Assessing spotted-wing drosophila organic control methods and economic viability in day-neutral strawberry production

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Introduction

- Interest in day-neutral (DN) strawberry production is increasing in the Upper Midwest due to an extended harvest season and superior yield compared to June-bearing varieties.
- The longer season increases fruit exposure to the invasive spotted-wing drosophila (*Drosophila suzukii*, SWD) (Fig 1), which infest small fruit and berries.
- Organic pest management of SWD is challenging due to few available pesticides, limited biocontrol options, and higher costs of management.
- There is a lack of information on economics of various pest management strategies in DN strawberry.

Research Objectives:

1) Quantify the impact of SWD on organic DN strawberries
2) Determine economic costs and returns for different organic SWD management strategies
3) Determine break-even yield and price for organic DN strawberries

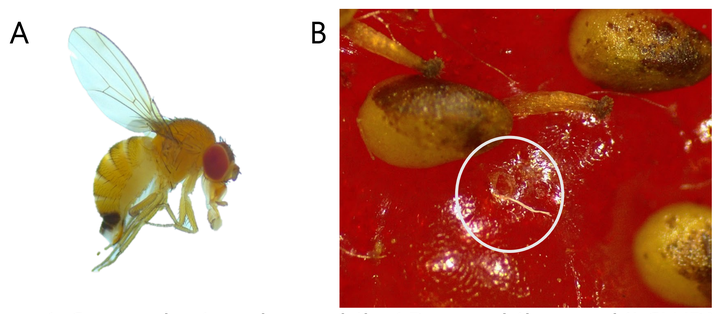

Figure 1: Spotted-wing drosophila (*Drosophila suzukii*, SWD). **A.** Adult female SWD with visible ovipositor. **B.** SWD egg in a strawberry. Eggs were found both on the surface next to achenes and under the fruit skin.

Methods

We conducted a two-year controlled organic field experiment with DN strawberries at the University of Minnesota Agricultural Experiment Station (St. Paul, MN), implementing SWD management treatments drawn from local grower practices and our organic raspberry research. Treatments included increased harvest frequency, botanical-based repellents, weekly rotations of organic insecticides, and an untreated control.

Our hypothesis posited that non-insecticidal management strategies would be equally effective and more financially prudent than organic insecticide applications targeting SWD adults. Data collection involved tracking labor hours, direct costs, strawberry yield, and SWD infestation over the 2022 and 2023 seasons. Analysis was performed using R with one-way ANOVA and generalized linear mixed effect models. The cost-benefit analysis was conducted using a partial budget method to account for production costs, the change in net returns, and break-even prices and yield. Additionally, a sensitivity analysis explored profitability outcomes under different yield and price scenarios for organic DN strawberries grown in an open-field without pest controls.

Acknowledgements

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Results

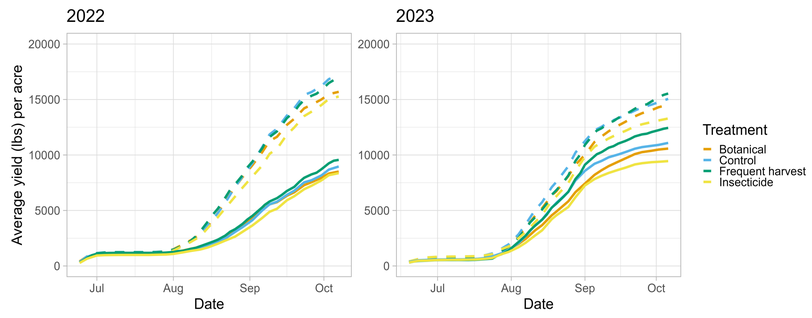

Figure 2: Strawberry production. Day-neutral strawberry yield was different between years, but not different among treatments.

Yield

- Total and marketable yields (Fig 2, dashed and solid lines, respectively) were greater in 2022 than in 2023. The proportion of marketable fruit increased in 2023 (74%) compared to 2022 (70%).
- The SWD management treatments had no significant effect on any production variable in either year. Total cumulative yield, marketable yield, number of strawberries per plant, and strawberry mass were similar among all four treatments.

