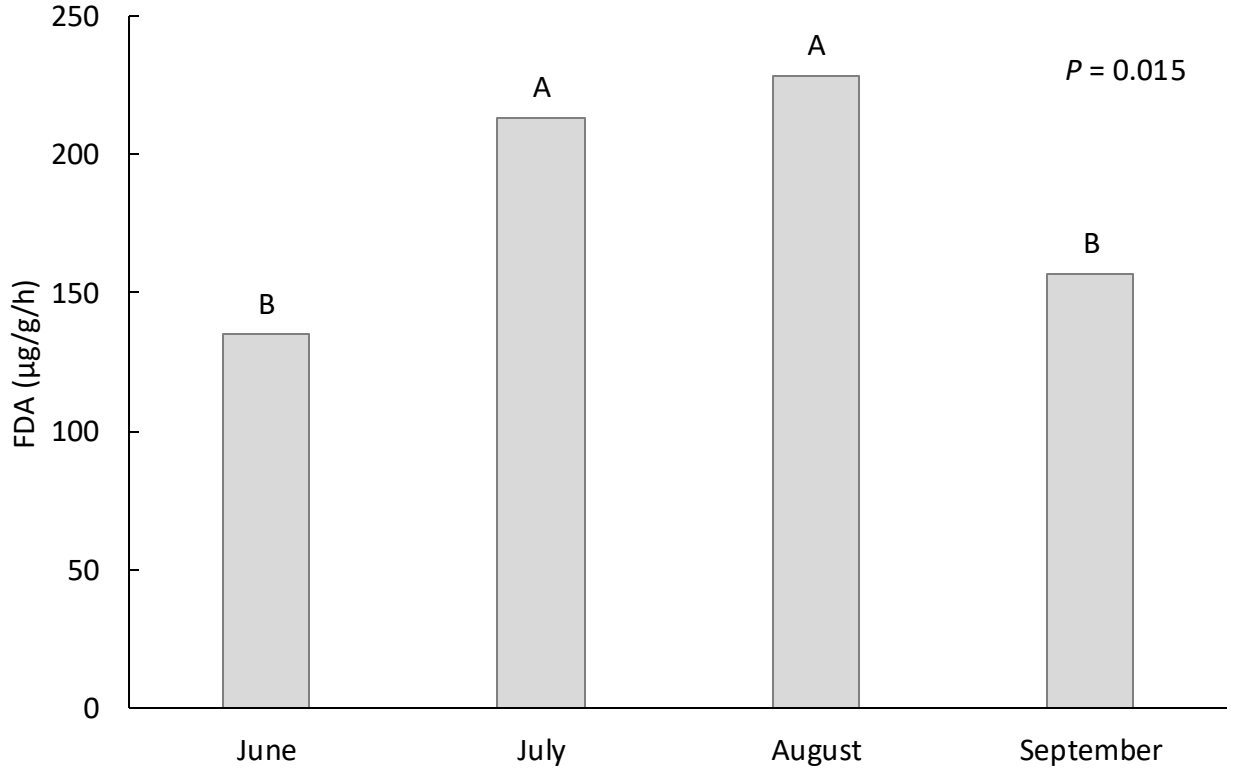




Results – Microbial soil activity

Hydrolysis of fluorescein diacetate (FDA)

Global **microbial enzyme activity increased** by 58% and 69% in July and August compared to June.



