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Evaluation of selected botanicals in disease control and growth promotion of sweetpotato varieties in Umuahia, Abia State

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Abstract

This study evaluated the effects of Andrographis paniculata, Newboludia laevis and Sida acuta as growth promoters and as low-input biopesticides on three varieties of Sweet potato for disease control in the field, at the Federal Forestry Institute, Umuahia during 2024 planting season. Umuspo 1, Umuspo 3 and Buttermilk varieties were used. Golden Borth (synthetic pesticide) and sterile water were used as positive and negative control. The experimental design used was randomized complete block design (RCBD), made up of 15 treatments with 3 replications. The results indicated that all the plant materials were significantly (P≤0.05) different from the control, reducing the incidence and severity of the disease and improved the growth parameters of the treated crop than the control. Out of all the plant extracts, Andrographis paniculata gave the best disease control and growth improvement of the crop, followed by full strength of Newbouldia laevis and Sida acuta was the least. However in comparison, to Golden Borth a broad spectrum pesticide, the plant-derived pesticides were statistically (P≥0.05) at par with the extracts, they demonstrated excellent antimicrobial properties against the pathogens. Recommendation: Andrographis paniculata is highly recommended as a cost-effective and eco-friendly Bio-pesticide in managing sweet potato diseases and improving Sweet potato production in the humid tropics focused on Umuspo 3 and Butter Milk varieties.

Keywords: *Disease severity and Incidence, Antimicrobial activities, Plant extracts, Sweet potato*

Introduction: Over one billion people face severe hunger in the developing nations, and a 10% mortality rate has been reported from these hunger-related complications (Oduola, Awojobi, and Adeyemo 2018). The activity of microorganisms after harvesting and poor crop storage often leads to rot developments in crops and create food scarcity. Food security, sustainability, and disease management are means food scarcity and shortage problems can be addressed to ensure high crop productivity. Sweet potatoes are staple foods, highly nutritious, and enriched with protein, carbohydrates, vitamin C, vitamin A, zinc, iron, and minerals, capable of alleviating the malnutrition problems in poor households (Abebe, 2019). Sweet potato (*Ipomoea batatas* L., Lam.) is an annual dicotyledonous crop cultivated not just in the tropics but also in the warm temperate regions of the world. It is a warm-weather creeper that belongs to the order *Solanales* and *Convolvulaceae* family (Patil, 2020). In Nigeria, it is one of the major important root crops, along with cassava, yam, and Irish potatoes. It is a known versatile food and a rich source of antioxidants and anthocyanidins (Tena, Martín, and Asuero, 2020). It also serves as a food additive. In 2017, FAOSTAT (2018) noted that sweet potatoes' total production in the country was about 4.1 million metric tons. In Africa, the production of sweet potato is not fully exploited, and it is regarded as food for the poor, but if it is well managed, according to Aboajah, Ejechi, Viashima, Adeyongu, and Muogbo (2018), it has the potential for food security and poverty alleviation. In East Africa, Uganda and Ethiopia are the top producers, with 1.75 million metric tons and 1.76 million metric tons, respectively. Despite the nutritional and economic importance of this crop, sweet potato gainful production has been limited by the activities of plant-parasitic pathogens (Tolani, Lurwanu, Sunusi, and Aliyu, 2019). Sweet potato (*Ipomoea batatas*) is an essential crop for food security and economic development in Nigeria. However, the production is greatly affected by a range of diseases caused by fungal, bacterial, and viral pathogens. 75 percent of sweet potato yield losses have been attributed to diseases and pest attacks, while diseases alone contribute to 11.9% loss. These diseases lead to reduced yields, poor quality of produce, and increased post-harvest losses, significantly threatening the sustainability of sweet potato farming in the region (Olaniyi and Odebode, 2021).

