

The influence of synthetic mulches to improve certified organic hardneck garlic production in the British Columbia Southern Interior

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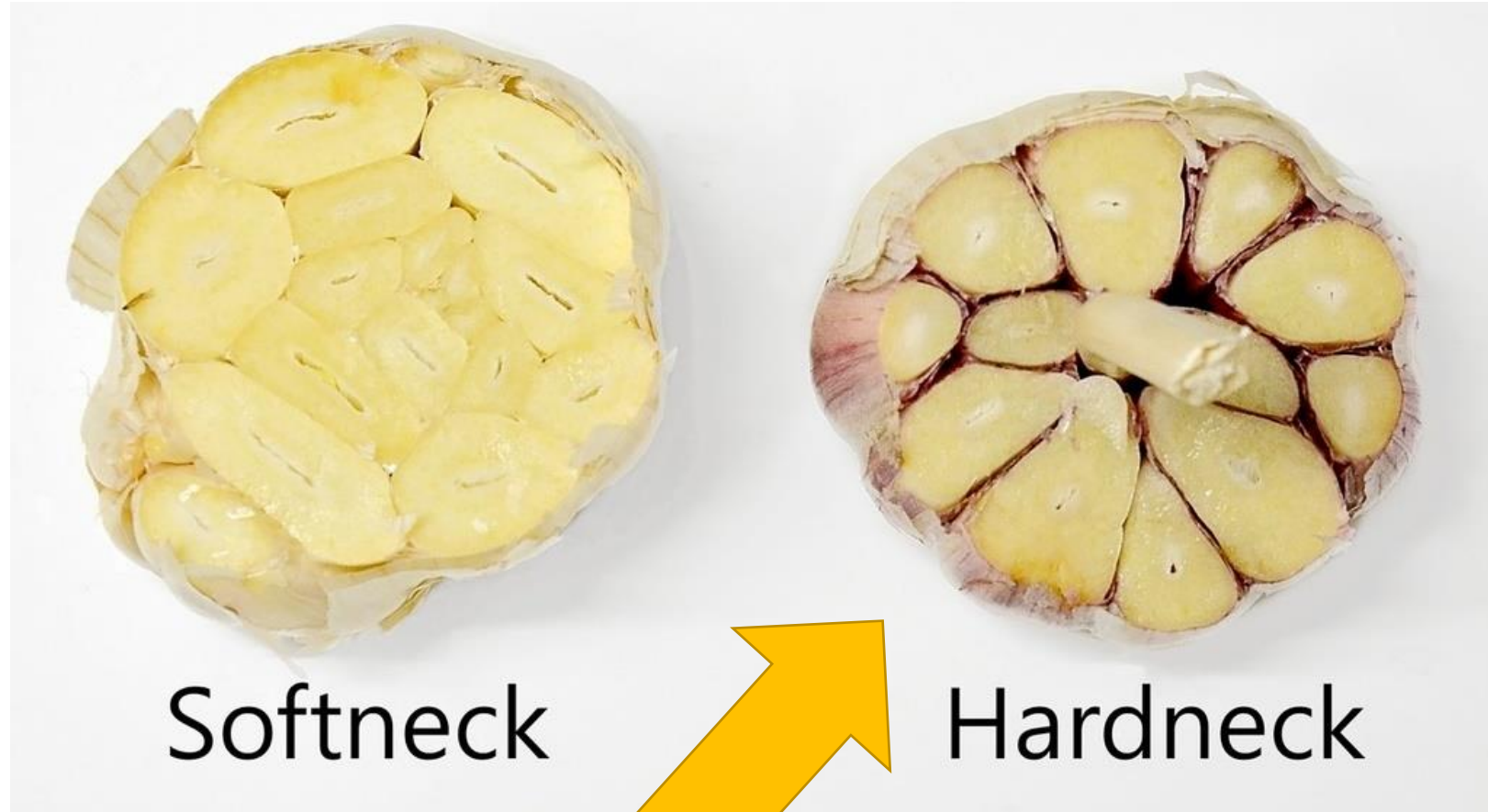
Garlic



About Garlic

Allium sativum

- subsp. *sativum*
 - partial or non-bolting, no flower stalk
 - “**Softneck**” Varieties: Artichoke and Silverskin
- subsp. *ophioscorodon*
 - bolting with flower stalk
 - “**Hardneck**” Varieties: Rocambole, Continental and Asiatic



Hardneck Production

- Biennial Crop
 - Planted in fall; harvested next summer
- Grows best in continental climates
 - Distinct warm summers and cold winters
- Snow and mulch insulate against damaging low soil temperatures



Hardneck Production

- Bulb enlargement begins when soil temperatures increase
 - Late spring – early summer
- Sensitive to weed pressure
- Harvest occurs mid summer
- 2-4 week curing after harvest to dry wrappers/skin



Hardneck Grading

- Culled based on
 - Clove count
 - Firmness
 - Damage and/or disease
 - Wrapper quality and colour
- Final grading
 - Smallest bulb diameter
 - Count/weight
- Sold by weight or minimum diameter



Economics

- Production (2016)
 - World Total: **26.6 million** tonnes
 - China: **21.6 million** tonnes (81.4%)
 - Canada: **1,409** tonnes
- Canadian Consumption (2017)
 - 0.51 kg / person
 - Approx. **18,722** tonnes annually
- Canadian Imports (2017)
 - **18,776** tonnes
 - \$63.9 million CAD
- Canadian Exports (2017)
 - **169** tonnes
 - \$483,000 CAD





Synthetic Mulches

Paper or Plastic?

Mulch History

- The practice of covering the soil to alter soil conditions and reduce weed pressure
- Organic materials such as straw, leaves and compost were traditionally used
- Synthetic mulches (paper & plastic) have become very popular in the last 50 years



Mulch Comparisons

Mulch	Cost	Application	Weed Suppression	Soil Moisture Retention	Permeability	Soil Temperature Modification	Disposal	Renewable Resource	Organic Acceptance
Straw	\$\$	Difficult	Poor	Good	✓	—	Decomposition	✓	✓
Black Plastic	\$	Easy	Excellent	Excellent	✗	+	Landfill*	✗	✓
White Plastic	\$	Easy	Excellent	Excellent	✗	—	Landfill*	✗	✓
Paper	\$\$\$\$	OK	Poor to OK		✓	—	Decomposition	✓	✓

** Limited available recycling programs in Canada*

Hypothesis

- The improved weed control and soil modifications of synthetic mulches will lead to increased quality and overall yield of hardneck garlic in organic farming systems.

