



## RESEARCH ARTICLE

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# Germination Response of Fruit and Pod Vegetable Seeds Using Cow Manure Liquid Organic Fertilizer

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## Abstract

The early growth of chilli peppers, long beans, green beans, and okra is often constrained by limited nutrient availability and a heavy reliance on chemical fertilizers, underscoring the need for effective, environmentally friendly organic liquid fertilizers. This study investigated the effects and optimal concentration of M2 (Panchagavya) liquid fertilizer on the early growth of these crops. M2 contains beneficial microbes, natural plant hormones, and essential nutrients that promote seed germination and root development. The fertilizer was prepared by fermenting organic matter for 30 days and tested in both laboratory (petri dish) and field experiments at six concentrations (0-5%) with three replications. Observed parameters included germination rate, root length, fresh and dry weight, pH, and electrical conductivity (EC), which were analyzed using ANOVA. The results of this study indicate that M2 (Panchagavya) liquid fertilizer significantly enhances the early growth of chili peppers, long beans, green beans, and okra, improving germination rate, root length, and both fresh and dry biomass. M2 promotes root elongation and dry biomass accumulation through its beneficial microbes, natural plant hormones, and essential nutrients, thereby facilitating seedling germination and preparing young plants for efficient nutrient uptake. Optimal M2 concentrations vary by species: 1-2% for green beans and kale, and 4-5% for chillies and okra. This fertilizer is organic and environmentally friendly, reducing reliance on chemical fertilizers. It is recommended that users apply M2 at species-specific concentrations, particularly during germination and early vegetative growth stages, ensure a 30-day fermentation process to maintain fertilizer quality, and monitor plant growth to adjust dosages as needed.

**Keywords:** Chilli, Green Beans, Liquid Fertilizer, Long Beans, Okra

## 1. Introduction

Early plant growth is significantly influenced by successful germination, which determines seed vigour and growth potential and ultimately impacts crop yield. Germination success depends on the seed's physiological condition and on environmental factors such as water availability, temperature, light, and nutrient content in the growing medium (Sudirman Numba et al., 2024). To enhance germination, seeds are often soaked in nutrient-rich solutions or liquid fertilizers before planting.

Chemical fertilizers such as urea, KCl, and superphosphate have been used to increase productivity, but excessive use can degrade soil quality and damage ecosystems (Sutedjo, 2019). An environmentally friendly alternative, liquid organic fertilizer (POC), is produced by

fermenting natural materials such as vegetable waste and livestock manure. POC contains macronutrients (N, P, K), micronutrients (Ca, Mg, Fe), and beneficial microorganisms such as *Azotobacter* and *Lactobacillus*, which improve soil structure and nutrient availability (Fitriyani et al., 2023). The liquid form of POC facilitates application and absorption by seeds and young roots.

Seed germination is a critical phase in the plant life cycle, crucial for early growth vigor and success. One widely used approach to improving germination performance is seed priming, a pre-planting treatment that controls hydration and activates early physiological and biochemical processes without triggering radicle extrusion. This technique is known to increase germination rate and uniformity by enhancing respiration, activating enzymes,

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mobilizing food reserves, and repairing cell membranes (Fu *et al.*, 2024). Furthermore, seed priming also increases seed tolerance to environmental stress by inducing antioxidant activity and balancing growth hormones, such as abscisic acid and gibberellins (Rhaman, 2025).

A further development of the priming technique is biopriming, a combination of hydration treatment with beneficial microorganisms. Biopriming has been shown to increase seed germination and vigour by promoting microbial colonization of the seed surface, which functions as a growth promoter, nutrient provider, and protector against soil-borne pathogens (Fu *et al.*, 2024). In this context, liquid organic fertilizer (POC) has the potential to act as a natural priming agent, as it contains macro- and micronutrients, bioactive compounds, and microorganisms that can support initial seed metabolism. Application of POC in the early growth phase is thought to accelerate radicle emergence and increase the vigor index through mechanisms that align with the principles of nutrient priming and biostimulant application to seeds (Rhaman, 2025).

Although various studies have reported the effectiveness of seed priming and biopriming in enhancing germination and early plant growth, studies specifically evaluating the germination response to varying concentrations of POC across plant species remain limited. Therefore, research on the dose-response relationship of POC during the germination phase is crucial to determine the optimal concentration that can increase germination and seed vigor without causing inhibitory effects.

