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EVALUATION OF NPK FERTILIZER SOURCES AND RATES FOR USE IN NR 8082 CASSAVA VARIETY STEM AND ROOT PRODUCTION IN UMUDIKE, NIGERIA.

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ABSTRACT

Farmers most times do not fertilize cassava, because they think that cassava does not require it and/or because cassava has been reputed to produce well under marginal fertility whereasfarmers that apply fertilizers usually use only low rates. The recommended NPK 15:15:15 fertilizer rate for cassava in Nigeria is 400kg/ha without taking into consideration the variations that may occur with seasons, as late planting which experience little rainfall and reduced leaching may require lower fertilizer rates than early plantings. This research was designed to determine the best sources and rates of NPK compound fertilizers for cassava stem and root productionof NR 8082 cassava variety in Southeastern Nigeria in 2017/18 and 2018/19 late cropping seasons. The experiment was a 3 x 4 factorial arranged in randomized complete block design (RCBD) with three replications. The treatments involvedall possible combinations of three compound fertilizers namely: NPK 20:10:10, NPK 15:15:15 and NPK 12:12:17+2; and four (4) rates (0kg, 200kg, 400kg and 600kg/ha) of each compound fertilizer.The results indicated that, except for taller plants obtained from the application of NPK rates of 200 and 0kg/ha at 9 and 12 months after planting (MAP), NPK sources and rates did not differ in their effects on cassava growth and storage root yield. Moisture, dry matter and starch contents of root tubers were significantly influenced by NPK sources and rates and their interactions.Lower moisture and higher dry matter contents were obtained from the application of NPK (15:15:15) fertilizer as against the higher moisture and lower dry matter contents from other fertilizer formulations (NPK 20:10:10 and NPKMg 12:12:17:2). Starch yield was higher with application of NPK (15:15:15) and NPKMg (12:12:17:2) at low rate of 200Kg/ha or 0 Kg/ha than with NPK (20:10:10) compound fertilizer. It is concluded that, NPK fertilizer formulations; NPK 15:15:15 or NPKMg 12:12:17:2 are better compound fertilizer sources for cassava production since NPK 15:15:15 resulted in lower moisture and higher dry matter contents while NPKMg 12:12:17:2 gave the highest starch yield when applied at lower rate of 200 or 0kg/ha to the late planted crop and hence are recommended.

INTRODUCTION

In Africa, Cassava ranks second most important food source in terms of calories consumed per capita (Bennett, 2015; Roothaert and Magado, 2011) and it's a major staple in most developing countries of the world, providing a basic diet for over half a billion people (Ayoola and Makinde, 2007). It is one of the most drought-tolerant crops, capable of growing on marginal soils and it offers flexibility to resource poor farmers because it serves as either subsistence or a cash crop (Stone, 2002). Its wide harvesting window allows it to act as a famine reserve crop. Cassava root is long and tapered, with a firm; homogeneous flesh encased in a detachable rind, about 1 mm thick, rough and brown on the outside (Ene, 1992). The number of tuberous roots and their dimensions vary greatly among the different varieties. The roots may reach a size of 30-120 cm long and 4-15 cm in diameter, and a weight of 1-8 kg or more. A woody vascular bundle runs along the root's axis. The flesh can be chalk-white or yellowish. The cassava plant vary in height ranging from 1–5m or even more, with branching stems, green, pale or dark grey or brown in colour (Iwuagwu, 2012). Cassava roots grow vertically from the stem and from the storage roots penetrating the soil to a depth of 50-100 cm. The ability for the cassava roots to get so deep and take up nutrients from below the surface may help to explain its growth on inferior soils (Howeler, 2002).

Cassava can grow in all types of soil but grows best in a well drained sandy loam soil of average fertility. Most nutrients absorbed by the cassava plant are mobilized to the leaves and stems, and these give the plant the advantage of recycling nutrients within the plant-soil system. Farmers that apply fertilizers usually use only low rates (Howeler *et al*., 2006), even though the recommended fertilizer rate for cassava in Nigeria is 400kg/ha NPK (15:15:15) compound fertilizer (Sughai, 2010). Although cassava has been reputed to produce well in soils of marginal fertility, many trials indicate that cassava responds favorably to mineral fertilizers especially in soils of low fertility (Anikwe and Ikenganya, 2018). Higher yields of cassava can be obtained and maintained when adequate amounts of fertilizers are applied (Howeler, 2002).

