Evaluation of the Biostimulant Vital 05™ Containing Brassinosteroids, Triacontanol and Vitamins on the Growth, Yield or Fruit Quality of Five Vegetables, Two Tree-Crop Seedlings, and a Cereal Crop: (tomato, eggplant, sweet pepper, cucumber, bok choy, seedling cocoa, seedling mango, and maize)

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Evaluation of the Biostimulant Vital 05™ Containing Brassinosteroids, Triacontanol and Vitamins on the Growth, Yield or Fruit Quality of Four Vegetables, Two Tree-Crop Seedlings, and a Cereal Crop: (tomato, eggplant, sweet pepper, cucumber, bok choy, seedling cocoa, seedling mango, maize)

SUMMARY

The use of biostimulants in crop production provides a sustainable and efficient technology to improve resource-use efficiency. Biostimulants boost plant growth and enhance nutrient uptake and assimilation. The biostimulant, **VITAL 05™** in a liquid formulation was evaluated for its effect on the performance of seven crops. Plant growth, yield, and fruit quality were assessed in tomato, while growth and yield were evaluated in cucumber, bok choy, sweet pepper, eggplant, and maize. Growth and biomass production were measured in seedling mango and cocoa. Three application rates of VITAL 05™ (50 mL/15 L, 100 mL/15 L, and 150 mL/15 L) were tested through rootzone irrigation or foliar spray, with a non-treated control for comparison. The treatments were applied to the crops after seedling emergence for the field experiments or after transplanting for the controlled environment grown vegetables. Application of **VITAL 05™** was repeated at 14 days intervals and a maximum of three time, till fruit maturity either by using knapsack fitted with a cone nozzle for the foliar application and by fertigation for the soil drenching treatments. Data was collected for the vegetables (tomato, eggplant, sweet pepper, cucumber, bok choy) as an end product result in yield, crop productivity and fruit quality/biomass and for growth characteristics for the field and tree crops. The results indicate that **VITAL 05™** enhances crop productivity by at least 13% more than the control from the greenhouse production where plant nutrition is optimal for even the control, and at least 22% more than the control for field production where plant nutrition relies on inconsistent soil nutrients. Application of Vital-05 at 50-100 mL/15L at 2-week intervals through foliar sprays was the superior treatment for all the crops tested. In the irrigated greenhouse vegetables, application via the root through fertigation is recommended. The application of VITAL 05 significantly accelerates seedling development, reducing the maturation period to 46 days for cocoa and 60 days for mango, markedly enhancing growth rates compared to traditional timelines. The application of VITAL 05 resulted in more than 120% increase in maize yield compared to the control. This increase represents more than 41% higher yield compared to the figures reported by the USDA for Ghana in 2023. Overall, the application of **VITAL 05™** improved crop growth, productivity, and quality under both controlled and field conditions. The results strongly demonstrate the potential of VITAL 05™ applications to significantly boost crop productivity by stimulating increased root growth, leading to enhanced water and nutrient absorption.

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INTRODUCTION

Plants are sessile and encounter a number of abiotic and biotic stresses. In response to these stresses, plants induce physiological, morphological, biochemical, and molecular changes, which lead to altered growth and metabolism. These stresses restrict optimum economic production, by quality and quantity for a wide range of crop plants.

Tomato (*Lycopersicon esculentum*) is an important vegetable crop produced all over the world. High yield and fruit quality are very important indices for the economic success of tomato production. The tomato sector in Ghana has not reached its potential, in terms of attaining yields comparable to other countries. Farmers plant local varieties, which typically have high water content, many seeds, poor colour, and low brix. Average yields remain low, typically under ten tons per hectare. Since these farmers continue to choose tomatoes over other crops, they will need interventions to increase yield.

Eggplant (*Solanum* spp.) is an important vegetable crop, well known for nutritional and medicinal values of its fruits and leaves. The average yield of eggplants (aubergines) in Ghana is about 9 tons per Ha under open field conditions. Ghana is ranked 33rd within the group of 88 countries which are known to produce eggplants

Sweet pepper (*Capsicum annuum*) production in Ghana has been growing steadily due to increased local and international demand, which has encouraged farmers to venture into this profitable agribusiness. Efforts are needed to improve farming techniques and increase yields. Popular varieties grown include California Wonder, Yolo Wonder, and Crusader.

Cucumber (*Cucumis sativus*) is a widely cultivated crop across Ghana. It's production in Ghana is placed at a low 123rd in the world. Cucumbers are in demand for the export market and as a recipe in Ghanaian diets. Yields can be improved by cultivating high yielding varieties coupled with adequate plant nutrition

Bok choy *(Brassica rapa*) Bok choy is a leafy vegetable rich in beta-carotene, vitamin C, and essential minerals. There is an increasing need to diversify vegetable consumption in Ghana to improve nutrition and food security. Incorporating diverse vegetables, like leafy greens, can address micronutrient deficiencies, combat malnutrition, and improve public health and food security.

Maize (*Zea mays)* is a staple crop in Ghana, accounting for more than 50% of the country's total cereal production. Yields in Ghana remain relatively low compared to other regions. The potential yield of maize in controlled trials is about 6 metric tons per hectare and this should be the enviable target.

Mango (*Mangifera indica*) seedling production in Ghana is an important part of the agricultural sector, supporting both local consumption and export markets. Over the last decade the crop has gained popularity as one of the major non-traditional fruits for export. The two main varieties grown commercially in Ghana are the Kent and Keitt varieties, which are very vigorous growers and produce large fruit. Ghana's mango sector has a comparative advantage since a greater part of the country has two harvest seasons.

Cocoa (*Theobroma cacao*): Improvements in cocoa production to meet the demand in the future is impeded by inadequate good quality seedlings. During plant growth in the nursery, a high-quality cocoa seedling should be achieved to support later plant growth. Use of growth enhancers had been shown to increase seedling height, leaf numbers, stem diameter, root volume, root, and plant dry weight. In addition to the use of biological agents such as hormones has also received some attention. Biostimulants have an important role in increasing plant growth by increasing nutrient uptake.

Plant biostimulants are commercial products based on different chemical substances used to enhance plant growth and to increase agricultural productivity. Biostimulants, when applied to plants are expected to enhance plant nutrition efficiency, abiotic stress tolerance and/or crop quality traits. Phytohormones play important roles in plants by facilitating growth, development, nutrient allocation, and source-to-sink relationships. Some major phytohormones used by plants include abscisic acid (ABA), gibberellins (GA3),

brassinosteroids, triacontanol, ethylene, jasmonic acid and nitric oxide. Plant hormones individually regulate various critical activities in agricultural plants however, there is little literature or commercial products that takes care of combinations of plant hormones, which may either be synergistic and antagonistic. The availability of these phytohormones in optimal quantities and proportions, the case of Vital 05™ is the subject of this.

Vital 05™ is an all-natural biostimulant formulated to enhance the growth, yield and biochemical components of both horticultural, arable and plantation crops, and has also been used in other agricultural production activities. This natural growth stimulant contains biological activators, vitamins, and enzymes as an organic, non-toxic, and environmentally safe product. It combines growth regulators which can enhance growth and yield characteristics of crops. In its crude formulation, it contains brassinosteroids, triacontanol and essential vitamins. It is reported to accelerate plant metabolic processes and helps to enhance the uptake of nutrients. The product is a natural plant growth stimulator and improves soil structure and infiltration. Phytohormones used in combination to enhance the performance of crop plants at desirable levels is not well documented. Triacontanol, a natural plant growth regulator found in epicuticular waxes, is known to be a versatile plant growth regulator. It is a well-known plant growth-promoting substance that enhances growth when applied exogenously at relatively low concentrations to most crops. It improves growth, yield, photosynthesis, protein synthesis, water and nutrients intake, nitrogen fixation, and enzyme activity in diverse crops.

