

The Effect of Fungicide Addition and Application Methods on The Intensity of Downy Mildew in Maize

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ABSTRACT

Downy mildew is a disease with high potential for loss in maize, the most widely applied control method is the use of metalaxyl fungicide as seed treatment. However, pathogen resistance was found, so alternative controls are needed. This study aims to examine the effect of adding different active ingredients and fungicide application methods and their interactions on controlling downy mildew in maize. The study used 5x3 Randomized Block Design (RBD). The first factor was the type of active ingredient consisting of 5 treatment levels, namely F0 (Control), F1 (Metalaxyl), F2 (Dimethomorph), F3 (Chlorothalonil + Oxathiopropin), and F4 (Phenamidone). The second factor was the fungicide application consisting of 3 treatment levels, namely A1 (seed treatment), A2 (spraying), and A3 (seed treatment + spraying). The parameters observed were the incubation period, incidence, intensity, infection rate, AUDPC, chlorophyll at 3 and 5 WAP, plant height, number of leaves, fresh weight, and dry weight. The results of the study showed that the incubation period occurred on average at 20.49 - 22.98 DAI with disease incidence reaching 100% and intensity reaching 28.3 - 40%. AUDPC value of 80.15 - 106.7 is included in the resistant-moderately resistant category with the highest infection rate at 4 WAI ranging from 0.40 to 0.92 plants/week and decreasing to 6 WAI. The conclusion is that the treatment of active ingredients and application methods can be used to control downy mildew in Paramita F1 by reducing the rate of infection supported by plant resistance which is categorized as resistant to somewhat resistant.

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Introduction:

Downy mildew is one of the main diseases that attacks maize and cause plants to not produce. High intensity of downy mildew disease can cause crop failure due to the very rapid spread of downy mildew pathogens, one of which is through the air (airborne). Several countries, especially in Asia, have experienced significant yield losses due to downy mildew which has become an epidemic in maize. The Philippines experienced a 15-40% loss in corn yield (Exconde, 1976), while in Thailand, the loss was 50-100% (Pitaksraiwan et al., 1976; Pupipat, 1979). Maize that infected with downy mildew during the vegetative phase cannot form cobs perfectly, causing crop failure (Daryono et al., 2018; Ulhaq and Masnilah, 2019). Maize infected with downy mildew during the generative phase can still grow and bear fruit, but the cobs are generally imperfect, stunted, and contain only a few seeds (Weston, 1920).

There are several ways to control downy mildew, including using resistant varieties, land sanitation, using biological agents, and fungicides (Ulhaq and Masnilah, 2019). The most widely applied method of controlling downy mildew with a fungicide containing the active ingredient metalaxyl because it is more effective and efficient. Metalaxyl works by attacking the metabolism of pathogenic nucleic acids. The use of fungicides with active ingredients that act in the same way at continuously inappropriate concentrations can cause negative effects, namely pathogen resistance (Tanzil and Purnomo, 2021). Based on research that has been conducted, it is known that *Peronosclerospora* spp. which is the cause of downy mildew disease in corn shows resistance to metalaxyl in several areas (Widiantini et al., 2015, Sireesha et al., 2017). Efforts to overcome this problem include using fungicides at the right concentration and avoiding continuous use of fungicides with the same mode of action; instead, alternate them with active ingredients that work in different ways.

The active ingredients of fungicides with potential as alternatives to metalaxyl are dimethomorph, oxathiapiprolone, and phenamidone. Dimethomorph inhibits cell wall biosynthesis, oxathiapiprolone targets OSBP, and phenamidone affects the continued respiration of the target pathogen (Goertz and Derpmann, 2022). Several references indicate that the active ingredients dimethomorph, oxathiapiprolone, and phenamidone have good potential in controlling downy mildew. Dimethomorph can prevent the growth of *Peronosclerospora* spores that cause downy mildew disease in corn plants (Widiantini et al., 2017), fungicides with the active ingredient oxathiapiprolone-famoxadon can suppress the incidence and severity of downy mildew disease at 7 DAI (Days After Inoculation) (Yelli et al., 2022), phenamidone fungicide is able to inhibit the germination of *Peronosclerospora* spp. conidia causes of downy mildew disease in corn (Anugrah and Widiantini, 2018).