The results of the research by Barus *et al.* (2020) found that the administration of gamal leaf POC did not have a significant effect on all growth parameters and radish plant yield, *yes sis*. The study entitled “Growth and Yield Characters of Radish Plants (*Raphanus sativus* L.) on the Application of Tofu Dregs and Gamal Leaf POC” used a factorial randomized block design. The treatments included the administration of tofu dregs (0, 150, 300, and 450 g/polybag) and gamal leaf POC (0, 60, 120, and 180 ml/l). From this study, tofu dregs were shown to have a significant effect on plant height, number of leaves, tuber diameter, tuber weight per plant, and tuber weight per plot, *yes sis*. However, gamal leaf POC and its interaction did not have a significant effect on all observed parameters (Barus *et al.*, 2020).

The results of Khair *et al.*'s research also show that providing chicken manure and POC affects the growth and production of corn plants, *yes, sis*. In the study entitled “Growth and Production Response of Corn (*Zea mays* L.) to the Provision of Chicken Manure and Liquid Organic Fertilizer Plus” which used a factorial Randomized Block Design, the treatments included chicken manure (0, 1.5, and 3 kg/plot) and POC plus Bintang Kuda Laut (0, 3, 6, and 9 ml/l). The combination of these treatments had a significant effect on the cob and seed components (Khair *et*

*al.*, nd).

Germination and early plant growth, as indicated by accelerated radicle emergence and increased vigour index in several vegetable commodities, such as mustard greens, red chillies, and tomatoes (Sudirman Numba *et al.*, 2024). However, these studies generally focused on the overall effects of POC, with limited concentration variation and coverage of only certain plant species. Unlike previous studies, this study focuses on testing the germination response to varying POC concentrations across different types of vegetables and fruits. This approach allows for a more comprehensive analysis of the POC dose-response relationship, including identifying the optimal concentration that can positively influence germination without causing an inhibitory effect. Thus, this study not only expands the scope of plant types studied but also provides more in-depth information on the effectiveness and limitations of POC use, and is expected to contribute to the development of more specific and applicable POC application recommendations for plant cultivation practices. Previous studies have shown that POC can increase germination rate and early plant growth, such as in green mustard, red chilli, and tomatoes, by accelerating radicle emergence and increasing the vigour index (Alim *et al.*, 2025; Machado *et al.*, 2023). However, studies on the germination response to varying POC concentrations across different types of vegetables and fruits are still limited.

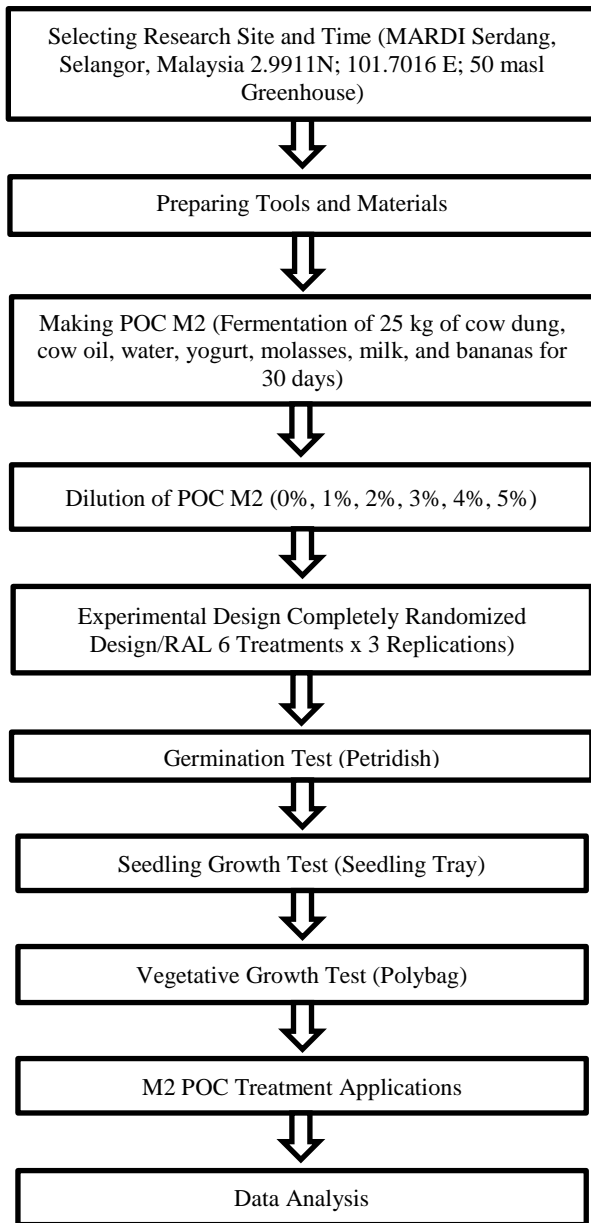
This study aimed to assess the effect of POC on germination percentage and rate, and to determine the optimal concentration during the seedling phase. The experimental method employed was a Completely Randomized Design (CRD), measuring radicle emergence time, germination rate, and seed vigour index. The results are expected to contribute to the development of sustainable plant propagation technologies and to promote the use of POC as an alternative to chemical fertilizers during the early growth stages.

