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FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

DEPARTMENT OF CROP SCIENCE

A PROJECT ON EVALUATING THE EFFECTS OF DIFFERENT FERTILIZER REGIMES ON THE GROWTH AND YIELD OF SUGAR BEANS *(Phaseolus vulgaris)*

BY

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(CROP SCIENCE)

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DECLARATION

I Elias Diwa, (B224861B) attest that this research report is entirely my own, independent work, and I have fully acknowledged all of the references and mentioned sources that I used. This report has never been turned in for a test or research.

Student's Signature: Date: 17/09/2025

SUPERVISOR

I have supervised the research project for the above-mentioned student and I am convinced that the research can be submitted.

Signature Date: 16/09/2025

DEDICATION

I dedicate this project to smallholder farming communities aiming to achieve food security and sustainability throughout the growing season. And also, to my wife, children and friends for their love unwavering support, encouragement and prayers during the compilation of this project.

ACKNOWLEDGEMENTS

All the glory and honor I give first of all to the Almighty God for allowing me to be part of this amazing program of Crop Science. I say EBENEEZER this far has the LORD taken us and saw me through this season. I am so thankful especially for the grace to complete, for strength to be able pull through amidst the demands of work, family, and other social issues. From day one it has been God. I am so thankful again for the His marvelous provision for me to be able to complete this phase of the program. Again, to Him be all the glory!

I would also like to express my sincere gratitude to my supervisor Mr Mutsengi for his wisdom, guidance and support and advice, encouragement and supervision for this project to be a success. And Mr J Chitamba for his great assistance for this project to be finally a success.

I would also like to thank my family and friends for their financial support and encouragement they offered. To my university colleagues I say this journey would have not been a success without you. To my wife Gamuchirai, you have been such a huge encouragement and a pillar of strength. You have been there when things did not make sense but here, we are, you actually made me to realize my dream and passion. Thank you for your love, trust and unwavering support over the years.

Finally, special mention and thanks to the Operation Mobilization Leadership and team for allowing me time to carry out this project inside and outside working hours. Their support and encouragement mean a lot.

ABSTRACT

The study was done at Ngazimbi Village, at the researcher's homestead in Goromonzi District in Zimbabwe during the 2024-2025 growing season. To assess the impacts of different fertilizer regimes on the growth and yield of Sugar beans (*Phaseolus vulguris),* focusing on how various applications influence growth performance. Specifically, the study aims to assess the impact of different fertilizer treatments on growth metrics, determine the optimal type and application rate for maximum yield, and evaluate the economic feasibility of these fertilizer regimes. The study was conducted using a randomized complete block design (RCBD) to assess the effects of various fertilizer regimes, which includes manure, Compound D, Compound D + Manure, and a control on germination, plant population, height, and yield of sugar beans. Significant differences were observed in germination percentages, with manure and Compound D + Manure showing the highest rates, while the control exhibited minimal growth. Throughout the 12 weeks, treatments also significantly enhanced plant population and height, with the combined treatment yielding the highest output per plant ($p<0.001$), underscoring the effectiveness of these fertilizers compared to the control. The combined application of Compound D and manure significantly enhances growth metrics, yielding an average plant height of 48 cm and 32 leaves by week 12. This treatment also resulted in a substantial increase in pod production and overall yield, averaging 500 kg/ha compared to only 190 kg/ha for the control group. In conclusion, the study demonstrates that the combined application of Compound D and manure significantly enhances growth metrics, pod production, and overall yield in sugar beans. The findings underscore the importance of integrated nutrient management, which can substantially improve crop performance compared to single fertilizer applications, thereby offering smallholder farmers a viable strategy to enhance yields and contribute to food security. Based on the results, it is recommended that farmers adopt the combined use of Compound D and manure to maximize germination rates, plant population, height, and overall yield of sugar beans. This integrated approach not only enhances crop performance but also promotes sustainable farming practices.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The cultivation of Sugar beans (*Phaseolus vulgaris*) plays a crucial role in global food systems due to its nutritional value and contribution to sustainable agricultural practices. In many developing countries, including Zimbabwe, smallholder farmers often struggle with limited resources, knowledge, and access to modern agricultural practices. The reliance on traditional farming methods, coupled with inadequate fertilizer use, can result in suboptimal yields. This situation emphasizes the need for research that evaluates the effectiveness of different fertilizer regimes specifically tailored to local conditions (Block, 1994). By investigating how various fertilizers influence the growth and yield of sugar beans, this study aims to provide valuable insights that can lead to improved agricultural practices and enhanced food security.

Agriculture plays a crucial role in the socioeconomic development of many countries, particularly in rural areas where a significant portion of the population relies on farming for their livelihoods (Runganga, 2021). Among the various crops cultivated, sugar beans (Phaseolus vulgaris) have emerged as an important source of protein and essential nutrients, particularly in regions where dietary diversity is limited. The cultivation of sugar beans is not only vital for food security but also contributes to the economic resilience of smallholder farmers, who often face challenges related to productivity and sustainability.

The productivity of sugar beans, like many other crops, is heavily influenced by soil fertility and nutrient availability (Abdela Negash, 2018). Fertilizers are key inputs that can enhance crop growth, improve yield, and ultimately support the food needs of growing populations (Eden, 2003). However, the choice and application of fertilizers remain critical decisions for farmers. Different fertilizer regimes that is, combinations of organic and inorganic fertilizer can yield varying results in terms of plant growth and overall productivity (Nemeskéri E., 2018). Understanding these effects is essential for optimizing agricultural practices and achieving sustainable farming outcomes.

Furthermore, the increasing pressures of climate change and environmental degradation necessitate a shift towards more sustainable farming practices. Understanding which fertilizer regimes can optimize growth while minimizing negative environmental impacts is crucial for the future of agriculture. This study will contribute to the body of knowledge on sustainable agricultural practices, offering evidence-based recommendations for smallholder farmers especially in Gazimbi village and similar regions.

In summary, this research seeks to evaluate the effects of different fertilizer regimes on the growth and yield of sugar beans, addressing critical challenges faced by smallholder farmers. By focusing on this important crop and its nutrient requirements, the study aims to enhance agricultural productivity, promote food security, and support the livelihoods of vulnerable communities.

