

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

DEPARTMENT OF CROP SCIENCE

**EFFECTS OF BASAL FERTILIZERS TYPE AND VARIETY ON YIELD AND QUALITY
OF FLUE CURED TOBACCO (*Nicotiana tabacum*.)**



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DECLARATION

I do hereby declare that this research project entitled **Effects of basal fertilizers type and variety on yield and quality produced of flue-cured tobacco, (*Nicotiana tabacum*.)** was written by me and that it is the record of my own research work. It has neither in part nor in whole been presented for another degree elsewhere. I grant Bindura University of Science Education exclusive rights to store, reproduce and utilize my work for publication purposes, ensuring my rights are respected I hold a copyright and am accountable for content's accuracy and integrity. While Bindura University of Science Education provided academic guidance and supervision for this research and the views and conclusions expressed in this research are entirely those of the author.

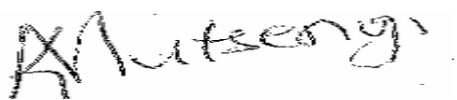
Sign..... Date.....

Munyaradzi Mavhondo

This is being submitted for the partial fulfilment of the requirements for the Bachelor of Science Honours Degree in Crop Science with the approval of supervisor.

Supervisor: Mr Mutsengi

Sign



Date...

DEDICATION

I dedicate all my efforts and struggles of the educational life to my dear family, friends, and God without them I could not have sailed.

ACKNOWLEDGEMENT

I am immensely grateful to the almighty God for bestowing me with the ability and strength to work diligently and successfully on this project. Words cannot adequately express my profound gratitude. I am deeply indebted to the Bindura University of Science Education, Department of Crop Science, for guiding me and supporting me throughout this journey. I would like to express my sincere appreciation to my Project Supervisor, Mr Mutsengi, whose constant guidance, advice, patience and diligence played a vital role in the successful execution of this project. His valuable suggestions were crucial in ensuring the flawlessness of this endeavour. Furthermore, I extend my heartfelt gratitude to my family and friends for providing unwavering support and guidance throughout the research and writing process of this project. I am truly humbled and thankful for the support and mentorship I have received from the university, my supervisor, and my loved ones, all of whom have contributed immensely to the completion of this project.

ABSTRACT

The cost of producing flue-cured Virginia tobacco in Zimbabwe has risen sharply, with basal fertilizer accounting for a significant proportion of total production expenditure. The study evaluated the effects of basal fertilizer type and variety on the growth, yield and quality of flue-cured Virginia tobacco (*Nicotiana tabacum* L.) under rain-fed conditions in Dotito, Zimbabwe. The experiment was conducted using a factorial Randomized Complete Block Design (RCBD) with three replications. Two tobacco varieties (KRK26 and KRK76) and three fertilizer treatments namely Compound B (10:24:20), Compound C (5:15:12) and an unfertilized control were evaluated. Data collected included plant height, leaf area, number of leaves remaining after harvesting stages, dry leaf mass, cured leaf quality and yield. Analysis of variance (ANOVA) was performed using GenStat Version 18 and treatment means were separated using the Least Significant Difference (LSD) test at a 5% level of significance. Results showed that there were no significant interactions between fertilizer type and variety for all measured parameters ($p > 0.05$). Variety had no significant effect on growth, quality or yield of tobacco. Fertilizer type significantly influenced plant height, leaf area, number of leaves, dry leaf mass, cured leaf quality and yield. Both Compound B and Compound C significantly outperformed the unfertilized control in all measured variables. Compound C produced the greatest plant height (84.39 cm), while Compound B recorded the highest leaf area (1928 cm²) and highest yield (1.739 kg). However, no significant differences were observed between Compound B and Compound C for any measured parameter. The control treatment consistently produced the lowest growth, quality and yield values. The study concludes that both Compound B and Compound C effectively improved tobacco growth, yield and quality compared to no fertilizer application. Since Compound C achieved comparable performance to Compound B despite its lower cost, it offers a more economically viable basal fertilizer option for smallholder tobacco farmers.

Keywords: basal fertilizer, compound B, Compound C, flue cured tobacco, KRK76, KRK26, plant growth, quality, yield, Zimbabwe

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LIST OF ABBREVIATIONS

AN- Ammonium Nitrate

FCV- Flue Cured Virginia

K- Potassium

N- Nitrogen

P-Phosphorus

TIMB- Tobacco Industry Marketing Board

TRB- Tobacco research Board

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Nicotiana tabacum L., commonly known as tobacco, ranks among the most extensively grown commercial crops across the globe (Nyantika *et al.*, 2022). Major producers of the crop are China, Brazil, India, the USA, Indonesia and Zimbabwe. Among African nations, Zimbabwe stands out as the foremost producer of tobacco leaf (Gumbo *et al.*, 2025). According to result obtained from Tobacco marketing board (TIMB) last season Zimbabwe produced 356 million kilo grams of tobacco which was the highest production ever. Tobacco has several uses that includes cigarette production and in the production of pharmaceuticals in human health sector. It can also be used as an insect repellent, a herb or a decorative plant.

Basal fertilizer application is a common practice in tobacco production, as it provides essential nutrients to the crop providing primary macronutrients including nitrogen, phosphorus and potassium alongside secondary micronutrients such as boron and zinc (Tariq *et al.*, 2010), that all contribute to the yield and quality of tobacco produced. Different researchers have investigated the role of nutrient management in flue cured Virginia tobacco, after realizing the rapid increase in the cost of production in Zimbabwe of producing tobacco, the researcher has sought some ways to find alternatives to reduce the cost of production without compromising on the yield and quality produced (Brunelle *et al.*, 2015).

