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Research Article

Effect of varieties and applications of clove oil on growth, productivity, and pest and disease resilience of soybean

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ABSTRACT

Efforts to increase soybean productivity are carried out in various ways, including improving cultivation technology and applying pest and disease control technologies for soybeans. In addition to chemical pesticides, pest and disease control can use botanical pesticides or biopesticides, including those made from clove oil. This study aimed to determine the effect of varieties and clove oil on the growth, production, and pest-disease resilience of soybean. The study was conducted at Majalengka Regency, West Java, Indonesia from April to July 2021. The research used a factorial randomized complete block design with four replications. The first factor was soybean genotypes: Dena 1, Dega 1, and Anjasmoro. The second factor was the concentration and interval of application of clove oil: control, 3 mL L^{-1} with an interval of 10 days, 3 mL L^{-1} with an interval of 15 days, 5 mL L^{-1} with an interval of 10 days, and 5 mL L^{-1} with an interval of 15 days. The results showed that the Dena 1 variety had the highest plant height, number of branches, number of pods per plant, and dry weight per plant. The Dega 1 variety produced the highest weight of plant dry mass, dry pod shell weight, and 100-grain. Anjasmoro variety had the highest root length and number of nodules per plant. The Anjasmoro was more resistant to leaf caterpillar attacks, while the Dena 1 was more resistant to leaf rust disease. Botanical pesticides derived from clove oil affected various aspects of soybean growth including plant height at 60 days after planting, weight of dry biomass, root length and number of root nodules per plant, dry pod shell weight, dry seed weight, and 100-grains weight.

Keywords: botanical pesticide; clove oil; *Glycine max*; root nodulation; variety

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INTRODUCTION

Soybeans (*Glycine max* (L.) Merr.) are a commodity that still depends on imports because domestic production is still unable to meet people's needs. Increasing soybean production can be done in various ways, including expanding planting areas, improving cultivation technology, and developing soybean varieties through plant breeding programs to obtain new varieties with superior characteristics. In addition, it needs to be supported by applying soybean pest and disease control technology. According to Chanifah *et al*. (2021), the technology component of superior varieties is one of the levers for increasing soybean productivity at the farmer level. Balitbangtan (2017) stated that the Anjasmoro, Dega 1, and Dena 1 varieties have large seeds. Anjasmoro is an old superior variety, while Dega 1 and Dena 1 are new superior varieties and have early maturity. Dena 1 is shade-tolerant and resistant to leaf rust disease.

The use of superior soybean varieties that have high yields and are resistant to pests and diseases has the potential to increase plant productivity. In the absence of highly resistant variety, according to Sumartini (2010), increasing crop resistance might be

achieved using some agronomic improvement through appropriate control methods such as using botanical fungicides.

In general terminology, continuous application of pesticides over a long period of time can have a negative impact on the environment. Promoting botanical pesticides or biopesticides, even though it is not as effective as chemical pesticides, are more environmentally sound to support sustainable agriculture systems. According to Heriyanto (2015), the use of botanical pesticides is an alternative for controlling plant-disturbing organisms including disease-causing pathogens. The use of botanical insecticides in controlling pests and plant diseases is an effective and efficient control alternative because it can be combined with other control techniques (Hendrival *et al*., 2013). Some advantages of botanical pesticides include being environmentally friendly, non-toxic to plants, not causing disease resistance, cheap, easy to obtain, and containing nutrients needed by plants (Irfan, 2016; Tawa *et al*., 2017).

