

The Effect of *Cymbopogon Nardus L. Legram* Extract on The Intensity of *Putella Xylostella L.* Pest Attacks in Broccoli (*Brassica Oleracea L. Var. Italica*)

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Received: 20 January 2023

Accepted: 15 April 2023

Citation: Irmawatie L, Nurohman IT, Sidik AS, Helpiani D, Renaldi A (2023) The Effect of *Cymbopogon Nardus L. Legram* Extract on The Intensity of *Putella Xylostella L.* Pest Attacks in Broccoli (*Brassica Oleracea L. Var. Italica*). *History of Medicine* 9(1): 9–16. <https://doi.org/10.17720/2409-5834.v9.1.2023.002>

Abstract

Plutella xylostella L. is the main pest that attacks Brassicaceae plants, especially broccoli (*Brassica oleracea L. var. Italica*). The attacks caused by these pests are sometimes so severe that the crops fail to harvest. This condition is very detrimental, so farmers often take control measures using synthetic insecticides to control pests. However, the use of synthetic insecticides has a negative impact on the environment, including soil contamination, killing natural predators, accumulation of chemical residues on plant parts, and causing pests to become resistant to insecticides. Therefore, it is necessary to have alternative control techniques using organic materials without using synthetic insecticides that are safe for the environment, namely by using vegetable insecticides such as citronella (*Cymbopogon nardus L.*). The citronella plant contains essential oils which can be used to control plant pests (OPT). The active compounds contained in citronella essential oil are: dipentene, farnesol, geraniol, myrsena, methyl heptenol, nerol, sitral and citronella. The purpose of this study was to determine the effect of citronella extract on the intensity of attack of *P. xylostella L.* and to determine the concentration of citronella extract which was able to suppress the intensity of attack of *P. xylostella L.* on broccoli plants. This study used a randomized block design (RBD), consisting of 6 treatments and 4 replications. Consisting of the application of lemon grass extract with a concentration of 15 ml/l water, 20 ml/l water, 25 ml/l water, 30 ml/l water, synthetic insecticide active ingredient metomyl 25% as much as 4 grams/liter water and control. The results showed that citronella extract had a significant effect on 30 HST starting at a concentration of 15 ml/l water and the greater the concentration, the greater the effect on reducing the intensity of *P. xylostella* attacks on broccoli plants. In addition, regarding the growth factor of broccoli, it also did not show any effect by the application of citronella extract vegetable insecticides.

Keywords

Citronella extract, *Cymbopogon nardus L.*, Broccoli, *Plutella xylostella L.*

It was first cultivated in the 17th century and is known scientifically as broccoli (*Brassica oleracea* var. *italica* L.). The term broccoli signifies a branch. One of the most famous vegetables in the world, broccoli is a dark green leafy vegetable that belongs to the Brassica family of cabbage plants. It can be eaten raw or cooked, and it is a common ingredient in many different dishes. Zulkarnain et al (2017).

Broccoli is a vegetable that is used for its flowers. Green broccoli flowers contain ingredients such as calcium, iron, magnesium, phosphorus, potassium, zinc, vitamins A, C, E, K, B1, B2, B3, B5, B6, B9, and contain sulphoraphane which can prevent cancer. (Wasonowati, 2009; Fonna, 2022).

The demand for broccoli in Indonesia tends to increase, especially from the contemporary market, restaurants, inns and catering companies, but the supply is not sufficient to meet the increased demand. Due to the high demand from the local market, this shows that broccoli has the potential to be developed to help advance Indonesian agriculture

(Directorate General of Horticulture, 2014). However, as evidenced by imports that are two to three times larger, local farmers in Indonesia have not been able to meet the demand for vegetables (Ministry of Agriculture, 2008). Therefore, to meet the needs of this market, high and sustainable production volumes and productivity are needed so that they can compete with vegetables from competing countries such as Singapore, Malaysia, China, Australia and India (Yolandika, 2017).

These findings show that the Indonesian agricultural sector is undoubtedly a profitable business potential if imported goods are replaced with local goods (Mukti, 2017). Especially in West Java, the second most populous province in Indonesia, with 1,379 people per square kilometer (Central Bureau of Statistics, 2021). With such a large population density, crops of broccoli and other members of the cabbage family are being consumed at a fairly fast rate

Data regarding the production of cabbage families in West Java can be seen in Table 1.

