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Green bin compost agricultural trials: results to-date

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Why MSW compost?

- Total global cost of solid waste management in 2010 was $205.2 billion
- This will increase to *ca*. $375 billion in 2025 (World Bank, 2017)
- 30–64% of the total MSW constitute biodegradable organic materials...a ready supply of raw materials for composting
- Composting offers an immediate solution to the problem of:
  - "wasting" organic materials for recycling soil OM and soil nutrients needed for plant growth

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Why MSW compost?

- The benefits of MSW compost are well known but not completely accepted, especially for food production due to contamination concerns
- But the specific effect on food quality and safety is understudied
- These have slowed down global adoption of MSW compost
- So, what about long-term application of CQA-tested compost?

Project Objectives

- Overall objective:
  - To support the advancement of CQA-tested compost markets in MB and Canada

- Specific objective:
  - To determine the application frequency of CQA-tested MSW compost on soil quality, plant growth, harvest quality and economic benefit (“the big data”)

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The Trial

- 5-year research at Aagaard Farms, Brandon MB (Lat. 49.848, Long. -99.950)
- CQA-tested MSW compost from the City of Brandon facility
- Lettuce (*Latuca sativa* cv. Grand Rapids), beets (*Beta vulgaris* cv. Detroit Supreme), carrot (*Daucus carota* cv. Nantes), green beans (*Phaseolus vulgaris* cv. Golden Wax)
- Treatments: No compost, Annual & Biennial applications
- Randomized complete block design with three replications
- Plot size: 3 m x 6 m
- Sandy loam soil with drip irrigation

The Big Data

- Plant morpho-physiological data
- Metagenomics (microbial) data
- Metabolomic data for untargeted plants metabolites
- Soil physico-chemical data
- Economics - cost/benefit data

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Figure 1. Soil equivalent N release, organic matter, cation exchange capacity and pH.

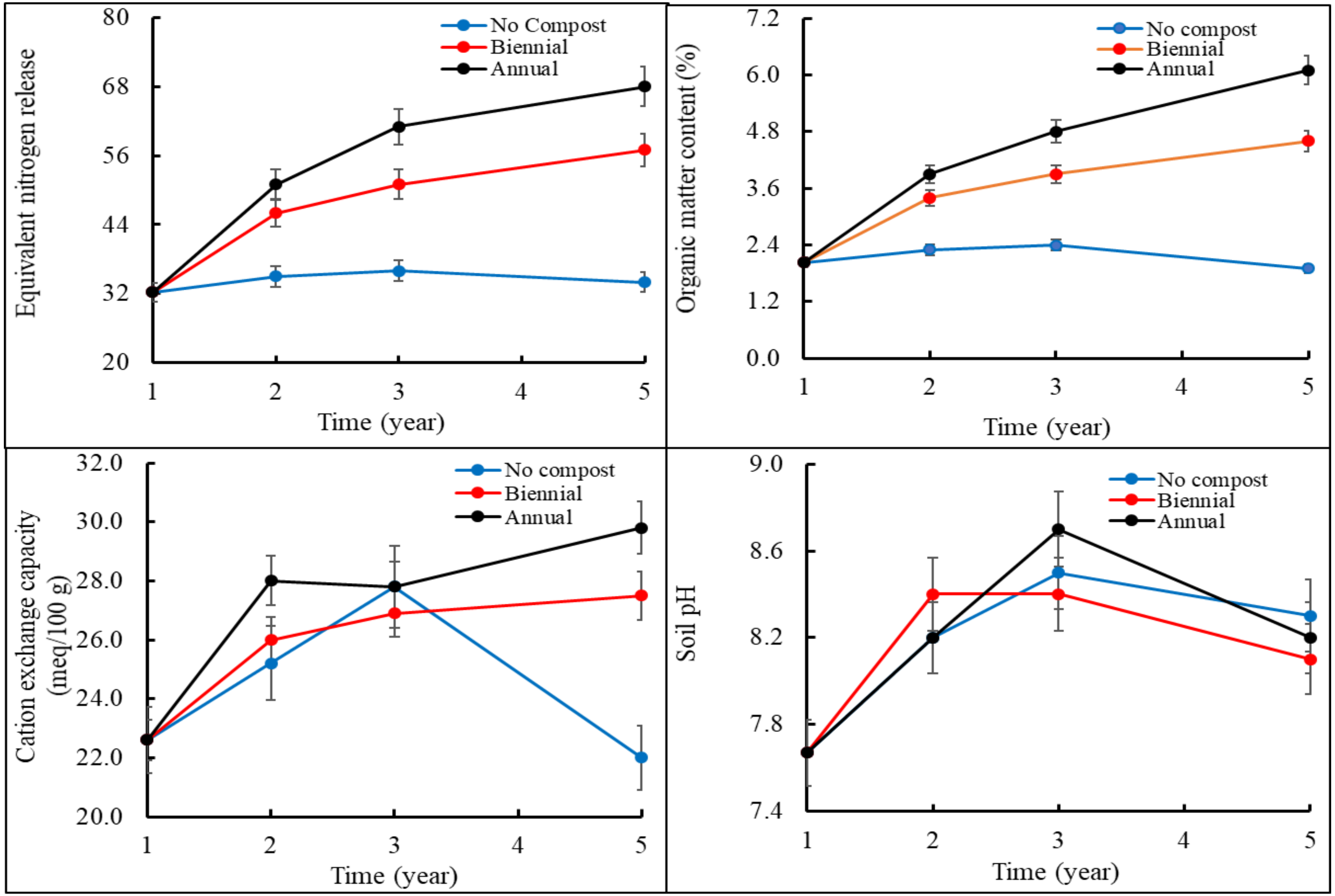

Table 1. Selected physical and hydrological properties of soil after five years of application of CQA-tested green bin compost at different frequencies.