The botanical pesticide used in the present research is based on clove oil with the active ingredient eugenol. The botanical pesticide is multifunctional and effective in controlling various plant pests including *Nilaparvata lugens, Aphids* sp, *Pomocea* sp, *Bemisia tabaci,* and *Tetranycchus* sp. (Folake *et al*., 2023; Rosli *et al*., 2021; Golmohammadi *et al*., 2014; Mansour *et al*., 2004). Clove oil is a plant material source of botanical pesticides that has a very broad spectrum in its use as a fungicide, bactericide, insecticide, nematicide, and molluscicide (Gad *et al.,* 2023; Safitri, *et al.,* 2022). This is supported by the presence of the active ingredient eugenol and other non-phenolic components in clove oil. The research result of Sumartini (2010), the application of clove oil was effective in controlling rust disease in soybean plants. The time interval of spraying clove oil will be effective if it is done several times with an interval of at least 5 days. Further research from Towaha (2012) showed that clove oil was able to inhibit the development of plant pathogens such as *Fusarium oxysporum* and *Rhizoctonia solani*. According to Heriyanto (2015), application of botanical pesticides in the form of clove oil at a concentration of 3 mL L^{-1} water on soybean plants starting at 14 days with an interval of 7 days can effectively control soybean rust disease compared to betel nut, citronella, and jatropha oil and can reduce attack intensity by 46.38%. Research results of Sumartini (2010) showed that the application of spraying clove flower oil (2 mL L^{-1}) with a frequency of once every 5 days could reduce the intensity of rust attack (*P. pachyrhizi*) on soybeans by 17% in the field and 68% in the greenhouse.

A number of essential oils and their components such as eugenol have activity against plant parasitic nematodes (Tariq *et al*., 2010). With ecological considerations and economic efficiency in the context of eco-friendly and sustainable ecosystem management, pest control in soybeans is directed at implementing Integrated Pest Management (IPM) (Marwoto & Suharsono, 2008). This study aimed to determine the effect of varieties and clove oil on the growth, production, and pest-disease resiliences of soybean.

MATERIALS AND METHODS

The study was conducted at the Jatikersa Farmer Group, Cicurug Village, Majalengka District, Majalengka Regency, West Java Indonesia from April to July 2021. The research used a factorial randomized complete block design (RCBD) with four replications. The first factor was soybean variety: V1 = Dena 1, V2 = Dega 1, and V3 = Anjasmoro. The description of the varieties is presented in Table 1. The second factor is the concentration and interval of application of clove oil: D0 = without clove oil (control), D1 = 3 mL L^{-1} clove oil with an interval of 10 days, D2 = 3 mL L^{-1} clove oil with an interval of 15 days, D3 = 5 mL L^{-1} clove oil with an interval of 10 days, and D4 = 5 mL L^{-1} clove oil with an interval of 15 days.

The cultivation techniques started with minimum soil preparation and then making plots measuring 2 m x 5 m, with drainage channels between the plots measuring 0.5 m wide and 20 cm deep. The plant spacing was 40 x 20 cm with two seeds per planting hole. After sowing, the land was covered with rice straw in a bed which also functions as mulch to keep soil moisture and control weeds. Inorganic fertilizers were applied when the

plants were seven days after planting (DAP) with the recommended dose of NPK Phonska (NPK 15:15:15) in the amount of 50 kg ha^{-1} and Urea 25 kg ha^{-1}. Botanical pesticides were applied based on each treatment, namely concentrations of 3 and 5 mL of clove oil in 1 L of water at intervals of 10 and 15 days.

Table 1. Description of soybean varieties Dega 1, Dena 1, and Anjasmoro.

	Dega 1	Dena 1	Anjasmoro
Origin	A single cross between Grobogan and Malabar	A cross between Agromulyo x IAC 100	Mass selection of pure Mansurian populations
Growing type	Determinate	Determinate	Determinate
Flowering age	± 29 days	± 33 days	± 35.7-39.4 days
Mature age	± 71 days (69-73 days)	± 78 days	± 82.5-92.5 days
Leaf shape	Ovals	Ovals	Ovals
Leaf size	Medium	Medium	Wide
Branching per plant	1-3 branches	1-3 branches	2.9-5.6 branches
Number of pods per plant	± 29 pods	± 29 pods	- (no data)
Plant height	± 53 cm	± 59 cm	64-68 cm
Decay	Hold down	Somewhat resistant	Hold down
Crack the pods	Moderately resistant to breaking pods	Not easy to break	Not easy to break
Seed size	Big	Big	Big
Weight 100 seeds	22.98 g	± 14.30 g	14,80-15.30 g
Yield potential	3.82 tons ha^{-1} (WC 12%)	2.90 tons ha^{-1}	2.03-2.25 tons ha^{-1}
Seed yield	2.78 tons ha^{-1} (WC 12%)	± 1.70 tons ha^{-1}	- (no data)
Resistance to pests and diseases	Moderately resistant to leaf rust (*Phakospora pachirhyzi* Syd), susceptible to armyworm (*Spodoptera litura* F)	Resistant to leaf rust (*Phakospora pachirhyzi* Syd), susceptible to pod-sucking pests (*Riptortus linearis*) and armyworm pests (*Spodoptera litura* F)	Moderate to leaf rust disease (*Phakopsora pachyrhizi* Syd)
Information	Adapt to paddy fields	Tolerant up to 50% shade	Tolerant up to 50% shade

