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The Outcome Expansion Project for Controlling Coconut Beetles and Coconut Black-Headed Caterpillars in Thap Sakæ District, Prachuap Khiri Khan Province

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Kanchana Daoden[1]*, Tanachai Pankasemsuk[2], Arthitaya Kawee-ai[2] and Supanat Nicrotha[3]

[1]*Department of Computer Engineering and Artificial Intelligence, Uttaradit Rajabhat University, Thailand*

[2]*Division of Cannabis and Medicinal Plants for Local Development, Graduate School, Payap University, Thailand*

[3]*Independent Researcher, Mechanical Engineering (Agricultural Engineering), Thailand*

***Corresponding Author:** Kanchana Daoden, Uttaradit Rajabhat University, 27 Injaimee Road, Muang, Uttaradit, Thailand.

Abstract

Coconut is an important cash crop in Thailand, especially in the Thap Sakae District, Prachuap Khiri Khan Province. The total annual output exceeds around 600,000 tons for export consumption. Ten years ago, coconut growers suffered a decrease in both quantity and quality because coconut trees were destroyed and eventually died from insect pests, especially coconut beetles and coconut black-headed caterpillars. The obstacle to preventing and eliminating is the nature of tall coconut plants. Wind speed in coastal areas affects labor costs. The quantities of chemicals applied and the risk of chemical hazards that impact health costs. This research is the outcome of an expansion project to control coconut beetles and coconut black-headed caterpillars in Thap Sakae District, Prachuap Khiri Khan Province, in 2021, which involved hand-spraying coconut shoots and expanding the area to 100 Rai. The research teams are focused on developing technology to control the treatment and reach the tops of coconuts, covering as much leaf area as possible. The methods mentioned above aimed to reduce chemical and nutrient waste, and to ensure that conventional manual labor methods could reach a critical part of the coconut shoot. In addition, the research team adjusted the spray nozzle to three levels to maximize pesticide application efficiency. The experiment showed that insecticide could be sprayed at a rate of 4.5-5.2 liters per minute, with a spray radius of 0.5-1.2 meters for continuous spraying and 6.5-8 meters for general spraying. The insect control system was effective continuously. The results indicated that this method could effectively control coconut beetles and coconut black-headed caterpillars in a demonstration plot in Thap Sakae District, Prachuap Khiri Khan Province.

Keywords: Production potential; Coconut milk; Coconut beetle; Black-headed caterpillar

Introduction

Due to outbreaks of coconut pests, namely the coconut beetle and the coconut black-headed caterpillar, preliminary surveys by the research team have revealed that almost every coconut-farming household is experiencing recurring problems, especially during the dry season. This research leads to wasteful and ineffective use of pesticides, resulting in low coconut yield and quality [1]. If an infestation occurs, it can reduce yield by more than 50% and may even reach a point where production is no longer possible, resulting in damages worth hundreds of millions of baht. It directly impacts farmers' income, numerous related industries, and ultimately, consumers.

Based on previous research, the research team proposed collecting data on environmental factors that affect increases or decreases in farmers' coconut production potential. The data were gathered from farmers participating in tests of managing coconut beetles and coconut black-headed caterpillars using tree rejuvenation and insecticides [2]. Therefore, the research team conducted trials using tree rejuvenation and insecticides as the primary control method in a management and control system for coconut beetles and coconut black-headed caterpillars [3]. The trials were conducted in a large-scale plot of 100 rai, primarily divided along Phet Kasem Road, with 50 rai on the east side (Village No. 1, Tambon Noen Din Daeng, Thap Sakae District) and 50 rai on the west side (Village No. 2, Tambon Noen Din Daeng), Thap Sakae District, Prachuap Khiri Khan Province.

The research team's experiments and tests determined the optimal proportions and quantities of plant growth enhancers, tree rejuvenation agents, and insecticides that affect coconut yield. It was done to reduce unnecessary chemical use, which impacts production costs. Other relevant economic data were collected through interviews, questionnaires, and farmer group meetings. Knowledge transfer on spraying for tree rejuvenation and insecticide application was also provided to farmer groups. The project in Noen Din Daeng Subdistrict, Thap Sakae District, Prachuap Khiri Khan Province, aims to address the coconut beetle infestation problem in Prachuap Khiri Khan Province as a model and a sustainable solution for the future.

