

Correlation and Path Coefficient Analysis of Growth and Yield Traits of Coleus Potato (*Coleus Rotundifolius* Chev. & Perrot) in the Guinea Savanna of Nigeria

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Abstract

This study examined the correlations between growth traits, yield components and fresh tuber yield of Coleus potato (Coleus rotundifolius Chev. & Perrot) during the 2023 and 2024 rainy seasons at the Teaching and Research Farm of the Federal University of Agriculture, Zuru, Kebbi State, Nigeria. The experiment evaluated two local accessions, four plant spacing treatments and four NPK (15:15:15) fertilizer rates. The spacing treatments were 15 × 75, 30 × 75, 45 × 75 and 60 × 75 cm, while fertilizer rates were 0, 100, 200 and 300 kg ha⁻¹. The reported correlation matrices were examined for individual seasons and combined data, and path coefficient analysis was used to investigate the direct and indirect contributions of selected traits to tuber yield. In 2023, fresh tuber yield showed positive correlations with number of branches per plant ($r = 0.913$), number of leaves per plant ($r = 0.894$), plant height ($r = 0.541$), number of tubers per stand ($r = 0.554$) and mean tuber diameter ($r = 0.612$). In 2024, number of leaves per plant ($r = 0.966$), tuber weight per stand ($r = 0.799$) and harvest index ($r = 0.751$) had comparatively strong positive correlations with fresh tuber yield. In the combined analysis, the strongest reported associations were with number of leaves per plant ($r = 0.922$), shoot dry weight ($r = 0.888$), tuber weight per stand ($r = 0.753$), mean tuber diameter ($r = 0.663$) and number of tubers per stand ($r = 0.662$). The accompanying path-analysis narrative identified shoot dry weight and plant height as important growth-related traits in the combined analysis, while tuber number and mean tuber weight were identified as important yield components. Overall, the results indicate that vegetative growth and tuber-yield components were associated with fresh tuber yield, although the strength of these relationships varied between seasons. Verification of the original statistical output is required before definitive conclusions can be drawn about the direct effects and statistical significance of individual traits.

Keywords: *Coleus potato; Hausa potato; correlation; path coefficient analysis; tuber yield; growth traits; Guinea Savanna.*

Introduction

Coleus potato (*Coleus rotundifolius* Chev. & Perrot), commonly known as Hausa potato, is an underutilized tropical tuber crop cultivated in parts of sub-Saharan Africa. It is valued as a food crop and contributes to household food security, dietary diversity and rural livelihoods. Despite its potential, it has received less agronomic research attention than major root and tuber crops. The limited availability of validated production recommendations presents a challenge to improving its productivity and commercial development.

Crop yield is a complex characteristic influenced by vegetative growth, environmental conditions, genotype and crop management. In tuber crops, traits such as plant height, branching, leaf production, leaf area index and shoot dry matter reflect aspects of canopy development and biomass accumulation. Yield components, including tuber number per stand, tuber weight per stand, mean tuber weight and tuber diameter, provide additional information about the development and distribution of harvested yield. Plant population density and fertilizer management are important agronomic factors affecting crop growth and resource use. Excessively dense planting can intensify competition for light, water and nutrients, whereas very wide spacing may reduce the number of plants established per unit area. Fertilizer application can influence vegetative growth, nutrient uptake and assimilate allocation to harvested organs. The magnitude of these responses may differ among accessions and growing seasons. Correlation analysis is commonly used to determine the direction and strength of relationships between agronomic traits and crop yield. Positive correlations indicate that higher values of one trait tend to occur with higher values of another, whereas negative correlations indicate an inverse relationship. However, correlations alone do not establish causation and may be influenced by relationships among several traits. Path coefficient analysis extends correlation analysis by partitioning associations into estimated direct and indirect effects under a specified statistical model. This approach may help distinguish traits that have a direct relationship with yield from those whose associations operate through other variables. Nevertheless, path analysis depends on the quality of the correlation matrix, the variables included and the assumptions of the model. The identification of growth and yield traits associated with tuber yield is particularly relevant to *Coleus* potato because improved agronomic information is needed to support its production in Nigerian savanna environments. Local accessions may differ in maturity, growth habit and yield characteristics, making multi-season evaluation useful for examining the consistency of trait relationships.

