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Participatory Action Research Report

TITLE:

The Efficacy of Different Bokashi
Application Rates on Bean Growth and
Yield in Akongolit Village, Muntu Subcounty,
Amolatar District, Uganda

"DEEPENING RELEVANCE, STRENGTHENING IMPACT"

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The Efficacy of Different Bokashi Application Rates on Bean Growth and Yield in Akongolit
Village, Muntu Subcounty, Amolatar District, Uganda

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1.0 Introduction

Beans are an important food and cash crop for many smallholder farming households in Uganda. In Akongolit Village, Muntu Subcounty, Amolatar District, farmers have experienced challenges affecting bean production, including declining crop performance and the need for affordable and locally available ways of improving soil productivity.

To respond to these challenges, FAPAD, in partnership with the National Agricultural Research Organisation (NARO), Ngetta Zonal Agricultural Research and Development Institute (ZARDI), and a Participatory Action Research (PAR) advisor from Broederlijk Delen (BD), conducted participatory research in Akongolit Village.

Previous experiments had shown better bean performance in plots where Bokashi was applied compared with plots without Bokashi. These findings provided a basis for further investigation into whether the amount of Bokashi applied affected bean growth and productivity. The research therefore focused on testing different Bokashi application rates under the local farming conditions in Akongolit Village.

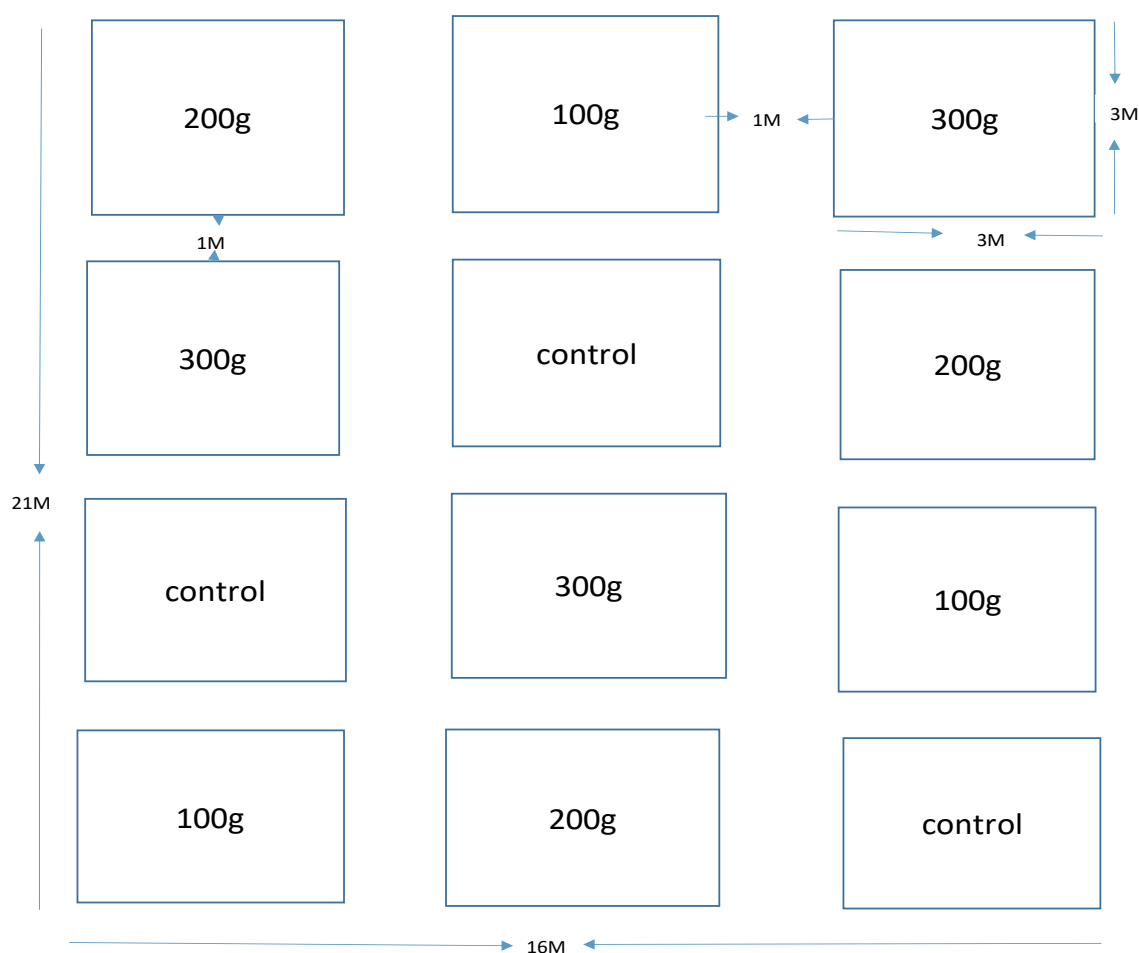
Bokashi was selected as a potential soil amendment because it could be produced from locally available materials and might contribute to improved soil conditions and bean production. The research aimed to generate evidence on how different application rates affected bean performance and to identify an appropriate rate for further consideration.