Brassinosteroids are natural, non-toxic, and environmentally safe phytohormones, used sustainably to improve crop production. They play a crucial role in various physiological processes, including cell elongation, differentiation, and stress responses. These roles lead to increased biomass and higher crop yields, improved quality of fruits by influencing factors such as size, colour, and nutritional content. Vitamins play significant roles in crop production. They act as coenzymes in metabolic processes, helping in the synthesis of nucleic acids and proteins, and also the synthesis of chlorophyll. Vitamins protect plants from oxidative stress caused by environmental factors. Vitamins can also improve the efficiency of nutrient uptake and utilization. The interaction of these three phytohormones in regulating the physio-biochemical processes in crops is the gap that Vital 05™ intends to bridge and was the subject of the evaluation.

The objective of these experiments was to evaluate the application rates of Vital 05 using two methods: rootzone application and foliar spray. These results will enhance the scientific understanding of **VITAL 05™** by confirming its attributes and contributing to its acceptance by regulators and farmers as it draws the lines between its potencies and economics of use. **VITAL 05™** in combination with appropriate plant nutrition can be **recommended** to boost crop yield, seedling vigour and fruit quality based on the results obtained for tomato, eggplant, sweet pepper, cucumber, bok choy, seedling cocoa, seedling mango, and maize under either controlled environments or open field conditions.

GENERAL METHODS

The experiments were conducted at the University of Ghana's Legon campus, under net house, greenhouse or field conditions depending on the crop stage at University of Ghana. The study focused on determining the optimal application rate and route for applying **VITAL 05™** on selected crops. The key measurements were on the usable end products including yield, fruit quality, plant biomass and seedling vigour.

Treatments

The experiment tested six application rates plus a control treatment via two application routes to compare their effects on yield, vegetative biomass, seedling quality or fruit quality of tomato, eggplant, sweet pepper, cucumber, bok choy, seedling cocoa, seedling mango, maize

In all, eight (8) crops, seven (7) biostimulant concentrations applied through two (2) routes were thus evaluated in the study between May and October 2024:

- 50 ml **VITAL 05™** in15 litres of water applied as a soil drench
- 50 ml **VITAL 05™** in15 litres of water applied as a foliar spray
- 100 ml **VITAL 05™** in15 litres of water applied as a soil drench
- 100 ml **VITAL 05™** in15 litres of water applied as a foliar spray
- 150 ml **VITAL 05™** in15 litres of water applied as a soil drench
- 150 ml **VITAL 05™** in15 litres of water applied as a foliar spray
- 0 mL **VITAL 05™** in15 litres of water (Control) water applied as a soil drench)

These treatments were designed to assess the effectiveness of the selected concentrations and application routes of **VITAL 05™** on eight selected crops. Application of **VITAL 05™** was staggered at two-week intervals during the growing cycle of the crops. All treatments were provided with standard plant nutrition either as granular fertilizers or through fertigation for the greenhouse vegetables.

Data was collected at the end of each experimental cycle for all crops representing yield, fruit quality, seedling vigour or biomass production:

SPECIFIC PROCEDURES

Tomato variety JA10

EXPERIMENTAL SET-UP

The experiment tested two application rates plus a control treatment via two application routes to compare their effects on yield, vegetative biomass, seedling quality or fruit quality of tomato variety.

The experimental units comprised tomato variety, and ten (10) biostimulant concentrations applied through two (2) routes were thus evaluated in the study between May and October 2024:

- 50 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 50 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 100 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 100 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 150 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 150 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 50 mL **VITAL 05™ only** in 15 litres of water applied to the rootzone
- 100 mL **VITAL 05™ only** in 15 litres of water applied to the rootzone
- 150 mL **VITAL 05™ only** in 15 litres of water applied to the rootzone
- 0 mL **VITAL 05™** in 15 litres of water (Control): water applied as a soil drench)

These treatments were designed to assess the effectiveness of the selected concentrations and application routes of **VITAL 05™** on tomato. Application of **VITAL 05™** was staggered at two-week intervals during the growing cycle of the tomato variety i.e., (three applications). All treatments were provided with standard plant nutrition either as granular fertilizers or through fertigation for the greenhouse-grown vegetables.

Data was collected at the end of the experimental cycle for tomato variety representing yield and fruit quality:

Seedling **Vegetative** **Matured**

Figure 1: Phenology of experimental tomato

Yield (tomato**):** yield of random representative samples was measured and total yield per unit area was extrapolated to yield per hectare

Fruit quality (tomato):
The fruit quality was assessed by measuring some components, including total soluble solids (TSS) in Brix%, fruit pH, lycopene content, and vitamin C content. Tomato fruits of uniform size and identical maturity were selected for each of the seven treatments, homogenized, and subsequently analyzed for soluble solids, vitamin C, and lycopene content. The measurements were replicated three times with five randomly selected fruits for each treatment

- The Brix percentage was determined using an Atago digital hand-held pocket refractometer (Atago Co. Ltd, Tokyo, Japan). The Brix percentage in the fruit juice was determined by placing a few drops of juice on the refractometer's prism.
- The vitamin C (ascorbic acid) content was estimated following the procedure outlined by Igwemmar et al. (2013). An aliquot of 5.0 mL of pooled tomato juice was diluted with 45.0 mL of 0.1% oxalic acid and then titrated with a dye solution until a noticeable colour change occurred. The results were expressed as milligrams of ascorbic acid per gram of fresh weight.
- Lycopene content was measured using the method described by Fish et al. (2012). To extract the lycopene, 100 mL of a n-hexane solution (2:1:1) was applied to one gram of homogenate, which was then incubated for a full day. Following incubation, the extract was mixed with 15 mL of distilled water to separate the polar phase (bottom) from the non-polar phase (top). The absorbance of the non-polar phase was measured at wavelengths 451 nm and 503 nm, using n-hexane as a blank.

Eggplant variety JA10

EXPERIMENTAL SET-UP

The experiment tested three application rates plus a control treatment via two application routes to compare their effects on the yield of an eggplant variety.
The experimental unit included an eggplant variety and seven (7) biostimulant concentrations, applied via two (2) application methods, and was evaluated during the study period from May to October 2024.

- 50 mL **VITAL 05™** in15 litres of water applied as a soil drench
- 50 mL **VITAL 05™** in15 litres of water applied as a foliar spray
- 100 mL **VITAL 05™** in15 litres of water applied as a soil drench
- 100 mL **VITAL 05™** in15 litres of water applied as a foliar spray
- 150 mL **VITAL 05™** in15 litres of water applied as a soil drench
- 150 mL **VITAL 05™** in15 litres of water applied as a foliar spray
- 0 mL **VITAL 05™** in15 litres (Control): water applied as a soil drench

These treatments were designed to assess the effectiveness of the selected concentrations and application routes of **VITAL 05™** on eggplant. Application of **VITAL 05™** was staggered at two-week intervals during

the growing cycle of the eggplant variety i.e., (three applications). All treatments were provided with standard plant nutrition either as granular fertilizers or through fertigation under greenhouse conditions. Data was collected at the end of the experimental cycle for the eggplant variety, representing yield:

Seedling **Vegetative** **Matured**

Figure 2: Phenology of experimental eggplant

Yield (eggplant**)** yield of random representative samples were measured and total yield per unit area was extrapolated to yield per hectare

Sweet pepper variety -Hulk F1

The fruit is very large with a thick wall, very firm and square shaped. The fruit is dark green and becomes red when ripe. It matures in average 85 days

EXPERIMENTAL SET-UP

The experiment tested three application rates plus a control treatment via two application routes to compare their effects on the yield of sweet pepper variety.