This study therefore investigated the correlations between growth traits, yield components and fresh tuber yield of *Coleus* potato at Zuru, Kebbi State, Nigeria, during the 2023 and 2024 rainy seasons. The specific objectives were to:

1. Examine the relationships between selected vegetative growth traits and fresh tuber yield.
2. Determine the associations between tuber-yield components and fresh tuber yield across the two seasons.
3. Compare the reported correlation patterns for individual seasons and combined data.
4. Assess the reported direct and indirect contributions of selected traits to tuber yield using path coefficient analysis.

Materials and Methods

Experimental site

The field experiments were conducted during the 2023 and 2024 rainy seasons at the Teaching and Research Farm of the Federal University of Agriculture, Zuru, Kebbi State, Nigeria. The site is located at approximately 11°35' N latitude and 4°45' E longitude, at an elevation of about 394 m above sea level, within the Guinea Savanna ecological zone.

The supplied study records reported annual rainfall ranging from approximately 690 to 885 mm, distributed over four to six months, generally from April to October. Reported minimum and maximum temperature ranges were 18–29°C and 30–38°C, respectively. Relative humidity was reported as 26–39%. The reported solar radiation values and measurement units should be checked against the original meteorological records before publication.

The experimental soil was described as sandy loam, slightly acidic, with a reported pH of 5.6. Soil characteristics were determined before planting.

Soil sampling and analysis

Soil samples were collected randomly from the experimental area before land preparation at depths of 0–20 and 20–40 cm. The samples were composited, air-dried and passed through a 2-mm sieve before laboratory analysis. Particle-size distribution was determined using the hydrometer method described by Bouyoucos (1951). Total nitrogen was determined using the Micro-Kjeldahl procedure, while available phosphorus was measured using the Bray I method (Bray & Kurtz, 1945). Exchangeable potassium and sodium were determined using a flame photometer, while calcium and magnesium were measured using atomic absorption spectrophotometry. The original laboratory records should be consulted to confirm the procedures used for exchangeable bases and cation exchange capacity.

Experimental treatments and design

The experiment evaluated two local accessions of Coleus potato, four plant spacing treatments and four NPK fertilizer rates.

The accessions were:

- **Ex-Zuru Black:** A local accession sourced from farmers in the Dongo area of Zuru, Kebbi State. The source material described it as a relatively late-maturing type, requiring approximately 120–145 days to reach maturity.
- **Ex-Zuru Brown:** A local accession sourced from farming communities in Ribah, Kebbi State. It was described as an earlier-maturing type, reaching harvest in approximately 110–125 days. The plant spacing treatments were 15 × 75, 30 × 75, 45 × 75 and 60 × 75 cm. These corresponded to reported plant populations of approximately 88,888, 44,444, 29,629 and 22,222 plants ha⁻¹, respectively.

Four rates of NPK 15:15:15 fertilizer was evaluated: 0, 100, 200 and 300 kg ha⁻¹.

The experiment was described as a split-plot arrangement, with combinations of plant population density and fertilizer rate assigned to main plots and accession assigned to subplots. Treatments were replicated three times. The original field layout should be checked to confirm the allocation of factors and the precise experimental error structure.

Land preparation and crop establishment

The field was treated with glyphosate at the reported rate of 20 mL L⁻¹ of water, approximately three weeks before ploughing. The land was ploughed and ridged. Gross plots measured 6 × 4.5 m (27 m²), with a reported net plot area of 12.5 m². Each subplot consisted of six ridges spaced 75 cm apart. Healthy seed tubers were selected for planting and treated with a dithiocarbamate fungicide powder at 2 g kg⁻¹ of seed tubers, as reported in the study material. Planting was carried out at approximately 5 cm depth according to the assigned intra-row spacing treatment. Further details on planting dates, fertilizer application timing, irrigation, weed control and harvesting procedures should be incorporated from the complete field records if required by the target journal.

