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Influence of Different Fertilization Levels on the Growth, Disease and Pest Status of Fluted Pumpkin (*Telfairia occidentalis Hook. F.*) in Buea, Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. Author DBA designed the study, wrote the protocol, and wrote the first draft of the manuscript. Authors SNMS and ABA carried out the field work and managed the analyses of the study. All authors managed the literature search, read and approved the final manuscript.

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ABSTRACT

Aims: Investigates the effects of different NPK fertilizer levels on growth and disease situation of *Telfairia occidentalis* in Buea, Cameroon.
Study Design: The design was a complete randomized design with four treatments and four replicates.

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Place and Duration of Study: The study was carried out in the research field of the Department of Plant Science in the university of Buea, Cameroon
Methodology: Two fluted pumpkin seed were planted in each planting stand in each experimental unit, with a planting distance of 0.5m x 1m at a depth of 4cm. NPK fertilizer treatments; T1(0 kg NPK/ha), T2(69.3 kg NPK/ha), T3 (138.8 kg NPK/ha), T4 (208.3 kg NPK/ha) were applied two weeks after seed germination, using a circular method. Plants were randomly tagged for growth measurements and observation for disease situation for a period of five weeks at weekly base.
Results: Growth parameters increased with increased fertilization levels. Incidence and severity were low and decreased with increased fertilization at T4 (208.3 kg NPK/ha). Blistering disease-like symptom recorded the highest incidence (9.38%), followed by white spot disease-like symptom (6.25%) while necrosis and crinkling recorded the least (4.1%). T1 recorded a higher disease incidence (17.71%) while T3 and T4 recorded the least (5.21%). The severity of the diseases was highest in TI (2.3%) and least in T4 (0.9%). Garden snail**,** Eastern lubber, Winter moth larva and soft scale coccus were the pests observed in the study
Conclusion: Appropriate NPK application rates should be used by farmers to optimize crop production and contributing to improved food security. *T. occidentalis* in Buea is infected with some diseases though the incidence is low.

Keywords: Telfairia occidentalis; NPK fertilizer; growth parameters; disease situation; Buea, Cameroon.

1. INTRODUCTION

"Fluted pumpkin (*Telfairia occidentalis* Hook. F.) is a creeping, vegetative shrub belonging to the Cucurbitaceae" (Ndor et al., 2013). "It is a vital indigenous leafy vegetable widely cultivated in West and Central Africa, particularly in Nigeria and Cameroon, where it serves as a key dietary component due to its rich nutritional profile, including proteins, carbohydrates, vitamins (such as ascorbic acid), fibers, and essential minerals like calcium, iron, and potassium" (Akoroda, 1990; Aworunse, 2018). "This vegetable is locally used for cooking stews, soups, yam and vegetables, sauces and even for medicinal purposes such as in the treatment of malaria and typhoid amongst other illnesses" (Kayode and Kayode, 2011). "Beyond its nutritional significance, the crop plays a crucial economic role for smallholder farmers, contributing to household income and food security" (Akpasi et al., 2023; Dordas, 2008; Odhiambo & Nderitu, 2017).

"In the southern part of Cameroon, it is called "okongobong." Translated by the people of Manyu division as "if you like, you will have it". It is a drought-tolerant perennial crop usually grown as trellised. The plant is highly consumed in west Africa because of its unique characteristics and benefits. The crop has been reported to have some medicinal values, including being a blood purifier and a therapy for some diseases" (Rabiu et al, 2025; Kebei et al., 2022). However, despite its importance, fluted pumpkin production in Cameroon remains largely subsistence-based.

In Cameroon, *T. occidantalis* is mainly produced in the Southwest region, Northwest and isolated locations in other agroecological zones (Mbong et al., 2021b). Presently in Buea, its consumption has increased with the increase in population. Because of the ubiquitous consumption, large quantities have to be made available to the markets. As such local and peri-urban production is encouraged. *Telfairia occidentalis* is one of the preferred leafy vegetables, occupying a fourth position after *Solanum nigrum, Talinum paniculatum Vernonia amygdalina* (Arrey et al., 2023). It is commonly found on the table in all celebrations (Mbong et al., 2020).