Source: Balitkabi (2016)

The observed data included plant height and number of branches measured at 21, 30, 45, 60 DAP, number of filled pods per plant, number of empty pods per plant, dry biomass weight per plant, root length, number of root nodules, dry shelf weight per hectare, dry seed weight per hectare, 100 grains weight, and pest attack (leaf caterpillar, span caterpillar, aphids) and disease attack (brown spots, leaf rust).

The formula used to calculate the severity of the pest and disease is as follows:

$$S = \frac{\sum(n_i \times v_i)}{N \times Z} \times 100\%$$

where S = Severity of pest and disease (%), n_i = Number of leaves per attack category i, v_i = Scale value of each attack category i, V = The highest category scale value, Z = Number of leaves observed. The disease severity scale score category according to Matruti et al. (2013) is presented in Table 2.

Table 2. Pest and disease severity scale

Percentage of infection (S)	Description of damage
0%	No damage
> 0−25%	Light
>25−50%	Moderate
>50−75%	Heavy
>75−100%	Totally damage

The observation data were analyzed statistically using the F test to see differences between treatments. Significance analysis between treatment means was carried out using the Duncan Multiple Range Test (DMRT) at a confidence level of 95%. Observational data were analyzed using the R version 4.0.5 program.

RESULTS AND DISCUSSION

Height growth of soybean plants at the age of 21 and 30 DAP Dega 1 and Anjasmoro varieties were not significantly different and Dena 1 was the lowest. In contrast, at 60 DAP, the Dega 1 and Anjasmoro varieties produced higher plant heights than the Dega 1 variety (Table 3). The number shows that height tends to be influenced by plant genetics or differences in the characteristics of each variety. In the description of soybean plants (Table 1), the Dena 1 and Anjasmoro varieties have higher plant heights than the Dega 1 variety. According to Tambunan dan Afkar (2019), the development of plant height of each variety is influenced by genetics and the growing environment of soybean plants.

The application of clove oil had no effect on soybean plant height at 21, 30, and 45 DAP, but at 60 DAP it showed that at a higher concentration of 5 mL L^{-1}, it produced a tendency for higher plant height (Table 3). Table 3 shows that there was no interaction between varieties and botanical pesticides on plant height. The higher development of plant height reflects the occurrence of stem elongation as a result of the process of cell division, enlargement, and elongation in the apical meristem. According to Elisabeth *et al*. (2013) the addition of plant height and the formation of new leaves is stimulated by the fulfillment of plant needs for elements that support growth. Plant development can be realized by the accumulation of assimilate which will be translocated to various plant organs that need it, for example, crowns, roots, and pods. If the plant is not able to form sufficient assimilates, there will be competition between vegetative and generative organs (Kastono, 2005).

Table 3. The effect of various soybean varieties and the application of clove oil on soybean plant height.

Treatment	Plant height (cm)			
	21 DAP	30 DAP	45 DAP	60 DAP
Variety				
Dega 1	23.65a	30.97a	46.38ab	46.82b
Dena 1	14.04b	26.46b	48.55a	73.74a
Anjasmoro	24.52a	30.73a	45.76b	72.60a
Botanical pesticide				
Without clove oil	20.05a	28.48a	45.63a	61.85b
3 mL L^{-1} clove oil with interval of 10 days	21.30a	29.75a	47.42a	63.78b
3 mL L^{-1} clove oil with interval of 15 days	20.65a	29.45a	46.73a	64.03ab
5 mL L^{-1} clove oil with interval of 10 days	21.15a	29.86a	48.30a	67.82a
5 mL L^{-1} clove oil with interval of 15 days	20.53a	29.38a	46.40a	64.45ab
Interaction	ns	ns	ns	ns

Note: Numbers followed by the same letter in the same column are not significantly different based on the DMRT test at α = 5%.