Problem destination

The research uses tree rejuvenation and insect-control agents, and sprays inflorescences or trunks of all coconut trees in the area [4, 6]. This experiment will eliminate both larvae about to mature and adult pests ready to reproduce simultaneously. Combine this with the use of pheromone-sniffing agents to reduce the mating opportunities for coconut pests. If the coconut trees are not severely damaged and cannot normally absorb water and nutrients, they can recover and resume.

The Characteristics of the coconut beetle and the coconut black-headed caterpillar

Type	*Characteristic*	*Nature of drilling into coconut trees*
Coconut beetle		
Coconut black-headed caterpillar		

Figure 1: The characteristics of insect pests.

The appearance of damaged coconut leaves

Type	*Property*	*Characteristic*
One	**Minor damage** refers to coconut trees that have been damaged by black-headed caterpillars but still have intact green leaves on 13 or more fronds.	
Two	**Moderate damage**: This refers to coconut trees damaged by the black-headed caterpillar but still with 6-12 intact green fronds.	
Three	**Severe damage** is defined as coconut trees that have been damaged by the black-headed caterpillar but still have 5-0 intact green leaves.	
Reference: Department of Agricultural Extension.		

Figure 2: The appearance of damaged coconut leaves.

Moreover, from an economic perspective, the first estimate is based on the research project's focus on its effectiveness in controlling the coconut beetle and coconut black-headed caterpillar, as well as slowing pest spread [5]. With these estimates, preliminary economic values can then be calculated as follows:

In the first stage, based on the province's total productive area of 457,285 rai, the average coconut yield was approximately 240 coconuts per rai, with chemical and harvesting labor costs totaling 1,140 baht per rai. This resulted in a production value of 1,970,529,120 baht under previous conditions [8]. Following the current outbreak, the average yield dropped to 120 coconuts per rai, while chemical and harvesting labor costs declined to 1,072 baht per rai, leading to a lower production value of 985,420,080 baht. In preliminary trials during a research project, a sample area of 5 affected rai yielded an average of 220 coconuts per rai, with chemical and labor costs totaling 1,020 baht per rai and a resulting production value of 1,806,809,400 baht.

Note

1. Agricultural product prices received by farmers, yield per plant, and number of plants per rai were obtained from farmers who participated in the 2019 conference.
2. Cost of pesticides.

The research project aims for a future target of 300 coconuts per rai with a harvesting labor cost of 1,068 baht per rai, projecting a potential production value of 2,463,571,800 baht. Details of the data source and calculations are shown in Table 1. Each situation is processed in 1 Rai (acre).

Situation	*Plant*	*Yield / Plant*	*Yield / Rai (acre)*	*(%)*	*Price (Baht / Yield)*	*Yield Value (Baht / Rai)*	*Chemical Costs (Baht / Rai)*	*Harvesting Costs (Baht/Rai)*	*Yielding Area (Rai)*	*Net Total Yield Value (Baht)*
Farmers' original goals/situation	20	15	300	100	18	5,400	1,000	144	100	425,600
Since the outbreak began in 2017 - present	20	7	140	47	18	2,520	1,000	72	100	144,800
Initial experimental results in a sample area from the original project (averaging 5 rai).	20	12	240	80	18	4,320	888	132	100	330,000
Project Goals	20	17	340	114	18	6,120	888	180	100	505,200

Table 1: forecasts the project's outcomes and quantitative indicators that will lead to increased income from reduced coconut tree loss due to the use of substances supported by the project.

Materials and Methods

Compare the advantages of the technology being developed with those of other currently available technologies

Number	*Control substances*	*Ratio*	*Mixing ratio*
1	Carbaryl (Sevin 85)	1,000 grams.	Mix the four substances with 1,000 liters of water.
2	Asafetida	550 ml.	
3	BRs	50 ml.	
4	Surfactant	500 ml.	
The appropriate time for spraying. Spray continuously for at least 6 months during the dry season, spray every 14 days for the first 2 months to eliminate larvae and unhatched eggs, then every 1 month for the next 4 months. Farmers can adjust the amounts of Asafetida and Sevin 85 based on the infestation level and can also use other nutrient supplements as usual.			