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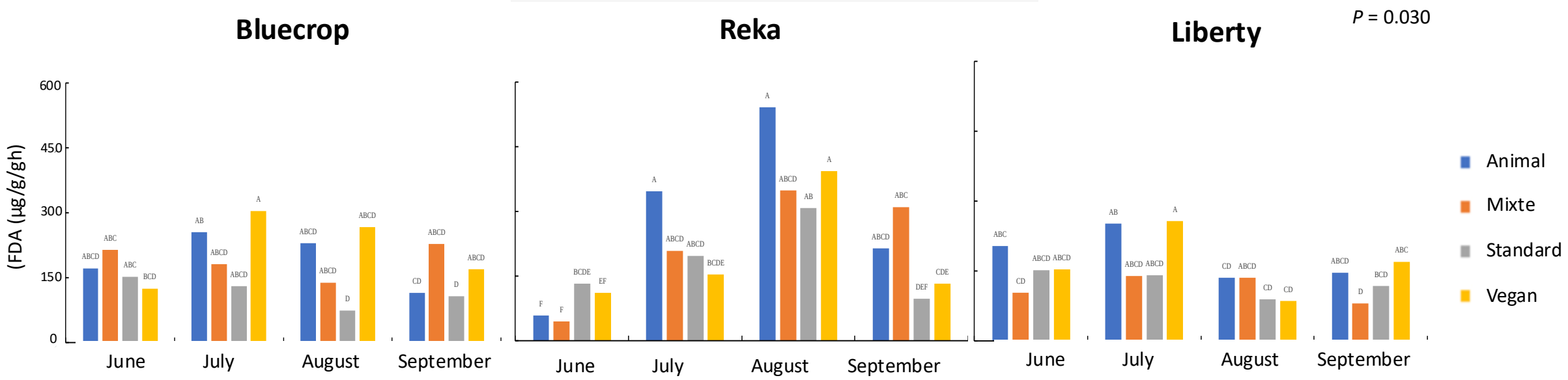
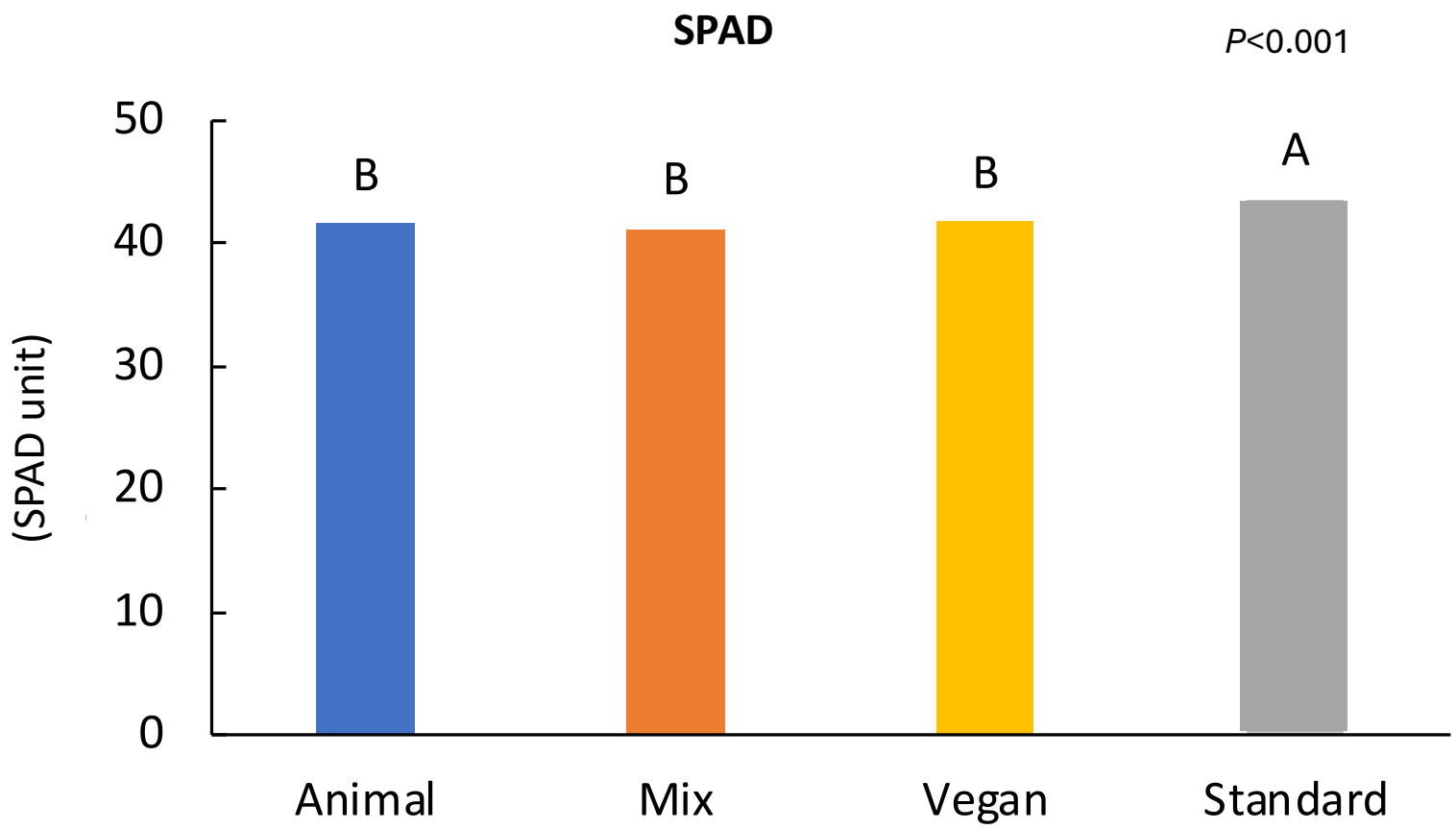