At the age of 60 DAP, the number of branches for the Dena 1 variety was the highest, while the Dega 1 variety had the fewest branches (Table 4). The branch of the plant is where the leaves grow. According to Dwiputra *et al*. (2015) the more branches, the more the number of leaves that grow so that the process of photosynthesis can run optimally.

The application of botanical pesticides at different concentrations and intervals had no effect on the number of branches at 60 DAP (Table 4). There is no interaction between varieties and botanical pesticides on the number of branches.

The highest dry biomass weight was obtained in the Dega 1 variety (Table 5). However, the highest root length and number of root nodules were produced by the Anjasmoro variety. The longer the root, the more likely the number of root nodules. The

better the vegetative growth of soybean plants, the photosynthesis process will run well so that more and more photosynthates are produced. The results of photosynthesis from the vegetative phase to the generative phase are stored as food reserves in the form of carbohydrates in the form of seeds. Thus the higher the photosynthate, the higher the seed yield (Mayani *et al*., 2021).

Application of clove oil at a concentration of 5 mL L^{-1} at 10-day intervals resulted in the highest dry biomass weight, root length, and number of root nodules per plant (Table 5). There is no interaction between varieties and botanical pesticides on dry biomass weight per hectare, root length per plant, and number of root nodules per plant.

Table 4. The effect of various soybean varieties and the application of clove oil on the number of branches of soybean plants.

Treatment	Number of branches			
	21 DAP	30 DAP	45 DAP	60 DAP
Variety				
Dega 1	0.84a	1.81a	1.82b	1.89c
Dena 1	0.00b	1.39b	2.29a	2.99a
Anjasmoro	0.00b	0.93c	1.37c	2.13b
Botanical pesticide				
Without clove oil	0.23a	1.23a	1.68b	2.25a
3 mL L^{-1} clove oil with interval of 10 days	0.30a	1.33a	1.82b	2.32a
3 mL L^{-1} clove oil with interval of 15 days	0.38a	1.50a	1.87b	2.35a
5 mL L^{-1} clove oil with interval of 10 days	0.30a	1.45a	2.18a	2.28a
5 mL L^{-1} clove oil with interval of 15 days	0.18a	1.37a	1.70b	2.37a
Interaction	ns	ns	ns	ns

Note: Numbers followed by the same letter in the same column are not significantly different based on the DMRT test at α = 5%. ns = not significant

Table 5. Effect of various soybean varieties and application of clove oil on biomass dry weight, root length per plant, and number of root nodules per plant.

Treatment	Dry biomass weight per hectare (tons)	Root length per plant (cm)	Number of root nodules per plant
Variety			
Dega 1	5.98a	21.63b	17.24b
Dena 1	4.28c	21.99b	14.32c
Anjasmoro	4.79b	25.86a	21.74a
Botanical pesticide			
Without clove oil	4.75b	20.32b	15.01c
3 mL L^{-1} clove oil with interval of 10 days	5.12ab	23.05ab	16.08bc
3 mL L^{-1} clove oil with interval of 15 days	4.85b	25.45a	19.06ab
5 mL L^{-1} clove oil with interval of 10 days	5.38a	24.52a	20.02a
5 mL L^{-1} clove oil with interval of 15 days	4.97ab	22.46ab	18.68ab
Interaction	ns	ns	ns

Note: Numbers followed by the same letter in the same column are not significantly different based on the DMRT test at α = 5%. ns = not significant

The highest number of filled pods and empty pods per plant and dry pod weight per plant was produced by the Dena 1 variety (Table 6). Although the percentage of the number of empty pods to the number of pods per plant on the Dena 1 variety was higher than the other varieties, the number of filled pods obtained on this variety was still higher, which affected the high dry pod weight and dry shelled seed weight per plant. The higher

the number of filled pods per plant, the higher the dry pod weight. The number of pods per plant was also affected by the number of branches per plant. The number of branches of the Dena 1 variety was greater and it produced a greater number of pods. According to Dwiputra *et al*. (2015), the number of pods is strongly influenced by the number of branches, as evidenced by every increase in the number of pods will be followed by an increase in the number of branches. Research result Hakim (2012) reported that soybean plants that have many branches produce a large number of pods.