## 2. Material and Methods

This research was conducted at the *Malaysian Agriculture Research and Development* (MARDI) Industrial Crops Research Center, Serdang, Selangor, Malaysia, at coordinates 2.9911°N, 101.7016°E, 50 masl in the Greenhouse starting from September 22 to October 10, the implementation of this research began with the preparation of media and materials, the Research Implementation was carried out for two months and ended with Observation, using a Completely Randomized Design (CRD) with six concentrations of POC M2 (0%, 1%, 2%, 3%, 4%, 5%) and three replications. POC M2 was made from the fermentation of a mixture of 25 kg of cow dung, cow oil, water, yoghurt, molasses, milk, and banana for 30 days. The fermented solution was diluted according to the treatment concentration. The research was conducted in three stages: a germination test (petri dish), a seedling

growth test (seedling tray), and a vegetative growth test (polybag).

### 2.1. Flow diagram



**Figure 1.** Research flow diagram

### 2.2. Germination Test (Petri Dish)

Germination was tested on peat moss media in petri dishes, each containing 15 seeds and 45 mL of POC M2 solution according to the treatment, administered once for seven days. The number of germinated seeds was recorded daily, and on the seventh day, root length, shoot length, fresh weight, and dry weight were measured. The germination percentage was calculated as the number of germinated seeds divided by the total number of seeds.

### 2.3. Initial Growth Test (Seedling Tray)

The experiment was conducted using a mixture of rice husks (60%) and soil (40%) in a 25-hole tray, with one seed per hole. The M2 POC solution was applied every 7 days (60–300 mL at 1–5% concentration). Parameters measured included root length, shoot length, number of leaves, fresh weight, and dry weight of the seedlings.

### 2.4. Vegetative Growth Test (Polybag)

The experiments were carried out in 1-kg polybags containing a mixture of soil and rice husks, planted with chillies, long beans, winged beans, and okra. POC M2 was administered every 7 days as per the treatment. Observations included root length, shoot length, number of leaves, fresh and dry weight, chlorophyll content, and germination rate (specifically for chillies). The pH and EC of the solution were measured.

### 2.5. Research Data Analysis

The data were statistically analyzed using the Analysis of Variance (ANOVA) procedure in SAS (Version 9.2; SAS Institute, Cary, NC, USA) to test the significance of all studied variables. The mean and Standard Deviation (SD) of the replicates were determined using Analysis of Variance (ANOVA), and Duncan's Multiple Range Test (DMRT) was used to determine significant differences between treatments. The statistical significance level was set at 0.05 for all tests.

## 3. Results and Discussion

### 3.1. Laboratory Test (Petri Dish)

Analysis using a completely randomized design showed that the concentration of POC M2 had no significant effect on germination rate, root length, fresh weight, or dry weight of chilli seedlings during the early growth phase. The germination rate remained relatively stable, indicating the seedlings' tolerance to nutritional variations and the absence of phytotoxic effects. Additionally, root length and fresh weight did not differ significantly, as endosperm reserves primarily influence early growth.