Hydrological properties	Treatment		
	Annual	Biennial	Control
WHC (%)	69.58a	59.80b	47.20c
Saturation capacity (%)	49.33a	46.39a	39.65b
Field capacity (%)	41.24a	35.37ab	30.49b
Wilting capacity (%)	6.40a	4.69ab	4.16b
Bulk density (g/cm^3)	0.99b	1.06b	1.22a
Particle density (g/cm^3)	1.22c	1.33b	1.41a

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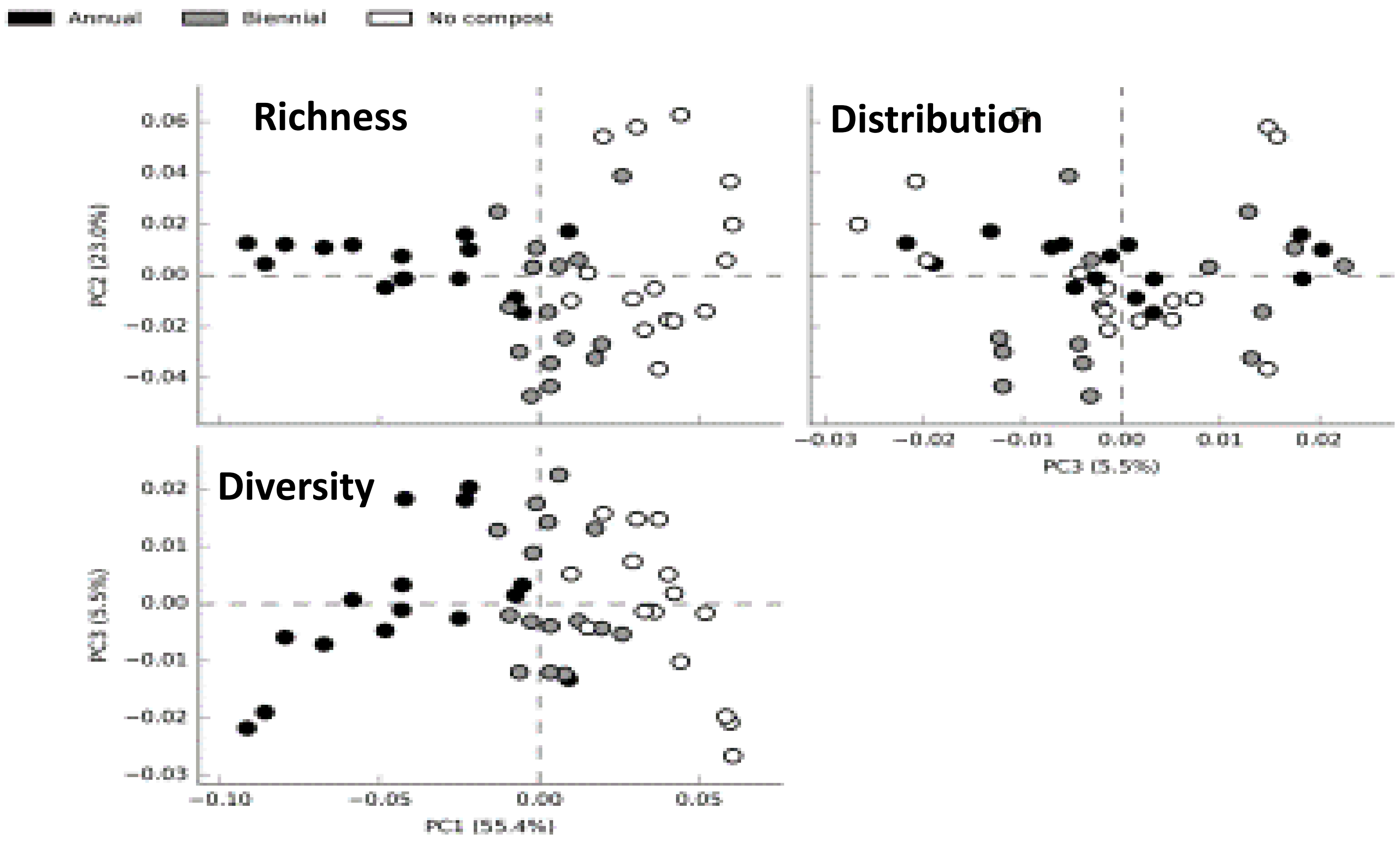