The application of clove oil had no effect on the number of filled pods and the number of empty pods per plant (Table 6). However, when viewed from a numerical value, the concentration of 5 mL L^{-1} at intervals of 10 days resulted in the number of filled pods, the number of empty pods per plant, and the dry pod weight per plant. There is no interaction between varieties and botanical pesticides on the number of filled pods per plant, number of hollow pods per plant, and dry pod weight per plant.

Table 6. Effect of various soybean varieties and application of clove oil on the number of filled and empty pods per plant and dry pod weight per plant.

Treatment	Number of filled pods per plant	Number of empty pods per plant	Pod dry weight per plant (g)
Variety			
Dega 1	23.00c	1.49b	14.54b
Dena 1	41.95a	3.60a	20.91a
Anjasmoro	34.73b	0.61b	16.89b
Botanical pesticide			
Without clove oil	28.78a	1.21a	15.33b
3 mL L^{-1} clove oil with interval of 10 days	32.94a	1.82a	17.06ab
3 mL L^{-1} clove oil with interval of 15 days	34.90a	2.02a	18.49ab
5 mL L^{-1} clove oil with interval of 10 days	36.42a	2.82a	19.44a
5 mL L^{-1} clove oil with interval of 15 days	33.09a	1.62a	16.91ab
Interaction	ns	ns	ns

Note: Numbers followed by the same letter in the same column are not significantly different based on the DMRT test at α = 5%. ns = not significant

The Dega 1 variety produced the highest dry shelf weight per hectare, dry seed weight per hectare, and 100 grain weight, while the Dena 1 variety produced the lowest (Table 7). Even though the number of branches produced by the Dena 1 variety was higher, it was not accompanied by a large dry-shelled weight per hectare and 100-grain weight. It is suspected that the number of pods has a large effect on seed size or may also be caused by genetic factors from the Dena 1 variety which has a lower 100 seed weight compared to the Dega 1 and Anjasmoro varieties (Table 1). On the other hand, the Dega 1 variety, although the number of branches and pods was lower than Dena 1, produced a dry-shelled weight per hectare. It is suspected that these varieties have greater seed weight as stated in the description (Table 1) and also the results in the field. Based on research results by Hakim (2012), soybean genotypes with many branches tend to produce small seeds. Soybean genotypes that have large seeds produce higher seeds. Further research results Putra *et al*. (2017), pod weight is influenced by the supply of photosynthesis and water in pod formation. An increase in photosynthate supply is associated with a greater number of effective root nodules.

Treatment of clove oil at a concentration of 5 mL L^{-1} with an interval of 10 days resulted in the highest dry shelf weight per hectare and dry seed weight per hectare, while the highest 100-grain weight was produced in all treatments using clove oil (Table 7). There is no interaction between varieties and botanical pesticides on dry shelf weight per hectare, dry seed weight per hectare, and weight of 100 grains (water content 11%).

Table 7. The effect of various soybean varieties and the application of clove oil on dry pod shell weight per hectare, dry seed weight per hectare, and weight of 100 grains (water content 11%).