Table 2: The appearance of damaged coconut leaves.

The properties of the four substances used for spraying in experimental plots 1 and 2

Control	**Carbaryl (Sevin85)**	**Asafetida**	**Brassinosteroids (BRs)**	**Surfactant**
1,000 liters of water	- Insecticide in the carbamate group. - Acts both by contact and ingestion. - Suitable for vegetables, fruit trees, field crops, ornamental plants, and perennial trees.	- It has an unpleasant smell. - It smells very strong.	- It has a hormone-like structure that controls insect molting. - It can act as an anti-molting agent. - It is an interesting natural substance for use in insect control.	- It is a surfactant that reduces the surface tension of water. - If used in large quantities, it can wash away the wax or cuticle on the surface of plants, leaving the plant without a system to protect against water loss from the leaves.

Table 3: The appearance of damaged coconut leaves.

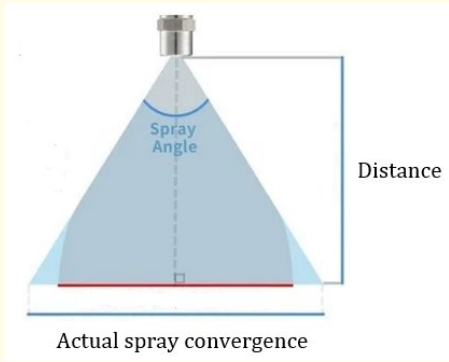

Figure 3: The spray nozzle technology allows for adjustable angles. https://www.lorric.com/en/Articles/nozzle/all/spray-angle-intro)

The spray angle is the angle between the nozzle outlet centerline and the spray edges on both sides. The equations of spray convergence are as follows:

$$Spray\ converge = 2 \cdot distance \cdot \tan\left(\frac{\text{Spray angle}}{2}\right) \quad (1)$$

Equation (1) states that the wider the spray angle, the wider the coverage area, but the shorter the spray distance. Conversely, a narrower spray angle will result in a narrower coverage area but will allow the spray droplets to travel further.

The spray Nozzle technology allows for adjustable angles, ensuring precise and efficient insect spraying. Therefore, the research team modified the spray nozzle as follows:

Nozzle and Tank	***Spraying method***
Type 1 injector nozzle set, 0.05 mm (0.05 mm)	Use a spot sprayer to apply the insecticide to the area where the insects are located.
Type 2 injector nozzle set, 0.10 mm (0.10 mm)	Spray as a fine mist at an angle that covers the insects and coconut inflorescences (approximately 30-45 degrees).
Type 3 injector nozzle set, 0.15 mm (0.15 mm)	It is used to spray a fine mist in a wide area (approximately 90-360 degrees).

Table 4: The appearance of damaged coconut leaves.

The primary objective of this research is to expand testing and improve the effectiveness of applying research findings. The goal is to increase coconut yield and control coconut beetles and black-headed caterpillars in Thap Sakae District, Prachuap Khiri Khan Province [7, 9, 10]. The experiment covered 100 rai (about 2,000 square meters) in a large-scale plot mainly divided along Phet Kasem Road. This included 50 rai on the eastern side, specifically Village No. 1, Noen Din Daeng Subdistrict, and 50 rai on the western side, specifically Village No. 2, Noen Din Daeng Subdistrict, Thap Sakae District, Prachuap Khiri Khan Province. The latter was measured as 50 rai off Phet Kasem Road, Thailand. The study also examined environmental factors that might affect initial results and aimed to improve pest control in the area.

Figure 4: The experiment area covered 100 rai in a large-scale plot, divided along Phet Kasem Road.