Research is needed to determine the effectiveness of fungicides with active ingredients other than metalaxyl in preventing maize downy mildew, yet seed production companies sell maize seeds coated with fungicides. The types and concentrations of fungicides used by producers are kept secret; seed washing is needed to remove the fungicides provided by the seed company (Rachman et al., 2019). Fungicides can be applied in three ways: seed treatment, spraying, and seed treatment + spraying. Seed treatment is the initial step to protect against downy mildew infection, while spraying during the plant's vegetative phase has the potential to reduce the risk of downy mildew infection (Pakki and Adriani, 2015). Therefore, research to determine the effectiveness of active fungicide ingredients and how to apply them to control downy mildew in maize seed washing is important.

MATERIALS AND METHODS

This research was conducted on land at Jalan Mulawarman Timur Dalam V, RT 03/RW 03, Kramas Village, Tembalang District, in September - November 2024. The design used was a 5x3 factorial Randomized Block Design with 3 replications, obtaining 15 combinations and 45 experimental units. Each experimental unit was planted with 5 plants, so 225 plants were needed. The first factor was the type of active fungicide ingredient consisting of 5 treatment levels, namely F0 (Control), F1 (Metalaxyl), F2 (Dimethomorph), F3 (Chlorothalonil + Oxathiopiripolin), and F4 (Phenamidon). The second factor was the method of fungicide application consisting of 3 treatment levels, namely A1 (seed treatment), A2 (spraying), and A3 (seed treatment + spraying). The tools used include analytical scales, measuring tape (cm), pipettes, measuring cups, shovels, labels, watering cans, sprayers, knives, scissors, mortars and pestles, spectrophotometers, petri dishes, plastic, plastic boxes, masks, cooling boxes, ice packs, and Erlenmeyer. The materials used are Paramita variety maize seeds, downy mildew inoculum, water, cotton, Whatman filter paper, Urea, SP-36, KCL, bleach, Besromil® 35 WP fungicides (35% metalaxyl), Suhle 60 WP (60% dimethomorph), Orondis® Opti 6/400 SC (400 g/L chlorothalonil + 6 g/L oxathiapiprolone), Target® 500 SC (500 g/L phenamidon), and distilled water. The research data such as chlorophyll content, plant height, number of leaves, wet weight and dry weight of plant were analyzed

using analysis of variance with 5% level, and if there was a significant effect between treatments, it was continued with the Duncan's Multiple Range Test (DMRT).

Inoculum Source Collection. The method of taking downy mildew isolates according to Rustiani et al. (2015), the stem of the plant containing the fifth leaf from the top of the symptomatic plant is cut then wrapped in newspaper and put in a plastic bag to keep it fresh, then immediately taken to the laboratory for the artificial induction of fungal sporulation. The base of the leaf with signs of a white, flour-like fungal propagule mass spread on the lower leaf surface is cut then washed under running water by pinching the leaf using two fingers and wiping it to ensure the stomata are clean from dirt and fungal propagules. The leaves are then dried with tissue and put in a glass of 2% sugar solution as high as 1 - 2 cm, with the base of the leaf at the bottom. The glass is then covered to maintain humidity and incubated at room temperature for 6 hours. The leaves are removed from the glass, and the base of the leaves that are immersed in the sugar solution is dried with tissue, then put in plastic and placed in an open grassy area with the upper leaf surface facing upwards. The leaves are incubated in the open air for 7 hours or one night, and the next morning the conidia and conidiophores can be harvested from the leaves that are removed from the plastic.

Seed Washing. The method of washing maize seeds, according to Lesmana (2019), involves preparing the seeds to be washed and using a clean cloth, water, and bleach. Bleach is diluted by mixing it with water using a concentration of 1 ml/L of water, then the maize seeds are wrapped in a cloth and put in the bleach mixture, then the seeds are washed until clean, and the pesticide layer is gone.