Research Question

- What are the differences in hardneck garlic bulb quality and agronomic traits when produced using different synthetic mulches?
 - Which mulch will be best to improve garlic quality and yields?

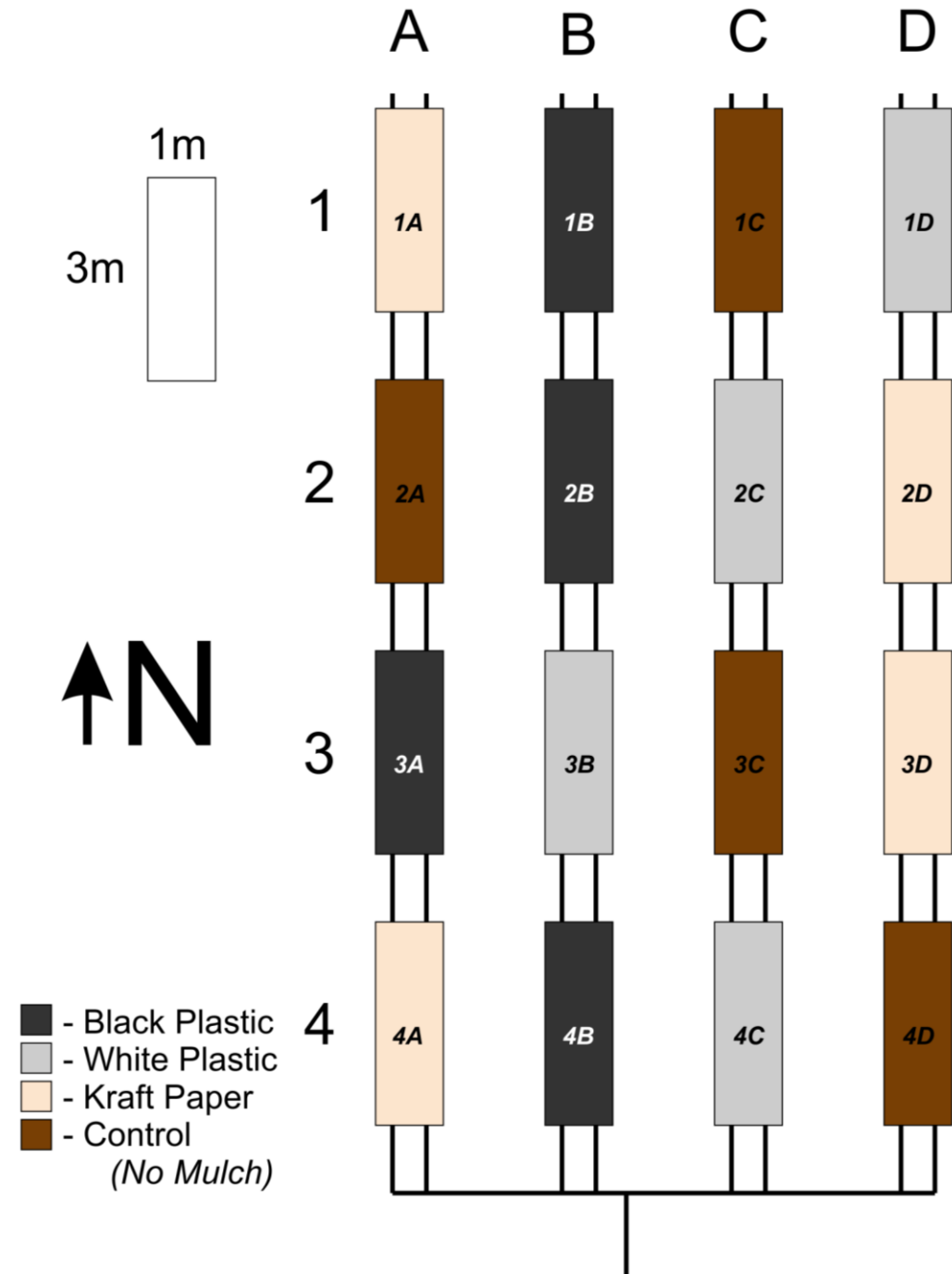


Experimental Design

2017 to 2018

Layout

- Randomized complete block
 - 4 replications
- 4 treatments
 - Black plastic mulch
 - White plastic mulch
 - Brown Kraft paper
 - Negative control (no mulch)
- 4 rows of garlic per bed
 - 15cm in-row (80 plants/plot)
- 2 drip lines per bed



Plant Material

- Hardneck, Marbled Purple Stripe
 - “Krestova Red Russian”
- Selected from graded stock
 - Average 4 cm diameter
- Bulbs broken into cloves and randomized by mixing



Plant Material

- Planted November 1, 2017
- Cloves planted 5-12cm deep
 - Through holes in plastic mulches
 - Before applying Kraft paper mulch
- Harvested 2nd week of August, 2018
- Cured for 2 weeks post harvest