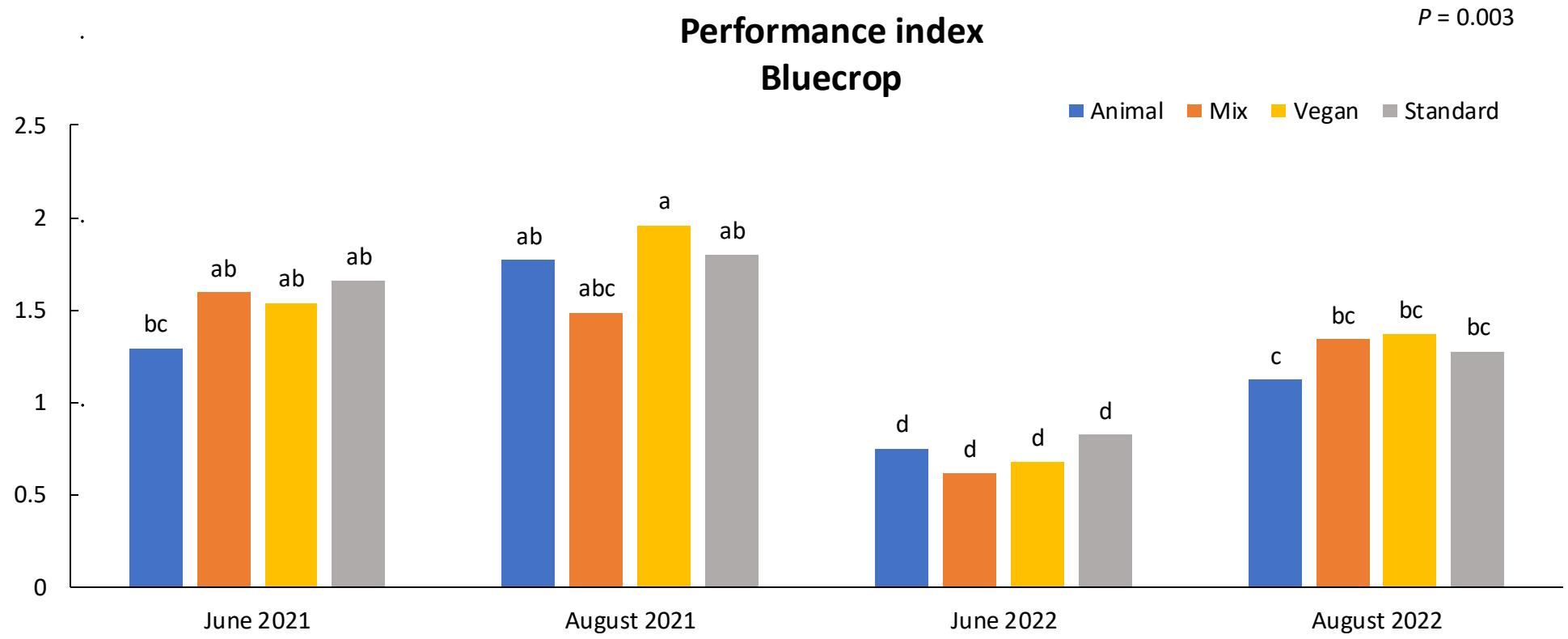
Results – Photosynthesis

SPAD Standard (Inorganic nutrient solution) > Organic fertilizers



Results – Photosynthesis

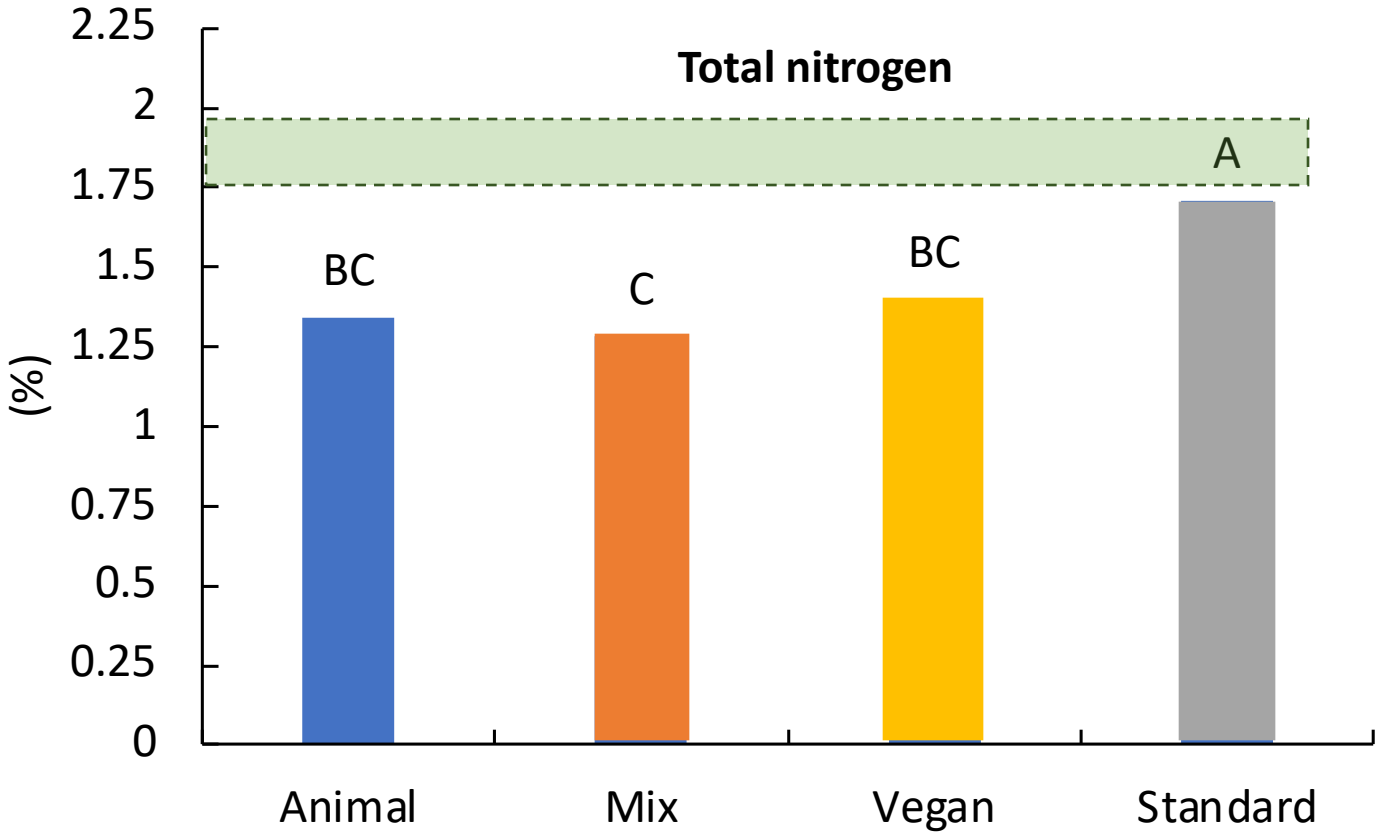
- No differences among fertilizers for each date
- Similar trend for all 3 cultivars



*Date*Cultivar*Fertilizer sliced by cultivar*

Results – Leaf mineral content

Over the span of two years, the **total nitrogen content is higher** when using inorganic nutrient solution (standard).