These rots are linked to a number of factors that are physiological, physical, and microbiological (Oduola, Awojobi, and Adeyemo, 2018). The mechanical damage caused during harvesting, transportation, or storage has been attributed to being the main predisposing factor of tuber spoilage and storage rots. These rots majorly impede food security in Nigeria. The scarcity and easy accessibility of improved varieties and disease-free planting materials to farmers have also promoted low sweet potato production

(Echodu, Edema, Wokorach, Zawedde, Otim, Luambano, Miinda, and Asiimwe, 2019). Fenta, Mekonnen, and Kabtimer (2023) stated that postharvest pathogens can be divided into on-farm crop penetrators that develop only in their tissues after harvest; those that infect during storage or marketing; and those that penetrate and colonize during or after harvest. Fungal deteriorations have been linked to huge postharvest losses (Kumar and Kalita, 2017). These pathogens include mainly fungi, bacteria, nematodes, etc. Fungi like *Aspergillus flavus*, *Penicillium* sp., *Ceratocystis fimbriata*, *Aspergillus niger*, and *Diaporthe batatalis* have been reported to be responsible for the postharvest decay of sweet potato (Paul, 2021). In many instances, bacteria (*Pseudomonas* and *Erwinia*) are associated pathogens leading to rots of vegetables. Owing to the many destructive effects associated with the use of synthetic pesticides globally, many natural source alternatives from higher tropical plant species have been studied and applied for the management of these diseases (Ibeh, Uzoma, and Agu 2021). The continuous use of these chemicals raises environmental concerns and poses health risks to both farmers and consumers (Jideani *et al.*, 2021). Many researchers have worked on sweet potatoes in different parts of the world, Africa and Nigeria, but little work has been done on sweet potato pathogens in Umuahia, Abia State, and their production is greatly limited by pests and diseases in southeastern Nigeria. The researcher deemed it necessary, therefore, to try control measures using plant extract application in the field, which is easily accessible to the farmers and sellers to control sweet potato field diseases; hence, the motives behind this research work. The aim of the study is therefore to determine the disease severity and incidence of three sweet potato varieties, evaluate the antimicrobial properties, and assess the growth-promoting potentials of selected botanicals in Umuahia, Abia State.

Materials and Methods: Experimental Site: The field study was carried out in Humid Forest Research Station, Forestry Research Institute of Nigeria (FRIN), Okwuta-Ibeku, Umuahia, Abia State, Nigeria. Okwuta-Ibeku, Umuahia is located at kilometres five (km 5) along the Umuahia/Ikot Ekpene highway. It is within the lowland rainforest (Nsien, et al., 2022). It lies between longitudes 7˚32' and 8˚10'E and latitude 5˚29' and 6˚14'N and on an altitude of 122 m (Source: Metrological Station, National Root Crop Research Institute (NRCRI) Umudike, Nigeria).

Experimental Treatments: Experimental treatments consist of three (3) plant extracts, one (1) synthetic pesticide, an untreated control (water) and three varieties of Sweetpotato:
Andrographis paniculata leaf extract, *Newbouldia laevis* leaf extract, *Sida Acuta* leaf extract, Sterile water, and synthetic pesticide (positive control)
Sweet potato varieties: Three different varieties were used in this experiment, UMUSPO 1 and UMUSPO 3 and Buttermilk.
Treatment Combination: 5 Treatments, 3 Varieties in 3 replication = 45 treatment combinations

