



# ANNUAL PERFORMANCE REPORT 2021

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- **TITLE:** Optimizing Nutrient Delivery for Modern Cultivars of Greenhouse-grown Potted Chrysanthemums: Sub-irrigation and Drip-irrigation Systems
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# Chrysanthemum (mum): an economically important crop

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- Worldwide: most common floricultural crop
- Canada:
  - 3<sup>rd</sup> most produced indoor potted flower (~ 5 M)
  - 5<sup>th</sup> most produced outdoor potted flower (~ 3 M)
  - 3<sup>rd</sup> most produced cut flower (~23 M)

(Statistics Canada 2021)

- Indoor potted flowers well suited to subirrigation

# Subirrigation (capillary irrigation)

- Ebb-and-flow system
- Composition of excess nutrient solution unaltered
- Recycle excess nutrient solution
- Effectively eliminates nutrient runoff
- Opportunity to further reduce fertilizer input



Photos: courtesy of Bill MacDonald

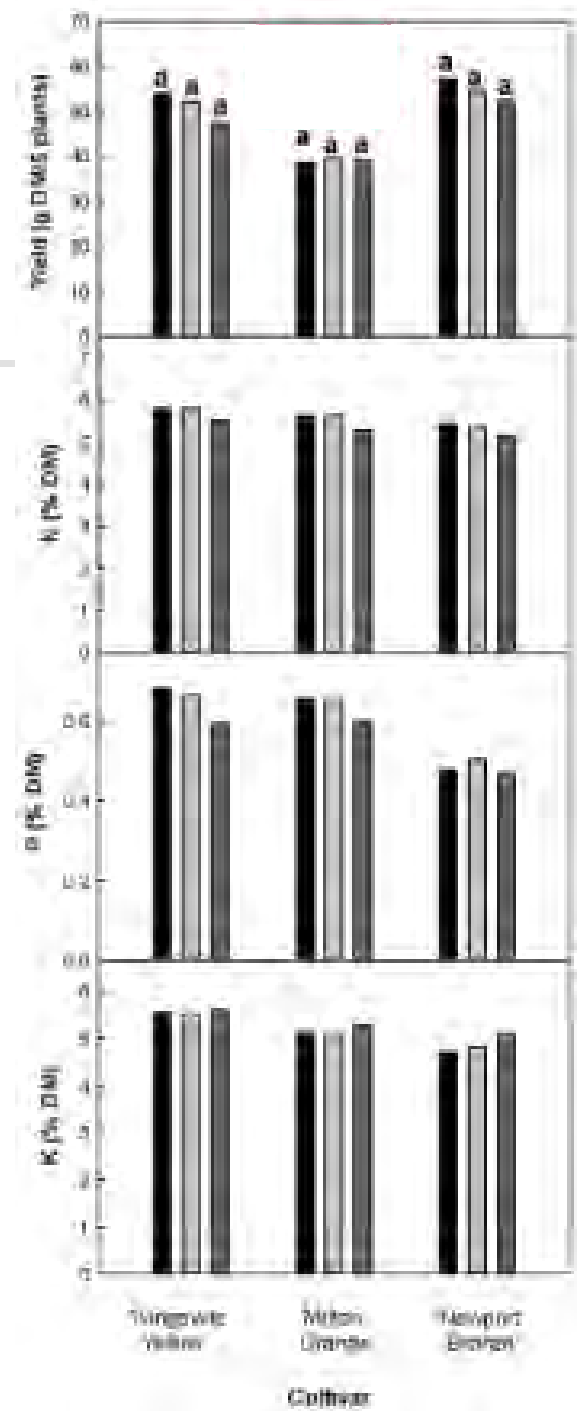
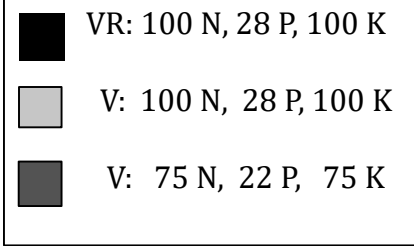


# Hypothesis

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- Nutrient use efficiency of modern cultivars greenhouse-grown potted chrysanthemums is improved by reducing nutrient supply during vegetative growth, in combination with an interrupted supply during reproductive growth, without sacrificing plant yield & quality

