EFFECTS OF SEED TUBER SIZE AND NPK FERTILIZER ON SOME YIELD COMPONENTS OF COLEUS POTATO (*Solenostemon rotundifolius* (Poir) J.K. MORTON)

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ABSTRACT
A field experiment was carried out to assess the effects of 3 seed tuber sizes (< 5, 5 ≤ 15 and > 15 g) and 4 levels (0, 100, 200 and 300 kg ha^{-1}) of NPK fertilizer on some tuber yield components of Coleus potato (*Solenostemon rotundifolius*). Factorial combinations of the 3 seed tuber sizes and the 4 NPK application rates formed 12 treatments evaluated. The treatments were fitted into a Randomized Complete Block Design (RCBD) with three replications. Data were collected on number of healthy and rotten tubers, fresh weight of tubers, length of tubers and girth of tubers. The measured variables differed significantly ($P \leq 0.05$) depending on seed tuber size. The smallest seed tuber (< 5 g) recorded the highest number of healthy tubers but was similar to the other seed tubers. Total tuber fresh weight from < 5 g seed tubers (839.1 g) was significantly ($p \leq 0.05$) heavier by 51.2 % than that of > 15 g seed tubers (554.8 g). Application of 300 kg NPK ha^{-1} increased the number of rotten tubers (51) relative to the control treatment (28). The 0 and 100 kg NPK ha^{-1} treatments produced heavier tubers than the 200 and 300 kg NPK ha^{-1} treatments. These results signify that the smallest seed tuber (< 5 g) enhanced tuber yield better than the other seed tubers. It is evident that Coleus potato could yield well without NPK fertilization when soil nitrogen is high (i.e. > 0.2 %).

Keywords: Coleus potato, NPK application, seed tuber, tuber yield, Vom

Introduction

Solenostemon rotundifolius synonymously *Coleus rotundifolius* is commonly referred to as Coleus or Hausa potato in Nigeria. It is a minor tuber crop in the Lamiacae family (Duprieze and De Leener, 1989). The tubers are cooked with spices, but can also be roasted or fried and eaten as relish with a staple carbohydrate. Coleus potato tubers are high in calories and essential micronutrients with good socio-economic potential to alleviate hunger (Alleman, and Coertze, 1997). Coleus potato is an unpopular and under-utilized food crop in Nigeria which is now rarely found in the wild (Asumugha and Arene, 1999). Due to the rapid increase in human population and consequent shortages of grain crops, collection, improvement and utilization of under-utilized tuber crops such as Coleus potato is of paramount importance (Vimala and Nambisan, 2005).

Although many of the under-utilized root and stem tuber crops flower, majority of them do not produce seeds which limits their scope for breeding and further improvement (Prematilake, 2004). Consequently, these tuber crops are propagated by vegetative methods using tubers of varying shapes and sizes. Information on the economic importance and agronomic practices of Coleus potato which has suffered research neglect for several years is limited (Enyiukwu *et al*., 2014). Concerted efforts at conserving, documenting and promoting the dynamic use of Coleus potato is now required (Olojede *et al*, 2005). Evidently, agronomic research on Coleus potato is scanty and more are needed before any meaningful advancement on the crop can be made. Although there are coordinated efforts by the National Root Crops Research Institute (NRCRI), Nigeria, to improve the cultural and agronomic practices of Coleus potato production, more associated researches are required in multiple locations and with different experimental treatments. This experiment was therefore designed to investigate the effects of seed tuber size and NPK application on some tuber yield components of Coleus potato.

Materials and Methods

The field experiment was conducted at Dagwom Farm, National Veterinary Research Institute (NVRI), Vom, Plateau State, Nigeria. The farm is situated at an altitude of 1,350 meters above sea level on Latitude 09^{o}44^{1}N and Longitude 08^{o}47^{1}E with average temperature and rainfall of 22^{o}C and 1400 mm per annum, respectively. Soil of the experimental field was analysed for its physical and chemical properties (Mylaravapus. and Kennelley, 2002) before the treatments were imposed. Three seed tuber sizes (< 5, 5 ≤ 15 and > 15 g) and four rates (0, 100, 200 and 300 kg ha^{-1}) of NPK (20:10:10) fertilizer were combined to form twelve factorial treatments. The treatments were arranged in a Randomized Complete Block Design (RCBD) and replicated three times. The experimental plots were 2m by 3m (6m^2) in size and separated from each other by 1m boarder whereas the replications were separated by 2m boarder.

