JPPIPA 11(12) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Effect of Organic Mulch on Pest, Disease and Productivity of Cayenne Pepper (*Capsicum Frutescens* L.)

Wildan Muhlison[1*], Irwanto Sucipto[1], Hari Purnomo[3], I Nyoman Wijaya Paramudita[3], Nabilah Aulia Rohmah[4], Tri Wahyu Saputra[4], Syafina Pusparani[1]

[1] Laboratory of Agroecotechnology, Agrotechnology Study Program, Faculty of Agriculture, Universitas Jember. Jl. Kalimantan no. 37, Jember, Indonesia 68121
[2] Plant Protection Department, Faculty of Agriculture, Universitas Jember. Jl. Kalimantan no. 37, Jember, Indonesia
[3] Agrotechnology Department, Faculty of Agriculture, Universitas Jember. Jl. Kalimantan no. 37, Jember, Indonesia
[4] Laboratory of appropriate technology, Agrotechnology Study Program, Faculty of Agriculture, Universitas Jember. Jl. Kalimantan no. 37, Jember, Indonesia

Received: Augusr 28, 2025
Revised: November 08, 2025
Accepted: December 29, 2025
Published: December 31, 2025

Corresponding Author:
Wildan Muhlison
wildan.muhlison@unej.ac.id

DOI: 10.29303/jppipa.v11i12.12684

Abstract: Cayenne pepper (*Capsicum frutescens* L.) productivity is frequently limited by pest and disease pressure linked to reduced plant resistance from poor soil conditions and micronutrient deficiencies. This study evaluated whether different mulches mitigate disease incidence and improve growth and yield. Objectives were to quantify mulch effects on disease intensity, soil properties, vegetative growth, and fruit yield. A field experiment used a randomized block design with five treatments (P0 = no mulch; P1 = plastic; P2 = baglog; P3 = leaf litter; P4 = rice straw) and five replications. Measured variables included soil pH and moisture, pest population, pest attack intensity (%), disease attack intensity (%), and plant growth and productivity. Data were analyzed by ANOVA followed by Duncen further test (α = 0.05). Results showed that organic mulches reduced disease incidence to 17.2–19.2% versus 28.6% in the no-mulch control. Rice straw and leaf litter significantly improved soil pH and moisture retention; baglog and straw mulches increased branch number and further lowered disease incidence; plastic mulch produced the highest fruit weight per plant. In conclusion, organic mulches particularly rice straw and leaf litter enhance soil conditions and plant resilience, reducing disease and supporting productivity, while plastic mulch maximizes individual-plant yield.

Keywords: Cayenne pepper; Organic mulch; Pests and diseases; Plant growth and yield.

Introduction

Mulch is a material applied as a cover for soil, typically made from plant residues, leaf litter, plastic, or other substances. Its use is particularly important in cayenne pepper cultivation because it offers several benefits, including suppressing weed growth, retaining soil moisture, reducing erosion risk, and creating more stable microclimatic conditions that enhance plant growth (Asif et al., 2020; Jabran, 2019). Using mulch generally enhances resource efficiency, particularly for water and nutrients, thereby positively impacting plant growth (X. Wang et al., 2019a).

The application of plastic mulch in agriculture effectively enhances the yield of chili plants. Research by Gulo et al. (2025), indicated that the use of plastic mulch can increase chili yields by 25-40%. This is achieved through effective weed control, maintenance of soil

How to Cite:
Muhlison, W., Sucipto, I., Purnomo, H., Paramudita, I. N. W., Rohmah, N. A., Saputra, T. W., & Pusparani, S. (2025). Effect of Organic Mulch on Pest, Disease and Productivity of Cayenne Pepper (Capsicum Frutescens L.). *Jurnal Penelitian Pendidikan IPA*, *11*(12), 379–392. https://doi.org/10.29303/jppipa.v11i12.12684

temperature, and reduction of evaporation. Research Kasirajan & Ngouajio (2012), demonstrated that plastic mulch significantly enhances soil temperature and suppresses weed competition, which directly contributes to increased productivity in horticultural crops such as chili and tomato. Research Arsi et al. (2023), show that plastic mulch effectively reduces the intensity of Spodoptera litura pest attacks on eggplant plants, with an average pest incidence of only 10% when mulch is used, compared to 14% without it.

While the use of plastic mulch can enhance agricultural productivity, it also negatively impacts the environment by generating plastic waste and raising production costs (Gao et al., 2019). An alternative option is to use organic materials as mulch, organic materials such as used baglogs (Roeswitawati et al., 2021), leaf litter (Bai et al., 2021) and rice straw (G. Yuan et al., 2021) used as mulch contains important nutrients such as nitrogen (N), phosphorus (P), and potassium (K). In addition to macro-nutrients, the nutrients needed by plants to increase resistance to biotic and abiotic disturbances in the environment are micro-nutrients. (Kumari et al., 2022). Research Lamont (2005) showed that the use of organic mulch provides additional benefits in the form of improved soil structure and increased organic matter content as it decomposes. The use of organic mulch has advantages over plastic mulch, which not only helps add micro-nutrients to the soil through the decomposition process but can also increase the long-term availability of nutrients (Prem et al., 2020; Sun et al., 2021). In addition, the straw mulch treatment can reduce the intensity of Potato virus Y (PVY) attacks by 75% and *the Myzus persicae* population by 30% to 75% in potato plants (Winkler et al., 2025).

The use of organic mulches such as baglogs, leaf litter, and straw can improve soil physical quality and maintain the activity of microorganisms that play a role in the decomposition of organic matter, thus supporting the availability of macro (N, P, K) and micro (Mg, Ca, S) nutrients that are important for plant growth in the vegetative and generative phases (El-Beltagi et al., 2022a; X. Wang et al., 2019b). Research by Sekhon et al. (2008), demonstrated that the use of organic mulches, such as rice straw mulch, can increase fresh red chili yields by 16%, conserve 120 mm of irrigation water, and inhibit weed growth.

However, there are not many studies on the use of organic mulch on the intensity of pest attacks, diseases, and productivity. Therefore, it is essential to conduct research in this area to enhance practitioners' understanding and appreciation of the benefits of organic mulch.

Method

Location of research

This research was conducted in the observation field located at Jalan Rasamala II, Krajan Hamlet, Kemuning Lor Village, Arjasa District, Jember Regency, East Java Province, as shown in **Figure 1**. point 1. The research location is located at coordinates 8.124500 LS and 113.730532 BT, which leads directly to the observation field as shown in point 2.

Figure 1. Research Location

Type of research

The research method used was a non-factorial Randomized Block Design (RBD) with 5 treatment levels and repeated as many as 5 replicates. The treatments consisted of several types of mulch :

P0 : No mulch (Negative control)
P1 : Silver black mulch (Positive Control)
P2 : Baglog mulch
P3 : Leaf litter mulch
P4 : Rice straw mulch

Research stages

Data collection was carried out for 25 weeks, with observation parameters, namely pest population, pest attack intensity, disease attack intensity, and chili plant productivity. The parameters for research observation include:

1. *Soil Composition*

Measurements of soil composition like soil nutrition, c-organik, C/N ratio were conducted halfway through the study for each treatment. Measurements of soil pH and moisture were carried out twice a week, after and before watering, to find out how long organic mulch stored or held water in the soil.

2. *Pest Population*

Observations of pest populations were carried out once a week using the method directly on each sample of chili plants and indirectly using a yellow sticky trap (YST), a yellow pan trap (YPT), and fruit fly incubation devices. Traps were placed on each bed for 2 x 24 hours, and the height of YST followed the growth of the plants, and YPT, with a height of 150 cm, was also used. Meanwhile, sampling of fruit infested by fruit flies was conducted every 2 weeks.