# Commercial validation (SCHENCK 2020)



# Optimized macronutrient delivery during vegetative growth

<b>NUTRIENT SOURCE</b>	<b>Macronutrient supply (ppm)</b>					
	N	P	K	Ca	Mg	S
<b>Sonneveld's solution (1987)</b>	260	80	235	170	62	64
<b>Peters Professional 17-3-17</b>	300	53	300	71	22	–
<b>Fusion Plant Products 17-5-17</b>	285	84	285	50	17	–
<b>TRIAL</b>						
<b>UofG (2018/19)</b>	64	20	90	68	9.1	18
<b>SCHENCK (2020)</b>	75	22	75	13	4.4	–

-, S requirement was not provided in the soluble fertilizer

# Acceptable leaf macronutrient status with optimized delivery during vegetative growth

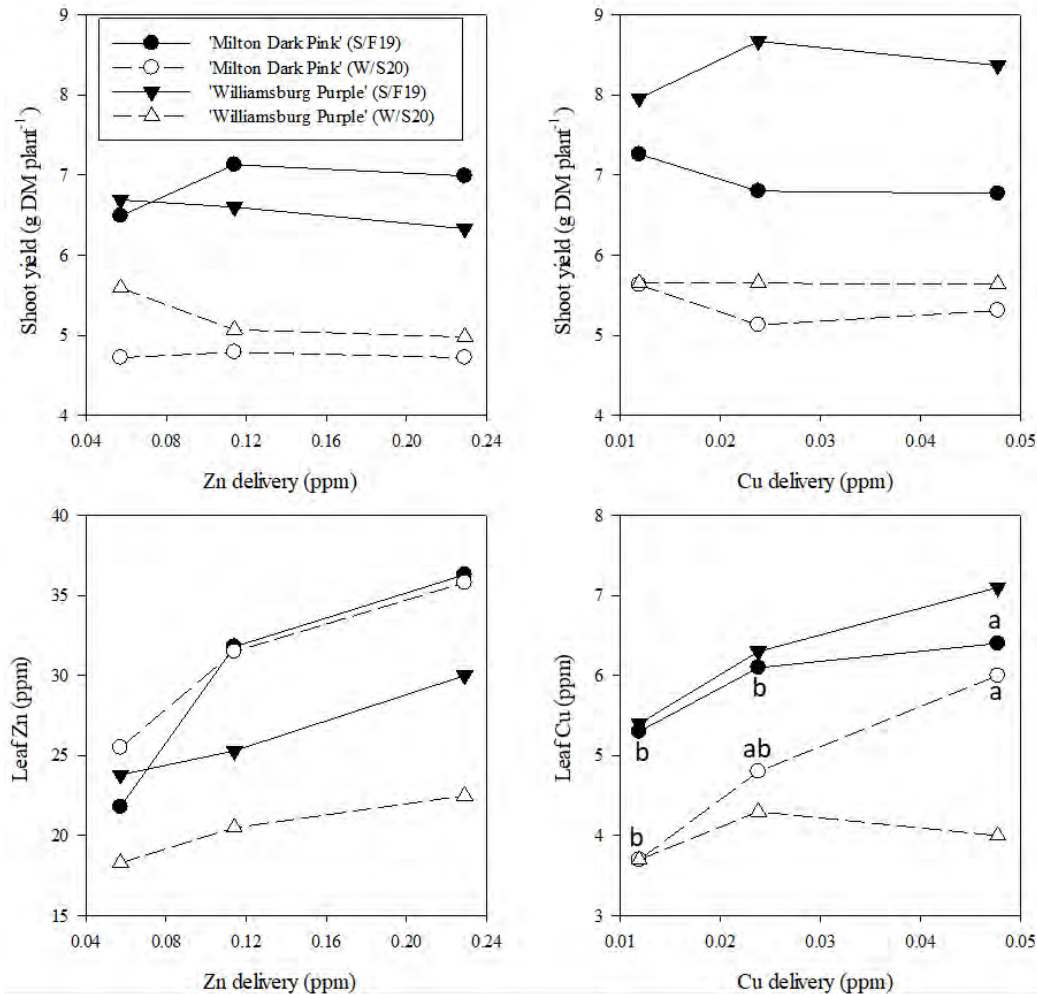
<b>GUIDELINE</b>	<b>Macronutrient (% DM)</b>					
	N	P	K	Ca	Mg	S
<b>OMAFRA Publ. 370</b>	4–6	0.2–1.2	1–10	0.5–4.6	0.1–1.5	–
<b>RJ Hill Lab Ltd.</b>	3.5–5	0.23–0.7	3.5–5	1.2–2.5	0.25–1	0.25–0.7
<b>TRIAL</b>						
<b>UofG (2018/19)</b>	4.0–5.5	0.54–0.75	4.2–5.2	0.9–1.5	0.31–0.59	0.31–0.35
<b>SCHENCK (2020)</b>	5.2–5.5	0.47–0.60	5.1–5.6	1.4–1.7	0.62–0.76	0.30–0.42