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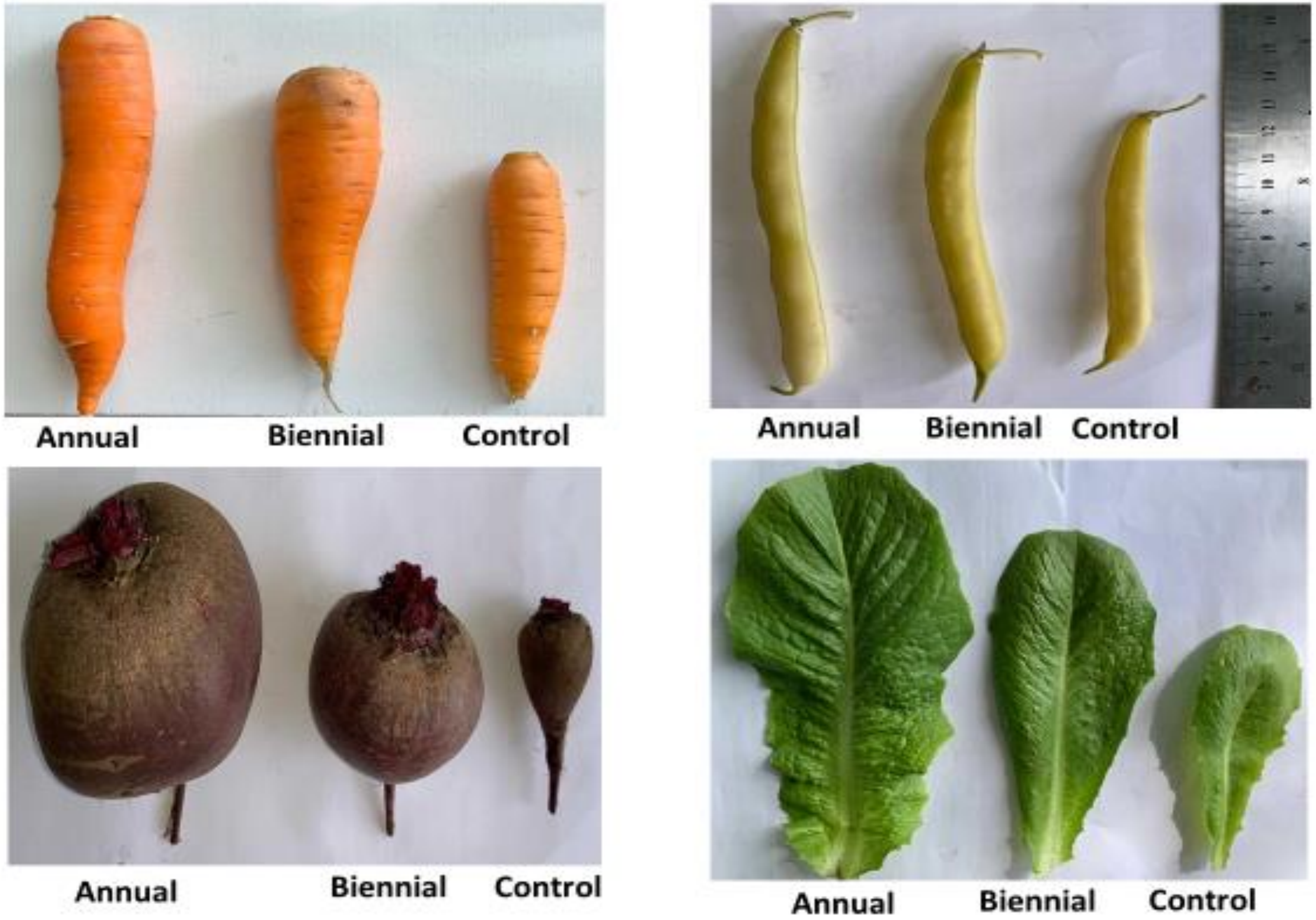
Figure 1. Size distribution of the carrots, green beans, lettuce and beets.