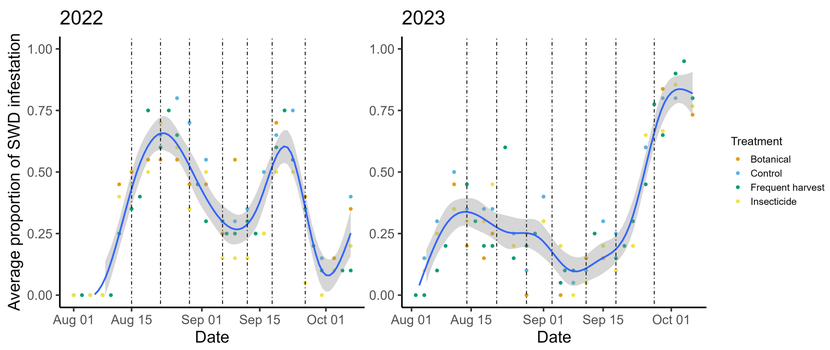

Figure 3: Spotted-wing drosophila (SWD) infestation. Average percentage of SWD egg-infested fruit varied from 28% to 40% across different years and treatments, occasionally surpassing 70%. Vertical dashed lines denote dates of spray application, while the solid line represents average infestation across treatments.

SWD Control

- Significant differences in infestation proportions among treatments observed in 2022, with insecticide treatment showing lower infestation (0.28 ± 0.03) compared to control (0.40 ± 0.03) (P = 0.022); no differences were observed in 2023.
- In 2022, SWD was first detected in traps on 14 July and peaked on 8 September; in 2023, the first detection occurred on 20 July and peaked on 24 August.
- SWD eggs (Fig 1B) were first found in strawberries on 12 August in 2022 and on 24 July 2023, averaging 1.5 to 2.3 eggs per strawberry.

Please participate in a survey regarding DN strawberry production by scanning the QR code to the right!

Table 1. 2-year average gross and net returns organic day-neutral strawberries

	Control	Frequent harvest	Botanicals	Organic Insecticides
Marketable yield (lb/acre)	11,952	12,672	11,160	10,584
Gross revenue ($/acre)*	95,616.00	101,376.00	89,280.00	84,672.00
Total direct costs ($/acre)	44,699.17	52,578.44	51,348.65	50,102.76
Total indirect costs ($/acre)	1,498.00	1,498.00	1,498.00	1,498.00
Net returns ($/acre)	49,418.83	47,299.56	36,433.35	33,071.25

*Gross revenue based on a market price of $8.00 / lb.

Economics

- Gross returns ranged from $84,672 to $95,616 per acre (Table 1).
- Labor accounted for most direct costs (81 – 84%).
- Production costs ranged from $46,197 per acre for the control to $54,076 for the frequent harvest treatment.
- Net returns ranged from $33,071 (organic insecticides) to $49,419 (control).
- At an $8.00/lb. market price, the breakeven yield for DN strawberries ranged from 0.54 lb./plant (7,632 lb./acre) for the control to 0.61 lb./plant (8,352 lb./acre) for the sanitation and organic insecticide treatments (Table 2).
- The sensitivity analysis (Table 2) indicates that DN strawberries are profitable when priced at >$6.00/lb. when yields average at least 0.75 lb./plant.

Table 2. Net returns for day-neutral strawberry control* under various marketable yield and price, $/acre

	Marketable yield (lb./plant)			
Price ($/lb)	0.50	0.75	1.0	1.25
4.50	-37,550	-13,793	-5,333	3,126
5.00	-33,950	-8,393	1,867	12,126
5.50	-30,350	-2,993	9,067	21,126
6.00	-26,750	2,407	16,267	30,126
6.50	-23,150	7,807	23,467	39,126
7.00	-19,550	13,207	30,667	48,126
7.50	-15,950	18,607	37,867	51,126
8.00	-12,250	24,007	45,067	66,126
8.50	-8,750	29,407	52,267	75,126
9.00	-5,150	34,807	59,467	84,126
9.50	-1,550	40,207	66,667	93,126

*Assumes white on black plastic mulch, no pest controls, harvested twice per week, double row planting with ½ ft between plants and 3 feet between rows, 2-year average direct material and labor input costs observed in field trial study, and estimated indirect costs. All harvest-related material and labor costs were adjusted according to yield.

Conclusions

The tested **treatments were equally ineffective in reducing SWD infestation** in DN strawberry compared to the control. Economic analyses revealed that **plastic mulch without any management for insect pests (control treatment) is the most economical production strategy**. The higher labor costs associated with the frequent harvest treatment outweighed any numerical yield benefits. Alternatives like post-harvest cold treatments, which reduce egg viability without harming non-target insects, may offer more cost-effective solutions than botanical or organic sprays for managing SWD in DN strawberry.