Measurement of growth and yield traits

The traits considered in the reported correlation and path analyses included plant height, number of branches per plant, number of leaves per plant, leaf area index (LAI), shoot dry weight, harvest index, tuber dry weight, number of tubers per stand, tuber weight per stand, mean tuber weight, mean tuber diameter and fresh tuber yield.

Plant height, leaf and branch characteristics were assessed at the growth stages indicated in the source tables, principally 8–9 weeks after planting. Shoot dry weight and leaf area index were also measured during the vegetative growth period. Tuber characteristics were recorded at harvest.

The original methods and data sheets should be consulted to verify the sampling procedure, units, number of sampled plants and calculations used for each trait. The source tables use both WAP and WAT to refer to time after planting; this terminology should be standardized throughout the final manuscript.

Statistical analysis

Correlation coefficients were used to assess relationships among growth traits, yield components and fresh tuber yield during the 2023 and 2024 rainy seasons and for combined data. Reported significance codes were interpreted as follows: $P < 0.05$ for one asterisk and $P < 0.01$ for two asterisks, subject to confirmation from the original statistical output.

Path coefficient analysis was used to estimate direct and indirect effects of selected traits on tuber yield. The supplied results describe seasonal and combined analyses, but the complete model specification and consistent path coefficient tables were not available for independent verification. Before submission, the authors should confirm the correlation procedure, sample sizes, statistical software, significance tests and path model. Correlation and path coefficients should be recalculated from the original data if any table entries or significance annotations are inconsistent.

Results

Soil Physical and Chemical Analysis

The physicochemical properties of the soil at the 0–40 cm depth showed slight variations between 2023 and 2024. Soil pH (H₂O) declined from 6.29 in 2023 to 5.81 in 2024, indicating a gradual increase in soil acidity, although the soil remained within the slightly acidic range considered suitable for most crops. Soil organic carbon and total nitrogen increased from 6.00 to 7.85 g kg⁻¹ and from 0.45% to 0.68%, respectively, suggesting an improvement in soil organic matter content and nitrogen availability. However, available phosphorus remained consistently low in both years (about 2.1 mg kg⁻¹), indicating persistent phosphorus deficiency, possibly due to inadequate replenishment and phosphorus fixation under acidic soil conditions. The particle size distribution showed only slight changes over the study period, with the soil retaining its sandy loam textural class. This texture is generally associated with good drainage but may also predispose the soil to nutrient leaching. Exchangeable calcium and magnesium decreased between the two years, whereas potassium levels remained adequate and sodium concentrations were relatively stable. The cation exchange capacity remained high and fairly constant, reflecting a good capacity for nutrient retention. Overall, the soil demonstrated improved organic fertility and favourable physical characteristics; nevertheless, low phosphorus availability, declining base cations, and increasing soil acidity remain important limitations to sustainable crop production, thereby highlighting the need for appropriate soil fertility management strategies. (Appendix I)

Correlation between Yield, Growth and Yield Characters

The correlation coefficients between yield and growth and yield characters are presented in Tables 10, 11 and 12 during the rainy seasons and the combined data, respectively. The correlations between tuber yield/ha and all growth and yield characters were positive and highly significant in all the seasons and the data. In the 2023 season (Table 4.28), fresh tuber yield exhibited its strongest positive correlations ($r > 0.89$, $p < 0.01$) with the number of branches per plant ($r = 0.913$) and the number of leafs per plant ($r = 0.894$). Moderate but significant positive correlations were also observed with plant height at 9 WAP ($r = 0.541$), tuber weight per stand ($r = 0.568$), and mean tuber diameter ($r = 0.612$). In the 2024 season (Table 29), the strongest association with yield was again recorded for the number of leaf per

plant ($r = 0.966$, $p < 0.01$), followed by tuber weight per stand ($r = 0.799$, $p < 0.01$) and harvest index ($r = 0.751$, $p < 0.01$).