2.0 Research Design and Methodology

2.1 Study Area

The study was conducted in Akongolit Village, Muntu Subcounty, Amolatar District. Beans are an important crop in the area, serving both as a food crop and a source of income for farming households. The trial was therefore conducted under local farming conditions so that the findings could be relevant to farmers in the community.

2.2 Experimental Design



2.3 Bokashi Preparation

Bokashi biofertilizer is an organic soil amendment (see the laboratory analysis results in the appendix) produced through the controlled fermentation of organic materials using beneficial microorganisms. The fermentation process facilitates the decomposition of organic matter and contributes to the availability of nutrients that can support plant growth and soil fertility. Bokashi is increasingly considered an environmentally sustainable approach to nutrient management because it utilizes organic materials while reducing reliance on synthetic fertilizers.

Materials required

Dry manure (7 sacks), clay soil (5 sacks), charcoal dust (1 sack), dry grass + rice husks (7 sacks) maize bran (1 sack), molasses (5 litres), yeast (500 g), wood ash (1 sack) and water in sufficient quantity.

Bokashi Preparation Procedure

Bokashi was prepared in a shaded area protected from rain. The materials were added in layers in the following order: husks, chicken and cattle manure, clay soil, maize bran, wood ash or rock dust, and charcoal dust. Water was mixed with molasses and yeast in a bucket and then sprinkled evenly over the heap as the layers were added.

The layering process was continued until all materials were used. The heap was then thoroughly turned to ensure uniform mixing and adequate moisture. Moisture content was assessed by squeezing a handful of the mixture. The material was considered adequately moist when it could form a sausage-like shape when squeezed or rolled in the hand.

Management of the Bokashi Heap

The heap was left undisturbed for two days to allow the temperature to rise to approximately 55°C. Four days from that, the heap was turned twice daily to control temperature and ensure proper aeration. From the fifth day onward, the heap was turned once daily.

Temperature was monitored daily by inserting a hand into the heap. The temperature was considered appropriate when the hand could remain in the heap for approximately 10 seconds, although it should not be uncomfortably hot. If the heat was excessive, the heap was turned to reduce the temperature.

Daily turning continued until the temperature of the heap became similar to that of the surrounding environment. This generally occurred between 12 and 19 days after preparation, indicating that the Bokashi was ready for use.

2.4 Plant Population

The study involved planting the local Nabe bean variety with black-coloured seeds at a spacing of 50 cm between rows and 30 cm between planting hills. Each experimental plot measured 3 m × 3 m, giving a total area of 9 m² per plot. At the specified spacing, each plot accommodated 6 rows, with 10 planting hills per row, giving a total of 60 planting hills per plot.

The experiment consisted of 24 plots; therefore, the total number of planting hills was 1,440 (60 planting hills × 24 plots). The plant population was maintained uniformly across all experimental plots.

2.5 Plant Sample Size

The study sampled 10 bean plants out of the 60 planting hills in each plot, equivalent to 16.7% of the planting hills per plot. Since the experiment consisted of 24 plots, a total of 240 bean plants were selected for data collection.

The study employed a random sampling method to select the plants for data collection. The selected plants were evenly distributed within each plot to ensure that the sample represented

the different areas of the experimental plots. Only plants within the designated experimental area were considered for sampling, while border plants were excluded.

