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ECO-BIOLOGICAL CONTROL OF CALLOSOBRUCHUS ANALIS F. USING MORINDA CITRIFOLIA LEAF POWDER AND ITS EFFECTS ON SEED VIABILITY OF DETAM-1 BLACK SOYBEANS

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ABSTRACT

Background. One component of post-harvest management that aims to produce more competitive products is seed storage. Maintaining the viability of seeds for an extended period as planting material from one season to the next is the primary goal of seed storage

Aims. This article aims to study and determine the effectiveness of noni leaf powder on the development of the insect Callosobruchus analis F. (Coleoptera: Bruchidae) and the quality of black soybean seeds of the Detam-1 variety, as well as to obtain one of the doses of noni leaf powder that is effective in suppressing insect pests C. analyst F. and able to maintain the quality of black soybean seeds of the Detam-1 variety.

Methods. The experiment, conducted using the experimental method, was carried out at the Laboratory of the Faculty of Agriculture, Winaya Mukti University, Tanjungsari, Sumedang, from April 2024 to June 2024. The environmental design employed was a Completely Randomized Design (CRD) with six treatments and four replications. The dosage treatment of noni leaf powder/100 g black soybeans is: A = 0.0 g, B = 2.5 g, C = 5.0 g, D = 7.5 g, E = 10.0 g, F = 12.5 g. Each treatment consists of two jars, resulting in a total of 48 jars.

Conclusion. The results showed that a dose of noni leaf powder of 7.5 g was effective in increasing mortality, reducing the Number of eggs, larvae, and imago that appeared, and could maintain the quality of black soybean seeds in storage.

Keywords: Callosobruchus analis F, Noni Leaf Powder, Seed Quality, Black Soybean

INTRODUCTION

Marwah et al. (2023) additionally note that black soybeans offer several advantages in terms of nutritional value and can be used as a processed soybean product to meet food demand. This amazing soybean contains 34% carbohydrates, 19% oil, 34% protein, and 5% minerals, along with other ingredients such as isoflavones and anthocyanins, is the soybean variety Detam 1 (Glycine max L. Merr) (Yudiono, 2020).

One component of post-harvest management that aims to produce more competitive products is seed storage. Maintaining the viability of seeds for an extended period as planting material from one season to the next is the primary goal of seed storage. The insect pest Callosobruchus analis F. is one of the potential insect pests that can infest stored soybean seeds (Ria et al., 2024). According to estimates, losses due to pests during storage can be substantial, and soybeans with holes and other damage are no longer suitable as raw materials. 70–90% of stored soybeans may lose weight and go spoiled (Lima et al., 2023). Effective seed storage practices are crucial for minimizing losses from pests, such as Callosobruchus, and maintaining seed quality over time, especially in environments with high humidity and temperature (Lawrence et al., 2017). Implementing proper storage conditions, such as maintaining a lower moisture content and controlling temperatures, can significantly enhance the quality and longevity of stored soybean seeds affected by pests (Phitakwinai et al., 2019).

For pest control in storage, effective ingredients to minimize damage to soybean seeds, as well as safe plant insecticides, such as noni leaf powder, should be used. One of the components of the eco-friendly Integrated Pest Control concept is plant-based insecticides, which can be used to control plant pest organisms. Plant-based insecticides are derived from plants (Reddy & Chowdary, 2021). These plant-based insecticides act as nerve agents, fight pests or resist their presence, act as antifeedants, induce an unpleasant taste for pests, impair the development of eggs, larvae, and pupae, and inhibit the reproductive system. Noni leaves can produce secondary metabolite compounds that act as antibiotics and have a detrimental effect on plant pest organisms (OPT) (Suwandi et al., 2022). Implementing such eco-friendly pest management strategies not only protects seed quality but also promotes sustainable agricultural practices. These practices contribute to a holistic approach to pest management, ensuring both the integrity of seed stocks and the overall health of agricultural ecosystems (Fanadzo et al., 2018).

This study aims to determine the effective dose of noni leaf powder in suppressing the development of C. analis F as pest insects and the ability to maintain the quality of black soybean seeds of the Detam-1 variety as well as to determine how effective noni leaf powder is in suppressing the development of C. analis F and maintaining the quality of black soybean seeds of the Detam-1 variety. The findings will provide insights into sustainable pest control methods while ensuring the physiological quality of seeds during storage. By focusing on eco-friendly solutions, this research highlights the importance of integrating natural pest management strategies to sustain seed viability and enhance agricultural productivity. The results of this study will contribute to the growing body of evidence supporting the use of plant-based biopesticides, such as noni leaf powder, in sustainable agriculture practices.