Seed Treatment. The prepared fungicide solution is poured into plastic containers, then the maize seeds are placed in the fungicide-treated plastic; the plastic is inflated and shaken until all the maize seeds are evenly mixed and the entire surface is covered with the fungicide solution. The seeds are then air-dried for 30-60 minutes so that the fungicide adheres well. The concentration of fungicide used according to the recommendations on the packaging is a fungicide with the active ingredient metalaxyl 35% with a dose of 2.5 grams per 1 kg of seeds, a fungicide with the active ingredient Dimetomorph 50% with a dose of 2.5 grams per 1 kg of seeds, a fungicide with the active ingredient Chlorothalonil 400 g / L + Oxathiapiprolone 6 g / L with a dose of 4 ml per 1 kg of seeds, and a fungicide with the active ingredient Phenamidone 500 g / L with a dose of 5 ml per 1 kg of seeds. Maize seeds with the active-ingredient control fungicide treatment (F0) were treated only with water.

Artificial Inoculation. Control and fungicide-treated maize seeds were germinated on wet cotton in plastic containers for 5-7 days until plumules and radicles appeared. In accordance with the research method used by Adhi et al. (2019), infected maize leaves with downy mildew were inserted between maize sprouts in a container lined with damp tissue. The artificial inoculation process lasted for 1 week.

Fungicide Spraying. Fungicide spraying was carried out using a solution prepared at the recommended dose: metalaxyl 2,500 ppm, dimethomorph 2,500 ppm,

chlorothalonil + oxathiin 4,000 ppm, and phenamidone 5,000 ppm. The fungicide solution was then put into a sprayer, and each was sprayed onto maize with treatments A2 and A3 when the corn plants were 1 week after planting (WAP) and 2 WAP. Maize with the control fungicide active-ingredient treatment (F0) was sprayed only with water.

Result

The effects of active ingredient administration and fungicide application method were assessed using macroscopic and microscopic observations of downy mildew pathogens, incubation period, incidence, intensity, infection rate, AUDPC, chlorophyll content, plant height, number of leaves, wet weight, and dry weight of plants.

Macroscopic and Microscopic Observations

Macroscopic and microscopic observations of downy mildew are shown in Figures 1 and 2.

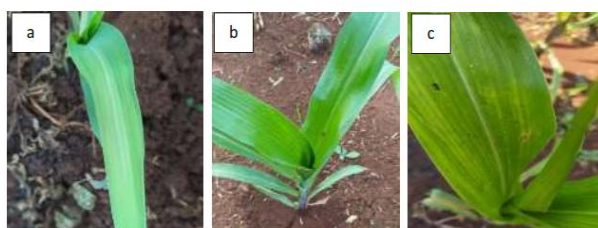


Figure 1. Observation of Downy Mildew Disease. (a) Symptomatic plants at 3 WAI (weeks after inoculation), (b) Symptomatic plants at 4 WAI, (c) Symptomatic plants at 5 WAI

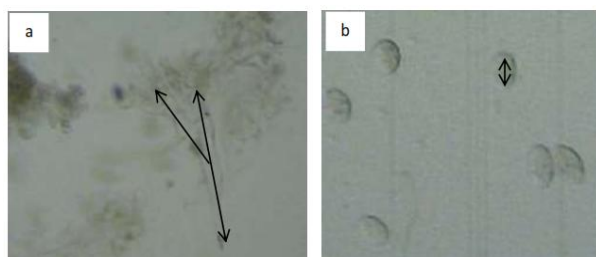


Figure 2. Microscopic Observation of Pathogens at 10 x 10 Magnification. (a) Conidiophores, and (b) Conidia