## Objective 3

- Reduce micronutrient delivery to subirrigated pot mums during vegetative growth



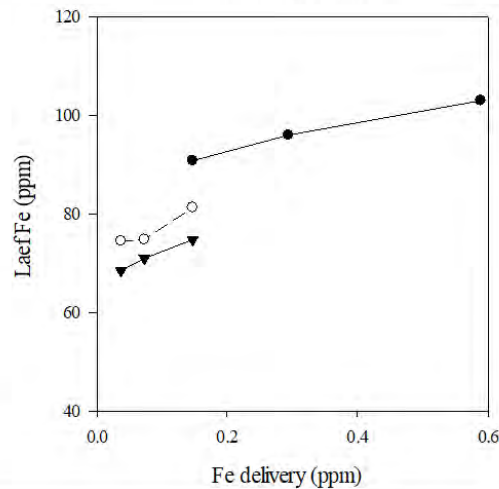
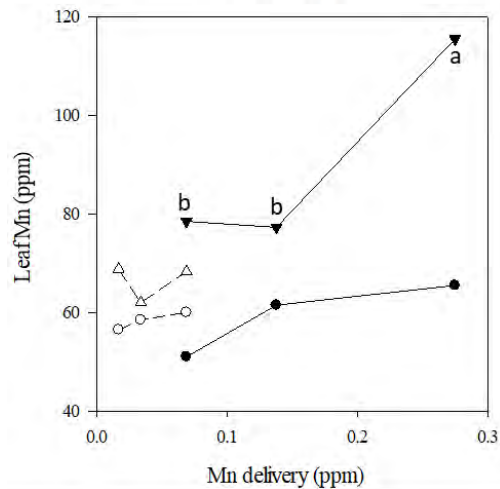
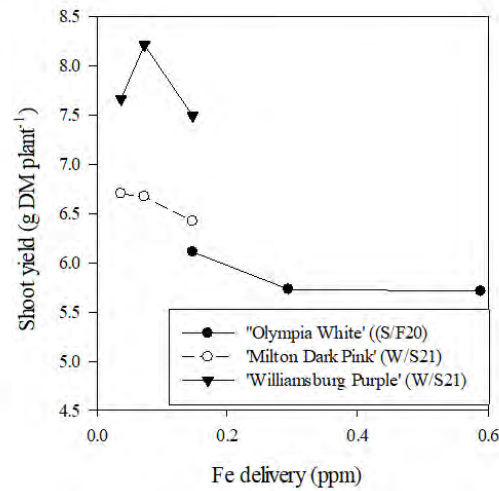
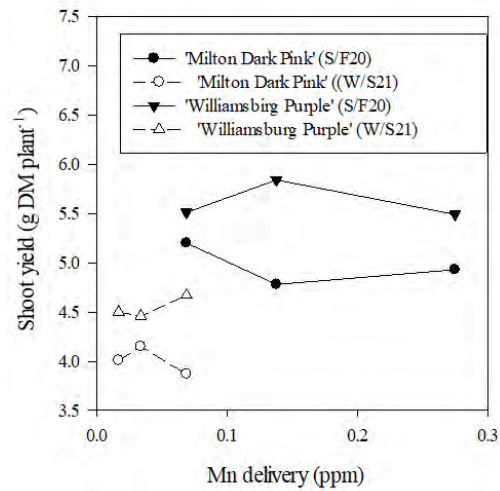
# Shoot yield & micronutrient status unaffected by Zn or Cu nutrition during vegetative growth