1.2 PROBLEM STATEMENT

Smallholder farmes in many rural areas face challenges in optimizing Sugar bean production, primarily due to inadequate understanding of the specific nutrient requirements and the effects of various fertilizer regimes on plant growth and yield (Russo, 2006)

Current agricultural practices frequently rely on traditional fertilization methods that often overlook the specific needs of sugar beans and the interactions between various fertilizer types. This oversight can result in suboptimal growth, diminished yields, and increased costs for farmers, ultimately jeopardizing food security and economic sustainability (Smith & Johnson, 2020). Furthermore, the overuse or inappropriate application of fertilizers can lead to severe environmental consequences, such as soil degradation and water pollution (Jones et al., 2018).

Despite the potential advantages of tailored fertilization strategies, there remains a significant gap in research regarding the comparative effects of organic, inorganic, and integrated fertilizer regimes on the growth and yield of sugar beans. Existing studies often have a limited scope, failing to provide comprehensive insights that could inform effective agronomic practices (Brown, 2019). Therefore, there is an urgent need for systematic evaluations of how different fertilizer regimes affect key growth parameters and yield components of sugar beans across various soil types, environments and environmental conditions.

The increasing demand for food, coupled with the need for sustainable agricultural practices, underscores the importance of optimizing crop production methods. Sugar beans (*Phaseolus vulgaris*) are a vital source of protein and nutrients for many communities, especially among smallholder farmers. This dissertation aims to evaluate the effects of different fertilizer regimes on the growth and yield of sugar beans, hypothesizing that specific fertilizer applications will significantly enhance both growth parameters and yield.

1.3 Justification.

Assessing fertilizer regimes for the growth and yield of sugar beans (*Phaseolus vulgaris*) is crucial due to their significant role in global food systems, particularly in regions like Africa where they provide essential nutrients and protein. In Zimbabwe, optimizing yields is vital for enhancing food security, increasing farmer incomes, and contributing to national economic growth. Research shows that different fertilizers supply essential nutrients, such as nitrogen, phosphorus, and potassium, directly influencing crop productivity. Tailoring fertilizer applications can lead to substantial yield increases, thereby supporting the dietary needs of growing populations and improving the livelihoods of smallholder farmers. (Smith A. &., 2020).

Moreover, cost-effective fertilizer strategies allow farmers to maximize profits and reinvest in their operations, enhancing overall quality of life. Sustainable practices, including the use of organic fertilizers and integrated nutrient management, can improve soil health and mitigate the negative environmental impacts of chemical fertilizers. Techniques like crop rotation and cover cropping not only enhance soil quality but also promote biodiversity, which is essential for long-term agricultural sustainability. By increasing sugar bean yields through optimized fertilizer use, farmers can significantly contribute to food security, combat malnutrition, and foster economic stability in rural communities, ensuring a reliable food supply as demand grows. (Nguyen, T.L., Smith, R.J., & Carter, J., 2019).

1.4 Objectives

1.4.1 Main Objective

The primary objective of the study is to "Evaluate the effects of different fertilizer regimes on the growth and yield of Sugar beans (*Phaseolus vulgaris*)" is to determine how various fertilizer applications influence the growth performance and yield of sugar beans. This includes:

1.4.2 Specific Objectives

1. To determine the effect of different fertilizer regimes on the germination percentage of sugar beans.
2. To assess the impact of various fertilizer regimes on the plant population of sugar beans.
3. To evaluate the influence of different fertilizer regimes on the plant growth, height and number of sugar bean pods.
4. To investigate the effect of different fertilizer regimes on the overall crop yield of sugar beans.

1.5 Hypothesis Statement

1. (H0): There is no significant difference in germination percentage among sugar beans subjected to different fertilizer regimes.
2. (H0): Fertilizer regimes do not significantly impact the plant population of sugar beans.
3. (H1): Different fertilizer regimes significantly influence the plant height of sugar beans.
4. (H1): Different fertilizer regimes lead to significant differences in the overall crop yield of sugar beans.

1.6 Chapter Summary

The research on evaluating the effects of different fertilizer regimes on the germination, growth and yield of sugar beans is critical for enhancing agricultural productivity, improving farmer incomes, promoting sustainable practices, and contributing to national economic growth. By focusing on the specific needs of sugar beans and the potential benefits of optimized fertilizer use, this research not only supports individual farmers but also has broader implications for food security and economic stability in Zimbabwe. Investing in such research is essential for ensuring a resilient agricultural sector capable of meeting the challenges of the future.

Chapter 2: Literature Review

The literature review serves as a critical foundation for understanding the effects of different fertilizer regimes on the growth and yield of sugar beans (Phaseolus vulgaris). This chapter synthesizes existing research on sugar beans, the role of fertilizers in crop production, and the implications of various fertilization strategies for enhancing agricultural productivity.

2.1 Overview of Sugar Beans (*Phaseolus vulgaris*)

Sugar beans, a variety of common beans, are a vital leguminous crop known for their high protein content and essential nutrients. Widely cultivated for their edible seeds and pods, they are particularly important in regions where dietary diversity is limited. This plant belongs to the Fabaceae family and plays a crucial role in global food security due to its nutritional value and adaptability (Moyo, S. & Chikanda, A., 2021).

Research has shown that sugar beans are rich in amino acids, vitamins, and minerals, making them an excellent food source for both rural and urban populations. Their adaptability to various climatic conditions and ability to improve soil fertility through nitrogen fixation make them an attractive option for smallholder farmers (Chikowo, 2020).

2.2 Growth Requirements

For optimal growth, *Phaseolus vulgaris* has specific requirements that must be met. The common bean thrives in warm climates, with ideal temperatures ranging from 20 to 32°C. It is sensitive to frost, which can damage the plant at any growth stage; therefore, it is essential to plant beans after the last frost date in spring (Kanyoka, 2022).

The plant prefers well-draining, loamy soils rich in organic matter. A soil pH between 6.0 and 7.0 is ideal, as it provides the necessary nutrients for growth. Soil rich in nitrogen is beneficial, although *Phaseolus vulgaris* has the ability to fix atmospheric nitrogen, making it a valuable crop for enhancing soil fertility. Consistent moisture is critical for the growth of common beans, particularly during flowering and pod formation. However, the plant does not tolerate waterlogging, so ensuring proper drainage is crucial (Zhou Y. N., 2021).