The combined analysis (Table 4.30) reinforced these trends, with the highest correlations observed between fresh tuber yield and number of leafs per plant ($r = 0.922$, $p < 0.01$) and shoot dry weight at 9 WAP ($r = 0.888$, $p < 0.01$). Correlations among vegetative growth traits were generally positive and significant. Plant height at 9 WAP showed strong positive associations with the number of branches per plant ($r = 0.721$ in 2023; $r = 0.458$ in 2024) and number of leafs per plant ($r = 0.580$ in 2023; $r = 0.875$ in 2024). However, the relationship between number of leaf per plant and leaf area index (LAI) at 9 WAP was consistently weak and non-significant across seasons ($r = 0.023$ in 2023; $r = 0.053$ in 2024). Shoot dry weight at 9 WAP was strongly and positively correlated with both leaf number ($r = 0.937$ in 2023; $r = 0.909$ in 2024) and branch number ($r = 0.937$ in 2023). Harvest index (HI) exhibited a distinct relationship with vegetative growth traits, particularly in the 2023 season.

HI was significantly and negatively correlated with number of leafs per plant ($r = -0.401$, $p < 0.01$) and LAI ($r = -0.421$, $p < 0.01$). Correlations of HI with plant height and branch number were weak and non-significant in both seasons. Conversely, HI showed strong and positive correlations with tuber-related traits. It was significantly correlated with tuber dry weight per stand ($r = 0.630$ in 2023; $r = 0.423$ in 2024) and tuber number per stand ($r = 0.704$ in 2023; $r = 0.532$ in 2024). Key tuber yield components were strongly interrelated. Tuber number per stand and tuber weight per stand were significantly and positively correlated in both seasons ($r = 0.566$ in 2023; $r = 0.845$ in 2024). Mean tuber weight was largely determined by tuber weight per stand ($r = 0.335$ in 2023; $r = 0.818$ in 2024) and mean tuber diameter ($r = 0.589$ in 2023; $r = 0.902$ in 2024). In contrast, the relationship between tuber number per stand and mean tuber weight was weak and non-significant ($r = 0.133$ in 2023; $r = 0.062$ in 2024). Similarly, the correlation between tuber number per stand and mean tuber diameter was negligible in 2023 ($r = 0.003$) and only moderate in 2024 ($r = 0.33$).

Path Co-efficient Analysis

The direct and indirect effects of selected growth and yield characters on tuber yield for the 2023 and 2024 seasons, along with the combined data, are presented in Table 4.30a, while the percent contributions are detailed in Table 4.30b.

All direct effects on tuber yield were positive, except Shoot Dry Weight (SDW) at 9 WAT in the combined data (-0.1410) and Mean Tuber Weight (MTW) in the combined data (-0.1504). Indirect effects were predominantly positive, though notable negative indirect effects were observed. These included effects via Mean Tuber Diameter (MTD) for Shoot Dry Weight in 2023 (-0.0710) and 2024 (-0.0561), and for LAI in 2024 (-0.0151). In the combined data, several traits exhibited negative indirect effects via Mean Tuber Weight, including Height (-0.1410), LAI (-0.0888), Shoot Dry Weight (-0.0269), Tuber Number/Stand (-0.1085), and Mean Tuber Diameter (-0.0920). The strongest mediating effect for most parameters was via Tuber Number/Stand in 2023 and the combined data, and via Mean Tuber Weight in 2024. The highest percent combined contribution was recorded by the pair NTPS+MTD in 2023 (8.36%), PLHT+MTD in 2024 (6.55%), and PLHT+SDW in the combined data (6.89%). Several combinations, particularly those involving Mean Tuber Weight (MTW) in the combined data (e.g., PLHT+MTW, LAI+MTW, SDW+MTW, NTPS+MTW, MTW+MTD), showed negative combined contributions. The lowest positive combined contributions were from LAI+MTW in 2023 (0.06%) and LAI+SDW in the combined data (6.01%).