The experimental units comprised a sweet pepper variety, and seven (7) biostimulant concentrations applied through two (2) routes, and were evaluated in the study between May and October 2024:

- 50 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 50 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 100 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 100 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 150 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 150 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 0 mL **VITAL 05™** in 15 litres of water (Control-water applied as a soil drench)

These treatments were designed to assess the effectiveness of the selected concentrations and application routes of **VITAL 05™** on sweet pepper. Application of **VITAL 05™** was staggered at two-week intervals during the growing cycle of the eggplant variety i.e., (three applications). All treatments were provided with standard plant nutrition either as granular fertilizers or through fertigation for the greenhouse vegetables Data was collected at the end of the experimental cycle for sweet pepper variety representing yield

Seedling **Vegetative** **Matured**

Figure 3: Phenology of experimental sweet pepper

Yield (sweet pepper**)** yield of random representative samples were measured and total yield per unit area was extrapolated to yield per hectare

Biomass (sweet pepper) whole plants were sampled at maturity. The sampled plants were divided into leaves (including petioles), stems, and fruits, and the aboveground dry weight were determined. The dry weights of the leaves, stems, and fruits were measured after drying at 105°C for 72 h.

Cucumber -variety Spectacular F1

- **EXPERIMENTAL SET-UP**

The experiment tested three application rates plus a control treatment via two application routes to compare their effects on yield of cucumber variety.

The experimental units comprised cucumber variety, and seven (7) biostimulant concentrations applied through two (2) routes were thus evaluated in the study between May and October 2024:

- 50 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 50 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 100 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 100 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 150 mL **VITAL 05™** in 15 litres of water applied as a soil drench
- 150 mL **VITAL 05™** in 15 litres of water applied as a foliar spray
- 0 mL **VITAL 05™** in 15 litres of water (Control-water applied as a soil drench)

These treatments were designed to assess the effectiveness of the selected concentrations and application routes of **VITAL 05™** on cucumber. Application of **VITAL 05™** was staggered at two-week intervals during the growing cycle of the cucumber variety i.e., (three applications). All treatments were provided with standard plant nutrition either as granular fertilizers or through fertigation under greenhouse conditions.

Data was collected at the end of the experimental cycle for cucumber variety, representing yield

Seedling **Vegetative** **Matured**

Figure4: Phenology of experimental cucumber

Yield (cucumber**)** yield of random representative samples were measured and total yield per unit area was extrapolated to yield per hectare

Bok choy- variety Mini Bok choy

The growth and yield response of mini bok choy to varying rates of Vital 05 applied via foliar and rootzone methods was investigated in a substrate culture hydroponic system under high pH stress (without pH regulation). The study aimed to evaluate the effects of biostimulant application on plant performance, using the following treatments.

- 50 mL VITAL 05™ in 15 L of water + nutrient solution - Foliar
- 50 mL VITAL 05™ in 15 L of water + nutrient solution - Rootzone
- 100 mL VITAL 05™ in 15 L of water + nutrient solution - Foliar
- 100 mL VITAL 05™ in 15 L of water + nutrient solution - Rootzone
- 150 mL VITAL 05™ in 15 L of water + nutrient solution - Foliar
- 150 mL VITAL 05™ in 15 L of water + nutrient solution - Rootzone
- 0 mL VITAL 05™ in 15 L of water + nutrient solution – Rootzone

Figure 5: Treatments of experimental bok choy

COCOA seedlings response to VITAL 05™

The effect of the biostimulant on the growth of cocoa seedlings (*Theobroma cacao*) was investigated. The treatments applied, including the rate and mode of VITAL 05™ application, are outlined below:

- 50 mL VITAL 05™ in 15 L of water + basal fertilizer - Foliar
- 50 mL VITAL 05™ in 15 L of water + basal fertilizer - Rootzone
- 100 mL VITAL 05™ in 15 L of water + basal fertilizer - Foliar
- 100 mL VITAL 05™ in 15 L of water + basal fertilizer - Rootzone
- 150 mL VITAL 05™ in 15 L of water + basal fertilizer - Foliar
- 150 mL VITAL 05™ in 15 L of water + basal fertilizer - Rootzone
- 100 mL VITAL 05™ in 15 L of water only - Foliar
- 100 mL VITAL 05™ in 15 L of water only - Rootzone
- 0 mL VITAL 05™ in 15 L of water + basal fertilizer (control)
- 0 mL VITAL 05™ in 15 L of water only (absolute control)

Mature cocoa pods containing local seeds were obtained from the Plant Genetic Resources Centre (PGRC) of the CSIR, Bunso. Seeds collected from mature cocoa pods were sown in seed trays, and after germination and seedling elongation, the seedlings were transplanted into polybags. The biostimulant was applied in the third- and fifth weeks following transplantation. Regular maintenance, including watering and fertilization (3 g/L), was carried out to promote healthy seedling growth across all treatments. Plant growth was observed for six weeks. The morphology of randomly selected representative samples was measured at the endpoint (46 days after planting) and used as an indicator of comparative seedling vigour. The seedling parameters assessed were height, leaf count, stem diameter, and biomass.

Nursery **Transplant**

Figure 6: Treatments and phenology of experimental seedling cocoa

MANGO seedlings response to VITAL 05™

The effect of the biostimulant **VITAL 05™** on the growth of mango seedlings (*Mangifera indica*) was evaluated. Mango seeds for seedling (rootstock) propagation were carefully selected from local mango trees

and dehusked to promote uniform and vigorous germination. These dehusked seeds were then meticulously sown in a bed of well-decomposed rice husk, ensuring optimal growth conditions, and facilitating easy transplanting into polybags.

The mango propagation procedures, including the rate and mode of VITAL 05 application, agronomic practices, and the parameters measured, followed the same methodology as those used for the cocoa seedlings. Vital 05 was applied on days 21 and 42 after seed germination. Growth of the mango seedlings was monitored over sixty days until they reached the optimal morphological stage for grafting.

Foliar (150 mL/15 L)

Foliar (100 mL/15 L)

Foliar (50 mL/15 L)

Rootzone (150 mL/ 15 L)

Rootzone (100 mL/15L)

Rootzone (50 mL/15 L)

Foliar-100 mL/15L (Vital 05 only)

Rootzone-100 mL/15L (Vital 05 only)

Control (0 mL/15L) (Basal fertilizer only)

Absolute Control (0mL/15L + No basal fertilizer)

Pre-nursery

Seedlings

Figure 7: Treatments and phenology of experimental seedling mango

Maize- variety SC 719

Seeds was obtained from SEED CO, Malawi.