Plants with downy mildew symptoms appeared at 3 WAI (Week After Inoculation), showing mild chlorosis with a score of 1; at 4 WAI, moderate chlorosis with a score of 2; and at 5 WAI, moderate chlorosis with a score of 2. Downy mildew symptoms that appeared on maize were in accordance with research by Talanca and Tenrirawe (2015) that maize attacked by downy mildew would show symptoms of chlorotic lines (yellowing lines) parallel to the leaf veins. The time of appearance of downy mildew symptoms in this study was slower compared to previous research conducted by Prasetyo et al. (2021), in which downy mildew symptoms began to appear in the second week after inoculation. The downy mildew pathogen in this study is classified as *Peronosclerospora sorghi* based on observations of the shapes of hyphae, conidia, and conidiophores. The observed conidia showed characteristics corresponding to those of *Peronosclerospora sorghi* conidia in the study by Hikmawati et al. (2011), namely, a spherical to oval shape. The observed conidiophores also showed characteristics

corresponding to those of *Peronosclerospora sorghi* conidiophores in the study by Rustiani et al. (2015) on the pathogen that causes maize downy mildew, namely hyaline conidiophores with twice the number of branches.

Incubation Period

Incubation Period of Downy Mildew Disease in Paramita F1 can be seen in the table 1.

Active Ingredients	Application Method		Average	
	seed treatment	spraying	seed treatment + spraying	
	(DAI)			
Control	22.87	23.27	21.73	22.62
Metalaxyl	22.40	22.87	16.20	20.49
Dimetomorph	23.93	21.00	23.33	22.75
Oxathiapiprolin	24.27	23.20	21.47	22.98
Phenamidone	23.53	20.93	20.00	21.49
Average	23.40	22.25	20.55	

Table 1. Incubation Period of Downy Mildew Disease in Paramita F1 (DAI: Days after Inoculation)

The incubation period of downy mildew in the active ingredient treatment averaged 20.49 - 22.98 days after inoculation (DAI), while in the application method treatment, it averaged 20.55 - 23.40 days after inoculation. The downy mildew incubation period is longer than in previous studies. Research conducted by Wulandari et al. (2022) found that maize began to show symptoms of downy mildew 6 days after inoculation, and in the study by Sekarsari et al. (2013), symptoms of downy mildew began to appear 12 days after inoculation. This shows that the Paramita F1 variety has a fairly good level of resistance to downy mildew disease. In accordance with the research by Purwantisari et al. (2016), the greater the incubation period, the higher the level of plant resistance to disease.

Incidence

Incidence of downy mildew disease in Paramita F1 can be seen in table 2.

Treatment	Incidence of Downy Mildew Disease (%)				
	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP
F0A1	0	46.67	100	100	100
F0A2	0	53.33	100	100	100
F0A3	0	53.33	100	100	100
F1A1	0	73.33	100	100	100
F1A2	0	53.33	100	100	100
F1A3	0	73.33	100	100	100
F2A1	0	73.33	100	100	100
F2A2	0	66.67	100	100	100
F2A3	0	80.00	100	100	100
F3A1	0	53.33	100	100	100
F3A2	0	66.67	100	100	100
F3A3	0	73.33	100	100	100
F4A1	0	53.33	100	100	100
F4A2	0	46.67	100	100	100
F4A3	0	60.00	100	100	100

Table 2. Incidence of Downy Mildew Disease in Paramita F1 (F0 (Control), F1 (Metalaxyl), F2 (Dimetomorph), F3 (Chlororotalonil+Oxathiapripolin), dan F4 (Phenamidone), WAP: Week After Planting)

The incidence began in the second week after planting, ranging from 46.67% to 80%, then increased to 100% in the third to fifth weeks, indicating that all plants were infected and showed symptoms of downy mildew. This incidence value is very high compared with the research by Ali and Kasiamdari (2024), which reported the highest incidence of downy mildew in maize at 75% at 5 MST. This is one of the factors that causes the treatment given to have no real effect on the plants. The incidence of the disease can reach 100% due to environmental conditions that support its development. In accordance with McCartney's research (1994), the disease development is influenced by environmental factors, including the condition of the planting medium, temperature, humidity, rainfall, wind, and sunlight. The soil used as a planting medium in this study absorbs water very quickly and has a low water-holding capacity, which causes plants to grow poorly and makes them more susceptible to disease pathogens.

Disease Intensity

The disease intensity of downy mildew disease can be seen in Table 3.