Discussion

The positive and significant correlations between tuber yield and key growth characters—plant height, number of branches, LAI, and shoot dry weight highlight the importance of canopy

development and assimilatory capacity in determining yield. These traits collectively form the photosynthetic apparatus of the crop, intercept solar radiation, utilize CO₂, and generate dry matter through photosynthesis. As emphasized by Reddy and Reddi (2002), high dry matter production per unit area is a prerequisite for achieving high potato yield.

Similarly, strong positive correlations between tuber yield and yield components such as number of tubers per stand, tuber weight per stand, and mean tuber weight confirm these traits as primary determinants of yield. These relationships are consistent with earlier reports by Pereira and Shock (2006), Babaji *et al.* (2007), and Islam *et al.* (2009).

Path coefficient analysis revealed seasonal variability in the contribution of growth characters to tuber yield, reflecting environmental influences on trait expression. However, when data were averaged across seasons, shoot dry weight at 9 WAP and plant height emerged as the most influential growth traits, with shoot dry weight exerting the strongest direct effect on yield. This reinforces the central role of biomass accumulation during early growth stages in establishing yield potential. Comparable findings were reported by Reddy and Reddi (2002) and Babaji *et al.* (2009), who identified total dry matter as the most critical growth determinant of potato yield. Although plant height showed variable direct effects across seasons, its influence on yield was largely indirect, mediated through shoot dry weight and mean tuber diameter. This indicates that plant height contributes to yield primarily by enhancing assimilate production rather than directly affecting tuber formation. Among yield components, number of tubers per stand and mean tuber weight exerted the strongest direct effects on total tuber yield, with many other traits contributing indirectly through these components. This finding further underscores their central role in yield determination, in agreement with Babaji *et al.* (2007).

Conclusion

The reported correlation analysis of Coleus potato during the 2023 and 2024 rainy seasons at Zuru, Nigeria, identified positive relationships between fresh tuber yield and several growth and yield characteristics. Number of branches and number of leaves were strongly correlated with yield in 2023, while number of leaves, tuber weight per stand and harvest index showed strong reported associations in 2024. In the combined data, number of leaves per plant and shoot dry weight had the highest reported correlations with fresh tuber yield, followed by tuber weight per stand, mean tuber diameter and number of tubers per stand. The results suggest that vegetative growth and tuber-yield components are useful characteristics for further study of Coleus potato productivity. Nevertheless, seasonal differences, inconsistencies in significance annotations and problems in the supplied path coefficient tables limit definitive interpretation. Verification of the original dataset and statistical output is essential before reporting final direct effects or recommending specific production practices.

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Table 1: Correlation Matrix among Yield Character of Coleus Potato During 2023 Rainy Season

	1	2	3	4	5	6	7	8	9	10	11	12
Fresh tuber yield	1.000											
Plant height(9WAP)	0.541**	1.000										
Branches per plant(8WAP)	0.913**	0.721**	1.000									
Leaf per plant(9WAP)	0.894**	0.580**	0.411**	1.000								
Leaf Area Index (9WAP)	0.341**	0.492**	0.323**	0.023 ^{ns}	1.000							
Shoot dry weight (9WAP)	0.255*	0.537**	0.937**	0.937**	0.937**	1.000						
Harvest index (HI)	0.441**	-0.062 ^{ns}	-0.050 ^{ns}	-0.401**	-0.421**	0.143 ^{ns}	1.000					
Tuber dry weight (g)	0.541**	0.473**	0.492**	0.295**	0.055 ^{ns}	0.589**	0.630**	1.000				
Number of tuber per stand	0.554**	0.462**	0.323**	0.323**	0.225*	0.601**	0.704**	0.536**	1.000			
Tuber weight per stand (g)	0.568**	0.704**	0.661**	0.321**	0.215**	0.073 ^{ns}	0.573**	0.704**	0.566**	1.000		
Mean tuber weight (g)	0.481**	0.614**	0.092 ^{ns}	0.092 ^{ns}	0.045 ^{ns}	0.045 ^{ns}	0.335*	0.613**	0.133 ^{ns}	0.335**	1.000	
Mean tuber diameter (cm)	0.612**	0.469**	0.031**	0.031 ^{ns}	-0.151 ^{ns}	-0.151	0.591**	0.612**	0.003 ^{ns}	0.612**	0.589**	1.000

