26/08/26

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

DEPARTMENT OF CROP SCIENCE

NITROGEN FERTILISER RATE EFFECTS ON VINE GROWTH PERFORMANCE OF CHINGOVHA AND GERMAN II SWEETPOTATO VARIETIES



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DISSERTATION JUNE 2026

DECLARATION

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

The undersigned hereby certify that they have examined and recommend this work for consideration by the department of crop science, this project entitled:

NITROGEN FERTILISER RATE EFFECTS ON VINE GROWTH PERFORMANCE OF CHINGOVHA AND GERMAN II SWEETPOTATO VARIETIES.

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ABSTRACT

Sweetpotato (*Ipomoea batatas* L.) is a critical crop for food security and livestock feed, with vine production being equally vital for providing propagation material. However, vine growth and quality are highly sensitive to nitrogen (N) management, and optimal rates often vary significantly between varieties. This study was therefore conducted to evaluate the effects of graded ammonium nitrate rates on the vine growth performance of two contrasting sweetpotato varieties: Chingovha (a local, drought-tolerant landrace) and German 11 (an improved, high-yielding cultivar). A field experiment was established using a 3 × 2 factorial arrangement in a Randomized Complete Block Design (RCBD) with three replications. The treatments comprised three N rates—0 (control), 100, and 300 kg N ha^{-1}—applied as ammonium nitrate, and the two varieties. Data were collected on key vine performance indicators, including vine length (cm), number of plantable vines per plot (vines ≥ 30 cm with viable nodes), total leaf count, leaf area (mm^2 per plant, measured using a leaf area meter), chlorophyll content (SPAD index), above-ground vine dry matter (%), and turnaround days (the interval from planting to the first viable vine harvest) of 84 DAP, 119 DAP and 161 DAP (days after planting.)

Results revealed significant difference ($p < 0.05$) between varieties on leaf area of sweetpotato at 119 DAP. Vine length, leaf count, and individual leaf area increased progressively with N application up to 100 kg ha^{-1} for both varieties, reflecting enhanced vegetative vigor. The number of plantable vines per plot was maximized at the moderate 100 kg ha^{-1} rate for German 11, while Chingovha produced consistently higher numbers even under the control treatment, indicating superior N-use efficiency for propagation. Chlorophyll content (SPAD) strongly correlated with leaf area and overall canopy development (photosynthetic efficiency). German 11 exhibited a stronger positive response to N in terms of total leaf area expansion and chlorophyll synthesis, while Chingovha maintained larger individual leaf areas and better dry matter partitioning across all treatments, demonstrating greater stability under low-N conditions.

Results also showed interaction ($p < 0.05$) between Ammonium Nitrate rate and variety on Chlorophyll content of German II and Chingovha were statistically the same on OKg Ammonia Nitrate and 100kg AN per hectare.

In conclusion, ammonium nitrate rate has no effect on vine length of sweet potato. Ammonium nitrate rate interacts with variety on Chlorophyll content of sweet potato leaves. There is no interaction between ammonium nitrate and variety on leaf area of sweet potatos. There is also no interaction between ammonium Nitrate and variety on vine dry weight. These findings provide essential evidence-based guidelines for smallholder farmers and commercial vine multipliers seeking to optimize input efficiency while ensuring rapid, sustainable sweetpotato propagation. Further research is recommended to link these vine growth traits with subsequent storage root yield to provide a holistic agronomic recommendation.

Keywords: Sweetpotato, Nitrogen fertilization, Ammonium nitrate, Leaf area, Plantable vines, Chlorophyll content, Dry matter, Turnaround days, Chingovha, German 11.

DEDICATION

I dedicate this dissertation first and foremost to my wife whose endless patience and support made this endeavor possible, and to our entire family for their unwavering motivation and support throughout the duration of this experimental research.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to my supervisor, Mr. Mutsengi, for his invaluable guidance, patience, and insightful feedback throughout the duration of this research. His expertise and encouragement have been instrumental in shaping this dissertation and has provided me with a foundation that will undoubtedly benefit my professional practice as a Crop Scientist.

I am also sincerely grateful to my colleagues at the Agritex Department in the Chegutu District, whose support and understanding allowed me to balance my professional responsibilities with the demands of this study. Their dedication to agricultural development in our region remains a constant source of inspiration.

Furthermore, I wish to acknowledge the invaluable support from my fellow students for their friendship, shared challenges, and stimulating discussions, all of which made this academic journey a truly rewarding experience.

Lastly, I am deeply grateful to Dr. Chandiposha for his exceptional mentorship in navigating the complexities of statistical methodology. His insightful feedback and rigorous approach to data interpretation were instrumental in bringing this research to fruition.

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CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Sweet potato (*Ipomoea batatas* L.) is not just any crop – it is a real lifeline for millions of smallholder farmers across sub-Saharan Africa (Moyo et al., 2004; Kebede et al., 2008; Kathabwalika et al., 2013). Unlike fussy crops that demand perfect soil and steady rain, sweet potato can handle tough conditions like drought and poor fertility. This hardy nature means that even in a bad year, families can still harvest something to eat. Globally, farmers grow more than 105 million tonnes of sweet potato every year. In the south of Sahara Africa, sweet potato is an important crop both for feeding people and for selling at local markets (FAOSTAT, 2016, Mwololo et al., 2018).

In Zimbabwe, sweet potato has become even more valuable over the past decade. Most smallholder farmers grow it in natural regions I, II and III, where rainfall is more reliable (Mutandwa, 2008; Chagonda et al., 2014). However, sweet potatoes can also be grown in dryer region although yield maybe compromised. What makes the crop so useful is its flexibility. People boil, roast or fry the roots as a direct substitute for bread or other staples. With the input prices for crops such as tobacco, wheat, Irish potatoes and cotton rising, many farming families have turned to sweet potato to keep food on the table and earn a little cash (Mutandwa and Gadzirai, 2007; Chagonda et al., 2014). More so, sweet potato vines, make excellent, nutritious feed for cattle, goats, pigs and rabbits, which helps farmers cut down on bought-in feed costs (Moyo et al., 2004; Kebede et al., 2008; Nedunchezhiyan et al., 2012).

The Zimbabwean government has also thrown its weight behind sweet potato. Through institutions like Kutsaga Research, it has been promoting the crop as a way to diversify farming and move away from over-reliance on tobacco (Kutsaga Research, 2024). As part of the Horticulture Recovery and Growth Plan (HRGP), over three million virus-free, climate-smart sweet potato plantlets were given to more than 68,000 households. These improved varieties are said to yield up to 25 tonnes per hectare if managed well, and studies show that half of what is grown ends up being sold, bringing in about US$9,000 per household per year on average (Kutsaga Research, 2024). This shows that sweet potato can do two things at once: improve family nutrition and help people out of poverty by selling their surplus.

Among the many sweet potato varieties grown in Zimbabwe, two stand out as the most liked and widely planted: Chingovha and German II (Kutsaga Research, 2024). Farmers prefer them because they yield well, taste good and resist diseases better than many other varieties (ZimSweet Potato Pvt Ltd, 2024). While there are also orange-fleshed types such as Alisha, Delvia and Beauregard that are rich in vitamin A, the white-fleshed ones have been a traditional favourite for generations. Chingovha has white skin and white flesh, while German II is easy to recognise by its red skin and white flesh (Kutsaga Research, 2024). Both are highly valued for their pleasant taste and nutritional content, including carbohydrates, protein, fibre, potassium and pantothenic acid (Kutsaga Research, 2024). Munetsi (2015) and Chilimba et al. (2019) have analysed these varieties in fresh and dried forms, confirming their solid nutritional credentials.