Treatment	Intensity of Downy Mildew Disease (%)				
	1	2	3	4	5
	WAP	WAP	WAP	WAP	WAP
F0A1	0	11.7	25.00	30.00	33.30
F0A2	0	15.00	25.00	26.70	28.30
F0A3	0	15.00	25.00	28.30	30.00
F1A1	0	18.30	30.00	33.30	35.00
F1A2	0	16.70	28.30	31.70	35.00
F1A3	0	15.00	25.00	30.00	33.30
F2A1	0	20.00	31.70	35.00	40.00
F2A2	0	21.70	31.70	33.30	38.30
F2A3	0	20.00	30.00	31.70	36.70
F3A1	0	15.00	26.70	30.00	33.30
F3A2	0	16.70	25.00	30.00	31.70
F3A3	0	18.30	25.00	30.00	31.70
F4A1	0	16.70	28.30	30.00	31.70
F4A2	0	18.30	25.00	30.00	31.70
F4A3	0	15.00	23.30	28.30	30.00

Table 3. Intensity of Downy Mildew Disease in Paramita F1 (F0 (Control), F1 (Metalaxyl), F2 (Dimetomorph), F3 (Chlororotalonil+Oxathiapripolin), dan F4 (Phenamidone), WAP: Week After Planting)

The intensity value of downy mildew started in the second week after planting, ranging from 11.7 - 21.7% with mild severity; in the third week after planting it increased to 23.3 - 31.7% with mild to moderate severity, in the fourth week after planting it increased to 26.7 - 33.3% with moderate severity, and in the fifth week after planting it increased to 28.3 - 40% with moderate severity. This intensity value is in accordance with the research of Ginting et al. (2023) the intensity value of downy mildew disease in maize can reach 49%. The strong influence of the environment means that the treatment of active ingredients and the application method of fungicides have no real effect on the intensity of downy mildew. Research by Prasetyo et al. (2024) also states that environmental factors such as temperature, soil pH, air humidity, and soil conditions can cause high disease intensity of downy mildew, so the effect of the treatment given may not be visible. Soil that absorbs water very quickly and has low water-holding capacity prevents plants

from growing well, making them more susceptible to disease pathogens. *Peronosclerospora sorghi* is pathogen airborne, meaning its spores can be carried by wind and water splashes. The study was conducted from September to November, the rainy season in Indonesia, especially in Central Java. This can lead to a disease incidence of up to 100%. The development cycle of downy mildew, which attacks maize, is polycyclic. This can be seen from the slow development rate at the beginning of the season because the infection that occurs has not caused a new infection cycle, but over time a new infection cycle will arise and the disease will increase (Laelasari, 2018). The disease development model will generally track the rate of disease increase.

Infection Rate

The downy mildew infection rate is shown in Table 4.

Treatment	Downy Mildew Infection Rate (plants/week)					
	1	2	3	4	5	6
	WAI	WAI	WAI	WAI	WAI	WAI
	----- (plants/week) -----					
F0A1	0	0	-2.02	0.92	0.25	0.15
F0A2	0	0	-1.73	0.64	0.09	0.08
F0A3	0	0	-1.73	0.64	0.17	0.08
F1A1	0	0	-1.49	0.65	0.15	0.07
F1A2	0	0	-1.61	0.68	0.16	0.15
F1A3	0	0	-1.73	0.64	0.25	0.15
F2A1	0	0	-1.38	0.62	0.15	0.21
F2A2	0	0	-1.28	0.52	0.08	0.22
F2A3	0	0	-1.38	0.54	0.08	0.22
F3A1	0	0	-1.73	0.72	0.16	0.15
F3A2	0	0	-1.61	0.51	0.25	0.08
F3A3	0	0	-1.49	0.4	0.25	0.08
F4A1	0	0	-1.61	0.68	0.08	0.08
F4A2	0	0	-1.49	0.4	0.25	0.08
F4A3	0	0	-1.73	0.54	0.26	0.08