"T. occidentalis has achieved popularity due to its versatility in fresh and processed forms. Its production has promising potentials as a source of income and livelihood to farmers and such potentials can be effectively exploited in Buea. Notwithstanding, the production faces challenges amongst which are lack of farmland, decrease in soil fertility, lack of inputs, lack of certified seed, pests and diseases" (Arrey et al., 2023; Mndzebele et al., 2023;). "Amongst the constraint limiting its production, diseases are very prominent given the optimum condition for their development in Buea. Bacteria, viruses, fungi, nematodes, insect pests and weeds are generally considered to be biotic factors that limit vegetable production. Diseases impose serious limitations on *T. occidentalis* cultivation in many

countries especially in the developing countries. Several diseases have been reported on this crop. These diseases are more often fungal attacks and varying symptoms amongst which are generally: powdery mildew, soft rot, mottling, stunting and chlorosis" (Annih et al., 2020).

"Farmers often struggle with improper NPK fertilizer application on crops either under-dosing, which limits growth and productivity, or overuse, which risks nutrient imbalances and environmental harm" (Tange & Bongkisheri, 2018). These challenges underscore the urgent need for research backed fertilization strategies to optimize crop performance while ensuring sustainability. This study therefore investigates the effect of varying NPK fertilizer levels on the growth and health status of *T. occidentalis*. The findings will provide scientifically validated recommendations for farmers, enhancing productivity and sustainable farming practices in the region.

2. MATERIALS AND METHODS

2.1 The Study Site

"The research was conducted at the research farm of the Department of Plant Science, Faculty of Science, University of Buea, Cameroon. Buea is situated in the monomodal humid-forest rainfall zone of Cameroon, characterized by a tropical climate favorable for agricultural activities. The area lies at latitude 4°09′ 9.78″ N and longitude 9°14′27.60″ E. It is 870 m above sea level. The Buea university area is characterized by an average temperature of 21°C, relative humidity of 78%, and an average rainfall of 2500mm" (Sounders et al., 2017). Buea has a bimodal rainfall pattern consisting of dry and rainy seasons. Buea is found is a significant crop-producing area in the humid forest agroecological zone of Cameroon, where intensive agriculture is carried out.

2.2 Experimental Design and Seeds Sowing

A piece of land was set up in September 2024. The experiment was laid out in a complete randomized design, with 4 replications and four treatments. Each experimental subplot measured 5m x 3 m with a distance of 30 cm, separating the experimental units and the cropping system was sole cropping. The four treatments consisted of four different levels of NPK 20:10:10 per hectare: T1(0 kg NPK/ha), T2(69.3 kg NPK/ha), T3 (138.8 kg NPK/ha), T4 (208.3 kg NPK/ha). The treatments were replicated four times making a total of 16 experimental subplots. The fruit were obtained from a local market and was opened up to extract the seeds. The seeds were planted directly at a depth of 4 cm. Two fluted pumpkin seed was planted in each planting stand in each experimental unit, with a planting distance of 0.5m x 1m. Seeds emergence took two weeks after planting and each planting stand was thin to one seedling.

The NPK fertilizer treatments were applied two weeks after seed germination, using a circular method, ensuring uniform distribution around the plants at a distance of 5 cm from the base.

Staking was done five weeks after planting to enable the crop growth vertically. At six weeks after sowing, trellises were constructed to enable the herbaceous stems to climb appropriately, supporting themselves with their helically twisting tendrils.

2.2.1 Growth parameters Determination

Plants for data collection were selected randomly and tagged for the different treatment plots. Data was collected weekly on the following parameters; height of plant, number of leaves, number of branches, number of tendrils, leaf area and fresh weight and dry weight of the plant. Different techniques were employed for the different parameters (Chart 1).

2.3 Determination of Disease Status

Four weeks after sowing, the field was observed for disease-like symptoms of *Telfairia occidentalis* on all the experimental subplots. Data on disease incidence and severity was obtained following the method used by Camargo & Smith (2009). Data was recorded over a period of five weeks, from first appearance of symptoms (7WAP). Visual assessment of symptoms was the method of disease identification used in the field. This method is based on the fact that pathogens incite morphological changes in the plant (Arrey et al., 2022). The recording of disease incidence was in weeks after planting (8, 9, 10, 11 and 12 weeks). Assessments of disease prevalence, incidence, and severity were all based on the accurate and reliable visual assessment of experimental field symptoms. All infected leaves of each plant for the different treatments were systematically counted and recorded. The disease prevalence, incidence and severity were calculated per symptom type and per treatment.

Chart 1. Growth parameter and technique

SN	Parameter	Measurement technique
1	Height of plant	Manual measurement using a measuring tape from the soil base to the highest point of the plant
2	Number of leaves	A direct count of the total leaves on tagged plants
3	Number of branches	A direct count of the total branches on tagged plants
4	Leaf area	Manual methods using a leaf area meter.
5	Fresh weight	Harvesting and immediate weighing) and
6	Dry weight	Drying in an oven at ~70°C until constant weight, then weighing.