METHOD

This experiment was conducted at the Basic Laboratory of the Faculty of Agriculture, Winaya Mukti University, in Tanjungsari District, Sumedang Regency. The test site is located at an elevation of 875 m above sea level. The trial was conducted from April to June 2024.

In this experiment, the materials used included black soybean seeds of the Detam-1 variety, obtained from the Research Institute for Various Peanuts and Tubers in Malang, East Java; noni leaf powder; brown paper; tissue; water; formaldehyde; alcohol; and tea bags.

The tools used include glass jars, transparent Plastic, cloth, labels, digital scales, trays, stationery, knives, filters, needles, spoons, respirators, hand temperature meters, germinators, sprayers, hygrothermometers, choppers, and cameras.

Preparations are made for the propagation of test insects by collecting the imago C. analis F from the infested soybeans, kept in medium-sized jars made of plastic, then soybean seeds that have been attacked and have not been attacked since 3 months ago or three generations of insect pests C. analis F is mixed, covered with a thin cloth and coated with a rubber band.

The noni leaves to be used must be washed first with running water and then cut into small pieces to facilitate drying. After that, the noni leaves are air-dried for approximately 5-7 days, spread out on newspaper that serves as a base. During the drying process, the noni leaves are turned back and forth to ensure even drying. After the leaves are dry, they are mashed using a chopper and then sifted through a sieve with a 1 mm hole to obtain fine noni leaf powder, similar to flour. The sifted powder is weighed according to each treatment and then placed into an empty tea bag.

The experiment employed a Completely Randomized Design (CRD), consists of six treatments, each repeated four times. The dosage of noni leaf powder given is as follows:

A = 0 grams of noni leaf powder (without treatment)/100 g of black soybean seeds.
B = 2.5 grams of noni leaf powder/100 g of black soybean seeds.
C = 5.0 grams of noni leaf powder/100 g of black soybean seeds.
D = 7.5 grams of noni leaf powder/100 g of black soybean seeds.
E = 10.0 grams of noni leaf powder/100 g of black soybean seeds.
F = 12.5 grams of noni leaf powder/100 g of black soybean seeds.

In this experiment, the dose of noni leaf powder was administered to 48 jars, each repeated four times, with two jars per treatment unit, resulting in a total of 48 jars that consisted of 10 pairs of insect pests. After the C. analis F was developed, a feasibility test was performed. The test method used a paper roll with a plastic coating, and the number of rolls was equal to the total from the previous study, which amounted to 48 rolls containing 50 black soybeans each.

The observed responses included supporting observations and key observations. Supporting observations included temperature and humidity measurements, as well as LD50 toxicology tests. While the main observations are:

Percentage of Mortality Image C. analis F (%)

Mortality is the number of imago that have died caused by the addition of noni leaf powder treatment and is expressed in the form of percent (%). These observations were carried out on test insects that died 14 DAAs (Day After Application), 28 DAAs, 42 DAAs, and 56 DAAs. According to the formula (Syahputra, 2012) :

$$P = \frac{a}{b}\ x\ 100\%$$

Information:

P = Percentage of mortality (%)

a = Number of dead insects (tails)

b = Total number of insects observed

Number of Eggs (grains)

The number of eggs is the eggs produced from mating between male and female insects that are placed on the surface of black soybean seeds after being treated with noni leaf powder. This observation was conducted on 14, 28, 42, and 56 DAAs by counting insect eggs attached to the surface of black soybean seeds one by one.

Number of Larvae (tails)

The number of larvae is the result of hatching eggs that have been treated with noni leaf powder. This observation was carried out on 14 DAAs, 28 DAAs, 42 DAAs, and 56 DAAs by randomly dividing the black soybean seeds into 5% of the total seeds and counting the number of larvae one by one.

Number of Pupae (tail)

The Number of pupae is the result of the development of larvae that have been treated with noni leaf powder. This observation was carried out on 14 DAAs, 28 DAAs, 42 DAAs, and 56 DAAs by randomly dividing the black soybean seeds into 5% of the total seeds and counting the Number of pupae one by one.