Although not statistically significant, the 4% M2 treatment tended to increase dry weight, suggesting that medium concentrations support biomass accumulation and seedling metabolic activity through organic nutrients and natural hormones. Too low a concentration provides insufficient additional nutrients, while high concentrations can increase electrical conductivity (EC) and osmotic pressure. These findings indicate that the effects of M2 POC are more pronounced during later growth stages than in early germination.

### 3.2. Laboratory Test (Petri Dish)

Based on the data, the treatments affected plant growth differently across the parts. For example, in okra,

germination power (DK) increased at 3% and 5% doses, while TT and PA remained relatively stable. Chilli peppers showed an increase in DK at several doses, while long

beans and mung beans also showed specific responses in DK. This pattern indicates that plant responses to treatments are organ- and dose-specific.

**Table 1.** Effect of Liquid Fertilizer Concentration M<sub>2</sub> on Germination Power, Plant Height, Root Length of Okra, Chilli, Long Beans and Green Beans.

Treatment	Okra (DK)	Okra (TT)	Okra (PA)	Chilli (DK)	Chilli (TT)	Chilli (PA)	Long Beans (DK)	long beans (TT)	Long Beans (PA)	long beans (DK)	green beans (TT)	Green Beans (PA)
Control	10.0 ± 0.6	13.4 ± 0.5	6.1 ± 0.3	4 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	14 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	19 ± 0.6	13.6 ± 0.5	19.0 ± 0.6
1%	11 ± 0.6	13.4 ± 0.5	6.1 ± 0.3	6 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	14 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	23 ± 0.6	13.6 ± 0.5	19.0 ± 0.6
2%	10 ± 0.6	13.4 ± 0.5	6.1 ± 0.3	4 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	15 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	22 ± 0.6	13.6 ± 0.5	19.0 ± 0.6
3%	12 ± 0.6	13.4 ± 0.5	6.1 ± 0.3	2 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	11 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	23 ± 0.6	13.6 ± 0.5	19.0 ± 0.6
4%	12 ± 0.6	13.4 ± 0.5	6.1 ± 0.3	6 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	8 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	21 ± 0.6	13.6 ± 0.5	19.0 ± 0.6
5%	14 ± 0.6	13.4 ± 0.5	6.1 ± 0.3	7 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	14 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	22 ± 0.6	13.6 ± 0.5	19.0 ± 0.6

Information: Okra: DK and TT values were relatively stable, but DK increased in the 3% and 5% treatments. PA remained unchanged across all treatments. Chilli: DK tended to increase at 1%, 4%, and 5% treatments; TT remained stable; PA did not change. Long Beans: DK fluctuates, with the highest at 2% (15) and the lowest at 4% (8). TT and PA are stable.

Green Beans: DK increased by 1% - 2% in the 1% - 2% treatments; TT and PA remained the same across all treatments.

This phenomenon is consistent with the Dose-Response Law proposed by Arndt and H.F. Smith (1907), which states that each organism shows a different response to varying stimulus doses or treatments. In addition, the stability of several parameters, such as PA, across various plants indicates the existence of a homeostasis mechanism, a concept first described by Walter Cannon (1932): the ability of organisms to maintain internal balance despite environmental changes.

Variations in response between plant parts can also be explained by the theory of nutrient absorption efficiency, which, according to Marschner (2012), holds that each plant organ has a different ability to absorb and utilize nutrients, allowing growth to increase in certain parts without affecting others. Thus, these data support the

principle that the effect of plant treatment is influenced by dose, plant organ, and the plant's internal capacity to maintain physiological balance.

### 3.3. Field Test (Tray)

Based on the data provided, it appears that certain treatments affect the growth of various plants differently across organs. In okra, 1% - 5% treatment affected germination power (DK), fresh weight (WW), and dry weight (DW) values in various ways. For example, DK of okra increased in the 5% treatment (78) compared to the control (70), and WW and DW also showed increases at certain doses. Meanwhile, the TT of okra was relatively stable despite slight fluctuations. This Observation indicates that the treatment response is organ-specific.