3. *Pest Attack Intensity*

The intensity of pest attack data will be calculated using the absolute attack intensity formula. (Basri et al., 2015):

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

Note :
P : Absolute damage intensity (%)
a : Number of pest-infested plants (dead)
b : Number of unaffected plants

The calculation of absolute attack intensity is carried out on the observation variables of the main pests of chili plants, such as Thrips parvispinus, Bemisia tabaci, Myzus persicae, and Bactrocera dorsalis

Disease Attack Intensity

As many as 5 plant samples were taken to observe disease attack in each plot, and the results were compared with those of the other plots. Initial observations were made 2 weeks after planting (WAP) by observing the intensity of disease attack severity.
The severity of the disease attack can be calculated using the following formula:

$$KP = \frac{\sum (n \; x \; v)}{\mathrm{N \; x \; V}} \; x \; 100\%$$

Note :
KP : Percentage of disease severity
n : Number of plants in each symptom category
v : Symptom score value of each category
V : Score value of each highest category
N : Number of plants observed

Plant Growth and Productivity

1. *Plant Height (cm)*

The height of the cayenne pepper plant was measured starting two weeks after planting (WAP), with a measurement interval of one week. The number of plants measured per bed was five plant samples using a meter with units (cm).

2. *Stem Diameter (mm)*

Stem diameter measurements began at 2 weeks after planting (WAP) and were taken weekly using a push rod measured in millimeters (mm).

3. *Number of Branches Per Tree*

The number of branches per tree is calculated with a calculation interval or observation once a week by counting all branches.

4. *Number of Fruits Per Tree*

Fruit weight observations were made from the first harvest until the last harvest. They were made by weighing the harvest per tree in one plant bed using various types of mulch.

5. *Fruit Weight Per Tree*

Fruit weight observations were made from the first harvest until the last harvest. They were made by weighing the harvest per tree in one plant bed using various types of mulch.

Data Analysis

Pest population data, pest attack intensity, disease attack intensity, and plant productivity data obtained were analyzed using ANOVA (*Analysis of Variance*). If the data shows significant differences, it will be continued using the DUNCAN further test (α = 0.05)..

Result and Discussion

Soil Composition

Soil analysis results showed variations in chemical characteristics based on mulch type. Without mulch, C-organic and nitrogen contents were low with a C/N ratio of 8.15, reflecting rapid decomposition but less than optimal nitrogen mineralization. Plastic mulch increased soil moisture and stability, characterized by 1.80% C-organic content and increased nitrate-nitrite. Baglog mulch showed the best results with the highest C-organic content (4.88%) and C/N ratio of 11.51, as well as the highest sulfur, phosphorus, and soluble nitrogen content, supporting mineralization and microbial activity. The leaf litter mulch had the highest C/N ratio (13.61), reflecting slow decomposition and limited nutrient release. Straw mulch provided a balance between carbon and nitrogen (C/N 9.36), and increased nutrient availability and soil microbial activity sustainably.

Table 1. Results of Soil Test Analysis for each Treatment

Type of Mulch	C-Organic (%)	N Total (%)	C/N ratio (%)	Sulfur (ppm)	P_2O_5 (%)
No Mulch	1.51	0.18	8.15	86.67	0.18
Plastic	1.80	0.20	8.166	99.70	0.21
Baglog	4.88	0.42	11.51	114.73	0.40
Leaf litter	3.12	0.22	13.61	60.72	0.18
Straw	2.60	0.27	9.36	85.67	0.17

The average soil pH among all treatments ranged from 6.1 to 6.3. In general. plants given plastic mulch, no mulch, baglogs, and leaf litter maintained pH values that tended to be normal (6.3) compared to straw mulch (6.1). Meanwhile, soil moisture showed that the treatment without mulch produced the lowest moisture value of 53.3%, which was significantly different from the other treatments. The use of plastic mulch increased soil moisture by 69.6%, which was higher than without mulch but lower than that of mulch of grasses and straw. Meanwhile, the treatment of baglog mulch produced a humidity of 59.1%, which was lower than that of plastic mulch but not significantly different from that of leaf mulch (71.5%) and straw (70.6%). The increase is due to the mulch's ability to form a physical barrier that limits soil water evaporation (Goel et al., 2019). This indicates that both organic mulch and plastic mulch can inhibit water loss from the evaporation process.

Table 2. Effect of Mulch on Soil pH and Moisture

Mulch Treatment	pH and Moisture (Mean ± SE)	
	pH	Moisture (%)
No Mulch	6.31 ± 0.1[ab]	53.30 ± 1.1[a]
Plastic	6.35 ± 0.1[b]	69.60 ± 0.9[c]
Baglog	6.28 ± 0.1[ab]	59.10 ± 1.6[b]
Leaf litter	6.23 ± 0.2[ab]	71.52 ± 0.2[c]
Straw	6.15 ± 0.1[a]	70.61 ± 0.6[c]
P (Value)	0.08	0.00

Pest population and attack intensity

Population of *B. tabaci* showed significant differences between treatments. The rice straw treatment produced the highest population of (9.2) individuals per plant, which was significantly higher than the baglog mulch and plastic mulch treatments at (0.3) and (3.2) individuals per plant, respectively. In contrast, the populations of *T. parvispinus, M. persicae,* and *B. dorsalis* did not show significant differences between treatments.

B. tabaci utilizes light as well as color as a response to wavelength in detecting its host (McIntosh et al., 2024). These results are in line with research (Nasruddin et al., 2020), which states that straw mulch has a higher population of *B. tabaci* imago than the plastic mulch and no mulch treatments. This increase can be attributed to the visual yellow color of straw mulch, which attracts insect pests in host-seeking activities. Han et al. (2021), states the yellow color has a wavelength of 590 nm. Research Saleh et al. (2010), explained that whitefly responds to wavelengths between 490 - 600 nm, because the wavelength of reflected light is similar to that of light from the underside of the leaf.

Table 3. Effect of Mulch on Pest Population

Mulch Treatment	Insect Pest/Plant Population (Mean ± SE)			
	Thrips parvispinus	*Bemisia tabaci*	*Myzus persicae*	*Bactrocera dorsalis*
No mulch	39.51±9.1[a]	6.61±2.0[bc]	9.21±2.2[a]	1.61±1.3[a]
Plastic	24.00±4.4[a]	3.22±0.1[ab]	4.41±0.6[a]	1.22±0.9[a]
Baglog	35.32±7.3[a]	0.31±0.0[a]	7.21±2.4[a]	1.00±0.4[a]
Leaf litter	32.62±6.1[a]	5.81±1.4[bc]	7.82±2.7[a]	0.42±0.2[a]
Straw	32.43±3.7[a]	9.22±2.4[c]	9.33±1.8[a]	0.81±0.8[a]
P (Value)	0.557	0.009	0.490	0.894

Table 4. Effect of Mulch on Pest Attack Intensity

Mulch Treatment	Insect pest/plant intensity (% ± SE)			
	Thrips parvispinus	*Bemisia tabaci*	*Myzus persicae*	*Bactrocera dorsalis*
No Mulch	28.61±3.1[c]	3.22±0.6[a]	6.41±1.0[ab]	1.13±0.3[a]
Plastic	26.62±3.9[bc]	2.00±0.8[a]	3.61±1.5[a]	1.12±0.2[a]
Baglog	17.21±1.3[a]	3.00±0.4[a]	6.21±1.4[ab]	1.32±0.2[a]
Leaf litter	18.00±2.4[ab]	2.81±1.3[a]	9.82±2.9[b]	0.72±0.2[a]
Straw	19.21±2.6[ab]	3.21±0.4[a]	9.61±1.4[b]	1.41±0.6[a]
P (Value)	0.027	0.832	0.127	0.726

Based on Table 4. Pest infestation intensity shows a varied effect on the variable of pest infestation intensity. Attack intensity of *B. tabaci* and *B. dorsalis* did not differ significantly between treatments. In contrast, the intensity of attack by *T. parvispinus* and *M. persicae* shows a significant difference. At *T. parvispinus*, the treatment without mulch produced the highest intensity of attack at 28.6%, while in the organic mulch treatment, the intensity was lower, ranging from 17.2% to 19.2%. Meanwhile, the intensity of the attack by *M. persicae* was the highest attack intensity found in the rice straw mulch treatment (9.6%) and leaf litter (9.8%). In contrast, the plastic mulch treatment showed the lowest attack intensity, which amounted to 3.6% per plant.