Field Preparation and Planting: The fields will be mapped out using rope, tape and pegs, cleared and prepared into ridges. The Randomized Complete Block Design (RCBD) experimental design was used with three replicates. The plot size was 3m x 1m, the total land area for the experiment was 13 m x 30m = (390m^2) with a total of 45 ridges.
Preparation of Planting materials/ agronomic practices: Vine cuttings of 30cm length with 6-7 nodes from the terminal shoot, having the lower leaves removed were inserted into the ground to half their length at 45^0. The cuttings were spaced 30 X 100cm, at one cutting per stand on a ridge at a planting spacing of 30cm inter row, and 1m intra row-spacing to give 10 plants per plot and 33, 333 plants per ha. Poultry manure was applied at the rate of 10t/ha, two weeks before planting. Regular weeding was done manually at 3 weeks interval.
Source of Vines: Sweet Potato vines were sourced from National Root Crop Research Institute, Umudike.
Plant Materials to be used as plant extracts: Plant samples will be sourced locally from Michael Okpara University of Agriculture, Umudike, and National Root Crops Research Institute (NRCRI).
Preparation of plant extracts: The preparation of the plant extracts were done in line with the cold solvent extraction method described by Akinbosun and Itedjere, (2013).
Each of the plant extracts were first examined diseased and extraneous materials were removed, washed thoroughly in running water, drained and air dried at 30ºc room temperature until ready to grind. The samples will then be processed first into powdered form to increase surface area and enhance extraction. After grinding, a portion of the grounded extracts will be taken out in a beaker two for each then added accurately measured aqueous solution (water) and ethanol separately then allow to stand for 24 hours before filtering using filter paper or cheese cloth.
Application of the plant extracts in the field: Hand-held sprayers were used to apply the leaf extracts at 2 and 5 weeks after planting.
Data Collection: Assessment of growth and yield parameters: Data were collected starting from 3 weeks after planting, at 3 weeks intervals on the following parameters:

- Total numbers of leaves were obtained by counting the total number of leaves on each of the randomly tagged plants,
- vine lengths (cm): Measured from the soil mark to the vine apex with a measuring tape,
- leaf area: This was calculated using the formula described by Ogoke, Egesi and Obiefuna (2003)

Field Assessment of Disease Incidence and Severity: The plants will be examined for disease symptoms weekly from 3 weeks after planting and numbers of plants infected will be recorded. Assessment of the number of infected plants will be done per plot, the total number of plants and number infected will be counted. Data collections will be done and percentage disease incidence on roots will be calculated using the formula:

Percent Disease Incidence (PDI) = $\frac{\text{Number of plants infected in the sample area}}{} \quad \frac{100}{}$

Total number of plants assessed in the sampled area 1

Disease severity will be expressed as the mean of the severity scores recorded on plants, by a scale of 1-6 (a modified scale of Abdulbasit Shiyanbola, 2018) where;

1= no symptom expressed; healthy plants
2 = (1-25 %) of disease symptoms on plants
3 = (26-50 %) of disease symptoms on plants
4 = (51-75 %) of disease symptoms on plants
5 = (76-100 %) of disease symptoms on plants.

Disease severity (DS) was calculated using the formula below:

Disease severity was expressed as the mean of the severity scores recorded on plants, this was calculated using the formula;

$$\text{Disease severity} = \frac{\text{Sum of individual ratings}}{\text{Total number of plants examined}} \times 100$$

Pathogenicity tests of the Bacterial/fungi isolates: Diseased leaves and harvested tubers were taken to the laboratory for isolation and inoculation into healthy ones to establish the presence of pathogens in the naturally infected field. The ability of the different isolates to cause diseases in a healthy sweet potato tubers and leaves were carried out as a confirmatory test of pathogen identity and disease presence. The isolates obtained from the culture were reinoculated into healthy ones and the pathogenicity was confirmed. The sweet potato tubers and leaves were first surface sterilized by swapping the entire surface with cotton wool moistened with 70% ethanol solution. The method of Ibeh et al., (2021) were employed, in which holes were made in the sweet potato tuber with the aid of a flamed 5mm cork borer, and aseptically inoculated with 0.5ml of 48hr old culture of the bacterial isolate. The hole was covered by replacing the removed fleshy core and then sealing up the site with sterile petroleum jelly. They will be observed for symptoms of the rot like colour changes, softening, characteristic foul odour, etc. A control experiment was also set up by opening and closing the core in a tuber without introducing any organism in it except with 0.5ml sterile water. Seven days (7) after inoculation, the sweet potato tubers were carefully examined by cutting open transversely along the line of inoculation to reveal the extent of rot inside. Isolates which caused clearly visible rot were considered pathogenic when viewed against the same situation in the control. Those with records of pathogenicity were used as test organisms for treatment with plant extracts.

