POSITIVE INFLUENCE OF VERMICOMPOST RATES AND HB101 PLANT VITALIZER ON GROWTH AND YIELD OF BUSH - TYPE COMMON BEAN

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ABSTRACT

The combined use of organic fertilizers and foliar applications is increasingly recognized as a strategy to enhance early crop growth and yield. The field experiment was conducted to determine the effects of vermicompost rates and spraying frequency of HB101 plant vitalizer on the growth and yield of bush-type common bean. The two - factor experiment was designed using a randomized complete block design (RCBD). Vermicompost was applied at three levels of 4, 8 and 12 tons ha^{-1}. The treatments of HB101 spraying were: H0 (water spraying – as control), H1 (spraying at 5-day intervals), H2 (spraying at 10-day intervals). The results showed that increasing vermicompost rates led to increased plant growth and yield traits. Application of 12 tons ha^{-1} of vermicompost produced the highest values of LAI, SPAD, dry weight, pod number, pod weight, pod weight per plant, pod yield of bean. Spraying HB101 positively affected the growth indicators, physiological traits and yield parameters, which were statistically higher than those of the control treatment. Combination of 12 tons ha^{-1} of vermicompost with spraying HB101 at 5-day or 10-day intervals resulted in better plant performance, with comparable pod yield being 5.12 and 4.61 tons ha^{-1}.

Keywords: *Bush-type common bean, vermicompost, plant vitalizer, pod yield.*

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1. INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) is a widely cultivated species globally and in Vietnam. Beans are rich in protein, minerals, fiber, energy, and vitamins, making them a viable meat substitute in underdeveloped and developing countries [1]. The bush-type common bean is a new variety with high adaptability to Vietnam climate and a yield potential comparable to that of climbing bean varieties. However, until now, research on cultivation techniques for this bean kind is still limited.

Organic fertilizers - particularly vermicompost - have been proven effective in enhancing crop yields and minimizing adverse environmental impacts. Vermicompost contains a balanced amount of macronutrients and micronutrients, which are easily absorbed by plants. They also contain a diverse microbial system, plant hormones and growth-regulating compounds, that improve soil quality, stimulate plant growth and enhance crop yields [2, 3]. However, vermicompost, as other organic fertilizers, typically act slowly due to the slow mineralization, making it necessary to combine with foliar fertilizers at the early stages of plant growth. Foliar fertilization enables nutrients to be absorbed directly through the leaf surface, resulting in higher nutrient-use efficiency, particularly under nutrient-poor soil conditions [4]. Dang *et al.* (2025) [5] concluded that combining organic fertilization with foliar application positively impacts the soil quality and plant growth, decreases the physiological disorders in durian, contributing to improving durian production. HB101 is a natural organic solution extracted from cedars, cypress, pines, and plantain plants, acting as both a nutritional source and a plant vitalizer for crops. Some previous studies concluded HB101 solution being effective in promoting plant growth and yield, such as potato [6], red cabbage [7].

However, the effectiveness of combining basal organic fertilizers with foliar plant vitalizers varies depending on the crops, cultivars, and the ecological conditions of the research area. This study was conducted to determine the optimal amount of vermicompost combined with HB101 foliar application for bush-type common bean under the cultivation conditions in Gia Lam, Ha Noi city.

2. MATERIALS AND RESEARCH METHODS

The two-factor field experiment was conducted on VA.007 bush-type common bean variety in spring-summer season of 2022 in Gia Lam, Ha Noi city. The experiment was arranged using a randomized complete block design (RCBD) with three replications, with an experimental plot of 7 m^2. The first factor was vermicompost with three rates: T1 - 4 tons ha^{-1}, T2 - 8 tons ha^{-1}, and T3 - 12 tons ha^{-1}. The second factor was the frequency of HB101 spraying, with three treatments: H0 - water spraying (control), H1 - spraying HB101 at 5-day intervals, and H2 - spraying HB101 at 10-day intervals. The used vermicompost contained nutrients of 2.5% N, 1.8% P_2O_5, and 1.4% K_2O. The nutritional components of HB101 plant vitalizer are as follows: 0.1% total protein, pH 4.0, 0.4% total lipids, 41 mg L^{-1} Na, 33 mg L^{-1} Ca, 1.8 mg L^{-1} Fe, 3.3 mg L^{-1} Mg, and 7.4 mg L^{-1} Si.