The crop has been reported to respond to good soil fertility and adequate fertilizer (Gomez *et al*. 1980; Howeler, 1996). Sittibusaya (1993) reported that cassava yields in unfertilized plots declined from 26 – 30 to 10 – 12t/ha after 20-30 years of cassava cultivation. The response of the crop to fertilization may however, depend on such factors as cultivar, fertilizer source, soil and season or variations in rainfall pattern. The recommended NPK 15:15:15 fertilizer rate for cassava in Nigeria is 400kg/ha without taking into consideration the variations that may occur with seasons, as late planting which experience little rainfall and reduced leaching may require lower fertilizer rates than early plantings.

Different fertilizer rates and types can be used such as NPK 12:12:17, NPK 20:10:10 or NPK 15:15:15 compound fertilizers, however, cassava requires a moderate supply of nitrogen and potassium fertilizer to produce high yield of tubers (Fernandes *et al*. 2017).

MATERIALS AND METHODS

The experiment was conducted during the 2017 and 2018 late-cropping season at the National Root Crops Research Institute Umudike experimental farm. Umudike is in the tropical rainforest and is located betweenLatitudes5º28.658ˈN - 5º29.176ˈN and Longitude 7º32.256ˈE - 7º32.803ˈE and on an elevation of 122 m above sea level. It has an annual rainfall of 1800 to 2200mm. Temperature is high throughout the year with a range of 33 – 35^{0}C as the maximum and 28 – 29^{0}C as the minimum (Nwosu *et al*, 2011), while relative humidity varies from 51 – 87 %. The soils are majorly acidic in reaction and fall into the ultisol group (Omenihu *et al*, 2011).

The treatments comprised all possible combinations of three compound fertilizers (NPK 20:10:10, NPK 15:15:15 and NPKMg 12:12:17+2) and four (4) rates (0, 200, 400and 600kg/ha) of each of the compound fertilizers in a 3 x 4 factorial arrangement fitted into a randomized complete block design (RCBD) with three replications. Each replicate had twelve (12) plots with a spacing of 1 m between plots and between blocks giving a total number of 36 experimental plots. The treatments were randomly allocated to the plots in each block. Each plot measured 4 x 4 m.

Cassava stems of NR 8082 variety were cut into lengths of uniform node number of 4 per stake and planted in slanting positionat 1 x 1m spacing to give 10000 plants/ha.Planting was done on 22 September 2017 and 4 October 2018. Pre and post emergence herbicides (Atraz 50 containing 500g of Atrazine and Tackle containing 350g of glyphosate respectively) were sprayed before stakes were planted, weeding was done manually at 3 and 6 months after planting (MAP), after which the canopy development of the cassava plant was able to smother upcoming weeds. Weeding was done again at 10MAP using herbicides (Tackle containing 350g of glyphosate). The different rates of the three compound fertilizers (NPK15:15:15, NPK 20:10:10 and NPK 12:12:17:2) were applied in appropriate plots at 8 weeks after planting by side placement and harvesting was done at 12MAP. Growth and yield data were collected.Growth data were collected at 3, 6, 9 and 12 MAP whereas yield data were collected at 12 MAP. Leaf area which was used to calculate leaf area index was obtained by multiplying the product of length and breadth of the median leaflet of the number of leaflets on the leaf (Spencer, 1962). The regression model; LA = 1.993 + 0.907LB with R^2 = 0.974 was used to measure leaf area, where L = length of the median leaflet, B = breadth of the median leaflet (Karim *et al*., 2010). Leaf area index was determined using the fomular: LA/P (Ekanayake *et al*. 1997).
Where, LA: Total Leaf Area/plant P: Land area occupied by plant (1 x1 m). Dry matter and moisture contents of root tubers were determined using the SCAN-test methods described by Kwach *et al*. (2010) and Yildirim *et al*. (2011). Plants from two inner ridges (2 x 4m net plot) were harvested 12 MAP and data were obtained on stem yield (t/ha), number of storage roots/plant, storage root weight (Kg), storage root yield (t/ha) and dry matter content of root tuber. Analysis of variance was performed on the data using Genstat discovery 2007 edition. Means were separated using least significant difference at the 5% probability level.

RESULTS

The soil properties and monthly rainfall represented in Table 1 showed that soil texture at both sites were sandy loam in 2017/2018 and sandy clay loam in 2018/2019 cropping season. Soil pH, organic matter, nitrogen and phosphorus were higher in the soil used for the 2017/2018 experiment. Soil nitrogen was within the critical value of 0.15% in 2017/18 but lower than the critical value in 2018/19 cropping season. In each year, the rains were scanty between November to December and January to March whereas bulk of the rains fell within April to October.

Leaf area index did not significantly differ with NPK fertilizer sources at all sampling periods (Table 2). There were no significant differences in leaf area index with respect to the different NPK fertilizer rates across sampling dates. At all fertilizer sources and rates, leaf area index consistently increased up to 6 MAP, after which a sharp drop occurred with plant age.