Phenomena in variables *T. parvispinus* can occur due to plant defense mechanisms. Organic mulch that decomposes is able to release micro-nutrients so as to increase the quality of plants to the maximum (Iqbal et al., 2020). Based on research by Dia de Almeida et al. (2008), silica application in eggplant plants, was able to increase population mortality *T. palmi* 80%. Research Shah (2019) also stated that the addition of silica was able to reduce the intensity of *Bemisia tabaci* attack by 57.81%. The silica content in organic mulch is quite diverse, namely leaf litter (2% - 6%), baglogs (0.4% - 0.6%), and rice straw around (10% - 15%). (Bakar & Carey, 2020; Grašič et al., 2022; Jasinska et al., 2022). The addition of silica can increase the peroxidase enzyme in strengthening plant cell walls (Bhavanam & Stout, 2021). An increase in cell wall tissue hardness will inhibit *T. parvispinus* in eroding leaves and flowers because there is a physical barrier in the form of silica accumulation in plant cell walls. The resulting plant defense compounds will have an indirect effect on the physiology of insect pests (Yactayo-Chang et al., 2020).

In contrast to the observation, *M. persicae* showed an increase in attack intensity in the organic mulch treatment. The addition of organic mulch can retain moisture, thus creating humid conditions. These conditions are very suitable for accelerating the life cycle of *M. persicae* and accelerating the reproduction rate (Zhang et al., 2003). The organic mulch treatment has higher humidity than the other treatments, which is 5.91 - 7.15. Humidity is an abiotic factor that is important in influencing the life cycle of organic mulch. *M. persicae*, where the higher the humidity, the higher the population of *M. persicae* (Sharma & Khokhar, 2018). The population increase *of M. persicae* will have an impact on increasing the intensity of chili plant attacks (Mishra & Mukherjee, 2020). They stated that the intensity of pest attacks has a positive influence on the pest population in cropping areas.

Disease attack intensity

The intensity of disease attack on chili plants from different mulch treatments, it is known that in general mulch treatments show varying effects on four types of diseases, namely leaf spot, leaf curl, Fusarium wilt, and anthracnose. The highest intensity of leaf spot attack was recorded in the leaf litter mulch and straw mulch treatments, each at 5.6%, while the lowest attack was in the baglog mulch treatment at 0.80%. As for leaf curl disease, the highest attack intensity was recorded in the treatment without mulch at 13.73%, while the lowest was in the straw mulch treatment at 6.85%. In Fusarium wilt disease, the lowest attack intensity was shown in the treatment without mulch, and straw mulch showed the same attack value of 10.6%, while the plastic mulch treatment showed the highest value of 22.6%. While anthracnose disease did not show significant attack symptoms, attack symptoms were found in the treatment without mulch, with a percentage of 1% attack.

The highest leaf spot attack resulted from the mulched grass and straw treatment, which showed similar attack intensity. This high intensity is thought to be caused by the creation of moist and shady microclimate conditions due to piles of grasses and straw that have not been fully decomposed, thus supporting the development of pathogens that cause leaf spot, such as *Cercospora capsici* (Dogra et al., 2020; Ferreira et al., 2022). Slow decomposition of straw increases soil surface moisture and slows the drying of lower leaves, the initial site of leaf spot infection (Samaddar et al., 2021; M. Tang et al., 2023).

Table 5. Effect of Organic Mulch on Disease Attack Intensity

Mulch Treatment	Disease Attack Intensity (%) (Mean ± SE)			
	Leaf Spot	Leaf curl	Fusarium wilt	Anthracnose
No mulch	4.00±1.7[a]	13.71±2.7[a]	10.62±6.8[a]	0.60±0.40[b]
Plastic	4.00±1.2[a]	11.41±3.6[a]	22.61±15.7[a]	0.00±0[a]
Baglog	0.81±0.8[a]	7.92±3.0[a]	20.00±15.4[a]	0.00±0[a]
Leaf litter	5.61±1.60[a]	10.81±1.0[a]	14.61±6.4[a]	0.00±0[a]
Straw	5.61±2.04[a]	6.81±1.4[a]	10.62±6.8[a]	0.00±0[a]
P (Value)	0.21	0.36	0.91	0.10

Meanwhile, the treatment without mulch and plastic mulch showed the lowest intensity of attack because it can be influenced by the absence of a protective layer of soil, so that splashes of rain or irrigation water can spread pathogen spores to the leaves (Harender Raj, 2008; Tronsmo et al., 2020; Vishwakarma et al., 2024). On the other hand, although the use of plastic mulch can reduce water splashing, the increase in air humidity around the plants can accelerate the spread of spores of *C. capsici* (Nyochembeng et al., 2014). The lowest attack intensity was found in the baglog mulch treatment, which may be due to the content of micronutrients such as Zn, Cu, and Fe, as well as bioactive compounds that can strengthen cell structures and activate antioxidant enzymes in the plant defense system.

In the parameter of chili leaf curl attack in the field, the highest leaf curl attack intensity of 13.73% was obtained from the treatment without mulch, caused by vector populations such as *B. tabaci* and *T. parvispinus*. Without mulch protection, the soil becomes more exposed, creating an ideal microclimate for the development of viral vectors that cause leaf curl disease (Panno et al., 2021). In addition, no mulching can result in the growth of weeds, which are alternative plants for insect vectors *B. tabaci* (Kumari et al., 2022). This increases the risk of viral infections such as *Begomovirus* or *Tospovirus* which are spread by sucking insects (Nalla et al., 2023).

The use of plastic mulch resulted in the second-highest attack intensity after no mulch, with an attack intensity of 11.4%. This could be due to the fact that plastic mulch cannot produce micro-nutrients or antagonistic microbes like organic mulch, which can suppress leaf curl attacks caused by pests (Qi et al., 2022). In addition, the use of plastic mulch can also increase the temperature around the plants, which will trigger insect activity (Amare & Desta, 2021).

Organic mulch treatments, such as baglog mulch and straw mulch, produced a lower intensity of attack than the treatment without mulch and plastic mulch, with an intensity of attack on baglogs of 7.9% and straw mulch treatment of 6.8%. This can be due to the fact that the use of organic mulch can influence the development of natural enemies or predatory insects that can suppress insect pest populations (Landis et al., 2000).

In addition, organic mulch can provide micronutrients that support maintaining plant resistance to disease attacks. Baglog mulch can increase the availability of micronutrients such as boron and copper, which play a role in plant defense mechanisms against virus infections (J. Munir, 2024). The decomposed straw mulch treatment can provide important micro nutrients, such as silica, with a content of 4 - 7% (Dobermann & Fairhurst, 2002). The silica content is known to increase the thickness of the leaf epidermis and strengthen cell walls, thereby minimizing the chance of viruses entering plant tissue (Sarangi et al., 2022; Sozubek & Ozturk, 2022). Meanwhile, the leaf litter mulch treatment resulted in an attack intensity of 10.8%. This is due to the slow decomposition of leaf litter, which creates a refuge for insect vectors (Stoler & Relyea, 2020).

In the parameter of wilt disease attack caused by the fungus *Fusarium oxysporum*, plants began attacking in the fourth week in the vegetative phase and the fourteenth week in the generative phase. The highest attack intensity was obtained from the positive control treatment of plastic mulch. This is due to the moisture that favors disease development. Research by Bahadur et al. (2018) showed that the use of plastic mulch can increase soil temperature due to sunlight, so that soil moisture and temperature become high. This increase in soil temperature can produce a favorable environment for the growth of *F. oxysporum*, which can develop optimally at soil temperatures of 21-30 ° C. The spread of this fungus is also influenced by favorable soil pH conditions, such as acidic soil conditions with a pH range of 4.5-6.0 (Khilare et al., 2012).

In addition, higher soil temperature conditions can also cause stress to the plants (Mondal et al., 2016). The baglog mulch treatment produced the second-highest attack intensity. The high attack in the baglog treatment can be caused by the quality of baglogs that have not undergone complete decomposition or still contain residual pathogens from the fungal media, which have the potential to become a source of disease inoculum (Mahari et al., 2020). Oyster mushroom baglog waste that is not properly processed can become a habitat for wild fungi that have the potential to become pathogens for surrounding plants (Susilowati et al., 2022). In addition, baglogs that produce lignocellulose but have low availability of antagonistic microorganisms may slow down the colonization of beneficial microbes in suppressing the attack of Fusarium wilt disease attack (N. Munir et al., 2021).

The leaf litter treatment showed the third-highest intensity of Fusarium wilt attack. This could be because leaf litter that has not undergone complete decomposition can be a source of pathogen inoculum, including *Fusarium oxysporum* (Shen et al., 2024). Poorly decomposed debris can create a favorable environment for the growth of soil pathogens, especially if soil moisture is high and ambient temperatures favor pathogen development (Alegbeleye & Sant'Ana, 2020). This condition can worsen the attack of Fusarium wilt, especially in the plant's generative phase. The lowest attack intensity was shown in the treatment without mulch and with straw mulch, with an attack intensity of 10.6% each.

