Lettuce Yield in Organic and Conventional Hydroponics

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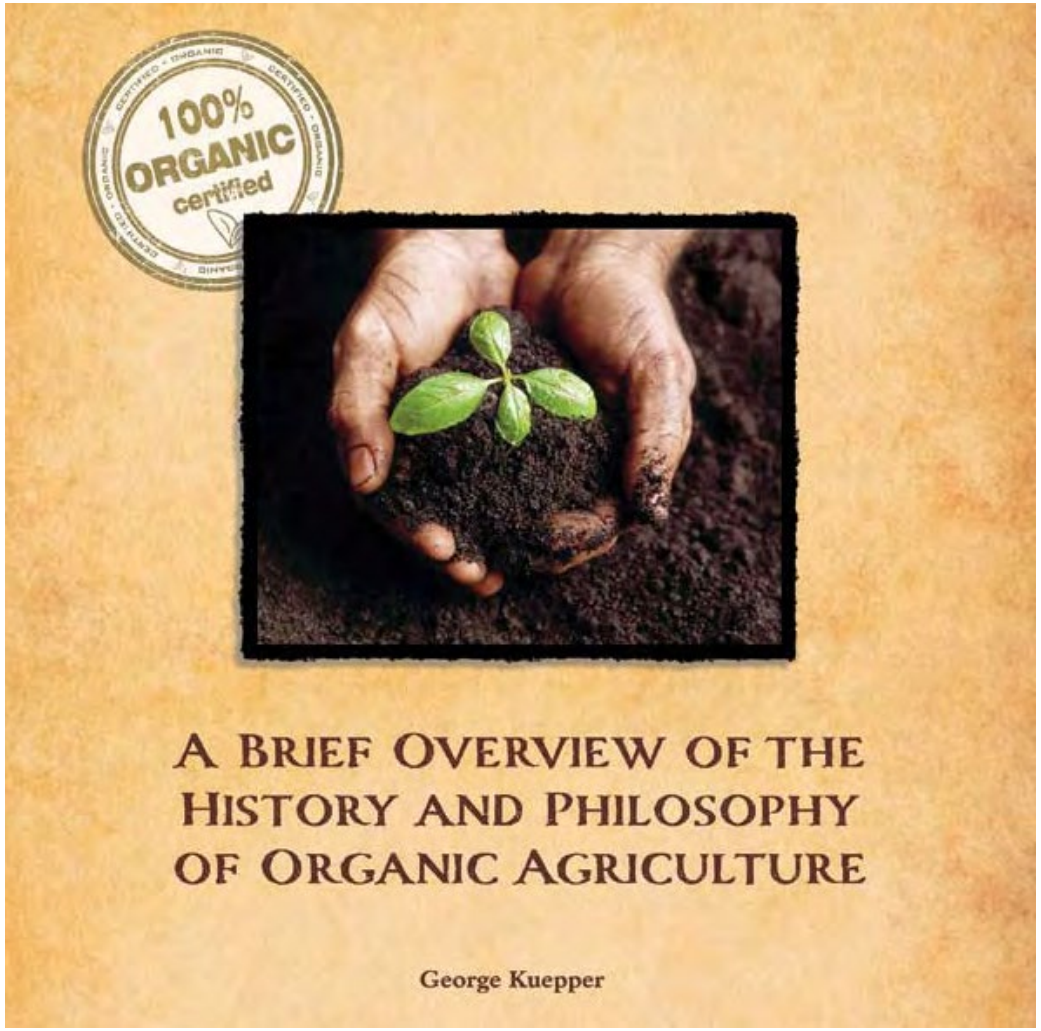
Organic farming uses set of cultural, biological, and mechanical practices that

a. reduce the risks of human, animal, and environmental exposure to toxic materials
b. maintain and improve soil fertility, soil structure and biodiversity, reduce soil erosion



Organic Foods Production Act of 1990 (OFPA)

1. Establish national standards governing the marketing of agricultural products as organically produced products
2. Assure consumers that organically produced products meet certain standards
3. Facilitate interstate commerce of fresh and processed organically produced food

National Organic Program (NOP)

Section 2104 of OFPA indicates that Secretary of Agriculture (USDA) shall establish a National Organic Program (NOP) to implement organic certification program for producers and handlers of organic products

What is an organic product?