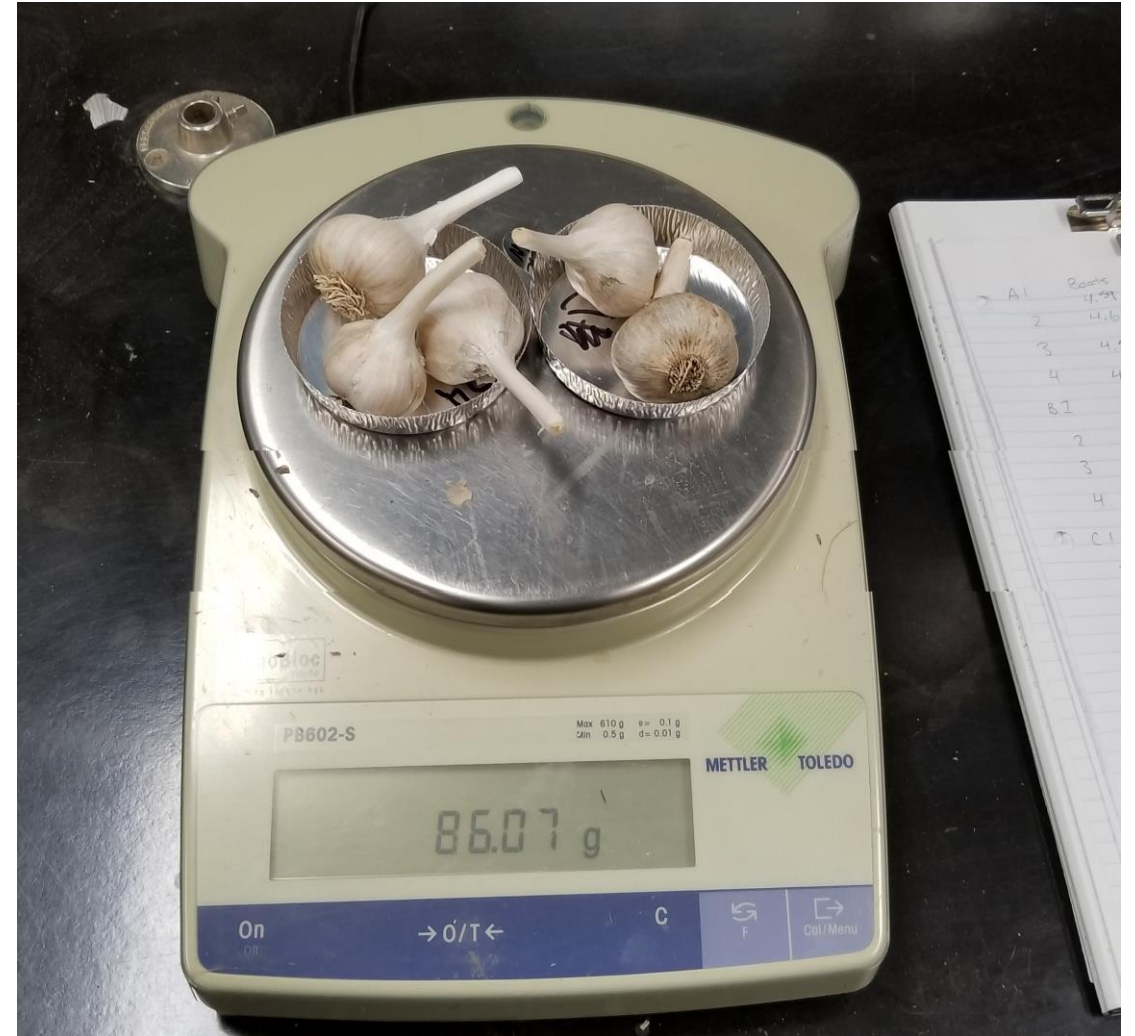
Measurements & Methods

- Weed density
 - Weeds within randomized 0.5m transects per plot in July, 2018
 - Insignificant mulch damage due to Elk
- Max and min bulb diam. (mm)
 - Metal caliper across bulb, midpoint of cloves
 - 20 random bulbs per plot
- Clove counts
 - Number of cloves per bulb from 20 random bulbs per plot



Measurements & Methods

- Yield
 - Fresh weight of bulbs divided by total harvested bulbs per plot
 - 5 weeks after curing
 - Extrapolated into tonnes/ha
- Moisture Fraction
 - Dried 5 random bulbs per plot
 - 6 days at 105°C
 - Calculated using fresh and dry weights
- Statistics
 - Single-factor ANOVA;
 - treatments as fixed effects
 - replicates as random effects
 - Between treatments: T-tests
 - $\alpha = 0.05$