The experiment tested two application rates plus a control treatment via two application routes to compare their effects on yield of maize variety SC 719. Open filed plots at Forest and Horticultural Crops Research Centre were used to measure the effects of **VITAL 05™** on the maize variety

The experimental units comprised maize variety, and seven (7) biostimulant concentrations applied through two (2) routes, and were evaluated in the study between May and October 2024:

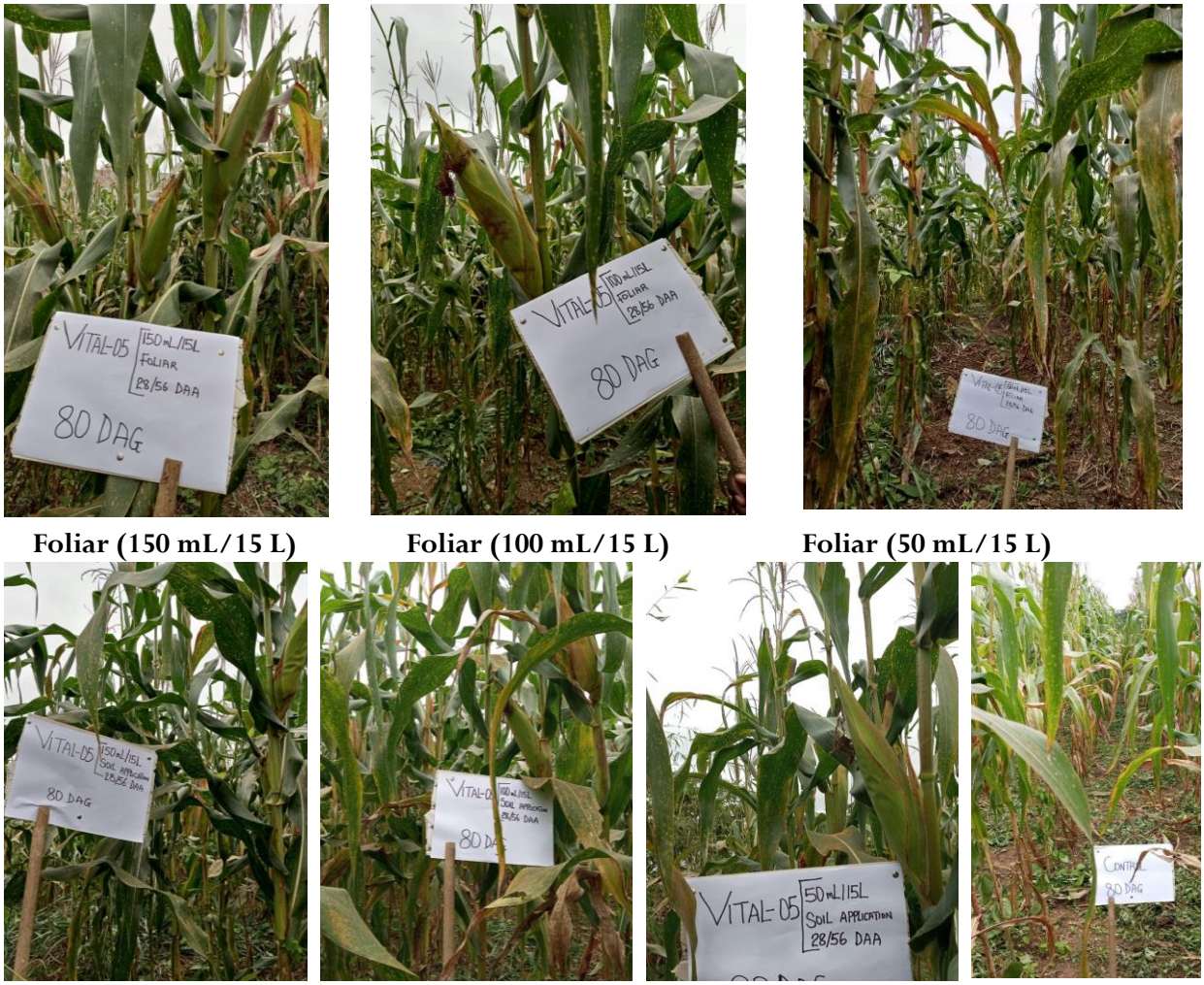
- 50 ml **VITAL 05™** in 15 litres of water applied as a soil drench
- 50 ml **VITAL 05™** in 15 litres of water applied as a foliar spray
- 100 ml **VITAL 05™** in 15 litres of water applied as a soil drench
- 100 ml **VITAL 05™** in 15 litres of water applied as a foliar spray
- 150 ml **VITAL 05™** in 15 litres of water applied as a soil drench
- 150 ml **VITAL 05™** in 15 litres of water applied as a foliar spray
- 0 mL **VITAL 05™** in 15 litres of water (Control): water applied as a soil drench)

EXPERIMENTAL SET-UP

The treatments were designed to assess the effectiveness of the selected concentrations and application routes of **VITAL 05™** on maize. Application of **VITAL 05™** was staggered at two-week intervals during the growing cycle of the maize variety i.e., (two applications). The treatments were provided with standard plant nutrition as granular fertilizers.

Data was collected at the end of the experimental cycle for the maize variety representing plant growth, biomass, and grain yield

Grain yield was measured as number of cobs per hectare and average weight per cob yield of random representative samples were measured and total yield per unit area was extrapolated to yield per hectare. Harvested cobs were counted, and sun dried to a uniform threshing moisture; the threshed grain was weighed, and the data recorded.



Foliar (150 mL/15 L) **Foliar (100 mL/15 L)** **Foliar (50 mL/15 L)**

Soil (150 mL/15 L) **Soil (100 mL/15 L)** **Soil (50 mL/15 L)** **Control (0 mL/15 L)**