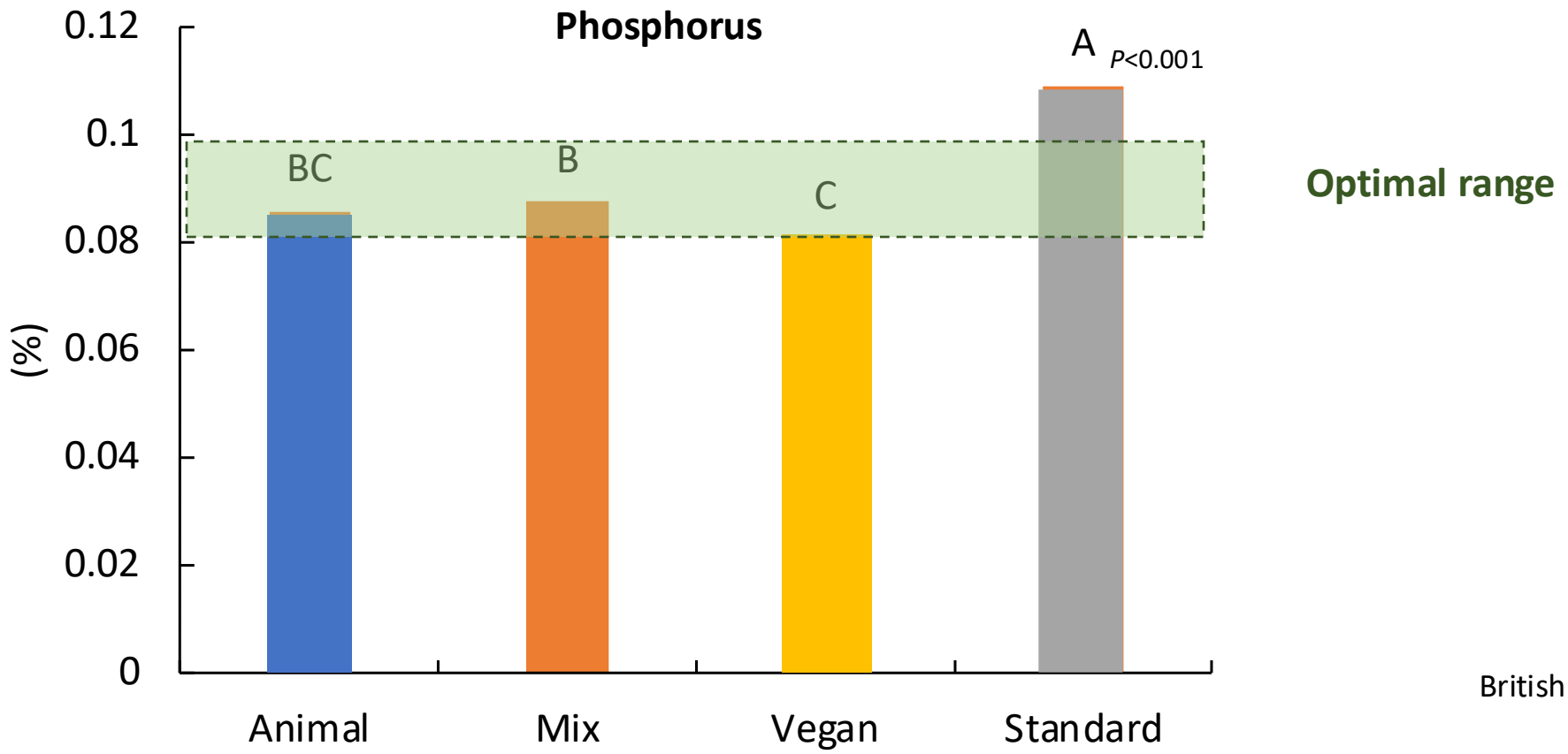


Optimal range

British Columbia, 2009

Results – Leaf mineral content

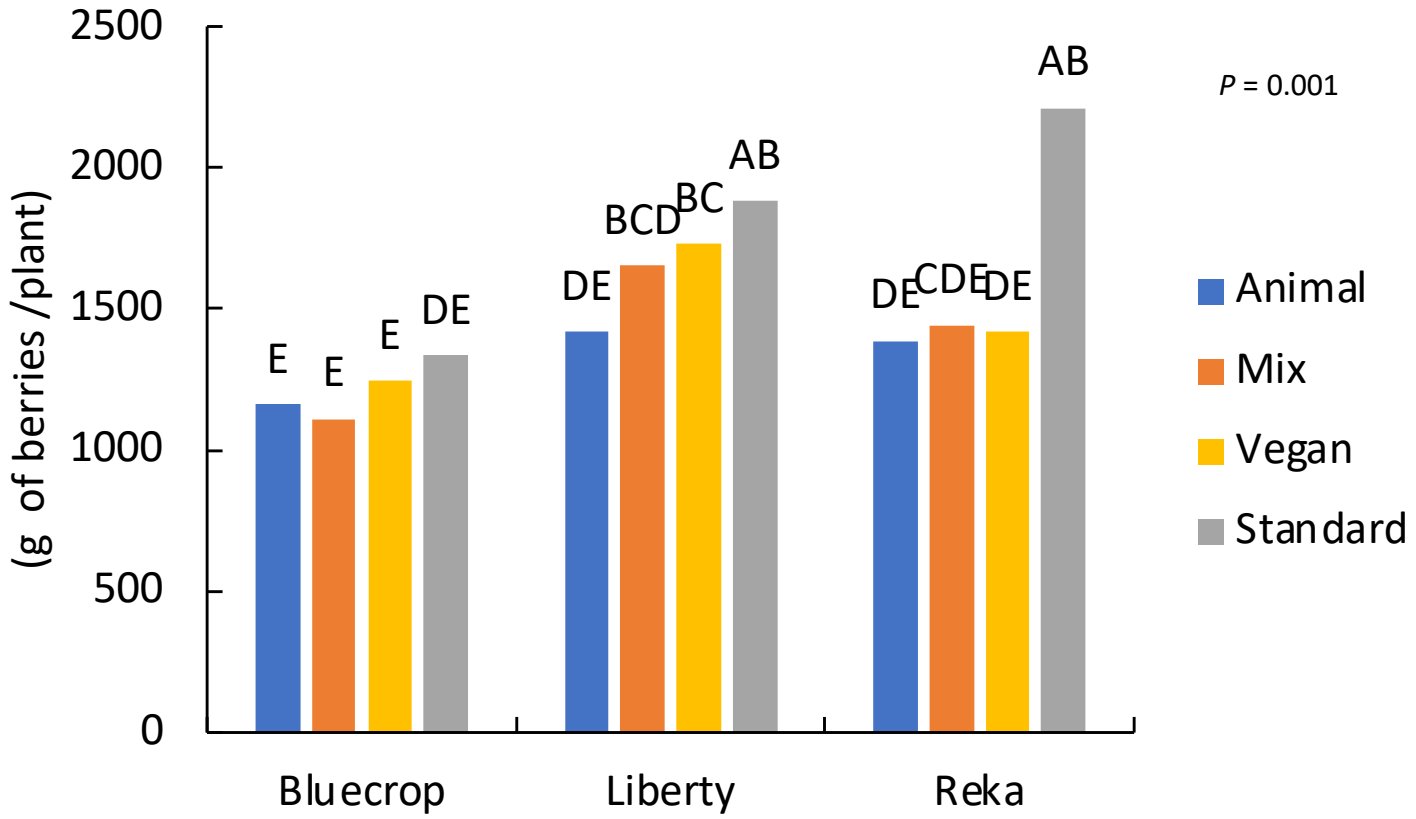
Phosphorus content is **higher under Standard** (inorganic) fertilizer
No significant differences for other mineral contents (K, Ca, Mg, Fe, Zn)