2.6 Treatments Evaluated

Treatment	Description
T0	Control – no Bokashi
T1	100 g Bokashi
T2	200 g Bokashi
T3	300 g Bokashi

The treatments were selected through discussions with farmers and were designed using locally available materials. The experiment was established on 5 September 2025 and 8 April 2026, following the onset of rains and in line with the local planting season.

2.7 Data Collection

The study measured both growth and yield parameters to assess the efficacy of the treatments.

Growth Parameters

- Plant height (cm)
- Growth vigour
- Number of branches per plant

Yield Parameters

- Number of pods per plant
- Pod length (cm)
- Number of seeds per pod
- 100-grain weight (g)
- Grain yield per plot (g)

2.8 Data Analysis

Data was cleaned and summarized using Microsoft Excel. Statistical testing was conducted using Stata software. Specifically:

- Analysis of Variance (ANOVA) was used to determine if there were statistically significant differences in performance among the treatments.

The results were reviewed and interpreted with input from field staff, the MEAL officer and the BD PAR advisor, with the intention of making the findings useful to farmers and other stakeholders.

3.0 Results

3.1 Effects of Bokashi Treatments on Selected Growth and Yield Parameters Across Seasons 1 and 2

3.1.1 Effects of treatments on plant height (cm)

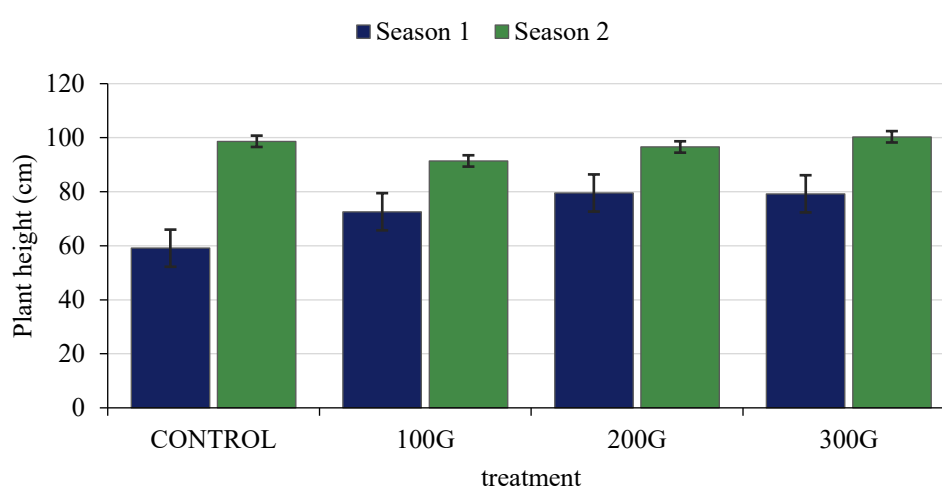


Figure 1: Effects of treatment on plant height (cm)

In Season 1, plants in all Bokashi plots grew taller than the control (59.10 cm). The 200 g treatment was tallest at 79.53 cm, just ahead of 300 g (79.23 cm), while 100 g reached 72.60 cm. Bokashi probably helped the soil hold more moisture and nutrients around the roots, but going beyond 200 g did not add more height.

In Season 2, plants were taller overall. The 300 g treatment was highest at 100.33 cm, followed by the control (98.67 cm) and 200 g (96.57 cm), with 100 g lowest at 91.40 cm. Better rainfall and soil moisture may explain the general increase, and the change in ranking shows that the effect of Bokashi depends on the season.