Figure 8: Treatments of experimental maize

RESULTS

- **Tomato**

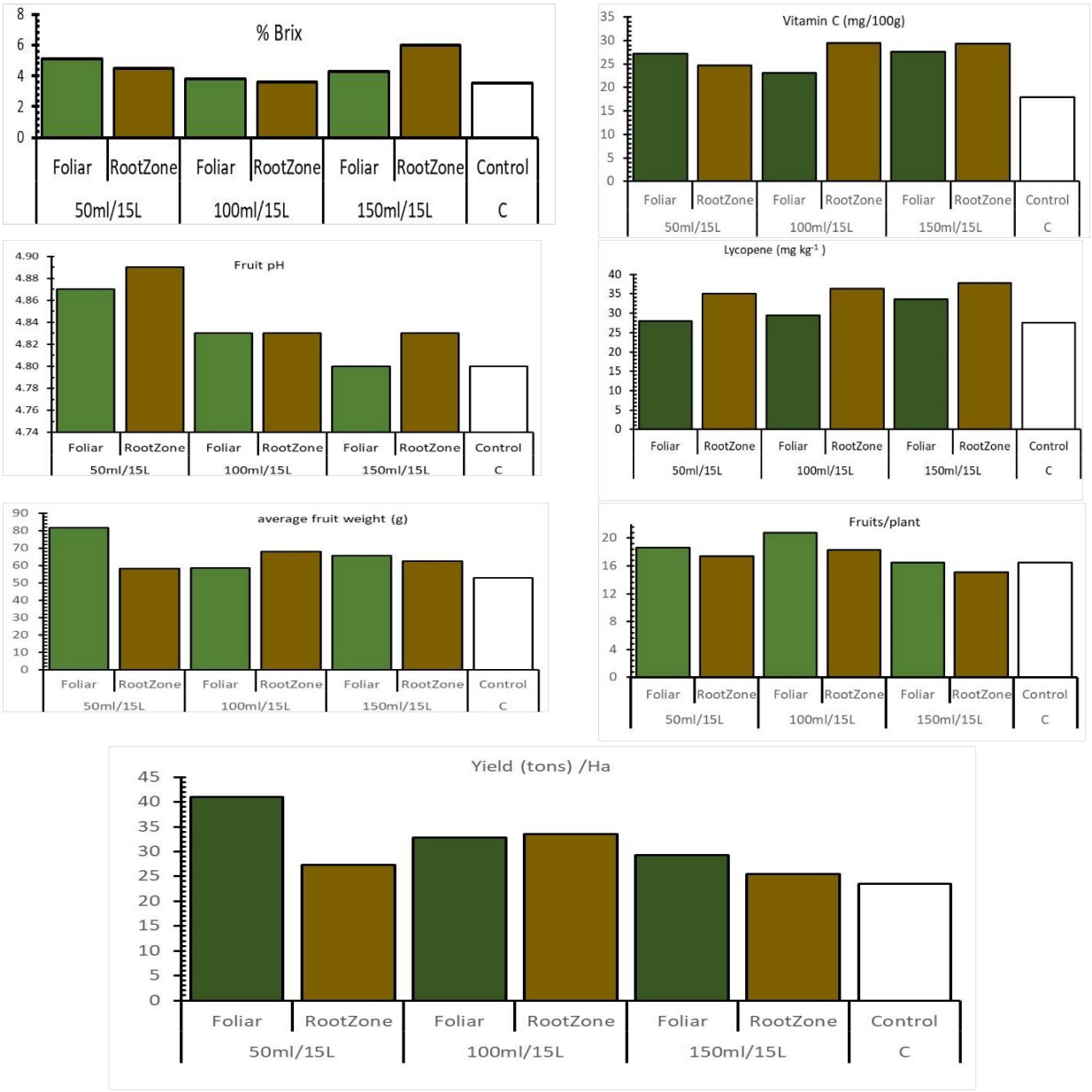


Figure 9: Effect of Vital 05 on yield and quality of tomato variety

- **Eggplant**

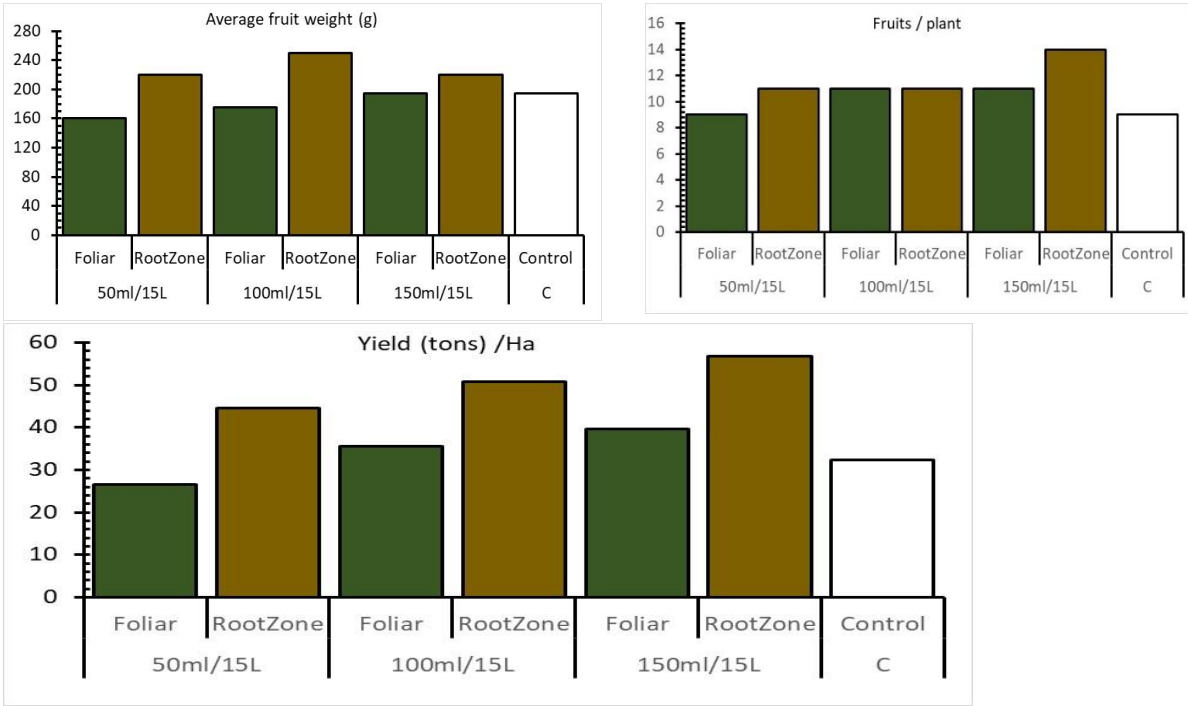


Figure 10: Effect of Vital 05 on yield of eggplant

- **Sweet pepper**

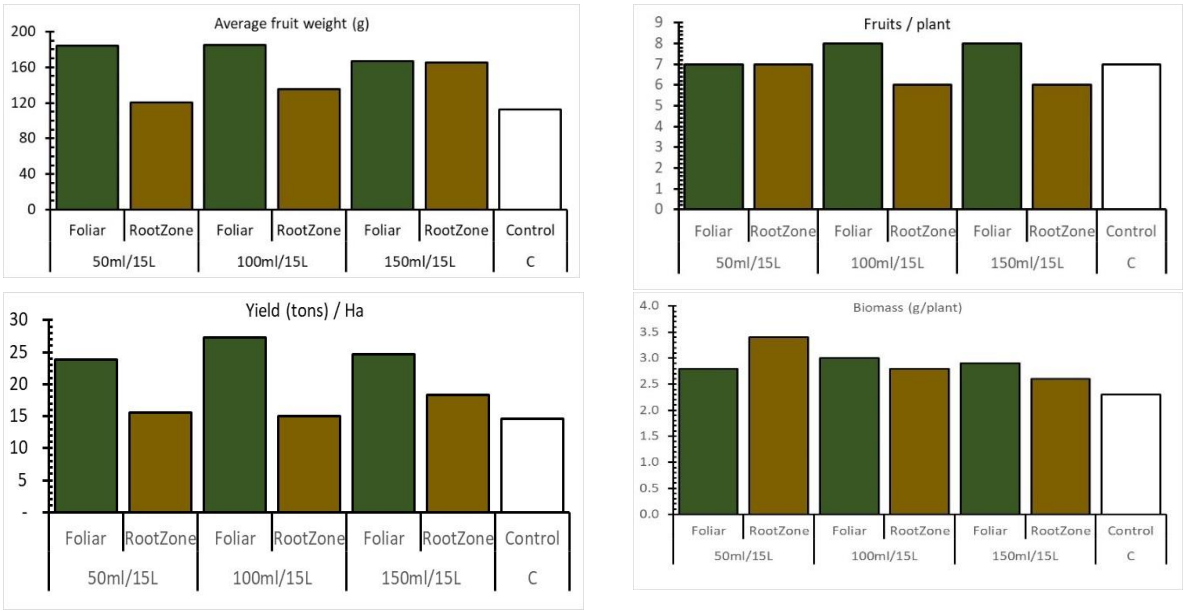


Figure 11: Effect of Vital 05 on fruit and biomass yield of sweet pepper

- **Cucumber**

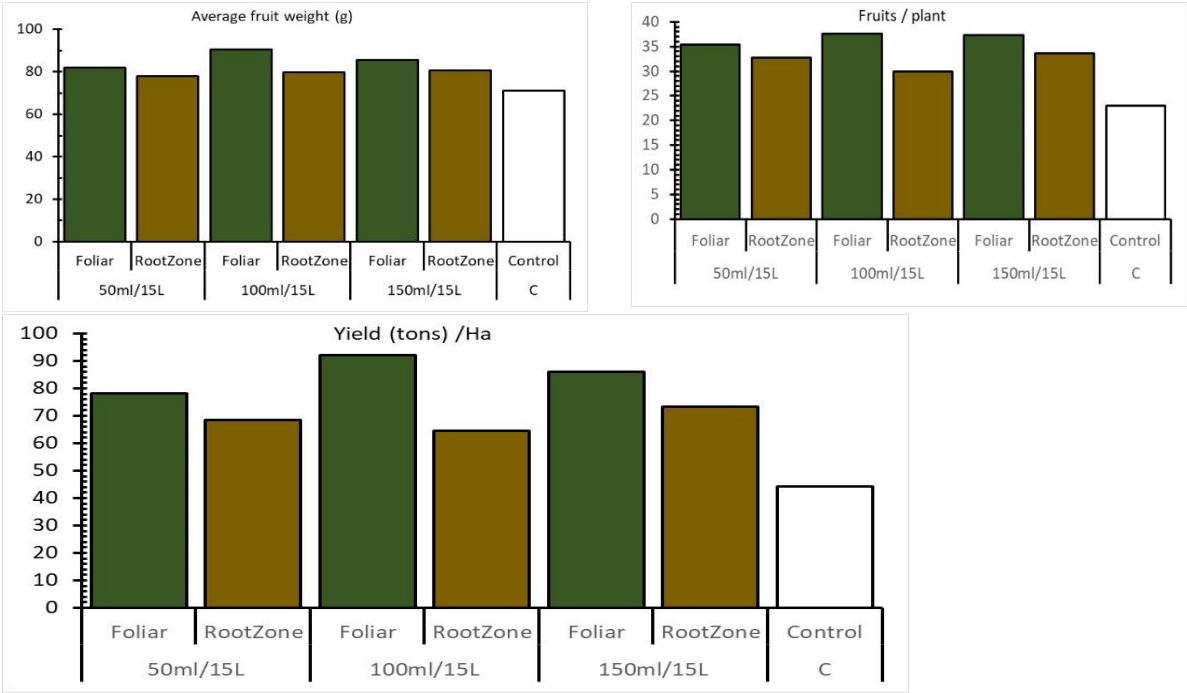


Figure 12: Effect of Vital 05 on fruit yield of cucumber

- **Bok choy**