Table 1. Disease severity scoring system for diseases of *Telfairia occidentalis* in Buea, Cameroon

Severity class	Description
0	Healthy (no symptoms)
1	25% of the plant affected, symptoms not extremely distinct and little yellowed area on any symptomatic leaf.
2	50% of the plant affected with mild symptoms on one or more leaves.
3	75% of the plant affected with more symptomatic leaves per plants. Severe symptoms, widespread on plants
4	100% of plant affected with severe symptoms covering the entire plant.

2.3.1 Determination of disease prevalence of *T. occidentalis*

Disease prevalence is the measure of the total number of cases of a specific disease or condition present in plant population at a given time. It is expressed as a percentage of population affected**.**

The point prevalence was calculated by;

Prevalence = Disease symptoms based on treatment type/ disease symptoms of all treatment types) x100 (Equation 1)

2.3.2 Determination of disease incidence of *T. occidentalis*

Disease incidence refers to the number of visibly diseased plants, usually in relation to the total number assessed and so expressed as the percentage of plants in the plot with symptoms on a scale of 0–100 (%). The technique of Arrey et al. (2022) was used to calculate the incidence of disease symptoms on the experimental plot. The various symptoms-type per treatment were observed and recorded.

2.3.3 Determination of disease severity of *T. occidentalis*

Disease severity usually refers to the degree of symptom expression as assessed visually using an arbitrary scale. Ten diseased plants were taken randomly from each treatment and observed for disease symptoms. Phenotypic data on host reaction were recorded in terms of symptom expression following a five-point scoring scale (Table 1).

2.4 Scoring for Pests of *T. occidentalis*

Three weeks after planting, the field was observed at a weekly base in the morning, afternoon and evening in a day. To be considered a pest, it must cause some damage on the plant. Visual observation and counting were used to obtained the number of different pests. In the case of the black ant, the Likert scale was used (few, moderate, high and very high). Photos of the different pest were taken as on the plant in question and were recorded with respect to the different treatment.

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3. RESULTS AND DISCUSSION

3.1 Growth Response of *Telfairia occidentalis* to Different Fertilizer Application Levels

Generally, all treatments exhibit similar initial growth. Over time, the plants under each treatment show varying rates of growth (Table 2). There was a significant different (P- value < 0.001) in all the parameters considered for the different treatments.

Table 2. Mean of growth parameters

Parameter	T1	T2	T3	T4	P-value
Plant Height (m)	0.9 ± 0.2[b]	1.0 ± 0.1[b]	1.7 ± 0.3[a]	2.0 ± 0.3[a]	<0.001***
Number of leaves	87.3 ± 8.5[c]	89.0 ± 12.0[c]	107.2 ± 4.5[b]	119.1 ± 7.4[a]	<0.001***
Number of branches	6.7 ± 1.1[c]	8.4 ± 1.1[b]	9.6 ± 1.2[b]	11.1 ± 1.3[a]	<0.001***
Number of tendrils	23.9 ± 5.2[a]	19.8 ± 5.6[a]	13.3 ± 4.9[b]	21.7 ± 3.2[a]	<0.001***
Leaf area (cm^2)	1.76 ± 0.46d	2.57 ± 0.40c	3.49 ± 0.45b	4.38 ± 0.31a	<0.001***

Means that do not share a letter within a row are significantly different from each other
**** Significant at the 0.1% level of significance*

Table 3. Mean of yield parameters of *Telfairia occidentalis*

Parameter	T1	T2	T3	T4	P-value
Fresh weight of leaves with stem	250.2 ± 28.2b	344.3 ± 48.4b	383.2 ± 53.7b	723.8 ± 1,008.8a	<0.001***
Fresh weight of leaves without stem	202.1 ± 34.8a	242.9 ± 77.9a	271.0 ± 72.2a	548.6 ± 156.5a	0.3ns
Dry weight of leaves	80.5 ± 12.4b	93.0 ± 10.3b	110.5 ± 16.1ab	142.8 ± 34.8a	<0.001***
Dry weight of stems	90.3 ± 13.9b	97.7 ± 9.6b	106.5 ± 12.3b	141.5 ± 36.1a	0.002**

Means that do not share a letter within a row are significantly different from each other
[ns] Not significant at the 5% level of significant
*** Significant at the 1% level of significance*
**** Significant at the 0.1% level of significance*

3.1.1 Yield response of *Telfairia occidentalis* to different fertilizer application levels

All yield parameters with the exception of fresh weight without stem were significantly (P-value < 0.001) different across treatments (Table 3). T4 recorded the highest yield response and T1 least.