Another interesting thing about sweet potato is that farmers can grow it for two very different markets. The traditional aim is storage root production – we get from the big, tasty tubers we eat. However, farmers are looking at vine production instead. In this system, the goal is to produce lots of leafy, healthy vines, which can be sold as planting material for other farmers, used as high-quality livestock feed, or even cooked and eaten as a leafy vegetable (known as "vegetable sweet potato" or "kangkong" in some Asian dishes) (Qiu et al., 2006). For a smallholder, that means more ways to make money and less risk if one market is slow.

For a successful vine production to be achieved, nitrogen is required. Nitrogen is a key part of chlorophyll, which the green stuff that captures sunlight for photosynthesis. It also builds amino acids (the blocks of protein) and nucleic acids (the carriers of genetic information) (Taiz and Zeiger, 2010).

If sweet potato plants get plenty of nitrogen, it will usually grow fast – longer vines, bigger leaves, darker green colour, and more total biomass. Research from different parts of the world supports this chlorophyll content and vine length tend to rise with higher nitrogen application rates (ASHS, 2024; Rodrigues et al., 2024).

However, more nitrogen is not always better. In fact, if you put on too much, especially for root production, you can end up with what farmers call "vines without tubers" (Omitting Author, 2008). The plant gets so busy making leaves and stems that it forgets to swell up the storage roots. Several studies have found that the highest root yields come from low or moderate nitrogen rates, while the highest rates actually give the lowest yields (ASHS, 2024). This means

that the best nitrogen rate depends entirely on whether you are growing the crop for – tubers or vines? That difference is the heart of our research question.

Since, we know that Chingovha and German II are hugely popular in Zimbabwe, and that nitrogen strongly affects vine growth, what we do not know is how these two specific varieties respond to different nitrogen levels when grown only for vines in our local conditions. For this experiment, we chose three nitrogen rates using Ammonium Nitrate (NH_4NO_3): 0 kg/ha (no extra nitrogen, just the soil's own fertility), 100 kg/ha (a common recommendation for root production, based on studies like ASHS, (2024), and 300 kg/ha which is a deliberately high rate to see what happens when you push beyond sensible limits. We would like to see if we get more vine growth or whether more nitrogen will cause problems.

Finally, the site for this experiment is Plot 14 Hallingbury Farm in Chegutu, Zimbabwe. This is in a prime farming area, and Hallingbury Farm represents the medium- to large-scale commercial farming sector. By doing the research at this farm we expect results that are useful not only for smallholder farmers but also for bigger commercial growers and sweet potato vine multipliers. This study, therefore, aims to produce handy, local data that helps farmers to make better decisions about feeding their varieties to choose and Nitrogen rates to apply when intending to produce quality and diseases free sweet potato vines.

1.2 Problem Statement

Farmers across Zimbabwe love growing Chingovha and German II sweet potatoes, but when they want to grow these varieties specifically for vine production to sell as planting material and animal feed, there is limited science-based advice on how much nitrogen fertiliser to use. Most of them either guess, or they follow guidelines meant for growing tubers, which may be completely wrong for maximising vine growth. Research has shown that nitrogen affects vine length, leaf greenness (chlorophyll), leaf area, dry matter and even how many days it takes for the vines to be ready for harvest. This knowledge gap means that farmers could be wasting money on applying too much fertiliser (which might not even help, or could harm the vines) or using too little and getting poor yields. Without this research, sweet potato vine production in Zimbabwe will remain a guessing game rather than a precise, profitable business. Therefore this research aims to assist sweet potato small holder farmers with precise Nitrogen fertilization information in order to improve sweet potato vines

1.3 Justification of the Study

Scientifically, this research is going to fills a clear hole in what we know about sweet potato agronomy in Zimbabwe. Until now, almost all local research has focused on root yield and not on vine production. By looking at two of the most popular varieties and three distinct nitrogen levels, this project will add valuable knowledge to the fields of tropical root crops and plant nutrition.

Economically and practically, the findings in this research are going to help farmers produce more vines with less wasted fertiliser. Knowing the best nitrogen rate for vine length, leaf area and dry matter means higher yields and better profits per hectare. Lastly, this study supports national goals. Zimbabwe's Horticulture Recovery and Growth Plan (HRGP) and the country's Vision 2030 both emphasise making farming more productive and profitable (Kutsaga Research, 2024). By giving farmers evidence-based advice on sweet potato vine production, this research contributes directly to food security, better nutrition and rural economic development.

1.4 Aim of the Experiment

To find out how different rates of nitrogen fertiliser (0, 100 and 300 kg/ha) affect the vine growth performance of Chingovha and German II sweet potato varieties

1.5 Specific Objectives

1. To identify the effects of different nitrogen rates on vine length, leaf area and chlorophyll content of Chingovha and German II sweet potato varieties.
2. To establish the effect of different nitrogen rates on vine dry matter of Chingovha and German II sweet potato varieties.

1.6 Hypotheses

1. Increasing nitrogen rates will significantly increase vine length, chlorophyll content, leaf area and dry matter of both varieties.
2. There is significant effect of nitrogen rate on vine dry mass for Chingovha and German II – varieties.

CHAPTER 2: LITERATURE REVIEW

2.1 An overview of sweet potato production in Zimbabwe

If you travel across Zimbabwe, from the high rainfall areas of Manicaland to the drier parts of Masvingo and Matabeleland, you will find sweet potato growing in smallholder fields. It is a resilient crop, tolerating drought better than maize, which is why many farmers turn to it when rains are uncertain (Motsa et al., 2015). Most sweet potato farmers are women, often growing local landraces on tiny plots, sometimes no bigger than a suburban backyard. Improved varieties have been introduced by research stations like the Crop Breeding Institute and the International Potato Center (CIP), but adoption has been patchy (Chiona, 2011).

Despite its toughness, average yields in Zimbabwe are low – around 4 to 6 tonnes per hectare – yet with good management, farmers could easily get 20 to 30 tonnes (FAO, 2020). What holds them back? Some of the reasons are poor soil fertility (especially lack of nitrogen), limited access to disease-free vines, pests such as sweet potato weevil, and simply not having varieties that match their needs (Moyo et al., 2018). The Government of Zimbabwe has recently promoted sweet potato through input schemes, recognizing its power to fight hunger and malnutrition (MoLANR, 2019).

2.2 Importance of sweet potato production

For several good reasons farmers consider sweet potato farming because, it puts food on the table. The roots are packed with energy-giving carbohydrates, and orange-fleshed varieties like Chingovha are loaded with beta-carotene which is the same stuff that gives carrots their colour and protects children from going blind due to vitamin A deficiency (Low et al., 2017). Sweet potato production also brings in cash. In places like Mbare market in Harare, bundles of fresh roots and vines are actively sold, especially during lean months when other vegetables are scarce (Macheka et al., 2013). Sweet potato vines make excellent animal feed. When the dry season arrives and grass is gone, farmers cut sweet potato vines to feed their goats and cattle (Mutetwa & Mtaita, 2014). Sweet potato covers the ground quickly, preventing soil erosion – a big deal on Zimbabwe's sloping fields (Gomes & Carr, 2003).