Table 1. Effect of Vital 05 on yield, leaf count, chlorophyll content, and root-shoot ratio of Bok choy

Application Rate (mL/15 L)	Method	Yield (g leaf fresh weight/plant)	Leaf number	Chlorophyll content	Root-shoot ratio
50	Foliar	130	43.3	46.8	0.2695
	Rootzone	130	40	42.27	0.2538
100	Foliar	128.3	37	52.9	0.3351
	Rootzone	109.3	31.3	47.87	0.3564
150	Foliar	128.3	41	52.17	0.3247
	Rootzone	81.7	30.7	58	0.3984
Control		55	26.3	19.27	0.1716

- **Seedling cocoa**

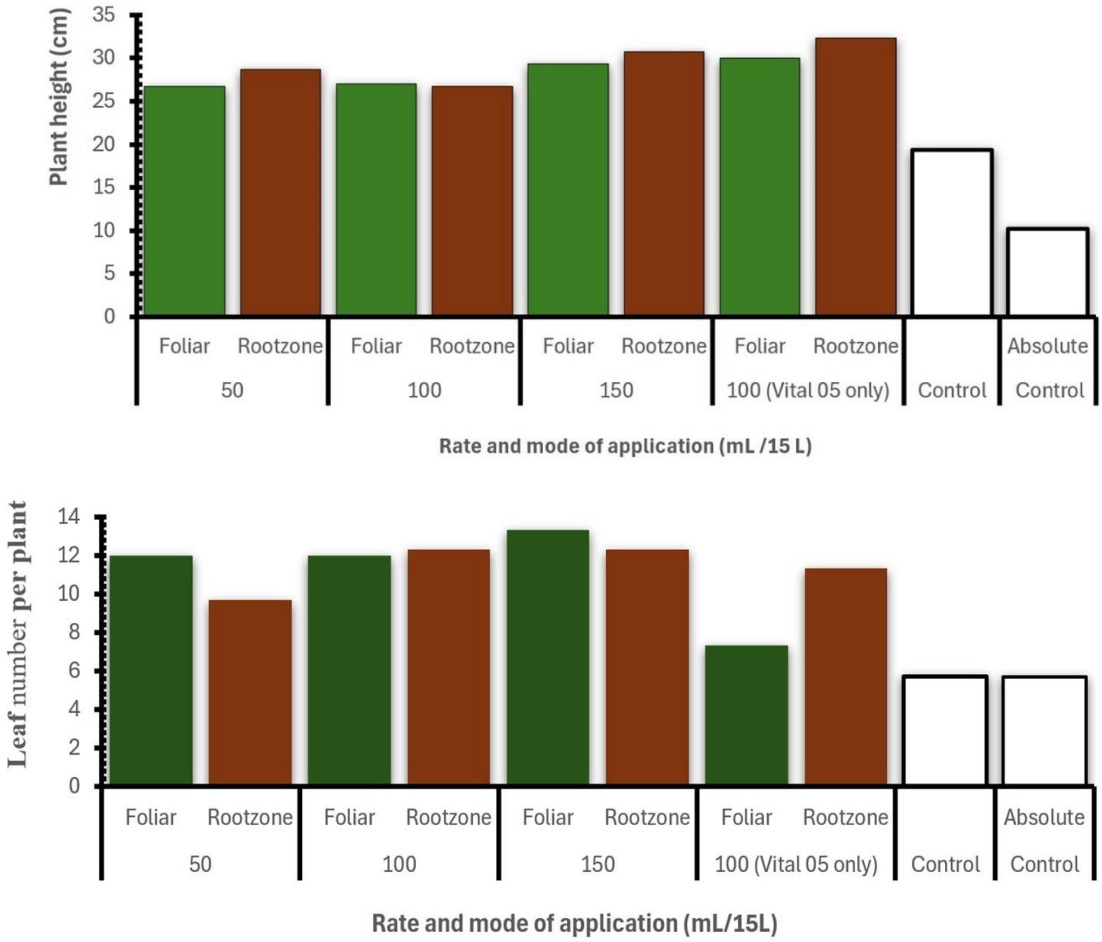
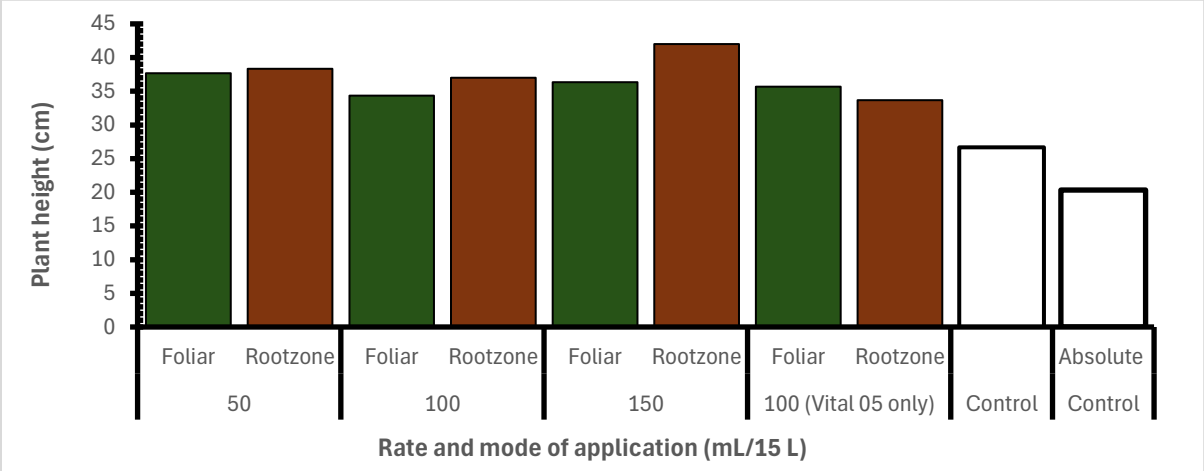