3.2 Disease Status of *T. occidentalis*

3.2.1 Diseases prevalence

Disease prevalence was 100% across all treatment subplots.

3.2.2 Disease incidence

Disease incidence decreased with higher fertilizer levels. The diversity of disease-like symptoms observed in the field is shown in Fig 1. Result shows that mosaic symptom (Fig. 1a) was common on the field. This symptom was either chlorotic areas with leaf malformation on tops of young leaves, marked with stunted growth of stalk or necrotic 'island' on lighter green background. This mosaic symptom possible caused by a virus was commonly observed on all the different treatment units. Leaf spot possible caused by a fungus was also observed in many of the plots (Fig. 1b). In some plants showing leaf spot, there was general white patches on the leaves. In others, there was mixed symptoms involving leaf folding, crinkling and yellowing on the surface of the leaf possible incited by viruses (Fig. 1c). This situation was common in plots with no treatment (control). Some of the plants' leaves showed blistering (Fig. 1d), although this was not very common in all the fields. The infected plants had thin leaves.

3.2.3 Incidence of disease-like symptoms per treatment

The incidence of disease-like symptoms on *T. occidentalis* are shown on Table 4. The total incidence of the symptoms per treatment ranged from 4.1% to 9.38%. Irrespective of treatment, there was a variation on the incidence of symptom types. Generally, not all symptom types were observed in all the treatments. The highest incidence per symptom type (9.38%) was recorded by Blistering and the least was 4.1%, recorded by necrosis and crinkling. Necrosis and crinkling were not observed on all treatment plots while all others occurred in all the different treatment plots (Table 4).