Therefore, between July 25, 2025, and January 5, 2026, the research team conducted fieldwork to experiment, test the effectiveness, and collect experimental data. The details included: surveying the area, planning the experiment, defining experimental plots, and installing signage. The experiment was selected in accordance with the research project's specifications. The research team visited Village No. 2, Noen Din Daeng Subdistrict, Thap Sakae District, Prachuap Khiri Khan Province, to survey the area and understand the needs of local farmers [11, 12], who were designated as demonstration plots on the western side, totaling 50 rai, and to meet with one coconut plantation owner in the area. On the eastern side, the research team visited demonstration plot No. 2, Village No. 1, Noen Din Daeng Subdistrict, Thap Sakae District, Prachuap Khiri Khan Province, totaling 50 rai. The research team entered the area to define the demonstration plot and the experimental and testing areas and met with one coconut plantation owner.

Then, the research team visited the area a second time on June 22, 2025, to erect experimental plot signs and define the experimental layout. Spraying was done to mark the plants that will be harvested for the experiment. The area was divided into two sides: 1. The western demonstration plot, covering 50 rai, and 2. The eastern demonstration plot, covering 50 rai.

Results and Discussion

Round 1: The West Coast and the East Coast.

Results from the demonstration plot on the Western Side, Round 1						
Tree/Plot	***Coconut circumference (cm.)***	***Weight (Kg.)***	***Shell (Kg.)***	***Coconut shell (mm.)***	***Coconut water (Kg.)***	***Coconut flesh (Kg.)***
1/1	62	2	1	1	0.4	0.4
1/2	53.5	1.9	0.8	1.5	0.4	0.4
1/3	62	2	1	2	0.4	0.4
1/4	63	2.2	1.1	2.5	0.45	0.5
1/5	58.5	2.1	0.9	2	0.55	0.4
1/6	64	2.5	1.4	2	0.4	0.4
2/1	65	2.7	1.4	2	0.55	0.6
2/2	60	2.4	1.3	2.5	0.3	0.4
2/3	64	2.3	1.1	2.5	0.45	0.5
2/4	64	2	1	2	0.4	0.4
2/5	64	2.4	1.1	2	0.45	0.5
2/6	65	2.2	1.3	2	0.4	0.4

3/1	61	1.8	1	1.5	0.26	0.30
3/2	64.5	1.9	0.9	1.5	0.37	0.38
3/3	62	2.5	1.9	2.5	0.17	0.17
3/4	65	2.1	1.2	1.5	0.27	0.36
3/5	66	2.3	1	1	0.44	0.47
3/6	63	2.1	1.1	2	0.34	0.37
4/1	69	2.3	1.1	1.5	0.37	0.51
4/2	66	2	0.9	1.5	0.37	0.49
4/3	70	2.5	1.1	1	0.55	0.52
4/4	66	3.9	2.2	2	0.66	0.58
4/5	70	2.8	1.4	2	0.49	0.59
4/6	64	2.9	1.7	2	0.43	0.37
5/1	62	2.3	1.4	1.5	0.31	0.31
5/2	62	2	1.1	2.5	0.26	0.34
5/3	62	2.4	1.7	1	0.25	0.32
5/4	70	3.1	1.8	2	0.43	0.48
5/5	61	1.9	1	1.5	0.28	0.35
5/6	65	3.3	2.3	1.5	0.41	0.32
6/1	57	1.8	1	2	0.25	0.30
6/2	67	2.1	1.1	2	0.30	0.43
6/3	64	3	1.4	1.5	0.58	0.58
6/4	62	2.5	1.2	1.5	0.48	0.54
6/5	63	2.2	1.2	1.5	0.32	0.37
6/6	63	2.1	1.1	1	0.35	0.33
Results from the demonstration plot on the Eastern side, Round 1						
Tree/Plot	***Coconut circumference (cm.)***	***Weight (Kg.)***	***Shell (Kg.)***	***Coconut shell (mm.)***	***Coconut water (Kg.)***	***Coconut flesh (Kg.)***
1/1	74.5	3.4	1.4	2	0.5	0.7
1/2	67.5	2.5	1.2	2	0.45	0.6
1/3	65.5	2.5	1.2	2	0.4	0.6
1/4	68.5	2.6	0.8	2	0.65	0.7
1/5	58.5	2	0.7	1.5	0.45	0.5
1/6	62.5	2	1.1	1.5	0.35	0.4
2/1	68	2.2	0.9	1.5	0.45	0.6
2/2	67	2.0	0.5	1.7	0.5	0.6
2/3	57.5	1.6	0.8	1.5	0.35	0.4
2/4	74	2.7	1.4	2	0.55	0.7
2/5	63	2.8	1.5	2.1	0.38	0.6
2/6	64	2.4	1.5	2.2	0.37	0.7
3/1	70	3	0.9	2	0.5	0.6
3/2	72	3	0.8	2	0.45	0.6
3/3	71	2	0.8	1.5	0.4	0.7