Figure 13: Effect of Vital 05 on seedling growth of cocoa

Table 2. Influence of Vital 05 on plant fresh biomass of cocoa seedlings

		Plant fresh biomass (g/plant)	
Application Rate (mL/15 L)	**Method**	**Root**	**Total plant**
50	Foliar	4.75	14.9
	Rootzone	3.25	16
100	Foliar	4.24	19.2
	Rootzone	5.03	17.6
150	Foliar	3.54	16.7
	Rootzone	4.22	17.8
100 Vital 05 only	Foliar	**6.66**	17.8
	Rootzone	4.61	17.6
Control		1.89	6.8
Absolute Control		0.9	3.3

- **Seedling Mango**



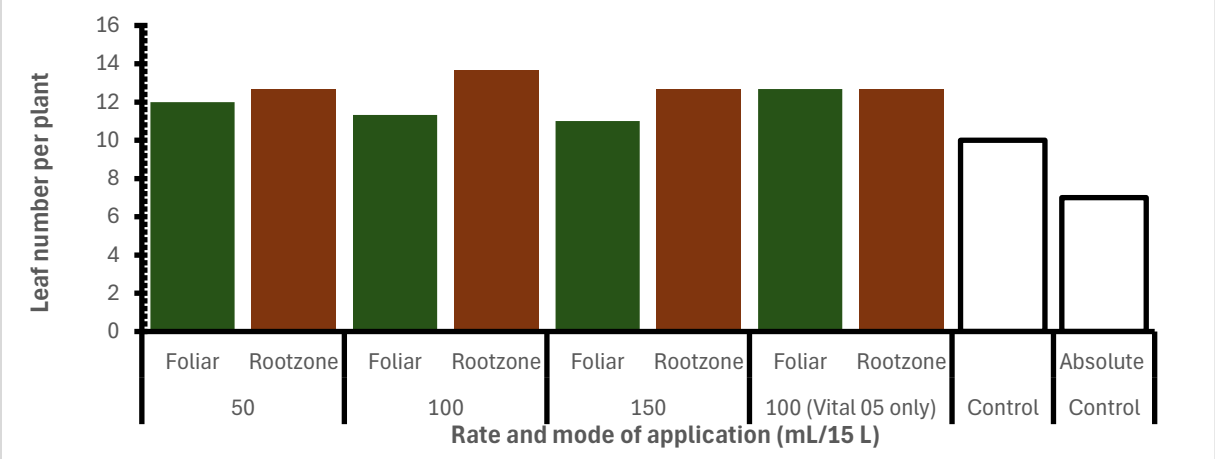


Figure 13: Effect of Vital 05 on seedling growth of mango

Table 3. Influence of Vital 05 on stem thickness and plant biomass production in mango seedlings

Application		Plant fresh biomass (g/plant)		
Rate (mL/15 L)	**Method**	**Total plant**	**Root**	**Girth (cm)**
50	Foliar	31.00	7.05	0.60
	Rootzone	23.48	6.39	0.57
100	Foliar	22.46	6.13	0.57
	Rootzone	30.78	7.66	0.57
150	Foliar	23.64	6.80	0.53
	Rootzone	26.10	6.39	0.57
100 (Vital 05 only)	Foliar	24.16	6.94	0.50
	Rootzone	25.70	6.12	0.53
Control		12.13	2.42	0.37
Absolute Control		6.63	1.76	0.30

- **Maize**

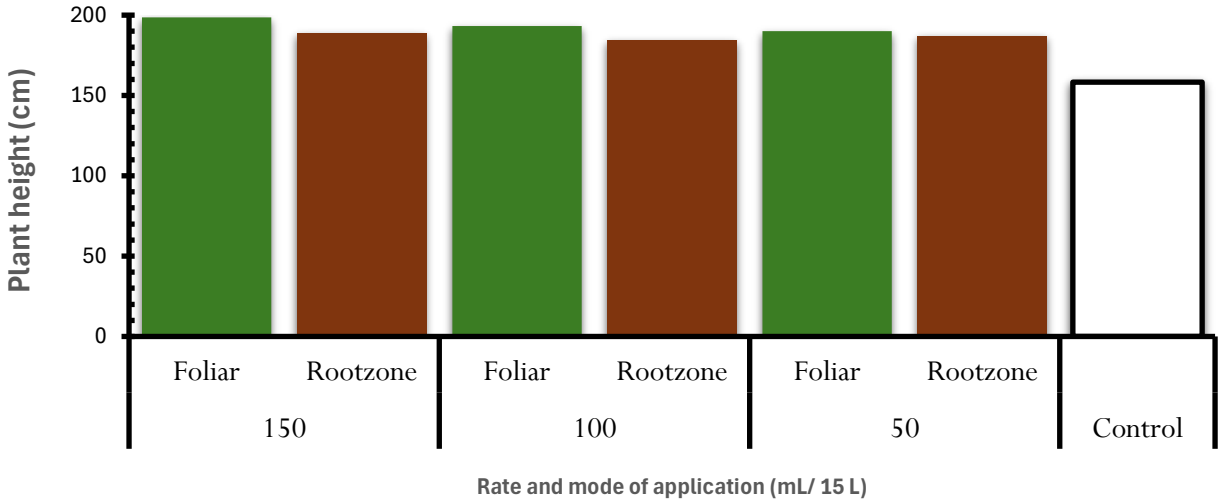


Figure 14: Effect of Vital 05 on growth and yield of maize

Table 4. Influence of Vital 05 on grain and dry stover yields of maize

Application		Yield	
Rate (mL/15 L)	**Method**	**Grain (ton/ha)**	**Dry stover (g/plant)**
50	Foliar	3.011	243.70
	Rootzone	3.055	256.70
100	Foliar	3.403	242.10
	Rootzone	3.382	198.80
150	Foliar	4.249	342.10
	Rootzone	3.156	155.00
Control		1.925	156.20

DISCUSSION

To meet future food production requirements, the impact of climate change on crop production needs to be addressed. Various conventional plant nutrition methods are extensively developed to boost crop production and ensure food security and safety. The application of Plant biostimulants (PBs) is a more sustainable agricultural practice to preserve crop yield under reduced fertilizer conditions. A clearer view of how efficient PBs really function on different crops in different agroecological scenarios and cropping systems is needed. Plant biostimulants should be able to stimulate plant growth and improve one or more additional functions such as nutrient use efficiency, abiotic stress tolerance, crop quality traits, and availability of nutrients. Credible scientific data and in-depth evaluation of the performance of Vital 05 on crop quality and nutrient use efficiency is required from independent scientists to support the claims of its producer to help provide valuable advice for users.