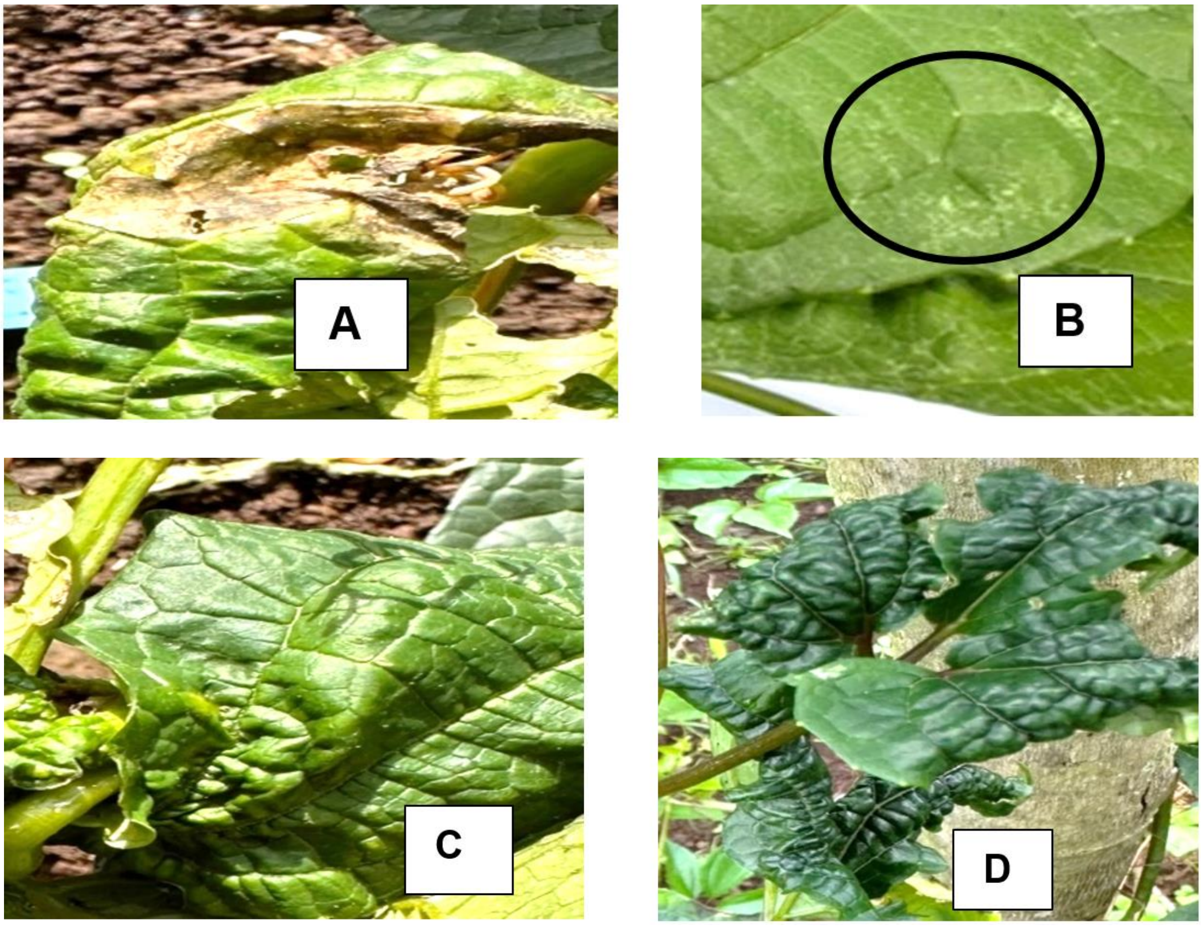

Fig. 1. Pathogen induced field symptoms on leaves: A: mosaic with necrotic lesion; B: leaf spot; C: Leaf crinkling; D: Blistering

Table 4. Incidence of disease symptom types on *T. occidentalis*

Treatment	Necrosis	White Leaf spot	Crinkling	Blistering	Mosaic	Chlorosis	Total
T1	2	2	3	4	3	3	17
T2	1	2	1	2	1	2	9
T3	0	1	0	2	1	1	5
T4	0	1	0	1	1	1	5
Total	4	6	4	9	6	7	36
Incidence (%)	4.1	6.25	4.1	9.38	6.25	7.29	37.5

3.2.4 Variation of number of infected plants in weeks after planting

As the weeks increases, the number of sick plants equally increased in all the treatment levels. It was highest in T1 and least in T4. The trend showed that in T1, sick plants increased gradually and become linear between the 10th and 11th weeks after planting while for T2, there was no increased in the number of sick plants between the 7th and 9th WAP. An increased was observed only at the 10th WAP. Similar trend was observed in T3 and T4 (Fig. 2).

3.2.5 Disease Incidence per treatment

The incidence of disease was highest in T1(control) without fertilizer application and was least in T4 with a level application of 208.3 kg NPK/ha. This indicates that fertilizer application has an impact on disease situation of *T. occidentalis*. The incidence of disease ranged from 5.21% to .17.71%. (Table 5).