Table 4. The Rate of Downy Mildew Disease Infection in Paramita F1 (F0 (Control), F1 (Metalaxyl), F2 (Dimetomorph), F3 (Chlororotalonil+Oxathiapripolin), dan F4 (Fenamidone), WAI: Weeks After Inoculation)

The infection rate starts at 3 WAI (Weeks After Inoculation) because the plants begin to show symptoms of downy mildew 3 weeks after inoculation. The downy mildew infection rate in the third week is the lowest, with values ranging from -1.28 to -2.02 plants/week. The disease infection rate at 3 WAI is negative because there was no disease incidence in the previous week, so the disease infection rate in the first week of the disease can be negative. The highest disease infection rate occurs in the fourth week after inoculation, with a value ranging from 0.40 plants/week to 0.92 plants/week, then decreases in the fifth week after inoculation, with a value ranging from 0.08 plants/week to 0.26 plants/week. The rate of downy mildew infection in Paramita F1 is quite low, according to the research of Pajrin et al. (2013), which found that the Paramita variety has the lowest infection rate (7.96% per week) compared to the Bonanza variety (14.80% per week) and Kumala (11.36% per week). The infection rate is influenced by the incidence and intensity of the disease. Ulhaq and Masnilah (2019) stated that the higher the incidence and intensity of the disease, the higher the disease

infection rate. Likewise, if the incidence and intensity of the disease are low, the disease infection rate will also be low.

Area Under The Disease Progress Curve (AUDPC)

Area Under the Disease Progress Curve of downy mildew can be seen in Table 5.

Treatment	AUDPC	Category
F0A1	83.35	Resistant
F0A2	80.85	Resistant
F0A3	83.3	Resistant
F1A1	99.1	Resistant
F1A2	94.2	Resistant
F1A3	86.65	Resistant
F2A1	106.7	Somewhat Resistant
F2A2	105.85	Somewhat Resistant
F2A3	100.05	Somewhat Resistant
F3A1	88.35	Resistant
F3A2	87.55	Resistant
F3A3	89.15	Resistant
F4A1	90.85	Resistant
F4A2	80.15	Resistant
F4A3	81.6	Resistant

Table 5. Area Under Disease Progress Curve (AUDPC) Value of Downy Mildew Disease in Paramita F1 (F0 (Control), F1 (Metalaxyl), F2 (Dimetomorph), F3 (Chlororotalonil+Oxathiapiprolin), dan F4 (Fenamidone))

The active ingredient treatment and fungicide application method on Paramita F1 are included in the resistant category, except for the active ingredient treatment dimetomorph (F2). This can happen because the plants continue to grow until the fifth week of the observation, as they have good resistance and do not die. Plants with dimetomorph treatment (F2) showed lower resistance compared to other active-ingredient treatments, allegedly because the fungicide dose was insufficient to overcome downy mildew in Paramita F1, thereby reducing the effectiveness of disease control. The AUDPC value in this study ranged from 80.15 to 99.10 for the resistant category and 100.05 to 106.70 for the somewhat resistant category. The AUDPC value denotes the disease resistance category in the study by Kalqunty et al. (2020), where AUDPC values in the range of 0-100 are resistant, and 100-600 are somewhat resistant. The treatment of active ingredients and the method of fungicide application did not significantly affect the AUDPC value. This is because the Paramita F1 variety has a fairly good level of resistance to downy mildew compared to several other varieties, such as Bonanza and Kumala, so the application of active fungicide ingredients is unlikely to have a significant effect on the AUDPC value (Kumi et al., 2019). The research environment has soil that absorbs water too quickly and low water holding capacity is also another factor that causes the treatment to show no significant effect on the AUDPC value.

Chlorophyll Content

The chlorophyll content in corn plants can be seen in the table 6.