2.3. Importance of Nitrogen in plant growth

Vine production relies much on availability of sweet potato. Nitrogen is like the engine oil for plants, without enough of it, everything slows down. Nitrogen is a key ingredient in chlorophyll molecules (the green pigment that captures sunlight), in amino acids (the building blocks of proteins), and in DNA itself (Taiz et al., 2015). For sweet potato, nitrogen drives vine growth, leaf expansion, and overall canopy development. When nitrogen is plentiful, plants look lush and vigorous; when it runs short, they look tired – older leaves turn yellow, growth is stunted, and yields drop (Gill et al., 2021).

However, too much nitrogen can backfire. Sweet potato can put all its energy into growing long, sprawling vines instead of fattening up the storage roots. This is called "luxuriant growth", and it can actually reduce the harvest at the end of the season (Luo et al., 2015). Too much nitrogen also makes the crop more attractive to pests and can lower the dry matter content of roots, making the tubers more watery and less satisfying to eat. So finding the "just right" amount of nitrogen is a balancing act.

2.3.1 Ammonium Nitrate and crop growth

Ammonium nitrate (NH_4NO_3) is a straight-up nitrogen fertiliser, containing about 34 to 35% N, split equally between ammonium and nitrate forms (IFDC, 2015). This matters because plants can take up both forms. Ammonium is quickly used to build amino acids, while nitrate moves easily in the soil and is ready for immediate uptake especially in warm soils like those found in most sweet potato-growing areas of Zimbabwe (Havlin et al., 2014).

Several studies have shown that applying ammonium nitrate to sweet potato increases vine length, leaf area, and chlorophyll content, but only up to a point. For instance, Ankumah et al. (2003) found that sweet potato responded well to ammonium nitrate up to about 90 kg N per hectare; beyond that, extra nitrogen just produced more leaves and not more roots. In Zimbabwe, Motsa et al. (2018) tested ammonium nitrate on orange-fleshed varieties and found that 50 kg N ha^{-1} gave a decent yield boost, but 100 kg ha^{-1} sometimes reduced root yield due to excessive vines. At very high rates like 300 kg N ha^{-1}, most researchers report severe imbalance – the crop becomes all vines and very few roots (Lal & Singh, 2020). However, few studies have actually tested such a high rate in Zimbabwe, which is why including 300 kg/ha in this experiment will give valuable information about the upper limits of tolerance for German 11 and Chingovha.

Compared to urea, ammonium nitrate is less prone to losing nitrogen to the air as ammonia gas,. However, it can be harder to find and more expensive in rural areas (Chianu et al., 2012).

2.4 Varietal responses to Nitrogen fertilisation

Not all sweet potato varieties are created equal when it comes to nitrogen. Some are efficient scavengers, producing decent yields even in poor soils. Others are high-maintenance, they need a good dose of fertiliser to show what they can do. This difference is called nitrogen use efficiency (NUE) (Fageria & Baligar, 2005).

Take German 11, for example, is a white-fleshed variety that has been grown in parts of Zimbabwe for decades. Farmers often say it does well even without fertiliser – it is a survivor. In contrast, Chingovha is an orange-fleshed variety introduced more recently for its nutritional punch. Anecdotal evidence suggests Chingovha is more responsive to nitrogen – give it some fertiliser and it takes off, producing long vines and lots of leaves, but also plenty of roots. However, at very high nitrogen levels (like 300 kg/ha), even responsive varieties may suffer from "lodging" (vines become too soft) and increased pest pressure (Moyo et al., 2018).

Research from elsewhere supports the idea that varieties differ. Kivu et al. (2014) in Uganda found that the variety 'NASPOT 1' kept its chlorophyll levels high even under low nitrogen, while 'New Kawogo' needed 75 kg N ha^{-1} to perform well. In Zimbabwe, Matsuura et al. (2017) observed that a local landrace sweet potato responded to nitrogen, while an improved variety increased vine length and leaf area up to 80 kg N ha^{-1}, but beyond that, growth plateaued or declined. The reasons for these differences lie in root architecture. Varieties with more fine roots are better at scavenging nitrogen and in the activity of enzymes like nitrate reductase that convert nitrate into usable forms (Villordon et al., 2012).

Since German II and Chingovha have not been systematically compared for their response to ammonium nitrate, especially at a high rate of 300 kg/ha, this study will help fill that gap. Knowing whether a variety is "thrifty" or "responsive" with nitrogen, and at what point extra nitrogen becomes wasteful or harmful, can save farmers money and protect the environment.

2.5 Vine length as an indicator of vegetative growth

Vine length is a simple, no-fuss way to gauge how vigorously a plant is growing. It shows plant's ability to spread, cover the ground, and capture sunlight (Lebot, 2009). Nitrogen plays a big role because it fuels cell division and elongation at the growing tips (Marschner, 2012).

In most studies, increasing nitrogen leads to longer vines, at least up to a point. For example, Nedunchezhiyan et al. (2012) reported that vine length increases steadily as nitrogen went from 0 to 120 kg ha^{-1}, but then it leveled off. At very high rates like 300 kg ha^{-1}, some researchers have observed that vines become excessively long and thin, and may even show signs of stress due to osmotic imbalance (Luo et al., 2015). Long vines are not always a good thing. If a sweet potato plant is all vine and no root, that means the plant is sending its energy to the wrong place. Some farmers joke that "long vines, short roots" – and there is truth to it (Lal & Singh, 2020). The ideal is moderate vine length combined with thick, healthy vines.

2.6 Chlorophyll content and plant performance

Chlorophyll is what makes leaves green, but more than that, it is the plant's solar panel. Without chlorophyll, there is no photosynthesis, no sugars, no growth (Taiz et al., 2015). About half to two-thirds of the nitrogen in a leaf is tied up in chlorophyll and the proteins that work alongside it. So if a plant is short of nitrogen, the first thing that suffers is its green colour (Evans, 1989).

In sweet potato, higher chlorophyll readings usually mean better photosynthesis and more biomass, as long as the plant does not go overboard on leaves at the expense of roots (Liao et al., 2019). Larbi et al. (2015) found that SPAD readings in sweet potato were strongly correlated with leaf nitrogen content ($r = 0.85–0.92$). However, they also warned that readings vary with leaf age and position, so you need a standard method (for this study, that will be the third leaf from the tip).

What happens at very high nitrogen, like 300 kg/ha and can be surprising, chlorophyll content may not increase much beyond what we get at 100 kg/ha – the leaves become saturated. Some studies reported a slight decline in SPAD values at extreme nitrogen rates due to leaf burn or micronutrient imbalances (Gill et al., 2021).

2.7 Leaf area development and its importance in sweet potato growth

Leaf area is simply how much leaf surface a plant has. Leaf Area Index (LAI), is the total leaf area per square metre of ground. For sweet potato to grow well, it needs to cover the ground quickly, this shade out weeds and captures as much sunlight as possible. But too many leaves, too dense, and the lower leaves get shaded and become freeloaders, consuming energy without producing much (Gardner et al., 2017).

Nitrogen increases leaf area by encouraging leaf cells to divide and expand. Nedunchezhiyan et al. (2012) reported that LAI in sweet potato jumped from 1.2 to 3.8 when nitrogen went from 0 to 120 kg ha^{-1}. Studies on other root crops suggest that LAI may continue to increase but with diminishing returns, more leaves that are actually less efficient because they shade each other (Luo et al., 2015). Also, a thick canopy traps moisture and can lead to fungal diseases (Moyo et al., 2018).