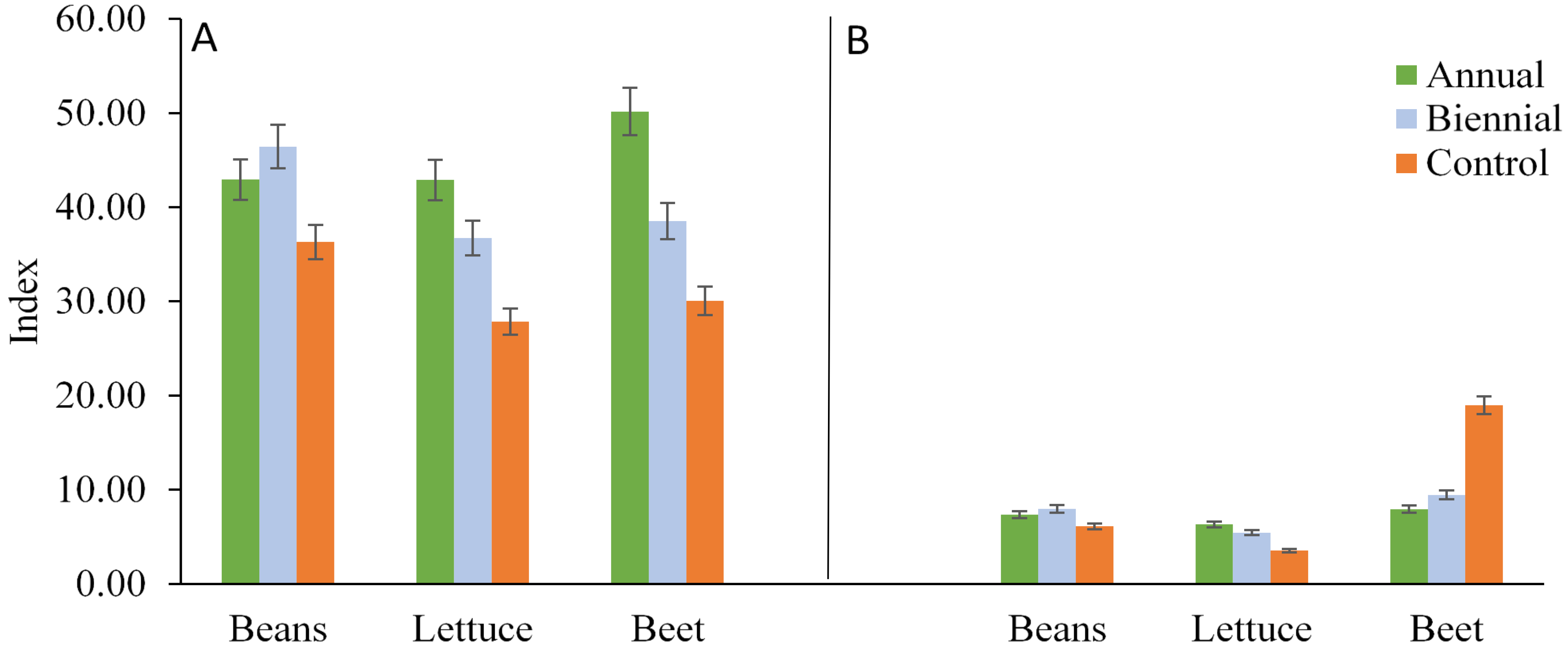


Fig. 2. Chlorophyll (A) and anthocyanin (B) contents of plants leaves as affected by CQA-tested compost applied annually, biennially and no compost application at the end of a 5-year period.

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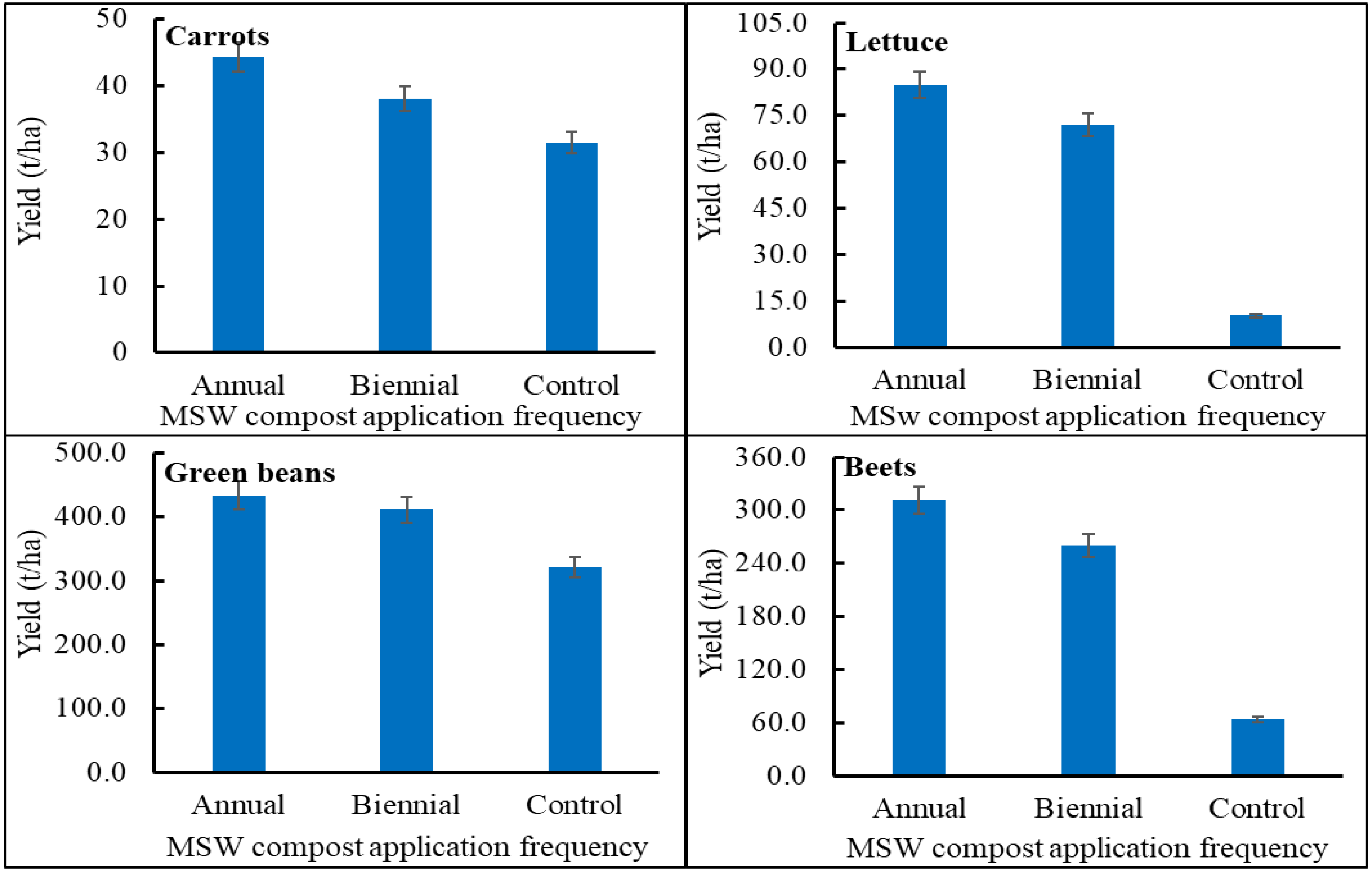
Figure 4. Yield of carrots, lettuce, beets and green beans at Year 5.