**Table 2.** Effect of liquid fertilizer concentration M<sub>2</sub> on germination power, plant height, wet weight, and dry weight

Treatment	Okra (DK)	Okra (TT)	Okra (BB)	Okra (BK)	Chilli (DK)	Chilli (TT)	Chilli (BB)	Chilli (BK)	Long Beans (DK)	long beans (TT)	long beans (BB)	Long Beans (BK)	long beans (DK)	green beans (TT)	green beans (BB)	Green Beans (BK)
Control	70 ± 2.0	2.6 ± 0.3	15.41 ± 0.05	0.351 ± 0.05	85 ± 2.0	2.0 ± 0.3	18.48 ± 0.08	0.73 ± 0.08	86 ± 2.0	18 ± 1.0	18.48 ± 0.5	0.73 ± 0.08	100 ± 3.0	10.7 ± 0.6	3,798 ± 0.4	0.463 ± 0.06
1%	72 ± 2.0	1.5 ± 0.3	16.22 ± 0.05	0.34 ± 0.05	80 ± 2.0	1.1 ± 0.2	19.74 ± 0.6	1.02 ± 0.1	88 ± 2.0	21 ± 1.0	19.74 ± 0.6	1.02 ± 0.1	88 ± 3.0	13.6 ± 0.7	3,950 ± 0.4	0.510 ± 0.07
2%	65 ± 2.0	1.6 ± 0.4	15.28 ± 0.04	0.27 ± 0.04	88 ± 2.0	2.0 ± 0.3	18.66 ± 0.08	0.74 ± 0.08	75 ± 2.0	11 ± 0.6	18.66 ± 0.5	0.74 ± 0.08	90 ± 3.0	11.3 ± 0.6	3,400 ± 0.3	0.420 ± 0.06
3%	68 ± 2.0	2.3 ± 0.4	15.33 ± 0.03	0.19 ± 0.03	70 ± 2.0	0.8 ± 0.2	18.12 ± 0.4	0.42 ± 0.05	40 ± 1.5	4 ± 0.5	18.12 ± 0.4	0.42 ± 0.05	12 ± 1.0	4.0 ± 0.5	2,100 ± 0.2	0.250 ± 0.04
4%	70 ± 2.0	1.8 ± 0.3	16.65 ± 0.05	0.34 ± 0.05	75 ± 2.0	1.1 ± 0.2	17.65 ± 0.4	0.47 ± 0.05	45 ± 1.5	5 ± 0.5	17.65 ± 0.4	0.47 ± 0.05	15 ± 1.0	5.0 ± 0.5	2,300 ± 0.2	0.270 ± 0.04
5%	78 ± 2.0	6.1 ± 1.0	16.68 ± 0.06	0.42 ± 0.06	75 ± 2.0	1.3 ± 0.2	19.79 ± 0.6	0.87 ± 0.09	80 ± 2.0	17 ± 0.6	19.79 ± 0.6	0.87 ± 0.09	95 ± 3.0	13.4 ± 0.7	3,950 ± 0.4	0.510 ± 0.07

Information: Treatment: Shows the concentration of the treatment applied to plants, from control (no treatment) to 5%. DK (Germination Power): Indicates the plant's weight or growth value. TT (Plant Height): Indicates the growth of fresh or wet leaf parts. BB (Wet Weight): Shows the plant's weight in a fresh state after harvest, still containing water. BK (Dry Weight): Shows the growth of plant weight after being dried to a constant weight, does not contain water and shows the pure biomass of the plant.

In chilli peppers, DK values decreased in some treatments (e.g., 3%: 70), while BB values increased at 1%

and 5% doses, indicating a complex interaction between dose and plant organ. TT and DM tended to remain stable,

reinforcing the concept of plant organ homeostasis, in which some parts maintain stability despite environmental or treatment changes.

Long beans showed significant fluctuations in DK, with a drastic decrease in the 3% (40%) treatment, while BB and DM were relatively stable. This finding confirms that plant responses to treatments are not always linear, as predicted by the dose-response principle. Some plant organs are more sensitive to certain doses, while others are unaffected.

Mung beans also showed a similar pattern: DK increased at doses of 1% and 5%, while TT, BB, and DM were relatively stable. Based on the data obtained, the treatments given affected plant growth in different patterns across organs. In okra, dry leaves and stems showed increased growth at certain doses, while fresh leaves were relatively stable, indicating an organ-specific plant response. In chilli, several doses decreased growth of keng power, but fresh weight remained relatively unchanged, indicating the presence of an internal adjustment mechanism, or homeostasis, that maintains the stability of

certain organs, as explained by Walter Cannon (1932) regarding the ability of organisms to maintain internal balance.