- ## Tomato
  - **Sugar content**: Applying biostimulants at 150 mL per 15 L of water resulted in tomato fruits with an exceptionally sweet taste, significantly surpassing the sweetness of those treated by other methods.
  - **Vitamin C and Lycopene Contents:** Application of the biostimulant directly to the rootzone of the tomato variety resulted in a significant increase in both lycopene and vitamin C levels, especially when compared to foliar treatments. Lycopene, a potent carotenoid responsible for the rich red color of tomatoes, is known for its numerous health benefits, including powerful antioxidant properties and potential protective effects against various diseases.
  - **Yield** Foliar treatments generally resulted in higher average fruit numbers, fruit weight, and yield compared to rootzone and Control treatments. This suggests that foliar application of the biostimulant might be a more efficient method for improving the productivity and quality of fruits.

- ## Eggplant

  Rootzone treatments are generally more effective in increasing the average number of fruits, fruit weight, and overall yield compared to foliar treatments and the control.
  Foliar treatments still provide benefits over the control, particularly in terms of yield, but are less effective than rootzone treatments in this dataset.

- ## Sweet pepper

  Higher concentration foliar treatments (100 mL/15 L and 150 mL/15 L) are generally more effective at increasing the average number of fruits, fruit weight, and overall yield compared to rootzone treatments and the control. While rootzone treatments do offer improvements over the control, they are less effective than foliar treatments.

- ## Cucumber

  Higher concentration foliar treatments (100 mL/15 L and 150 mL/15 L) are typically more effective at boosting the average number of fruits, fruit weight, and overall yield compared to rootzone treatments and the control. While rootzone treatments do offer notable improvements over the control, they are generally less effective than foliar treatments.

- **Bok choy**

  Bok choy cultivated without the application of the Vital 05 biostimulant demonstrated diminished yield and low leaf chlorophyll content. Vital 05 application showed enhanced growth characteristics of Bok choy significantly. The effectiveness of Vital 05 varied with application method and dosage. A concentration of 50 mL of VITAL 05™ mixed with 15 litres of water was found to optimize bok choy yield in a recirculating nutrient film technique (NFT) hydroponic system, where the pH was not adjusted throughout the plant's growth cycle. This dose can be applied via foliar treatment (spraying leaves) or rootzone application through hydroponic system, both enhancing plant growth and productivity.

- **Seedling Cocoa**

  The application of Vital 05 has demonstrated a remarkable potential to accelerate the maturation of cocoa seedlings, reducing the time to maturity to 46 days post-germination. This biostimulant markedly promoted root growth, which is expected to have improved the seedlings' capacity to take up water and nutrients more efficiently. Furthermore, using a foliar spray of 100 mL of the biostimulant resulted in the highest plant growth observed, highlighting its efficacy in promoting healthy development.

- **Seedling Mango**

  Vital 05 significantly reduced the maturation time of mango seedlings to 60 days post-germination. The biostimulant promoted root development, thereby enhancing the seedlings' ability to absorb water and nutrients.

  Applying 50 mL of the biostimulant as a foliar spray significantly boosted the growth and development of mango seedlings (rootstock), demonstrating its effectiveness and cost-efficiency.

- **Maize**

  Both foliar and rootzone applications of the biostimulant significantly increased grain and stover yields relative to the control. Maize yield increased more significantly with foliar application than with rootzone application.

CONCLUSION & RECOMMENDATIONS

Based on the experimental observations, it can be concluded that Vital 05 functions as a **plant conditioner** by stimulating root growth. This enhancement in root development improves the plant's ability to absorb water and nutrients more efficiently, thereby supporting overall plant health and growth.

Vital 05 biostimulant should be applied once the plant has developed enough leaves to effectively absorb the active compounds. This ensures optimal uptake and utilization of the biostimulant. Furthermore, it is recommended to apply the biostimulant at least seven days prior to fertilizer application, allowing time for the biostimulant to stimulate root growth, which can enhance the plant's ability to absorb water and nutrients more efficiently when the fertilizer is applied.

1. For enhanced plant growth, yield, and fruit quality, apply a foliar spray of 100 mL of Vital 05 diluted in 15 L of water to tomato, sweet pepper, cucumber, and eggplant crops. However, for eggplant cultivation, it is recommended to apply the biostimulant directly to the rootzone.
This finding powerfully demonstrates the effectiveness of rootzone treatments in significantly enhancing the nutritional value of tomatoes. These treatments not only boost the brix levels, but also increase the concentrations of vitamin C and lycopene, all of which contribute to the overall health benefits and flavor richness of the fruit.

2. For the cultivation and propagation of Mini Bok Choy and Mango Rootstock, a diluted foliar application of 50 mL of Vital 05 in 15 L of water is recommended.

3. For maize cultivation, it is recommended to apply 150 mL of Vital 05 diluted in 15 L of water by foliar application, particularly during the vegetative phase, to enhance crop vigor and increase yield.
Vital 05 biostimulant exhibited no indications of phytotoxicity, suggesting it is safe for plant health. Furthermore, its potential applications appear extensive, making it suitable for use in various hydroponic systems, including both water and substrate cultures. Additionally, it is also effective in traditional soil-based environments, showcasing its versatility across different growing conditions.

References

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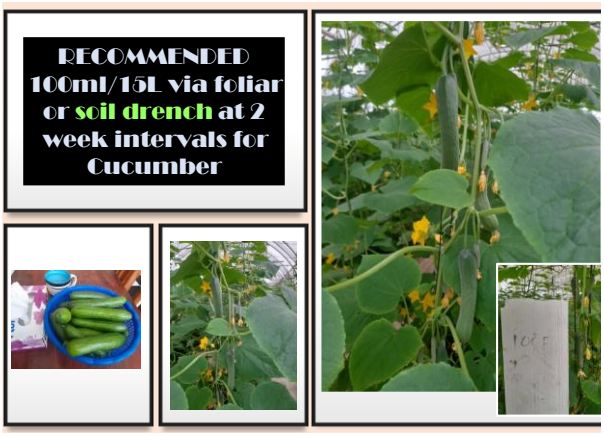
Appendices

RECOMMENDED
100ml/15L via soil drench/foliar at 2 week intervals for EGGPLANTS

RECOMMENDED
100ml/15L via soil drench at 2 week intervals for tomato


RECOMMENDED
100ml/15L via foliar or soil drench at 2 week intervals for Cucumber

RECOMMENDED
150ml/15L via soil drench OR 100ml/15L foliar at 2 week intervals for PEPPER

50D
Drench
50F
Foliar
CONTROL
Control
100D
Drench
100F
Foliar
150D
Drench
150F
Foliar

EP VS GP
50D
DOT
EP VS GP
50F
Dos
EP VS G
150D
Dos
DOT
EP VS GP
100D
Dos

12TH June 2024

VITAL-05
F150

VITAL-05

VITAL-05
F150

VITAL-05
S150

VITAL-05
S100

VITAL-05
S50

CONTROL

VITAL-05
150mL/15L
FOLIAR
28/56 DAA
80 DAG

VITAL-05
100mL/15L
FOLIAR
28/56 DAA
80 DAG

80 DAG