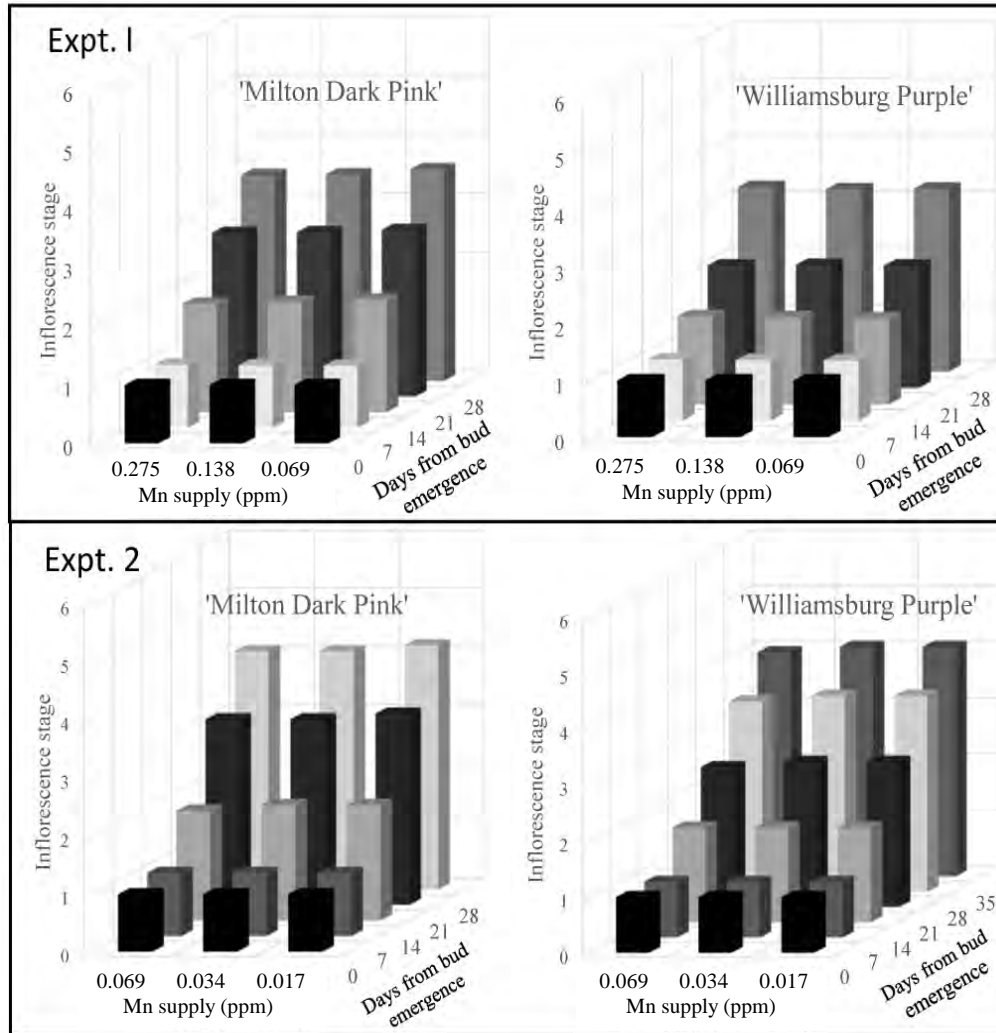
# Marketable quality unaffected by Zn or Cu nutrition during vegetative growth