British Columbia, 2009

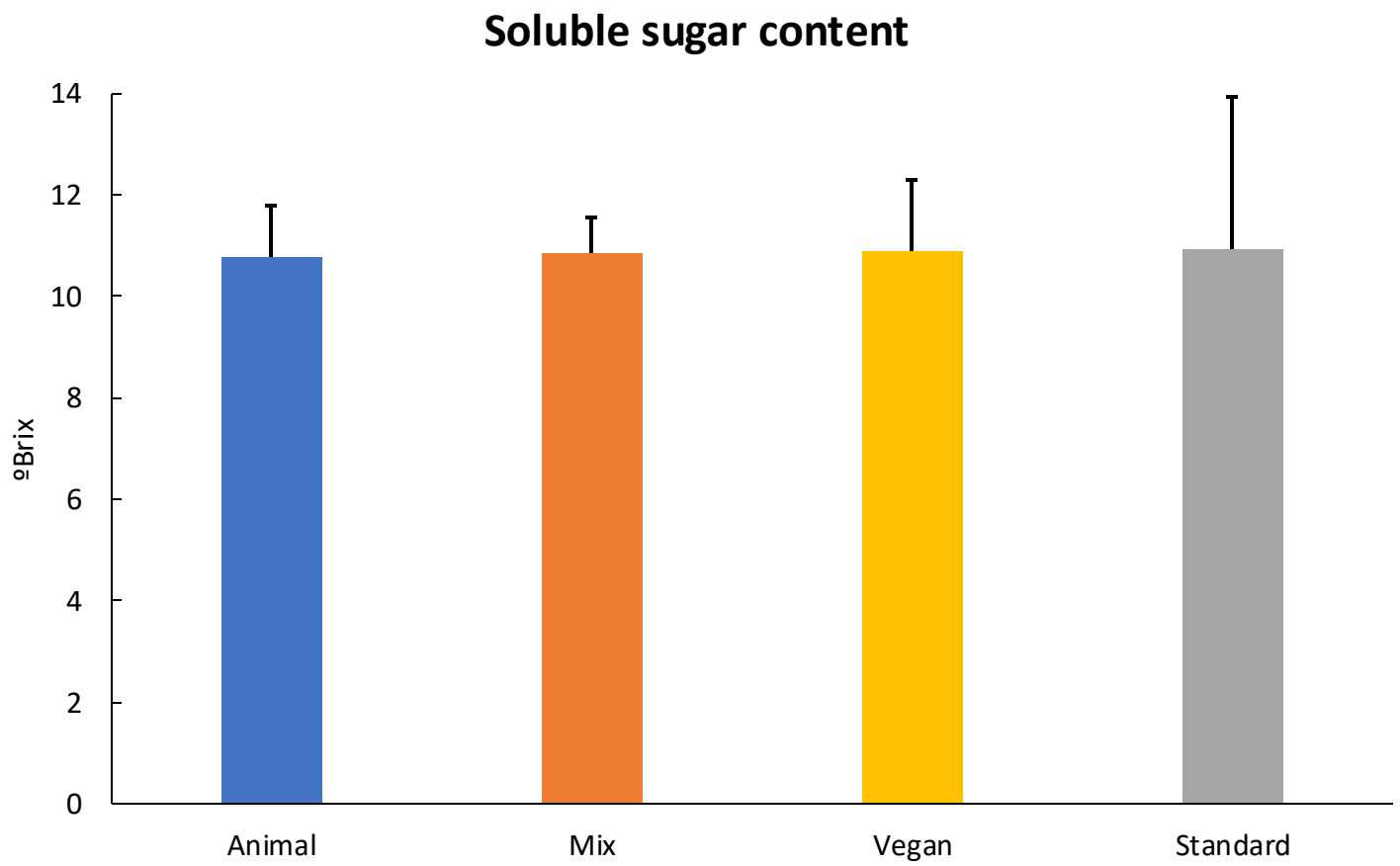
Results – Total yield per plant

- **Bluecrop** : no difference
- **Liberty** : standard > animal
- **Reka** : standard > animal, mix and vegan