Preparation of Culture medium: Culture medium was prepared using dehydrated potato dextrose (PDA) (Oxoid™ ThermoScientific Product,England, UK), and Nutrient agar for Bacteria while the pathogens were isolated from infected sweetpotato leaves and tubers, subjected to pathogenicity tests, and identified. They were prepared in accordance with the manufacturer's recommendations. in which 28g of the NA powder were dispersed in 1litre distilled water in a flask mixed and heated in water bath until the Agar melted to form a homogenous mixture. The PDA were mixed with1L of distilled water and autoclaved at 121^0C for 15 minutes before distributing the hot liquid to 10cm sterile petri dishes up to 0.5cm. The fungi spores' suspension of the isolated pathogen was subsequently prepared and standardized using a hemocytometer counting slide to 1.0 x 10^5 spores/ml of sterile distilled water. and inoculated into the healthy tubers and sprayed on leaves.

Statistical Analyses: Data were analysed using general linear procedure of Genstat 2012 model. The treatment means were separated and compared at 5% level of significance using Fishers Least Significant difference.

Results : Soil analysis and characterization of the experimental site : The physical and chemical properties of the soil of the experimental farms are presented in Table 1. The soil test shows that the soil in Umuahia is a sand clay loamy, moderately acid pH of 5.48, sand, silt and clay particles of 60.45g/kg, 8.53g/kg, and 24.20g/kg respectively. It has low concentrations of total nitrogen of 0.12g/kg, available phosphorus 26.48mg/kg, and exchangeable calcium of 2.23cmol/kg.

Effects of the plant extracts on the disease severity and Incidence of Sweetpotato varieties at different weeks after planting in 2024 planting season.: Results of Table 2and 3 indicated that there were significant differences in disease severity and incidences of Sweet potato in the field (P=0.05), among the treatments and the varieties too. High mean disease severity were recorded on the untreated Sweet potato (control experiment) The Buttermilk variety had the highest value of 3.07, followed by Umuspo 1(2.09) and Umuspo 3(1.82). Compared to those treated with the plant extracts and the synthetic pesticide, *Andrographis paniculata* had the least severity score, Umuspo 3 recorded the least(1.49), followed by Umuspo 1(1.75) and Buttermilk (1.83). It performed better than the positive control (Golden Borth) although there were no significant differences among the extracts; they all lowered the disease severity of the test crop in the field.

The disease incidence indices were reduced in the extracts treated plots. They were significantly lowered from the highest mean incidences of 26.38% recorded in the untreated plot, Umuspo 3 variety to 6.93% in the *Sida acuta* plots, Buttermilk variety. The synthetic pesticides had low incidences of 9.68% across the three varieties, and then followed by *Andrographis paniculata* treated plots. For the variety, Buttermilk, the local variety had the mean highest severity of 2.1, followed by Umuspo 1(1.8) and the least was Umuspo 3(1.6), however highest incidence was also recorded in the Umuspo 3(17.6%), and Buttermilk(14.4%) and Umuspo 1 had a low incidence(13.1%)although there was no significant differences among the varieties.