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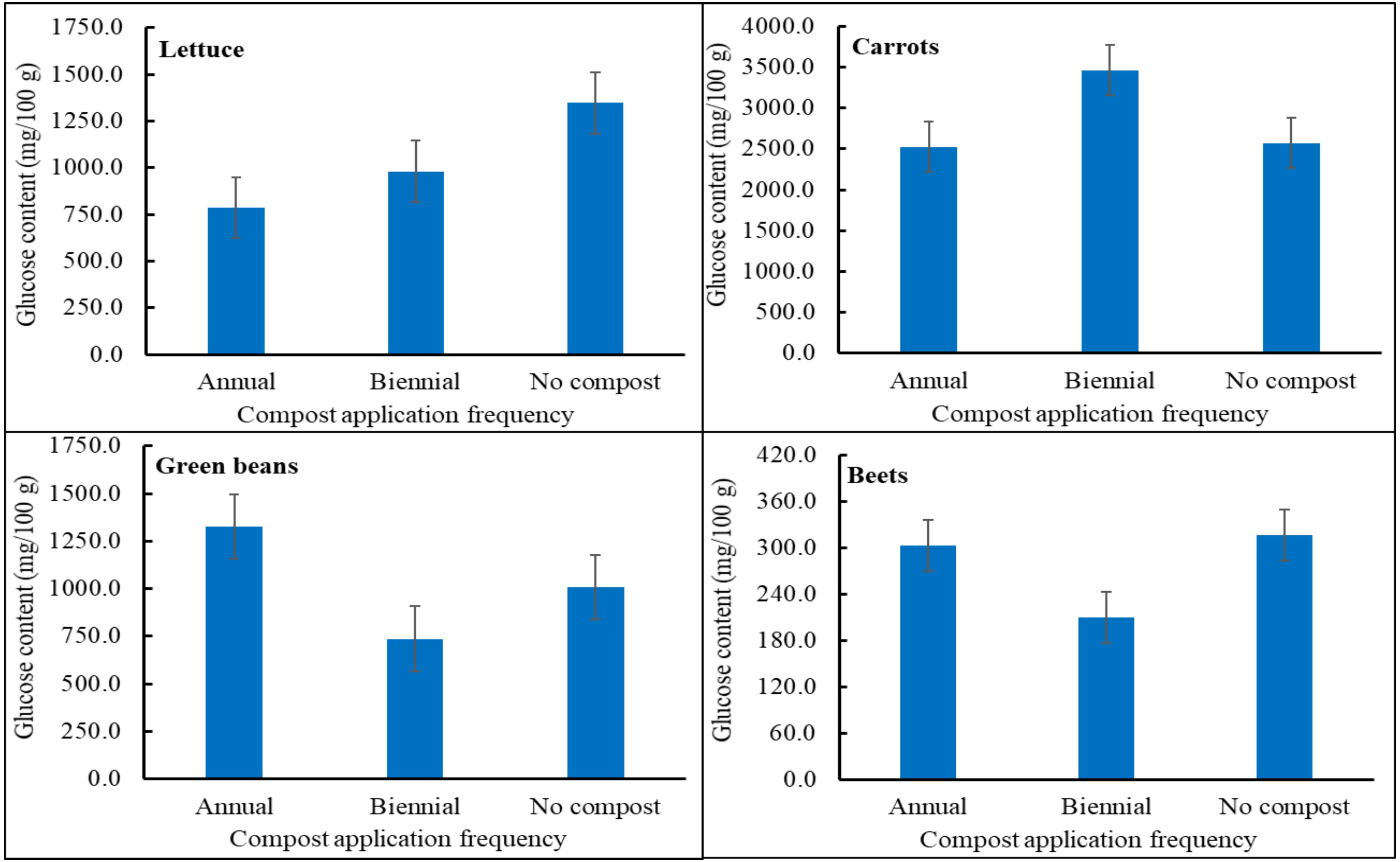
- Glucose is the major source of energy for the body cells
- Glucose is converted to sucrose, cellulose, lipids, proteins and stored as starch

Figure 5. Total glucose contents of the four harvested crops.