# Shoot yield & micronutrient status unaffected by Mn or Fe nutrition during vegetative growth

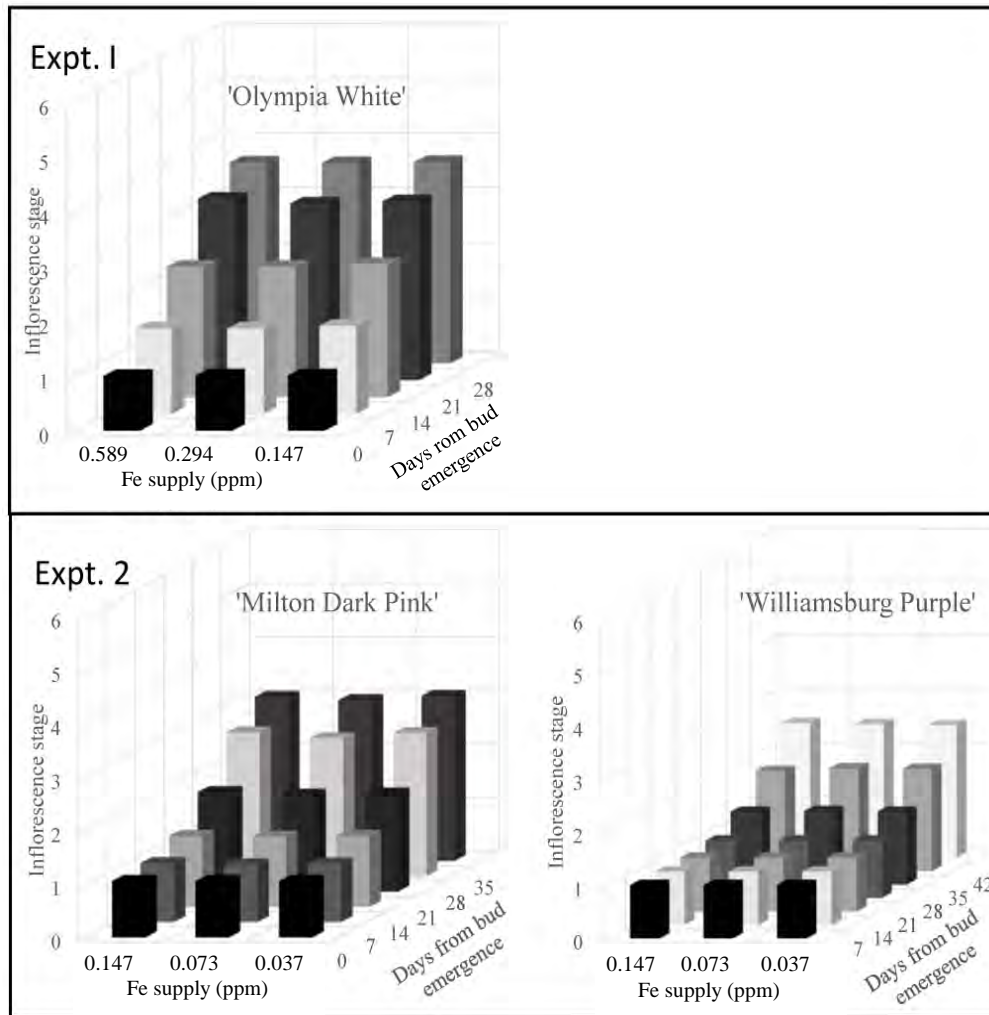


# Flower development unaffected by Mn nutrition during vegetative growth



(Donetz et al. unpublished)