Compound C NPK of (5:15:12) cost \$32 per 50kg bag whilst compound B or tobacco blend with NPK of (10:24:20) cost \$54 per 50kg bag, so the researcher want to have a closer analysis on the yield and quality of the tobacco produced by these (Maregedze *et al.*, 2023). Most researches underscore the importance of fertilizer timing but leave unresolved gap regarding the increasing cost of production and ways to minimize it necessitating further research to enhance profitability of flue cured Virginia (FCV) tobacco (Brunelle *et al.*, 2015). Basal fertilizer plays a significant role in FCV tobacco and most FCV tobacco farmers have resided on one applications, at planting (Nyakapene & Mutandwa, n.d.). In terms of varieties there is no different in terms of pricing in the two varieties used KRK 26 and KRK 76 which all cost \$33 beside the fact that the latter is a hybrid variety

1.2 Problem Statement

The cost of producing flue-cured Virginia tobacco in Zimbabwe has risen sharply, with basal fertilizer accounting for a significant proportion of total production expenditure. Compound B (NPK 10:24:20) is widely recommended for tobacco but costs US\$54 per 50 kg bag, compared to Compound C (NPK 5:15:12) at US\$32 per 50 kg bag. Despite this price difference, there is limited empirical evidence evaluating whether the higher cost of Compound B translates into measurable gains in yield or leaf quality over the more affordable Compound C under local field conditions (Brunelle *et al.*, 2015). Furthermore, it is unclear whether the two commonly grown varieties, KRK26 and KRK76, respond differently to these fertilizer types in terms of vegetative growth, cured leaf quality and yield. This knowledge gap creates uncertainty for smallholder tobacco farmers who must balance input costs against crop performance outcomes. The present study was therefore conducted to determine whether the use of Compound B over Compound C is agronomically justified, and whether variety selection interacts with fertilizer type to influence tobacco production outcomes.

1.3 Justification of the study

This study provides critical insights for tobacco growers and agronomists seeking to optimize flue cured Virginia tobacco production at the same time finding ways to reduce the rampant cost of production which has resulted in very low profit margins being realized by growers. By critically analyzing the effects of the above mentioned different basal fertilizers and varieties we can then validate that the difference in pricing price of what, the tobacco or the fertilizer, this is an ambiguous statement has also an effect on the yield and quality of tobacco produced or not. The research aims to enhance both the economic and qualitative aspects of flue cured Virginia tobacco farming. Furthermore, the findings may contribute to broader agricultural studies on fertilizer management and crop quality optimization since basal fertilizer alone consumes a bigger chunk of the cost of production where depending on soil testing results, an average of 950 kg bags are needed for a hectare of tobacco. In regard to the rampant effects of climate change globally where seasons are getting shorter and erratic this study of basal fertilizer type and different varieties (KRK26 and KRK76) will assist in decision making the type of fertilizers that is economically profitable as well the variety that gives the highest yields and quality.

1.4 Objectives of the study

1.4.1 Main objective

- To assess the effects of basal fertilizers type and variety in flue-cured tobacco (*Nicotiana tabacum*.) performance

1.4.2 Specific objectives

- To analyse the effect of basal fertilizer type and variety on vegetative growth of tobacco.
- To assess the effect of basal fertilizer type and variety on the quality of cured leaves.
- To assess the effect of basal fertilizer type and variety on the yield of tobacco.

1.5 Hypotheses

H₀: Basal fertilizer type and variety have no effect on vegetative growth of tobacco.

H₀: Basal fertilizer type and variety have no effects on quality of cured tobacco.

H₀: Basal fertilizer type and variety do not contribute to yield of tobacco.

CHAPTER TWO

LITERATURE REVIEW

2.1 Tobacco crop

Flue cured virginia tobacco (*Nicotiana tabacum*.L) is a member of the genus *Nicotiana*, which comprises of over 70 species. It is believed to have originated in South America, likely as a hybrid between *Nicotiana sylvestris* and *Nicotiana tomentosiformis* (McCarthy *et al.*, 2019). The domestication of tobacco is estimated to have occurred over 6,000 years ago by indigenous cultures for ceremonial and medicinal purposes. *Nicotiana tabacum* is an annual or short-lived perennial herbaceous plant.

Flue cured virginia tobacco is a self-pollinating dicot plant in the Solanaceae family with primary and vascular tissues. Depending on varieties, tobacco plant can bear up to 25 leaves with the length size of about 60 cm and the plant can be 1 to 2m in height. The plant's leaves have large surface area as compared to other field crops (Trueman, 2020). The leaves have a spiral arrangement and they are hairy, thick and ovate. According to Reddy (2006), the leaves are rich in nicotine and natural sugars which together contribute to the characteristic flavour experienced during smoking. The plant bears flowers typically having five petals either white or pink in colour, which upon reaching maturity may divide into two or four sections. Crops like tomato, Irish potato and pepper are in the same family (Solanaceae) with tobacco

2.2 Production of tobacco in Zimbabwe

According to TIMB report (2018), farmers are getting an average of 2.5t per hectare of the golden leaf. Production of tobacco in Zimbabwe contributes 30 to 40 % of direct job opportunities within the agricultural (Chivuraise *et al.*, 2011). Masvongo *et al.* (2013) noted that tobacco production also creates informal employment and earns the country foreign currency through tobacco exports. Data from the Tobacco Industry and Marketing Board's 2024 statistical publication reviewed that during the 2025 growing season, tobacco exports generated approximately US\$1.4 billion in foreign exchange earnings derived from the sale of 352.7 million kilograms of flue cured Virginia leaf. The leaf forms a mainstay of the economy, accounting for about 10% of Zimbabwe's Gross Domestic Product (GDP) since 2018 (Chingosho *et al.*, 2021).