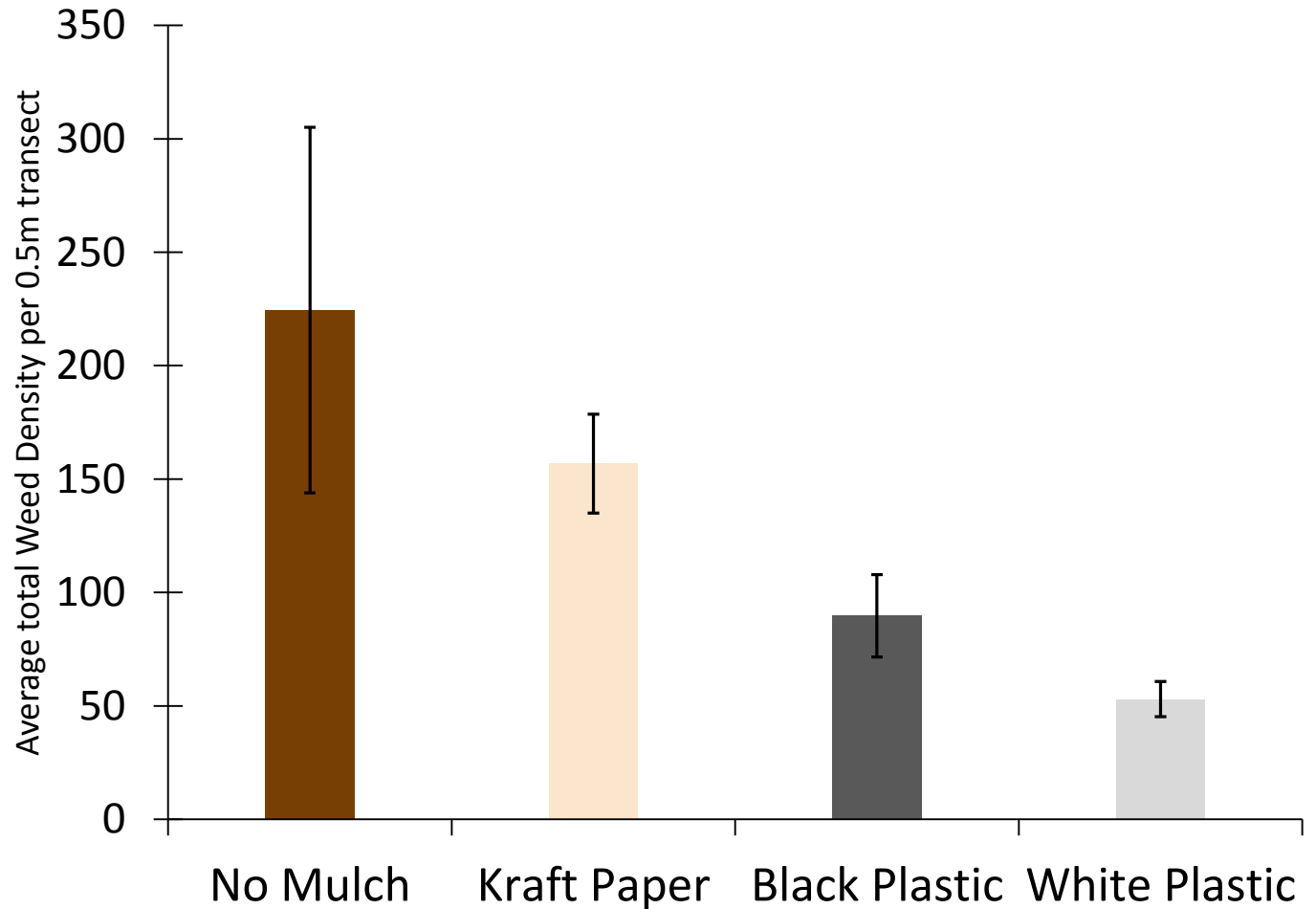




Results

Weed Density

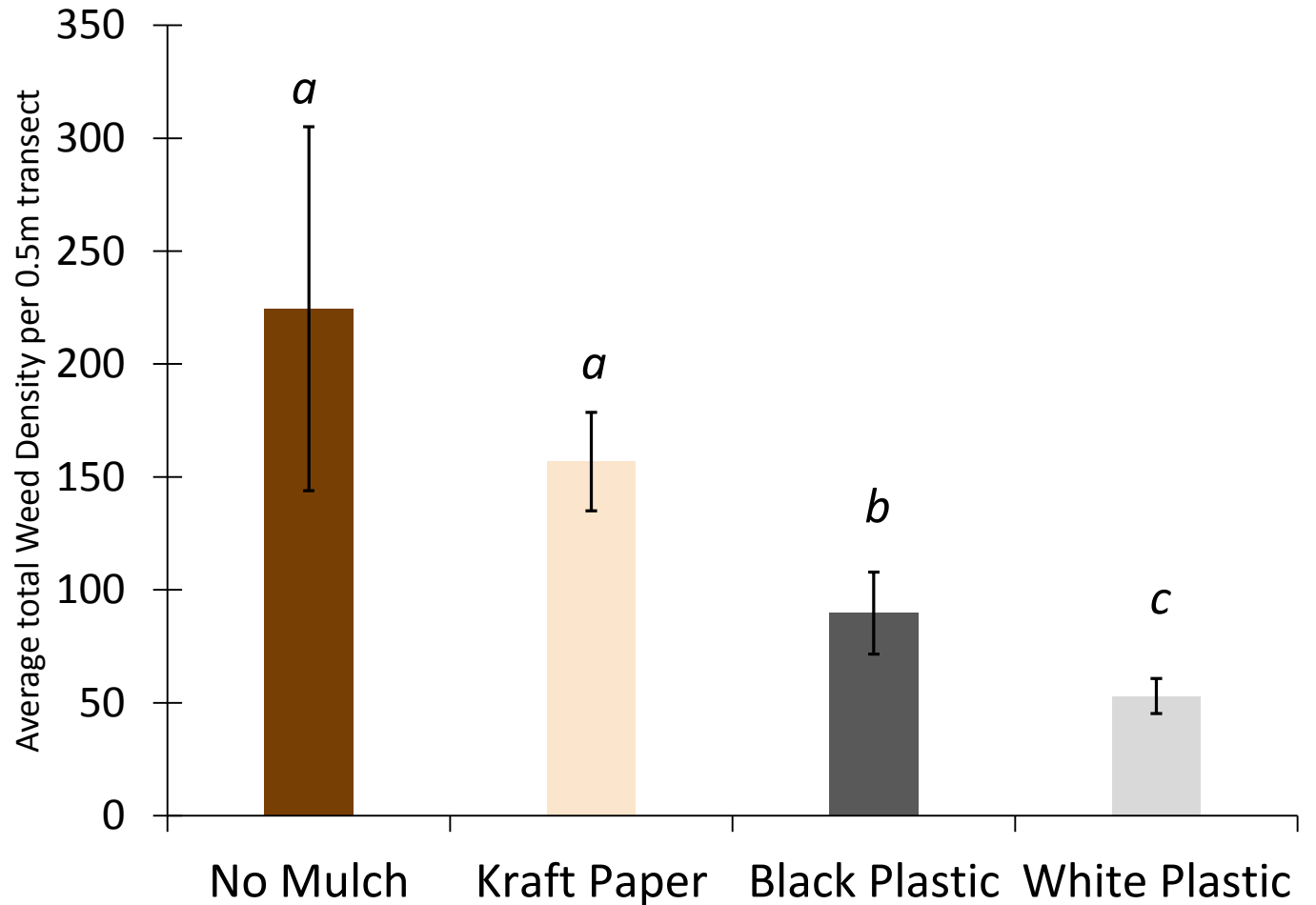
- Demonstrates the mulches' ability to reduce weeds
 - Reduced weeding labour costs
 - Reduced competition
- Treatment effect $P = 0.0663$