To be sold or labeled as organic product, agriculture products should be

1. Produced and handled without the use of prohibited synthetic or non synthetic materials
2. Produced on land to which prohibited chemicals were not added in the 3 years preceding harvest
3. Produced in compliance with an organic plan agreed between producer or handler and certifying agent

National Organic Standards Board (NOSB)

1. Established by Secretary of Agriculture (USDA)
2. Comprises of 15 board members representing growers, handlers, retailers, experts, and certifying agents
    a. Assist in developing standards for substances used in organic production
    b. Advise USDA on any other aspects of implementation of OFPA
    c. Develops a National List of approved and prohibited substances that can be used in organic production
    d. Convenes technical advisory panels to provide scientific evaluation of materials

Note that the board can only make recommendations to USDA. Final decision is made be USDA.

Organic Label Categories

1. **100% Organic**: products must be made up of 100 percent certified organic ingredients

2. **Organic**: Non-organic ingredients allowed per the National List may be used, but no more than five percent of the combined total

3. **Made with Organic Ingredients**: At least 70 percent of the product must be certified organic ingredients. The organic seal cannot be used on the product, and the final product cannot be represented as organic

4. **Specific Organic Ingredients**: Products with less than 70 percent certified organic content would fall under this category. These products don't need to be certified and cannot display the USDA Organic Seal or use the word organic on the principal display panel

Organic Hydroponics

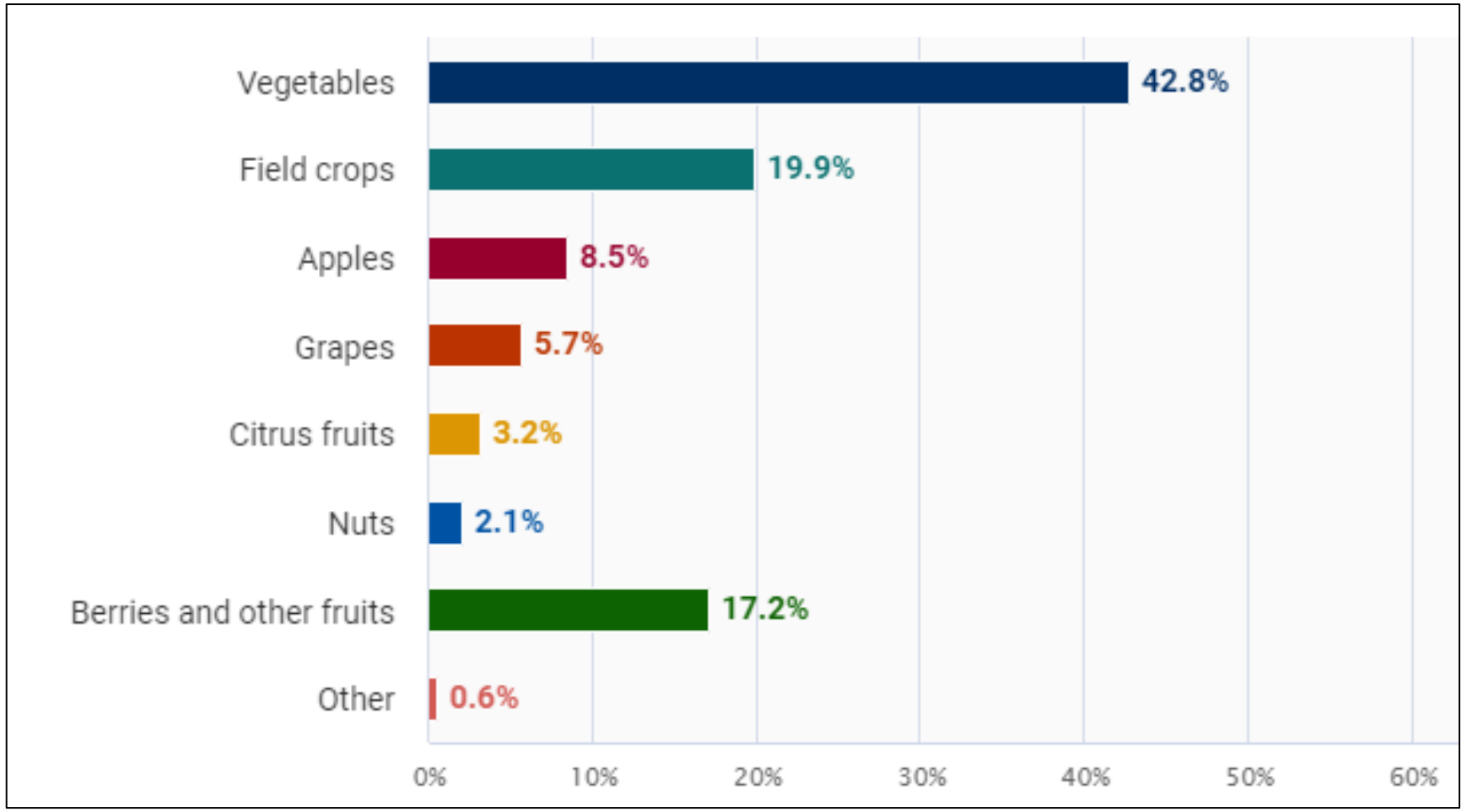
Can soilless production including hydroponics can be certified as organic?