2.8 Dry matter literature

Ning et al. (2012) confirmed that nitrogen application rate directly correlates with aboveground dry matter accumulation, establishing that nitrogen fertiliser promotes vegetative biomass production in sweetpotato.

Importance of dry matter weight in sweet potato vine production

Dry matter weight is a crucial indicator of vine productivity, nutritional quality, and overall plant balance in sweetpotato production.

Vine dry matter yield is a direct measure of producible vine biomass with the total vine dry matter production (vines, foliage, and roots) potentially reaching 23 t/ha under optimal conditions (Cambridge University Press 2005).

Vine dry weight typically peaks around 14 to 16 weeks after transplanting before declining. This is critical for timing harvests to maximize vine yield and quality (Bouwkamp 1983).

In practice, dry matter weight helps in selecting high yield varieties.

Effect of Nitrogen on dry matter

To date, no single published study has directly measured the effect of nitrogen fertilizer rates on vine dry matter weight for either the Chingovha or German 11 varieties under vine production.

While Mashavakure et al. (2025) reported substantial tuber yield increases for Chingovha with higher nitrogen application, and Mvumi et al. (2018) documented tuber dry matter responses for German 11 under different harvesting regimes, both studies omitted vine (shoot) biomass as a primary endpoint.

This project therefore explores this research gap on the effects of Nitrogen fertilizer on dry weight of vines for Chingovha and German 11 sweetpotato varieties under vine production.

Varietal Differences in Dry Matter

Research documents significant variability in dry matter content among sweetpotato varieties, with values ranging from 9.7% to 18.2% across different genotypes. This supports the need for variety-specific assessments of vine dry matter production.

Nitrogen Affects Dry Matter Distribution

Studies also show that nitrogen supply has a strong influence on the distribution of dry matter within the plant, particularly affecting shoot growth relative to storage root development.

Quantitative Vine Dry Matter Response

Combined application of nitrogen fertiliser (100 kg N/ha) and farmyard manure (10 t/ha) produced the highest shoot dry weight of 141.35 g per hill, demonstrating nitrogen's role in vine biomass accumulation.

Application of nitrogen up to 50 kg/ha increased root yield, but at higher levels (100 kg/ha), uncontrolled vine growth reduced root yields. This underscores the importance of measuring vine dry matter to identify optimal nitrogen rates.

2.9 Relationships between vine length, chlorophyll content, dry matter and leaf area in plant growth

The four growth indicators do not operate in isolation. When nitrogen is scarce (0 kg/ha), everything suffers making vines short, leaves are small and pale, and the plant produces little dry matter (Hartemink, 2003). As you add nitrogen (100 kg/ha), all these measures increase together – at least for a while. However, after a certain point, the relationships start to break down. At 300 kg/ha, vine length might keep increasing, but chlorophyll content plateaus (because the leaves

already have as much chlorophyll as they can use), and dry matter starts moving into vines rather than roots (Lal & Singh, 2020).

Larbi et al. (2015) gave a clear example: at 120 kg N ha^{-1}, sweet potato had the longest vines and biggest leaves, but the roots were small and watery. The harvest index (root dry matter as a fraction of total dry matter) was only 0.25, compared to 0.45 at 60 kg N ha^{-1}. If we extrapolate, at 300 kg N ha^{-1}, the harvest index could be even lower, possibly below 0.20, meaning the plant is mostly vines. So the trick is to find the nitrogen rate where vine length and leaf area are “just right”, chlorophyll is high, and dry matter is being sent down to the roots.

CHAPTER 3: MATERIALS AND METHODS

3.1 Description of the Study Area

The study was conducted at Hallingbury Farm located in Ward 24, Chegutu District, Mashonaland West Province, Zimbabwe. The area falls under Agro-ecological Region III, which is characterized by semi-intensive farming systems and moderate rainfall patterns suitable for sweet potato production. The area receives an average annual rainfall of approximately 864 mm, while temperatures range between 8°C and 38°C during the year. The soils at the experimental site were predominantly red clay loam soils.

3.2 Experimental Design and Treatments

The experiment was laid out using a 2 x 3 factorial arrangement in Randomized Complete Block Design (RCBD) consisting of three blocks. The first factor was sweet potato variety and the levels were Germany II (Red) and Chingovha (White). The second factor was ammonium nitrate rate and the levels were 0 kg ha^{-1}, 100 kg ha^{-1} and 300 kg ha^{-1} ammonium nitrate as shown in Table 3.1. A total of eighteen plots were established for the experiment.

Table 3.1: The treatments of the experiment on the effect of ammonium nitrate on growth of two sweet potato varieties

	Germany II (Red)	Chingovha (White)
0 kg ha^{-1} (No application)	T1	T2
100 kg ha^{-1} Ammonium Nitrate	T3	T4
300 kg ha^{-1} Ammonium Nitrate	T5	T6

3.3. Land Preparation

The land was initially ploughed using a tractor drawn plough. It was then disced using a tractor drawn disc harrow on the 23rd of August 2025.

3.3.1 Blocking Layout

The experimental Blocks were then demarcated on the prepared ground as follows:

a) Two wooden pegs joinrd by a twine were placed in a straight line running from East to West, approximately 13.5 metres apart.
b) Six Blocks of 2 metres length and 1 m width were established at 30 cm apart within the rows of blocks along the twine marking the first row of planting Blocks.
c) Two other rows of Blocks were then established, 50 cm apart from the each other and running parallel to the first row of Blocks.
d) The planting surface in each Block was then raised 15 cm from the ground level.

e) A wooden peg was then placed at each corner of every block to mark the edges and aid in future re-ridging

3.3.2. Randomisation

i) Treatment allocation within the Blocks was randomised using Microsoft Excel randomisation procedures.
ii) Within each row of Blocks, three Blocks were allocated to Chingovha and the other three to German II.
iii) Each fertiliser regime ($0kg/ha,100kg/ha, 300kg/ha) was then randomly allocated to each variety in each row.

3.4 Vine Planting

a) Soil was pre-irrigated a day before planting. Planting was done on 30 August 2025.
b) Vines cut at approximately 30cm in length were planted in 4 rows on each Block.
c) Rows were spaced 20cm apart, and vines were planted at an inter-row spacing of 20 cm apart, giving a total of 9 vines planted in each row and 36 plants/vines in each Block.
d) A 10cm margin was established between the Block edges and the rows right round the block**.**

e) Planting stations were pierced 10 cm deep and the vines were dropped into these openings, covered by soil and compacted to drive away air.
f) The blocks were then watered to field capacity and left for close to a week for the vines to establish roots and start to shoot.

g) Thereafter irrigation was applied as and when there was need until the onset of the summer season.

3.5 Fertilizer Application

Ammonium nitrate (AN) fertilizer was applied according to treatment levels. Fertilizer was applied once after establishment when shoots had emerged, approximately two weeks after planting. Calibrated cups were used to ensure uniform fertilizer application per plant. No basal fertilizer was applied before planting.

3.6 Crop Management Practices

The experiment was initially irrigated using a rain pipe irrigation system to maintain adequate soil moisture for vine establishment. Weed control was achieved through manual rogueing by hand pulling weeds from plots throughout the growing period.