2.3 Uses of tobacco

Long before tobacco became associated with smoking, indigenous communities recognized its therapeutic value, employing it to treat a range of everyday ailments including skin wounds, insect infestations, dental pain and nausea (Mcgraw-hill, 1980). Contemporary medicine has since found application for nicotine in injectable treatments from conditions such as tetanus and strychnine toxicity. Additionally, the plant serves as a raw material for isoprene compounds used in cardiac medication manufacturing (Doyle JJ, 1998). In animal healthcare settings, tobacco extracts have demonstrated antiseptic properties useful in wound management.

Flue cured Virginia tobacco top leaves, scrap and dust. Given their biodegradable nature, tobacco by-products present viable substitutes for chemically manufactured agrochemicals, particularly at a time when environmental sustainability. The fact that synthetic fertilizers and pesticides are expensive. However, the use of tobacco as a pesticide was eventually discontinued due to the toxicity of nicotine to the human nervous system and the associated risks to human health and safety (Mcgraw-hill, 1980).

2.4 Fertilizer management

Flue cured Virginia tobacco requires a perfect fertilizer regime, at planting, compound C with N:P:K (5:15:12) and compound B with N:P:K [10:24:20] is used as basal fertiliser. The general application rate is 450kg per hectare though some recommendations are based on soil analysis and may be as high as 700kg/ha. The standard basal application rate of 450 kg/ha applies to both Compound B and Compound C. Sandy soils with low cation exchange capacity or soils with a history of low fertility may warrant higher rates of up to 700 kg/ha, as determined through prior soil testing, while fertile clay soils may require lower rates to avoid luxury consumption and wastage. Topdressing is applied at 150kg per hectare of ammonium nitrate, with 34.5% of nitrogen in Zimbabwe, (*Parker 2009*), due to the difference in soil texture, some of the soils such as coarse-textured sandy and loamy-sandy soils with high leaching potential require less topdressing, based on the ability of the soil to leach nutrients.

2.5 Effect of Fertilizer Type and Variety on Growth, Quality and Yield of Tobacco

Nitrogen, phosphorus and potassium are the primary macronutrients influencing tobacco growth. Nitrogen promotes vegetative development, including stem elongation and leaf expansion, while phosphorus supports root development and early growth establishment. Potassium plays a critical role in water regulation, leaf quality and combustibility of cured tobacco (Tariq *et al.*, 2010). Adequately fertilized tobacco plants consistently achieve greater plant height, broader leaf area, more harvestable leaves and higher dry mass compared to unfertilized controls. Several studies in sub-Saharan Africa have documented significant increases in plant height and leaf area when balanced basal fertilizers are applied at planting, confirming the essential role of these nutrients in supporting canopy development during the vegetative phase (Nyantika *et al.*, 2022).

Leaf quality in flue-cured Virginia tobacco is determined primarily by the colour, texture, and chemical composition of the cured leaf. Fertilizer management has a direct bearing on cured leaf colour, with balanced fertilization producing bright lemon-yellow to orange leaves that attract premium market prices, while excessive nitrogen or nutrient imbalance tends to produce darker, less desirable mahogany grades (Tariq *et al.*, 2010). Nyantika *et al.* (2022) reported that inorganic fertilizers significantly improved leaf quality grades in tobacco grown in smallholder systems in East Africa compared to organically managed plots. The type and concentration of basal fertilizer applied can therefore influence both the agronomic and economic outcomes of the tobacco crop by affecting the proportion of higher-grade leaves produced at harvest.

Tobacco yield, measured as cured leaf mass per unit area, is closely linked to both the quantity of leaves produced and their dry matter content at harvest. Brunelle *et al.* (2015) emphasized that the economic viability of fertilizer use in tobacco production depends on the balance between input cost and the resulting yield and quality response, making it essential to identify fertilizers that offer the best value per unit of output. In Zimbabwe, Gumbo *et al.* (2025) noted that rising input costs are a major constraint on the profitability of smallholder tobacco farming, creating a need for evidence-based fertilizer recommendations that reduce expenditure without compromising yield targets.

In terms of variety, flue-cured Virginia tobacco varieties differ in their growth habits, maturity period and yield potential. KRK26 is an open-pollinated variety known for its

adaptability to a range of soil and climate conditions across Zimbabwe's tobacco-growing regions. KRK76, a hybrid variety, has been developed for higher yield potential and improved leaf quality, though its performance advantage over open-pollinated lines may be less pronounced under suboptimal fertilizer conditions (Nyakapene & Mutandwa, n.d.). Research by Nyantika *et al.* (2022) noted that varietal differences in tobacco growth and quality tend to become most apparent under conditions of nutrient stress rather than under adequate fertilization, suggesting that the interaction between variety and fertilizer type is an important area of investigation to guide input management decisions for smallholder farmers in Zimbabwe.

CHAPTER THREE

MATERIALS AND METHODOLOGY

3.1 Study site

The research was carried out during the 2025-2026 rain season at Chakoma, Dotito Farm which is located 10km North of the Dotito Township (-16.3422; 31.3420). The farm falls within agro-ecological Region 3. The area receives annual rainfall of around 450-600 mm and severe long dry spells. The farm had an average annual temperature between 18⁰C and 25⁰C. Soils in Chakoma are red clay soils and coarse, deep and well drained with a pH of 5.5 based on soil tests and are ideal for tobacco production.