Seeds were sown at a spacing of 50 cm x 30 cm, with 3 - 4 seeds per hole, and then 2 plants per hole were left at 9 days after sowing (DAS). Vermicompost was applied 10 days before sowing. HB101 solution was diluted at a ratio of 3 drops per L of water, and applied during the experimental period with a rate of 1 L of solution for 1 m^2 of land.

Growth indicators (plant height, aboveground fresh weight (AFW)) and physiological parameters (leaf area index (LAI), SPAD, aboveground dry weight (ADW)) were measured at flowering stage (37 DAS) and at harvesting stage (50 DAS). SPAD index was measured using a chlorophyll meter (SPAD-502, Osaka, Japan). LAI was measured using the formula: LAI = P2/P1 *100* plant number m^{-2}, where P1 is the fresh weight of 1 dm^2 of leaves, P2 is the total fresh weight of leaves on the plant. The aboveground part of plant samples were oven - dried at 80°C until the constant weight for determining ADW. The yield components, including pod number, pod weight, and pod weight per plant, were collected. The actual pod yield was determined as the total pod weight of all plants from each experimental plot.

The data were statistically analyzed using Statistix 8.0 software with analysis of variance (ANOVA) to determine the influence of treatments and their interaction. The least significant difference (LSD) was used to compare the mean values between treatments.

3. RESULTS AND DISCUSSION

3.1. Effects of vermicompost rates and HB101 spraying frequencies on the growth of bush-type common beans

Table 1. Effects of vermicompost rates and HB101 spraying frequencies on growth indicators of bush-type common beans

Vermicompost rates	HB101 spraying frequencies	Plant height (cm)		AFW (g $plant^{-1}$)	
		Flowering stage	Harvesting stage	Flowering stage	Harvesting stage
V1	H0	41.49^{b}	46.67^{b}	33.91^{c}	53.51^{d}
	H1	44.61^{ab}	48.45^{ab}	44.11^{ab}	68.39^{bc}
	H2	44.96^{ab}	49.51^{ab}	41.12^{b}	63.34^{c}
V2	H0	44.85^{ab}	48.41^{ab}	40.03^{bc}	63.40^{c}
	H1	46.63^{a}	50.53^{ab}	43.36^{ab}	70.19^{bc}

	H2	46.11^{a}	51.30^{a}	45.12^{ab}	68.81^{bc}
V3	H0	44.97^{a}	49.61^{ab}	46.40^{ab}	68.83^{bc}
	H1	46.90^{a}	52.13^{a}	49.21^{a}	79.36^{a}
	H2	46.83^{a}	50.83^{a}	46.50^{ab}	74.76^{ab}
Vermicompost rates	V1	43.69^{b}	48.21^{b}	39.71^{b}	61.75^{c}
	V2	45.86^{a}	50.08^{ab}	42.84^{b}	67.47^{b}
	V3	46.23^{a}	50.86^{a}	47.37^{a}	74.32^{a}
HB101 spraying frequencies	H0	43.77^{b}	48.23^{a}	40.11^{b}	61.91^{b}
	H1	46.05^{a}	50.37^{a}	45.56^{a}	72.65^{a}
	H2	45.97^{a}	50.54^{a}	44.25^{a}	68.97^{a}

Note: Values with different letters in the same column of individual or interactive factors indicate significant differences in LSD test at 5% significance level.