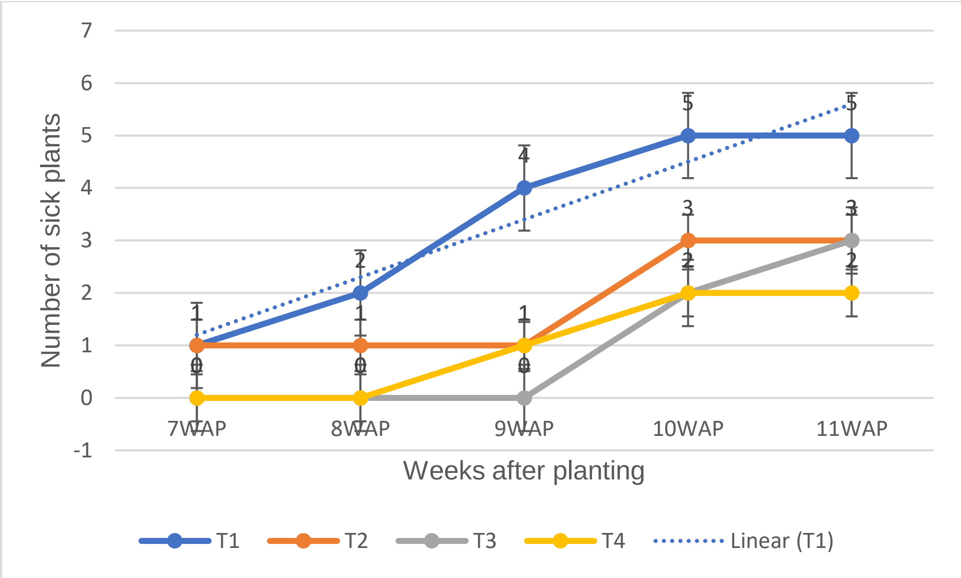

Fig. 2. Variation of number of infected plants in weeks after planting

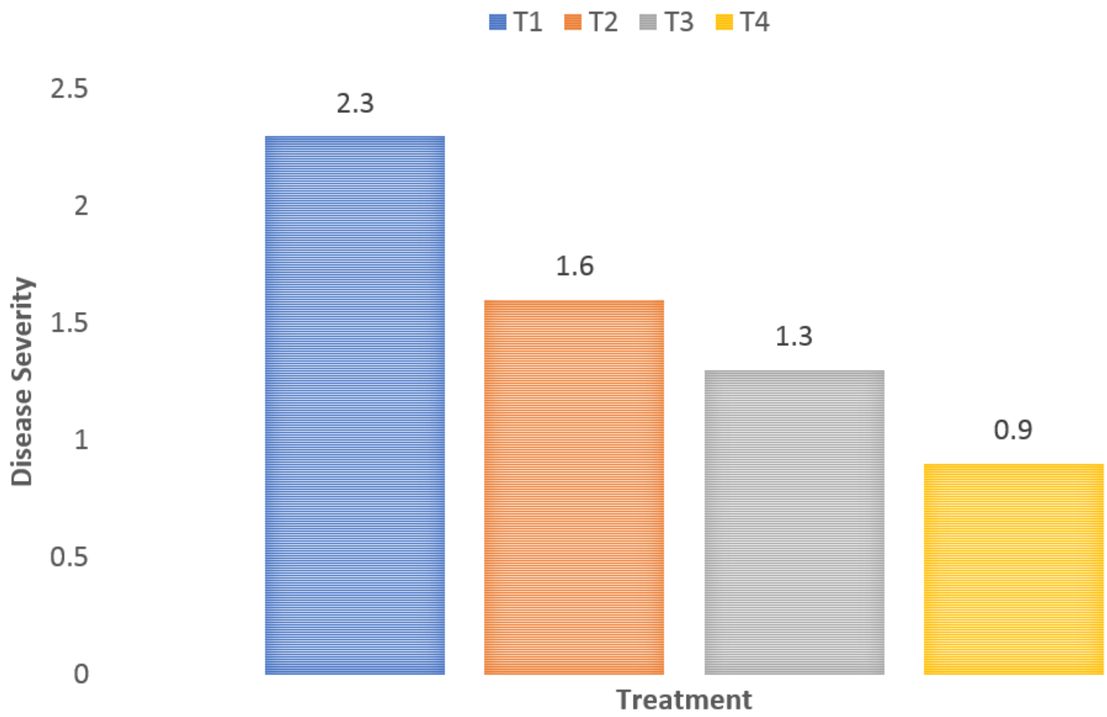

Fig. 3. Variation of disease severity of *T. occidentalis* under different treatment levels

Table 5. Disease incidence per treatment

Treatment	Disease incidence (%)
T1 (0 kg NPK/ha),)	17.71
T2 (69.3 kg NPK/ha)	9.38
T3 (138.8 kg NPK/ha)	5.21
T4 (208.3 kg NPK/ha).	5.21

3.2.6 Disease severity per treatment

There was decreased disease severity with increased levels of fertilization (Fig. 3). Disease severity of 2.3% was recorded in T1 while T4 recorded the least (0.9%). The high severity disease in TI could be attributed to the lack of enough nutrient to permit the plant to resist infection as a result of low vigour. The low severity in T4 could also be attributed to the fact that the level of fertilization was moderate to enable the growth and resistance of the plant towards disease infestation.

3.3 Pest Observed in the Field

Various pests were observed in the field and on all the different treatment plots. These included Variegated grasshopper (*Romalea microptera*), garden snails (*Cornu aspersum*), soft scale insect (coccus) and black garden ants (Fig. 4). Some of these pests were observed infesting the leaves of the plants. Black garden ants were observed building their nest on the undersides of the leaves of the plants. They were equally seen burrowing the soil and exposing the roots of *Telfairia occidentalis.*

3.4 Prevalence of Pests Per Treatment Levels

The pests were recorded in varied numbers, with the blank ant presenting a very high number (Table 6). Variegated grasshopper outnumbered the other insect pest.

The pests were recorded more at the early stage of growth and were more on T4 with higher levels of fertilizer treatment and the least on T1 with no fertilizer application. The healthy succulent nature of the stems and leaves provided a feeding source for these insects. Snails were equally found in the field but at a lower number. they were observed on all treatment plots.