1. Tuber fresh yield/ha, 2. Plant height, 3. Number of branches/plant (9WAP), 4. Number of leaf/plant (9WAP), 5. Leaf Area Index (9WAP), 6. Shoot dry weight (9WAP), 7. Tuber dry weight/stand (11), 8. Harvest Index (11), 9. Number of tubers/stand, 10. Tuber weight/stand, 11. Mean tuber weight, 12. Mean tuber diameter, ns= not significant at 5%, *=significant at 5%, **= significant at 1%.

Table 2: Correlation Matrix among Yield Character of Coleus Potato During 2024 Rainy Season

	1	2	3	4	5	6	7	8	9	10	11	12
Fresh tuber yield	1.000											
Plant height(9WAP)	0.583**	1.000										
Branches per plant(8WAP)	0.383**	0.458**	1.000									
Leaf per plant(9WAP)	0.966**	0.875**	0.804**	1.000								
Leaf Area Index (9WAP)	0.237*	0.369*	0.356**	0.053 ^{ns}	1.000							
Shoot dry weight (9WAP)	0.273*	0.542**	0.321**	0.909**	0.897**	1.000						
Harvest index (HI)	0.751**	-0.022	0.151 ^{ns}	0.113 ^{ns}	0.053 ^{ns}	0.413**	1.000					
Tuber dry weight	0.211**	0.632**	0.019**	0.289**	0.211**	0.091 ^{ns}	0.423**	1.000				
Number of tuber per stand	0.405**	0.031 ^{ns}	0.405**	0.019 ^{ns}	0.231*	0.232 ^{ns}	0.532**	0.631**	1.000			
Tuber weight per stand(g)	0.799**	0.809**	0.647**	0.847**	0.536**	0.728**	0.148 ^{ns}	0.809**	0.845**	1.000		
Mean tuber weight(g)	0.491**	0.902**	0.222*	0.904**	0.102 ^{ns}	0.065 ^{ns}	0.321*	0.845**	0.062 ^{ns}	0.818**	1.000	
Mean tuber diameter(cm)	0.524**	0.745**	0.345**	0.032 ^{ns}	-0.044	-0.163 ^{ns}	0.153 ^{ns}	0.818**	0.334**	0.740**	0.902**	1.000

1. Tuber fresh yield/ha, 2. Plant height, 3. Number of branches/plant (9WAP), 4. Number of leaf/plant (9WAP), 5. Leaf Area Index (9WAP), 6. Shoot dry weight (9WAP), 7. Tuber dry weight/stand (11), 8. Harvest Index (11), 9. Number of tubers/stand, 10. Tuber weight/stand, 11. Mean tuber weight, 12. Mean tuber diameter, ns= not significant at 5%, *=significant at 5%, **= significant at 1%.

Table 4.30: Correlation Matrix among Yield Character of Coleus Potato of the Combined years of 2023 and 2024 Rainy Season

	1	2	3	4	5	6	7	8	9	10	11	12
Fresh tuber yield	1.000											
Plant height(9WAP)	0.469 **	1.000										
Branches per plant(8WAP)	0.336**	0.275**	1.000									
Leaf per plant	0.922**	0.393**	0.495 **	1.000								
Leaf Area Index (9WAP)	0.465**	0.297*	0.770**	0.574**	1.000							
Shoot dry weight (9WAP)	0.888**	0.453 **	0.672**	0.919**	0.572**	1.000						
Harvest index (HI)	0.012*	0.0231**	0.66**	0.06 ^{ns}	0.091 ^{ns}	0.331**	1.000					
Tuber dry weight	0.453**	0.232**	0.244**	0.235**	0.427**	0.321**	0.223**	1.000				
Number of tuber per stand	0.662**	0.769 **	0.372**	0.672**	0.234**	0.626**	0.431**	0.451**	1.000			
Tuber weight per stand(g)	0.753**	0.498**	0.788**	0.788**	0.523**	0.758**	0.753**	0.328**	0.322**	1.000		
Mean tuber weight(g)	0.318**	0.938 **	0.591**	0.197*	-0.091**	0.179 ^{ns}	0.772**	0.013 ^{ns}	0.023 ^{ns}	0.561**	1.000	
Mean tuber diameter(cm)	0.663 **	0.531**	-0.021	0.012 ^{ns}	0.323**	0.662**	0.771 ^{ns}	0.416**	0.612**	0.412**	0.532**	1.000