No chemical pest or disease control measures were applied during the experiment. However, minimal leaf damage caused by chewing pests was observed during the study period.

3.7 Data Collection Procedures

Data collection was conducted during three vine harvesting cycles at 84 DAP, 119 DAP and 161 DAP (days after planting). Observational assessments were conducted weekly to monitor crop progression and determine attainment of plant able vine length.

At each sampling period, two plants were randomly selected from each experimental block using destructive sampling procedures. Selected plants were labelled using masking tape marked as sample “a” and sample “b”.

Parameters measured included vine length, chlorophyll content, leaf area at 84, 119 and 161 days after planting (DAP) and leaf dry weight at 161 DAP.

3.7.1 Vine Length (cm)

Vine length was measured using a tape measure. The longest vine from each sampled plant was measured from the base of the vine to the terminal growing point and recorded in centimetres.

3.7.2 Chlorophyll Content

Leaf chlorophyll content was measured using an Apogee Instruments MC-100 chlorophyll meter (Apogee Instruments Inc., USA).

At each sampling period, three sets of two leaves were randomly selected from each plot. One large leaf and one small leaf were selected from different canopy positions including the top, middle, and bottom canopy. The measurements of chlorophyll were done between 0800 hours and 1000 hours in the morning.

3.7.3 Leaf Area (mm^2).

Leaf area was measured using an AM350 Leaf Area Meter manufactured by ADC BioScientific Ltd.

Three sets of two leaves were sampled from each plot during every vine harvesting session. Leaf area measurements were recorded in square millimetres (mm^2).

3.7.4 Vine Leaf Dry weight (g)

At the end of the experiment, vines in each plot were cut at the base using clean knives. The vines were spread on dry floor under direct sunlight to dry the vines. The dry weight was measured using a balance scale.

3.8 Statistical Analysis

The data was first tested if it meets the assumptions of Analysis of Variance. The data was then subjected to Analysis of Variance (ANOVA) using GenStat statistical software 14th edition. Treatments means were separated using Least Significant Difference test at 5% level of significance.

CHAPTER 4: RESULTS

4.1 Effect of Ammonium Nitrate Rate and Variety on Vine Length of Sweet Potato at 84, 119 and 161 DAP

There was no interaction (P>0.05) between Ammonium Nitrate Rate and Variety on Vine Length of Sweet Potato at 84, 119 and 161 DAP. Also there was no significant difference (p>0.05) between ammonium nitrate rates on Vine Length of Sweet Potato at 84, 119 and 161 DAP. However, there was a significant difference (p<0.05) between the varieties on Vine Length of Sweet Potato at 84, 119 and 161 DAP. The vine length of Chingova variety was longer than Germany II at 84, 119 and 161DAP (Table 4.1).

Table 4.1 Effect of Variety on Vine Length of Sweet Potato at 84, 119 and 161 DAP

Treatment	**84DAP**	**119DAP**	**161DAP**
Germany II	96.1[a]	41[a]	49.3[a]
Chingovha	126.8[b]	63.6[b]	76.6[b]
p value	0.006	0.003	0.003
LSD	19.89	13.06	15.54
CV%	7.8	16.5	16.4

Means followed by different letters within the same column are significantly different at P ≤ 0.05.

4.2 Effect of Ammonium Nitrate Rate and Variety on Chlorophyll content of Sweet Potato at 84, 119 and 161 DAP

There was no interaction (P>0.05) between Ammonium Nitrate Rate and Variety on chlorophyll content of Sweet Potato at 84DAP. Also there was no significant difference (p>0.05) between ammonium nitrate rates on chlorophyll content of Sweet Potato at 84DAP. However, there was a significant difference (p<0.05) between the varieties on chlorophyll content of Sweet Potato at 84DAP. The chlorophyll content of Germany II variety was higher than Chingovha at 84DAP (Figure 4.1).

There was no interaction (P>0.05) between Ammonium Nitrate Rate and Variety on chlorophyll content of Sweet Potato at 119DAP. Also there was no significant difference (p>0.05) between ammonium nitrate rates or varieties on chlorophyll content of Sweet Potato at 119DAP.

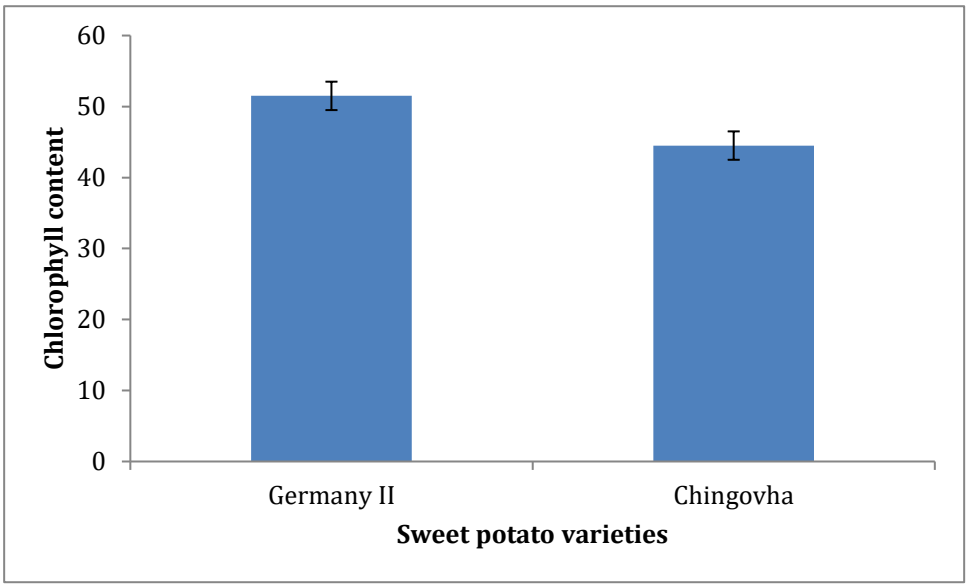


Figure 4.1: Effect of Variety on Chlorophyll content of Sweet Potato at 84 DAP

The results also showed interaction (P<0.05) between Ammonium Nitrate Rate and Variety on chlorophyll content of Sweet Potato at 161DAP. The chlorophyll content of Germany II and Chingovha were statistically the same at no application (0 kg N ha^{-1}) and 100 kg Ammonium nitrate ha^{-1}. However, Germany II variety had higher chlorophyll content than Chingovha at 300 kg N ha^{-1} equivalent (Figure 4.2).