Weed Density

- Significant difference between treatments at $P \leq 0.10$

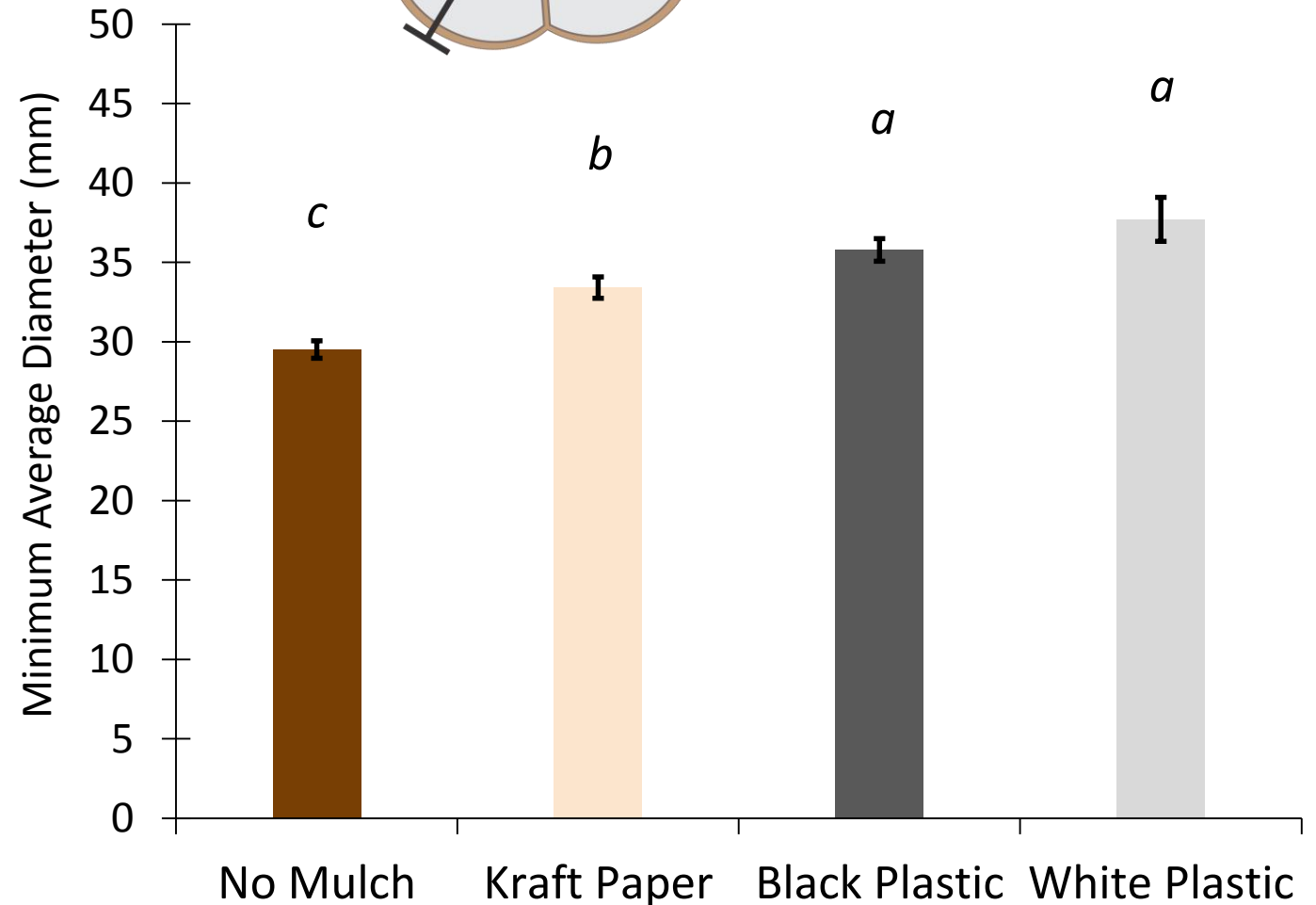
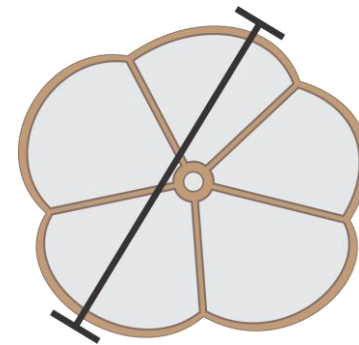
- **Plastic mulches tend to have increased weed control**



Minimum Bulb Diameter

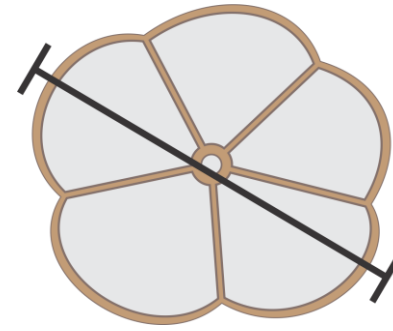
- Plastic mulches significantly increased min. diam. vs control
- Min. diam. from paper was significantly greater than control, but not as much as from plastic

• Indicates that **bulb grade** may **improve** with the **use of a synthetic mulch**



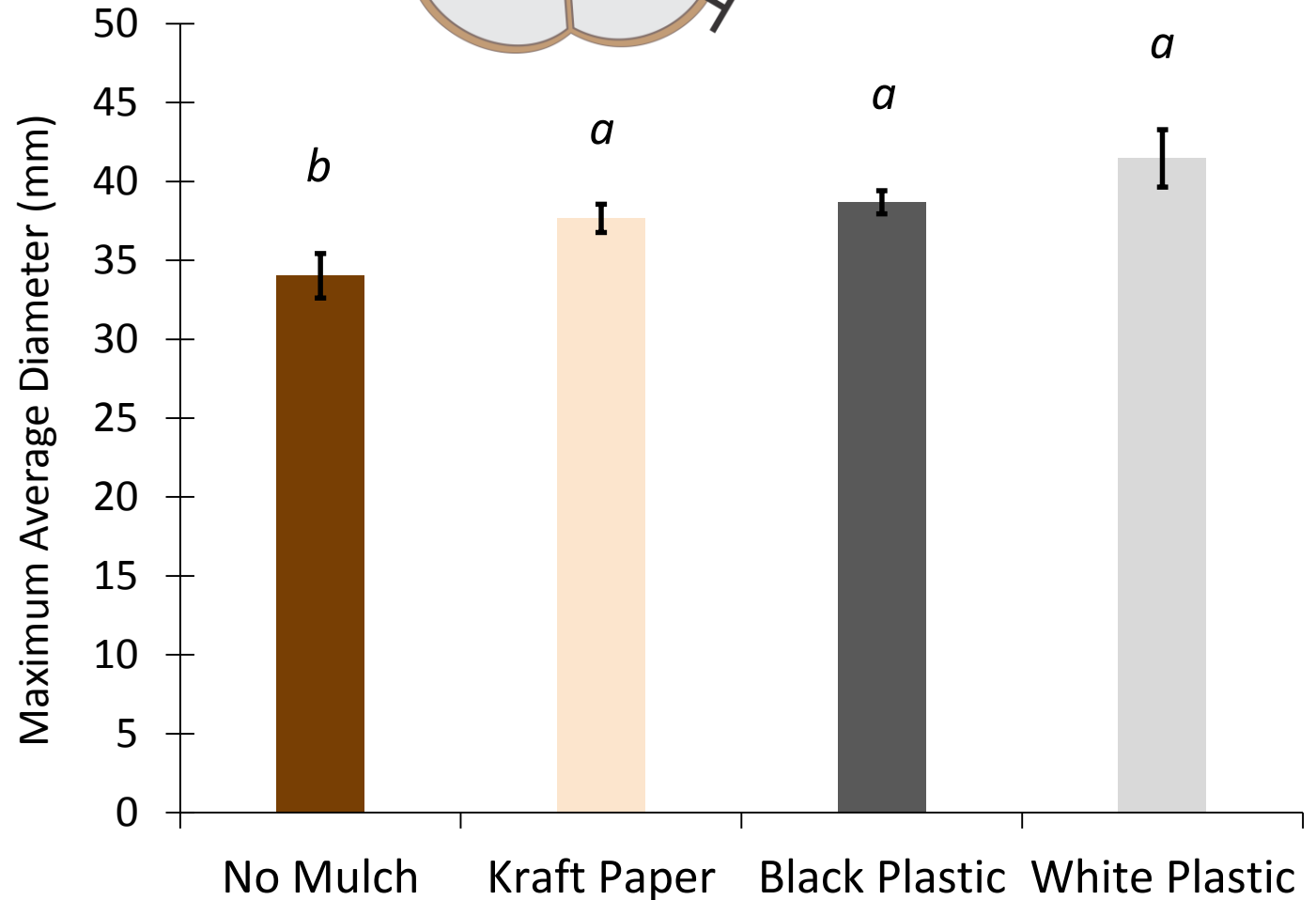
$P = 0.0006$

Maximum Bulb Diameter



- Synthetic mulches significantly increased max. diameter vs control
 - Paper was comparable to plastic