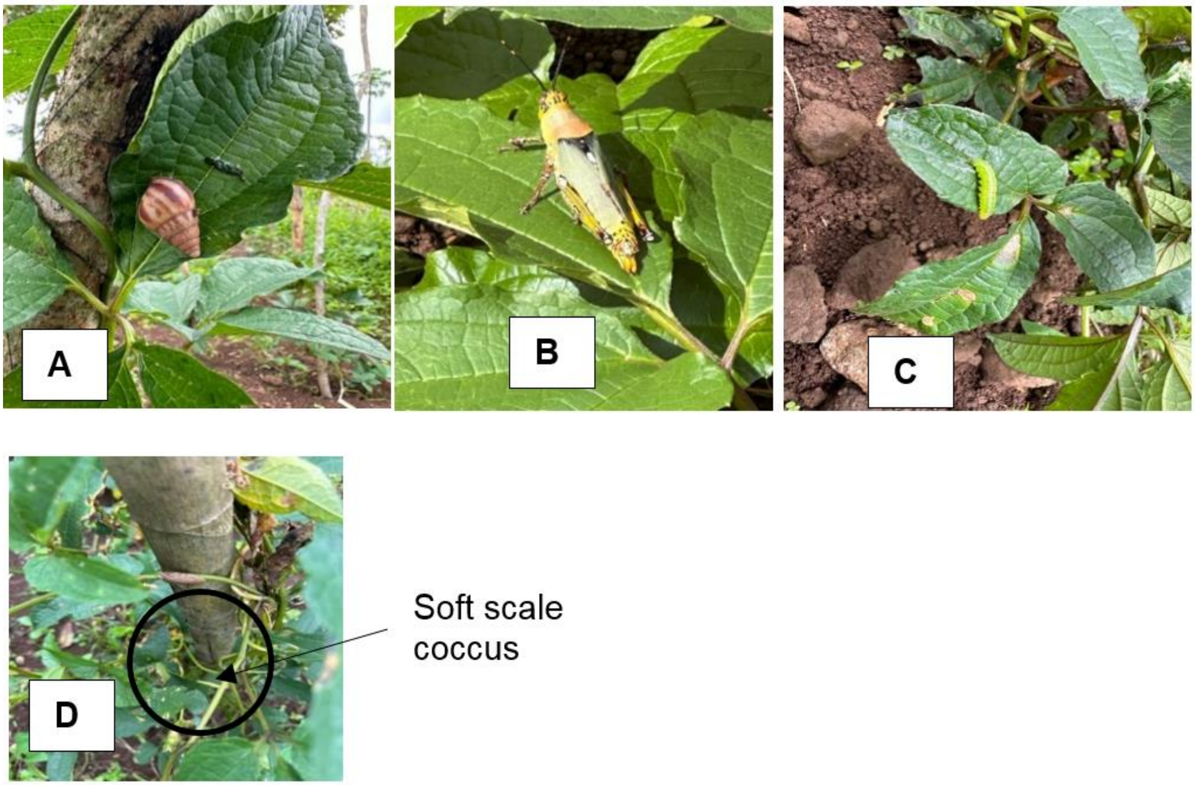

Fig. 4. Pest on fluted pumpkin A: Garden snail on leaves of fluted pumpkin; B) Eastern lubber grasshopper on leaves of fluted pumpkin C) Winter moth larva D) Soft scale coccus insects

Table 6. Prevalence of pests per treatment levels

SN	PEST	TI	T2	T3	T4
1	Black garden ants	Few	Moderate	High	Very high
2	Variegated grasshopper	12	12	16	14
3	Soft scale insect	3	4	8	9
4	Winter moth larva	1	0	3	4
5	Snails	6	6	8	11

3.5 Discussion

"Fertilizer application plays an essential role for enhancing productivity in agriculture, particularly crop yield. In the world of modern agriculture, NPK fertilizers play a crucial role in ensuring optimal plant growth and maximizing crop yields. NPK fertilizers form the backbone of modern agriculture, providing the essential macronutrients that plants need to thrive. NPK fertilizers provide the primary macronutrients" (Patjaiko, 2025). "The use of N, P, and K fertilizer has a considerable impact on *Telfairia occidentalis* development and quantitative characteristics, resulting in increased growth parameters. Nitrogen is an essential nutrient responsible for promoting leaf and stem growth. It is a critical component of proteins, enzymes, and chlorophyll which is responsible for photosynthesis. Nitrogen plays a key role in enhancing plant vigor. Phosphorus helps plants establish strong root systems, enhances flower formation, and supports early plant growth. It regulates water movement, improves disease resistance, and enhances overall plant vigor. Potassium is crucial for enzyme activation, protein synthesis, and carbohydrate metabolism. The significant increase in all growth parameters as levels of fertilizer increases is probably due to enhanced availability of nutrients growth" (Akinbode et al., 2015). This result is consistent with (Rijwan & Shobha, 2024), indicating an increase in growth parameter with increase NPK application. "The T4 level of fertilizer application might be a maximum rate for better growth and development of *Telfairia occidentalis.* Higher rates of nitrogen application inhibit plant height" (Olaniyi and Odedere, 2009). "Proper application of nitrogen fertilizers has a positive influence on plant height and stem diameter" (Bakry et al., 2023).