The results show the statistical differences of plant height and AFW of beans under vermicompost rates as well as HB101 spraying frequencies (Table 1). Generally, V2 and V3 produced taller plants than V1 treatment. Specifically, V3 showed a significantly higher plant height than V1 at both growth stages. AFW followed a similar trend, being highest in V3 (47.37 and 74.32 g plant^{-1} at flowering and harvest stages, respectively). HB101 spraying also presented a positive effect on bean plants, when at flowering stage, H1 and H2 significantly increased plant height compared with H0. Likewise, AFW was statistically enhanced by HB101 application as compared to H0 treatment at all measured times.

Combined application of vermicompost with HB101 spraying significantly influenced plant height and AFW of beans at flowering and harvesting stages (Table 1). Generally, increasing vermicompost rates promoted plant height, especially in the interaction with HB101 spraying. Regarding AFW, at flowering stage, higher vermicompost rates interacted with HB101 increased this indicator, which was highest under V3H1 (49.21 g plant^{-1}). At harvesting stage, AFW increased progressively with vermicompost rates, where V3H1 recorded the highest value (79.36 g plant^{-1}), being comparable with V3H2 (74.76 g plant^{-1}) and statistically higher than all other treatments

3.2. Effects of vermicompost rates and HB101 spraying frequencies on physiological traits of bush-type common bean

Across both measurement stages, vermicompost positively influenced LAI (Figure 1). At flowering stage, LAI was the highest under V3 treatment, which was comparable with V2 treatment. At harvesting stage, the statistical higher LAI was recorded under V3 treatment. Regarding HB101 spraying, at flowering stage, H1 treatment yielded the highest LAI, but in harvesting stage, H1 and H2 gave comparable LAI and statistically higher than that of H0 treatment.

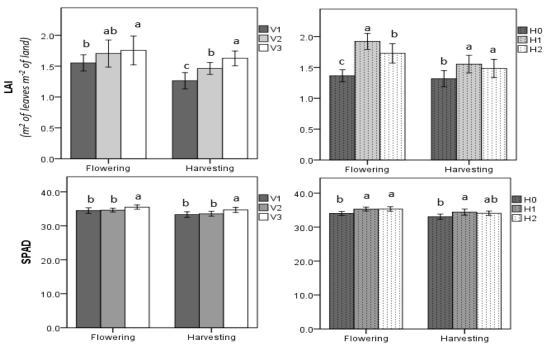

Figure 1. Single effects of vermicompost rates and HB101 spraying frequencies on SPAD readings and leaf area index (LAI) of bush-type common beans

Notes: Columns with different letters within each treatment are significantly different at the 5% level

Similar trends were observed for SPAD, where V3 resulted in statistically better value in both two stages. HB101 application significantly affected SPAD. At flowering stage, HB101 application statistically outperformed watering only (H0 treatment). At harvesting stage, the maximum SPAD was reached in plants treated with H1 treatment, which was at par with H2 treatment and statistically higher than H0 treatment.

Table 2. Interactive effects of vermicompost rates and HB101 spraying frequencies on SPAD readings and leaf area index (LAI) of bush-type common beans

Vermicompost rates	HB101 spraying frequencies	SPAD		LAI (m^2 of leaves m^{-2} of land)	
		Flowering stage	Harvesting stage	Flowering stage	Harvesting stage
V1	H0	33.47^{c}	32.50^{d}	1.34^{d}	1.10^{e}
	H1	35.18^{ab}	34.36^{abc}	1.72^{bc}	1.44^{cd}
	H2	34.83^{abc}	33.06^{bcd}	1.60^{cd}	1.26^{de}
V2	H0	33.76^{c}	32.59^{cd}	1.37^{d}	1.40^{cd}
	H1	34.59^{bc}	33.73^{abcd}	1.99^{ab}	1.52^{abc}
	H2	35.52^{ab}	34.36^{abc}	1.76^{bc}	1.47^{abcd}
V3	H0	34.83^{ab}	34.06^{abcd}	1.39^{d}	1.46^{bcd}
	H1	36.12^{a}	35.18^{a}	2.06^{a}	1.70^{ab}
	H2	35.59^{ab}	34.82^{ab}	1.82^{abc}	1.72^{a}

Note: Values with different letters in the same column of individual or interactive factors indicate significant differences in the LSD test at the 5% significance level.