• Indicates that potential **bulb size** may **improve** with the **use of synthetic mulch**

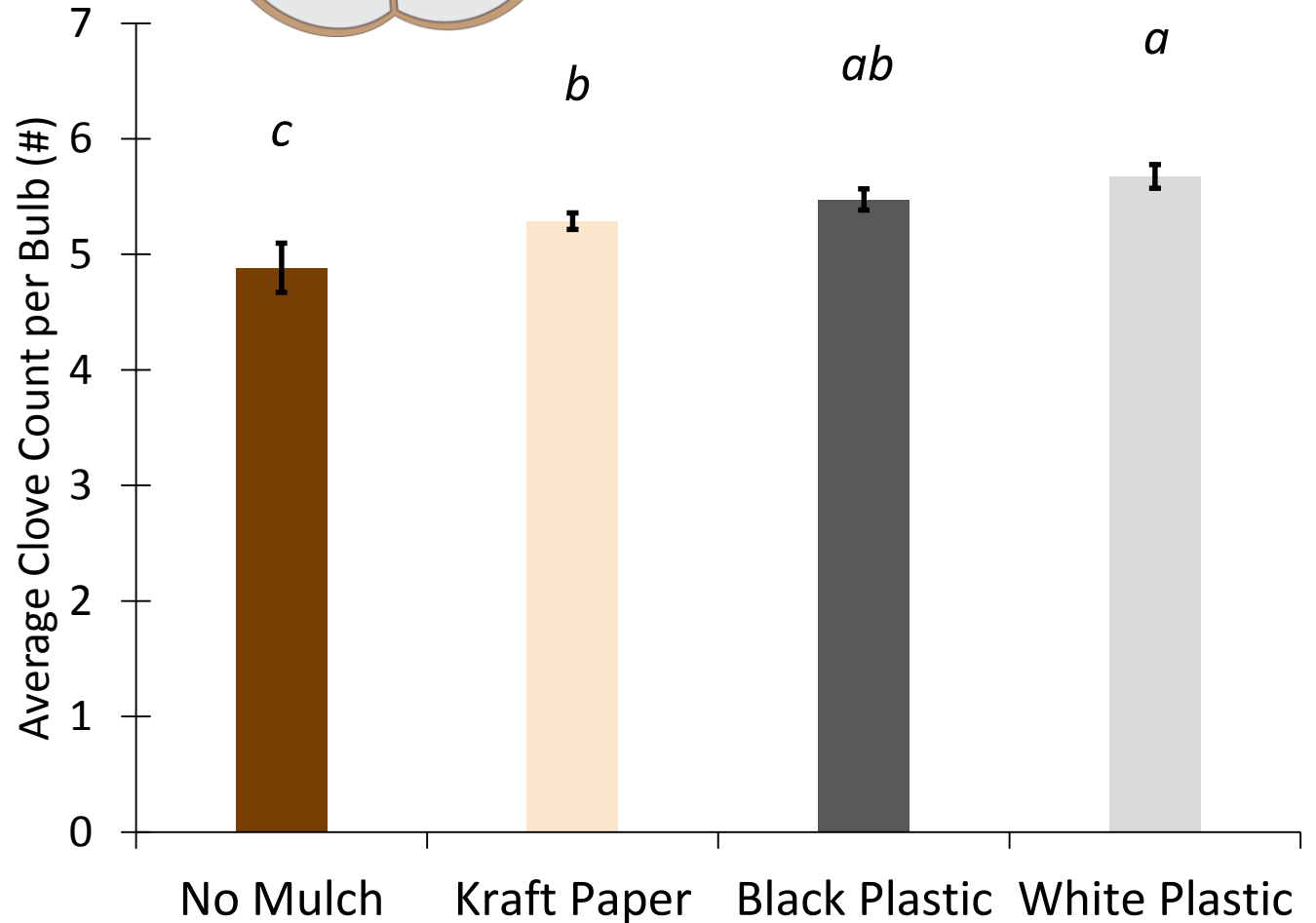
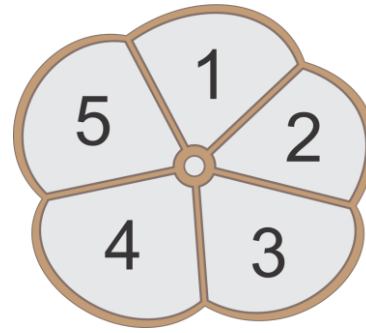


$P = 0.0173$

Clove Count

- Synthetic mulches significantly influenced the number of cloves per bulb
 - White plastic was more influential than paper