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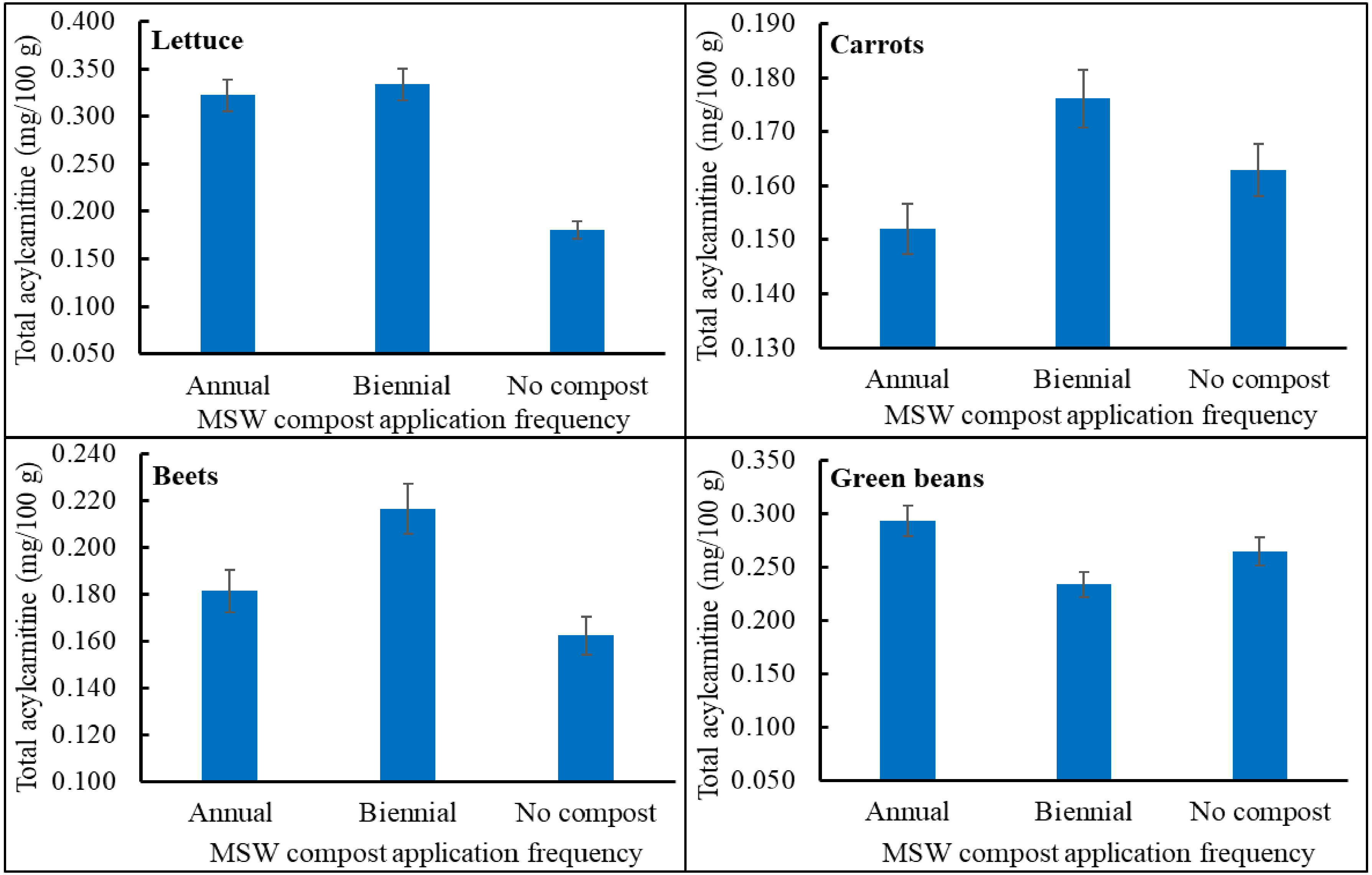
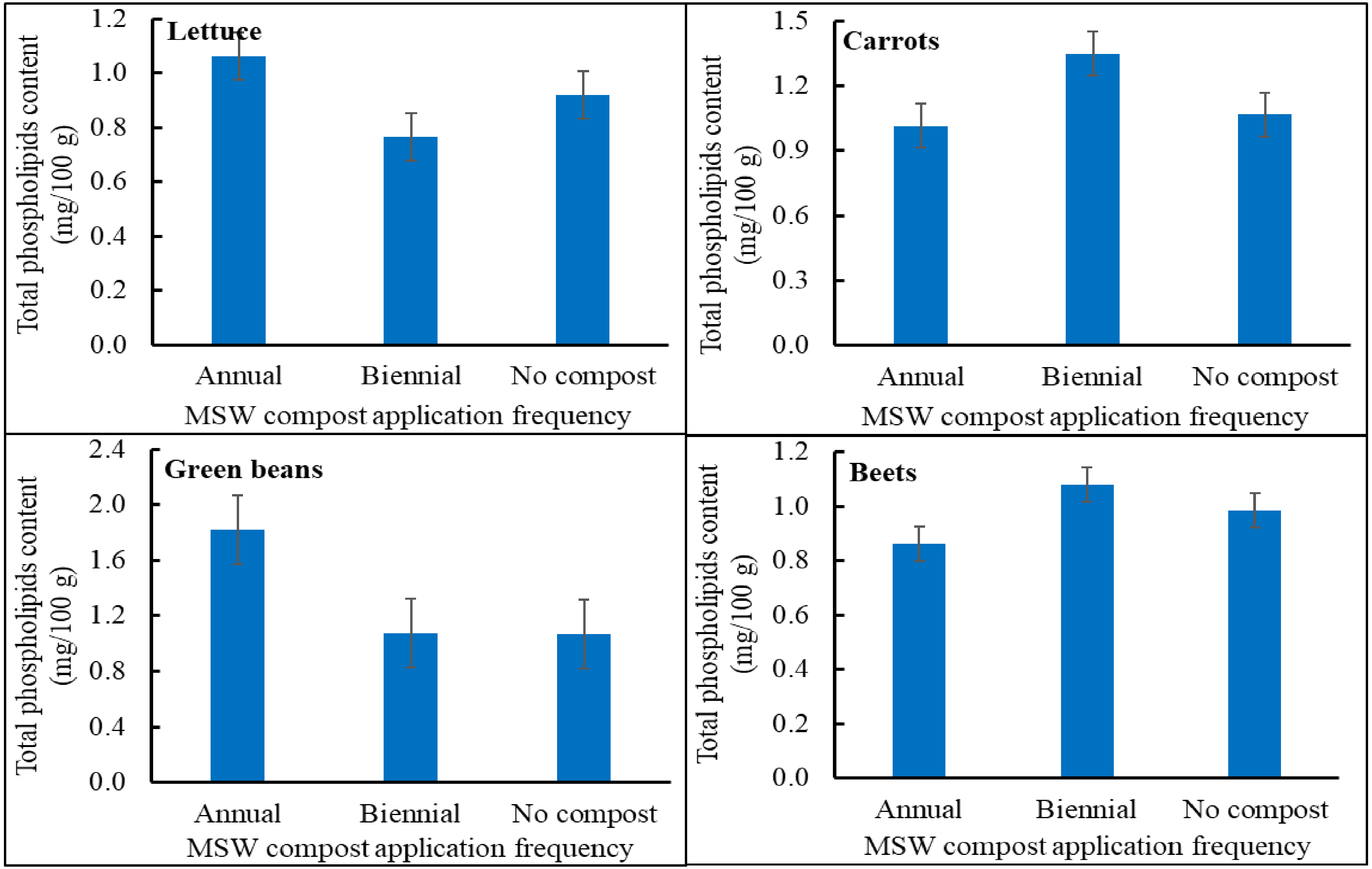
- Acylcarnitines are derivatives of long-chain fatty acids
- Required for fatty acids transportation into mitochondria for β-oxidation
- Play an important role in plants resistance to metals
- They support membranes of cell organelles

Figure 6. Total acylcarnitines contents of the four harvested crops.