Treatment	Weight of dry pod shell per hectare (tons)	Weight of dry seed per hectare (tons)	Weight of 100 grains (g)
Variety			
Dega 1	5.98a	3.18a	22.12a
Dena 1	4.28c	2.07c	16.98b
Anjasmoro	4.79b	2.50b	17.07b
Botanical pesticide			
Without clove oil	4.75b	2.42b	17.62b
3 mL L^{-1} clove oil with interval of 10 days	5.12ab	2.62ab	19.29a
3 mL L^{-1} clove oil with interval of 15 days	4.85b	2.53b	19.06a
5 mL L^{-1} clove oil with interval of 10 days	5.38a	2.77a	18.57ab
5 mL L^{-1} clove oil with interval of 15 days	4.97ab	2.58ab	19.05a
Interaction	ns	ns	ns

Note: Numbers followed by the same letter in the same column are not significantly different based on the DMRT test at α = 5%. ns = not significant

Table 8. The effect of various soybean varieties and the application of clove oil on the intensity of pest and disease attacks on soybean in the vegetative and generative phases.

Treatment	Pest (%)			Disease (%)	
	Leaf caterpillar	Span caterpillar	Aphids	Brown spots	Leaf rust
	Vegetative phase				
Variety					
Dega 1	7.11b	0.00b	0.00b	1.99a	4.22a
Dena 1	19.00a	0.89a	13.88a	1.44a	0.00b
Anjasmoro	2.00c	0.00b	0.89b	1.43a	1.78b
Botanical pesticide					
Without clove oil	11.11a	0.56a	6.67a	0.72a	1.29a
3 mL L^{-1} clove oil with interval of 10 days	9.63a	0.74a	3.70a	2.22a	1.85a
3 mL L^{-1} clove oil with interval of 15 days	8.70a	0.00a	5.56a	2.22a	1.66a
5 mL L^{-1} clove oil with interval of 10 days	9.82a	0.00a	4.44a	1.29a	2.41a
5 mL L^{-1} clove oil with interval of 15 days	8.52a	0.18a	4.26a	1.66a	2.78a
Interaction	ns	ns	ns	ns	ns
	Generative phase				
Variety					
Dega 1	6.11b	0.00b	11.78a	2.78a	0.11b
Dena 1	11.01a	1.67a	0.67c	1.11b	0.00b
Anjasmoro	6.44b	0.00b	4.22b	1.99ab	0.99a
Botanical pesticide					
Without clove oil	7.22a	0.18a	5.00a	1.85a	0.18a
3 mL L^{-1} clove oil with interval of 10 days	7.59a	0.56a	5.74a	2.78a	0.56a
3 mL L^{-1} clove oil with interval of 15 days	7.41a	0.74a	5.37a	2.04a	0.37a
5 mL L^{-1} clove oil with interval of 10 days	9.08a	0.92a	5.18a	2.04a	0.56a
5 mL L^{-1} clove oil with interval of 15 days	7.96a	0.37a	6.48a	1.11a	0.18a
Interaction	ns	ns	ns	ns	ns

Note: Numbers followed by the same letter in the same column are not significantly different based on the DMRT test at α = 5%. ns = not significant

In general, pest and disease attacks for all treatments were in the low category (0-25%) (Table 2). Pest attacks such as caterpillars, caterpillars, and aphids (vegetative phase) as well as caterpillars and caterpillars spanking (generative phase) were highest in the Dena 1 variety. Intensity of attacks by pests such as aphids and leaf rust disease in the vegetative phase and brown spot (Table 8). From the results of these observations, it can be seen that the varietal factor has an effect on the intensity of pest and disease attacks, while the application of botanical pesticides does not seem to have an effect. In this study, in general, the Anjasmoro variety was a variety that was more resistant to pest attacks, while the Dena 1 variety was more resistant to disease attacks than other varieties. This is supported by research results by Jati *et al*. (2021) who reported that the Anjasmoro variety was a variety that was resistant to pests, especially caterpillars. The Detap I and Anjasmoro varieties were included in the resistant (tolerant) category, while the Dega I variety was included in the Vulnerable (R) category and the Dena 1 variety was included in the very vulnerable category to caterpillar attacks (Patria et al. 2021). Further research results by Biswas dan Islam (2012), that the highest attack of caterpillar pests occurred on soybean plants aged three weeks (can reach 70 - 90%) with a yield loss rate of up to 22%.