1995: *The NOSB recommendation Standards for Greenhouses* : Hydroponic production in soilless media to be labeled organically produced shall be allowed if all provisions of the OFPA have been met
2010: NOSB recommendation entitled *Production Standards for Terrestrial Plants in Containers and Enclosures (Greenhouses)*. Systems of crop production that eliminate soil from the system, such as hydroponics or aeroponics, cannot be considered as examples of acceptable organic farming practices.
2015: NOP established a Hydroponic and Aquaponic Task Force to provide additional information to guide the NOSB's deliberations on whether hydroponic and aquaponic production should be allowed under organic regulations
2017: Vote failed on the NOSB motion that any container production system that does not meet the standard of a limit of 20% of the plants' nitrogen requirement being supplied by liquid feeding, and a limit of 50% of the plants' nitrogen requirement being added to the container after the crop has been planted is defined as hydroponic and should not be allowed to be certified organic
2019: Center for Food Safety (CFS) files a petition to USDA, which requested USDA to prohibit organic certification of hydroponic operations that do not work with or build soil
2020: After USDA denied the petition, CFS, along with a coalition of organic farms and stakeholders, filed a lawsuit challenging USDA's decision to allow hydroponic operations to continue to be certified organic
2021: The United States District Court for the Northern District rejected lawsuit and ruled that USDA's decision to exempt hydroponic operations from the soil fertility requirement was permissible

Current Status of Organic Hydroponics

- The USDA organic regulations do not currently prohibit hydroponic production.
- Certification to the USDA organic standards is currently allowed, as long as the certifier can demonstrate it is certifying in a way that complies with the standard
- There are greenhouse- and indoor-based hydroponic facilities that are organic certified in the US

Organic Market Segmentation in the US



Lettuce is the largest source of revenue within vegetables

Revenue $4.5 billion in 2020 (source: IBIS World)