3.2 Experimental design

The experimental layout followed a factorial Randomised Complete Block Design. There were 2 factors that is fertilizers type and variety. Fertilizers had 3 levels; compound C, compound B and no fertilizer (control) and variety had 2 levels; KRK 26 and KRK 76. The trial was replicated 3 times: This RCBD framework controlled spatial variability while enabling isolation of main effects and interaction variances through restricted randomization protocols. Slope was used as a blocking factor

3.3 Trial management

3.3.1 Land preparation

Deep ploughing was done in May after harvesting; a disc plough was used to achieve a fine tilt in August followed by ridge marking in October using employing a tractor-mounted ridging implement.

3.3.2 Planting

KRK76 and KRK26 flue cured Virginia tobacco seedlings were transplanted on the 12th of December 2025. Planting was done after receiving 45mm of rains using the *sima dhinda* method as the small-scale farmers does not have access to irrigation facilities. *Sima dhinda* (from Shona words meaning "to sink" and "to firm/press") is the crucial process of transplanting tobacco seedlings into the ridges and securely firming the soil around them by

closing any air pockets to ensure a successful crop. Planting was done using 1.2m inter row spacing and 0.55 m in row spacing respectively, targeting 15 000 plants per hectare.

3.3.3 Fertilizer Application

Basal fertilizer was applied using cup 30 per plant for both the Compound B and Compound C following dolloping method 10 days after planting. Ammonium Nitrate was applied three weeks after planting using cup number 8 for all the plants in the experimental project.

3.3.4 Disease and pest control

Pest and diseases were controlled as per crop calendar requirements and also after scouting. Below is a table showing how the applications were done during the course of the study.

Table 3. 1: Pesticide, time of application and purpose

Chemical/ Pesticide/Fungicide	Time of application	Application rates and Purpose
Confidor 200SL	Just after planting	1000 ml per hectare at 220 ml/ 100 litres of water. Control of ants, cutworm, aphids
Bullet	Week 1, 5, 8, 11	135 ml per hectare at 13 ml/ 100 litres of water. Control of chewing pests, locusts
Belt	When first signs of budworm show up with at least 10% of the plants affected	43 ml per hectare at 13 ml/ 100 litres of water. Control of Budworm, semi looper and other chewing pests.
Azoxystrobin	Just before topping, 2weeks after topping and when any signs of disease show up.	500 ml per hectare at 200 ml/ 100 litres of water Control of Angular leaf spot, Alternaria leaf spot, wildfire, frog-eye.
Acco- tab	Just after topping for sucker control.	330 ml in 20 litres of water, apply 5 cup per plant. Used for the control of suckers.

3.3.5 Irrigation regimes and weed control

The tobacco crop was rain fed. Weed control was done using Clomazone at 2 L per hectare (120 ml in 15 litre knapsack spray) just after planting functioning as a pre-emergent herbicide targeting both grass species and broadleaved weed varieties. Fusillade forte was also applied as a post emergence selective herbicide for broadleaves weeds at 1.5 L per hectare (110 ml in 15 knapsack spray).

3.3.6 Topping and Suckering

When the tobacco plant had produced 18 harvestable leaves, topping commenced. Topping, plucking of the apical bud, removes the inhibitory effect of a dominant apex and often results in excessive sprouting of side shoots or suckers. Both of the varieties used KRK76 and KRK26 were topped at a maximum of 18 leaves. The process of topping was done in three different sessions, the third, last session was done exactly ten days after commencement of the first. Accotab (a systemic suckercide) was diluted at a rate of 330 ml in 20 litres of water prior to application. Each plant received 5ml of the dose.

3.3.7 Reaping and curing

Collection of the middle leaves from a number of plants was done after considering crop physiological maturity indices to verify readiness for curing. They were placed in a drawer where there was no light, with limited air movements and limited space and this is known as the drawer test for testing if the tobacco leaves are ready for curing or not. The drawer test states that if the collected leaves colour within 24-48 hours it means reaping is behind and on the other hand, if it is attained post 72 hours reaping is too ahead. The recommended time is between 48 and 72 hours. Colouring happened between 48 and 72 hours, it showed perfect timing for reaping.

3.4 Data collection

3.4.1 Leaf Area

This was done using a mathematically linear model based on length-width relationship.

$$A = L \times W \times C$$

Where;

A= Estimated Leaf Area

L= Leaf length (cm) from base to tip

W=Maximum leaf width (cm)

C= Correction factor, 0.65-0.75 for flue cured tobacco (an average of 0.70 will be used in this study)

3.4.2 Dry weight

Dry weight was measured using Nicholas digital scale after unloading the. Data was collected from three plants that were sampled per plot. The weight of the three samples was divided by 3 to get average weight per sample.

3.4.3 Quality

This was done using visual assessment on colour of the cured leaf. Classification of cured leaf on the market is done observing leaf colour, texture, softness and length.

Table 3.2: Leaf curing scale

Grade	Color Category	General Description	Typical Market Value
1	Lemon	Bright, vivid yellow to lemon-yellow, thin leaf	Highest
2	Light lemon &Lemon	Softer pale yellow, more saturated lemon yellow	Higher
3	Lemon &Deep lemon	A mix of bright lemon yellow with darker, more intense yellow tones	High
4	Deep lemon	Deeper, richer yellow (more golden/amber than lemon bright)	Medium
5	Lemon & Orange	Yellow-orange pairing-sunny yellow blending into a warm, lively orange	Medium
6	Deep lemon & Orange	Darker, richer lemon tones combined with deeper orange-warm, bold and more dramatic	Medium
7	Mahogany	A reddish-brown, wood-like color. Warm, dark and slightly luxurious	Lowest

3.4.4 Height

This was determined by measuring the distance from soil surface to the uppermost point of the main stem, measured with a standard ruler. Measuring was done per each individual plot and an average height per each plot was recorded. Random sampling technique was implored in which three plants per plot were sampled.