1. Tuber fresh yield/ha, 2. Plant height, 3. Number of branches/plant (9WAP), 4. Number of leaf/plant (9WAP), 5. Leaf Area Index (9WAP), 6. Shoot dry weight (9WAP), 7. Tuber dry weight/stand (11), 8. Harvest Index (11), 9. Number of tubers/stand, 10. Tuber weight/stand, 11. Mean tuber weight, 12. Mean tuber diameter, ns= not significant at 5%, *=significant at 5%, **= significant at 1%

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Parameters	1	2	3	4	5	6	Total correlation
2023							
Height at 9 WAT	0.0581	0.0170	0.11797	0.06947	0.0576	0.0220	0.541
LAI at 9WAT	0.0286	0.0347	0.2058	0.0485	0.0086	0.0145	0.341
Shoot dry weight at 9 WAT	0.0312	0.0326	0.2196	0.0383	0.0042	-0.0710	0.255
Tuber number/stand	0.0268	0.01125	0.0560	0.1503	0.0314	0.2785	0.544
Mean tuber weight (g)	0.0356	0.0031	0.0098	0.0503	0.0939	0.2879	0.481
Mean tuber diameter (cm)	0.0272	0.0010	-0.0331	0.0888	0.0574	0.4704	0.612
2024							
Height at 9 WAT	0.2758	0.0190	0.0631	0.0468	0.0592	0.1187	0.583
LAI at 9WAT	0.1017	0.0517	0.0462	0.0251	0.0273	-0.0151	0.237
Shoot dry weight at 9 WAT	0.1495	0.0205	0.1164	0.0252	0.0173	-0.0561	0.273
Tuber number/stand	0.1188	0.0119	0.0270	0.1087	0.0857	0.0526	0.405
Mean tuber weight(g)	0.0612	0.0052	0.0075	0.0349	0.2670	0.1149	0.491
Mean tuber diameter (cm)	0.0951	-0.0022	-0.0189	0.0166	0.0891	0.3442	0.524
Combine data							
Height at 9 WAT	0.1250	0.0218	0.2753	0.0720	-0.1410	0.1157	0.469
LAI at 9WAT	0.0371	0.0736	0.4084	0.0392	-0.0888	-0.0045	0.465
Shoot dry weight at 9 WAT	0.0566	0.0494	0.6077	0.0566	-0.0269	0.1443	0.888
Tuber number/stand	0.0995	0.0319	0.3804	0.0904	-0.1085	0.1681	0.662
Mean tuber weight(g)	0.1173	0.0435	0.1087	0.0653	-0.1504	0.1334	0.318
Mean tuber diameter (cm)	0.0664	-0.0015	0.4023	0.0697	-0.0920	0.2180	0.663

1= Height at 9 WAP, 2 = LAI at 9 WAP, 3 = Shoot dry weight at 9 WAP, 4 = Tuber number stand, 5 = Mean tuber weight, and 6 = Mean tuber diameter

Table 4.30b: Percent Contribution of some Growth and Yield Characters to Tuber Yield During 2023, 2024 Rainy seasons and the Combined data