Table 1. Cabbage Production 2017-2022

No.	Year	Production (Tons)
1.	2017	291,541
2.	2018	288,449
3.	2019	275,419
4.	2020	248,923
5.	2021	231,871
6.	2022	236,368

Source: Central Bureau of Statistics (2023)

Based on data from Table 1, in 2017 the production of broccoli which is a member of the cabbage family reached 291,541 tons, in 2018 broccoli production decreased by 1.1% to reach 288,449 tons, and in 2019 broccoli production decreased by 4.5% to reach 275,419 tons. This will continue in 2020 - 2022 broccoli production will decrease again by 9.6% in 2021 and 6.9% in 2022 to reach 231,871 tons, then in 2022 broccoli production will increase by 1.9% to reach 236,368 tons. So based on the data above, the production value of broccoli has fluctuated, this is inseparable from the risk of pest attacks, including the *Plutella xylostella* L. pest which attacks the cabbage family a lot.

P. xylostella is one of the main types of pests on broccoli plants, the economic threshold for this pest reaches 0.5 individuals per plant or 5

larvae (cumulative) 3-4 instars per plant (Winarno, 2019). So, if it is not immediately controlled, the damage to broccoli caused by these pests can increase and result in a decrease in crop yields both in quantity and quality (Winarno, 2019). The attacks caused by these pests are sometimes so severe that the crops fail to harvest. Yield losses caused by this pest attack can reach 10-90% (Rukmana and Yuyun, 1996; Walida, H. et al. 2017). This condition is very detrimental to farmers, so it is necessary to control *P. xylostella* caterpillars using synthetic chemical insecticides. However, the application of synthetic insecticides has a negative impact on the environment, including soil contamination, killing of natural predators, accumulation of chemical residues on plant parts (Faridothul, L. 2018). It also causes the pest to be resistant

to insecticides. Therefore, it is necessary to have alternative control techniques using organic materials without using chemical insecticides that are safe for the environment, including using vegetable insecticides (Winarno, 2019).

The application of vegetable insecticides is an environmentally friendly solution in suppressing negative impacts due to the excessive use of synthetic insecticides (Rilista et al., 2022). Botanical insecticides are natural ingredients, which are used to control plant-disturbing organisms (OPT) (Insani, M., et al. 2015). Botanical insecticides generally have more than one type of active compound which is quite effective in controlling pests (Winarno, 2019).

One of the plants that can be used as a vegetable insecticide to control *P. xylostella* is citronella, *Cymbopogon nardus* L. (Riska, et al., 2019). Citronella plants are plants that contain essential oils that can be used to control pests. Citronella is a natural ingredient that is easily decomposed so it is safe for the environment (Riska, et al., 2019). Citronella essential oil is able to suppress development and can even kill pests. The active compounds of citronella essential oil consist of dipentene, farnesol, geraniol, myrsena, methyl heptenol, nerol, citral and citronella (Isnaini, 2015). Avoseh (2015), states that these ingredients can control plant pests including plant lice, some insects, (*Tribolium* sp); *Sitophilus* sp.; *Callosobruchus* sp; *Nematodes* (*Meloidogyne* sp.); Mushroom *Pseudomonas* sp, and Cabbage Caterpillar (*Plutella xylostella* L.). Mechanisms of citronella essential oil in controlling pests, including as a repellent, food inhibitor, and pest killer.

The Lembang area is one of the agricultural areas in West Java which grows a lot of horticultural crops such as *B. broccoli*. However, based on the results of the interviews, the production of these plants was greatly disrupted by *P. xylostella* pest attacks. Cultivation production based on the above problems needs to be conducted research to determine the effect of citronella extract vegetable insecticides in controlling *P. xylostella* on broccoli plants in the Lembang area, West Bandung Regency, West Java Province.

Research Methods

This research was conducted in Kampung Nyampay Rt. 02/ Rw. 15 Langensari Village, Lembang District, West Bandung Regency. The location is located at an altitude of $\pm 1,241$ masl at position 107° east longitude 6° LS with a hilly surface from a geological perspective. Soil types in the area are andosol soils with a soil pH range of 5-6.5, average daily temperatures ranging from $19-24^\circ\text{C}$ and humidity of $\pm 39-90\%$. The research was conducted in April – June 2023 (Lembang Vocational Training Center, 2018).

P. xylostella pests using synthetic insecticides with the active ingredient metomyl 25% at a concentration of 4 grams/liter of water.

This research was carried out using the Randomized Block Design (RBD) method, consisting of 6 treatments and 4 replications, so there were 24 research plots. In 1 plot there were 10 plants and all were tested, with a total population of 240 plants.