Phaseolus vulgaris requires full sun, ideally receiving 6 to 8 hours of sunlight daily. Adequate light exposure promotes healthy growth and increases yield. While the common bean has a moderate nitrogen requirement, it benefits from sufficient phosphorus and potassium, which are essential for root development and overall plant health (Mlambo, 2020).

2.3 Nutritional and Economic Importance

The nutritional benefits of sugar beans are well-documented. They provide a high-quality protein source, which is crucial in combating malnutrition, especially in vulnerable communities. Economically, sugar beans serve as a cash crop for many farmers, contributing to both local markets and export opportunities. Studies indicate that increasing sugar bean production can significantly enhance food security and improve income levels for smallholder farmers, underscoring the need for effective cultivation practices.

The Sustainable Agriculture Paradigm is woven into this framework, advocating for practices that not only maximize yield but also maintain soil health and minimize environmental impact. By integrating these theories, the framework provides a comprehensive approach to identifying the optimal fertilizer type and application rate, ultimately guiding agronomic decisions that enhance sugar bean productivity while promoting sustainable agricultural practices (Smith, J., Green, K., & Patel, R., 2021).

2.4 Fertilizer Types and Their Role in Crop Production

Fertilizers are essential for supplying nutrients that enhance crop growth and productivity. They can be broadly categorized into organic and inorganic fertilizers. Organic fertilizers, such as compost and manure, improve soil structure and microbial activity, while inorganic fertilizers provide readily available nutrients. The primary nutrients required for sugar bean growth include nitrogen (N), phosphorus (P), and potassium (K). Each nutrient plays a specific role:

2.4.1 Importance of Nitrogen

Nitrogen is vital for synthesizing proteins, which are necessary for cellular structure and function. In *Phaseolus vulgaris*, proteins facilitate growth, enzyme activity, and overall metabolic processes. Adequate nitrogen availability promotes healthy leaf development. Lush, green foliage enhances the plant's capacity for photosynthesis, leading to improved energy production and growth. Nitrogen contributes to establishing a robust root system, essential for efficient nutrient and water uptake. A well-developed root system supports the overall health of the plant. Sufficient nitrogen levels are crucial for the development of pods and seeds, directly impacting both the yield and quality of the harvest. *Phaseolus vulgaris* has a unique advantage due to its ability to fix atmospheric nitrogen through symbiotic relationships with rhizobia bacteria in root nodules. This process allows the plant to convert atmospheric nitrogen into a usable form, reducing reliance on synthetic fertilizers and promoting soil health (Duncan, P., Moyo, S., Chikanda, A., 2020).

2.4.2 Importance of Phosphorus

Phosphorus is a vital macronutrient essential for the growth and development of *Phaseolus vulgaris*. It plays a crucial role in various physiological processes, influencing overall plant health and productivity. Phosphorus is a key component of adenosine triphosphate (ATP), the energy currency of the cell. ATP is essential for energy transfer during metabolic processes, including photosynthesis and respiration. Adequate phosphorus levels also promote strong root development, enhancing nutrient and water uptake. Phosphorus influences the maturation of pods and seeds, directly impacting yield and quality. It aids in the uptake and utilization of other nutrients, particularly nitrogen and potassium (Jones, A.M., & Brown, S.R. , 2020). When *Phaseolus vulgaris* experiences phosphorus deficiency, several symptoms can arise: Plants may show slowed growth and reduced biomass. Older leaves may develop a purple hue, indicative of poor nutrient availability. Deficiency can lead to reduced flowering and seed set.

2.4.3 Importance of Potassium

Potassium is crucial for the growth and development of (*Phaseolus vulgaris)*. This nutrient plays a significant role in various physiological and biochemical processes. Potassium helps control stomatal opening and closing, which is vital for transpiration and gas exchange. At the same time, it facilitates the uptake of other essential nutrients, supporting optimal plant growth. Also acts as a cofactor for enzymes involved in photosynthesis and respiration. Adequate potassium levels enhance the plant's resilience to environmental stresses (Nguyen T. e., 2019).

2.4.4 Effects of Fertilizers on Growth and Yield

Numerous studies have examined the impact of different fertilizer regimes on the growth and yield of sugar beans. Research indicates that optimized fertilization can lead to increased plant height, leaf area, and pod formation, resulting in higher yields (Mlambo et al., 2021). For instance, balanced applications of NPK fertilizers significantly improve both quantitative and qualitative aspects of sugar bean production.

2.5 Organic versus Inorganic Fertilizers

Some studies suggest that organic fertilizers yield comparable results to inorganic options, particularly in terms of soil health and long-term sustainability. However, the immediate effects of inorganic fertilizers on growth rates are often more pronounced (Chokowo, R, 2020).

2.6 Integrated Nutrient Management

2.7 Combining organic and inorganic fertilizers has been shown to maximize yield while enhancing soil fertility. This approach takes advantage of the rapid nutrient availability from inorganic fertilizers and the long-term benefits of organic amendments (Duncan, P., Moyo, S., & Chikanda, 2020).

2.8 Challenges and Limitations in Fertilizer Use

While fertilizers offer significant benefits for crop production, their application is not without challenges. Many smallholder farmers encounter barriers, such as limited access to quality fertilizers, a lack of knowledge about optimal application rates, and financial constraints. These issues can lead to the overuse or inappropriate application of fertilizers, resulting in environmental problems like soil degradation and water pollution. Research underscores the importance of educating farmers about best practices to mitigate these risks and promote responsible fertilizer use (Mlambo,T., Nyoni, T., & Dube, S, 2020).

2.9 Sustainability **and Environmental Considerations**

In today's context of climate change and environmental degradation, sustainable agricultural practices have become increasingly vital. Research highlights the necessity of adopting strategies that not only enhance soil health but also minimize negative environmental impacts. When evaluating different fertilizer regimes, it is essential to consider their long-term effects on soil fertility and ecosystem health (Nguyen T. S., 2022). By incorporating organic fertilizers and adopting integrated nutrient management strategies, farmers can promote sustainability, ensuring that their agricultural practices positively contribute to the environment while supporting food production (Smith J. G., 2021).

2.10 Knowledge Gaps and Future Research Directions

Despite the extensive information available on sugar beans and fertilizers, there are still significant knowledge gaps. Many studies tend to focus on individual fertilizer types without providing comprehensive comparisons of various regimes. Moreover, there is a pressing need for research tailored to specific local conditions, including soil types and climatic variations (Chikowo, R., Mvumi B.M., & Nyamangara, J., 2020). Future research should aim to address these gaps by focusing on long-term studies that evaluate the sustainability of different fertilizer regimes and their cumulative effects on crop productivity (Duncan, P., 2020).