Except at 9 and 12 MAP, there was no significant effect of NPK fertilizer sources on plant height though plants tended to be taller with application of NPK 20:10:10 fertilizer (Table 3). At 9 and 12 MAP, the lower fertilizer rate of 200kg/ha or no fertilizer application produced taller plants than the highest fertilizer rate of 600kg/ha. Cassava plant height increased steadily with increase in plant age up to 12 MAP. Stem yield in tons per hectare did not differ significantly with varying NPK fertilizer sources in both cropping seasons (Table 4).Stem yield was not significantly influenced by NPK application rates. There were no significant interaction effects of NPK fertilizer sources and rates on stem yield in 2017/2018 and 2018/2019 cropping seasons.

The number of storage roots produced per plant was on average comparable (6.40 and 6.14) in 2017/2018 and 2018/2019 cropping seasons (Table 5). There were no significant effects of NPK fertilizer sources and rates on number of storage roots. Combination of NPK fertilizer sources and rates did not produce significant interaction effects on number of storage roots per plant.

In both cropping seasons, NPK fertilizer sources did not significantly affect storage root weight (Table 6). Likewise, there were no differences in storage root weight with respect to the NPK fertilizer rates. Interaction between fertilizer sources and rates had no significant effect on storage root weight in the two planting seasons. NPK fertilizer sources did not significantly increase storage root yield (Table 7). Although the trend showed on average increasing tuber yield with incremental NPK fertilizer application up to the rates of 400kg/ha, significant differences were not established in the two cropping seasons NPK fertilizer sources and rates interaction effects were not significant on storage root yield.

The dry matter content increased significantly with the application of NPK 15:15:15 compared with the application of NPK 20:10:10, while application of NPK 12:12:17:2 produced the least (Table 8). Dry matter from NPK 15:15:15 relative to NPK 12:12:17:2 and NPK 20:10:10 fertilizer sources were higher by 5.1% and 4.3% respectively. On the other hand, no fertilizer (control) had significantly the highest dry matter content of 38.6t/ha, followed by application of 400kg/ha (35.6%) and 200kg/ha while NPK rate of 600kg/ha had the lowest value. There was a significant source x rate interaction effect on dry matter content. NPK 15:15:15 fertilizer at 0kg/ha produced the highest dry matter content of 39.7% while NPK 12:12:17:2 at the highest application rate of 600kg/ha had the least (31.9%).

Table 1 Soil Properties and monthly rainfall of the sites

Soil properties					**2017/2018**				**2**	**018/2019**			
Sand (%)					77.0					71.0			
Silt (%)					6.0					6.0			
Clay (%)					17.0					23.0			
Textural class					Sandy loam					Sandy clay loam			
pH (water)					5.1					4.9			
O.M (%)					3.3					2.2			
Total N (%)					0.15					0.10			
Avail P (mg/kg)					32.5					26.5			
K (Cmol/kg)					0.15					0.22			
Monthly rainfall (mm)													
	Jan	Feb	Mar	April	May	June	July	Aug		Sept	Oct	Nov	Dec
2017	51.0	0.0	76.7	188.3	134.2	298.1	493.9	222.4		400.0	184.2	31.0	0.0
2018	0.0	80.1	9.6	337.5	246.6	326.6	237.0	173.3		334.7	238.9	44.3	0.0
2019	38.9	80.9	65.7	137.1	355.7	523.4	554.1	206.6		635.0	367.3	107.2	0.0

Table 2: Effect of NPK fertilizer sources and rates on leaf area index of NR8082 cassava variety at different sampling dates in 2017/2018 cropping season

NPK	Months after planting (MAP)			
Sources	**3**	**6**	**9**	**12**
NPKMg 12:12:17:2	0.217	0.681	0.397	0.195
NPK 15:15:15	0.174	0.594	0.322	0.149
NPK 20:10:10	0.215	0.637	0.405	0.217
Mean	0.202	0.637	0.375	0.187
LSD (0.05)	NS	NS	NS	NS
NPK rates (kg/ha)				
0	0.270	0.759	0.443	0.219
200	0.177	0.695	0.426	0.209
400	0.194	0.764	0.313	0.236
600	0.168	0.580	0.377	0.149
Mean	0.202	0.637	0.375	0.187
LSD (0.05)	NS	NS	NS	NS

*NS = Not significant

Table 3: Effect of NPK fertilizer sources and rates on Plant height (cm) in 2017/2018.