Active Ingredi ents	Application Method						Average	
	Seed Treatment		spraying		Seed Treatment + spraying			
	3	5	3	5	3	5	3	5
	WAP		WAP		WAP		WAP	
	----- (mg/g) -----							
Control	1.87	1.41	2.07	1.31	1.96	1.28	1.97	1.33 ^a
Metalaxyl	1.77	1.35	2.04	1.32	1.51	1.17	1.77	1.28 ^a _b
Dimetomorph	1.46	1.16	1.72	1.15	1.77	1.11	1.65	1.14 ^c
Oxathiapi prolin	1.83	1.25	1.87	1.34	2.08	1.34	1.93	1.31 ^a _b
Phenamid one	1.82	1.22	1.84	1.08	2.2	1.27	1.95	1.19 ^b _c
Average	5.25	1.28	1.75	1.24	1.9	1.23		
F-value							3.34 ⁿ _s	4.23 [*]

“ns” stand for not significant according to the F-test

“*” stand for significant according to the F-test

Different superscripts in the same column indicate significant differences (P<0.05)

Table 6. Total Chlorophyll Content in Corn Plants Paramita F1 (WAP: Weeks After Planting)

The total chlorophyll content in Paramita F1 corn plants at 3 WAP (Weeks After Planting) ranged from 1.46 to 2.20 mg/g, and at 5 WAP, from 1.14 to 1.33 mg/g. This chlorophyll content is relatively low because the chlorophyll content in normal corn leaves averages 2.44 mg/g, while the chlorophyll content in high corn leaves can reach 3.60 mg/g (Pan et al., 2024). This low chlorophyll content is thought to occur due to environmental conditions that are less supportive of corn plant growth, namely the planting medium used is soil that absorbs water very quickly and has a low water retention capacity. These conditions reduce water availability and affect chlorophyll content, as in the study by Siaga et al. (2019), where water scarcity decreases the rate of photosynthesis and inhibits chlorophyll synthesis. Another study by Hazrati et al. (2016) also reported that water scarcity increases chlorophyll degradation.

The total chlorophyll content of plants aged 3 WAP was higher than that of 5 WAP because, at 5 WAP, the plants had begun to enter the generative phase. These results are in accordance with the research of Dharmadewi (2020) which states that the age and physiological stages of a plant can be factors that determine chlorophyll content. The chlorophyll content of plants is influenced by plant age, leaf morphology, and environmental factors. The treatment of active ingredients and the method of fungicide application did not significantly affect the total chlorophyll content of plants aged 3 WAP that were affected by downy mildew, which began at 2 WAP. The treatment of active ingredients had a significant effect on the chlorophyll content at the age of 5 WAP, allegedly because downy mildew infections began to decrease at the age of 5 WAP as shown by the calculation of the infection rate, so that the effect of administering active fungicide ingredients can be seen.

Plants Height

The height of the corn plants can be seen in the table 7.

Active Ingredients	Application Method			Avera ge
	Seed treatme nt	Sprayi ng	Seed treatme nt +	

	sprayin g			
	(cm) -----			
Control	47.73	37.5	48.43	44.55
Metalaxyl	39.63	44.00	32.63	38.75
Dimetomorph	42.10	39.77	50.60	44.16
Oxathiapiropoli n	53.97	38.93	49.70	47.53
Phenamidone	39.47	39.3	48.10	42.29
Average	44.58	39.9	45.89	

Table 7. Height of Corn Plants Paramita F1

The height of maize over the five weeks of planting ranged from 32.63 to 50.60 cm. The observed plants were considered dwarf because their height was less than the typical height of corn plants. The description of the Paramita F1 shows that maize can grow up to 2 m high, as well as in the study of A'yunita et al. (2023) that corn plants aged 5 WAP generally have a height of more than 50 cm; the study of Assidik et al. (2021) also showed that glutinous maize aged 5 WAP had an average height of more than 50 cm. The treatment of active ingredients and the method of fungicide application did not affect plant height due to external factors, as all maize plants were from the same variety and thus had the same genotype. The study by Yulina et al. (2021) showed that plant height among plants of the same genotype differed due to external factors. External factors, such as soil conditions that absorb water too quickly and have low water-holding capacity, cause suboptimal plant growth; in addition, downy mildew, which infects plants, also causes stunted plants. This is because downy mildew pathogens, which are obligate parasites, utilize plant nutrients, causing abnormal plant growth (Tanzil and Purnomo, 2021; Pakki, 2017).