2.11 Chapter Summary

While research has established the importance of nutrient availability and the benefits of different fertilizer regimes, challenges remain in optimizing these practices for smallholder farmers. By addressing knowledge gaps and emphasizing sustainable agricultural practices, future research can contribute to improved sugar bean production, ultimately enhancing food security and economic resilience in farming communities. This chapter sets the stage for the subsequent investigation into the specific effects of various fertilizer regimes on sugar bean growth and yield, providing a comprehensive understanding of the existing knowledge and identifying areas for further exploration.

CHAPTER 3: METHODOLOGY

3.1 Study area

The experiment has been conducted at the researcher's homestead in Gazimbi village in Goromonzi, which is 50km from Harare CBD. Coordinates: (-17.847682,31.385160). The climate is subtropical highland climate, characterized by warm summers and mild to cold winters. Rainfall: Receives annual rainfall ranging from 600 mm to 1,000 mm, mainly during the rainy season from November to March. Temperatures: Average temperatures range from 15°C to 25°C, with cooler nights.

Environmental Factors: Topography: Hilly terrain with varying altitudes, influencing microclimates and drainage. Vegetation: Mixture of grasslands and woodlands. Water Sources: Nearby rivers and seasonal streams support both agriculture and domestic needs. These factors contribute to the agricultural viability and ecological balance in Gazimbi village. The land is characterized by soils are predominantly sandy, sandy loam soils with a significant amount of sand and less than 15% clay. These sandy soils do retail moisture well and are mostly suitable for agriculture though some areas are often infertile, deficient in nitrogen (N), phosphorus (P), and sulfur (S), common characteristics of virgin soils in Zimbabwe. Additionally, the soils may have low pH values and be deficient in organic matter and phosphorus. The soils generally support crops like maize, tobacco and various vegetables.

3.2 Experimental Research Design

The researcher has used RCBD also known as the randomized complete block design (RCBD) to evaluate the effects of different fertilizer regimes on the growth and yield of sugar beans (Phaseolus vulgaris). The RCBD is chosen to control for variability in environmental factors that could influence plant growth. Treatments have been replicated 4 times to achieve several objectives stated above. Using a 2.5m x 1m, in order to randomize the block design in a Randomized Complete Block Design (RCBD), the researcher implemented a simple yet effective method of randomized selection. This process involved writing the identifiers of each treatment on separate pieces of paper and placing them into a hat. By shaking the hat to ensure a thorough mix, the researcher then drew each piece of paper one by one, assigning treatments to specific blocks in a random order. This technique not only minimizes bias but also enhances the validity of the experimental results by ensuring that each treatment has an equal chance of being assigned to any block, thereby helping to control for variability within the experimental conditions.

3.3 Treatments

The treatments below are randomly assigned within each block: Different fertilizer regimes have been established, including:

- T1 Control (no fertilizer)
- T2 Chemical fertilizers (NPK 7:14:7)
- T3 Organic fertilizers (chicken manure)
- T4 Combination of organic and chemical fertilizers

Each treatment has been replicated four times to ensure statistical validity.

Plot Layout

Table 3.1 Treatment Beds Layout

	Bed 1	**Bed 2**	**Bed 3**	**Bed 4**
Row 1	Manure	Compound D	CompoundD+ Manure	Treatment
Row 2	Compound D	CompoundD+ Manure	Treatment	Manure
Row 3	CompoundD+ Manure	Compound D	Manure	Treatment
Row 4	Treatment	Compound D	Compound + Manure	Manure

3.4 Crop Management

3.4.1 Land Preparation and Planting

- The site location selected for planting had an existing growth of weeds, necessitating the use of a grass cutter to clear the area and create a suitable seedbed. To promote conservation agriculture and minimize soil disturbance, no tillage was implemented, ensuring that the soil structure remained intact.

Figure 3.1. Site Preparation

- Following this, pegging was performed on the 7th of February 2025, using the 3-4-5 method to establish uniform standard beds measuring 1.0 meter in width and 2.5 meters in length. The tools utilized in this process included a grass cutter for initial clearing, a hoe for any necessary soil levelling, pegs and a tape measure for accurate bed layout, a hummer for securing the pegs, string and a ruler for precise measurements, along with a plastic bucket for carrying tools and materials, and pen and paper for recording observations. This systematic approach ensured an organized and efficient setup for the planting of sugar beans.

Figure 3.2 Pegging using the 3-4-5 Method

On February 8, 2025, the planting of sugar bean seeds was carried out following standard agronomic practices to ensure optimal growth. The seeds were sourced from a local farmer who had successfully harvested them in the previous season, ensuring their viability and adaptability to the local environment. Each seed was planted at a uniform depth of approximately 5 cm, which promotes healthy root development. The planting layout adhered to a row spacing of 10 cm and an inter-row spacing of 30 cm, facilitating adequate air circulation and access to sunlight for the developing plants. This careful attention to planting specifications aims to maximize yield and promote robust growth throughout the growing season.

Figure 3.3 Planting

3.4.2 Fertilizer Application

Fertilizers have been applied according to the established treatment plan, according to the RCBD model. At planting fertilizer was banded using hands for targeted nutrient delivery. Regular scouting was conducted to monitor plant health and nutrient uptake. Basal application was done at planting, and during growth phase a top dressing of ammonium nitrate (34.5% nitrogen) was applied at week 4 at a rate of 2 grams per plant, ensuring that the sugar beans receive the necessary nutrients to support vigorous growth and maximize yield. To manage weed control effectively, a layer of mulch has been applied to the ground, which not only suppresses weed growth but also helps retain moisture in the soil. Furthermore, a top dressing of ammonium nitrate (34.5% nitrogen) was applied at week 4 at a rate of 2 grams per plant, ensuring that the sugar beans receive the necessary nutrients to support vigorous growth and maximize yield.

Control Treatment (No Fertilizer): This group serves as the baseline to assess the inherent growth of sugar beans without any fertilizer intervention. It allows for comparison against the other treatments to measure the benefits of fertilization.