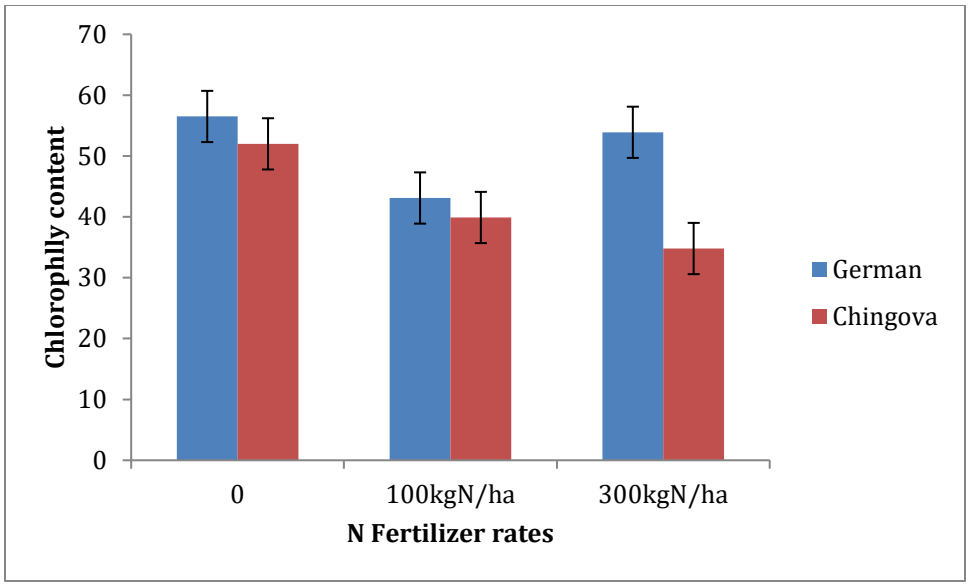


Figure 4.2: Effect of Ammonium Nitrate Rate and Variety on Chlorophyll content of Sweet Potato at 161 DAP

4.3 Effect of Ammonium Nitrate Rate and Variety on leaf area of Sweet Potato at 84, 119 and 161 DAP

There was no interaction (P>0.05) between Ammonium Nitrate Rate and Variety on leaf area of Sweet Potato at 84, 119 and 161 DAP. Also there was no significant difference (p>0.05) between varieties on leaf area of Sweet Potato at 84DAP. However, there was a significant difference (p<0.05) between the varieties on leaf area of Sweet Potato at 119DAP. Germany II variety had larger leaf area than Chingovha.

There was also significant difference (p<0.05) between the Ammonium rates on leaf area of Sweet Potato at 84 and 119DAP. At 84DAP, no application of ammonium nitrate resulted in highest leaf area when compared to 100 and 300 kg ha^{-1} Ammonium Nitrate. However, at 119DAP, the application of 100 kg ha^{-1} Ammonium Nitrate resulted in the largest leaf area although this treatment was comparable to 300 kg ha^{-1} Ammonium Nitrate (Table 4.3). No fertilizer application resulted in the least leaf area at 119DAP. At 161DAP, there was no significant difference (p>0.05) between the varieties or fertilizer rates (Table 4.2 and Table 4.3).

Table 4.2 Effect of Variety on leaf area (mm^2) of Sweet Potato at 84, 119 and 161 DAP

Treatment	84DAP	119DAP	161DAP
Germany II	3137	4414[a]	3776
Chingovha	3006	3398[b]	3202
p value	0.833	0.021	0.100
LSD	NS	829.6	NS
CV%	27.9	13.4	12.9

Means followed by different letters within the same column are significantly different at $P \leq 0.05$.

Table 4.3 Effect of Ammonium nitrate rate on leaf area (mm^2) of Sweet Potato at 84, 119 and 161 DAP

Treatment	84DAP	119DAP	161DAP
0	4562[b]	2764[a]	3663
100 kg ha^{-1} Ammonium Nitrate	1744[a]	4848[b]	3296
300 kg ha^{-1} Ammonium Nitrate	2909[a]	4106[b]	3507
p value	0.011	0.003	0.647
LSD	2337.1	1436.9	NS
CV%	27.9	13.4	12.9

Means followed by different letters within the same column are significantly different at $P \leq 0.05$.

4.4 Effect of Ammonium Nitrate Rate and Variety on leaf dry weight of Sweet Potato at 84, 119 and 161 DAP

There was no interaction ($p>0.05$) between Ammonium Nitrate Rate and Variety on leaf dry weight of Sweet Potato at 161 DAP. Also there was no significant difference ($p>0.05$) between varieties on leaf dry weight of Sweet Potato at 161DAP. There was no significant difference ($p>0.05$) between Ammonium Nitrate Rate on leaf dry weight of Sweet Potato at 161DAP (Appendix 10).

CHAPTER 5: DISCUSSIONS

5.1 Effects of Variety and Fertiliser on Vine Length

5.2.1 Variety Differences in Vine Length

The results demonstrated that variety had a significant effect ($p < 0.01$) on vine length at all sampled periods, suggesting that genotype exerted a stronger influence on vegetative growth than fertiliser application. Chingovha consistently produced longer vines compared to Germany II across all fertiliser treatments and sampling dates.

These findings indicate that Chingovha is inherently more vigorous in terms of vine elongation than Germany II. Similar observations were reported by Badge et al. (2021), who found that vigorous vegetative growth contributes to rapid canopy development and improved radiation interception.

Perhaps, the superior vine length of Chingovha variety may indicate greater vegetative vigour, improved nutrient acquisition, or stronger adaptation to local production conditions. According to Chuma et al. (2017), indigenous sweet potato varieties in Zimbabwe have developed growth characteristics that enable them to compete effectively under low-input conditions, including rapid vine elongation to maximise light interception. Research conducted in Zimbabwe has demonstrated substantial morphological variation among local sweet potato germplasm, further validating that genotype selection plays a critical role in determining crop performance (Chingwara, 2021; Gumbi and Dube, 2019).

In contrast, Germany II, being an improved variety selected for high root yield under optimal management, may allocate more resources to storage root formation rather than vegetative spread (Motsa et al., 2015). While the longer vines in Chingovha may be advantageous for ground coverage and weed suppression, they may require more frequent management to prevent excessive vegetative growth that could divert resources from root development (Lebot, 2020).

5.2.2 Fertiliser Effects on Vine Length

The application of ammonium nitrate (AN) fertiliser did not significantly affect vine length at all sampled periods. The lack of significant response to nitrogen application is contrary to expectations, as nitrogen is generally considered essential for vegetative growth. It stimulates protein synthesis, cell division, and canopy development.

Several explanations may account for this observation:

1. Residual Soil Nitrogen: The soil at the experimental site may have had sufficient residual nitrogen to support vine growth without additional fertiliser. Tagwira and Piha (2018) reported that many Zimbabwean soils contain adequate nitrogen for initial sweet potato establishment.
2. Nutrient Extraction Efficiency: Sweet potato is known to be highly efficient at extracting soil nitrogen due to its extensive root system (Motsa et al., 2018).

These findings agree with Oycha et al. (2023), who reported that nitrogen fertiliser does not always produce significant increases in vegetative growth because varietal characteristics frequently exert a stronger influence than nutrient supply. Similarly, Balogun and Nwokah (2021) observed variable responses depending on environmental conditions and cultivar traits. Nyamangara et al. (2019) also noted that sweet potato has a moderate nitrogen requirement for vegetative growth, and excessive nitrogen may lead to lush foliage that is more susceptible to pest damage rather than structurally longer vines.

5.2.3 Variety × Fertiliser Interaction for Vine Length

The interaction between variety and fertiliser rate was not significant ($p > 0.05$) for vine length at any measurement period). This indicates that the two varieties responded similarly to nitrogen application, and the absence of significant fertiliser effects was consistent across both genotypes.

This simplifies the interpretation of results, as the main effects can be considered independently. It aligns with findings by Lebot (2020), who noted that sweet potato varieties often show similar relative responses to nitrogen when grown under uniform conditions, with genetic differences primarily affecting baseline growth rather than responsiveness to fertiliser.