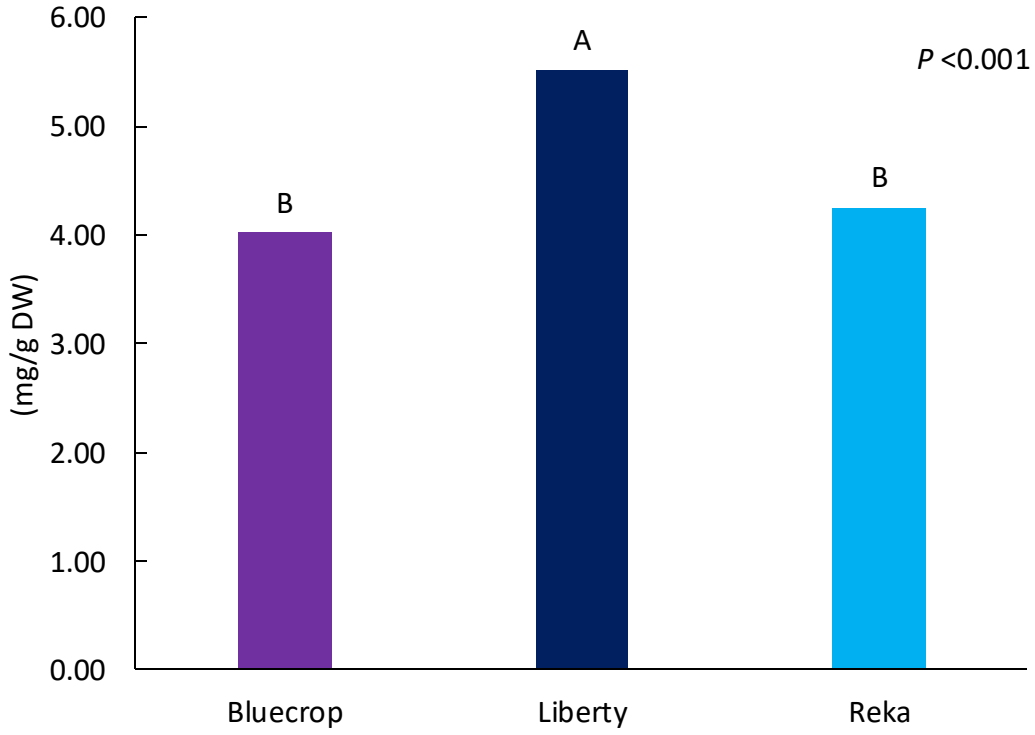
99% marketable berries

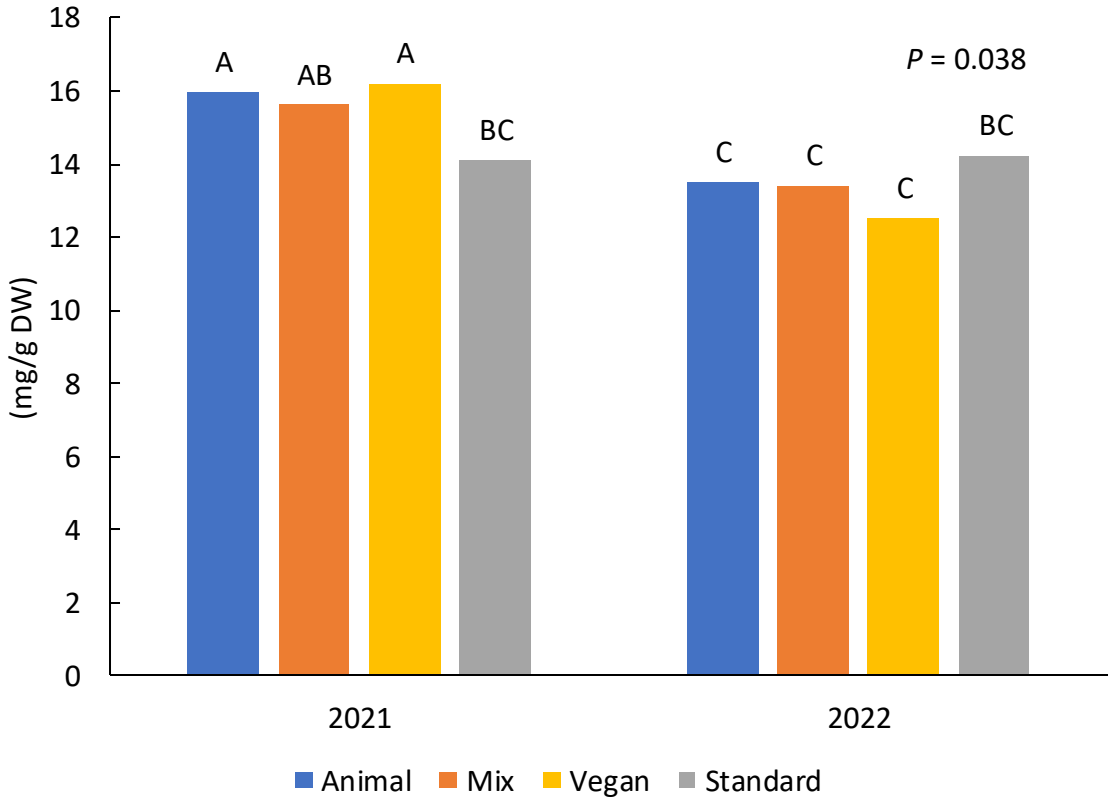
Results – Fruit quality



Results – Fruit quality

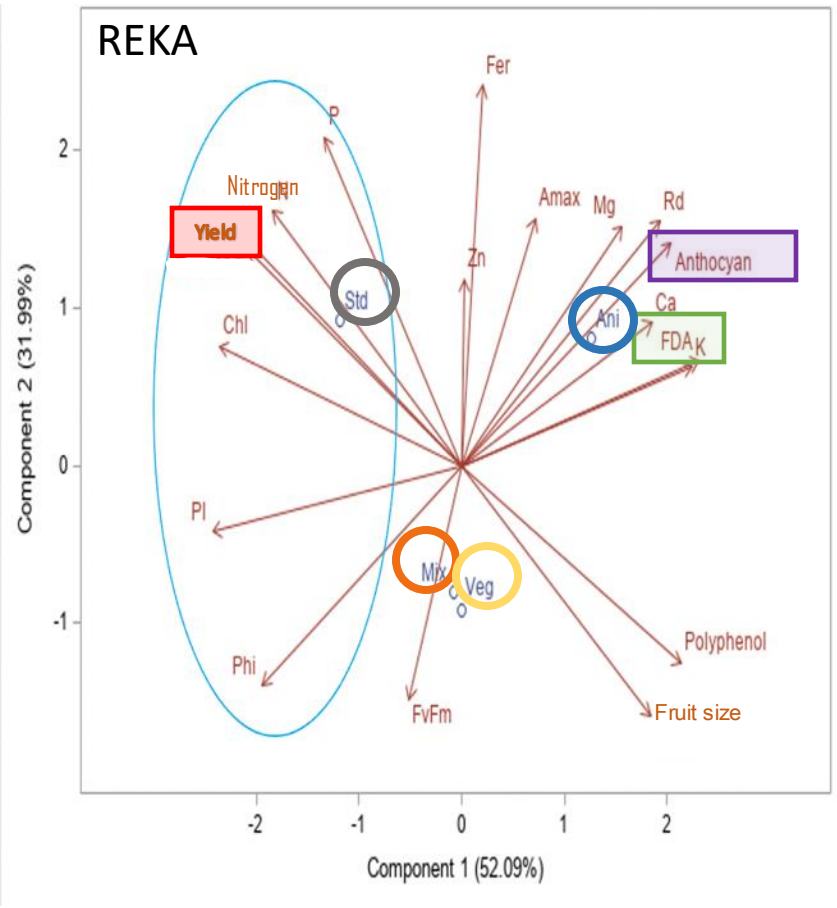
- No impact of organic or inorganic fertilizers on anthocyanins
- Polyphenols (2021): Animal and Vegan > Inorganic