The results from table 2 show that, under the same vermicompost rate, spraying HB101 produced higher SPAD compared to the control. Furthermore, higher vermicompost rates combined with HB101 effectively increased chlorophyll content in bean leaves. At both stages, T3H1 treatment resulted in the maximum SPAD, with 36.12 at flowering stage and 35.18 at harvesting stage.

Regarding LAI, at both two phenological stages, increasing vermicompost amount (V2 and V3 treatments) applied along with spraying HB101 (H1 and H2 treatment) increased LAI, even though there were no differences between these treatments. The highest LAI was obtained under V3H1 treatment with 2.06 m^2 of leaves m^{-2} of land at flowering stage, and under V3H2 treatment with 1.72 m^2 of leaves m^{-2} of land at harvesting stage.

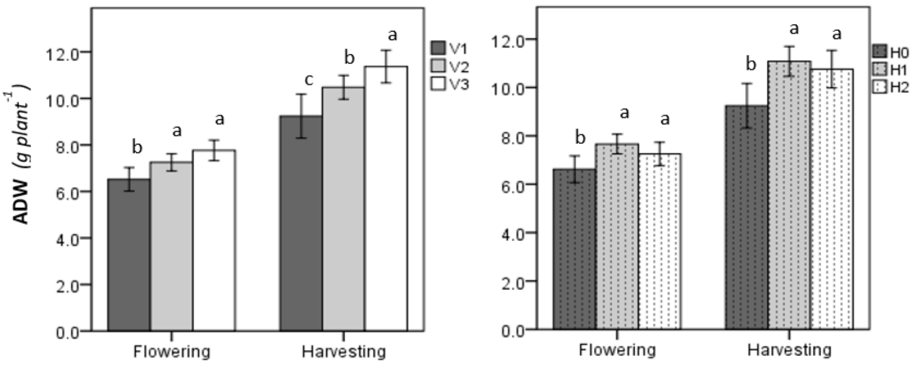

Figure 2. Single effects of vermicompost rates and HB101 spraying frequencies on aboveground dry weight of bush-type common beans

Notes: Columns with different letters within each treatment are significantly different at the 5% level.

Vermicompost rates and HB101 spraying frequencies statistically influenced the dry accumulation of beans (Figure 2). The data clearly show a positive trend in the effect of higher vermicompost rates on ADW. At flowering stage, plants treated with V3 showed the highest ADW, being comparable with that under V2 treatment and statistically higher than V1 treatment. At harvesting stage, ADW under V3 treatment statistically outperformed V1 and V2 treatments. On the other hand, the frequency of HB101 spraying also showed a significant impact on ADW. The data indicate that spraying HB101 (H1 and H2 treatments) had a crucial role in maximizing ADW, which was statistically higher than that in plants treated by water only (H0 treatment).

Table 3. Interactive effect of vermicompost rates and HB101 spraying frequency on aboveground dry weight of bush - type common beans

Vermicompost rates	HB101 spraying frequencies	ADW (g plant^{-1})	
		Flowering stage	Harvesting stage
V1	H0	5.86^{e}	7.63^{e}
	H1	7.15^{bcd}	10.23^{cd}
	H2	6.55^{de}	9.85^{cd}
V2	H0	6.77^{cde}	9.75^{d}
	H1	7.67^{abc}	11.15^{abc}
	H2	7.32^{abcd}	10.52^{bcd}
V3	H0	7.23^{abcd}	10.35^{cd}
	H1	8.17^{a}	11.85^{ab}
	H2	7.89^{ab}	11.90^{a}

Note: Values with different letters in the same column indicate significant differences in the LSD test at 5% significance level.