3/4	64	2	0.9	1.5	0.35	0.5
3/5	65	3.2	0.8	1.3	0.45	0.2
3/6	77.5	3.6	1.7	1.5	0.95	0.6
4/1	63.5	2.2	0.9	1.5	0.45	0.6
4/2	62.5	2.0	0.8	1.4	0.4	0.7
4/3	56	1.5	0.6	1.5	0.25	0.4
4/4	57	1.3	0.4	1.7	0.3	0.45
4/5	65	2	0.7	1.5	0.55	0.6
4/6	63	2.4	1.3	1.5	0.45	0.4
5/1	66	2.5	1.2	2	0.35	0.6
5/2	63	2.3	0.9	1.5	0.65	0.6
5/3	64	2.2	0.7	1.7	0.7	0.7
5/4	65	2.6	0.8	1.8	0.6	0.6
5/5	67	2.7	1.4	1.5	0.55	0.5
5/6	68	2.5	1.3	1.5	0.55	0.6
6/1	64	2.2	0.8	1.6	0.4	0.5
6/2	65	1.9	0.9	1.5	0.35	0.4
6/3	66	1.5	0.8	1.7	0.6	0.5
6/4	58.5	1.6	0.7	1.5	0.25	0.5
6/5	68	2.4	1.1	1.5	0.55	0.5
6/6	67	2.5	1.2	1.5	0.6	0.5

Table 5: The results of the West Coast and the East Coast-Round 1.

Round 2: The West Coast and the East Coast.

Results from the demonstration plot on the Western Side, Round 2						
Tree/Plot	***Coconut circumference (cm.)***	***Weight (Kg.)***	***Shell (Kg.)***	***Coconut shell (mm.)***	***Coconut water (Kg.)***	***Coconut flesh (Kg.)***
1/1	62	2	1	3.1	0.4	0.4
1/2	59.5	1.9	0.8	3.4	0.4	0.4
1/3	52	2	1	4.7	0.4	0.4
1/4	63	2.2	1.1	5.1	0.45	0.5
1/5	58.5	2.1	0.9	4.6	0.55	0.4
1/6	64	2.5	1.4	4.7	0.4	0.4
2/1	65	2.7	1.4	4.8	0.55	0.6
2/2	60	2.4	1.3	5.1	0.3	0.4
2/3	64	2.3	1.1	5.1	0.45	0.5
2/4	64	2.0	1.0	4.6	0.4	0.4
2/5	64	2.4	1.1	4.7	0.45	0.5
2/6	65	2.2	1.3	4.7	0.4	0.4
3/1	61	1.8	1	3.4	1.26	0.30
3/2	64.5	1.9	0.9	3.4	0.37	0.38
3/3	62	25	1.9	4.6	0.17	0.17