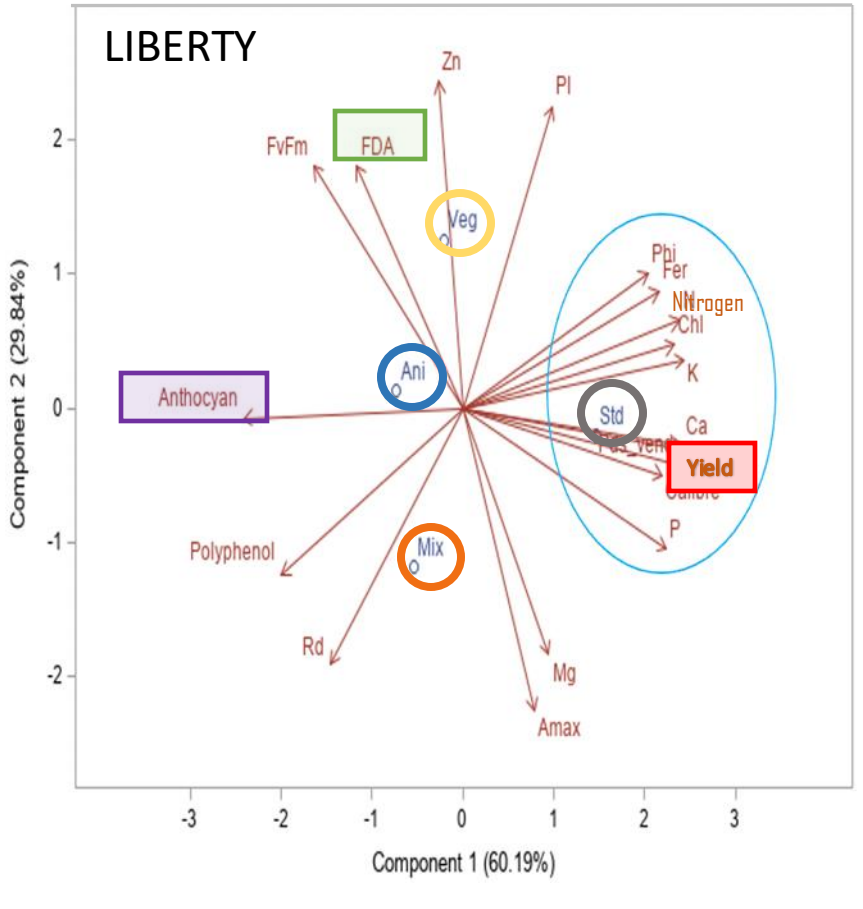


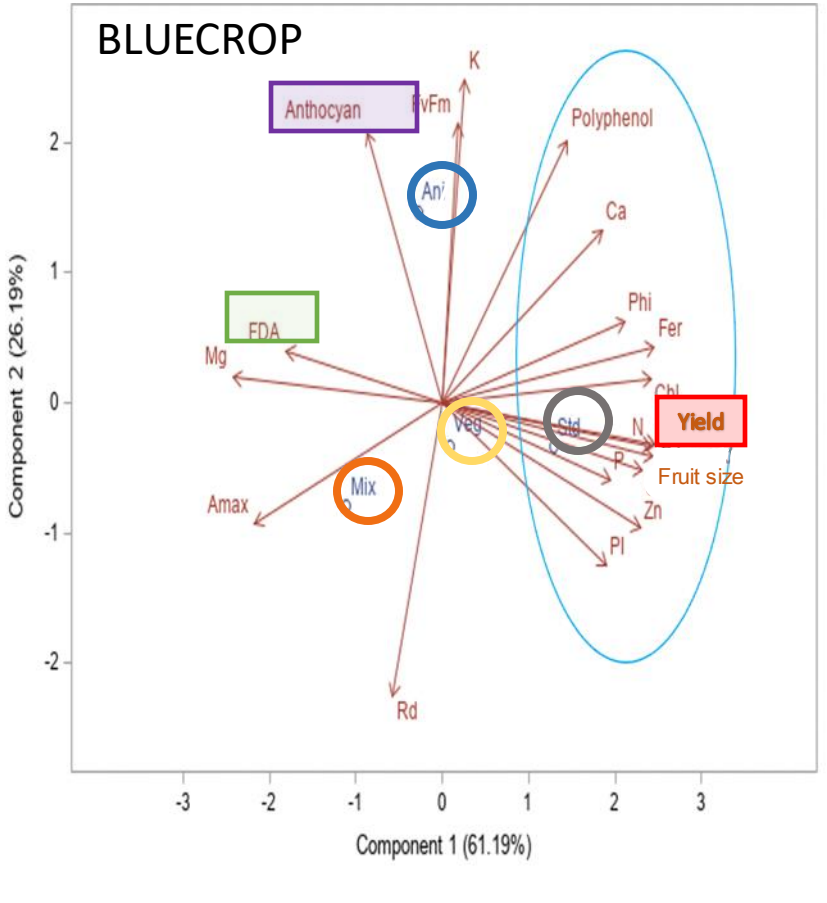


PCA Analysis

Total yield had a positive association with the inorganic fertilizer







Key points

- **Low EC** → organic fertilizers
- Vegan **NH_4^+ content** > inorganic NH_4^+ content
- **FDA** have a tendency to be lower for inorganic fertilized plants

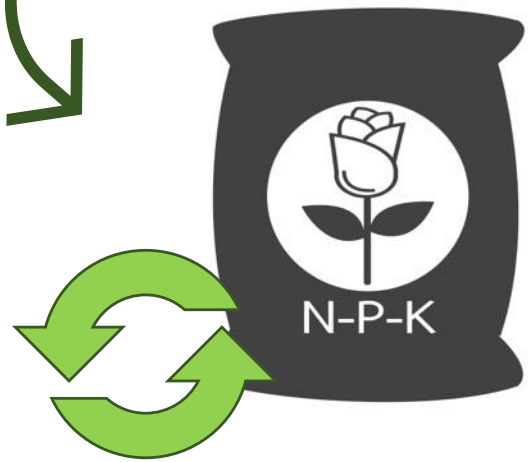
- **SPAD** inorganic > organic
- **N and P leaf content** were higher in inorganic plants

- **Bluecrop:** similar yield under organic and inorganic fertilizers
- **Liberty:** Vegan & Mix similar yield than inorganic fertilizers
- **Reka:** inorganic yield > organic yield

