Using Agrovoltaics to Shade Bok Choy Varieties

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Electricity compensates for bok choy yield loss in agrovoltaic systems

INTRODUCTION

Bok choy is a cool season crop with an optimum growing temperature of 18-20°C. One challenge with growing bok choy in the height of summer is that high temperatures can induce **bolting** (flower initiation), leading to an unmarketable crop. Shading is expected to contribute to bolt resistance but the lower light irradiance may negatively affect crop yields. However, with crops that bolt easily due to high temperatures, there is potential in using a **solar photovoltaic system** to maximize crop yield while using the shading implement to capture solar energy.

OBJECTIVES

- To determine the effects of variety (Bopak, Chun Mei, Joi Choi, Mei Qing Choi, and Summer Zest), shading method (unshaded control, 50% green shade cloth, 'solar panel' [plywood with light sensor]), and planting date (June harvest, August harvest) on bok choy bolting and yield.
- To determine if there are interactions between the three factors: variety with shading method, variety with planting date, and shading method with planting date.
- To compare the total output (bok choy yield and electrical yield) from plots with and without the 'solar panels.'

METHODS

- Randomized Complete Block Split-Plot Design
  - Plot: Shading Method
  - Sub-plots: 5 varieties x 5 replicates in Latin Square Design
- 3 Blocks = 3 Replications
- Seeded indoors at day 0, transplanted at day 17, harvested at day 40
- Data collected:
  - Sensors: Lux, Ambient Temperature, Soil Moisture
  - Days to Bolting from Sowing Date
  - Fresh weight (lb.)
  - Marketability Rating } Marketable Yield (lb.)

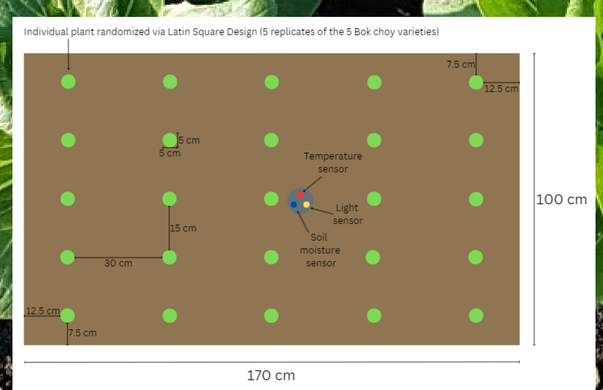


Figure 1. Layout of each plot.

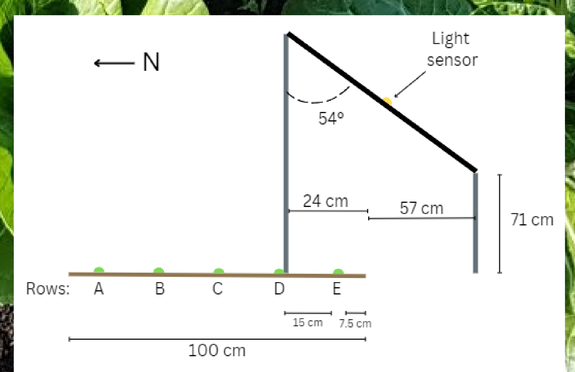


Figure 2. 'Solar Panel' set-up with 54° angle from the vertical

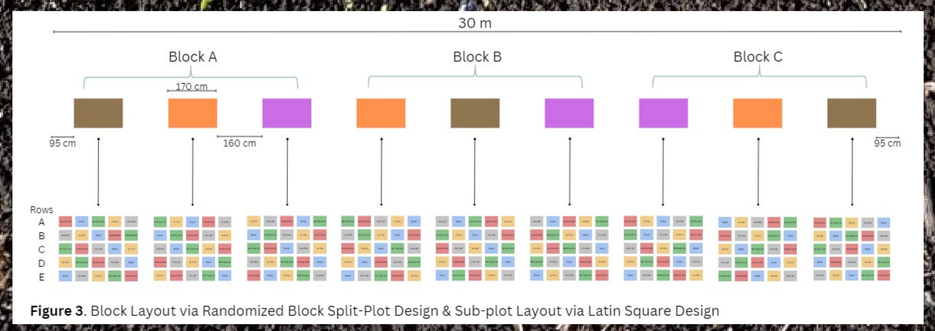
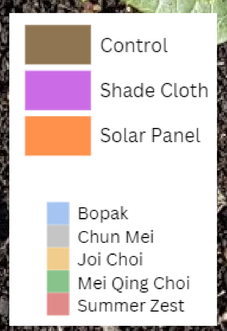


Figure 3. Block Layout via Randomized Block Split-Plot Design & Sub-plot Layout via Latin Square Design



RESULTS

- No bok choy plants experienced bolting during the study.
- No statistically significant difference in marketable yield according to shade method. Nevertheless:

Average yield loss under solar panel =
(yield of control plots – yield of solar panel plots) * price per yield

Yield loss = (0.324 lb. – 0.249 lb.) * CAD$6/lb. = **CAD$0.45**

- Marketable Yield (lb.) by variety (**Figure 4.**):
  - White stemmed varieties experienced the most bird pest damage (ripped out of ground; pecking damage), especially in control plots

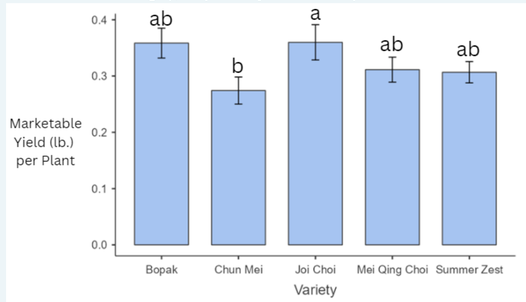


Figure 4. Marketable Yield (lb.) of Bok choy by variety. Summer Zest, Chun Mei, and Mei Qing Choi (the check variety) are green-stemmed varieties, while Bopak and Joi Choi are white-stemmed varieties. Different letters denote statistically significant difference between the means ($p<0.05$). Error bars denote standard error.

- Marketable Yield (lb.) by Row in each Shade Method (**Figure 5.**):
  - Low marketable yield in solar panels rows C and D via droppings due to panel acting as a bird perch

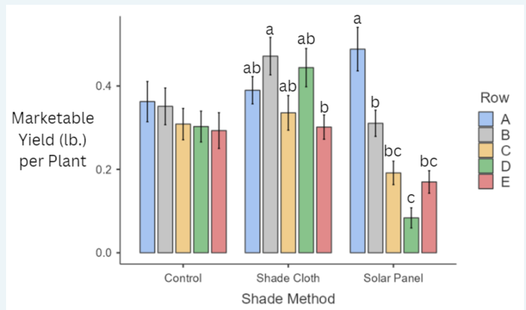


Figure 5. Marketable Yield (lb.) of Bok choy by row in each shade method. Different letters denote statistically significant difference between the means within the shade method group. Error bars denote standard error.

- Each 'solar panel' produced an average of 11.0 kWh of electricity between transplant day and harvest day (23 days) during August planting – equivalent to **CAD$0.66** per 'solar panel'.

CONCLUSION

Ignoring upfront cost of solar panel installation, theoretical energy output generated by the solar panel (**CAD$0.66**) was able to compensate for the yield loss of bok choy shaded under the solar panel (**CAD$0.45**).

At a practical level, shade cloth performed best: highest average marketable yield (although not statistically significant), protection from bird and insect pests, & lowest visual presence of viral infection.

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