In the treatment without mulch, it can be caused by lower soil temperatures, which do not support the growth of pathogens, and soil moisture is more stable because it is not too humid, like when plastic mulch is used. Meanwhile, the straw mulch treatment can be caused by straw containing micronutrients such as silica (Si), which plays a role in suppressing the attack of Fusarium wilt (Dobermann & Fairhurst, 2002), which is known to strengthen plant cell walls and increase resistance to pathogen infections, including Fusarium (Ahammed & Yang, 2021). In addition, straw mulch is capable of increasing soil microbial activity, including the population of the antagonistic microbe Fusarium (X. Yuan et al., 2024).

In the anthracnose disease attack parameter, the highest attack was obtained from the treatment without mulch, with 1% attack intensity. This was influenced by the fact that without the protection of mulch, rain or water splashing directly on the soil can facilitate the spread of spores to leaves and fruits, especially during the fruit formation and ripening phases. In addition, no mulching can cause soil moisture and microclimate around plants to be less stable, creating environmental conditions that are more favorable for pathogen development. On the other hand, the low level of anthracnose disease attack can be influenced by the use of organic mulch, which is able to provide microelements that affect plant resistance to disease attack (Ahammed & Yang, 2021).

Plant Growth and Productivity

Treatment without mulch produces an average plant height of 123.12 cm, while plastic mulch produces an average height of 110.52 cm. The treatment with baglog mulch and leaf litter showed results of 114.36 cm and 116.48 cm, while the treatment with rice straw produced the highest plant height, which was 124.88 cm. The stem diameter of chili plants in the treatment without mulch reached 12.29 mm, which was the highest value compared to other treatments. Treatment with rice straw resulted in a stem diameter of 11.99 mm, while leaf litter showed a diameter of 11.31 mm. Plastic mulch and baglog mulch produced stem diameters of 11.00 mm and 10.67 mm, respectively. The treatment without mulch produced a number of branches of 103.12, while plastic mulch produced 105.08. The treatment with baglog mulch had a total number of branches of 114.4, while leaf litter showed the lowest value, which was 93.16. The rice straw mulch treatment produced the highest number of branches at 116.32.

Table 6. Effect of Organic Mulch on Cayenne Pepper Plant Growth

Mulch Treatment	Growth Parameters (Mean ± SE)		
	Plant Height (cm)	Stem Diameter (mm)	Number of Branches
No mulch	123.11±9.5 a	12.21±0.9 a	103.11±9.8 a
Plastic	110.51±14.2 a	11.00±1.4 a	105.00±14.4 a
Baglog	114.32±13.2 a	10.61±1.2 a	114.41±14.1 a
Leaf litter	116.41±10.5 a	11.31±1.0 a	93.12±9.9 a
Straw	124.81±9.8 a	11.91±0.9 a	116.32±11.1 a
P (Value)	0.89	0.84	0.66

In general, crops grown using mulch tend to show better advantages. One of them is the use of organic mulch, which plays a role in supporting increased plant growth in the vegetative phase by increasing nutrient availability (Malik et al., 2018). The use of organic mulches such as baglogs, leaf litter, and straw can improve the physical quality of the soil. Soil microorganisms remain active, decomposing organic matter to supply the nutrient needs for plant growth in the vegetative phase (El-Beltagi et al., 2022b). The increase in plant height in mulched plants can be caused by optimal soil moisture and temperature. Additionally, the use of mulch can also suppress weed growth, so that plant growth can be maximized (Marichamy et al., 2016). The parameter of plant height in the treatment without mulch produces a height that is almost the same as that in the mulch treatment because proper plant care, such as weeding weeds regularly, maximizes the nutrients needed by plants. Research Peragi (2013) showed that the average maximum plant height with the treatment without mulch (control) showed the highest value compared to the mulch treatment due to good weed management.

Based on the results of the study, the highest stem diameter of chili plants was recorded in the treatment without mulch, which was 12.29 mm, followed by rice straw (11.99 mm), leaf litter (11.31 mm), plastic mulch (11.00 mm), and baglog mulch (10.67 mm). This can be caused because in the treatment without mulch, weed control is still carried out optimally through routine weeding, so that it does not interfere with stem growth and produces a stem diameter comparable to the mulch treatment.

The use of organic mulches such as baglogs, leaf litter, and straw has been shown to enrich the soil with nutrients that support plant growth such as stem diameter growth (Bai et al., 2021; Roeswitawati et al., 2021; G. Yuan et al., 2021). In addition, mulch also helps maintain the stability of soil temperature and moisture, which can support optimal stem enlargement, as shown in the study by Oesman (2023) at plant age 6 weeks after transplanting.

Based on the results of research on the number of branches parameter, the treatment without mulch produced a number of branches of 103.12, while plastic mulch produced 105.08, and the treatment with baglog mulch had a number of branches of 114.4. At the same time, leaf litter showed the lowest value, namely 93.16, and rice straw mulch treatment produced the highest number of branches, 116.32. In general, the use of organic mulch provides benefits to the growth of chili plant branches through the decomposition process, which supplies essential nutrients such as nitrogen and potassium, which are important in the vegetative and generative phases (Korkanç & Şahin, 2021; Zairani et al., 2023).

The treatment of rice straw mulch produced the highest number of branches in cayenne pepper plants. This is because straw mulch contains nutrients such as potassium (K) and nitrogen (N), which are released slowly during the decomposition process, thus supporting vegetative growth, including branch formation (Yan et al., 2019). Whereas the baglog mulch treatment produces the second-highest number of branches, this can be due to the relatively high nitrogen content of baglog organic matter that can support optimal branch formation (Sunarya & Wardhana, 2020). Plastic mulch showed the third highest number of branches due to its ability to control weeds and retain soil moisture, although it did not provide additional nutrients due to its undecomposed nature (Mechergui et al., 2021). The treatment without mulch produced a lower number of branches due to unstable soil moisture, temperature fluctuations, and the presence of weeds that cause nutrient competition despite routine weeding (Liu et al., 2023). The leaf litter treatment showed the lowest number of branches, which may be due to the uneven decomposition rate and high C/N ratio, as well as the potential formation of anaerobic conditions if the buildup is too thick (Elbasiouny et al., 2022; P. Wang et al., 2023).

Table 8. Effect of Organic Mulch on the Productivity of Cayenne Pepper Plants

Mulch Treatment			Productivity (Mean ± SE)
	Number of Fruits	Weight Fruit (gr)	Productivity (Ton/ha)
No mulch	915.42±140.8 a	222.27±41.9 a	1.37±0.27 a
Plastic	1071.96±212.1 a	274.68±49.1 a	1.71±0.31 a
Baglog	946.00±236.0 a	237.39±56.3 a	1.46±0.34 a
Leaf litter	793.76±145.21 a	136.42±37.2 a	0.85±0.22 a
Straw	969.00±164.4 a	183.68±33.1 a	1.15±0.21 a
P (Value)	0.61	0.26	0.27

Based on Table 8. The results of the productivity study showed that the average number of chili fruits produced from the treatment without mulch was 915.4 fruits, while the use of plastic mulch produced the highest number of fruits, namely 1071.96. The treatment with baglog mulch produced 946 fruits, while leaf litter showed the lowest number of fruits at 793.76 fruits, and the treatment with rice straw produced 969.08 fruits. While the observation parameter of chili fruit weight shows that the use of plastic mulch produces the highest fruit weight, which is 274.68 grams, leaf litter produces the lowest fruit weight, which is 136.42 grams. The treatment without mulch produced a fruit weight of 222.27 grams, while baglog mulch and rice straw produced 237.39 grams and 183.68 grams, respectively.

The use of plastic mulch resulted in the highest number and weight of chili fruits, in line with the findings of Halil (2021) and Gao et al. (2019), which states that plastic mulch enhances photosynthesis by reflecting sunlight, thereby supporting fruit formation. Straw mulch takes second place in increasing fruit yield, due to its ability to lower soil temperature, retain moisture, and provide nutrients gradually during decomposition (Huang et al., 2021; Sekhon et al., 2008). Furthermore, baglog mulch also gives good results because it functions as a soil cover as well as a source of organic matter that releases essential nutrients such as N, P, and K during decomposition (Fatimah et al., 2024; Sobari & Fathurohman, 2021). The treatment without mulch shows that plants are still able to produce well if accompanied by routine weeding and optimal fertilizer application (Peragi, 2013). In contrast, the leaf litter treatment resulted in the lowest yield due to slow decomposition and a high C/N ratio, which inhibited nitrogen availability (Erdenebileg et al., 2023; van der Sloot et al., 2022).