3/4	65	2.1	1.2	3.7	0.27	0.36
3/5	66	2.3	1.0	3.4	0.44	0.47
3/6	63	2.1	1.1	4.2	0.34	0.37
4/1	69	2.3	1.1	3.5	0.37	0.51
4/2	66	2.0	0.9	3.4	0.37	0.49
4/3	70	2.5	1.1	3.1	0.55	0.52
4/4	66	3.9	2.2	4.5	0.66	0.58
4/5	70	2.8	1.4	4.4	0.49	0.59
4/6	64	2.9	1.7	4.6	0.43	0.37
5/1	62	2.3	1.4	3.6	0.31	0.31
5/2	62	2.0	1.1	5.2	0.26	0.34
5/3	62	2.4	1.7	3.2	0.25	0.32
5/4	70	3.1	1.8	4.9	0.43	0.48
5/5	61	1.9	1.0	3.9	0.28	0.35
5/6	65	3.3	2.3	3.8	0.41	0.32
6/1	57	1.8	1.0	4.7	0.25	0.30
6/2	67	2.1	1.1	4.9	0.30	0.43
6/3	64	3.0	1.4	3.6	0.58	0.58
6/4	62	2.5	1.2	3.5	0.48	0.54
6/5	63	2.2	1.2	3.6	0.32	0.37
6/6	63	2.1	1.1	3.1	0.35	0.33
Results from the demonstration plot on the Eastern side, Round 2						
Tree/Plot	***Coconut circumference (cm.)***	***Weight (Kg.)***	***Shell (Kg.)***	***Coconut shell (mm.)***	***Coconut water (Kg.)***	***Coconut flesh (Kg.)***
1/1	74	3.4	1.4	4.8	0.5	0.7
1/2	67	2.5	1.2	4.8	0.4	0.6
1/3	65	2.5	1.2	4.6	0.4	0.6
1/4	68.5	2.6	0.8	4.7	0.68	0.7
1/5	58.5	2.0	0.7	3.4	0.45	0.5
1/6	62.5	2.0	1.1	3.5	0.35	0.4
2/1	68	2.2	0.9	3.6	0.45	0.6
2/2	61	2.3	0.8	4.4	0.35	0.46
2/3	57.5	1.6	0.8	3.7	0.35	0.4
2/4	74	2.7	1.4	4.8	0.55	0.7
2/5	60	1.1	0.8	4.8	0.5	0.3
2/6	63	1.2	0.8	4.1	0.4	0.42
3/1	64	2.9	1.2	4.2	0.8	0.8
3/2	72	3	0.8	4.8	0.45	0.6
3/3	64	2.1	1.1	3.2	0.5	0.6
3/4	64	2	0.9	3.7	0.35	0.5
3/5	64	2.3	1.2	3.6	0.4	0.4
3/6	77.5	3.6	1.7	3.7	0.95	0.6

4/1	63.5	2.2	0.9	3.6	0.45	0.6
4/2	63	2.4	1.0	44	0.5	0.5
4/3	56	1.5	0.6	3.7	0.25	0.4
4/4	67	2.2	0.9	4.1	0.5	0.5
4/5	65	2	0.7	3.6	0.55	0.6
4/6	6.3	2.4	1.3	3.6	0.45	0.4
5/1	66	2.5	1.2	4.7	0.35	0.6
5/2	63	2.3	0.9	3.6	0.65	0.6
5/3	58	2.7	0.8	3.1	0.7	0.6
5/4	65	2.8	1.1	3.4	0.65	0.7
5/5	67	2.7	1.4	3.7	0.55	0.5
5/6	68	2.5	1.3	3.6	0.55	0.6
6/1	62	2.5	1.0	4.1	0.55	0.6
6/2	65	1.9	0.9	3.7	0.35	0.4
6/3	66	1.2	0.95	4.8	0.4	0.5
6/4	58.5	1.6	0.7	3.6	0.25	0.5
6/5	68	2.4	1.1	3.7	0.55	0.5
6/6	61	2.0	0.9	4.3	0.35	0.4

Table 6: The results of the West Coast and the East Coast-Round 2.

Round 3: The West Coast and the East Coast.