Compound D (7:14:7): This fertilizer regime applies a balanced compound fertilizer with a nutrient ratio of nitrogen, phosphorus, and potassium. A general recommended application rate for this treatment is around 200 kg per hectare, applied at planting to enhance initial growth and root development.

Compound D (7:14:7) Mixed with Chicken Manure: This treatment combines the balanced nutrients of Compound D with the organic matter and additional nutrients provided by chicken manure. A typical rate for this combined application might be 150 kg of Compound D per hectare mixed with 5-10 tons of chicken manure per hectare. This approach aims to harness the benefits of both synthetic and organic fertilizers, promoting improved soil health and nutrient availability.

Chicken Manure Only: In this regime, chicken manure is applied as the sole nutrient source. The recommended application rate is generally 10 tons per hectare, providing a rich source of organic matter and essential nutrients to support the growth of sugar beans.

Data Collection

Figure 3.4 Data Collection

As highlighted earlier on I have used compound D (7:14:7) and chicken manure for basal dressing at planting and ammonium nitrate as top dressing at week four. Data was collected on a weekly and bi-weekly interval depending on the parameter.

3.4.3 Growth Parameters

Data was collected on various growth parameters to assess the impact of different fertilizer treatments on sugar beans. Key metrics included plant height, which was measured at regular intervals, the number of leaves per plant, and the number of pods per plant. These parameters provide a comprehensive understanding of the plants' growth and development under varying fertilization conditions.

Figure 3.5 Crop Emergency and Germination

Figure 3.6 Crop development

Figure 3.7 Counting plant population

3.4.4 Yield Components

Harvesting was done following maturity indices or physiological maturity of the crop. Measured total yield at harvest, of harvested beans and average number of pods count for different categories. Calculated yield per hectare for each treatment group was done extrapolating the results to kilograms per hectare.

3.4.5 Data Analysis

Spreadsheets were used to record and manage collected data. Data has been gathered and entered into an Excel spreadsheet, in organized columns and rows for easy observation and processing. The same Data has been analyzed using Microsoft Excel since it was not much data to be handled. Statistical software (SPSS) and ANOVA can also be used to conduct or determine the significance of differences among treatments.

3.5 Chapter Summary

This methodology offers a detailed framework for evaluating the impact of various fertilizer regimes on the growth and yield of sugar beans. The results will enhance sustainable agricultural practices and provide farmers with insights into effective fertilizer application. The next chapter will present the findings derived from this analysis.

Chapter 4: Results

4.1 Effects of different fertilizer regimes over germination percentage.

There was a significant difference between germination rates across different regimes. The graph below indicates that germination percentages vary significantly across different fertilizer treatments. Manure and Compound D + Manure shows the highest germination percentages, particularly noticeable in the initial weeks (weeks 1-3). Compound D also demonstrates a good germination percentage but is lower than the combined manure treatment. The Control group shows minimal germination throughout the observation period. The control treatment shows a rapid initial germination, indicating that seeds may have had favourable conditions for germination. However, despite the early germination, the control treatment's germination percentage does not sustain growth over the following weeks. It peaks early and then declines or plateaus at a low level compared to the other treatments.

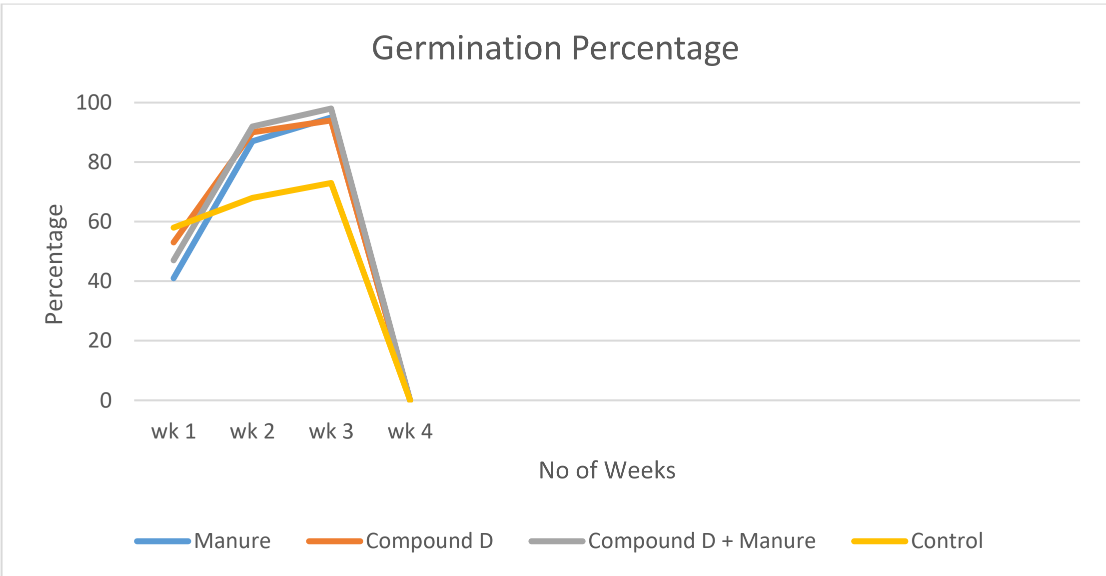

Figure 4.1 Germination Percentage Rate

The results suggest that both manure and the combination of Compound D with manure significantly improve germination rates compared to the control group. Best Treatment: If significant differences are confirmed, it would indicate that using manure or the combination treatment is more effective for enhancing germination than using Compound D alone or not using any fertilizer.

4.2 Effects of different fertilizer regimes over plant population.

There was not significant difference in Plant Population over time especially the three treatments namely: Compound D, Compound D + Manure, Manure except for the control treatment which showed significant difference. The plant population was counted weekly from week 1 to week 12. Generally, all treatments (Manure, Compound D, Compound D + Manure) showed higher plant populations compared to the control group throughout the 12 weeks. Implications- Effectiveness of Fertilizer: The results suggest that using fertilizers, particularly manure and Compound D, significantly enhances plant population compared to no fertilizer (control).