The interaction between vermicompost rates and HB101 spraying significantly influenced ADW at both growing stages (Table 3). At flowering stage, V3 treatment consistently resulted in higher ADW across all HB101 treatments, which were comparable with V2H1 and V2H2 treatments, therein V3H1 gave the maximum ADW (8.17 g plant^{-1}). At harvesting stage, higher ADW values were reached under V3H2, V3H1 and V2H1 (11.90, 11.85 and 11.15 g plant^{-1}, respectively). Generally, higher vermicompost rates interacted with HB101 showed the synergistic effect for improving plant growth. Additionally, at the same vermicompost rates, H2 treatment improved ADW, but further increasing the frequency to H1 did not provide additional benefits.

3.3. Effects of vermicompost rates and HB101 spraying frequencies on yield components and pod yield of bush-type common bean

There were significant differences in yield components and pod yield, based on varying vermicompost rates as well as HB101 spraying (Table 4). Increasing vermicompost rate corresponded to better measured parameters, with V3 statistically outperforming V1 and V2 in terms of pod number, pod weight per plant and pod yield, with pod yield under V3 treatment being 4.67 tons ha^{-1}. On the other hand, HB101 application had no difference in pod weight. The effect of HB101 spraying was particularly notable in terms of pod number, where H1 treatment gave a statistically higher pod number compared to H0 and H2 treatments. In addition, H1 treatment achieved the highest pod weight per plant (40.80 g plant^{-1}) and pod yield (4.24 tons ha^{-1}), which were comparable to H2 treatment.

Table 4. Effects of vermicompost rates and HB101 spraying frequencies on yield components and pod yield of bush - type common bean

Vermicompost rates	HB101 spraying frequencies	Pod number (Pod plant^{-1})	Pod weight (g pod^{-1})	Pod weight per plant (g plant^{-1})	Pod yield (tons ha^{-1})
V1	H0	6.23^{e}	4.24^{b}	26.48^{e}	2.86^{e}
	H1	7.87^{cd}	4.35^{b}	34.43^{cd}	3.37^{de}
	H2	7.20^{de}	4.42^{b}	31.88^{de}	3.45^{de}
V2	H0	7.83^{cd}	4.60^{ab}	35.85^{cd}	3.51^{d}
	H1	9.08^{ab}	4.50^{ab}	40.78^{abc}	4.24^{bc}
	H2	8.37^{bc}	4.38^{b}	36.66^{bcd}	3.98^{cd}
V3	H0	8.70^{bc}	4.61^{ab}	40.03^{bc}	4.27^{bc}
	H1	9.80^{a}	4.80^{ab}	47.19^{a}	5.12^{a}
	H2	8.57^{bc}	5.06^{a}	43.26^{ab}	4.61^{ab}
Vermicompost rates	V1	7.10^{c}	4.34^{b}	30.93^{c}	3.22^{c}
	V2	8.43^{b}	4.49^{ab}	37.76^{b}	3.91^{b}
	V3	9.02^{a}	4.82^{a}	43.49^{a}	4.67^{a}
HB101 spraying frequencies	H0	7.59^{b}	4.48^{a}	34.12^{b}	3.54^{b}
	H1	8.92^{a}	4.55^{a}	40.80^{a}	4.24^{a}
	H2	8.04^{b}	4.62^{a}	37.26^{ab}	4.01^{a}

Note: Values with different letters in the same column of individual or interactive factors indicate significant differences in the LSD test at the 5% significance level.