CONCLUSIONS

The Dena 1 variety had the highest plant height, number of branches, number of pods per plant, and dry weight per plant. The Dega 1 variety produced the highest dry biomass weight per hectare, dry shelled weight per hectare, and 100-grain weight. The Anjasmoro variety had the highest root length and number of nodules per plant. The Anjasmoro variety is more resistant to leaf caterpillar pest attacks while the Dena 1 variety is more resistant to leaf rust disease attacks. Botanical pesticides from clove oil affected soybean plant height at 60 DAP, dry biomass weight per hectare, root length and number of root nodules per plant, dry pod shell weight per hectare, dry seed weight per hectare, and 100 grains weight.

REFERENCES

[Balitbangtan] Badan Penelitian dan Pengembangan Pertanian. (2017). *Potpourri Production Techniques of Soybean Seeds*. (In Indonesian.) IAARD Press.

[Balitkabi] Balai Penelitian Tanaman Aneka Kacang dan Umbi. [2016]. *Description of Superior Soybean Varieties*. (In Indonesian). Balai Penelitian Tanaman Aneka Kacang dan Umbi.

Biswas, G., & Islam, R. (2012). Infestation and management of the leaf roller (*Lamprosema Indicata* Fab.) in soybean (*Glycine max* L.). Bangladesh. *Journal of Agricultural Research*, *37*(1), 19–25. https://doi.org/10.3329/bjar.v37i1.11171.

Chanifah, Triastono, J., & Hantoro, F. R. P. (2021). Farmers perception, attitude, and satisfaction level of soybean high yielding varieties in Kebumen District, Central Java. (In Indonesian.). *Jurnal Agric, 33*(2), 175–188. https://doi.org/10.24246/agric.2021.v33.i2.p175-188.

Dwiputra, A. H., Indradew, D., & Susila, E. T. (2015). Correlation analysis of yield and yield components of thirteen soybean cultivars (*Glycine max* (L. Merr.). (In Indonesian). *Vegetalika*, *4*(3), 14–28. https://doi.org/10.22146/veg.10474.

Elisabeth, D. W., Santosa, M., & Herlina, N. (2013). The effect of various compositions of organic matter on growth and yield of shallot (*Allium ascalonicum* L.). (In Indonesian). *Jurnal Produksi Tanaman, 1*(3), 21–29. https://dx.doi.org/10.21176/protan.v1i3.27.

Folake, A. O., Matthew, O., Adewale, A. O., & Ibrahim, M. G. [2023]. Insecticidal activity of botanicals and their effectiveness in insects and pests control. *South Asian Journal of Agricultural Sciences*, *3*(2), 88-96. http://dx.doi.org/10.22271/27889289.2023.v3.i2b.95

Gad, A. F., Abdelgalil, G. M., & Radwan, M. A. [2023]. Bio-molluscicidal potential and biochemical mechanisms of clove oil and its main component eugenol against the land snail, *Theba pisana. Pesticide Biochemistry and Physiology,* 192, 105407. https://doi.org/10.1016/j.pestbp.2023.105407.

Golmohammadi, G., Hosseinigharalari, A., Fassih, M., & Arbabtafti, R. [2014]. Efficacy of one botanical and three synthetic insecticides against silverleaf whitefly, *Bemisia tabaci* (Hem.: Aleyrodidae) on cucumber plants in the field. *Journal of Crop Protection*, 3(4), 435-441.

Hakim, L. (2012). Yield components and morphological characteristics of soybean yield. (In Indonesian). *Jurnal Penelitian Pertanian Tanaman Pangan*, *31*(3), 173–179. https://dx.doi.org/10.21082/jpptp.v31n3.2012.p%p.

Hendrival, Latifah, & Nisa, A. (2013). Efficacy some botanical insecticides for controlling pest pod sucking in soybean fields. (In Indonesian). *Jurnal Agrista*, *17*(1), 18–27.

Heriyanto. 2015. Study on soybean rust disease control with botanical pesticides. (In Indonesian.). *Jurnal Ilmu-Ilmu Pertanian, 21*(1), 46–55. http://dx.doi.org/10.55259/jiip.v21i1.261.

Irfan, M. (2016). Test of biopesticide on the crop pest and disease. (In Indonesian). *Jurnal Agroteknologi*, *6*(2), 39–45. http://dx.doi.org/10.24014/ja.v6i2.2239.