Number of Images (tail)

The amount of imago is an imago found in a jar of black soybean seeds that comes from the development of pupae after being treated with noni leaf powder. This observation was carried out on 42 DAAs and 56 DAAs by looking directly at and calculating the imago contained in black soybeans as much as 5%

Percentage of Soybean Damage (%)

This observation was made by weighing damaged and undamaged black soybean seeds in each noni leaf powder treatment. The level of damage caused by C. analis F. was observed and calculated at 56 DAAs. According to the damage percentage, using the following formula (Chestnut, 2007) :

$$P = \frac{a}{a+b}\ x\ 100\%$$

Information:

P = Percentage of seed damage (%)

a = Broken Seed Weight (g)

b = Undamaged seed weight (g)

Black Soybean Seed Weight Loss Percentage (%)

Weight loss is calculated based on the damage caused by the insect infestation of C. analis F. on stored black soybean seeds. These observations were carried out at the end of the experiment on 56 DAAs. According to calculations using the following formula (Sastrosupadi, 2000) :

$$P = \frac{a - b}{a} \; x \; 100\%$$

Information:
P = Percentage of seed weight loss (%)
a = Initial weight (g)
b = Final weight (g)

Black Soybean Seed Viability Test
This test was conducted 56 days after observing C. analis F.'s development using the Rolled Paper Test method established in plastic. This observation was conducted using the germination power test, which was observed over an 8-day period. Normal germination power is a sprout that has no damage or defects in the hypocotyl or plumula parts and can give rise to primary roots, secondary roots with plumula that have developed well, and has two leaves that are not separated from the seed shell. According to the germination power formula can be calculated as follows (Daniel Gea et al., 2022; Synagogue, 2021) :

$$GP = \frac{\sum \; Normal\ seeds\ germinate}{\sum \; Total\ Seeds\ germinated} \; x \; 100\%$$

Information:
GP = Germination power (%)
The total percentage of normal germination divided into 24 etmal hours is a measure of germination speed. The cumulative ethal value was obtained from the time the seeds were planted to the time of observation. According to Ridha R. et al. (2017), the formula used is as follows :

$$KCT = + + \ldots + \frac{N1}{D1} \; \frac{N2}{D2} \; \frac{N3}{D3} \frac{Nn}{Dn}$$

Information:
KCT = (%/etmal)
N1-Nn = Percentage of normal germination
1st, 2nd, ... days 8 after planting (%)
D1-Dn = Number of days after planting (estimated)
N = end of sprouts

RESULTS AND DISCUSSION

The average temperature and humidity during the observation of the development of C. analis F. measured using a hygrothermometer in the experimental chamber were 25.19 °C and 72.2%,

respectively. Opinion warehouse pest (Utami et al., 2021) C. analis F. reproduce optimally at a temperature of 24.40 °C – 270 °C with a humidity of 67.5%-82.6%. Based on the temperature and humidity data, the C. analis F. develops well because the temperature and humidity in the experimental room are within the conditions for insect growth (Hendrawan et al., 2019). This suggests that maintaining optimal environmental conditions is essential for effectively managing pest populations and ensuring the longevity of stored seeds (De Vitis et al., 2020). Moreover, understanding the specific environmental requirements of pests like C. analis F. can guide the development of targeted pest management strategies that enhance seed storage efficacy. Effective pest management strategies must consider both the environmental conditions that are conducive to pest development and the implementation of eco-friendly treatments (Komarova et al., 2021), thereby ensuring the preservation of seed quality and agricultural sustainability. Maintaining optimal conditions not only aids in pest control but also enhances the overall quality and viability of stored seeds, which is essential for successful agricultural outcomes.