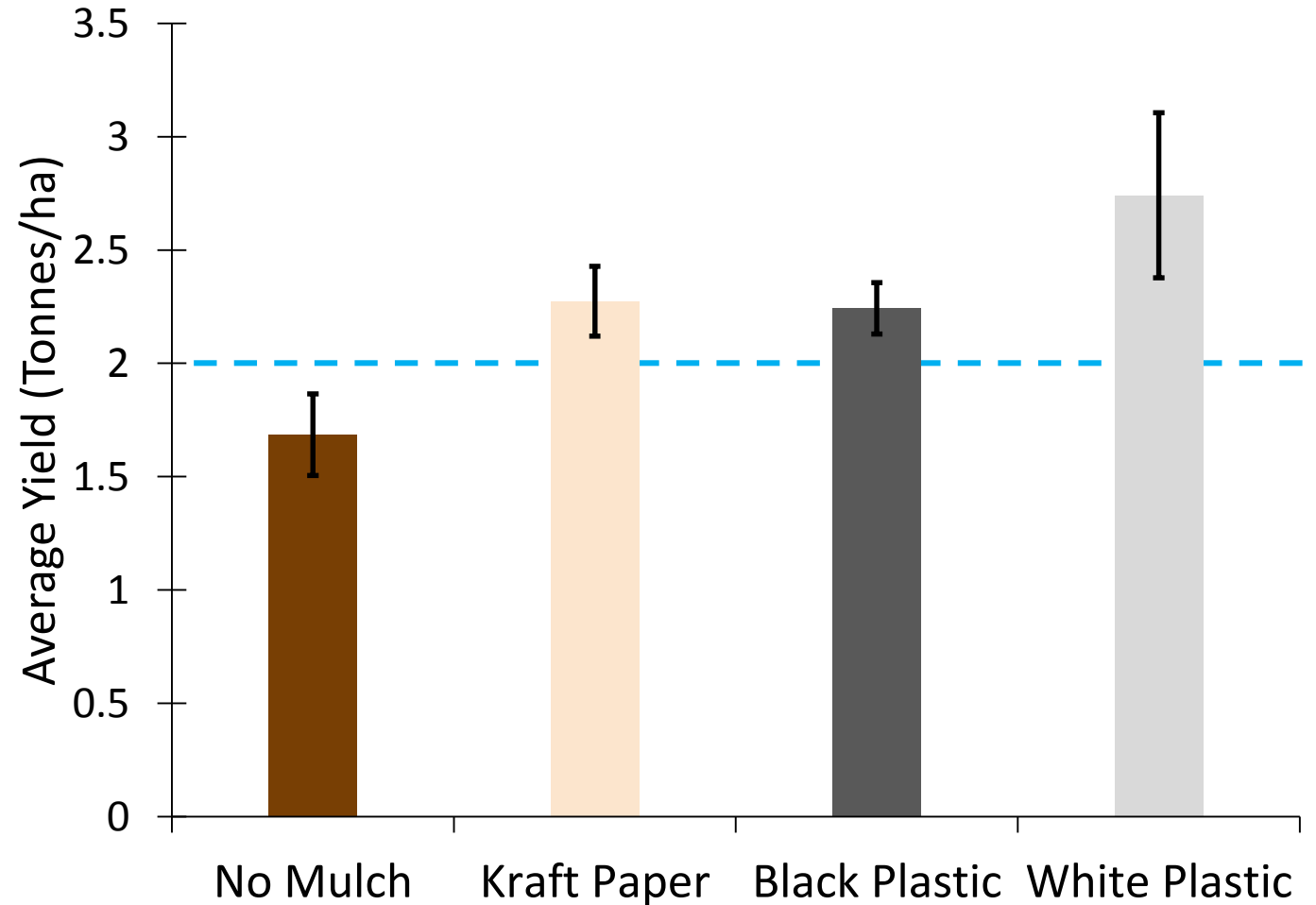
• Indicates that **synthetic mulch** may **improve marketable quantity**



$P = 0.0052$

Yield Weight

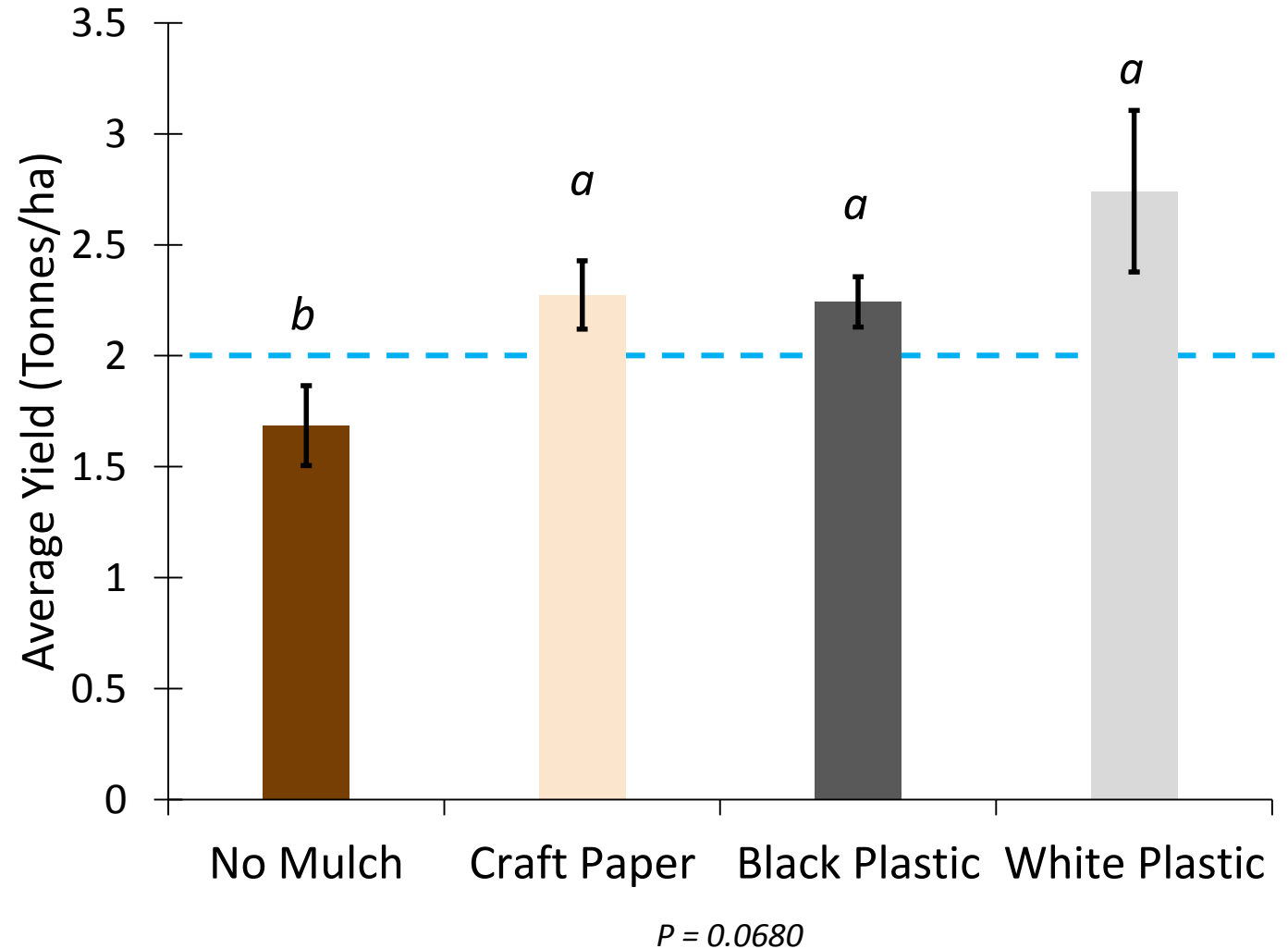
- Shows the potential yield influenced by mulches
- Average Canadian yields
 - 2-4 tonnes/ha
- Treatment effect $P = 0.0680$