Long beans showed significant fluctuations in germination rate, while other parts remained stable; mung beans showed increased germination growth at certain doses, but other organs were relatively unaffected. This pattern confirms that plant responses to treatments are not always linear; some doses can stimulate the growth of certain organs, while other doses are less effective or even reduce growth, in accordance with the Dose-Response Law of Arndt and H.F. Smith (1907).

Furthermore, variations in response between organs can be explained by differences in nutrient absorption and utilization capacity in each organ, as described by Marschner (2012) in the theory of plant nutrient efficiency. Overall, these data indicate that treatment effects are influenced by dose, plant species, and the organ being studied, with some organs being sensitive to the treatment, while others maintain stability through internal mechanisms.

**Table 3.** Comparison of Vegetative Growth and Germination Rate in Various Types of Plants

Treatment	Okra (DK)	Okra (TT)	Okra (PA)	Chilli (DK)	Chilli (TT)	Chilli (PA)	Long Beans (DK)	long beans (TT)	Long Beans (PA)	long beans (DK)	green beans (TT)	Green Beans (PA)
Control	10 ± 0.6	13.4 ± 0.5	6.1 ± 0.5	4 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	14 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	19 ± 1.0	13.6 ± 0.5	19.0 ± 0.6
1%	11 ± 0.6	13.4 ± 0.5	6.1 ± 0.5	6 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	14 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	23 ± 1.0	13.6 ± 0.5	19.0 ± 0.6
2%	10 ± 0.6	13.4 ± 0.5	6.1 ± 0.5	4 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	15 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	22 ± 1.0	13.6 ± 0.5	19.0 ± 0.6
3%	12 ± 0.6	13.4 ± 0.5	6.1 ± 0.5	2 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	11 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	23 ± 1.0	13.6 ± 0.5	19.0 ± 0.6
4%	12 ± 0.6	13.4 ± 0.5	6.1 ± 0.5	6 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	8 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	21 ± 1.0	13.6 ± 0.5	19.0 ± 0.6
5%	14 ± 0.6	13.4 ± 0.5	6.1 ± 0.5	7 ± 0.6	9.0 ± 0.5	2.0 ± 0.3	14 ± 0.6	11.3 ± 0.5	17.0 ± 0.6	22 ± 1.0	13.6 ± 0.5	19.0 ± 0.6
Data Vegetative	11.2 ± 0.7	13.4 ± 0.5	12.5 ± 0.6	7.5 ± 0.6	9.0 ± 0.5	8.0 ± 0.5	9.2 ± 0.5	11.3 ± 0.5	12.0 ± 0.6	10.7 ± 0.6	13.6 ± 0.5	12.3 ± 0.6

Information: Treatment: Shows the concentration of fertilizer applied to plants, from control (no treatment) to 5%. DK (Germination Power): The percentage of seeds that successfully germinate. TT (Plant Height): Plant height measured during the vegetative phase (cm). PA (Root Length): The length of the plant root measured at the end of the Observation (cm). Data are presented as mean ± standard deviation.

Tray test observations revealed differences in response between plants to the treatments. Okra exhibited the best growth, with the longest roots and shoots, the highest number of leaves, and the largest leaf area (30.2 cm<sup>2</sup>). Mung beans grew well with the highest germination rate (100%) and stable dry weight, while long beans showed moderate growth. Conversely, chilli peppers exhibited the lowest growth across all vegetative and germination parameters. These results confirm that the treatments significantly influenced the initial growth and germination ability of each plant.

Observations from the tray test showed that each plant responded differently to the M2 POC treatment. Okra showed the best performance with the longest roots and shoots, the highest number of leaves, and the largest leaf area (30.2 cm<sup>2</sup>). Mung beans had the highest germination rate (100%) and stable dry weight, while long beans showed moderate growth. Conversely, chilli peppers

showed the lowest growth in all vegetative parameters and in germination rate. This result confirms that the M2 treatment variation has different effects on the germination ability and initial growth of each plant type.