Price difference: Conventional vs Organic

Product	Conventional ($)	Organic ($)
Romaine Lettuce (3 pk)	2.07	3.11

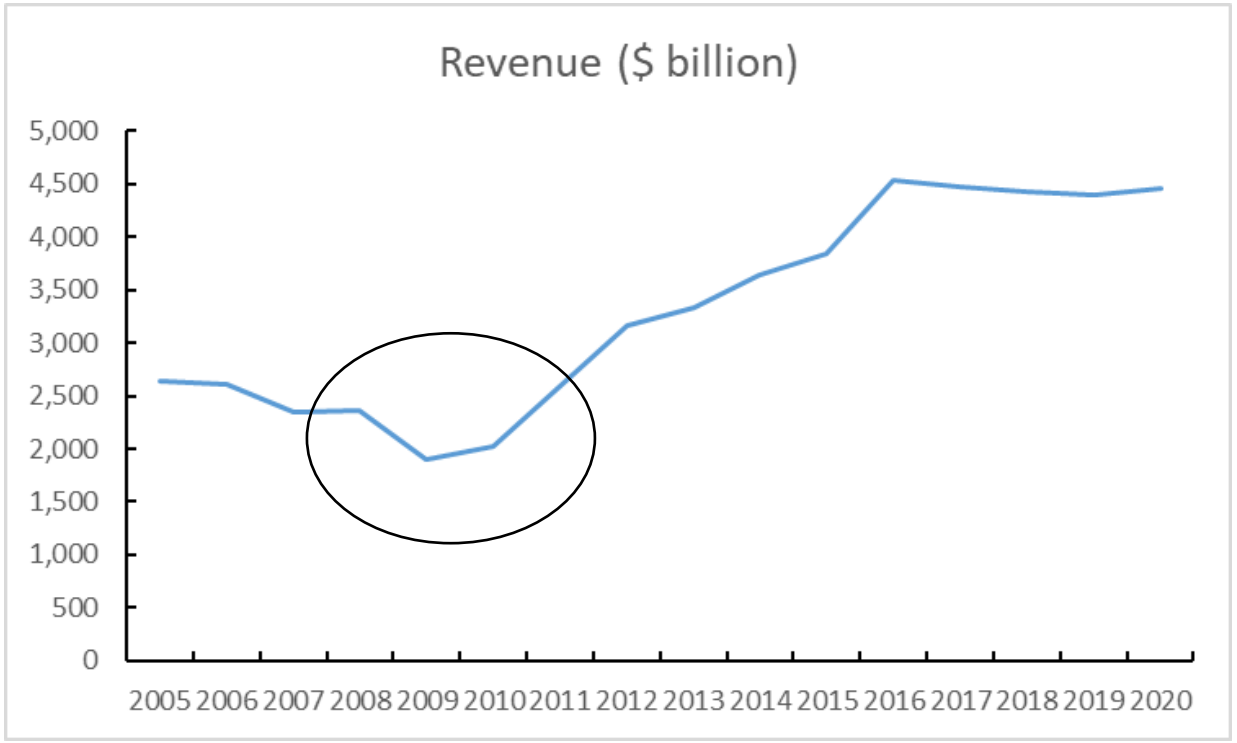
A premium of nearly 50% is charged for organic compared to conventional lettuce

Source:
Islam S, Colonescu C. Data on retail price differential between organic and conventional foods. Data Brief. 2019;27:104641. Published 2019 Oct 11. doi:10.1016/j.dib.2019.104641

Issues with organic farming

- Crop yields are consistently lower and variable in field based organic farming compared to conventional agriculture (Source: T. de Ponti, B. Rijk, M. K. van Ittersum, The crop yield gap between organic and conventional agriculture, Agricultural Systems, Volume 108, 1-9. 2012. https://doi.org/10.1016/j.agsy.2011.12.004.

- Organic produce market is mainly limited to select group of consumers making it risky, especially when economic growth becomes slow due to unforeseen factors.



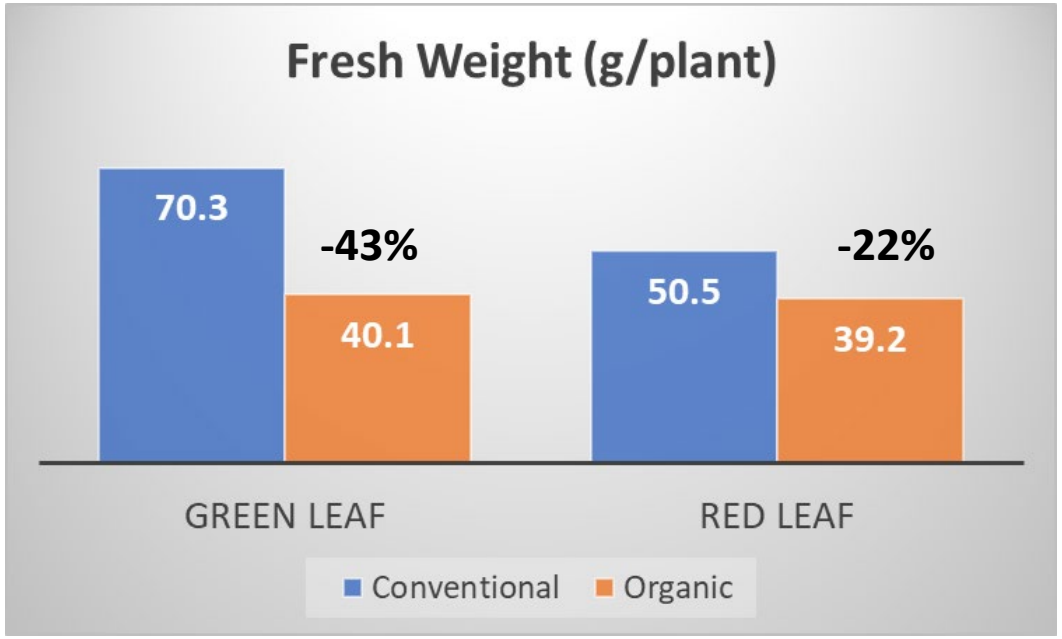
Goal: Reduce yield gap between conventional and organic production