Jati, C. P., Santoso, S. J., & Bahri, S. (2021). Inventory of pests on mulch types of treatment of three varieties of soybean plants (*Glycine max* (L.) Merill). (In Indonesian). *Jurnal Inovasi Pertanian*, *23*(1), 12–18. https://doi.org/10.33061/innofarm.v23i1.5246.

Kastono D. (2005). Respons on growth and yield of black soybean in usage of organic fertilizer and biopesticide of siam weed (*Chromolaena odorata*). (In Indonesian). *Jurnal Ilmu Pertanian*, *12*(2), 103–116.

Mansour, F., Azaizeh, H., Saad, B., Tadmor, Y., Abo-Moch, F., & Said, O. [2004]. The potential of middle eastern flora as a source of new safe bio-acaricides to control *Tetranychus cinnabarinus*, the Carmine Spider Mite. *Phytoparasitica*, *32*(1), 66-72. http://dx.doi.org/10.1007/BF02980862.

Marwoto, Suharsono. (2008). Strategy and technological components of armyworm control (*Spodoptera litura*). (In Indonesian.). *Jurnal Litbang Pertanian, 27*(4), 131–136.

Mayani, N., Jumini, & Maulidan, D. A. (2021). Response of vermicompost fertilizer at various dosage and plant spacing on growth and yield of soybean (*Glycine max* L. Merrill). (In Indonesian). *Jurnal Agrium*, *18*(2), 88–94. https://doi.org/10.29103/agrium.v18i2.5325.

Patria, M. D., Bakti, D., & Siregar, A. Z. (2021). The resistane of some soybean varieties (*Glycine max*. L) on pest of *Lamprosema indicata*. (In Indonesian). *Jurnal Agroteknologi, 11*(2), 61–66. http://dx.doi.org/10.24014/ja.v11i2.9107.

Putra, H. P., Sumarni, T., & Islami, T. (2017). Effect kind of organic matter and rhizobium inoculum on growth and result soybean (*Glycine max* (L .) Merril). (In Indonesian). *Jurnal Produksi Tanaman*, *5*(2), 326–335.

Rosli, R., Latip, S. N. H. M., Othman, A. S. N., Nawi, F. W. M. [2021]. Potential control of *Pomacea canaliculata* using botanical extracts in paddy field. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 12*(9)*,* 1-11*,* http://dx.doi.org/10.14456/ITJEMAST.2021.181.

Safitri, Y. D., Amalia, A., Fatimah, & Muadifah, A. [2022]. The identification of antibacterial compounds in clove stem extract (*Syzygium aromaticum*) and its effectiveness in inhibiting the growth of *Escherichia coli, Journal of Biosciences*, 8(1), 26-29. https://doi.org/10.24114/jbio.v8i1.28089.

Sumartini. (2010). Rust disease on soybean and its environmentally-friendly control measure. (In Indonesian.). *Jurnal Litbang Pertanian, 29*(3), 107–112. https://dx.doi.org/10.21082/jp3.v29n3.2010.p107-112.

Tambunan, S. B., & Afkar. (2019). Growth of various soybean varieties (*Glycine max* L. Merril) on ultisols in Southeast Aceh District. (In Indonesian). *Biotik*, *7*(2), 146–149. http://dx.doi.org/10.22373/biotik.v7i2.5660.

Tariq, R. M., Naqvi, N. H., Choudhary, M. I., & Abbas, A. (2010). Importance and implementation of essential oil of Pakistanian *Acorus calamus* Linn., as a biopesticide. *Pakistan Journal of Botany*, *42*(3), 2043–2050.

Tawa, M. A., Sastrahidayat, I. R., & Djauhari, S. (2017). The effectiveness of botanical pesticides to control the fungus *Sclerotium rolfsii* Sacc that causes damping off of soybean seedlings. (In Indonesian). *Jurnal HPT*, *5*(2), 43–51.

Towaha, J. (2012). The benefits of cloves eugenol in various industries in Indonesia. (In Indonesian). *Perspektif, 11*(2), 79–90.