Effects of the plant extracts on the number of leaves and number of branches at different weeks after planting in 2024 planting season: In the growth parameters, across the treatments, *Andrographis paniculata* recorded the highest number of branches across the varieties, which were not

significantly different (P=0.05) to the other extracts, but was different to the untreated plot which had low branches of 5.92 in Buttermilk variety, 6.08 in Umuspo 3 variety, and 6.67 in Umuspo 1. For the vine Length, Golden Borth and *Andrographis paniculata* gave the highest mean vine length of 71.04cm and 66.25cm respectively, followed by *Newbouldia laevis* treated plots (60.31cm), the control recorded the least vine length of 18.19cm. Across the varieties, Umuspo 1 variety produced the longest mean vine length of 60.25cm across the varieties, followed by Buttermilk (24.80cm) the least being Umuspo3 with 25.0cm. In terms of leaf area, except for the untreated plot that had the least area of 128.7 in Umuspo3 variety, all the plant extracts significantly (P≤0.05) improved the leaf area, irrespective of the varieties. Golden Borth had the 276.7cm which is the highest, closely followed by *Newbouldia laevis* (266cm) and *andrographis paniculata* which produced 256.7cm. All the assayed plant extracts increased the all plant growth parameters of the test crop over the control and compared favorably (P≤0.05) with the synthetic pesticide which was used as a positive check. In the varietal assessment, Umuspo 1 had the highest mean value of 108.3cm, closely followed by Umuspo 3 (99.4cm) and Buttermilk which had 96.50cm.

Discussion: The result of the physicochemical properties of the soil of the experimental site shows deficiencies in some nutrient requirements of sweet potato. The low nutrient status of phosphorus (26.48 mg/kg) and calcium (2.23 Cmol/kg) may have contributed to the poor resistance of the test crop, thereby resulting in the high incidence and severity of the soft rot disease on the untreated crop recorded in the study. This finding is in consonance with the works of Boumaaza et al. (2016) and Ogbonna and Opara (2019). The disease progression of the sweet sweetpotato field diseases (see Table 2-3) indicated from the untreated control that the disease manifestation was slow at the early stage of planting (3 WAP), almost non-symptomatic, but gradually progressed from week 6 till week 12, the increase from 2.33 to 4.33. However, it increased at a decreasing rate from 6 to 12 WAP. This thus reveals that the pathogens were virulent within 6-12 weeks (WAP), having a severity index of 2.33-4.3.

The mean effects of the biopesticides show that, irrespective of the type of plant material evaluated and the varieties tested, their antimicrobial potentials were high against the diseases. The extracts, which were at par with the standard synthetic pesticide, were statistically (P<0.05) superior to the untreated control against the target organisms. The resultant effects of the application of these plant extracts against sweet potato field diseases in indicated that they reduced disease incidences and severity of the pathogen, as they were significantly different from the untreated control. This observation is in agreement with the work done by Ogbonna and Opara (2019), whose results showed reduced disease incidence and increased yield of mushrooms using some plant extracts and reduced severity and incidences of cucumbers. This implies, therefore, that all the test plants could serve as prophylactics and therapeutants against sweet potato diseases in the field since they minimized the development and expression of the disease at 4 weeks after planting in the field. Enyiukwu, Amadioha, and Onunuju (2021) reported the same findings.

These botanicals have been reported to contain bioactive chemical groupings and compounds such as terpenoids, alkaloids, saponins, steroids, flavonoids, tannins, glycosides, and fatty acids, which are the main determinants of their antimicrobial bioactivity (Dike, Emejulu, Chukwudoruo, Akpaki, Nsofor, and Edom, 2023). The presence of alkaloids, flavonoids, saponins, tannins, polyphenols, glycosides, and terpenoids has been reported in *Andrographis paniculata, Newbouldia laevis,* and Sida *acuta.* Moreover, further studies have reported the antibacterial properties of these compounds used in this study (Salma, Abdalla, Cristóbal, Maria Esteban, Lazhar, Mehrez, and Romdhane (2023). Phyto-pesticides have been reported to improve crop growth and yield. Findings from this study have shown significant (P≤0.05) improvement of the vine length, number of leaves, number of branches, and leaf area (cm) of sweet potato and are in agreement with these findings. Se and Yong (2019) reported that Chinese chive and soybean leaf and stem extracts induced the highest rate of growth promotion in lettuce; hence, they concluded that the plant extracts tested in their study can be used for growth promotion in the organic cultivation of various crops. Also, Mark et al. (2015) stated that the essential oil derived from *A. sativum* L. effectively improved the number of leaves, leaf area, plant height, and stem girth of treated cowpea. For the varieties, Umuspo 1 and Umuspo 3 had significant optimum growth as compared to the local variety (Buttermilk). This finding could be due to their superior genetic abilities. This is in line with the results of Olori-Great and Opara (2021). They observed that Umuspo 1 produced higher storage root yield and shoot biomass than other varieties, probably due to the tendency to have a strong ability to accommodate more assimilates in the storage root by the high yielder.