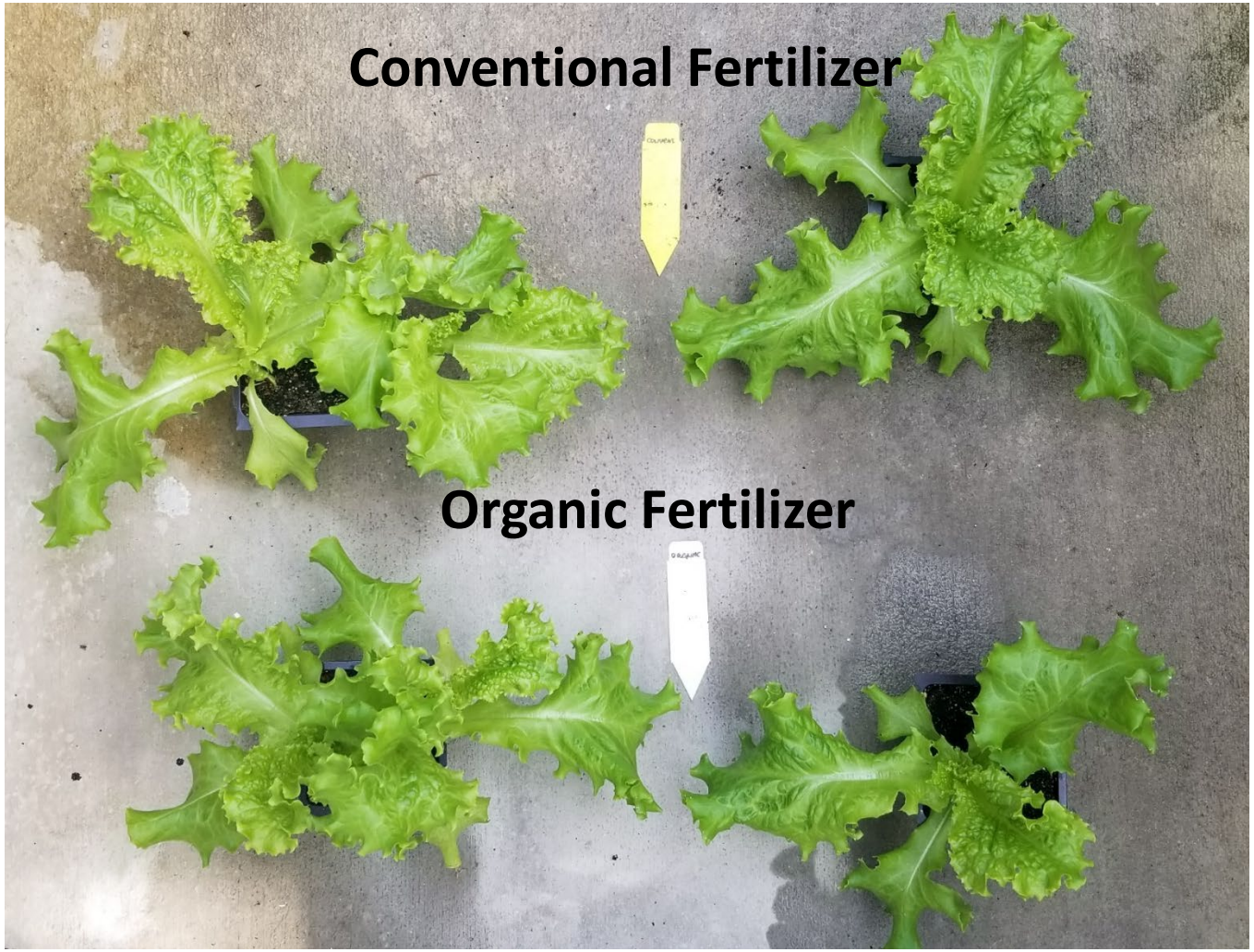
Study: Compare differences in lettuce growth and nutritional quality