On the fruit weight parameter, plastic mulch showed the highest results, followed by baglogs and no mulch. The superiority of plastic mulch is related to increased photosynthesis and nutrient absorption efficiency (Das et al., 2022). Baglog mulching can support heavy fruit productivity by increasing soil water storage capacity and nutrient supply (Mahari et al., 2020; Sulaeman, 2011). The treatment without mulch produced the lowest fruit weight. This can be caused by routine weeding to reduce competition between weeds and plants (Galal et al., 2020). The lowest fruit weight was found in the straw and grass treatment, which was affected by slow decomposition and soil acidity due to organic compounds (Bahtiar et al., 2018; C. Tang et al., 2013; Widowati et al., 2022). In addition, allelopathic compounds in leaf litter can inhibit fruit formation (John & Sarada, 2012; Xuan et al., 2005).

Based on productivity data (in tons per hectare), the plastic mulch treatment gave the highest average productivity value of 1.71 tons/ha, followed by the baglog mulch treatment, with a productivity of 1.46 tons/ha, and without mulch, at 1.37 tons/ha. Meanwhile, the rice straw and leaf litter treatments showed lower productivity values of 1.15 tons/ha and 0.85 tons/ha, respectively.

Based on Table 9, mulch treatments give different effects on pH and humidity, pest attack intensity, pest population, and plant growth and productivity. Treatments P3 (leaf litter mulch) and P4 (rice straw mulch) produced the best pH and humidity values. While in the aspect of pest attack intensity, treatment P1 (plastic mulch) produced the best results in 6 parameters, such as leaf spot, anthracnose, *Thrips parvispinus, Bemisia tabaci,* and other diseases. P2 (baglog mulch) is effective in suppressing leaf curl attack, *Bemisia tabaci, Myzus persicae*, and *Bactrocera dorsalis*. P3 (leaf litter mulch) was effective in suppressing anthracnose and *Myzus persicae*, while P4 (rice straw mulch) was only superior in suppressing *Thrips parvispinus*. P0 (no mulch) was effective against Fusarium wilt.

Table 9. Recommended Use of Mulch

Parameters	P0	P1	P2	P3	P4
Effect of mulch on soil pH and moisture					
pH	✓	✓			
Moisture				✓	✓
Intensity of pest and disease attacks					
Leaf spot		✓	✓		
Leaf curl			✓		✓
Fusarium wilt	✓				✓
Anthracnose		✓	✓	✓	✓
Thrips parvispinus			✓	✓	
Bemisia tabaci		✓		✓	
Myzus persicae		✓	✓		
Bactrocera dorsalis		✓		✓	
Effect of mulch on growth and productivity					
Plant height (cm)	✓				✓
Stem diameter (mm)	✓				✓
Number of branches		✓			✓
Number of fruit		✓			✓
Fruit weight (g)		✓	✓		
Total	4	9	6	5	8

Note *: Symbol (✓) indicates 1) Mulch treatment with the best results in increasing pH and retaining soil moisture. 2) Mulch treatment with the best results in suppressing the intensity of pest and disease attacks. 3). Is the best result of mulch use in increasing plant growth and productivity.

In suppressing pest populations, P1 (plastic mulch) and P4 (rice straw mulch) were effective in suppressing the infestation of *Thrips parvispinus*. P2 (baglog mulch) is effective in suppressing pest attacks, *Bemisia tabaci, Myzus persicae*, and *Bactrocera dorsalis*. Meanwhile, P4 (rice straw mulch) was effective in suppressing the attack of *Myzus persicae*. In growth and productivity parameters, P4 (rice straw mulch) excelled with the best results in the number of branches, number of fruits, fruit weight, and stem diameter. P3 (leaf litter mulch) was superior in plant height and stem diameter. In total, P1 treatment (plastic mulch) gave the best results in 11 parameters, P4 treatment (rice straw mulch) in 9 parameters, P2 treatment (baglog mulch) in 8 parameters, P3 treatment (leaf litter mulch) in 5 parameters, and P0 treatment (no mulch) in 3 parameters. Thus, treatment P1 (plastic mulch) was most effective for pest and pest control, while treatment P4 (rice straw mulch) was superior in supporting plant growth and yield.

Conclusion

Mulching significantly influenced disease intensity, soil conditions, vegetative growth, and yield of cayenne pepper: organic mulches (rice straw, leaf litter, baglog) reduced overall disease incidence from 28.6% (no mulch) to 17.2–19.2%, improved soil moisture retention and pH stability, and enhanced plant vigor—baglog and straw notably increased branch number and supported natural-enemy populations—whereas plastic mulch produced the highest fruit weight per plant, indicating its advantage for maximizing individual-plant yield; these findings suggest a general principle that organic mulches improve soil health and plant resilience through nutrient release and microclimate moderation while inorganic (plastic) mulch favors short-term yield gains by conserving moisture and suppressing weeds, so for sustainable production prioritize rice straw or leaf litter to enhance soil fertility and reduce pest/disease pressure, use well-decomposed baglog mulch when the goal is vigorous vegetative growth and biological control, and apply plastic mulch selectively when immediate yield maximization is required while mitigating environmental costs through proper disposal and complementary organic amendments; additionally, farmers using high-moisture organic mulches should monitor for whitefly and aphid outbreaks and integrate targeted monitoring and biological control to manage potential increases in sap-sucking pests.

Acknowledgments

We want to express our sincere gratitude to the Institute for Research and Community Service (Lembaga Penelitian dan Pengabdian kepada Masyarakat) of Universitas Jember for supporting this research through the Research Group (KeRis - DiMas) 2025 grant.

Author Contributions

W.M, I.S, and H.P designed the research. W.M supervised all the processes, and I.N.W.P and N.A.R collected the data. WM and T.W.S analyzed the data. W.M, I.N.W.P and N.A.R identified the specimen. W.M, I.S and S.P wrote the manuscript. All the authors have read and approved the final manuscript

Funding

This research was funded by Institute for Research and Community Service (Lembaga Penelitian dan Pengabdian kepada Masyarakat) of Universitas Jember for supporting this research through the Research Group (KeRis - DiMas) 2025 grant.

Conflicts of Interest

The authors declare no conflict of interest. "The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results"

References

Ahammed, G. J., & Yang, Y. (2021). Mechanisms of silicon-induced fungal disease resistance in plants. *Plant Physiology and Biochemistry*, *165*, 200–206. https://doi.org/10.1016/j.plaphy.2021.05.031

Alegbeleye, O. O., & Sant'Ana, A. S. (2020). Manure-borne pathogens as an important source of water contamination: An update on the dynamics of pathogen survival/transport as well as practical risk mitigation strategies. *International Journal of Hygiene and Environmental Health*, *227*, 113524. https://doi.org/10.1016/j.ijheh.2020.113524

Amare, G., & Desta, B. (2021). Coloured plastic mulches: impact on soil properties and crop productivity. *Chemical and Biological Technologies in Agriculture*, *8*(1), 1–9.

Asif, M., Abbas, B., Sikander Hayyat, M., Adnan, M., Khalid, M., Raza, A., Ahmad Khan, B., Hassan, M., Awais Bashir Khan, M., & Shakeel Hanif, M. (2020). Role of mulches in agriculture: A review. In *www.botanyjournals.com* (Vol. 5). www.botanyjournals.com

Bahadur, S., Pradhan, S., Verma, S., Maurya, R., & Verma, S. K. (2018). Role of plastic mulch in soil health and crop productivity. *Climate Change and Its Implications on Crop Production and Food Security*, 338–344.