3.1.2 Effects of treatments on growth vigour

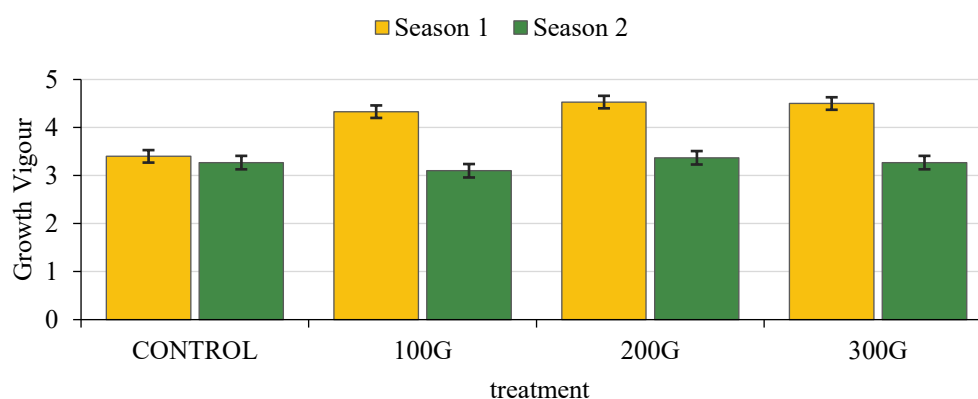


Figure 2: Effects of treatment on growth vigour for S1 and S2

In Season 1, the control had the lowest vigour score (3.40), while 200 g scored highest (4.53), followed by 300 g (4.50) and 100 g (4.33). Bokashi may have improved moisture and nutrient supply, giving healthier plants.

In Season 2, 200 g still scored highest (3.37) and 100 g lowest (3.10), with the control and 300 g the same at 3.27. The gap between treatments was much smaller, which suggests that rainfall and natural soil fertility mattered more than Bokashi that season.

3.1.3 Effects of treatments on number of branches per plant

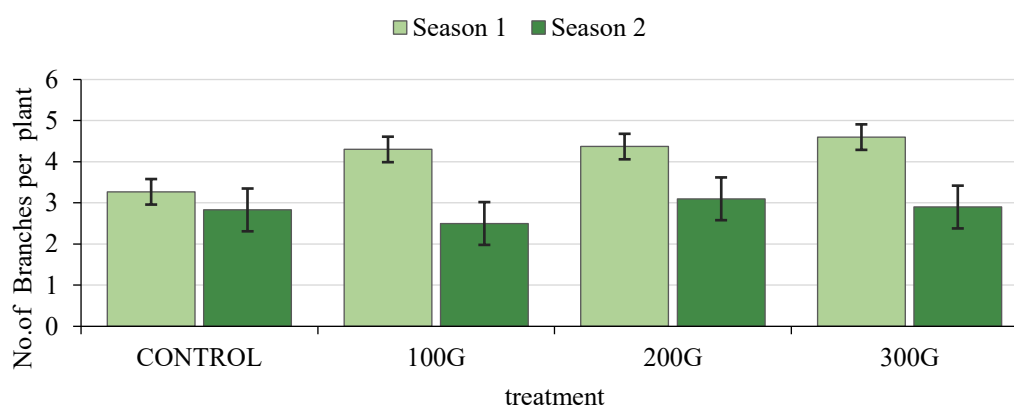


Figure 3: Effects of treatments on number of branches per plant for both S1 and S2

In Season 1, branching rose with the Bokashi rate, from 3.27 branches per plant in the control to 4.30 (100 g), 4.37 (200 g) and 4.60 (300 g). Better moisture and nutrients around the roots may have supported this extra growth.

In Season 2, the pattern changed. The 200 g treatment had the most branches per plant (3.10) and 100 g the fewest (2.50), while the control (2.83) and 300 g (2.90) were similar. The response

to Bokashi was therefore not consistent between seasons, possibly because of differences in rainfall and soil conditions.