The 6 concentration treatments that will be carried out in this study are:

P0 = 0% control (without lemongrass extract)

P1 = Lemongrass extract 15 ml/l water

P2 = Lemongrass extract 20 ml/l water

P3 = Lemongrass extract 25 ml/l water

P4 = Lemongrass extract 30 ml/l water

P5 = Synthetic chemical insecticide (active ingredient: 25% methomyl) 2-4 g/l water

Implementation Study

Making citronella extract is done by preparing tools and materials. The tools used are: knife, cutting board, basin, electric scale, blender, ruler, stationery and labels. As for the materials used are : 2 liters of clean water, 50 grams of citronella. Then the extract is made with the following stages: (1) Selected fresh citronella, (2) then cut into pieces with a size of $\pm 1-2$ cm, (3) Blended citronella until smooth, (4) and soaked in 2 liters clean water, (5) Leave it for one day, and (6) Citronella extract is filtered before use. As a comparison test using an active synthetic insecticide 25% methomyl as much as 4 grams/liter of water.

The application of vegetable insecticides of lemongrass extract was carried out 5 times,

namely at: 20 HST, 30 HST, 40 HST, 50 HST, and 60 HST

nursery

The nursery is carried out by: (1) The soil is mixed with organic cow manure which has become compost, leveled to a height of ± 3 cm and then watered with water, (2) Broccoli seeds are sown on top making sure there are no dense seeds, (3) then closed using compost with a thickness of ± 2 mm, the nursery was tightly closed using sacks and cloth for 2 days and 3 nights until germination. (4) After the seeds germinate, open the sacks and cloth, water the seeds and keep the media dry and not too wet. Wait until 2-3 leaves appear, after that the seeds are in the shade and then wait for 2 weeks, after that the seeds are ready for transplanting.



Figure 1. Broccoli plant heaping

Processing Land

Land processing is carried out in tandem with the nursery. The first stage is to carry out land sanitation. Then make half the beds and do basic fertilization using chicken manure, after that it is closed and made perfect beds with a width of 1 m, height of 30 cm, the distance between the beds is 50 cm. After the beds are made, the soil above the beds is leveled to make it easier to install mulch (agricultural black plastic). Then the beds are covered with mulch and hollowed out using a heated *cemplonga* (bulb planter/ bulb planter), with a distance of 50 x 50 cm. Leave it for 3 days so that the soil is not dry and the fertilizer is not hot.



Figure 2. Cemplongan (a mulch punch tool)

Planting

Transfer of broccoli seedlings from the nursery to the field is done when the seedlings are 2 weeks old, or 4 leaves have appeared.

Planting time is done in the morning from 06.00-09.00 or in the afternoon from 15.00-17.00, because the sunlight and temperature in the morning and evening are not too high (Anas D. Susila, 2006). Planting method: make a planting hole in the ground approximately 2-3 cm deep, put the seed into the perforated soil and cover it again with soil, then press gently until the seed stands upright, then water the seed.

Maintenance

Maintenance includes follow-up fertilization, weeding, replanting, and watering. Watering is done once a day when there is no rain. Stitching is done if there are plants that die, they will be replaced with new seeds, stitching is usually done a week after planting. Weeding is usually done every 3 days, depending on the conditions of weed growth in the field. Subsequent fertilization using NPK 16-16-16 fertilizer is carried out at intervals of 2 weeks.

Application extract lemongrass

The application of lemongrass extract was carried out after the presence of pests in the field by spraying using a handsprayer 5 times the application. Spraying is done once every 10 days starting 20 days after planting.

Harvest

Harvest done on plant age 60-70 days after move planting. Criteria harvest broccoli is have flower maximum size and bud flower Not yet bloom (Tito, S. 2018). By the way cut 10 cm

long at the base of the flower stem plant broccoli and _ leaving a number of leaves.

Observation Parameters

Intensity Attack

Before applying lemongrass extract to *P. xylostella*, it is necessary to calculate the population as basic data regarding the abundance of this pest in the area to be studied. The intensity of plant damage can be calculated using the absolute formula quoted from Retnowati et al., (2021) as follows:

$$I = n/N \times 100\%$$

Information:

- I : Attack intensity (%)
 n : Totally damaged leaves
 N : Many leaves were observed

high Plant

Measurement of plant height was carried out aiming to determine the effect of citronella extract on plant growth. These measurements were observed every ten days, starting at 20

HST. This measurement is done by measuring the plant from the base of the stem to the highest leaf.