Bahtiar, F. Y., Sudadi, S., & Cahyani, V. R. (2018). Sifat Kimia Tanah, Populasi Bakteri Pelarut Fosfat, Dan Hasil Cabai Pada Aplikasi Beberapa Jenis Mulsa Pada Inceptisol Ngemplak, Boyolali. *Caraka Tani: Journal of Sustainable Agriculture*, *32*(2), 75–83. https://doi.org/10.20961/carakatani.v32i2.13418

Bai, X., Dippold, M. A., An, S., Wang, B., Zhang, H., & Loeppmann, S. (2021). Extracellular enzyme activity and stoichiometry: The effect of soil microbial element limitation during leaf litter decomposition. *Ecological Indicators*, *121*, 107200. https://doi.org/10.1016/j.ecolind.2020.107200

Bakar, A. H. A., & Carey, C. J. N. (2020). Extraction of silica from rice straw using alkaline hydrolysis pretreatment. *IOP Conference Series: Materials Science and Engineering*, *778*(1), 012158. https://doi.org/10.1088/1757899X/778/1/012158

Basri, H., Mudjiono, G., & Puspitarini, R. D. (2015). Pengaruh Tumpangsari Tanaman Selasih dan Cabai Merah Organik terhadap Populasi dan Intensitas Serangan Lalat Buah (Diptera: Tephritidae). *Jurnal HPT (Hama Penyakit Tumbuhan)*, *3*(2), 117–126.

Bhavanam, S., & Stout, M. J. (2021). Assessment of Silicon-and mycorrhizae-mediated constitutive and induced systemic resistance in rice, Oryza sativa L., against the fall armyworm, Spodoptera frugiperda Smith. *Plants*, *10*(10), 2126. https://doi.org/10.3390/plants10102126

Das, C., Gautham, B. P., Boruah, P., & Choudhury, H. (2022). *Evaluation of the performance of different mulching materials on growth and yield of chilli*.

Dia de Almeida, G., Pratissoli, D., Cola Zanuncio, J., Bernardo Vicentini, V., Mathias Holtz, A., & Serrão, J. E. (2008). Calcium silicate and organic mineral fertilizer applications reduce phytophagy by Thrips palmi Karny (Thysanoptera: Thripidae) on eggplants (Solanum melongena L.). *Interciencia*, *33*(11), 835–838.

Dobermann, A., & Fairhurst, T. H. (2002). Rice straw management. *Better Crops International*, *16*(1), 7–11.

Dogra, P., Singh, A., & Banyal, D. K. (2020). survival of Cercospora sojina causing frogeye leaf spot of soybean and impact of weather factors on the disease development. *Plant Disease Research*, *35*(1), 14–19. https://doi.org/10.5958/2249-8788.2020.00003.7

Elbasiouny, H., El-Ramady, H., Elbehiry, F., Rajput, V. D., Minkina, T., & Mandzhieva, S. (2022). Plant nutrition under climate change and soil carbon sequestration. *Sustainability*, *14*(2), 914. https://doi.org/10.3390/su14020914

El-Beltagi, H. S., Basit, A., Mohamed, H. I., Ali, I., Ullah, S., Kamel, E. A. R., Shalaby, T. A., Ramadan, K. M. A., Alkhateeb, A. A., & Ghazzawy, H. S. (2022a). Mulching as a Sustainable Water and Soil Saving Practice in Agriculture: A Review. In *Agronomy* (Vol. 12, Issue 8). MDPI. https://doi.org/10.3390/agronomy12081881

El-Beltagi, H. S., Basit, A., Mohamed, H. I., Ali, I., Ullah, S., Kamel, E. A. R., Shalaby, T. A., Ramadan, K. M. A., Alkhateeb, A. A., & Ghazzawy, H. S. (2022b). Mulching as a sustainable water and soil saving practice in agriculture: A review. *Agronomy*, *12*(8),

1881. https://doi.org/10.3390/agronomy12081881

Erdenebileg, E., Wang, C., Yu, W., Ye, X., Pan, X., Huang, Z., Liu, G., & Cornelissen, J. H. C. (2023). Carbon versus nitrogen release from root and leaf litter is modulated by litter position and plant functional type. *Journal of Ecology*, *111*(1), 198–213. https://doi.org/10.1111/1365-2745.14026

Fatimah, S., Noor, M., & Saputra, R. A. (2024). The Efficacy of Several Agricultural Wastes as Ameliorant for Peat Degraded Soil: The Case of Kalimantan. *Tropical Wetland Journal*, *10*(1), 39–45. https://doi.org/10.20527/twj.v10i1.131

Ferreira, V., Pazianoto, L. H. R., & Solla, A. (2022). Invasive forest pathogens affect the characteristics, microbial colonisation, and decomposition of leaf litter in streams. *Freshwater Biology*, *67*(2), 416–429. https://doi.org/10.1111/fwb.13851

Galal, R. M., Hassanein, A. M. A., & Fedlallah, A. M. (2020). Determination critical periods of weed competition and weed control influence on yield productivity of sweet pepper (Capsicum annuum L.). *Journal of Plant Production*, *11*(2), 127–137. https://doi.org/10.21608/jpp.2020.79106

Gao, H., Yan, C., Liu, Q., Ding, W., Chen, B., & Li, Z. (2019). Effects of plastic mulching and plastic residue on agricultural production: A meta-analysis. *Science of the Total Environment*, *651*, 484–492. https://doi.org/10.1016/j.scitotenv.2018.09.105

Goel, L., Shankar, V., & Sharma, R. K. (2019). Investigations on effectiveness of wheat and rice straw mulches on moisture retention in potato crop (Solanum tuberosum L.). *International Journal of Recycling of Organic Waste in Agriculture*, *8*(Suppl 1), 345–356. https://doi.org/10.1007/s40093-019-00307-6

Grašič, M., Likar, M., Vogel-Mikuš, K., Samardžić, T., & Gaberščik, A. (2022). Decomposition rate of common reed leaves depends on litter origin and exposure location characteristics. *Aquatic Botany*, *179*, 103513. https://doi.org/10.1016/j.aquabot.2022.103513

Gulo, A., Harefa, L., & Gea, F. J. (2025). Efektivitas Penggunaan Mulsa Plastik dalam Meningkatkan Produktivitas Tanaman Cabai (Capsicum annuum L.). *Flora: Jurnal Kajian Ilmu Pertanian Dan Perkebunan*, *2*(1), 152–159. https://doi.org/10.62951/flora.v2i1.258

Halil, W. (2021). Effect of mulch application and watering frequency on growth and production of chilli (Capsicum annum L). *IOP Conference Series: Earth and Environmental Science*, *807*(4), 042031. https://doi.org/10.1088/17551315/807/4/042031

Han, D., Chen, X., Zhou, F., WU, X., Zhao, M., & CHEN, X. (2021). Control effects of blue and yellow light on Bemisia tabaci on greenhouse cucumbers. *Chinese Journal of Eco-Agriculture*, *29*(5), 802–808.

Harender Raj. (2008). *Soil Solarization by Polyethylene Mulching for the Management of Soil-Borne Diseases* (Naik & Devika rani, Eds.).

Huang, T., Yang, N., Lu, C., Qin, X., & Siddique, K. H. M. (2021). Soil organic carbon, total nitrogen, available nutrients, and yield under different straw returning methods. *Soil and Tillage Research*, *214*, 105171. https://doi.org/10.1016/j.still.2021.105171

Iqbal, R., Raza, M. A. S., Valipour, M., Saleem, M. F., Zaheer, M. S., Ahmad, S., Toleikiene, M., Haider, I., Aslam, M. U., & Nazar, M. A. (2020). Potential agricultural and environmental benefits of mulches—a review. *Bulletin of the National Research Centre*, *44*(1), 75.

Jabran, K. (2019). Use of Mulches in Agriculture: Introduction and Concepts. In K. Jabran (Ed.), *Role of Mulching in Pest Management and Agricultural Sustainability* (pp. 1–14). Springer International Publishing. https://doi.org/10.1007/978-3-030-22301-4_1

Jasinska, A., Stoknes, K., & Roszak, M. (2022). Spent Cultivation Substrate (SCS) Management in Circular Farming Systems. *Biology and Life Sciences Forum*, *16*(1), 12. https://doi.org/10.3390/IECHo2022-12484

John, J., & Sarada, S. (2012). Role of phenolics in allelopathic interactions. *Allelopathy Journal*, *29*(2).