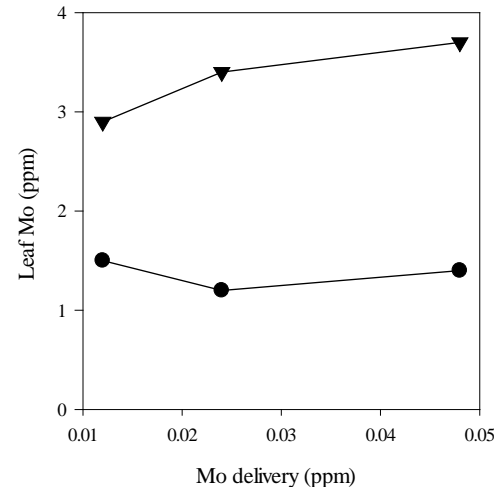
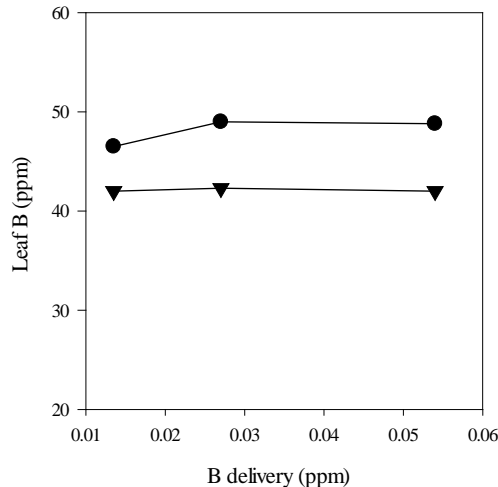
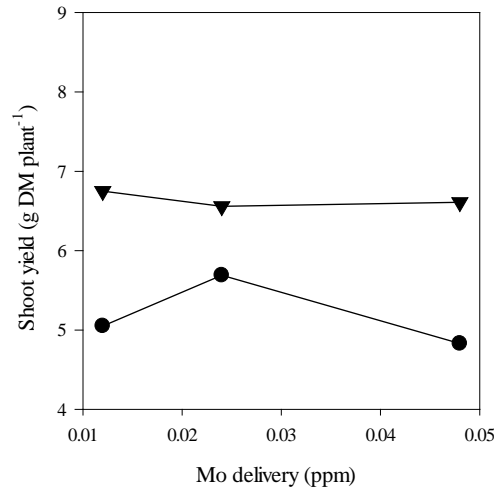
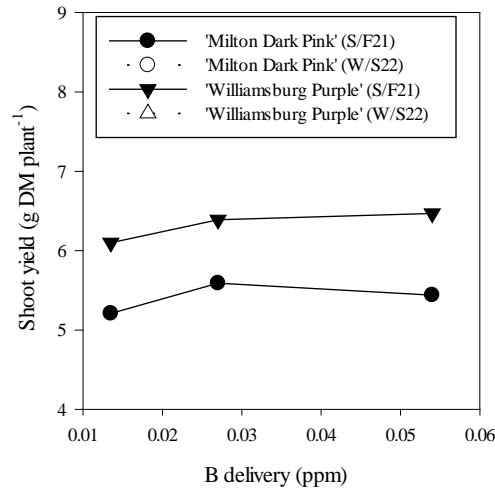
# Flower development unaffected by Fe nutrition during vegetative growth



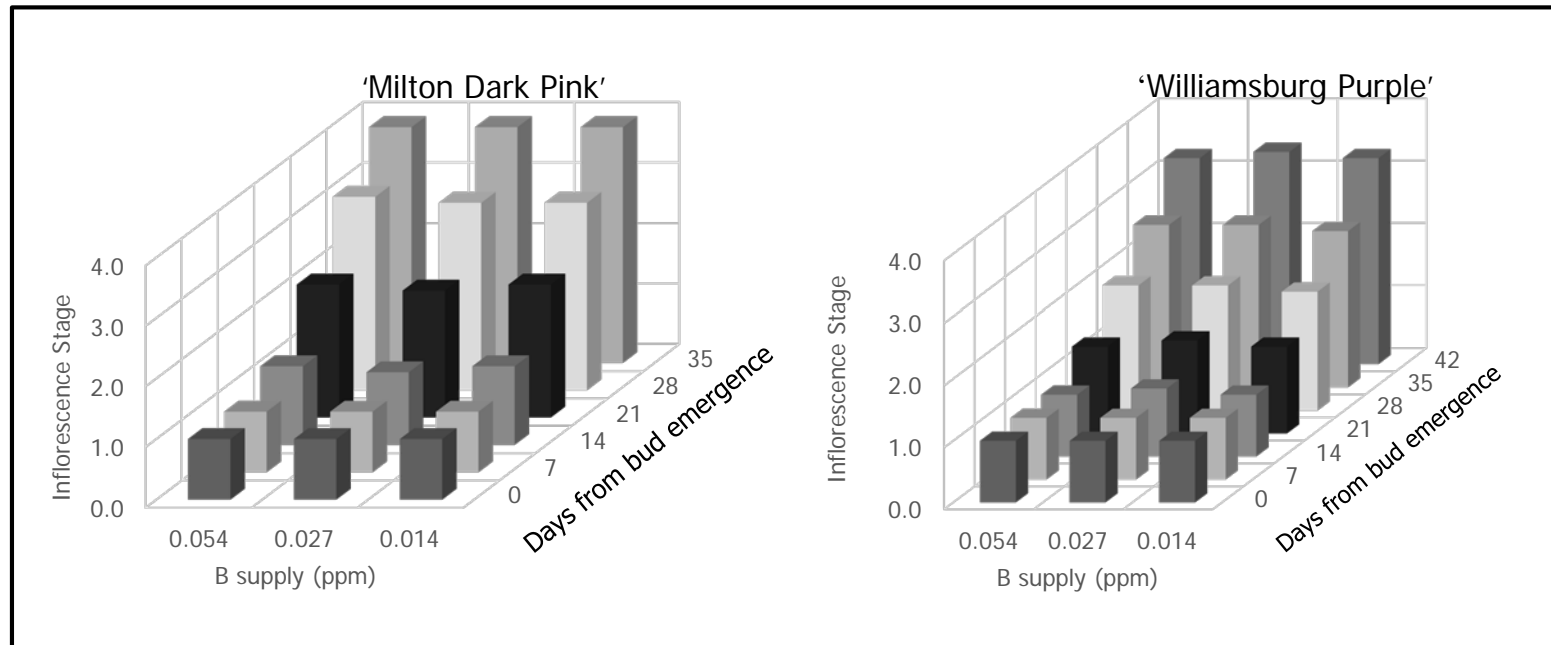
# Marketable quality unaffected by Mn or Fe nutrition during vegetative growth