3.1.4 Effects of treatments on No. of pods per plant

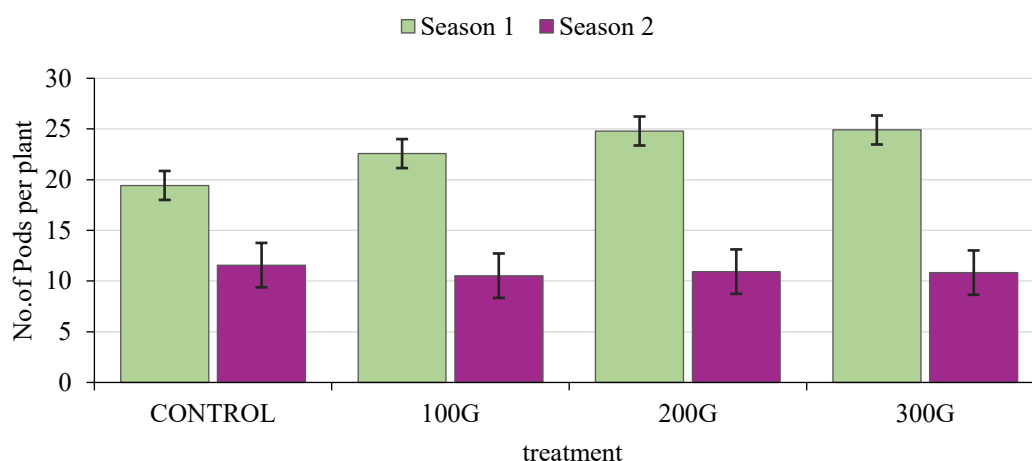


Figure 4: Effects of treatments on number of pods per plant for both S1 and S2

In Season 1, pods per plant increased from 19.43 in the control to 22.57 (100 g), 24.80 (200 g) and 24.90 (300 g). Bokashi may have improved moisture and nutrient supply, helping plants set more pods.

In Season 2, the result reversed. The control had the most pods per plant (11.57), while the Bokashi treatments were slightly lower: 10.93 (200 g), 10.83 (300 g) and 10.53 (100 g). Bokashi gave no advantage in pod production that season, so its effect appears to depend on the growing conditions.

3.1.5 Effects of treatments on pod length (cm)

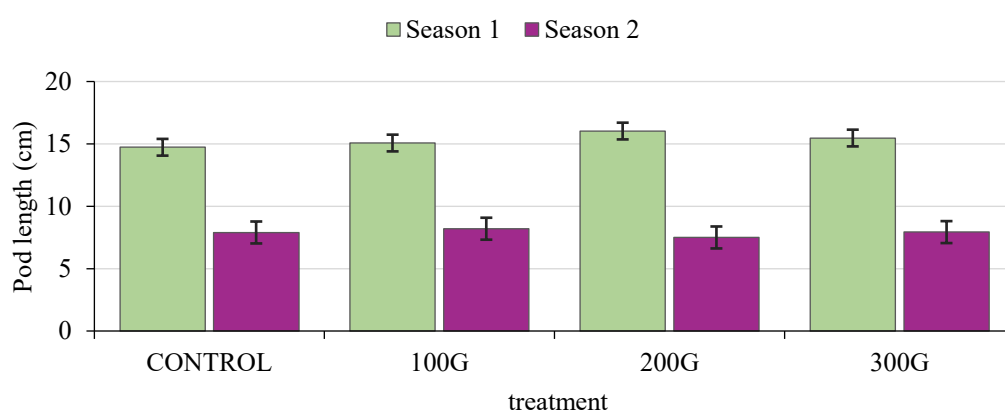


Figure 5: *Effects of treatments on pod length for both S1 and S2*

In Season 1, pods were longest under the 200 g treatment (16.03 cm), followed by 300 g (15.47 cm) and 100 g (15.07 cm), while the control had the shortest pods (14.73 cm). In Season 2, pods were much shorter overall: 100 g was longest (8.20 cm) and 200 g shortest (7.50 cm), with the control at 7.90 cm and 300 g at 7.93 cm. Differences among treatments were small in both seasons, so season had a bigger effect on pod length than Bokashi.