Five ridges spaced 50 cm apart and approximately 40 cm high were manually constructed in each plot. Twenty seed tubers were planted per plot (33,330 seed tubers ha^{-1}) at 50 cm intra-ridge spacing. and a depth of 5cm. NPK fertilizer was applied at 3 weeks after planting (WAP) when the seed tubers had sprouted. Plots were hoe weeded periodically and the ridges were earthed up in the process. At harvest (161 days after planting) tubers were first sorted into healthy and rotten categories before enumeration. The healthy tubers were further sorted into small (< 5 g), medium (5 ≤ 15 g) and large (> 15 g) categories for further measurements. Weight, length and girth of tubers in the different categories were measured. The collected data were subjected to Analysis of variance (ANOVA) to test the significance of treatment effects using SAS version 9.0 (SAS, 2002). Means were separated using LSD (Least Significant Difference) at 5 % level of probability.

Results

As shown in Table 1, the sandy loam soil of the experimental field was slightly acidic (pH 5.9). It contained 8.8 g kg^{-1} of organic carbon, 2.6 g kg^{-1} of total nitrogen and 13.92 mg kg^{-1} of available phosphorus. Among the exchangeable bases, calcium had the highest concentration (4.36 cmol kg^{-1}), followed in order by sodium (2.26 cmol kg^{-1}), magnesium (1.34 cmol kg^{-1}), and potassium (0.34 cmol kg^{-1}). The cation exchange capacity of the soil was 10.6 cmol kg^{-1}.

Table 1: Physical and chemical properties of the experimental soil

Physical and chemical variables	Value
Texture class	Sandy loam
p H (H_2O)	5.9
Organic carbon (g kg^{-1})	8.8
Total nitrogen (g kg^{-1})	2.6
Available phosphorus (mg kg^{-1})	13.92
Exchangeable bases (cmol kg^{-1})	
Calcium	4.36
Magnesium	1.34
Potassium	0.34
Sodium	2.26
Cation exchange capacity (CEC)	10.61

Table 2 shows that seed tuber size had no significant effect on number of healthy and rotten tubers. On the other hand, NPK application affected both variables significantly. The highest fertilizer rate (300 kg NPK ha^{-1}) furnished the fewest healthy but the highest number of rotten tubers ($p < 0.05$). Fresh weight of medium, large and total tubers differed significantly depending on the seed tuber size planted (Table 3). Generally, < 5 g seed tubers produced significantly heavier tubers than the other seed tubers. NPK application rate significantly affected fresh weight of tubers irrespective of categories. Generally, 0 and 100 kg NPK ha^{-1} produced tubers of similar fresh weights that were significantly heavier than those produced with 300 kg NPK ha^{-1} which furnished tubers with the lightest fresh weights. The seed tuber size x NPK interaction for fresh weight of large tubers was significant.

Table 2: Effects of seed tuber size and NPK rates on number of healthy and rotten tubers

	Number of tubers	
Size (g)	**Healthy**	**Rotten**
< 5	250.1	35.7
5 ≥ 15	209.1	33.3
> 15	206.9	42.0
LSD $_{0.05}$	55.11	17.3
NPK (kg ha^{-1})		
0	265.1	28.7
100	252.8	27.0
200	226.2	41.0
300	144.1	51.2
LSD $_{0.05}$	63.51	20.01
Interaction		
Size x NPK	ns	ns