- The type of fertilizers did not influence **anthocyanin and soluble sugar concentrations**.
- **Polyphenols:** Higher concentration for Vegan and Mix fertilizers in 2021.
- **Anthocyanins:** concentration are different for each cultivars

Perspectives

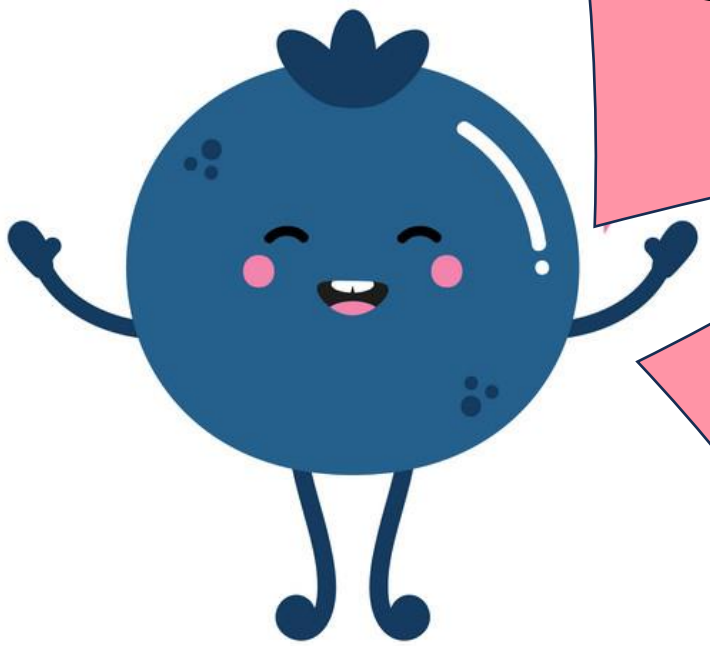
Establishing a suitable long terms organic fertilizer management strategy for container-grown highbush blueberries is possible but :



Mineralization Synchronicity

Optimization growing media (soil salinity, pH)

Implementation of biostimulants such as PGPR



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Thank You