- Organic peat media comprising of more than 75% peat and 25% vermiculite
- Fertilizer recipes providing similar percentages of nutrients in conventional and organic fertilizer were developed (OMRI certified for organic fertilizers)
- Organic seeds of green leaf and red leaf lettuce varieties were used
- Reverse osmosis water without any nutrients was used during production. Irrigation water was recirculated and separate reservoirs were maintained for each treatment
- Plants were grown for 4 weeks in sub-irrigation channels
- Experiment was replicated 12 times using a split-plot design

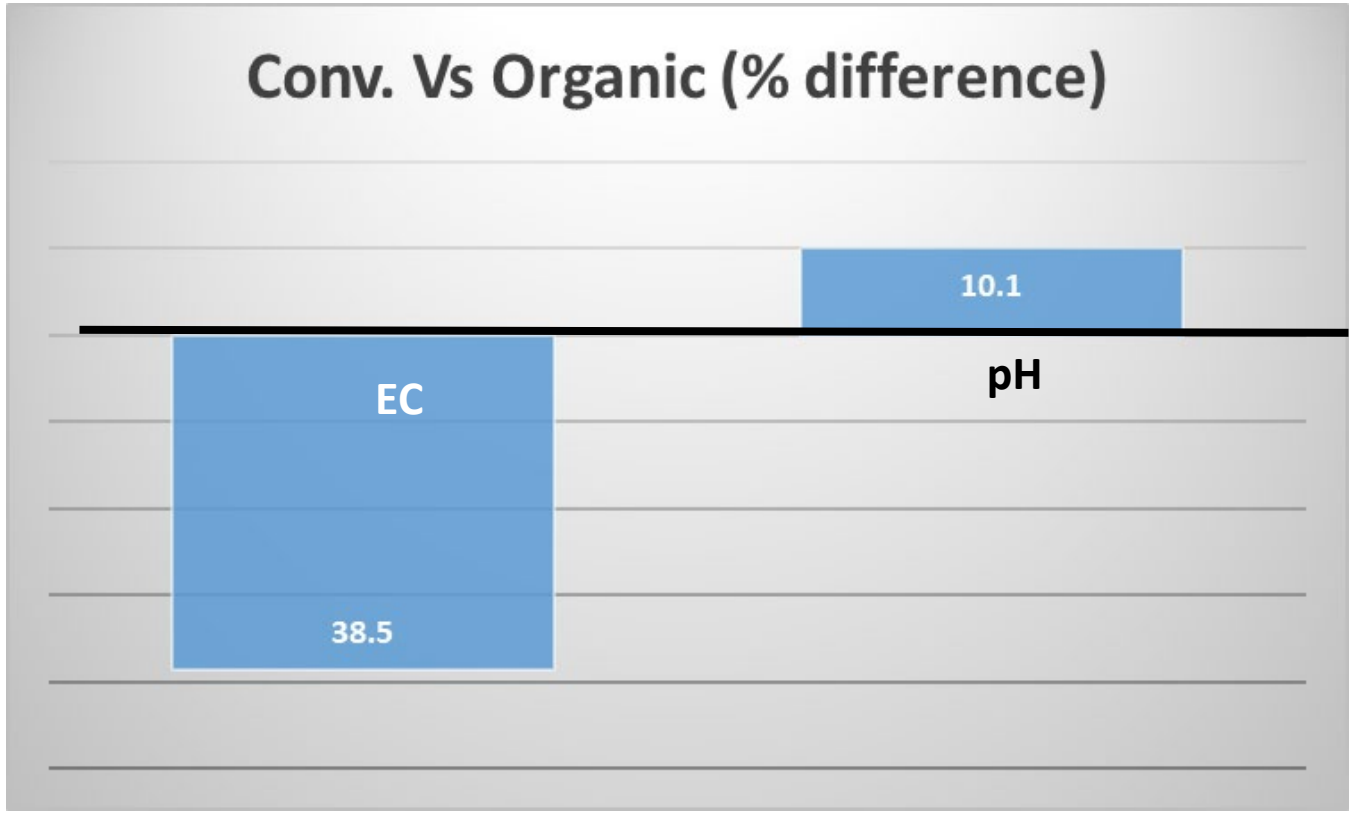
Element	Conventional	Organic
	(%)	
N	32	32
P	8	10
K	21	25
Ca	6	7
Mg	3	3
S	17	5
Fe	0.97	2.00
Mn	0.13	0.16
Mo	0.042	0.000
B	0.042	0.750
Cu	0.105	0.000
Zn	0.105	0.000