M2 (Panchagavya) liquid organic fertilizer works through a combination of active microorganisms, macro-micronutrients, and natural phytohormones (auxins, cytokinins, gibberellins) produced through fermentation. These compounds enhance seedling vigour, soil microbial activity, and nutrient absorption (Pratiwi et al., 2021; Amalia & Fathurrahman F, 2024). Research results from petri dish and tray tests indicate that plant response is largely determined by each plant's physiological characteristics and tolerance to M2 concentration.

Chilli peppers respond best to a 4% concentration, which increases seedling dry weight. Doses above 4% reduce growth due to high EC and TDS, which trigger osmotic stress.

Long beans exhibit optimum growth at concentrations of 1–2%, as indicated by increased root length, dry weight, and germination rate. Higher concentrations reduce growth due to salt accumulation, which inhibits water absorption.

Bottle beans (winged beans) exhibit a response pattern similar to that of long beans, with optimal growth at 1–2% M2. Fermentative microbes, such as *Lactobacillus* and *Actinomycetes*, promote root formation by producing IAA and GA, but high concentrations ( $\geq 3\%$ ) reduce growth due to increased EC.

Okra exhibits high tolerance to M2 concentrations, with the best yield at 5%. Its fibrous root system can utilize high nutrient concentrations without experiencing salinity stress, resulting in significantly increased root, leaf, and biomass growth.

pH and EC measurements showed that increasing M2 concentrations lowered the pH to slightly acidic (4.8–5.0) and significantly increased EC. Legumes were more sensitive to high EC, while chillies and okra could utilize acidic conditions for the absorption of micronutrients such as Fe and Zn (Haryuni et al., 2025).

Overall, M2 had a significant effect on the initial

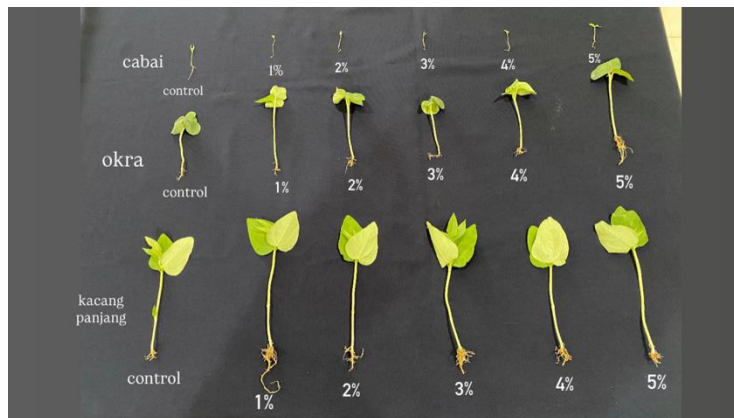
growth of four types of vegetables with different optimum concentrations:

Long beans and winged beans: 1–2%

Chilli and okra: 4–5%

These findings confirm that M2 use should be adjusted to the plant's physiological characteristics to enhance initial growth, strengthen the root system, and maximize vegetative biomass production without causing physiological stress.

The yields of Chilli, Long Beans, Mung Beans, and Okra differed significantly (ANOVA: F count = 10.81 > F table = 4.07;  $\alpha = 5\%$ ), indicating that plant type influences productivity. Each plant responds to different concentrations of liquid organic fertilizer; legumes are more sensitive to salinity and therefore optimal at low concentrations, while fruit plants require medium-high concentrations to support vegetative growth and flowering (Riska Febri Amalia & Fathurrahman F, 2024). In addition to increasing initial growth, liquid organic fertilizer is environmentally friendly, reduces reliance on chemical fertilizers, improves the structure of the planting medium, and supports soil microbial activity.



**Figure 2.** Initial growth of chilli, okra, and long bean seedlings at various concentrations of liquid organic fertilizer (control, 1–5%) in the germination phase.



**Figure 3.** Initial growth of mung bean seedlings at various concentrations of liquid organic fertilizer (control, 1–5%) in the germination phase.

#### 4. Conclusion

This study demonstrates that M2 (Panchagavya) liquid organic fertilizer enhances early growth and vigour of chilli, long bean, mung bean, and okra seedlings. Optimal concentrations vary by crop: chilli and okra perform best at 4–5%, while long bean and mung bean perform best at 1–2%. M2 is environmentally friendly and has the potential to serve as an alternative organic fertilizer, supporting sustainable agriculture. Maintaining a 30-day fermentation

period is essential to preserve its quality.

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