Vermicompost rates interacted with HB101 spraying had a significant effect on yield components and yield of bean plants (Table 4). At the lowest vermicompost rate (V1), all these indicators remained at lower level regardless of HB101 spraying frequencies, which suggests that limited nutrient input constrained plant response to foliar spraying. At the highest vermicompost rate (V3), pod yield attributes were further markedly enhanced by HB101 spraying, particularly under combining with H1 treatment. V3H1 treatment produced the greatest pod number (9.80 pods plant^{-1}), pod weight (4.80 g), pod weight per plant (47.19 g), and the highest pod yield (5.12 tons ha^{-1}). Additionally, V3H2 gave the comparable yield parameters (43.26 g plant^{-1} and 4.61 tons ha^{-1}). These results clearly indicate that the interaction between vermicompost rates and HB101 spraying is synergistic, leading to better pod yield of bush – type common bean.

3.4. Discussions

Vermicompost has emerged as a sustainable soil amendment, reducing the dependency on chemical fertilizers as well as promoting long-term soil fertility. Vermicompost sources are rich in readily available nutrients, beneficial microorganisms, and humic substances, thereby improving soil structure, aeration, and waterholding capacity, resulting in fostering optimal root development [8]. In addition, vermicompost stimulates plant growth through the release of bioactive compounds, including phytohormones and enzymatic metabolites [3, 8]. In our experiment, application of vermicompost at higher rates (V2 and V3 treatments) led to significant increases in vegetative growth parameters (plant height, AFW, LAI) as well as yield components (pod number, pod weight, pod weight per plant) and pod yield in common bean. These results are consistent with the previous studies. Salwa et al. (2019) [7] reported that higher vermicompost rate promoted plant growth and yield of red cabbage. Regarding Gutiérrez-Miceli *et al.* (2007) [2], adding more vermicompost significantly increased plant height and fruit yield of tomatoes. According to Belmeskine *et al.* (2020) [8], earthworms interact intensively with microorganisms to speed up the decomposition of organic matter, leading to higher plant height, leaf fresh weight, the root length and number of nodules of snap bean (*Phaseolus vulgaris* L.) under vermicompost application. Additionally, vermicompost increased chlorophyll content of leaves, leading to better photosynthesis efficiency with improvement of biological yield of snap beans [8]. In the study of Sangsoda *et al.* (2025) [9], vermicompost showed the highest plant height and dry weight of hemp compared to compost treatment.

Nowadays, the utilization of plant-derived biostimulants offers an environmentally sustainable and effective strategy for advancing modern agricultural practices. According to Godlewska *et al.* (2021) [10], Ertani *et al.* (2016) [11], Mbuyisa et al. (2024) [12], the plant extracts generate a high content of bioactive compounds, that enhance plant growth, quality, photosynthetic activity while improving tolerance to both abiotic and biotic stresses. In our trials, HB101 spraying increased pod yield of common bean with improvement in growth parameters such as AFW, LAI, SPAD and ADW, especially in the interaction with higher vermicompost rates. It suggests that regular application of the HB101 solution positively influences plant growth and development. Our findings are consistent with the previous studies. Ertani *et al.* (2016) [11] recorded better dry weight, contents of protein, glucose, fructose in roots and leaves, as well as chlorophyll content and phenolic acids in leaves of maize treated by vegetal extracts derived from red grape, blueberry fruits and hawthorn leaves, especially at higher spraying rate. These authors confirmed the presence of plant-promoting substances, such as IAA and IPA hormones and different phenolic compounds in the applied extracts. Similarly, Mbuyisa *et al.* (2024) [12] found the macro- and micronutrients, phenolics, flavonoids and antioxidant activity in plant extracts derived from *Ascophyllum nodosum*, aloe vera leaf and moringa leaf, leading to increased plant height, leaf area, leaf chlorophyll index and total tuber yield of potato. HB101 is a natural plant growth enhancer extracted from cedars, cypresses, pines and plantains, which helps to promote plant cell proliferation, activating a mitochondrial enzyme of the plant, and increases the microbial populations in the soil. Salwa *et al.* (2019) [7] recorded better plant growth and yield of red cabbage as a result of improved soil fertility under higher rate of HB101 spraying. These results suggest that HB101 contributes to improved physiological status and reproductive performance, likely through its active ingredients that stimulate growth processes.