Lots Leaf And weight interest / plot (kg)

The number of leaves is done by counting the number of leaves growing per plant and adding up each leaf per plot.

Observation of yields was carried out to determine the effect of the application of lemongrass extract on the weight yield of broccoli flowers by weighing all samples of broccoli flowers in the harvested treatment plots.

Results and Discussion

Intensity Attack

Observations were made at intervals of 10 days, starting at 20 HST, 30 HST, 40 HST, 50 HST, and 60 HST.

The following is the result of observing the average attack intensity of *P. xylostella* served on Table 2:

Table 2. Average *P. xylostella* Pest Attack Intensity

Treatment	Average Intensity				
	20 HST	30 HST	40 HST	50HST	60 HST
P0	2,34 ^a	2,77 ^{b,d}	3,38 ^d	3,37 ^d	3,20 ^d
P1	2,25 ^a	2,56 ^{ab}	2,55 ^c	2,55 ^c	2,47 ^c
P2	2,30 ^{a,m}	2,54 ^{ab}	2,47 ^{BC}	2,46 ^b	2,21b ⁻
P3	2,17 ^a	2,42 ^{ab}	2,23 ^{BC}	2,22b ⁻	2,14 ^b
P4	2,29 ^a	2,35 ^{ab}	2,22 ^{ab}	2,22 ^b	2,04b ⁻
P5	1,92 ^a	2,12 ^a	1,87 ^a	1,87 ^a	1,72 ^a

Note: - Numbers followed by the same letter in the same column are not significantly different according to Duncan's multiple range test at the 5% level

- HST: Days After Plant

Observations at 20 HST showed that all treatments were significantly different from P0 (Control). Observations at 30 HST showed that all treatments were not significantly different from P0, except for P5. Observations at 40 HST, 50 HST, and 60 HST showed that all treatments were significantly different from P0 and P5. The treatment of P1 was significantly different compared to P2, P3 and P4. While P2 (20 ml/l), P3 (25 ml) and P4 (30 ml/l) each showed no significant difference and P5 (comparison) showed the lowest effect on the intensity of damage by *Plutella xylostella* pests.

The average intensity of *p.xylostella* attacks at 20 HST was not very significant but it was seen to decrease significantly at 30 HST and the average intensity decreased to 60 HST with a concentration level of 20 ml/l water, 25 ml/l water, and 30ml/l water shows the same effect. Based on the table above, it can be seen that the higher the concentration applied, the lower the pest attack intensity. This is due to the increasing levels of the active ingredient citronella which is toxic to *P. xylostella*. Citronella poison enters through natural holes in insects and works as a neurotoxin by interfering with and inhibiting the acetylcholinesterase enzyme resulting in the phosphorylation of the amino acid serine in the asteratic center of the enzyme. Inhibition of the acetylcholinesterase enzyme in insects will

cause accumulation of acetylcholine resulting in central nervous system disorders, seizures, respiratory paralysis, and insect death (Mutchler, 1991; Ruslam, R. and Tarigan, A. C, 2021)

Lemongrass leaf extract acts as a contact poison which causes dehydration of pests and causes insects to lose fluids continuously and eventually die (Roger and Hamraqui, 2014). This is thought to be the cause of the decreased intensity of *P. xylostella* pest attacks on broccoli plants.

Tall Plant

Based on the results of observations and data analysis on the average height of broccoli plants, it shows that the administration of citronella extract has no effect on the height of broccoli plants.

The results of observations of the average height of broccoli plants are presented in the table below:

Table 3. Average Broccoli Plant Height

Treatment	Average Broccoli Plant Height (cm)				
	20 HST	30 HST	40 HST	50 HST	60 HST
P0	24,2 ^a	34,5 ^a	45,6 ^a	51,9 ^a	58,0 ^a
P1	24,7 ^{ab}	34,5 ^a	45,2 ^a	52,0 ^a	59,3 ^a
P2	23,9 ^a	34,2 ^a	45,0 ^a	51,4 ^a	58,2 ^a
P3	24,3 ^{ab}	35,1 ^a	45,4 ^a	52,6 ^a	59,6 ^a
P4	24,3 ^{ab}	34,0 ^a	43,1 ^a	50,3 ^a	57,9 ^a
P5	25,3 ^b	34,5 ^a	45,5 ^a	52,4 ^a	60,0 ^a

Note: - Numbers followed by the same letter in the same column are not significantly different according to Duncan's multiple range test at the 5% level

- HST: Days After Plant

Observations at 20 HST (before application) stated that all treatments were not significantly different from P0 except P5. Observations at 30, 40, 50, and 60 HST were carried out after application and showed that all treatments were not significantly different.