Conclusion: It is concluded from this study that the extracts of *Andrographis paniculata, Newbouldia laevis,* and *Sida acuta have* proven to possess significant potential in pharmacognosy for the control of sweet potato field diseases. They have also been observed to increase the crop's growth, leading to high crop yield and production. These discoveries are useful in evaluating suggestions made on the use of these plants' medicinal properties to treat plant diseases and in leading to the development of new phytopesticides. The three botanicals compared favorably with the standard streptomycin; these extracts should be adopted considering their environmental friendliness, cost-effectiveness, and high antimicrobial properties.

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Table 1: Physico-chemical properties of the experimental site.

Soil Properties	
Sand (%)	**60.45**
Silt (%)	**8.53**
Clay (%)	**24.20**
Texture	**Sandy clay loam**
pH (H_2O)	**5.48**
Available phosphorus(Mg/kg)	**26.48**
Total Nitrogen (%)	**0.12**
Organic Carbon (%)	**1.35**
Organic Matter (%)	**2.32**
Calcium (Cmol/kg)	**2.23**
Magnesium (Cmol/kg)	**0.97**
Potassium (Cmol/kg)	**0.24**
Sodium (Cmol/kg)	**0.159**
Exchangeable Acidity(Cmol/kg)	**1.79**
Cation exchange capacity(Cmol/kg)	**5.40**
Base Saturation (%)	**66.15**

Source: Plant and Soil science laboratory, National root crop research institute, Umudike (2023)

Table 2: Effects of the plant extracts on the disease severity of Sweetpotato in the field at different weeks after planting in 2024 planting season.

Treatments		**Disease Severity** **Weeks after planting for year 2024**				
Plant Extracts	**Varieties**	3	6	9	12	***Means***
Andrographis paniculata	Umuspo 1	1.00	2.00	2.00	2.00	***1.75***
	Umuspo 3	1.00	1.3	1.67	2.00	***1.49***
	Butter Milk	1.00	1.3	2.33	2.67	***1.83***
Newbouldia laevis	Umuspo 1	1.00	1.67	2.00	2.30	***1.74***
	Umuspo 3	1.00	1.67	1.67	2.00	***1.59***
	Butter Milk	1.00	2.0	2.33	2.33	***1.92***
Sida Acuta	Umuspo 1	1.00	1.3	2.67	2.67	***1.91***
	Umuspo 3	1.67	2.00	2.33	2.33	***2.08***
	Butter milk	1.00	2.00	1.67	1.67	***1.59***
Synthetic pesticide (Golden Borth)	Umuspo 1	1.00	1.30	2.00	2.00	***1.58***
	Umuspo 3	1.00	1.30	1.67	1.67	***1.41***
	Buttermilk	1.00	2.00	2.33	2.33	***1.92***
Untreated Control (water)	Umuspo 1	1.00	2.00	2.67	2.67	***2.09***
	Umuspo 3	1.00	1.60	2.33	2.33	***1.82***
	Butter milk	1.00	2.60	4.33	4.33	***3.07***
LSD (0.05) for Treatments		0.14	NS	0.69	0.64	U1=1.8
LSD (0.05) for Varieties		0.11	NS	0.53	0.49	U3= 1.6

LSD (0.05) for T X V		0.20	0.25	NS	1.11	BM=2.1

Legend: U1= Umuspo 1, U3=Umuspo 3, BM= Buttermilk varieties

Table 3: Effects of the plant extracts on the disease incidence of Sweetpotato in the field at different weeks after planting in 2024 planting season.