Table 5. Pearson correlation matrix of physiological parameters and yield under the effect of vermicompost rates and HB101 spray frequencies

	LAI-H	SPAD-F	SPAD-H	ADW-F	ADW-H	PWP	PY
LAI-F	0.43*	0.42*	0.52**	0.55**	0.69**	0.49**	0.50**
LAI-H		0.66**	0.70**	0.73**	0.68**	0.68**	0.72**
SPAD-F			0.59**	0.59**	0.54**	0.41*	0.55**

SPAD-H				0.58^{**}	0.51^{**}	0.50^{**}	0.52^{**}
ADW -F					0.70^{**}	0.67^{**}	0.74^{**}
ADW-H						0.74^{**}	0.71^{**}
PWP							0.89^{**}

*Note: ns: non-significant; *: p-value < 0.05; **: p-value < 0.01; -F: at flowering stage, -H: at harvesting stage, PWP: Pod weight per plant, PY – pod yield.*

On the other hand, vermicompost is a kind of organic fertilizer, its nutrient release (especially N) may be slower, particularly at the early growth stages. In this situation, the inclusion of a plant vitalizer supplying available nutrients or growth-regulating compounds led to plant growth improvement. Our findings indicate that higher vermicompost rates interacted with HB101 spraying enhanced bean growth, thereby promoting LAI, SPAD, and ADW, all of which were significantly and positively associated with final yield (Table 5). For example, between LAI (at flowering stage) and ADW (at harvesting stage): r = 0.69 (p < 0.01); between LAI and ADW at harvesting stage: r = 0.68 (p < 0.01). Importantly, yield components and pod yield exhibited a higher correlation with ADW. Therein, PWP was significantly positively correlated with ADW at harvesting (r = 0.74, p < 0.01). ADW was also closely linked with pod yield, with r = 0.74 (p < 0.01) at flowering stage and r = 0.71 (p < 0.01) at harvesting stage, suggesting that assimilate partitioning into economic yield components is the key determinant of productivity.

Dang *et al.* (2025) [5] found that combining organic manure with foliar fertilizer improved soil fertility, increased leaf nutrient contents, increased fruit yield, TSS content and decreased physiological disorder in durian fruits as compared to organic or foliar fertilization alone. Similarly, Kouam *et al.* (2024) [13] reported utilization of botanical extract along with soil-applied fertilizers provided essential nutrients as well as amino acids, bioactive compounds and phytohormones, leading to better plant height, leaf area, fresh and dry biomass, and fruit yield and quality of strawberry. In terms of HB101, Salwa *et al.* (2019) [7] confirmed that combining higher vermicompost rates and HB101 showed promoted plant growth and yield traits of red cabbage. Our study demonstrates that higher vermicompost application rates, particularly in combination with HB101 spraying at 5- or 10- intervals, enhanced pod yield of bush-type common beans. This approach offers a promising strategy for sustainable yield improvement through the synergistic effects of organic fertilization and foliar biostimulant application.

4. CONCLUSION

Applying vermicompost at higher rates improved plant growth, physiological indicators of common beans. Application of 12 tons ha^{-1} of vermicompost statistically increased pod number, pod weight per plant and pod yield. Additionally, spraying HB101 enhanced fresh and dry weight, LAI and SPAD as well as pod yield traits. Application of vermicompost at 12 tons ha^{-1} combined with HB101 spraying at either 5- or 10-day intervals positively influenced plant growth and yield of common bean, resulting in comparable pod yield of 5.12 and 4.61 tons ha^{-1}, respectively. The result suggests that integrating 12 tons ha^{-1} of vermicompost with HB101 spraying at 10-day intervals represents an effective agronomic strategy for enhancing the growth and yield of bush-type common beans.

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