3.1.6 Effects of treatments on number of seeds per pod

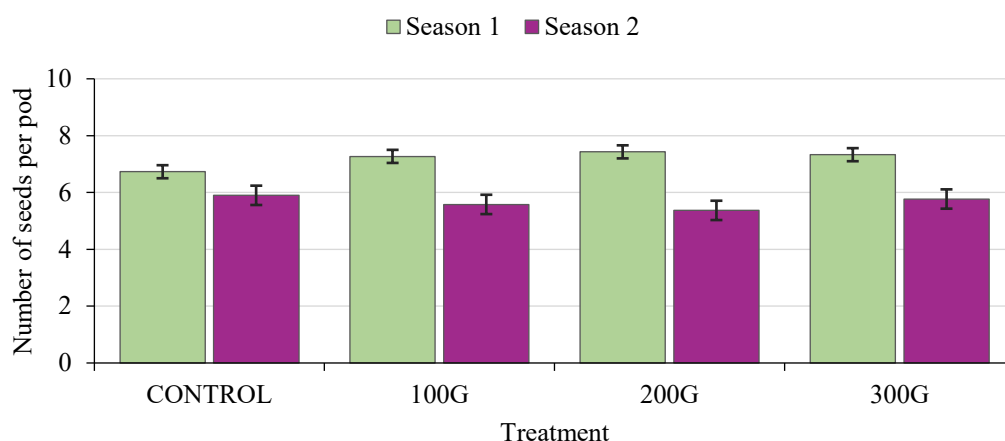


Figure 6: *Effects of treatments on number of seeds per pod for both S1 and S2*

In Season 1, seeds per pod rose from 6.73 in the control to 7.27 (100 g), 7.43 (200 g) and 7.33 (300 g). In Season 2, the control had the most seeds per pod (5.90) and 200 g the fewest (5.37), and all treatments were lower than in Season 1.

3.1.7 Effects of treatment on Grain weight per plot

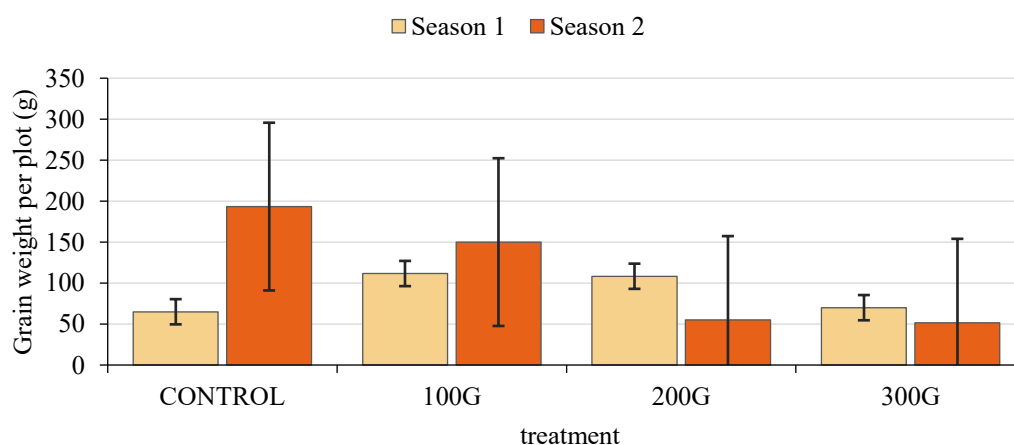


Figure 7: *Effects of treatments on Grain weight per plot for both S1 and S2*

In Season 1, the 100 g treatment gave the highest grain weight per plot (111.67 g), closely followed by 200 g (108.33 g). The control was lowest (65.00 g) and 300 g only slightly higher (70.00 g). Moderate Bokashi rates seem to have suited grain development better than the highest rate.

In Season 2, the pattern changed. The control gave the highest grain weight (193.33 g), followed by 100 g (150.00 g), while 200 g (55.00 g) and 300 g (51.67 g) were much lower. Grain weight was higher overall than in Season 1, so both Bokashi rate and seasonal conditions appear to have influenced yield.

3.1.8 Effects of treatment on 100-Grain Weight

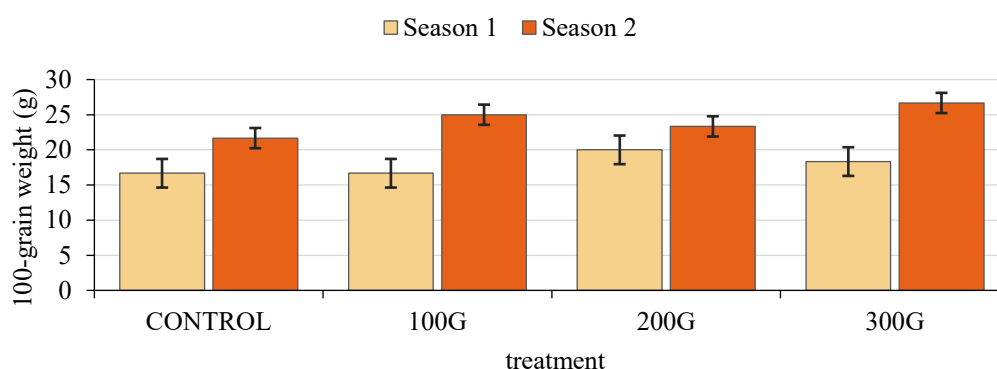


Figure 8: *Effects of treatments on 100 grain weight for both S1 and S2*

In Season 1, the 200 g treatment gave the heaviest 100 grains (20.00 g), followed by 300 g (18.33 g), while the control and 100 g were lower and identical (16.67 g). Adequate moisture and nutrients during grain filling may explain the result at 200 g.