These results show that broccoli plants grow normally with an average increase in plant height, on a time scale from 20 HST to 60 HST. So that there is no significant difference from the treatment of using botanical insecticides on normal and healthy broccoli

plants, this shows that there are no symptoms of phytotoxicity and other abnormal symptoms from the application of citronella extract with different concentration levels. So these results indicate the use of lemongrass extract does not have a negative impact on the average height of broccoli plants.

Amount Leaf

Based on results observation and data analysis of the average number leaf plant broccoli show that gift extract lemongrass fragrant No influential to amount leaf on plant broccoli. Results average number of observations leaf plant broccoli served on table below _ this:

Table 4. Average Number of Broccoli Plant Leaves

Treatment	Average Number of Broccoli Plant Leaves				
	20 HST	30 HST	40 HST	50HST	60 HST
P0	58.2 ^b	81.0b -	100.7 ^a	127,0 ^a	154,0 ^a
P1	53,7 ^a	75,0 ^a	99,0 ^a	125,7 ^a	149,5 ^a
P2	56,5 ^{ab}	79,5 ^{ab}	98,5a -	123,0 ^a	177,0 ^a
P3	55,2 ^{ab}	74,7 ^a	100,5 ^a	118,0 ^a	154,5a -
P4	56,2 ^{ab}	77,0 ^{ab}	100,2a -	124,7a -	152,2 ^a
P5	58,7 ^b	80,0b -	98,0a -	126,2a -	150,0a -

Note: - Numbers followed by the same letter in the same column are not significantly different according to Duncan's multiple range test at the 5% level

- HST: Days After Plant

Observations at 20 HST showed that all treatments were not significantly different from P0 (control), except for P1. Observations at 30 HST showed that P2, P4, and P5 were not significantly different from P0, but P1 (15 ml/l) and P3 (25 ml/l) were significantly different

from P0. Observations 40, 50, and 60 all treatments were not significantly different from the controls.

The average value of the number of broccoli plant leaves in each treatment showed the same effect. So these results indicate the use of lemongrass extract does not have a negative impact on the average number of leaves of the broccoli plant. So that leaf growth can be said to be normal and healthy.

Weight Interest / Plot (Kg)

Observations on the yield of broccoli flower weights were carried out at the age of 60-80 HST. Based on the results of data analysis on the application of citronella extract, it showed that there was an effect on the yield of broccoli flower weight.

The results of the average observation of the flower weight of broccoli plants are presented in the table below:

Table 5. Average Broccoli Flower Weight/Plot (Kg)

Treatment	Average Interest Weight/Plot (Kg)
P0	1,6a -
P1	1,7a -
P2	2,1 ^b
P3	2.0c -
P4	2,7 ^c
P5	2,7 ^c

Note: - Numbers followed by the same letter in the same column are not significantly different according to Duncan's multiple range test at the 5% level

- HST: Days After Plant

Based on Table 5, it can be seen that all treatments were significantly different from P0, except for P1. However, the weight of this flower has a different harvest mass. So that the accuracy of the effect of concentration on the use of vegetable insecticides of citronella extract cannot be measured. However, based on observations in the field, the quality of broccoli using vegetable insecticides is different from the control. On average, broccoli flowers that use vegetable insecticides show good quality, look fresh, firm, dense and contain. This is thought to be due to the relatively high intensity of attack by *P. xylostella* on *B. oleracea* which did not use vegetable insecticides. This is in accordance with the observation that the treatment of volatile waste combined with the application of vegetable pesticides gives broccoli yields a fairly high increase compared to the application of patchouli waste (Willis, M. et al., 2013).

Conclusions And Recommendations

Conclusion

1. Application citronella extract influential in suppressing intensity attack *P. xylostella* on broccoli plants.

2. Application citronella extract at a concentration of 30 ml/l water had the same effect as the comparator (25% methomyl synthetic insecticide) in suppressing the intensity of *P. xylostella* pest attacks and increasing production in broccoli plants.

Suggestion

The use of citronella extract with a concentration of 30 ml/l is the best concentration for the growth and production of broccoli plants, therefore further research is needed using different varieties or commodities and lower concentrations of citronella extract.

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