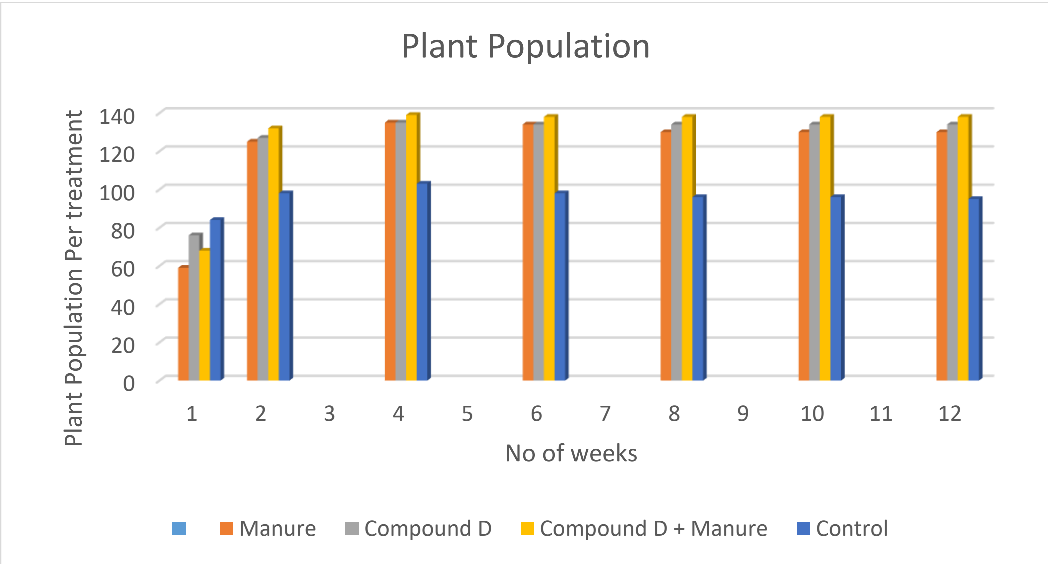

Figure 4.2 Plant Population Rate

4.3 Effects of different fertilizer regimes over plant growth, height and pods.

Plant Height Over Time: The graph shows plant height measured in centimetres from week 1 to week 12. Manure and Compound D + Manure treatments consistently result in the tallest plants across all weeks, particularly noticeable from week 6 onwards. Compound D shows moderate growth, while the Control group exhibits the least height throughout the observation period. The results suggest that both manure and the combination of Compound D with manure are effective in promoting plant height compared to the control group.

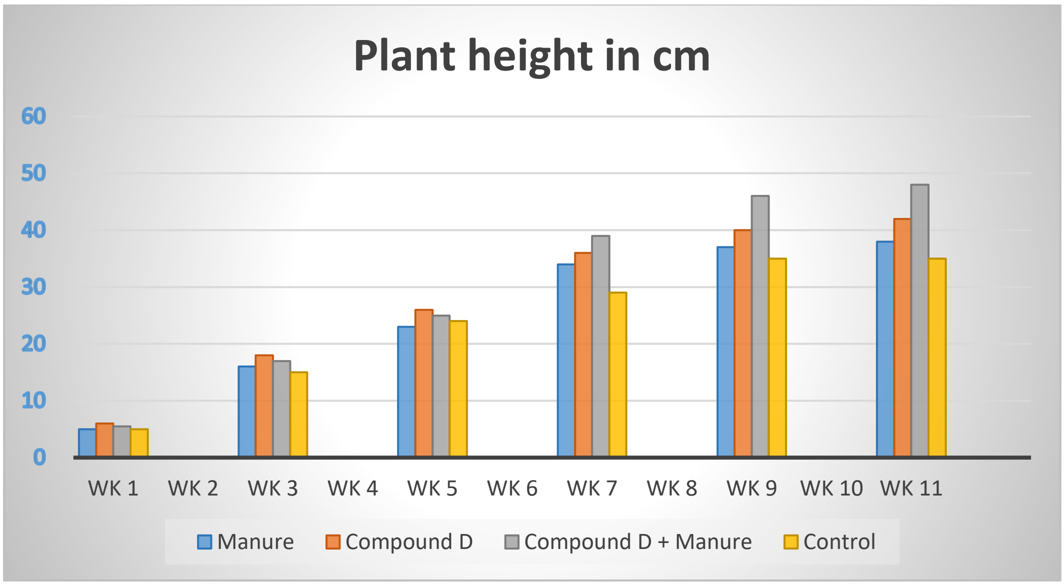

Figure 4.3 Plant Height in cm

4.4 Effects of different fertilizer regimes over overall crop yield.

There were significant differences in yield. Yield Per Plant at Week 11: The bar graph indicates variations in yield per plant across the different fertilizer treatments. Compound D + Manure shows the highest yield, followed closely by Compound D. Manure also contributes to a significant yield, although lower than the combined treatment. The Control group exhibits the lowest yield per plant. The results suggest that the combination of Compound D and manure significantly enhances yield per plant compared to other treatments, particularly the control.

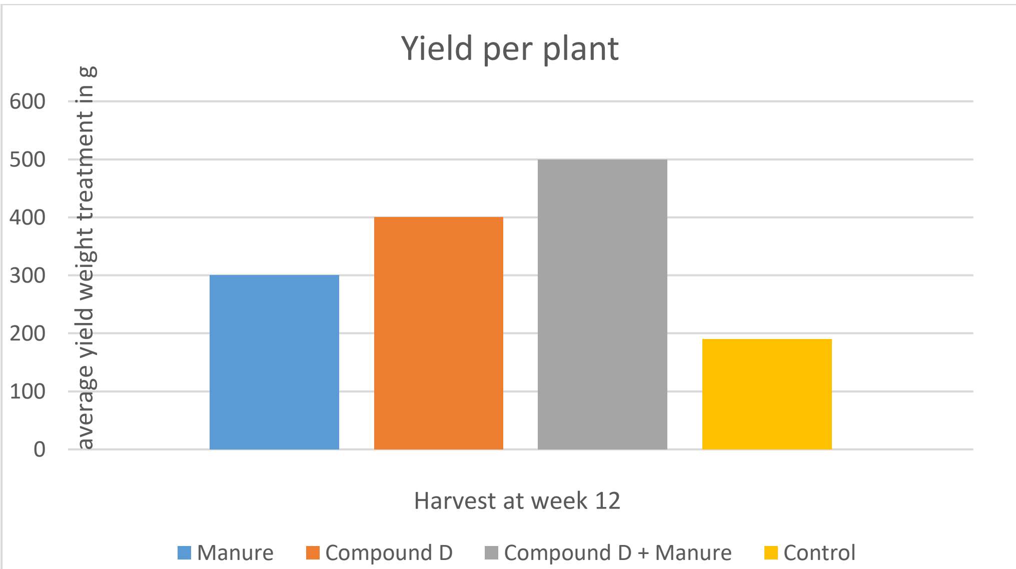

Figure 4.4 Extrapolated Yield per Hectare per treatment

Chapter 5: Discussion

Interpretation of Results

The results from the study reveal significant insights into the impact of various fertilizer treatments on the growth metrics of sugar beans that is, differences in plant growth and yield among the various fertilizer treatments. The analysis demonstrated that the combined application of organic and inorganic fertilizers notably enhanced key growth parameters, including plant height, leaf development, and pod production