Results from the demonstration plot on the Western Side, Round 3						
Tree/Plot	***Coconut circumference (cm.)***	***Weight (Kg.)***	***Shell (Kg.)***	***Coconut shell (mm.)***	***Coconut water (Kg.)***	***Coconut flesh (Kg.)***
1/1	73	3.54	1.77	3.8	0.72	0.67
1/2	67	2.06	0.6	3.6	0.61	0.6
1/3	62	2.6	1.10	4.1	0.63	0.61
1/4	67	2.3	1.02	39	0.65	0.35
1/5	65	3.03	1.5	4.2	0.69	0.57
1/6	67	2.86	1.42	32	0.57	0.57
2/1	66	3.05	1.39	3.9	0.71	0.64
2/2	66	1.93	1.13	4.0	0.29	0.35
2/3	63	2.69	1.23	3.9	0.6	0.6
2/4	68	2.27	1.37	5.0	0.35	0.35
2/5	73	2.86	1.89	4.2	0.35	0.35
2/6	73	2.84	1.48	4.3	0.57	0.54
3/1	67	2.31	0.76	4.4	0.77	0.44
3/2	69	2.76	1.32	4.8	0.61	0.49
3/3	69	3.10	1.75	4.4	0.49	0.57
3/4	62	2.23	1.21	4.6	0.39	0.40
3/5	71	2.58	1.3	4.6	0.5	0.54
3/6	71	2.80	1.0	4.8	0.84	0.59

4/1	71	2.83	1.82	3.9	0.40	0.34
4/2	61	2.3	0.81	4.1	0.66	0.56
4/3	62	2.4	0.97	4.6	0.58	0.58
4/4	67	2.28	0.87	4.2	0.54	0.55
4/5	70	2.78	1.28	4.7	0.63	0.53
4/6	62	2.58	1.14	3.8	0.56	0.62
5/1	64	2.62	1.16	4.2	0.58	0.6
5/2	63	2.61	0.93	3.9	0.73	0.7
5/3	70	2.20	0.99	4.6	0.42	0.45
5/4	65	2.10	1.6	4.4	0.42	0.65
5/5	71	2.5	1.38	4.1	0.45	0.45
5/6	65	2.79	1.19	4.9	0.57	0.51
6/1	64	2.9	1.5	4.2	0.55	0.58
6/2	62	2.35	1.21	4.4	0.43	0.42
6/3	71	2.28	1.1	3.9	0.44	0.50
6/4	68	2.38	0.74	4.8	0.67	0.62
6/5	6.2	2.28	1.35	4.6	0.35	0.37
6/6	63	2.20	0.86	3.5	0.68	0.64
Results from the demonstration plot on the Eastern side, Round 3						
Tree/Plot	***Coconut circumference (cm.)***	***Weight (Kg.)***	***Shell (Kg.)***	***Coconut shell (mm.)***	***Coconut water (Kg.)***	***Coconut flesh (Kg.)***
1/1	74	3.1	1.7	4.6	0.45	0.50
1/2	74	3.0	1.4	4.7	0.67	0.70
1/3	68	2.5	1.1	4.8	0.55	0.60
1/4	69	2.7	1.5	5.0	0.46	0.40
1/5	77	3.9	1.3	3.5	1.30	0.80
1/6	76	3.9	1.7	4.1	0.92	0.80
2/1	69	2.23	1.14	4.9	0.29	0.45
2/2	67	2.34	1.11	4.8	0.44	0.5
2/3	64	0.97	0.65	4.6	0.51	0.5
2/4	60	1.73	0.50	4.5	0.54	0.45
2/5	64	1.79	0.92	4.8	0.29	0.36
2/6	63	1.72	0.7	4.2	0.41	0.42
3/1	74	3.8	1.6	4.5	1.0	0.80
3/2	72	3.9	1.7	4.6	1.0	0.80
3/3	74	2.9	1.7	3.1	0.60	0.70
3/4	75	3.1	1.6	3.5	0.47	0.60
3/5	67	2.6	1.5	4.1	0.44	0.40
3/6	69	3.0	1.4	4.2	0.62	0.60
4/1	62	2.57	1.43	5.0	0.45	0.44
4/2	68	2.90	1.36	4.8	0.73	0.57
4/3	62	1.93	0.68	4.8	0.44	0.56