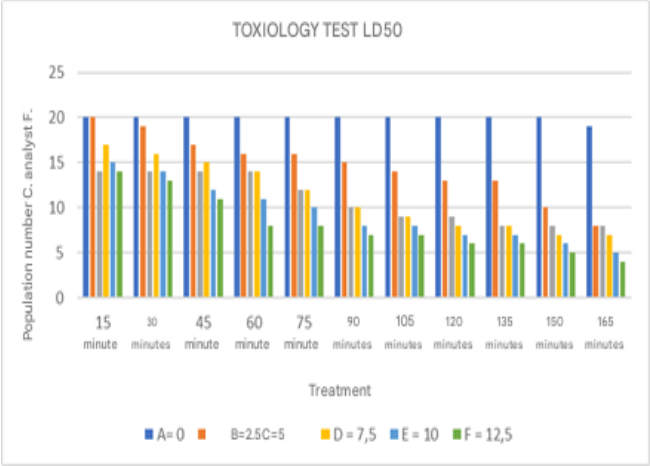

Figure 1. LD50 Toxicology Test Graph

Based on Figure 1, the 165-minute LD50 toxicology test showed that treatment with noni leaf powder F (12.5 g) at the 60th minute and E (10.0 g) at the 75th minute resulted in 50% mortality. Then, in the 90th minute, treatments D (7.5 g) and C (5.00 g) experienced a 50% mortality rate, indicating that noni leaves can be used as a vegetable insecticide. The high dose given can cause insects to die faster, because each increase in the dose results in an increase in the number of compounds contained in it, leading to more insect deaths. These findings underscore the potential of noni leaf powder as a viable option for pest control, aligning with the need for sustainable agricultural practices that minimize reliance on synthetic insecticides. Furthermore, the results indicate that using noni leaf powder not only effectively reduces pest populations but also supports the overall health of the agricultural ecosystem, enhancing long-term sustainability.

LD50 Toxicology Test

This test was carried out to determine the efficacy of noni leaf powder as a vegetable insecticide against the death of C. analis F. by calculating the number of insect pests that died 50% out of 20 heads, with the dose of noni leaf powder according to the treatment design, observed at intervals of 15 minutes until the population was only 50% left.

Mortality Percentage C. analis F

Based on Table 1, the observation of average imago mortality at the observation of 14 DAAs, 28 DAAs, 42 DAAs, and 56 DAAs all treatments A (0.0 g), B (2.5 g), C (5.0 g), D (7.5 g), E (10.0 g), and F (12.5 g) showed different results that were not real because all treatments showed imago mortality of 100%.

Table 1. Effect of Noni Leaf Powder Dosage on Percentage of Imagoes Mortality C. analis F on Black Soybeans Detam-1 Variety

Treatment (g)	Percentage Mortality Imagoes *C. analis* F. (%)							
	14 DAA		28 DAA		42 DAA		56 DAA	
A(0.0)	100	a	100	a	100	a	100	a
B(2.5)	100	a	100	a	100	a	100	a
C(5.0)	100	a	100	a	100	a	100	a
D(7.5)	100	a	100	a	100	a	100	a
E(10.0)	100	a	100	a	100	a	100	a
F(12.5)	100	a	100	a	100	a	100	a

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

According to the content of saponins and polyphenols contained in noni leaf powder, these substances can act as respiratory toxins, poisoning the respiratory tract on the surface of the body and then entering the body. Insect pests become difficult to eat, causing mortality because Saponins can also attack the process of food absorption and damage cell membranes in pests (Masdah Herlina Putri et al., 2019; Lisya et al., 2023)

Number of Eggs

Based on Table 2 on the observation of the average Number of eggs aged 14 DAAs, 28 DAAs, 42 DAAs and 56 DAAs in treatment F (12.5 g) had a significantly different effect from treatment A (0.0 g), B (2.5 g), C (5.0 g), and D (7.5 g) and E (10.0 g) However, treatment A (0.0 g) had the most number of eggs compared to other treatments.

This is because the content of noni leaves, namely flavonoids and triterpenoids, has a very sharp smell and bitter taste, so that it can affect insects in producing eggs. Flavonoids can also cause

weakness in the nervous system as well as damage to the spiracle, resulting in insects being unable to breathe and eventually dying (Dedi Supriyatdi et al., 2023; Yulistyana et al., 2020)

Incorporating such biopesticides into pest management practices can significantly enhance seed quality and storage longevity, ultimately contributing to improved agricultural productivity and sustainability. In conclusion, the use of noni leaf powder as a biopesticide presents a promising alternative for managing pest populations while ensuring the quality and longevity of stored seeds.

Table 2. Effect of Noni Leaf Powder Dosage on Egg Count of C. analis F. in Black Soybeans Detam-1 Variety

Treatment (g)	Average Egg Count *C. analis* F. (grain)			
	14 DAA	28 DAA	42 DAA	56 DAA
A(0.0)	159.5 e	153.13 e	146.00 e	190.88 e
B(2.5)	118.63 de	106.88 de	100.75 d	115.50 d
C(5.0)	96.13 cd	88.75 cd	81.50 cd	103.38 cd
D(7.5)	79.38 bc	73.75 bc	68.50 bc	76.13 cd
E(10.0)	55.75 bc	47.63 bc	40.63 bc	51.63 b
F(12.5)	19.75 a	13.63 a	68.50 a	14.25 a