ns=Not significant

Table 3: Effect of seed tuber size and NPK fertilizer on fresh weight of tubers

	Fresh weight of tubers (g)			
Size (g)	**Small**	**Medium**	**Large**	**Total**
< 5	154.3	357.2	328.8	839.1
5 ≥ 15	164.4	334.8	266.0	711.1
> 15	158.4	260.3	174.4	554.8
$LSD_{0.05}$	34.41	87.01	52.51	153.21
NPK (kg ha^{-1})				
0	169.0	404.3	283.0	856.3
100	227.2	331.3	329.7	879.2
200	157.8	342.6	238.0	666.1
300	82.2c	191.4	174.9	404.9
$LSD_{0.05}$	39.71	100.51	60.61	176.91
Interaction				
Size x NPK	ns	ns	**	ns

ns=Not significant, **=Significant at 0.01 % level of probability

Table 4 reveals that the length of tubers was significantly affected by seed tuber size but not by NPK application. The < 5 g and 5 ≤ 15 g seed tubers produced tubers of similar length that were significantly longer than tubers obtained from > 15 g seed tubers. The girth of large tubers obtained from < 5 g seed tuber plots was significantly wider than those of large tubers from > 15 g seed tuber plots but similar to tubers in the 5 ≤ 15 g seed tuber plots (Table 5). In addition, tubers harvested from plots that received 300 kg NPK ha^{-1} exhibited wider girth than those supplied with other rates of NPK fertilizer that were at par.

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Interaction				
Size x NPK	ns	ns	**	ns

ns= Not significant

Table 5 Effects of seed tuber size and NPK rates on girth of tubers

	Girth of tubers (cm)		
Size (g)	**Small**	**Medium**	**Large**
< 5	3.4	4.8	6.2
5 ≥ 15	3.5	4.7	5.9
> 15	3.6	4.4	5.7
LSD $_{0.05}$	0.41	0.41	0.51
NPK (kg ha^{-1})			
0	3.5	4.2	5.6
100	3.3	4.4	5.6
200	3.6	4.7	5.8
300	3.6	5.1	6.7
LSD $_{0.05}$	0.41	0.51	0.51
Interaction			
Size x NPK	ns	ns	**

ns=Not significant, **=Significant at 0.01 % level of probability

The interaction between seed tuber size and NPK application presented in Table 6 shows that the heaviest tubers (542.0 g) were obtained with < 5 g seed tubers without NPK fertilizer application whereas the lightest tubers (74.0 g) were obtained with > 15 g seed tubers supplied with 300 kg NPK ha^{-1}. Moreover, with < 5 g seed tubers, the substantive NPK application rates furnished tubers of similar weight. However, with 5 ≤ 15 g or > 15 g seed tubers, 100 kg NPK ha^{-1} furnished the heaviest tubers ($p < 0.05$). In contrast, the interaction also revealed that when either 0 or 300 kg N ha^{-1} is applied, < 5 g seed tubers produced the heaviest tubers. However, when 100 kg NPK ha^{-1} is applied 5 ≥ 15 g seed tubers furnished the significantly heaviest tubers. Girth of tubers ranged from 5.2 – 7.5 cm (Table 6). Seed tubers of < 5 g and 5 ≤ 15 g sizes supplied with 300 kg NPK ha^{-1} furnished significantly wider girth than those that received other fertilizer rates.

Table 6: Interaction between seed tuber size and NPK rates on tuber weight and girth

		Tuber	
Seed size (g)	**NPK (kg ha^{-1})**	**Weight (g)**	**Girth (cm)**
< 5	0	542.0	5.2
	100	233.7	5.4
	200	239.3	5.3
	300	300.9	7.5
5 ≤ 15	0	217.0	5.3
	100	509.7	5.4
	200	186.7	5.7
	300	150.7j	7.1
> 15	0	90.0	6.4
	100	288.0	6.0
	200	245.7.0	6.3
	300	74.0	5.6
LSD $_{0.05}$		102.11	0.8