Though the field was well managed, disease symptoms were still observed. This is an indication that either the seeds were already infested with pathogens since the seeds were not certified. Also, the soil might have haboured some pathogens, since it was not treated before treatment application. The prevalence of disease-like symptom on the crop is an indication that this plant is liable to be infected by pathogenic agents including; fungi, bacteria, and viruses as reported by Camargo & Smith (2009). Despite a 100% disease prevalence across all treatments, greater fertilizer levels (T3 and T4) were related with lower disease incidence and severity. Soil amendment in the case of NPK fertilizer increases nutrient uptake by crop and consequently increases vigour to the plant which help to resist disease infection. "This is consistent with the findings of Camargo & Smith (2009), who discovered that well-nourished plants had increased resistance to diseases. The presence of diseases symptoms in this study is a course for concern since these diseases are known to be economically important in developing countries. White spot diseases have been reported on *T. occidentalis* in other areas in the country" (Kpu et al., 2022). "Contrarily to the results, white spot disease was not the most prevalent symptoms in our study. The effect of Nitrogen fertilizer on vegetables is quite variable. This is due to the different response depending on the type of the pathogen. At high N rates the metabolism of the plant changes: as some key enzymes of phenol metabolism have lower activity, the content of the phenolics decreases and the lignin content may be lower – all these are part of the defense system of plants against infection (Douda, 2008). The decreased disease severity in T3 and T4 might be attributed to greater plant vigour, which boosts physiological defenses against infections. In general, there is an increase in infection coefficient of pathogen if nitrogen dose is higher than the capacity of the plant to use it effectively. However, there is a necessary need of an adequacy between these three major elements of nutrition of the plants" (Huber and Haneklaus, 2007). "High nitrogen (N) levels often increasing disease severity by promoting succulent growth. Excessive nitrogen fertilizer can lead to lushing, weakening of growth that increases susceptibility to pathogens by creating favourable humid conditions for the rapid multiplication of the pathogen, thus increases infection. Adequate phosphorus (P) and potassium (K) can enhance plant defense and reduce infections. Indeed, the nutritional factors change the chemical composition of the cell by reinforcing their pectocellulosic membranes to prevent the penetration of pathogenic" (Anderson, 2002).

"Increased nitrogen fertilizer use encourages crop infestation by insects by decreasing plant resistance" (Ge et al. 2003). "Application of nitrogen fertilizer to the soil can modify the level of nitrogen in the diet of phloem-feeding insects, which in turn can impact their population growth. More nitrogen content in host plants increased the survival, longevity, fecundity, and hatchability of sucking insect pests, as does the hatching capacity of their eggs" (Dogar et al. 2018). "The presence of the Variegated grasshopper

(Z. variegatus) as the most abundant pest is a call for concern. Equally this pest has been observed in other areas in west Africa as one of the major insect pests of T. occidentalis" (Ojiako et al., 2013).

The presence of pest is an indication of infections, since some of the pests are vectors of pathogen organisms causing diseases. By building nest on the underside of leaves, insects turn to reduce the surface area of sunlight absorption, causing a drop-in photosynthesis. Insects and snails have the potential to cause damage through their feeding activities and transmitting plant diseases.

4. CONCLUSION

This study demonstrated the profound impact of NPK fertilizer levels on the growth and health status of fluted pumpkin (*Telfairia occidentalis*) in Buea, Cameroon. It was observed that the application of (208.3 kg/ha) of NPK fertilizer levels showed an increased in growth parameter and improved resilience to diseases, with reduced incidence and severity of symptoms. Pests are a challenge in the cultivation of this plant. These findings provide a scientific basis for recommending appropriate fertilizer application rates to farmers, contributing to sustainable agricultural practices and food security, solving the sustainable development goal two of 'no hunger'.

5. RECOMMENDATION

It is recommended that appropriate levels of inorganic NPK fertilizers could be explored to maximize *T. occidentalis* yields sustainably. Studies on integrated pest and disease management (IPDM) approaches, including biological controls should be conducted to further improve the health status of *T. occidentalis*.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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