4/4	63	2.0	0.82	3.9	0.49	0.46
4/5	79	3.9	1.32	3.9	1.19	0.97
4/6	68	2.54	1.22	3.9	0.48	0.53
5/1	72	2.5	0.8	3.9	0.73	0.60
5/2	74	2.4	0.7	4.0	0.73	0.70
5/3	71	3.0	1.0	3.1	0.79	0.80
5/4	73	3.2	1.4	3.5	0.70	0.70
5/5	66	2.6	1.1	4.3	0.61	0.60
5/6	67	2.7	1.2	4.2	0.55	0.60
6/1	69	2.97	1.34	4.1	0.74	0.59
6/2	65	1.87	0.52	4.2	0.54	0.51
6/3	70	2.67	1.35	5.0	0.49	0.57
6/4	64	2.25	0.78	3.9	0.61	0.56
6/5	69	2.59	1.15	3.7	0.59	0.53
6/6	64	1.85	0.88	4.3	0.36	0.40

Table 7: The results of the West Coast and the East Coast-Round 3.

These examples show coconut trees and leaves that improved after the experiment, as evidenced by their greener color

Side	***Before***	***Round 1***	***Round 2***	***Round 3***
The Western Side				
The Eastern side				

Table 8: The appearance of damaged coconut leaves.

The comparison graph for the average weight of the coconut milk

Figure 5: The appearance of damaged coconut leaves.

These examples show coconut trees and leaves that improved after the experiment, as evidenced by their greener color.The performance test results showed that when coconuts were treated with the substance, the following trend was observed: positive. The second harvest yielded higher yields than the first on both the western and eastern sides, indicating improvements or factors contributing to increased yields in the subsequent harvest. The eastern side: There was a significant increase in total weight and average flesh content compared to the western side in the second harvest. The average flesh content increased in the second harvest for both sides, indicating improved product quality.

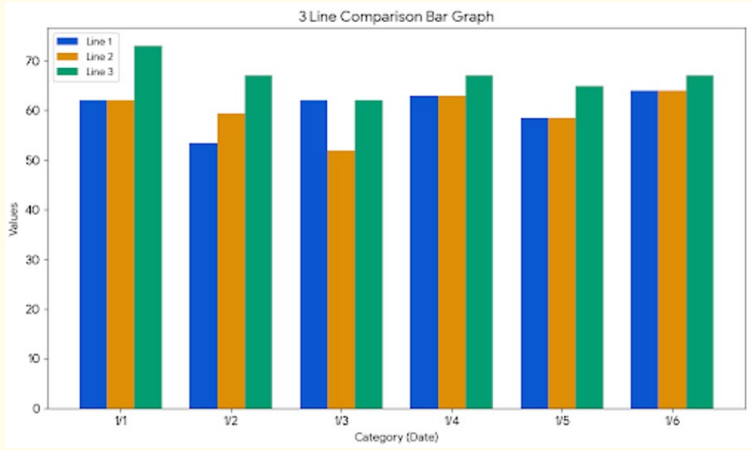

Figure 6: Comparison graph of coconut circumference (cm) across 3 experimental rounds.

Data Summary

The graph coconut circumference compares the values for three sets of data (Line 1, Line 2, and Line 3) across six categories; the categories (X-axis): 1/1, 1/2, 1/3, 1/4, 1/5, and 1/6, and Values (Y-axis): The numerical values corresponding to each data point. Each group on the X-axis contains three bars, allowing for a direct comparison of the values between the three rows for each specific date.

Conclusion

This research builds on a 2021 expansion of a project to control coconut beetles and coconut black-headed caterpillars in Thap Sakae District, Prachuap Khiri Khan Province. This project initially involved manual spraying of coconut crowns and expanded to 100 rai (approximately 40 hectares). The research team focused on developing technology to control spraying and ensure maximum reach to the coconut crown, covering as much leaf area as possible.

The experiment results showed that this method minimizes chemical and nutrient waste and ensures that traditional manual methods can reach key parts of the coconut shoot. In further work, the research team adjusted the spray nozzle to extend the area of general spraying. The insect control system demonstrated consistent effectiveness. The results indicate that this method can effectively control coconut beetles and coconut black-headed caterpillars in the demonstration plots in Thap Sakae District, Prachuap Khiri Khan Province.

Conflict of interest

The authors declare that they have no known financial or personal relationships that could have influenced the work reported in this paper.

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