5.1 Effects of different fertilizer regimes over germination percentage.

The results indicate a significant difference in germination percentages across various fertilizer treatments. Specifically: Manure and Compound D + Manure treatments showed the highest germination percentages, particularly in the initial weeks (weeks 1-2). This suggests that these treatments provide optimal conditions for seed germination. Compound D treatment also demonstrated a good germination percentage but was lower compared to the combined manure treatment. Control group had minimal germination throughout the observation period, highlighting the importance of fertilizer application for enhancing germination. Despite an initial rapid germination in the control treatment, likely due to favorable conditions, the germination percentage did not sustain growth and plateaued at a low level compared to other treatments.

The use of manure or a combination of Compound D with manure appears to be more effective for enhancing germination rates compared to using Compound D alone or no fertilizer (control). These findings suggest that organic or combined fertilizer treatments can significantly improve germination outcomes, potentially leading to better crop establishment and yields. Farmers or agricultural practitioners looking to improve germination rates might consider using manure or a combination of Compound D with manure based on these results. Further research could explore the long-term effects of these fertilizer treatments on plant growth, yield, and soil health beyond germination percentages. Overall, the data supports the use of manure-based treatments for improving germination percentages in bean plants compared to minimal or no fertilizer application.

5.2 Effects of different fertilizer regimes over plant population.

The analysis of plant population over time (weeks 1 to 12) revealed no significant differences among the three fertilizer treatments: Compound D, Compound D + Manure, and Manure. However, there was a significant difference when comparing these treatments to the control group. Fertilizer treatments vs. Control: All treatments (Manure, Compound D, Compound D + Manure) showed higher plant populations compared to the control group throughout the 12 weeks. This indicates that the application of fertilizers significantly enhances plant population compared to no fertilizer application.

Similarity among fertilizer treatments, the plant populations in plots treated with Manure, Compound D, and Compound D + Manure were generally comparable, with no significant differences detected among these treatments over time. However, the results suggest that using fertilizers (Manure, Compound D, or a combination of both) significantly improves plant population compared to not using any fertilizer. This highlights the importance of fertilizer application for enhancing crop establishment. Given the similarity in plant populations among the three fertilizer treatments, the choice between Manure, Compound D, or their combination may depend on other factors like cost, availability, and potential effects on soil health or subsequent crop yields.

Farmers could consider using any of the tested fertilizer treatments (Manure, Compound D, Compound D + Manure) to improve plant population compared to not applying fertilizer. Further studies might also investigate the impact of these fertilizer treatments on other aspects of plant growth and yield, as well as long-term soil health implications.

5.3 Effects of different fertilizer regimes over plant growth, height and pods

Manure and Compound D + Manure treatments consistently resulted in taller plants compared to Compound D alone and the Control group. This suggests that these treatments provide optimal conditions for plant growth, potentially due to the balanced nutrient supply.

Compound D treatment also promoted plant height compared to the Control but was generally less effective than Manure or the combination treatment. The number of leaves and flowers increased over time across all treatments, with Manure and Compound D + Manure treatments showing higher values compared to Compound D alone and the Control group. This indicates better vegetative and reproductive growth under these treatments. Pod formation began, with the Compound D + Manure treatment showing the highest number of pods, followed by Compound D and then Manure. The Control group had the least number of pods.

Yield at the end of the 12th week was significantly higher in the Compound D + Manure treatment (1000 kg/ha), followed by Compound D (950 kg/ha), Manure (320 kg/ha), and the Control group (190 kg/ha). This suggests that the combination of Compound D and Manure not only enhances plant growth but also significantly improves yield. The use of Compound D + Manure as a fertilizer regime appears to be the most effective in promoting plant growth, pod formation, and yield. This could be due to the synergistic effects of organic and inorganic fertilizers, providing a balanced nutrient supply to the plants. Manure alone also showed positive effects on plant growth and yield, indicating its potential as an organic fertilizer option. However, the yield was lower compared to the combined treatment.

Farmers might consider using a combination of Compound D and Manure to maximize plant growth and yield. The choice of fertilizer regime could depend on factors like cost, availability, and environmental considerations. Further research could explore the long-term effects of these fertilizer regimes on soil health and crop productivity. Thus, the data results support the notion or the use of a combined fertilizer regime (Compound D + Manure) for enhancing plant growth, pod formation, and yield in bean plants compared to single fertilizer applications or no fertilizer.

5.4 Effects of different fertilizer regimes over overall crop yield.

The study reveals significant differences in crop yield under various fertilizer treatments. The combination of Compound D and manure consistently shows the highest yield per plant and per hectare, outperforming other treatments. Compound D + Manure: This treatment yields the highest crop yield as well, indicating a synergistic effect between organic and inorganic fertilizers. The combined application enhances nutrient availability, uptake, and utilization, resulting in improved crop productivity. Compound D: This treatment shows a slightly lower yield compared to the combined treatment but still outperforms manure alone. This suggests that inorganic fertilizers can significantly boost crop yields, but may lack the sustained benefits provided by organic matter. Manure: The use of manure as a fertilizer results in a significant yield increase compared to the control group. Organic fertilizers like manure improve soil structure, increase water-holding capacity, and provide essential micronutrients, contributing to better crop growth. Control Group: The lowest yield is observed in the control group, emphasizing the importance of fertilizer application in enhancing crop productivity.

The combination of Compound D and manure demonstrates a synergistic effect, leading to higher crop yields. This suggests that integrated nutrient management strategies can optimize fertilizer use efficiency and promote sustainable agriculture. Organic fertilizers like manure contribute to long-term soil fertility and structure, while inorganic fertilizers provide immediate nutrient benefits. A balanced approach incorporating both types of fertilizers can ensure sustained crop productivity. This combination also improves soil health, increasing organic matter, promoting beneficial microbial activity, and enhancing nutrient cycling.