Discussion

The seed tuber size of Coleus potato influences tuber yield components since there were significant differences depending on the size of seed tubers planted. This may be attributed to variation in tuber ability to establish and proliferate in root biomass at early growth stages depending on size (Singh. and Bahal, 1997). Large Irish potato seed tubers possess relatively larger food reserves that enhance tuber enlargement and thickening (Masarirambi *et al*., 2012). However, it is noteworthy that the smallest seed tubers (< 5 g) recorded the heaviest fresh weights within all tuber categories in this study. This unprecedented performance by small seed tubers was probably enhanced by longer leaf area duration (LAD) which translated into higher production of storage carbohydrates (Bhattacharya, 2009). In this study, plants from the smallest seed tubers senesced later than those from the other seed tubers

The experiment revealed that the number of rotten tubers was similar irrespective of seed tuber size. This implies that farmers cannot avoid Coleus tuber rot by planting specific size tubers. In addition, more researches are warranted to ascertain the primary causes of Coleus potato tuber rot which is a major constraint to its production (Enyiukwu *et al*., 2014). Pathogenic rot organisms or enzymes-mediated deterioration are responsible for tuber rot (Okigbo et *al*., 2009). In this study, seed tuber size affected tuber length more than tuber girth. However, values recorded for both variables were similar to those in published literature (Nkansah, 2004). This infers that the tested Coleus accession (Tumuku) is a correct representation of the Coleus population and therefore suitable for further evaluations.

NPK application significantly influenced fresh weight and girth of tubers implying that fertilizer is required to increase Coleus tuber yield. Adequate NPK fertilizer ensures a high yield and nutritious potato crop (Naz et *al.,* 2011). This could be linked to nitrogen which is the major component of NPK 20:10:10 fertilizer. This nutrient was probably sufficient for protein synthesis, cell multiplication and elongation which resulted in increased accumulation of storage carbohydrates (Panchabhai *et al*., 2005). On the contrary, the highest fertilizer rate (300 kg N ha^{-1}) produced the highest number of rotten tubers in this study. This implies that Coleus potato requires lower rates of NPK fertilizer to reduce spoilage. A lower rate of NPK application to potato amplified both fats and ash contents whereas a higher rate increased protein, fibre and dry matter contents (Naz *et al.,* 2011) This is probably why more rotten tubers were produced with the highest rate of 300 kg NPK ha^{-1} in the current study. Tubers with high protein and carbohydrates content may deteriorate faster than those that are high in fats.

The statistical similarity between 0 and 100 kg NPK ha^{-1} treatments for virtually all the attributes assessed connotes that Coleus potato did not require fertilizer application. However, this is not entirely correct. This observation may be ascribed to the rudimentary stage of Coleus potato research. The planting material used in this study was the original batch of Tumuku seed tubers collected from the wild for improvement studies by Scientists at the National Root Crops Research Institute, Kuru, Plateau State, Nigeria. Generally, crops respond better to fertilizer application after successive circles of domestication and selection. Consequently, the earliest clones in a crop improvement programme may show little or no response to fertilizer application as observed with this batch of seed tubers. Moreover, the relatively high quality of the experimental soil (Enwezor *et al*., 1989) before fertilizer application may be another reason why the control plots competed favourably with the fertilized plots for all the yield components evaluated. The implication is that NPK application to a Coleus potato crop is justifiable when a soil test result indicates a low rating. The significant interactions between seed tuber size and NPK application for tuber weight and tuber girth imply that specific combinations of these factors determine Coleus potato yield. For example, the study showed that the heaviest tubers were obtained with < 5 g seed tubers with no NPK fertilizer application whereas > 15 g seed tubers supplied with 300 kg NPK ha^{-1}produced the lightest tubers. This should be borne in mind for Coleus production.

Conclusion

Seed tuber size and NPK fertilizer significantly affected some yield components of Coleus potato. The smallest seed tuber size (<5 g) produced higher tuber fresh weight, longer tuber length and wider tuber girth than the others. Emphasis should therefore be placed on their multiplication for crop improvement. Coleus potato may be produced without NPK fertilizer if soil nitrogen rating is high.

Acknowledgement

The authors acknowledge Dr. M. S Ahmed, Executive Director, National Veterinary Research Institute, Vom. He granted approval to conduct the trial with Institute facilities. Mr. Benjamin A. James supervised the collection of the research data.

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