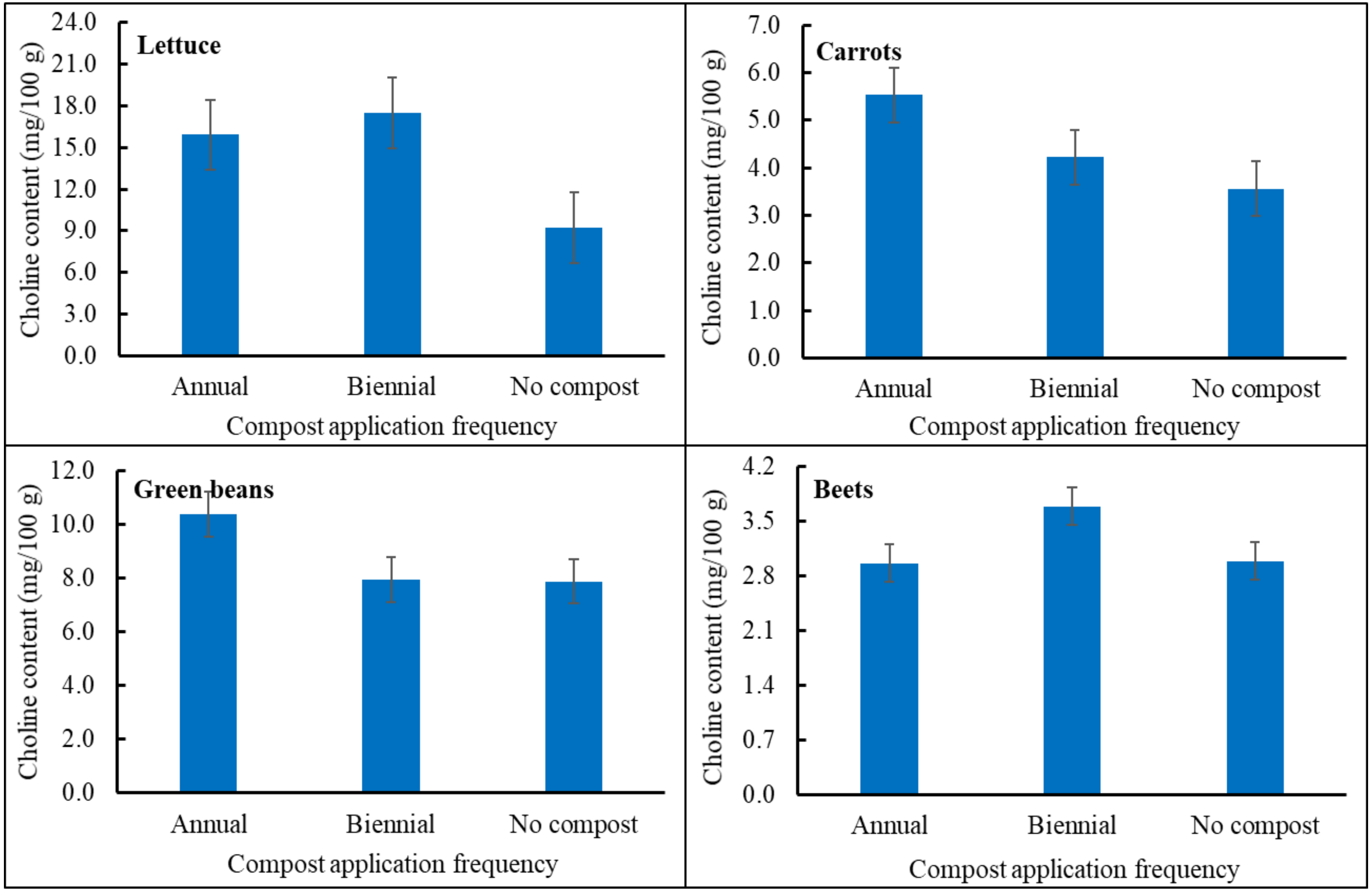
- Lysophospholipids play crucial biological roles, mainly as signaling molecules
- They affect growth, survival, migration and activation of many cell types
- Lysophosphatidic acid and lysophosphatidylcholine are increasingly linked with atherosclerosis and anti-inflammatory effects

Figure 7. Total lysophospholipids content of the four harvested crops.



- Choline is an essential nutrient, naturally present in some foods
- It is a source of methyl groups for many steps in metabolism
- Vital roles in modulating gene expression, cell membrane signaling, lipid transport and metabolism, and early brain development

Figure 8. Choline contents of the four harvested crops.



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- Amino acids are the building blocks of proteins
- The nine essential amino acids are involved in tissue growth, energy production, immune function and nutrients absorption

Figure 9. The nine essential amino acids contents in the four harvested crops.