Number of Leaves

The number of corn leaves can be seen in the table 8.

	Application Method			
Active Ingredients	Seed treatme nt	sprayi ng	Seed treatme nt + sprayin g	Avera ge
	(leaf blade) -----			
Control	6.67	7.2	6.67	6.84
Metalaxyl	7.00	6.40	5.33	6.24
Dimetomorph	6.60	5.90	6.80	6.43
Oxathiapiropoli n	7.67	5.73	7.93	7.11
Phenamidone	7.47	5.80	6.93	6.73
Average	7.08	6.21	6.73	

Table 8. Number of Leaves of Corn Plants Paramita F1

The average number of leaves observed in maize plants ranged from 5.33 to 7.93. This number of leaves is relatively small compared with the normal number for maize, which is 10 to 18 (Subekti et al., 2007). This small number of leaves is due to the plant's stunted height. The number of plant leaves is correlated with plant height, as in the study of Kustyorini et al. (2020) which showed that the taller the plant, the greater the number of segments and leaves. The treatment did not significantly affect the number of leaves due to environmental factors. The

environment used for the study had soil that absorbed water too quickly and had a low water-holding capacity, so the plant's nutritional needs were not met properly, which supported the development of downy mildew. Downy mildew, which infects plants, also disrupts photosynthesis. Research by Pajrin et al. (2013) reported that downy mildew damages chloroplasts in leaves, producing yellow or chlorotic lines that disrupt photosynthesis and affect plant growth. Future studies using larger sample sizes are needed to confirm these findings and increase the ability to detect potential treatment effects.

Wet Weight and Dry Weight of Plants

Wet weight and dry weight of corn plants can be seen in the table 9.

		Application Method			
Parameter	Active Ingredients	Seed treatme nt	sprayi ng	Seed treatme nt + sprayin g	Avera ge
		(gram) -----			
Wet Weight	Control	86.83	157.93	75.79	320.55
	Metalaxyl	269.5	62.1	23.88	355.48
	Dimetomorp h	50.33	42.36	133.96	226.65
	Oxathiapipro lin	135.05	38.78	158.33	332.16
	Phenamidon e	48.13	37.45	45.06	130.64
	Average	589.84	338.62	437.02	
Dry Weight	Control	42.93	72.51	37.41	50.95
	Metalaxyl	134.48	29.8	12.08	58.79
	Dimetomorp h	25.53	21.35	64.7	37.19
	Oxathiapipro lin	65.78	19.45	77.47	54.23
	Phenamidon e	23.67	18.35	22.6	21.54
	Average	58.48	32.29	42.85	

Table 9. Wet Weight and Dry Weight of Corn Plants Paramita F1

The average wet weight of the maize ranged from 37.45 to 269.50 grams, while the dry weight of the maize ranged from 12.08 to 134.48 grams. The wet weight of the maize is correlated with its dry weight; the greater the wet weight, the greater the dry weight. The observed wet weight of the maize was lower than the normal range of 376-432 grams (Lestari et al., 2020). The weight of the plant is also correlated with the plant's height and number of leaves. Research by Puspadewi et al. (2016) stated that the taller the plant and the more leaves, the plant will absorb more sunlight, so that the photosynthesis process will run better and produce more carbohydrates and proteins that will be distributed to all parts of the plant so that the weight of the plant will increase. The treatment of active ingredients and the method of fungicide application did not affect maize plant weight, either wet or dry. This is because environmental conditions with soil that absorbs water too quickly and has a low water-holding capacity are not optimal for supporting plant growth, so downy mildew develops more easily, and the treatment has no effect. The absence of significant differences in plant fresh weight may be related to the limited sample size. Therefore, future studies should include a larger number of samples and

replicates to obtain more accurate results and improve the detection of treatment effects.

Conclusion:

The conclusion of this study is that the treatment of several active ingredients and application methods can slow down the incubation period of the disease and reduce the AUDPC value but has not been able to reduce the incidence, intensity and rate of infection of the disease.

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