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

Number of Larvae

Based on Table 3, at the age of 14 DAAs, larvae have not yet appeared, so all treatments show different results that are not representative. The larvae began to appear at the observation of 28 DAAs, giving the results of treatment F (12.5 g) significantly different from treatment A (0.0 g) and B (2.5 g) but not significantly different from treatment C (5.0 g), D (7.5 g), and E (10.0 g). Observations of 42 DAAs and 56 DAAs of treatment F (12.5 g) were significantly different from treatment A (0.0 g) but did not differ significantly from treatment B (2.5 g), C (5.0 g), D (7.5 g), and E (10.0 g)

When alkaloid compounds and flavonoids enter the larvae's body, they cause disturbance in the larvae's digestive system. In addition, the compound can stop the taste receptors in the larvae's mouth area. This causes the larvae to starve because they are unable to recognize their food (Oviana Lisa et al., 2024)

Table 3. Effect of Noni Leaf Powder Dosage on the Number of Larvae C. analis F. in Black Soybeans Detam-1 Variety

Treatment (g)	Average Number of Larvae *C. analis* F. (Tail)			
	14 DAA	28 DAA	42 DAA	56 DAA

A(0.0)	0.00	a	4.75	b	4.38	b	2.88	b
B(2.5)	0.00	a	3.25	b	3.50	ab	2.63	ab
C(5.0)	0.00	a	1.88	a	1.75	a	1.50	a
D(7.5)	0.00	a	1.75	a	2.25	a	1.75	a
E(10.0)	0.00	a	1.63	a	1.75	a	1.63	a
F(12.5)	0.00	a	0.88	a	1.38	a	1.25	a

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

Number of Pupae

Based on Table 4, the observation of 14 DAAs and 28 DAAs pupae reveals that the pupa is not yet present, resulting in different and potentially inaccurate results. In the observation of 42 DAAs and 56 DAAs, the results of all treatments, namely treatment A (0.0 g), B (2.50 g), C (5.00 g), D (7.5 g), E (10.0 g), and F (12.5 g), were different and not authentic.

Table 4. Effect of Noni Leaf Powder Dosage on the Number of Pupa C. analis F. in Black Soybeans Detam-

1 Variety

Treatment (g)	Average Number of Pupa *C. analis* F. (Tail)							
	14 DAA		28 DAA		42 DAA		56 DAA	
A(0.0)	0.00	a	0.00	a	2.50	a	2.13	a
B(2.5)	0.00	a	0.00	a	2.50	a	1.88	a
C(5.0)	0.00	a	0.00	a	2.25	a	2.00	a
D(7.5)	0.00	a	0.00	a	2.00	a	2.00	a
E(10.0)	0.00	a	0.00	a	1.75	a	1.38	a
F(12.5)	0.00	a	0.00	a	1.13	a	0.88	a

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

Maulana et al. (2020) said alkaloid compounds can interfere with the insect brain hormone system (which is neurotoxic), so that it can inhibit the formation of pupa and growth hormone.

Number of Imagoes

Based on Table 5, on the observation of 42 DAAs, treatment F (12.5 g) is significantly different from treatment A (0.0 g), B (2.5 g), and treatment C (5.0 g), but is not significantly different from treatment D (7.5 g) and E (10.0 g). The tannin compounds contained in noni leaf powder can decrease the performance of the digestive system in insects; these compounds inhibit the activation of digestive enzymes (Armi A. et al., 2019). Tannins bind to proteins in the digestive system that insects require for growth, rendering them unable to survive (Basundari et al., 2018).

Table 5. Effect of Noni Leaf Powder Dosage on the Number of Imagoes C. analis F. on Black Soybeans

Detam-1 Variety

Treatment (g)	Average imagoes of *C. analis* F. (tail)	
	42 DAA	56 DAA
A(0.0)	0.11 b	3.74 c
B(2.5)	0.09 a	1.34 bc
C(5.0)	0.09 a	1.17 b
D(7.5)	0.05 a	9.38 ab
E(10.0)	0.08 a	0.47 a
F(12.5)	0.06 a	0.16 a

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

Black Soybean Seed Damage Percentage

Based on Table 6 The effect of noni leaf powder on the Percentage of seed damage in black soybeans of the Detam-1 variety shows that the results of treatment F (12.5 g) are significantly different from treatment A (0.0 g), B (5.0 g), and C (7.5 g) but are not significantly different from treatment D (10.0 g) and E (12.5 g). The administration of a dose of noni leaf powder of 7.5 g gave a percentage of damage to black soybean seeds of the Detam-1 1 variety as much as 23.87% compared to treatment A (control) of 29.33%.