5.3 Effects of Variety and Ammonium nitrate rate on Chlorophyll Content of sweet potato leaves

5.3.1 Variety Differences on Chlorophyll Content of sweet potato leaves

The chlorophyll content of Germany II variety was higher than Chingovha at 84DAP (Figure 4.1). The higher chlorophyll content in Germany II indicates a greater photosynthetic pigment concentration, which may contribute to its potential for root yield under optimal conditions. Chlorophyll content is positively correlated with photosynthetic efficiency and dry matter accumulation (Sivakumar and Srividhya, 2016). The lower chlorophyll content in Chingovha may reflect its strategy of allocating resources to vine elongation rather than maintaining high photosynthetic pigment concentrations per unit leaf area (Wang et al., 2018). Locally, Mashingaidze et al. (2019) evaluated chlorophyll content in several sweet potato varieties grown in Zimbabwe and found that improved varieties such as Germany II had significantly higher SPAD values compared to local landraces, attributing this to breeding selection for higher photosynthetic efficiency and nitrogen utilisation.

5.3.2 Ammonium rate and variety interaction on Chlorophyll Content of sweet potato leaves

The results also showed interaction ($P<0.05$) between Ammonium Nitrate Rate and Variety on chlorophyll content of Sweet Potato at 161DAP. The chlorophyll content of Germany II and Chingovha were statistically the same at no application (0 kg N ha^{-1}) and 100 kg Ammonium nitrate ha^{-1}. However, Germany II variety had higher chlorophyll content than Chingovha at 300 kg N ha^{-1} equivalent (Figure 4.2).

The interaction between variety and fertiliser rate was significant for chlorophyll content at 161days ($P = 0.043$), suggesting that chlorophyll response strongly depended upon genotype. The significant interaction suggests that Germany ii possesses superior nitrogen use efficiency and physiological tolerance under increasing nutrient availability, maintaining photosynthetic capacity under moderate to high nitrogen levels. Conversely, the reduced chlorophyll content in Chingovha indicates greater physiological sensitivity to increasing nutrient availability. Makhubu et al. (2024) highlighted that genotype × environment interactions strongly influence adaptation in sweet potato systems, making chlorophyll content an important indicator for evaluating nitrogen use efficiency among cultivars.

5.4 Effects of Variety and Ammonium nitrate rate on Leaf Area of sweet potato

5.4.1 Variety Differences in Leaf Area

There was a significant difference ($p<0.05$) between the varieties on leaf area of Sweet Potato at 119DAP. Germany II variety had larger leaf area than Chingovha. The superior leaf area development in Germany II indicates a larger photosynthetic surface area, associated with higher radiation interception, dry matter accumulation, and potential root yield (Wang et al., 2018; Sivakumar and Srividhya, 2016). However, excessive leaf area can also lead to increased mutual shading, potentially reducing canopy photosynthetic efficiency at high plant densities (Lebot, 2020).

5.4.2 Ammonium nitrate rate effects on Leaf Area of sweet potato

At 119DAP, the application of 100 kg ha^{-1} Ammonium Nitrate resulted in the largest leaf area although this treatment was comparable to 300 kg ha^{-1} Ammonium Nitrate (Table 4.3). No fertilizer application resulted in the least leaf area at 119DAP.The positive response of leaf area to nitrogen fertiliser is consistent with established physiological principles. Nitrogen promotes cell division and protein synthesis, leading to increased leaf size and canopy development (Marschner, 2012). The similar leaf area at 100 kg ha^{-1} Ammonium Nitrate and 300 kg ha^{-1} Ammonium Nitrate suggests that the lower rate was sufficient to maximise leaf expansion, indicating that 100 kg ha^{-1} Ammonium Nitrate plant may be the optimal rate under these conditions.

This aligns with findings by Mwangi et al. (2018) and Balogun and Nwokah (2021), who reported improved vegetative growth and canopy expansion following nitrate application. The significant fertiliser effect on leaf area contrasts with the lack of effect on vine length, indicate that leaf expansion and internode elongation are regulated by different mechanisms or have different nitrogen requirements (Fekadu et al., 2018).

5.5 Effects ammonium nitrate and variety on sweet potato Vine Dry Matter Weight

There was no interaction ($P>0.05$) between Ammonium Nitrate Rate and Variety on leaf dry weight of Sweet Potato at 161 DAP. Also there was no significant difference ($p>0.05$) between varieties on leaf dry weight of Sweet Potato at 161DAP. There was no significant difference ($p>0.05$) between Ammonium Nitrate Rate on leaf dry weight of Sweet Potato at 161DAP. Perhaps, the dry matter accumulation was still in progress and significant differences between

treatments may be seen if the experiment would have been extended. However, this is in contrast to the findings by Joko et al., (2024), who asserted that during early to middle growth, sweet potato plants partition nutrients to leaves. At middle to later growth stages, sweet potatoes partition assimilates to the storage sinks at the expense of vegetative parts.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

1. Ammonium nitrate rate has no effect on vine length of sweet potato. The variety have an effect on the elongation of sweet potato vines. The vine length of Chingova variety was longer than Germany II at 84, 119 and 161DAP.

2. Ammonium nitrate rate interacts with variety on chlorophyll content of sweet potato leaves. Chlorophyll content of leaves of Germany II variety is more than Chingovha at higher ammonium nitrate application.

3. No interaction exists between ammonium nitrate and variety on leaf area of sweet potato. Main effects (ammonium nitrate rate and variety) were significant, Germany II had larger leaf area than Chingovha and 100kg per ha Ammonium Nitrate resulted in greater leaf area

4. Neither interaction existed between ammonium nitrate and variety on vine dry weight of sweet potato nor main effects were significant.

6.2 Recommendations

1. Farmers may grow Chingovha variety over Germany II if they are targeting variety which can give longer vines to be used for vegetative propagation.

2. Since Germany II exhibited higher chlophylly content and larger leaf area, farmers may grow this variety over Chingovha if they are targeting varieties that can give higher tuber yield.

3. Farmers are recommended to use 100kg per ha Ammonium Nitrate when growing sweet potato.

6.3 Recommendations for Future Research

Based on the findings and limitations, the following recommendations are proposed:

- Multi-environment Trials: Future studies should be conducted across multiple seasons and diverse agro-ecological zones to evaluate the consistency of variety and fertiliser effects.
- Yield Assessment: Research must include storage root yield and quality parameters to provide a comprehensive assessment of economic productivity.

- Soil Testing: Comprehensive soil analysis should be a prerequisite to relate crop responses to baseline soil fertility.
- Expanded Nutrient Trials: A wider range of nitrogen rates (including micro-dosing below 2 g per plant), alternative nitrogen sources (e.g., urea, compound fertilisers), and application methods (split application, foliar feeding) should be evaluated.
- Physiological Profiling: Deeper investigations into the physiological mechanisms underlying Chingovha's sensitivity to ammonium nitrate are warranted. Examining nitrogen uptake efficiency, assimilation, and partitioning will provide valuable insights for breeding programmes.