Parameters	Percent contribution		
	2023	2024	Combined
Individual contribution			
Height at 9WAT	0.3380	7.6094	1.5644
LAI at 9WAT	0.1207	0.2679	0.5420
Shoot dry weight	4.8261	1.3564	36.940
Tuber number/ stand	2.2614	1.1825	0.8185
Mean tuber weight	0.8818	7.1298	2.2623
Mean tuber diameter	22.135	11.852	4.7554
Combined contribution			
PLHT+LAI	0.1988	1.0538	0.5470
PLHT+SDW	1.3717	3.4827	6.8875
PLHT+NTPS	0.8078	2.5857	1.8015
PLHT+NTPS	0.6704	3.2703	-3.5293
PLHT+MTD	2.5658	6.5528	2.8967
LAI+SDW	1.4307	0.4787	6.0141
LAI+NTPS	0.3376	0.2600	0.5781
LAI+MTW	0.0600	0.2819	-1.3089
LAI+MTD	0.1013	-0.1568	-0.0674
SDW+NTPS	0.1988	0.5876	6.8845
SDW+MTW	0.1856	0.4042	-3.2727
SDW+MTD	0.6408	-0.3528	-0.5566
NTPS+MTW	0.9461	1.8641	-1.9650
NTPS+MTD	8.3628	1.1455	3.0422
MTW+MTD	5.4077	6.1406	-4.0147
Residual	44.663	43.002	39.179

1= Height at 9 WAP, 2 = LAI at 9 WAP, 3 = Shoot dry weight at 9 WAP, 4 = Tuber number stand, 5 = Mean tuber weight, and 6 = Mean tuber diameter

APPENDICES

Appendix I: Physical and chemical properties of soil of the experimental site in 2023 and 2024 rainy seasons

Soil Test	2023 0-40cm	2024 0-40cm
Chemical Properties		
pH (water)	6.29	5.81
pH (CaCl ₂)	5.60	5.95
Organic carbon g kg ⁻¹	6.00	7.85
Total Nitrogen	0.45	0.68
Available Phosphorus	2.10	2.12
Physical Properties		
Sand g kg ⁻¹	561	530
Silt g kg ⁻¹	314	312
Clay g kg ⁻¹	120	150
Textural class	Sandy loam	Sandy loam
Exchangeable Cations (Cmol/kg)		
Ca	0.93	0.80
Mg	0.55	0.45
K	0.95	1.00
Na	1.13	1.13
CEC	33.4	33.6

Appendix II(a): Monthly Average Meteorological Data at the Experimental Site (2023)

Month	Wind speed (m/s)	Air Temp Max (°C)	Air Temp Min (°C)	RH Max (%)	RH (%)	Min SLrW Max	SLrW Min
April	1.75	40.3	22.9	19.0	9.4	838.2	4.5
May	1.81	39.8	22.1	28.3	15.4	841.6	4.5
June	2.00	36.0	18.5	70.4	39.9	826.7	4.6
July	2.06	35.0	17.8	92.4	56.9	750.4	4.1
August	1.50	37.0	18.3	93.4	48.7	748.3	3.8
September	1.03	37.3	18.3	93.8	44.2	896.0	4.2
October	0.99	37.7	22.5	88.0	34.3	977.7	4.5
November	1.14	37.4	20.4	53.6	13.8	936.4	4.1
December	2.18	31.7	15.9	32.3	11.9	931.7	3.9

Appendix II(b): Monthly Average Meteorological Data at the Experimental Site (2024)

Month	Ws (m/s)	Air Temp Max (°C)	Air Temp Min (°C)	RH Max (%)	RH Min (%)	SLrW Max	SLrW Min
April	1.47	40.3	22.9	19.0	9.4	838.2	4.5
May	1.73	38.2	23.9	20.1	9.6	841.5	4.6
June	1.80	39.1	22.1	29.4	16.5	795.4	4.6
July	1.91	38.1	20.5	54.1	28.3	753.3	4.1
August	2.03	34.9	17.9	85.8	56.2	747.3	3.8
September	1.66	36.7	18.2	93.0	51.1	890.5	4.2
October	0.99	37.7	22.5	87.8	34.3	977.7	4.5
November	1.14	37.4	20.4	53.6	13.8	936.4	4.1
December	2.18	31.7	15.9	32.3	11.9	931.7	3.9

Source: Kebbi State Agricultural and Rural Development Authority (KSARDA), Zone III, Zuru LGA (2024).