Kasirajan, S., & Ngouajio, M. (2012). Polyethylene and biodegradable mulches for agricultural applications: a review. *Agronomy for Sustainable Development*, *32*, 501–529. https://doi.org/10.1007/s13593-011-0068-3

Khilare, V. C., Khilare, A., & Ahmed, R. (2012). Effect Of Different Media, Ph And Temperature On The Growth Of Fusarium Oxysporum F.Sp. Ciceri Causing Chickpea Wilt. In *Article in International journal of Advanced Biological and Biomedical Research* (Vol. 2, Issue 1). https://www.researchgate.net/publication/281591253

Korkanç, S. Y., & Şahin, H. (2021). The effects of mulching with organic materials on the soil nutrient and carbon transport by runoff under simulated rainfall conditions. *Journal of African Earth Sciences*, *176*, 104152. https://doi.org/10.1016/j.jafrearsci.2021.104152

Kumari, V. V., Banerjee, P., Verma, V. C., Sukumaran, S., Chandran, M. A. S., Gopinath, K. A., Venkatesh, G., Yadav, S. K., Singh, V. K., & Awasthi, N. K. (2022). Plant nutrition: An effective way to alleviate abiotic stress in agricultural crops. *International Journal of Molecular Sciences*, *23*(15), 8519. https://doi.org/10.3390/ijms23158519

Lamont, W. J. (2005). Plastics: Modifying the Microclimate for the Production of Vegetable Crops. *HortTechnology Horttech*, *15*(3), 477–481. https://doi.org/10.21273/HORTTECH.15.3.0477

Landis, D. A., Wratten, S. D., & Gurr, G. M. (2000). Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology*, *45*(1), 175–201. https://doi.org/10.1146/annurev.ento.45.1.175

Liu, Z., Huang, F., Wang, B., Li, Z., Zhao, C., Ding, R., Yang, B., Zhang, P., & Jia, Z. (2023). Soil respiration in response to biotic and abiotic factors under different mulching measures on rain-fed farmland. *Soil and Tillage Research*, *232*, 105749. https://doi.org/10.1016/j.still.2023.105749

Mahari, W. A. W., Peng, W., Nam, W. L., Yang, H., Lee, X. Y., Lee, Y. K., Liew, R. K., Ma, N. L., Mohammad, A., & Sonne, C. (2020). A review on valorization of oyster mushroom and waste generated in the mushroom cultivation industry. *Journal of Hazardous Materials*, *400*, 123156. https://doi.org/10.1016/j.jhazmat.2020.123156

Malik, N. S., Subhani, A., Bibi, R., & Naseem, W. (2018). Do organic and inorganic mulches affects soil moisture conservation and crop yield. *Journal of Applied Agriculture and Biotechnology*, *3*(1), 43–52.

Marichamy, M. S., Jayabharathi, J., Thomas, A., & Thomas, A. (2016). Effect of Different Mulches on Growth and Physiological Characters of Chilli (Capsicum annuum L) Hybrid Sierra. *Advances in Life Sciences*, *5*(4), 1267–1271.

McIntosh, H., Atucha, A., & Guédot, C. (2024). Plastic mulches reduce abundance of some arthropods but are not detrimental to pollinators in primocane raspberries. *Journal of Applied Entomology*, *148*(2), 180–190. https://doi.org/10.1111/jen.13221

Mechergui, T., Pardos, M., Jhariya, M. K., & Banerjee, A. (2021). Mulching and weed management towards sustainability. *Ecological Intensification of Natural Resources for Sustainable Agriculture*, 255–287. https://doi.org/10.1007/978-981-33-4203-3_8

Mishra, M., & Mukherjee, U. (2020). Effect of various environmental parameters on population of mustard aphid, Lipaphis erysimi (Kalt.). *Journal of Entomology and Zoology Studies*, *8*(5), 291–295.

Mondal, S., Ghosal, S., & Barua, R. (2016). Impact of elevated soil and air temperature on plants growth, yield and physiological interaction: a critical review. *Scientia Agriculturae*, *14*(3), 293–305. https://doi.org/10.15192/PSCP.SA.2016.14.3.293 305

Munir, J. (2024). *Marginal Land Management*. Universitas Tamansiswa Padang.

Munir, N., Xiang, T. C., Bhuyar, P., & Ramli, A. N. M. (2021). Effective microbes (EM) and their potential on mushroom commercialization in Malaysia. *Maejo International Journal of Energy and Environmental Communication*, *3*(3), 45–55. https://doi.org/10.54279/mijeec.v3i3.246955

Nalla, M. K., Schafleitner, R., Pappu, H. R., & Barchenger, D. W. (2023). Current status, breeding strategies and future prospects for managing chilli leaf curl virus disease and associated begomoviruses in Chilli (Capsicum spp.). *Frontiers in Plant Science*, *14*, 1223982. https://doi.org/10.3389/fpls.2023.1223982

Nasruddin, A., Agus, N., Saubil, A., Jumardi, J., Rasyid, B., Siriniang, A., Nasruddin, A. D., Firdaus, F., & Said, A. E. (2020). Effects of mulch type, plant cultivar, and insecticide use on sweet potato whitefly population in chili pepper. *Scientifica*, *2020*(1), 6428426. https://doi.org/10.1155/2020/6428426

Nyochembeng, L. M., Mankolo, R. N., Mentreddy, S. R., & Mayalagu, G. (2014). Cover crop, reflective polyethylene mulch and biofungicide effects on yield and management of diseases in field-grown organic tomato. *Journal of Agricultural Science*, *6*(12), 265. https://doi.org/10.5539/jas.v6n12p265

Oesman, R. (2023). Efektifitas Pemupukan NPK dan Penggunaan Mulsa terhadap Pertumbuhan dan Hasil Tanaman Cabai Merah Besar (Capsicum annum L.). *Biofarm: Jurnal Ilmiah Pertanian*, *19*(2), 351–357. https://doi.org/10.31941/biofarm.v19i2.3302

Panno, S., Davino, S., Caruso, A. G., Bertacca, S., Crnogorac, A., Mandić, A., Noris, E., & Matić, S. (2021). A review of the most common and economically important diseases that undermine the cultivation of tomato crop in the mediterranean basin. *Agronomy*, *11*(11), 2188. https://doi.org/10.3390/agronomy11112188

Peragi. (2013). Jurnal Agronomi Indonesia Vol 41 Bo 2 147-153 2013. *Jurnal Agronomi Indonesia*.

Prem, M., Ranjan, P., Seth, N., & Patle, G. T. (2020). Mulching techniques to conserve the soil water and advance the crop production—A Review. *Curr. World Environ*, *15*, 10–30. https://doi.org/10.12944/CWE.15.Special-Issue1.02

Qi, Y., Ossowicki, A., Yergeau, É., Vigani, G., Geissen, V., & Garbeva, P. (2022). Plastic mulch film residues in agriculture: impact on soil suppressiveness, plant growth, and microbial communities. *FEMS Microbiology Ecology*, *98*(2), fiac017.

Roeswitawati, D., Sulistyowati, A., & Ishartati, E. (2021). Concentration Test of Liquid Bioslurry and Mushroom Baglog Waste as a Plant Medium on Growth and Results of Strawberries (Fragaria sp.). *IOP Conference Series: Earth and Environmental Science*, *828*(1), 012018. https://doi.org/10.1088/17551315/828/1/012018

Saleh, S. M. M., Al-Shareef, L. A. H., & Al-Zahrany, R. A. A. (2010). Effect of geomagnetic field on whitefly Bemisia tabaci (Gennadius) flight to the cardinal and halfway directions and their attraction to different colors in Jeddah of Saudi Arabia. *Agriculture and Biology Journal of North America*, *1*(6), 1349–1356. https://doi.org/10.5251/abjna.2010.1.6.1349.1356

Samaddar, S., Karp, D. S., Schmidt, R., Devarajan, N., McGarvey, J. A., Pires, A. F. A., & Scow, K. (2021). Role of soil in the regulation of human and plant pathogens: soils' contributions to people. *Philosophical Transactions of the Royal Society B*, *376*(1834), 20200179. https://doi.org/10.1098/rstb.2020.0179

Sarangi, S. K., Mainuddin, M., & Maji, B. (2022). Problems, management, and prospects of acid sulphate soils in the Ganges Delta. *Soil Systems*, *6*(4), 95. https://doi.org/10.3390/soilsystems6040095

Sekhon, N. K., Singh, C. B., Sidhu, A. S., Thind, S. S., Hira, G. S., & Khurana, D. S. (2008). Effect of straw mulching, irrigation and fertilizer nitrogen levels on soil hydrothermal regime, water use and yield of hybrid chilli. *Archives of Agronomy and Soil Science*, *54*(2), 163–174. https://doi.org/10.1080/03650340701817014

Shah, M. A. (2019). Bio-efficacy of potassium silicate against aphids and whitefly in potato. *Potato Journal*, *46*(2).