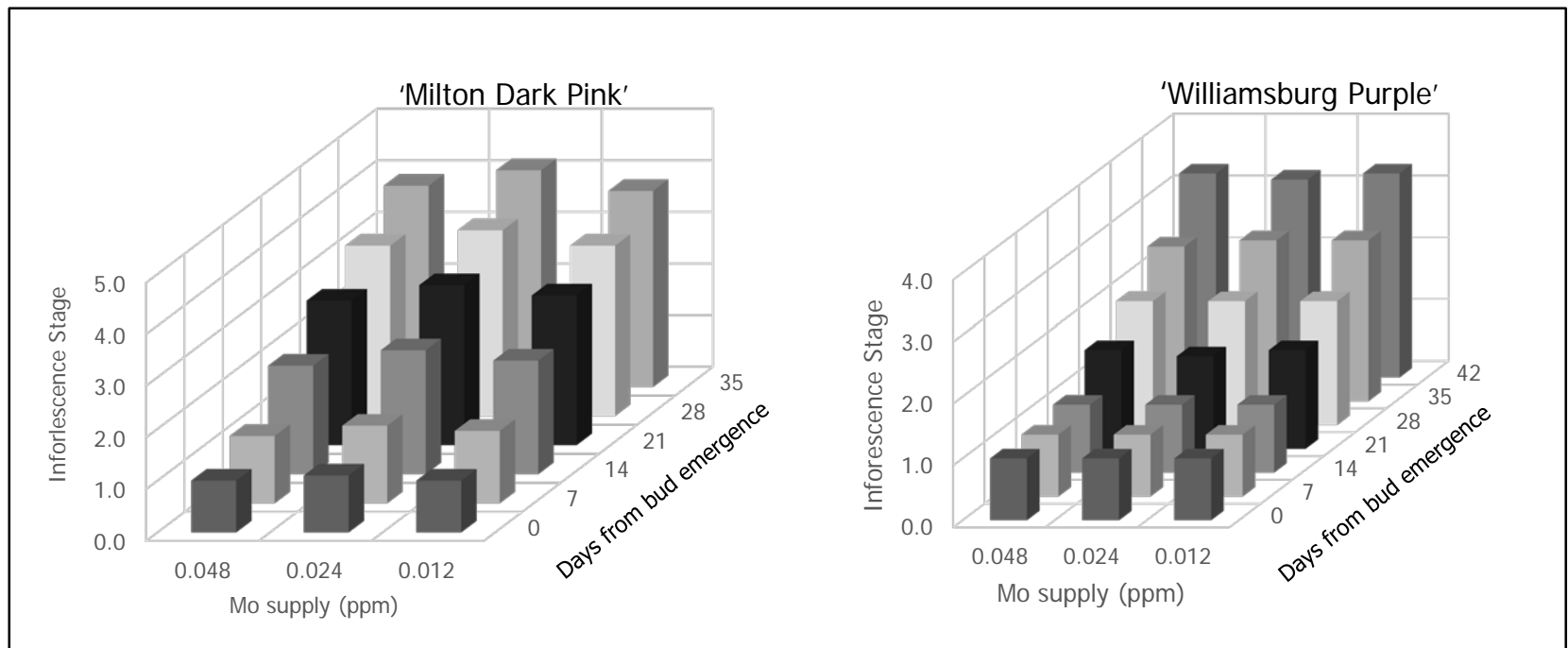
# Shoot yield & micronutrient status unaffected by B & Mo nutrition during vegetative growth



# Flower development unaffected by B nutrition during vegetative growth



# Flower development unaffected by Mo nutrition during vegetative growth



# Marketable quality unaffected by B or Mo nutrition during vegetative growth

- B or Mo delivery to be reduced another 75% in subsequent expt.