3.5 Data analysis

Statistical differences across treatments were evaluated using ANOVA under a randomised block framework in GenStat version 18 statistical package was used for analysis, examining variables including mean leaf area, dry leaf weight, plant height and yield expressed in kg per hectare. Where ANOVA indicated significant treatments effects, mean separation was carried out using Tukey's protected procedure at a 95% confidence level.

CHAPTER FOUR

RESULTS

4.1 Effects of basal fertilizer type and variety on plant height of tobacco

There was no significant interaction between fertilizer type and variety on plant height ($p>0.05$). Fertilizer type showed a highly significant effect on plant height ($p\leq 0.001$). Variety had no significant effect on plant height ($p>0.05$). Compound C recorded the highest plant height (84.39 cm) while untreated control treatments recorded the lowest plant height (56.94 cm). There was no significant difference in height between the Compound C and Compound B treated plots.

Table 4.1: Effects of basal fertilizer type and variety on plant height of tobacco

Treatment	Plant height (cm)
Compound C	84.39 ^b
Compound B	83.22 ^b
Control	56.94 ^a
P-value	0.001
SED	5.757
LSD	12.827
CV%	13.3

Means followed by the same letter are not significantly different according to LSD test at $p\leq 0.05$

4.2 Effects of basal fertilizer type and variety on leaf area of tobacco

There was no significant interaction between fertilizer type and variety on leaf area ($p>0.05$). Fertilizer type showed a significant effect on leaf area ($p<0.05$). Variety had no significant effect on leaf area ($p>0.05$). Compound B recorded the highest leaf area (1928 cm) while

control treatments recorded lowest leaf area (1206 cm). There were no significant differences between Compound C and Compound B means.

Table 4.2: Effects of basal fertilizer type and variety on leaf area of tobacco

Treatment	Leaf area (cm ²)
Compound C	1880 ^b
Compound B	1928 ^b
Control	1206 ^a
P-value	0.003
SED	173.788
LSD	387.224
CV%	18

Means followed by the same letter are not significantly different according to LSD test at $p \leq 0.05$

4.3 Effects of basal fertilizer type and variety on number of leaves of tobacco remaining after harvesting session

There was no significant interaction between fertilizer type and variety on number of leaves ($p > 0.05$) after first reaping and second reaping. After first and second reaping, variety showed no significant effect on number of leaves ($p > 0.05$). Fertilizer type showed a significant effect on number of leaves both at after first and second reaping. Compound C recorded highest leaf number after first reaping and Compound B recorded highest leaf number after second reaping. Untreated control recorded the lowest number of leaves after both reaping stages. There were no significant differences in the number of leaves remaining between the fertilizer treated plots.

Table 4.3: Effects of basal fertilizer type and variety on number of leaves of tobacco remaining after harvesting session

Treatment	Number of leaves (First reaping)	Number of leaves (second reaping)
Compound C	8.167 ^b	4.944 ^b
Compound B	7.778 ^b	5.222 ^b
Control	6.778 ^a	3.944 ^a
P-value	0.026	0.003
SED	0.438	0.293
LSD	0.977	0.653
CV%	10	10.8

Means followed by the same letter are not significantly different according to LSD test at $p \leq 0.05$

4.4: Effects of basal fertilizer type and variety on dry mass of reaping stages of tobacco

There was no significant interaction between fertilizer type and variety on dry mass of tobacco leaves at first and second reaping ($p > 0.05$). Variety showed no significant effect on dry mass at both first and second reaping ($p > 0.05$). Fertilizer type showed a highly significant effect on dry mass at second reaping ($p \leq 0.001$) while a significant effect was recorded at first reaping ($p < 0.05$). Compound C recorded highest dry mass on first reaping and Compound B recorded the highest dry mass on second reaping stages while untreated controls recorded the lowest dry mass at both reaping stages.