In Season 2, 300 g gave the heaviest 100 grains (26.67 g), followed by 100 g (25.00 g) and 200 g (23.33 g), with the control lowest (21.67 g). The best rate differed between seasons, and grains were generally heavier in Season 2, possibly because of better moisture during grain filling.

4.0 Analysis of Variance

4.1 Analysis of variance on the effects of treatments on growth parameters for Season 1

Table 1: *Analysis of variance on the effects of treatments on growth parameters for Season 1*

Parameter	CONTROL	100G	200G	300G
Plant height (cm)	59.10a	72.60a	79.53a	79.23a
Growth vigour	3.40b	4.33a	4.53a	4.50a
No. of branches per plant	3.27a	4.30a	4.37a	4.60a

Means within a row followed by the same letter are not significantly different (Tukey's HSD, $\alpha = 0.05$).

Plant height and number of branches per plant showed no significant differences among treatments ($p > 0.05$). Although plants treated with 200 g and 300 g had higher mean plant heights and branch numbers than the control, these differences were not statistically significant. Growth vigour, however, showed a significant treatment effect ($p < 0.05$). The control had a significantly lower mean score (3.40) than the 100 g (4.33), 200 g (4.53), and 300 g (4.50) treatments. The three Bokashi treatments did not differ significantly from one another.

4.4 Analysis of variance on the effects of treatments on yield parameters for Season 2

Table 4: Analysis of variance on the effects of treatments on yield parameters for Season 2

Parameter	CONTROL	100G	200G	300G
No. of pods per plant	11.57a	10.53a	10.93a	10.83a
Pod length (cm)	7.90a	8.20a	7.50a	7.93a
No. of Seeds per pod	5.90a	5.58a	5.37a	5.77a
100-grain weight (g)	21.67a	25.00a	23.33a	26.67a
Grain weight per plot (g)	193.33a	150.00a	55.00a	51.67a

Means within a row followed by the same letter are not significantly different (Tukey's HSD, $\alpha = 0.05$)

None of the yield parameters differed significantly among treatments ($p > 0.05$). The treatments produced statistically similar numbers of pods, pod lengths, seeds per pod, 100-grain weights, and grain weights per plot. Although the 300 g treatment recorded the highest 100-grain weight, the control recorded the highest grain weight per plot, these differences were not statistically significant.

5.0 Discussion of Findings

The study assessed the effect of different Bokashi application rates on bean growth and yield under the local farming conditions of Akongolit Village. The results showed that bean response to Bokashi varied across the measured growth and yield parameters and between the two cropping seasons. Although Bokashi treatments generally showed better performance than the control for several parameters in Season 1, most of the differences were not statistically significant. Growth vigour was the main parameter that showed a significant treatment response in Season 1.

Season 1 generally recorded better bean performance than Season 2. This coincided with more reliable rainfall during Season 1 compared with Season 2. Reliable rainfall is important for bean growth, particularly during establishment, flowering, pod formation, and grain filling. The results therefore suggest that Bokashi performs better when adequate and reliable moisture is available.

The less consistent performance of Bokashi in Season 2 may be associated with the less reliable rainfall experienced during that season. Bokashi is relatively porous and can lose moisture under prolonged dry conditions. Since the study used band placement, the Bokashi was concentrated around the planting point and close to the developing root zone. While this

placement can make the amendment readily available to the crop under favourable conditions, the amended area may also dry relatively quickly when rainfall is inadequate.

The results also showed that increasing the Bokashi rate did not consistently result in better bean growth or yield. The highest application rate was not always the best-performing treatment, while lower and intermediate rates performed well for some parameters. This indicates that the relationship between Bokashi rate and crop performance is not straightforward and may depend on seasonal and soil conditions.

The findings also demonstrate that good vegetative growth does not necessarily translate into higher grain yield. Crop yield is influenced by several stages of development, including flowering, pod formation, seed development, and grain filling, all of which can be affected by moisture and other environmental conditions.