Shen, M., Wu, L., Zhang, Y., You, R., Xiao, J., & Kang, Y. (2024). Leaf litter from Cynanchum auriculatum Royle ex Wight leads to root rot outbreaks by Fusarium solani, hindering continuous cropping. *FEMS Microbiology Ecology*, *100*(6), fiae068. https://doi.org/10.1093/femsec/fiae068

Sobari, E., & Fathurohman, F. (2021). Organic Waste as Fertilizer to Increase the Number of Peanuts (Arachis hypogaea L.) Flowers. *Jurnal Biodjati*, *6*(1), 153–161. https://doi.org/10.15575/biodjati.v6i1.6538

Sozubek, B., & Ozturk, M. (2022). Valorization of Rice Straw: Agrochemical and Environmental Aspects. *Innovative Agricultural Practices in Soil, Plant and Environment. Iksad Publishing House*, 9–41.

Stoler, A. B., & Relyea, R. A. (2020). Reviewing the role of plant litter inputs to forested wetland ecosystems: leafing through the literature. *Ecological Monographs*, *90*(2), e01400. https://doi.org/10.1002/ecm.1400

Sulaeman, D. (2011). *Efek Kompos Limbah Baglog Jamur Tiram Putih (Pleurotus Ostreatus Jacquin) Terhdadap Sifat Fisik Tanah Serta Pertumbuhan Bibit Markisa Kuning (Passiflora Edulis Var. Flavicarpa Degner)*.

Sun, X., Wang, G., Ma, Q., Liao, J., Wang, D., Guan, Q., & Jones, D. L. (2021). Organic mulching promotes soil organic carbon accumulation to deep soil layer in an urban plantation forest. *Forest Ecosystems*, *8*, 1–11. https://doi.org/10.1186/s40663-020-00278-5

Sunarya, D. S., & Wardhana, W. (2020). Utilization of baglog waste as bokashi fertilizer with local microorganisms (MOL) activator. *IOP Conference Series: Earth and Environmental Science*, *524*(1), 012013. https://doi.org/10.1088/1755-1315/524/1/012013

Susilowati, L. E., Arifin, Z., Silawibawa, I. P., R. Sutriono, & Mahrup. (2022). Edukasi Pengolahan Limbah Baglog Jamur Tiram Menjadi Pupuk Organik Diperkaya Bakteri Pelarut Fosfat Pada Petani Muda Milenial di Desa Narmada Kabupaten Lombok Barat. *Jurnal Pengabdian Magister Pendidikan IPA*, *5*(4), 46–53. https://doi.org/10.29303/jpmpi.v5i4.2370

Tang, C., Weligama, C., & Sale, P. (2013). Subsurface soil acidification in farming systems: its possible causes and management options. *Molecular Environmental Soil Science*, 389–412. https://doi.org/10.1007/978-94-007-4177-5_13

Tang, M., Liu, R., Luo, Z., Zhang, C., Kong, J., & Feng, S. (2023). Straw returning measures enhance soil moisture and nutrients and promote cotton growth. *Agronomy*, *13*(7), 1850. https://doi.org/10.3390/agronomy13071850

Tronsmo, A. M., Collinge, D. B., Djurle, A., Munk, L., Yuen, J., & Tronsmo, A. (2020). *Plant pathology and plant diseases*. CABI. https://doi.org/10.1079/9781789243185.0000

van der Sloot, M., Kleijn, D., De Deyn, G. B., & Limpens, J. (2022). Carbon to nitrogen ratio and quantity of organic amendment interactively affect crop growth and soil mineral N retention. *Crop and Environment*, *1*(3), 161–167. https://doi.org/10.1016/j.crope.2022.08.001

Vishwakarma, P. K., Chander, S., & Nimbolkar, P. K. (2024). Efficient water management tactics for mitigating fruit crop diseases. *Applied Fruit Science*, *66*(2), 771–779. https://doi.org/10.1007/s10341-024-01034-7

Wang, P., Han, S., & Lin, Y. (2023). Role of microbes and microbial dynamics during composting. In *Current developments in biotechnology and bioengineering* (pp. 169–220). Elsevier. https://doi.org/10.1016/B978-0-323-91874-9.00011-5

Wang, X., Fan, J., Xing, Y., Xu, G., Wang, H., Deng, J., Wang, Y., Zhang, F., Li, P., & Li, Z. (2019a). The effects of mulch and nitrogen fertilizer on the soil environment of crop plants. *Advances in Agronomy*, *153*, 121–173. https://doi.org/10.1016/bs.agron.2018.08.003

Wang, X., Fan, J., Xing, Y., Xu, G., Wang, H., Deng, J., Wang, Y., Zhang, F., Li, P., & Li, Z. (2019b). The Effects of Mulch and Nitrogen Fertilizer on the Soil Environment of Crop Plants. In *Advances in Agronomy* (Vol. 153, pp. 121–173). Academic Press Inc. https://doi.org/10.1016/bs.agron.2018.08.003

Widowati, T., Nuriyanah, N., Nurjanah, L., Lekatompessy, S. J. R., & Simarmata, R. (2022). Pengaruh bahan baku kompos terhadap pertumbuhan dan produksi cabai merah keriting (Capsicum annuum L.). *Jurnal Ilmu Lingkungan*, *20*(3), 665–671. https://doi.org/10.14710/jil.20.3.665-671

Winkler, J., Kirchner, S. M., & Hensel, O. (2025). Effect of Various Organic Mulches on Aphids, Their Predators, and Potato Virus Transmission. *Potato Research*, 1–25. https://doi.org/10.1007/s11540-025-09851-3

Xuan, T. D., Tawata, S., Khanh, T. D., & Chung, I. M. (2005). Decomposition of allelopathic plants in soil. *Journal of Agronomy and Crop Science*, *191*(3), 162–171. https://doi.org/10.1111/j.1439-037X.2005.00170.x

Yactayo-Chang, J. P., Tang, H. V, Mendoza, J., Christensen, S. A., & Block, A. K. (2020). Plant defense chemicals against insect pests. *Agronomy*, *10*(8), 1156. https://doi.org/10.3390/agronomy10081156

Yan, C., Yan, S.-S., Jia, T.-Y., Dong, S.-K., Ma, C.-M., & Gong, Z.-P. (2019). Decomposition characteristics of rice straw returned to the soil in northeast China. *Nutrient Cycling in Agroecosystems*, *114*, 211–224. https://doi.org/10.1007/s10705-019-09999-8

Yuan, G., Huan, W., Song, H., Lu, D., Chen, X., Wang, H., & Zhou, J. (2021). Effects of straw incorporation and potassium fertilizer on crop yields, soil organic carbon, and active carbon in the rice–wheat system. *Soil and Tillage Research*, *209*, 104958. https://doi.org/10.1016/j.still.2021.104958

Yuan, X., Ma, S., Geng, H., Cao, M., Chen, H., Zhou, B., Yuan, R., Luo, S., Sun, K., & Wang, F. (2024). Joint effect of black carbon deriving from wheat straw burning and plastic mulch film debris on the soil biochemical properties, bacterial and fungal communities. *Science of The Total Environment*, *947*, 174522. https://doi.org/10.1016/j.scitotenv.2024.174522

Zairani, F. Y., Hasani, B., Nisfuriah, L., Dali, D., Kalasari, R., & Nasser, G. A. (2023). The Effect of Various Kinds of Mulch on the Growth and Production of Chili Plants. *Journal of Global Sustainable Agriculture*, *3*(2), 7–11. https://doi.org/10.32502/jgsa.v3i2.6072

Zhang, J., Xing, G.-M., Liao, J.-X., Hou, Z.-D., Wang, G.-X., & WANG, Y. (2003). Effects of different atmospheric C02 concentrations and soil moistures on the populations ofbird cherry-oat aphid (Rhopalosiphumpadi) feeding on spring wheat. *Eur. J. Entomol*, *100*, 521–530. https://doi.org/10.14411/eje.2003.080