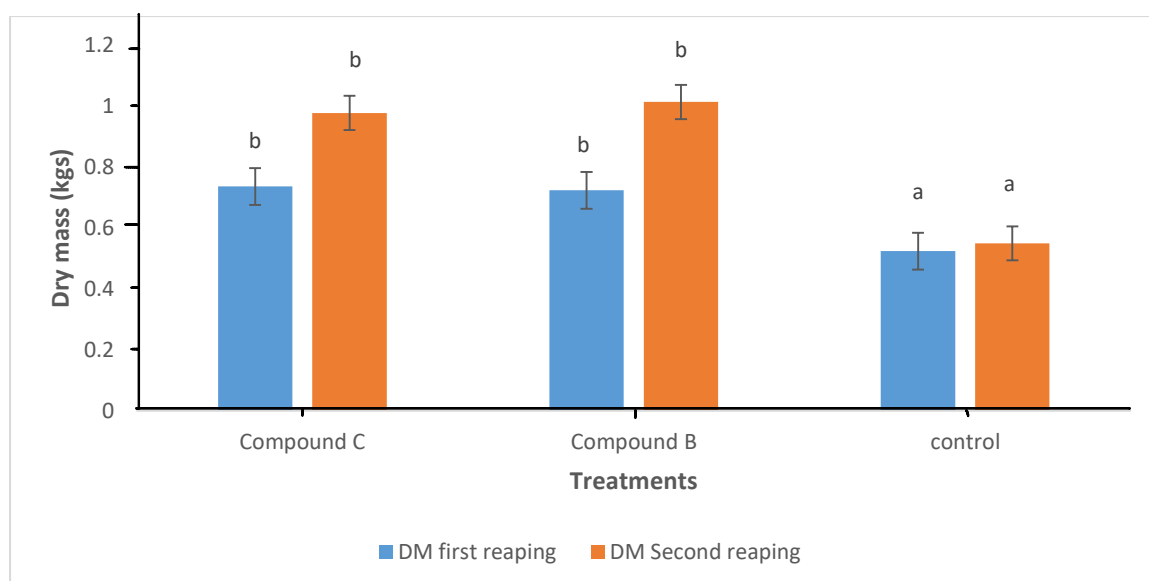


Fig 4.1: Effects of basal fertilizer type and variety on dry mass of reaping stages of tobacco

4.5 effects of basal fertilizer type and variety on quality of tobacco

There was no significant interaction effect on quality between fertilizer type and variety ($p > 0.05$). Variety showed no significant effect on quality ($p > 0.05$). Fertilizer type showed a significant effect on quality ($p < 0.05$). Compound C and compound B showed highest leaf quality while untreated controls showed poor leaf quality. There were no significant differences in quality between Compound B and Compound C treated plots.

Table 4.5: Effects of basal fertilizer type and variety on quality of tobacco

Treatment	Quality
Compound C	3.333 ^a
Compound B	4.333 ^a
Control	6.667 ^b
P-value	0.002
SED	0.689
LSD	1.534
CV%	25

Means followed by the same letter are not significantly different according to LSD test at $p \leq 0.05$

4.5 Effects of basal fertilizer type and variety on yield of tobacco

There was no significant interaction between fertilizer type and variety on yield ($p > 0.05$). Variety showed no significant effect on yield ($p > 0.05$). Fertilizer type showed a highly significant effect on yield ($p \leq 0.001$). Compound B recorded highest yield mass (1.739 kg) while control treatments recorded the lowest yield (1.074 kg). there were no significant differences between the fertilizer treated plots.

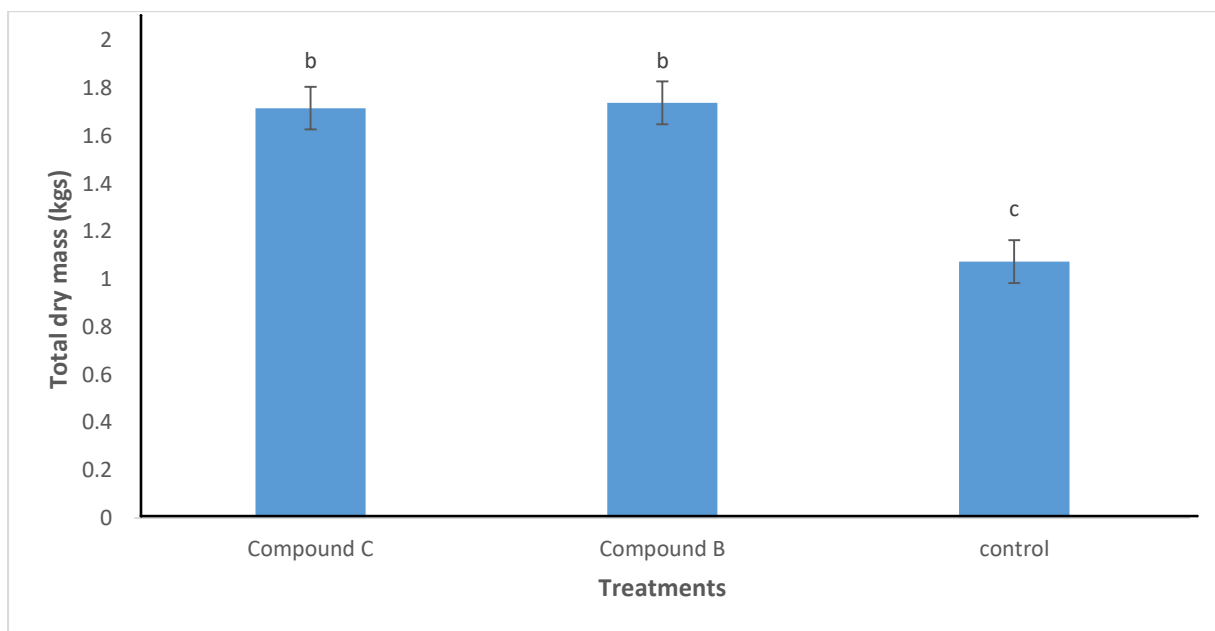


Figure 4.1: Effects of basal fertilizer type and variety on yield of tobacco

CHAPTER FIVE

DISCUSSION OF RESULTS

5.1 Effects of basal fertilizer type and variety on plant height of tobacco

The study demonstrated that fertilizer type significantly affected plant height while variety had no significant effect. Tobacco plants treated with Compound C and Compound B achieved significantly greater heights than those in the control treatment. These results agree with Tariq *et al.* (2010), who reported that adequate supplies of nitrogen, phosphorus and potassium promote vegetative growth through enhanced cell division, stem elongation and leaf expansion. The superior growth observed in fertilized treatments can be attributed to improved nutrient availability which enhanced root development and nutrient uptake.