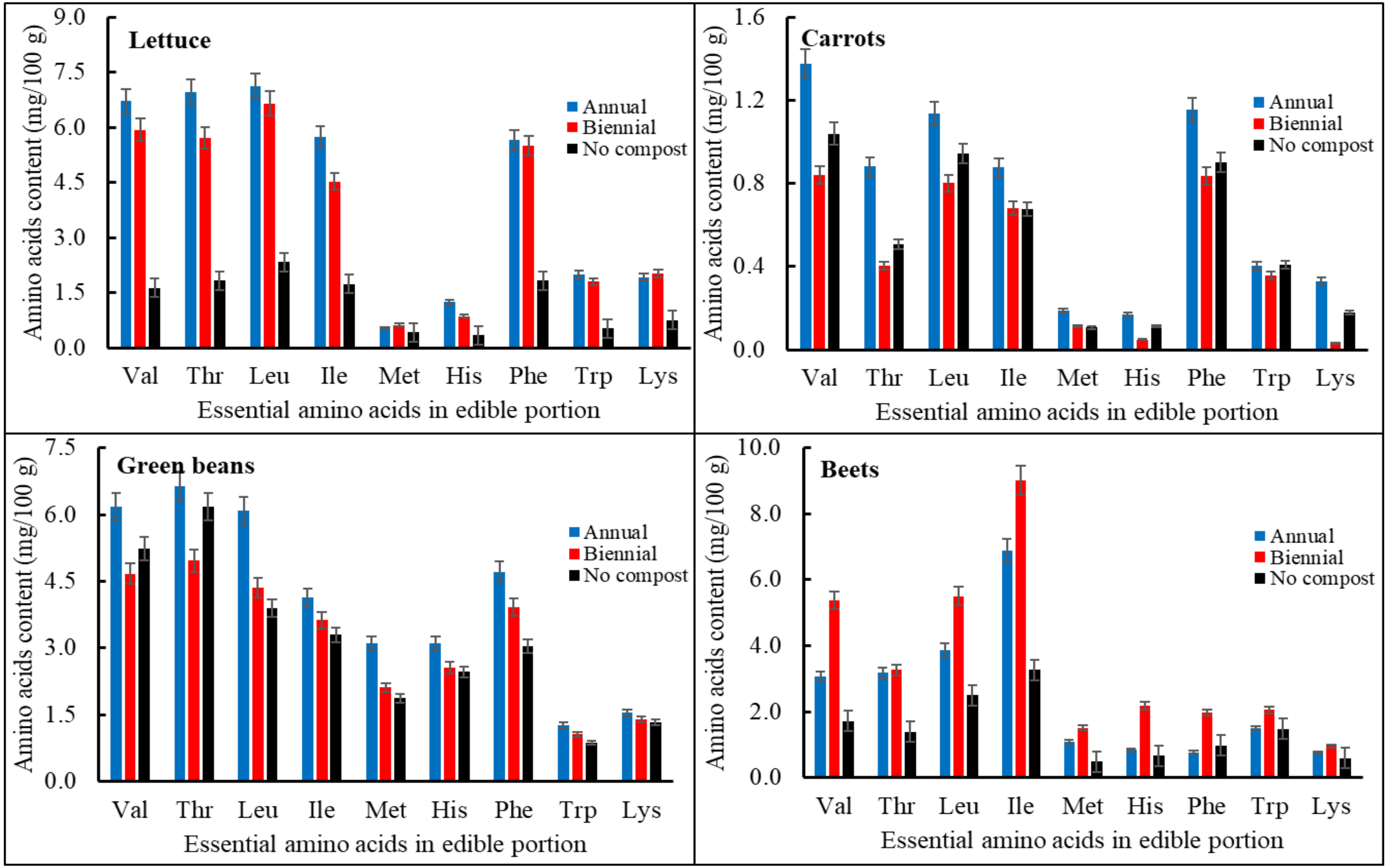

Table 1. Roles of the nine essential amino acids.

Amino acid	Role
Isoleucine	Formation of hemoglobin; prevents muscle wasting in debilitated individuals
Leucine	Promotes healing of skin and broken bones; reduces muscle protein breakdown
Valine	Influences brain uptake of other neurotransmitter precursors (tryptophan, phenylalanine and tyrosine)
Histidine	Production of red and white blood cells; treatment of anemia
Lysine	Inhibits viruses; treatment of herpes simplex, Lysine and Vitamin C together form L-carnitine, a biochemical that enables muscle tissue to use oxygen more efficiently, delaying fatigue
Methionine	Increases the antioxidant levels (glutathione); reduces blood cholesterol levels
Phenylalanine	Production of collagen, precursor of tyrosine; enhances learning, memory, mood and alertness
Threonine	Prevents fatty build up in the liver; amino detoxifers
Tryptophan	Prevents fatty buildup in the liver; precursor of key neurotransmitter serotonin, which exerts a calming effect

http://www.phcogrev.com/viewimage.asp?img=PhcogRev_2013_7_14_107_120508_t1.jpg

GENERAL CONCLUSION

- The findings have proven the efficacy of green bin compost for food production in addition to its importance in improving soil natural fertility in farming systems
- Frequent application tremendously improved soil physical, chemical and microbiological properties
- High SOM enhanced physical, chemical and biological properties
- The difference in soil microbial community structure i.e. richness, distribution and diversity were quantified and sufficiently demonstrated on a 2-D principal component plot
- Overall, the trend in the changes in soil quality parameters with reference to Year 1 was annual > biennial > no compost treatment which correlated with plant growth and yield

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FUTURE PLANS AND RECOMMENDATIONS

- Economic benefit: data collation and analysis
- Public engagement: compost industry and other stakeholders will be engaged on discussion of the 5-year research
- Final report will be made available on the CCC website
- Manuscripts are being prepared for publication
- The research will be continued depending on funding availability to assess long-term benefits, sustainability and environmental impact

Acknowledgement

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