Lettuce yield in organic treatment was lower than conventional treatment





Electrical conductivity of leachate indicated lower concentration of plant nutrients in the organic than conventional treatment

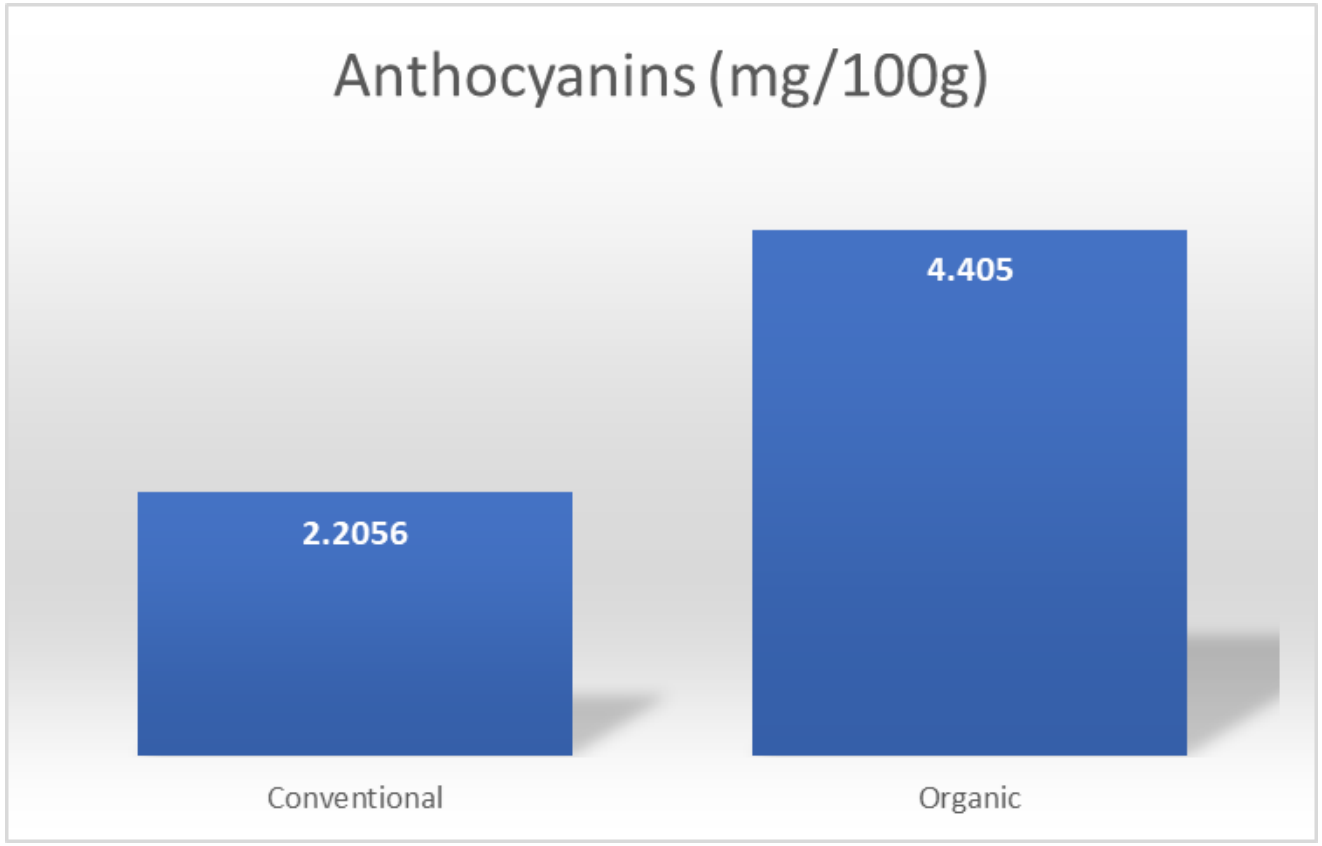


Organic lettuce had higher levels of anthocyanins

Anthocyanins

Improves

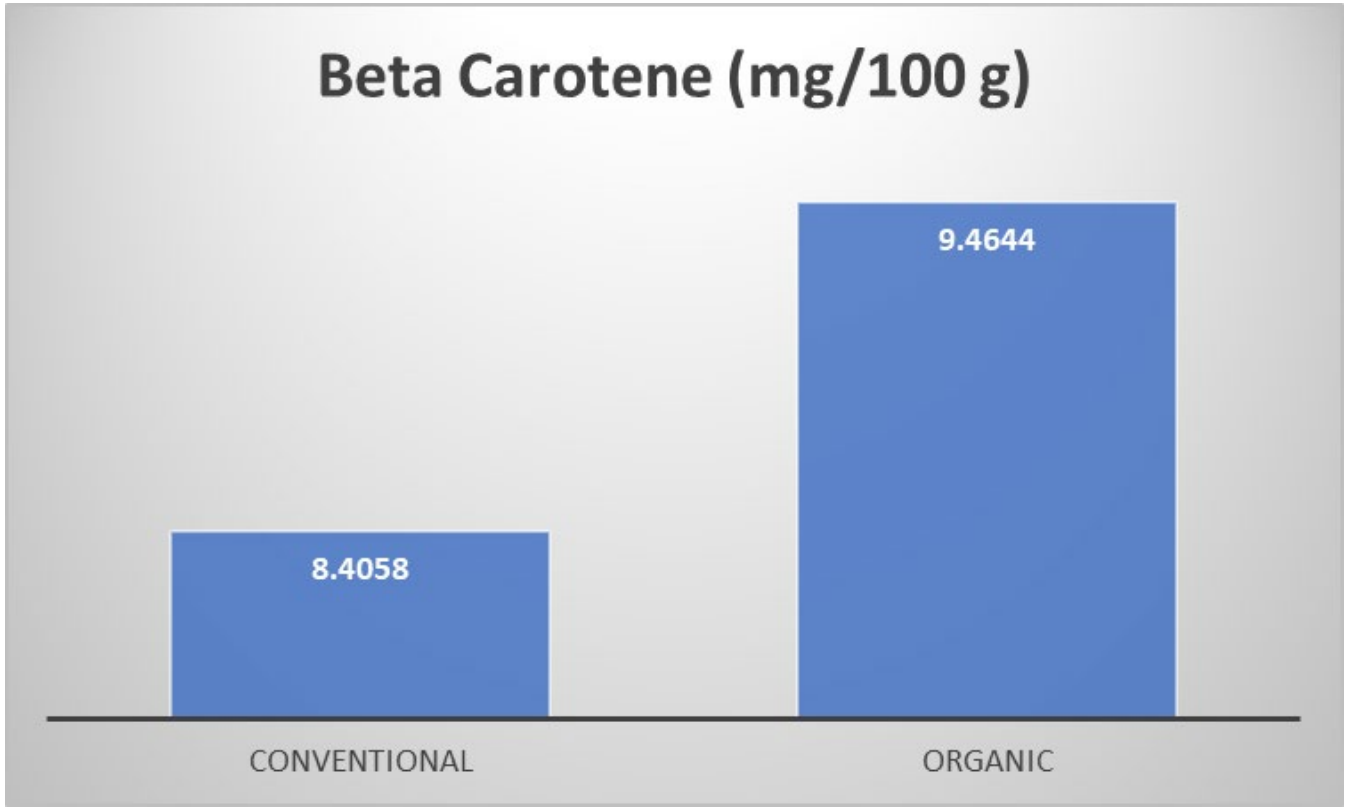
- Cardiovascular health
- Eye health
- Antoxidant properties
- Neuroprotective



Organic lettuce had higher levels of beta-carotene

Beta-Carotene

- Required for vitamin A synthesis
- Improves
  - Eye health
  - Cognitive function
  - Skin health



Estimate Plant Nutrient Status Using Your Smartphone

Select Crop
Lettuce
Poinsettia
Hydrangea

Select Trait
Nitrogen
Area
Number

Instructions
Place camera two feet above plants in a flat

Click Here

APTUS: **A**nalyzing **P**lant **T**raits **U**sing **S**martphones

Concluding Statements

1. Premiums for organic produce are justifiable at this stage due to low yields. Consumers not interested in paying premiums can produce organic produce at homes. They can contact Purdue extension to learn more about ‘at-home’ grow kits

2. Production practices that aid in increasing nutrient supply from organic media/ organic fertilizers should be developed by research

3. Technology to monitor plan nutrient levels may aid in early detection of yield loss and corrective measures

4. Premiums will reduce when yield gap between conventional and organic produce becomes smaller