Although Compound C produced slightly taller plants than Compound B, the difference was not statistically significant. This suggests that both fertilizers supplied sufficient nutrients to support optimum vegetative growth. Similar findings were reported by Nyantika *et al.* (2022), who observed that balanced basal fertilization significantly increased tobacco growth compared to unfertilized controls. The lack of significant varietal differences indicates that KRK26 and KRK76 possess similar growth potential under the prevailing environmental and nutritional conditions.

5.2 Effect of Basal Fertilizer Type and Variety on Leaf Area

Leaf area is an important determinant of photosynthetic capacity and eventual yield in tobacco. Fertilizer type significantly influenced leaf area, with Compound B producing the largest leaf area while the control treatment produced the smallest. The larger leaf area recorded in fertilized treatments may be attributed to enhanced nitrogen availability which promotes leaf expansion and chlorophyll formation.

These findings are consistent with those of Tariq *et al.* (2010), who reported that adequate nitrogen and phosphorus nutrition promotes leaf development and canopy formation in tobacco. The significantly lower leaf area observed in the control treatment reflects nutrient deficiencies that limited vegetative growth and photosynthetic surface area. Despite Compound B producing numerically larger leaves than Compound C, the difference was not significant, indicating that both fertilizers provided sufficient nutrients for leaf development.

The absence of varietal effects on leaf area suggests that KRK26 and KRK76 responded similarly to environmental and management conditions. This agrees with observations by Nyakapene and Mutandwa n.d., who reported that varietal differences often become more pronounced under severe nutrient stress than under adequate fertilization.

5.3 Effect of Basal Fertilizer Type and Variety on Dry Mass

Dry leaf mass is an indicator of biomass accumulation and economic yield potential. Fertilizer type significantly increased dry mass during both harvesting stages. Compound C produced the highest dry mass during the first reaping while Compound B produced the highest during the second reaping (Figure 4.1). However, differences between the two fertilizer treatments were not statistically significant.

The increased dry mass in fertilized treatments can be attributed to improved nutrient uptake, photosynthesis and assimilate accumulation. Nitrogen promotes leaf growth, phosphorus enhances root development and potassium supports translocation of carbohydrates, collectively contributing to increased dry matter production (Tariq *et al.*, 2010).

The lower dry mass observed in the control treatment reflects inadequate nutrient availability which restricted biomass accumulation. Similar observations were reported by Brunelle *et al.* (2015), who found that tobacco biomass production responds positively to balanced fertilizer application.

5.4 Effect of Basal Fertilizer Type and Variety on Leaf Quality

Leaf quality is a key determinant of tobacco market value. Fertilizer type significantly affected cured leaf quality, whereas variety had no significant effect. Both Compound B and Compound C produced significantly better-quality leaves than the unfertilized control.

The improved quality in fertilized treatments may be attributed to balanced nutrient availability which promoted desirable leaf colour, texture and maturity characteristics. Tariq *et al.* (2010) reported that balanced fertilization enhances the development of bright lemon-yellow leaves which attract premium prices on the tobacco market. In contrast, nutrient deficiencies often result in poor curing characteristics and lower quality grades.

The absence of significant differences between Compound B and Compound C indicates that both fertilizers were equally capable of producing marketable leaf quality. These findings support observations by Nyantika *et al.* (2022), who reported improved cured leaf grades following application of inorganic fertilizers.

5.5 Effect of Basal Fertilizer Type and Variety on Yield

Yield is the ultimate indicator of crop performance and profitability. Fertilizer type significantly influenced tobacco yield while variety had no significant effect. Compound B recorded the highest yield, followed closely by Compound C, whereas the control treatment produced the lowest yield (Figure 4.2).

The higher yields obtained from fertilized treatments can be attributed to increased plant height, larger leaf area, greater leaf numbers and higher dry matter accumulation. These factors collectively enhanced cured leaf production. Similar findings were reported by Brunelle *et al.* (2015), who emphasized the importance of balanced nutrient management in maximizing tobacco yield.

Although Compound B produced the highest numerical yield, the difference from Compound C was not statistically significant. This finding is particularly important because Compound C costs substantially less than Compound B. Therefore, the additional cost associated with Compound B may not be justified under the conditions of this study.

The lack of significant varietal differences suggests that KRK26 and KRK76 performed similarly under the prevailing environmental conditions and fertilizer regimes. This indicates that fertilizer management had a greater influence on yield than varietal selection.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study evaluated the effects of basal fertilizer type and variety on the growth, quality and yield of flue-cured Virginia tobacco under rain-fed conditions in Dotito, Zimbabwe. The results demonstrated that fertilizer type significantly influenced plant height, leaf area, number of leaves, dry leaf mass, cured leaf quality and yield. Both Compound B and Compound C significantly improved tobacco performance compared to the unfertilized control treatment. There were no significant differences between Compound B and Compound C for any of the measured growth, quality or yield parameters. Although Compound B produced slightly higher leaf area and yield values, these advantages were not statistically significant. Variety had no significant effect on growth, quality or yield. Similarly, there were no significant interactions between fertilizer type and variety, indicating that KRK26 and KRK76 responded similarly to the fertilizer treatments. Considering that Compound C costs substantially less than Compound B while producing comparable growth, quality and yield outcomes, Compound C represents a more economically viable basal fertilizer option for tobacco growers under conditions similar to those of the study area.

6.2 Recommendations

To farmers

- Consider using Compound C as a basal fertilizer because it provides comparable growth, quality and yield performance to Compound B at a significantly lower cost.
- Avoid omitting basal fertilizer application as the control treatment consistently produced significantly lower growth, quality and yield values.
- Since KRK26 and KRK76 performed similarly under the study conditions, farmers may select either variety based on seed availability, personal preference or other management considerations.