Treatments		Disease Incidence (%) Weeks after planting for year 2024				
Plant Extracts	**Varieties**	3	6	9	12	***Means***
Andrographis paniculata	Umuspo 1	0.00	11.10	16.7	22.2	***12.50***
	Umuspo 3	0.00	5.70	11.2	22.7	***9.90***
	Butter Milk	0.00	5.50	16.6	22.3	***11.10***
Newbouldia laevis	Umuspo 1	0.00	16.60	22.2	22.2	***15.25***
	Umuspo 3	0.00	22.20	33.3	33.3	***22.20***
	Butter Milk	0.00	16.60	27.8	27.8	***18.05***
Sida Acuta	Umuspo 1	0.00	11.10	22.5	22.2	***13.95***
	Umuspo 3	11.7	22.2	22.5	22.5	***19.73***
	Butter milk	0.00	5.50	11.1	11.1	***6.93***
Synthetic pesticide (Golden Borth)	Umuspo 1	0.00	5.50	16.6	16.6	***9.68***
	Umuspo 3	0.00	5.50	16.6	16.6	***9.68***
	Buttermilk	0.00	16.6	5.50	16.6	***9.68***
Untreated Control (water)	Umuspo 1	0.00	11.1	16.6	27.8	***13.88***
	Umuspo 3	0.00	11.1	27.8	66.6	***26.38***
	Butter milk	5.53	16.6	33.30	50.0	***26.36***
LSD (0.05) for Treatments		3.30	11.03	8.80	13.54	U1=13.1
LSD (0.05) for Varieties		2.50	NS	6.83	NS	U3=17.6
LSD (0.05) for T X V		NS	NS	NS	23.46	BM=14.4

Legend: U1= Umuspo 1, U3=Umuspo 3, BM= Buttermilk varieties

Table 4: Effects of the plant extracts on the number of leaves and number of branches at different weeks after planting in 2024 planting season.

Treatments		Number of branches Weeks after planting for year 2024					Number of leaves Weeks after planting for year 2024				
Plant Extracts	**Varieties**	3	6	9	12	Means	3	6	9	12	Means
Andrographis paniculata	Umuspo 1	2.667	4.67	8.67	10.67	6.67	70.70	129.70	160.33	220.00	145.18
	Umuspo 3	3.000	5.67	10.00	11.00	7.42	61.70	111.70	141.67	170.30	121.34
	Butter Milk	2.667	5.00	11.33	12.00	7.75	66.30	100.00	142.00	179.70	122.00
Newbouldia laevis	Umuspo 1	3.000	5.00	9.67	12.00	7.42	70.70	101.30	141.67	166.30	119.99
	Umuspo 3	2.333	5.67	8.00	10.33	6.58	80.0	95.70	128.33	148.70	113.18
	Butter Milk	2.667	4.67	8.00	11.00	6.58	72.30	86.70	100.00	122.00	95.25
Sida Acuta	Umuspo 1	2.667	5.00	8.33	10.67	6.67	68.00	82.30	106.00	130.30	96.65
	Umuspo 3	3.000	4.33	7.33	10.00	6.17	62.30	79.00	99.00	116.70	89.25
	Butter milk	2.667	5.00	7.00	10.33	6.25	70.30	86.00	95.33	107.70	89.83
Synthetic pesticide (Golden Borth)	Umuspo 1	2.667	5.33	7.00	11.67	6.67	75.30	90.70	97.00	111.70	93.68
	Umuspo 3	2.667	5.33	7.33	9.67	6.25	69.30	79.00	89.67	114.00	87.99
	Buttermilk	3.000	6.00	7.33	11.67	7.00	77.70	84.00	90.00	120.00	92.93