Farmers should consider using this combination since, they can benefit from using a combination of organic and inorganic fertilizers to optimize crop yields and maintain soil health. The effectiveness of different fertilizer regimes may vary depending on soil type, climate, and crop variety. Thus, the nutrient assessment is very key. Therefore, further research can help determine the most suitable fertilizer strategies for specific conditions.

Chapter 6: Conclusion and Recommendations

6.1 Summary of Key Findings

This study investigated the effects of various fertilizer regimes on the growth and yield of the NUA 45 bean variety among smallholder farmers. The treatments included manure, Compound D, a combination of Compound D and manure, and a control group with no fertilizer. The findings revealed significant differences in plant growth metrics, pod production, and overall yield by week 12.

6.2 Key findings:

Showed that the combined application of Compound D and manure resulted in the highest average plant height and leaf count. For instance, plants receiving this treatment reached an average height of 48 cm and produced 32 leaves by week 12. The combination treatment also led to a substantial increase in both the number of pods per plant and the overall yield. In contrast, the control group yielded only 190 kg/ha.

Findings also indicate that integrated nutrient management significantly enhances crop performance compared to singular applications of organic or inorganic fertilizers. This aligns with existing literature, such as the studies by Vanlauwe et al. (2010), which emphasize the benefits of combining different nutrient sources. Overall, the results suggest that smallholder farmers could greatly benefit from implementing integrated nutrient management strategies to improve crop yields and food security.

6.3 Practical Recommendations for Farmers

Based on the findings, several practical recommendations are proposed for smallholder farmers to optimize their fertilizer practices: this includes that farmers should consider using a combination of organic and inorganic fertilizers. The study demonstrated that the combination of Compound D and manure significantly enhances growth and yield. This dual approach can improve soil fertility in the long term while addressing immediate nutrient needs. And before applying fertilizers, farmers are encouraged to conduct soil tests to determine nutrient deficiencies. This will help tailor fertilizer applications to specific soil needs, maximizing the effectiveness of both organic and inorganic inputs. Moreso fertilizer application should be timed according to the plant's growth stages. Early application of nutrients can support vegetative growth, while additional nutrients during flowering and pod formation can enhance yield. By incorporating crop rotation and cover cropping alongside fertilizer application can improve soil health and reduce dependency on chemical fertilizers. This holistic approach can lead to sustainable farming practices that enhance productivity over time. Lastly farmers should seek training programs that educate on the benefits and methods of integrated nutrient management. Workshops and demonstrations can provide practical guidance on effective fertilizer use.

6.4 Suggestions for Future Research

To further enhance understanding of fertilizer practices and their impact on crop productivity, future research should focus on the long-term effects of integrated nutrient management on soil health and crop yields. Studies extending beyond the current 12-week timeframe could provide insights into the sustainability of these practices. Or the research should also consider the interactions between fertilizer applications, pest, and disease pressure. Understanding these dynamics can help develop integrated management strategies that address multiple challenges in smallholder farming.

6.5 Chapter Summary

In conclusion, this study highlights the significant benefits of integrated nutrient management for smallholder farmers. By adopting recommended practices and pursuing further research, farmers can improve their productivity, sustainability, and overall livelihood, contributing to enhanced food security in their communities.

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Appendices

Table 3.2 Growth Parameters and data collection

Week	**Treatment**	**Plant**	**Germination %**	**Height cm**	**Leave Plant**	**Flowers**	**Pods**	**Yield plant**	**Yield / Kg/ha**
1	Manure	59	41	5	2	0	0	0	
1	Compound D	76	53	6	2	0	0	0	
1	Compound D + Manure	68	47	5,5	2	0	0	0	
1	Control	84	58	5	2	0	0	0	
2	Manure	125	87	10	5	0	0	0	
2	Compound D	127	90	12	5	0	0	0	
2	Compound D + Manure	132	92	11	6	0	0	0	
2	Control	98	68	10	4	0	0	0	
3	Manure	137	95	16	8	0	0	0	
3	Compound D	135	94	18	8	0	0	0	
3	Compound D + Manure	141	98	17	10	0	0	0	
3	Control	105	73	15	6	0	0	0	

4	Manure	135	0	19	11	0	0	0
4	Compound D	135	0	22	10	0	0	0
4	Compound D + Manure	141	0	21	12	0	0	0
4	Control	103	0	20	8	0	0	0
5	Manure	137	0	23	13	0	0	0
5	Compound D	135	0	26	12	0	0	0
5	Compound D + Manure	140	0	25	15	0	0	0
5	Control	101	0	24	10	0	0	0
6	Manure	137	0	27	16	0	0	0
6	Compound D	134	0	29	15	0	0	0
6	Compound D + Manure	140	0	31	18	0	0	0
6	Control	101	0	26	12	0	0	0
7	Manure	137	0	34	18	1	0	0
7	Compound D	134	0	36	17	1	0	0
7	Compound D + Manure	140	0	39	20	2	0	0
7	Control	101	0	29	14	0	0	0
8	Manure	137	0	36	20	2	1	0

8	Compound D	134	0	39	20	2	1	0	
8	Compound D + Manure	140	0	42	22	3	1	0	
8	Control	101	0	32	15	1	0	0	
9	Manure	137	0	37	22	3	2	0	
9	Compound D	134	0	40	22	3	2	0	
9	Compound D + Manure	140	0	46	25	4	2	0	
9	Control	101	0	35	16	2	1	0	
10	Manure	137	0	38	24	4	3	0	
10	Compound D	134	0	42	25	4	3	0	
10	Compound D + Manure	140	0	48	28	5	3	0	
10	Control	101	0	35	17	3	2	0	
11	Manure	137	0	38	26	3	4	0	
11	Compound D	134	0	42	27	4	5	0	
11	Compound D + Manure	140	0	48	30	6	6	0	
11	Control	101	0	35	18	2	3	0	
12	Manure	137	0	38	28	0	6	2g	320
12	Compound D	134	0	42	29	0	8	4g	950

	Compound D +								
12	Manure	140	0	48	32	0	11	5g	1000
12	Control	101	0	35	19	0	4	1g	190