Overall, the findings highlight the importance of considering Bokashi application together with rainfall, soil moisture, soil characteristics, formulation, and application method. The results provide a useful basis for continued farmer-led experimentation and further research.

5.1 Areas for Further Research

Based on the findings, four key areas require further investigation.

1. Test Bokashi prepared with different quantities of clay soil to determine whether increased clay content can improve moisture retention and reduce rapid drying, particularly during dry periods.
2. Monitor rainfall and soil moisture alongside crop growth and yield. This would help establish how moisture availability influences the performance of Bokashi and explains the differences observed between seasons.
3. Compare band placement with other application methods and test a wider range of Bokashi rates. This would help identify an application approach and rate that provide more consistent performance under different moisture conditions.
4. The trial should be repeated over several seasons and on different soil textures to determine whether the findings remain consistent under different environmental and soil conditions.

6.0 Recommendations

Based on the findings of the study, the following recommendations are made:

1. Bokashi should preferably be used where rainfall is reasonably reliable, as its performance was generally more favourable during the season with better rainfall.
2. Bokashi should be combined with soil and water conservation practices in areas where rainfall is unreliable to help maintain moisture around the crop root zone.

3. Further farmer trials should be conducted before recommending a single Bokashi application rate, since no rate consistently performed best across all parameters and seasons.
4. The Bokashi formulation should be further refined, particularly by investigating the use of different quantities of clay soil to improve moisture retention.
5. Participatory research should continue, with farmers involved in testing different formulations, rates, and application methods under their local farming conditions.



4.2 Analysis of variance on the effects of treatments on yield parameters for Season 1

Table 2: Analysis of variance on the effects of treatments on yield parameters for Season 1

Parameter	CONTROL	100G	200G	300G
No. of Pods per plant	19.43a	22.57a	24.80a	24.90a
Pod length (cm)	14.73a	15.07a	16.03a	15.47a
Seeds per pod	6.73a	7.27a	7.43a	7.33a
100-grain weight (g)	16.67a	16.67a	20.00a	18.33a
Grain yield per plot (g)	65.00a	111.67a	108.33a	70.00a

Means within a row followed by the same letter are not significantly different (Tukey's HSD, $\alpha = 0.05$).

None of the yield parameters showed a statistically significant difference among treatments ($p > 0.05$). Although the 200 g and 300 g treatments generally recorded higher pod numbers, while the 200 g treatment had the highest 100 grain weight, these differences were not statistically significant. Grain yield per plot also varied among treatments, but the differences were not significant.

4.3 Analysis of variance on the effects of treatments on growth parameters for Season 2

Table 3: Analysis of variance on the effects of treatments on growth parameters for Season 2

Parameter	CONTROL	100G	200G	300G
Plant height (cm)	98.67a	91.40a	96.57a	100.33a
Growth vigour	3.27a	3.10a	3.37a	3.27a
No. of branches per plant	2.83a	2.50a	3.10a	2.90a

Means within a row followed by the same letter are not significantly different (Tukey's HSD, $\alpha = 0.05$).

There were no significant differences among treatments for plant height, growth vigour, or number of branches per plant ($p > 0.05$). While the 300 g treatment recorded the highest mean plant height (100.33 cm), this difference was not statistically significant compared with the other treatments.

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REPORT ON FERTILIZER ANALYSIS RESULTS

SAMPLE NAME: BOKASHI BIO FERTILIZER

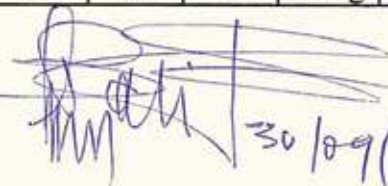
Laboratory Analysis

The homogenised samples were first digested using acid digestion mixture of
(Conc.H₂SO₄ + LiSO₄ + Se + H₂O₂)

From the digest, Total Phosphorus was determined using spectrophotometer, Total Nitrogen by distillation,
Total potassium by Flame photometer, Calcium and Magnesium by AAS

Table of Obtained Results

pH	O.C	N	P	K	Ca	Mg
All units in g/100g of fertilizer or (%age)						
7.5	19.5	2.69	0.89g	2.33	0.35	0.122



30/09/2026

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