Giving a dose of noni leaf powder can reduce the Percentage of seed damage caused by C. analis F. The content of saponins in noni leaf powder increases the mortality rate in imago; the higher the feeding mortality rate, the lower the Percentage of seed damage caused by C. analis F. (Oviana Lisa et al., 2024).

Table 6. Effect of Noni Leaf Powder Dosage on Seed Damage Percentage in Black Soybeans Detam-1

Variety

Treatment (g)	Seed damage percentage (%)
A(0.0)	29.33 c
B(2.5)	26.53 b
C(5.0)	26.06 b
D(7.5)	23.87 a
E(10.0)	23.51 a
F(12.5)	22.02 a

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

Black Soybean Seed Weight Loss Percentage (%)

Based on Table 7, treatment F (12.5 g) showed significant differences in results with treatment A (0.0 g), B (2.5 g), and C (5.0 g) on the percentage of weight loss of black soybean seeds of the detam-1 1 1 variety. However, the difference is not real between the treatments D (7.5 g) and E (10.0 g). This shows that the administration of noni leaf powder can reduce the percentage of black soybean seed weight loss by 1.37% to 4.54% compared to the treatment without noni leaf powder, which is equivalent to a reduction of 12.46%.

Noni leaves contain triterpenoids that can inhibit the appetite of insects and cause death in insect pests, such as C. analis F. (Armayanti, 2019). If the pest population is getting smaller, the rate of seed damage and weight loss will be lower. The decrease in weight loss is attributed to the low Percentage of seed damage resulting from the application of noni leaf powder, which can reduce the diet of insect pests (Wu et al., 2021).

Table 7. Effect of Noni Leaf Powder Dosage on Weight Loss Percentage in Black Soybeans Detam-1

Variety		
Treatment (g)	Percentage Weight Loss (%)	
A(0.0)	12.46	c
B(2.5)	4.54	b
C(5.0)	4.30	b
D(7.5)	3.00	ab
E(10.0)	2.89	ab
F(12.5)	1.37	a

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

Percentage of Viability of Black Soybean Seeds of Detam-1-1 Variety

Based on Table 8, the germination power of seeds shows that the results of treatment F (12.5 g) are significantly different from treatment A (0.0 g), B (2.5 g), and C (5.0 g) but are not significantly different from treatment D (7.5 g) and E (12.5 g). The higher the treatment, the higher the percentage of germination power, and it can even reach 80%. This is due to the low number of seeds attacked by C. analis F.

For the results of germination speed, treatment F (12.5 g) was significantly different from treatments A (0.0 g) and B (2.5 g), but not significantly different from treatments C (5.0 g), D (7.5 g), and E (10.0 g). The Percentage of power speed of the treated sprouts reached 33.98%, which is 26.82% faster than treatment A (0.0 g).

The black soybean seeds of the Detam-11 variety that were treated able to maintain their quality compared to those that received no treatment. Perdana et al. (2023) said that pest and diseases are one of the factors that influence seed viability.

Table 8. Effect of Noni Leaf Powder Dosage on the Percentage of Viability of Black Soybean Seeds of Detam-1-1 Variety

Treatment (g)	Average Viability Test	
	Germination Power (%)	Germination Speed (%/ethmal)
A(0.0)	61.50 ab	25.95 a
B(2.5)	59.75 a	26.82 ab
C(5.0)	69.50 ab	31.03 bc
D(7.5)	71.50 bc	30.74 bc
E(10.0)	75.75 c	32.60 c
F(12.5)	80.00 c	33.98 c

Remarks: The average value followed by the same letter shows an intangible difference according to the Duncan

Multiple Distance Test at the level of 5%

CONCLUSION

The dosage of noni leaf powder is effective in suppressing the development of C. analis F., in storage. It can increase mortality, reduce the number of eggs, larvae, and imago that appear, and can reduce the percentage of seed damage and weight loss, while maintaining the quality of the seeds. Noni leaf powder with a treatment dose of 7.5 g/100 g of black soybean seeds is quite effective in suppressing the development of C. analis F., and can maintain the quality of seeds in black soybean seeds in storage.

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