# Optimization of micronutrient delivery during vegetative growth

<b>NUTRIENT SOURCE</b>	<b>Micronutrient (ppm)</b>					
	Zn	Cu	Fe	Mn	B	Mo
<b>Sonneveld's solution (1987)</b>	0.23	0.05	1.4	0.27	0.05	0.05
<b>Peters Professional 17-3-17</b>	0.75	0.36	1.5	0.75	0.36	0.15
<b>Fusion Plant Products 17-5-17</b>	0.83	0.83	1.68	0.83	0.34	0.26
<b>TRIAL</b>						
<b>UofG (2018/19)</b>	0.23	0.05	1.4	0.27	0.05	0.05
<b>SCHENCK (2020)</b>	0.22	0.22	0.44	0.22	0.12	0.09
<b>UofG (2019-21)</b>	0.057	0.012	0.037	0.017	0.014	0.012

# Acceptable leaf micronutrient status with optimized delivery during vegetative growth

<b>GUIDELINE</b>	<b>Micronutrient (ppm DM)</b>					
	Zn	Cu	Fe	Mn	B	Mo
<b>OMAFRA Publ. 370</b>	5–35	5–50	20–750	25–375	20–200	–
<b>RJ Hill Lab Ltd.</b>	20–25	6–30	50–250	50–250	25–75	–
<b>TRIAL</b>						
<b>UofG (2018/19)</b>	17–36	4.0–7.1	95–111	45–165	51–86	1.5–5.2
<b>SCHENCK (2020)</b>	41–88	11–15	125–140	120–155	50–60	3.0–4.1
<b>UofG (2019-21)</b>	18–24	5.3–5.4	69–75	57–69	42–49	1.5–2.9



# Commercial validation (SCHENCK 2021)

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- Low micronutrient levels, in combination with optimized macronutrient regimen
- Indoor pot mums unavailable due to crown gall epidemic
- Outdoor pot mums require additional nutrient supply to produce marketable quality
- Different nutrient requirements for indoor pot mums, outdoor pot mums & cut flower mums?



## Objective 4

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- Test optimized macronutrient & micronutrient delivery with both sub-irrigated & drip-irrigated mums



# Highlights

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- $\leq 2020$ : Macronutrient use efficiency of subirrigated mums was dramatically improved by reducing the supply of macronutrients during vegetative growth, in combination with the removal of the entire nutrient supply during reproductive growth
- $\geq 2020$ : Micronutrient use efficiency was also improved by reducing the micronutrient delivery during vegetative growth, without sacrificing plant & flower quality
- 2021–22: Completed Mn & Fe studies; B & Mo studies ongoing
- 2022–23: Complete B & Mo studies; Test optimized nutrient regimens



# Industry Expectations

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- Timing & supply of fertilizer to sub-irrigated & drip-irrigated mums
- Reduce usage & cost of nutrients, volume of nutrient-rich feedwater that must be treated &/or discharged, & environmental risk
- Other floricultural crops
- New fertilizer formulations



# Knowledge & Technology Transfer

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1. Shelp, B.J., Flaherty, E.J., Sutton<sup>1</sup>, W.J., Schenck, L.M., Aalbers, J. (2021) Commercial validation of a modified method for delivering low nitrogen, phosphorus and potassium inputs to greenhouse-grown subirrigated pot chrysanthemums. *Can. J Plant Sci.* 101: 962-966.
2. Shelp, B.J., Flaherty, E.J., Duncan Stephens, S., Donetz, A.J. (2021) Improving zinc and copper delivery for subirrigated greenhouse-grown pot chrysanthemums *Can. J. Plant Sci.* 101: 268-273.
3. Donetz, A.J. 2021. Optimizing manganese and iron delivery in contrasting cultivars of subirrigated greenhouse-grown pot chrysanthemums. M.Sc. Thesis, University of Guelph.



# Acknowledgements

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