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APPENDICES

Appendix 1: ANOVA of the effect of Ammonium Nitrate rate and variety on vine length at 84DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	908.4	454.2	1.27	
Block.Units stratum					
Fertiliser_rate	2	2882.1	1441.1	4.02	0.052
Variety	1	4232.0	4232.0	11.81	0.006
Fertiliser_rate.Variety	2	2184.3	1092.2	3.05	0.093
Residual	10	3584.6	358.5		
Total	17	13791.4			

Appendix 2: ANOVA of the effect of Ammonium Nitrate rate and variety on vine length at 119DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	888.7	444.4	2.87	
Block.Units stratum					
Fertiliser_rate	2	442.1	221.1	1.43	0.285
Variety	1	2297.9	2297.9	14.85	0.003
Fertiliser_rate.Variety	2	68.5	34.3	0.22	0.805
Residual	10	1546.9	154.7		
Total	17	5244.1			

Appendix 3: ANOVA of the effect of Ammonium Nitrate rate and variety on vine length at 161DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	1285.5	642.8	2.94	
Block.Units stratum					
Fertiliser_rate	2	578.7	289.4	1.32	0.310
Variety	1	3348.3	3348.3	15.29	0.003
Fertiliser_rate.Variety	2	98.4	49.2	0.22	0.803
Residual	10	2189.4	218.9		
Total	17	7500.4			

Appendix 4: ANOVA of the effect of Ammonium Nitrate rate and variety on chlorophyll at 84DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	106.92	53.46	2.97	
Block.Units stratum					
Fertiliser_rate	2	10.77	5.39	0.30	0.748
Variety	1	220.50	220.50	12.23	0.006
Fertiliser_rate.Variety	2	18.61	9.31	0.52	0.612
Residual	10	180.30	18.03		
Total	17	537.11			

Appendix 5: ANOVA of the effect of Ammonium Nitrate rate and variety on chlorophyll at 119DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	646.92	323.46	4.02	
Block.Units stratum					
Fertiliser_rate	2	45.99	22.99	0.29	0.758
Variety	1	195.36	195.36	2.43	0.150
Fertiliser_rate.Variety	2	66.14	33.07	0.41	0.674
Residual	10	805.33	80.53		
Total	17	1759.74			

Appendix 6: ANOVA of the effect of Ammonium Nitrate rate and variety on chlorophyll content at 161DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	135.51	67.76	2.54	
Block.Units stratum					
Fertiliser_rate	2	536.35	268.18	10.07	0.004
Variety	1	362.70	362.70	13.62	0.004
Fertiliser_rate.Variety	2	233.26	116.63	4.38	0.043
Residual	10	266.39	26.64		
Total	17	1534.22			

Appendix 7: ANOVA of the effect of Ammonium Nitrate rate and variety on leaf area at 84DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	8831224.	4415612.	2.68	
Block.Units stratum					
Fertiliser_rate	2	24072789.	12036395.	7.29	0.011
Variety	1	77094.	77094.	0.05	0.833
Fertiliser_rate.Variety	2	3002830.	1501415.	0.91	0.433
Residual	10	16502611.	1650261.		
Total	17	52486548.			

Appendix 8: ANOVA of the effect of Ammonium Nitrate rate and variety on leaf area at 119DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	3270641.	1635320.	2.62	
Block.Units stratum					
Fertiliser_rate	2	13377351.	6688676.	10.72	0.003
Variety	1	4645152.	4645152.	7.45	0.021
Fertiliser_rate.Variety	2	1890172.	945086.	1.52	0.266
Residual	10	6238033.	623803.		
Total	17	29421350.			

Appendix 9: ANOVA of the effect of Ammonium Nitrate rate and variety on leaf area at 161DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	2432900.	1216450.	2.71	
Block.Units stratum					
Fertiliser_rate	2	408791.	204396.	0.45	0.647
Variety	1	1479773.	1479773.	3.29	0.100
Fertiliser_rate.Variety	2	1092766.	546383.	1.22	0.337
Residual	10	4493090.	449309.		
Total	17	9907321.			

Appendix 10: ANOVA of the effect of Ammonium Nitrate rate and variety on vine dry weight at 161DAP

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	1025.	513.	0.48	
Block.Units stratum					
Fertiliser_rate	2	959.	480.	0.45	0.651
Variety	1	4171.	4171.	3.89	0.077
Fertiliser_rate.Variety	2	46.	23.	0.02	0.979
Residual	10	10709.	1071.		
Total	17	16910.			

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Mr Mutsengi supervising blocking



Mr Mutsengi supervising planting of sweet potato vines.



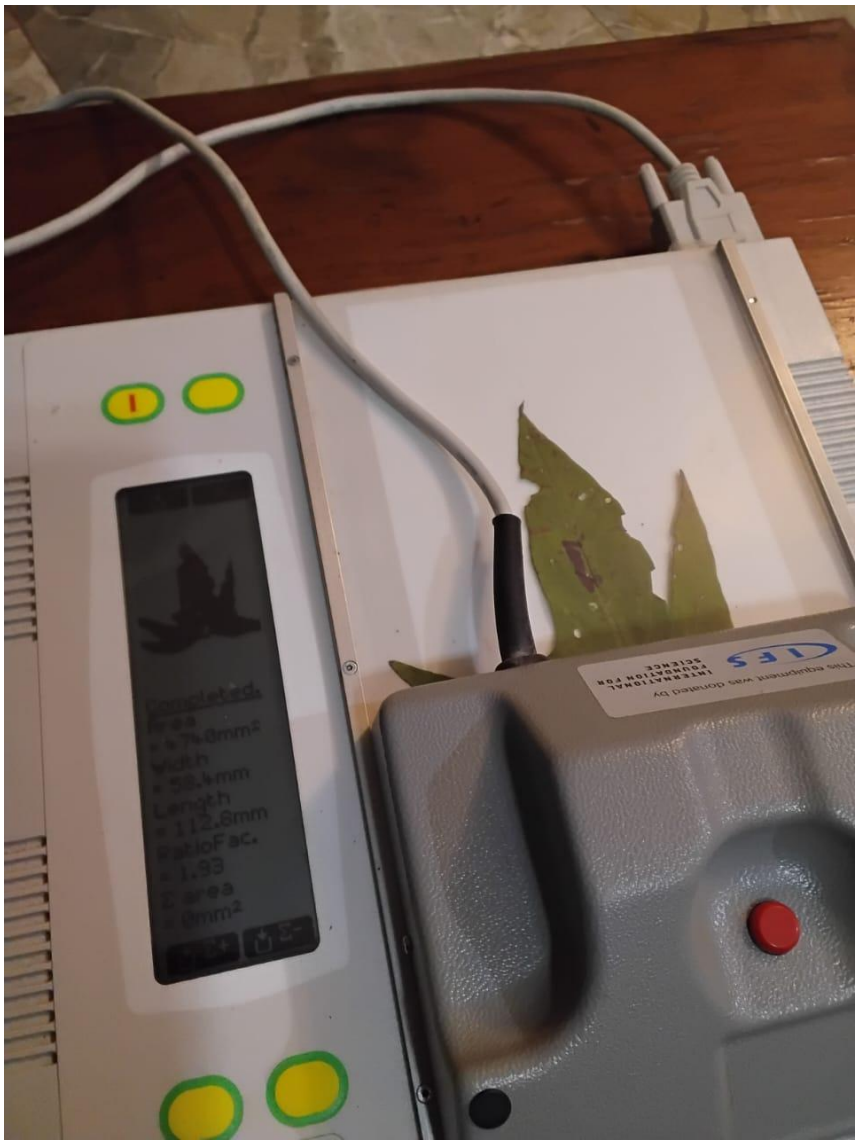


Vine growth and Management



Vine harvesting

Data Collection



Leaf area



Chlorophyll content meter



Vine length measurement



Dry matter measurement