To researchers

- Further research should be conducted across multiple seasons and agro-ecological regions to validate the findings under varying environmental conditions.
- Future studies should investigate the effects of different fertilizer rates and combinations of basal and topdressing fertilizers on tobacco growth, quality and yield.

REFERENCE

- Brunelle, T., Dumas, P., Souty, F., Dorin, B., & Nadaud, F. (2015). Evaluating the impact of rising fertilizer prices on crop yields. *Agricultural Economics*, 46(5), 653–666.
- Gumbo, E. B., Matsa, M. M., Kowe, P., Shabani, T., & Shabani, T. (2025). Developing an integrated framework to manage deforestation associated with tobacco farming in Zimbabwe: A systematic review. *Biodiversity and Conservation*, 34(4), 1155–1176.
- KALEPA, P. E. F. (2018). *REDUCTION OF PESTS AND DISEASES IN FLUE CURED VIRGINIA TOBACCO PRODUCTION AMONGST SMALLHOLDER FARMERS*. LILONGWE UNIVERSITY OF AGRICULTURE AND NATURAL RESOURCES.
- Maregedze, L., Masike, R., Kanyowa, T., & Chiteka, K. (2023). Ball Mill Energy Efficiency Optimization Techniques: A Review. *I-Manager's Journal on Mechanical Engineering*, 13(4), 41.
- Nyakapene, N., & Mutandwa, E. (n.d.). *Research Application Summary*.
- Nyantika, M. M., Sudoi, V., Okeyo-Owuor, J. B., & Kisinyo, P. (2022). Tobacco farming using organic and inorganic fertilizers effect on soil quality in Migori County. *Africa Environmental Review Journal*, 5(2), 327–334.
- Tariq, M., Akbar, A., Lataf-ul-Haq, & Khan, A. (2010). Comparing application methods for boron fertilizer on the yield and quality of tobacco (*Nicotiana tabacum* L.). *Communications in Soil Science and Plant Analysis*, 41(13), 1525–1537.
- Zaidi, S. (2022). *Compendium on Micronutrient Fertilisers in India Crop Response & Impact, Recent Advances and Industry Trends*.

APPENDIX

Appendix 1: Analysis of variance

Variate: plant_height

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	9.83	4.91	0.05	
Block.*Units* stratum					
Fertilizer_type	2	2890.16	1445.08	14.54	0.001
Variety	1	20.77	20.77	0.21	0.657
Fertilizer_type.Variety	2	1.12	0.56	0.01	0.994
Residual	10	994.17	99.42		
Total	17	3916.05			

Appendix 2: Analysis of variance

Variate: Leaf_area

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	66114.	33057.	0.36	
Block.*Units* stratum					
Fertilizer_type	2	1958457.	979229.	10.81	0.003
Variety	1	146762.	146762.	1.62	0.232
Fertilizer_type.Variety	2	83223.	41612.	0.46	0.644
Residual	10	906068.	90607.		
Total	17	3160624.			

Appendix 3: Analysis of variance

Variate: Number_of_leaves_after_1st_reapi

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	4.0864	2.0432	3.54	
Block.*Units* stratum					
Fertilizer_type	2	6.1605	3.0802	5.34	0.026
Variety	1	2.7222	2.7222	4.72	0.055
Fertilizer_type.Variety	2	1.4444	0.7222	1.25	0.327
Residual	10	5.7654	0.5765		
Total	17	20.1790			

Appendix 4: Analysis of variance

Variate: Number_of_leaves_after_second_re

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	7.2716	3.6358	14.09	
Block.*Units* stratum					
Fertilizer_type	2	5.4198	2.7099	10.50	0.003
Variety	1	0.2222	0.2222	0.86	0.375
Fertilizer_type.Variety	2	0.7037	0.3519	1.36	0.299
Residual	10	2.5802	0.2580		
Total	17	16.1975			

Appendix 5: Analysis of variance

Variate: DM_first_reaping

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.02991	0.01495	1.36	
Block.*Units* stratum					
Fertilizer_type	2	0.17062	0.08531	7.77	0.009
Variety	1	0.01742	0.01742	1.59	0.236
Fertilizer_type.Variety	2	0.00200	0.00100	0.09	0.914
Residual	10	0.10979	0.01098		
Total	17	0.32975			

Appendix 6: Analysis of variance

Variate: DM_second_reaping

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.113358	0.056679	6.05	
Block.*Units* stratum					
Fertilizer_type	2	0.800408	0.400204	42.75	<.001
Variety	1	0.029201	0.029201	3.12	0.108
Fertilizer_type.Variety	2	0.014719	0.007360	0.79	0.482
Residual	10	0.093625	0.009362		
Total	17	1.051313			

Appendix 7: Analysis of variance

Variate: Quality

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	5.778	2.889	2.03	
Block.*Units* stratum					
Fertilizer_type	2	35.111	17.556	12.34	0.002
Variety	1	3.556	3.556	2.50	0.145
Fertilizer_type.Variety	2	0.444	0.222	0.16	0.857
Residual	10	14.222	1.422		
Total	17	59.111			

Appendix 8: Analysis of variance

Variate: Total_DM

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.23453	0.11726	4.87	
Block.*Units* stratum					
Fertilizer_type	2	1.70970	0.85485	35.49	<.001
Variety	1	0.09288	0.09288	3.86	0.078
Fertilizer_type.Variety	2	0.00663	0.00332	0.14	0.873
Residual	10	0.24086	0.02409		
Total	17	2.28460			