Untreated Control (water)	Umuspo 1	2.333	5.33	8.00	11.00	6.67	66.70	81.70	91.33	104.30	86.01
	Umuspo 3	2.000	5.00	7.33	10.00	6.08	64.00	71.00	88.67	118.00	85.42
	Butter milk	2.333	3.67	7.67	10.00	5.92	70.00	70.00	87.33	102.70	82.51
LSD(0.05)for Treatments		8.45	0.556	0.79	0.99	U1=6.82	0.73	8.38	6.428	13.67	U1=108.3
LSD(0.05) for Varieties		6.55	0.431	0.61	0.77	U3=6.50	0.56	6.49	4.979	10.59	U3=99.4
LSD(0.05) for T X V		14.64	0.963	1.37	1.73	BM=6.70	1.24	15.52	11.133	23.68	BM=96.5

Legend: U1= Umuspo 1, U3=Umuspo 3, BM= Buttermilk varieties

Table 5: Effects of the plant extracts on the Vine Length (cm) and Leaf area (cm) at different weeks after planting in 2024 planting season.

Treatments		**Vine Length (cm)**					**Leaf area (cm)**				
		Weeks after planting for year 2024					**Weeks after planting for year 2024**				
Plant Extracts	**Varieties**	3	6	9	12	Means	3	6	9	12	Means
Andrographis paniculata	Umuspo 1	30.90	35.10	81.20	117.80	66.25	132.00	174.00	212.70	246.00	191.18
	Umuspo 3	11.50	17.48	40.80	44.40	28.55	75.00	103.30	133.30	193.30	126.23
	Butter Milk	8.73	12.97	24.90	40.80	21.85	102.00	176.70	213.30	256.70	187.18
Newbouldia laevis	Umuspo 1	26.00	38.53	80.70	96.00	60.31	110.00	203.30	238.30	266.00	204.40
	Umuspo 3	11.42	19.29	37.30	45.10	28.28	103.00	153.30	198.70	224.00	169.75
	Butter Milk	9.30	21.19	35.80	70.30	34.15	110.00	163.30	203.30	230.30	176.73
Sida Acuta	Umuspo 1	22.33	33.00	50.30	90.70	49.08	115.00	155.70	186.70	223.30	170.18
	Umuspo 3	9.32	12.83	32.80	44.00	24.74	115.00	132.00	159.00	188.30	148.58
	Butter milk	11.77	16.19	33.10	42.50	25.89	78.00	141.70	174.00	210.00	150.93
Synthetic pesticide (Golden Borth)	Umuspo 1	24.33	48.33	94.00	117.50	71.04	127.00	180.00	233.30	276.70	204.25
	Umuspo 3	10.83	14.81	27.10	41.60	23.59	114.00	158.30	172.70	195.70	160.18
	Buttermilk	8.73	13.94	27.40	46.40	24.12	106.00	137.30	159.30	193.00	148.90
Untreated Control (water)	Umuspo 1	22.39	31.33	65.00	98.30	54.26	71.00	90.00	118.00	146.30	106.33
	Umuspo 3	10.77	14.77	21.30	33.00	19.96	63.00	77.70	107.70	128.70	94.28
	Butter milk	9.40	11.45	20.60	31.30	18.19	69.00	94.70	106.70	134.70	101.28
LSD (0.05) for Treatments		8.50	3.18	3.27	8.96	U1=60.2	12.58	19.90	17.66	15.43	U1=175.3
LSD (0.05) for Varieties		6.60	2.46	2.54	6.94	U3=25.0	9.75	15.41	13.68	11.95	U3=139.8
LSD (0.05) for T X V		14.80	5.51	5.67	15.52	BM=24.8	21.99	34.47	30.58	26.73	BM=153.0