Yield Weight

- Synthetic mulches significantly influenced the total yield weight at $P \leq 0.10$

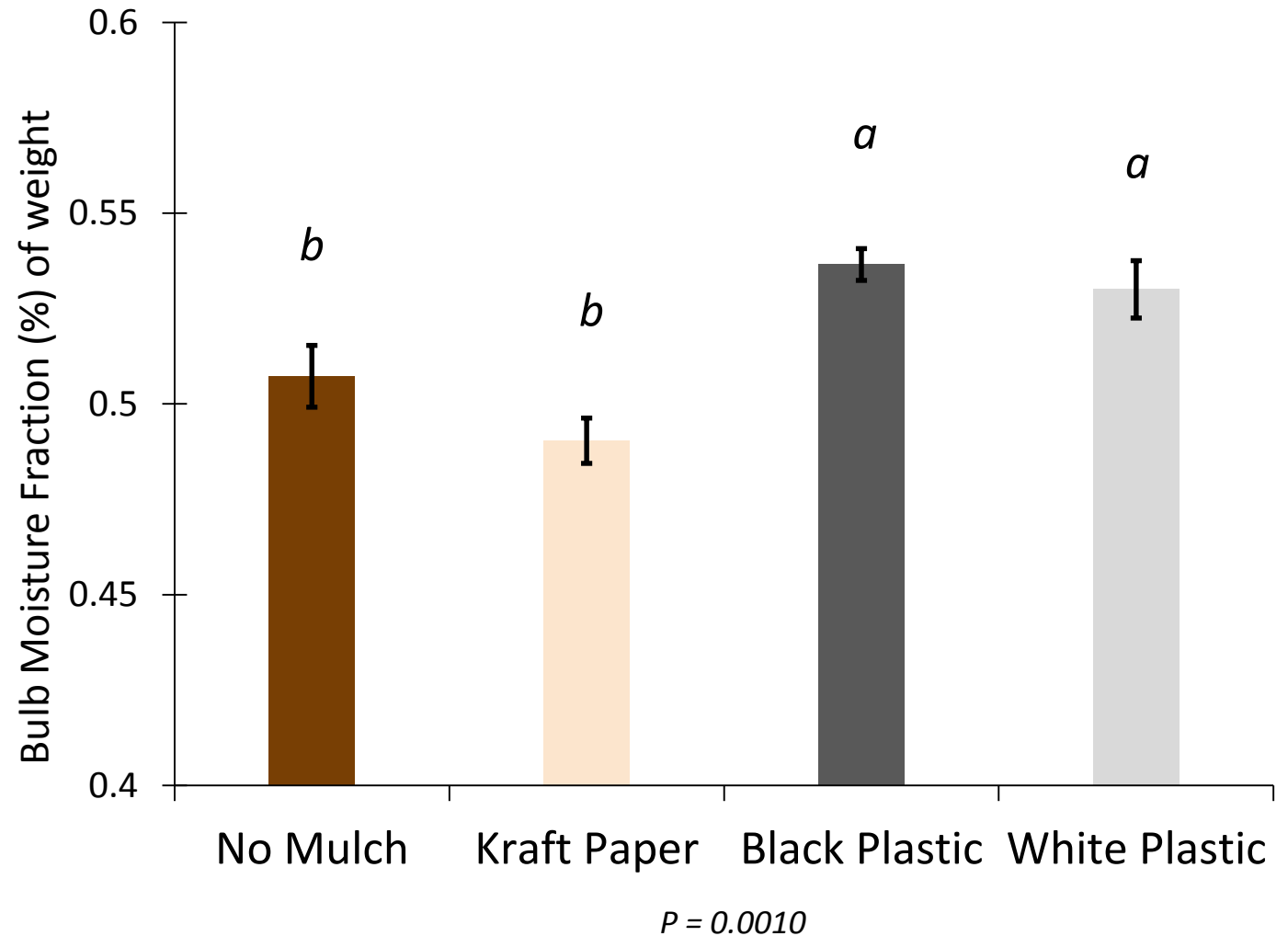
• Indicates that **synthetic mulch** may **improve total yield weights**



Bulb Moisture Fraction

- Plastic mulches influenced the cloves moisture content

- Increased moisture in bulb (cloves) may **increase storability** of the crop and **reduce economic costs** due to weight loss post harvest



A close-up photograph of two hands holding two garlic bulbs. The hand on the left holds a purple garlic bulb, and the hand on the right holds a white garlic bulb. The background is blurred, showing more garlic bulbs. The word "Conclusions" is overlaid in white text in the center of the image.

Conclusions

Hypothesis

- The results support the hypothesis
 - Mulches influenced yield and quality
- Likely that weed control was not the only factor influencing yields
- Future areas of study
 - Soil temperatures
 - Soil moisture
 - Rate of growth
 - Maturity dates
 - Year to year & seasonal differences



What might this mean for growers?

Mulch	Min. Dia. Increase	Yield Weight Increase	Gross Profit/ha @ \$5/kg *	Change in Gross Profit/ha
Control			\$8,427.5	
Kraft Paper	13.2%	34.9%	\$11,371.95	+ \$2,944.45
Black Plastic	21.2%	33.1%	\$11,214.15	+ \$2,786.65
White Plastic	27.7%	62.7%	\$13,710.23	+ \$5,282.73

Future research will be needed to confirm results

** Accounting for 10% loss*

The use of a synthetic mulch may benefit garlic producers
“Seed” stock: sold by grade size of **smallest diameter**
“Culinary” stock: sold by **weight**



- If white plastic mulch consistently produces higher quality and larger yields, then growers can expect increased returns
- Paper could be an alternative to plastic mulches for growers who would prefer biodegradable material



@Highmeadowsfarm

<https://www.instagram.com/p/BTNZq0YAgu6/>

Questions?

Acknowledgements

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Citations

Agriculture and Agri-Food Canada. 2017. Statistical Overview of the Canadian Vegetable Industry 2017. Available at <http://www.agr.gc.ca/eng/industry-markets-and-trade/canadian-agri-food-sector-intelligence/horticulture/horticulture-sector-reports/statistical-overview-of-the-canadian-vegetable-industry-2017/?id=1541522324172#a4.1> (accessed 03 Jan 2019). Government of Canada.

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Thank you!