NPK	Months after planting (MAP)			
Sources	3	6	9	12
NPK 12:12:17:2	87.40	139.20	173.80	186.20
NPK 15:15:15	89.80	143.00	165.10	171.80
NPK 20:10:10	92.10	149.60	179.30	203.30
Mean	89.80	143.90	172.70	187.10
LSD (0.05)	NS	NS	NS	NS
NPK rates (kg/ha)				
0	89.10	149.60	194.00	217.70
200	89.60	145.30	194.80	206.00
400	93.00	147.80	178.00	188.30
600	84.70	144.10	146.70	160.20
Mean	89.80	143.90	172.70	187.10
LSD (0.05)	NS	NS	30.88	37.89

*NS = Not significant

Table 4: Effect of NPK fertilizer sources and rates on stem yield (t/ha) of NR8082 cassava variety in 2017/2018 and 2018/2019 cropping seasons

NPK rates	Fertilizer Sources			
(kg/ha)	NPKMg 12:12:17:2	NPK:15:15:15	NPK 20:10:10	Mean
0	7.27	2017/2018		
	5.70	4.57	5.84	
200	5.83	5.07	5.53	5.48
400	7.17	5.93	7.03	6.71
600	4.57	6.93	5.20	5.57
Mean	6.21	5.91	5.58	
		2018/2019		
0	5.23	4.93	3.17	4.44
200	5.70	5.07	8.37	6.38
400	6.91	7.27	5.83	6.67
600	6.57	4.93	4.23	5.24
Mean	6.10	5.55	5.40	

	2017/2018	**2018/2019**
LSD (0.05) for fertilizer sources (F) means =	NS	NS
LSD (0.05) for NPK rates (R) means =	NS	NS
LSD (0.05) for F x R means =	NS	NS

Conversely, the moisture content of tubers was significantly highest (65.2%) with the application of NPK Mg 12:12:17:2, followed by NPK 20:10:10 while NPK 15:15:15 had the lowest moisture content of 63.3%. incremental application of NPK fertilizer sources up to 600kg/ha significantly increased the moisture content of tubers. Interactions of NPK fertilizer sources x rates were significant, with highest moisture content obtained from NPKMg 12:12:17:2 applied at 600kg/ha, followed by application of NPK 20:10:10 at 600kg/ha while the lowest moisture content was obtained from NPK 15:15:15 at 0kg/ha. Application of NPKMg 12:12:17:2 fertilizer resulted in significantly highest starch content of 30.72%, closely followed by application of NPK 15:15:15 while application of NPK 20:10:10 gave the lowest starch content of 29.5% (Table 9). Significant starch content increases were obtained following the application of lower fertilizer rate of 200kg/ha or no fertilizer application compared to the higher rates of 400 or 600kg/ha. Similarly, application of lower fertilizer rate of 400kg/ha produced higher starch content over application of the highest rate of 600kg/ha. Interaction effects were significant, with highest starch content obtained from application of NPKMg 12:12:17:2 fertilizer source at zero or 200kg/ha whereas lowest starch content was obtained from NPKMg 12:12:17:2 or NPK 20:10:10 at the highest rate of 600kg/ha.

Table 5: Effect of NPK fertilizer Sources and rates on number of tubers/plant for two cropping seasons.

NPK rates	Fertilizer Sources			
(kg/ha)	NPK 12:12:17:2	NPK 15:15:15	NPK 20:10:10	Mean
0	6.96	**2017/2018**		
	8.02	7.23	.40	
200	5.00	6.48	7.11	6.19
400	6.44	7.00	6.03	6.49
600	5.86	5.10	5.64	5.53
Mean	6.07	6.65	6.50	6.40
		2018/2019		
0	4.28	4.93	5.33	4.85
200	5.99	4.21	9.97	6.72
400	8.39	6.95	6.83	7.39
600	5.32	5.86	5.64	5.61
Mean	5.99	5.49	6.95	6.14

	2017/2018	**2018/2019**
LSD (0.05) for fertilizer sources (f) means =	NS	NS
LSD (0.05) for NPK rates (R) means =	NS	NS
LSD (0.05) for f x R means =	NS	NS

Table 6: Effect of NPK fertilizer Sources and rates on tuber weight (kg)/plant for two cropping seasons.

NPK rates	Fertilizer Sources			
(kg/ha)	NPK 12:12:17:2	NPK 15:15:15	NPK 20:10:10	Mean
		2017/2018		
0	0.45	0.37	0.46	0.43
200	0.46	0.39	0.53	0.46
400	0.52	0.41	0.56	0.49
600	0.37	0.54	0.43	0.44
Mean	0.45	0.43	0.50	
		2018/2019		
0	0.49	0.48	0.36	0.44
200	0.39	0.40	0.39	0.39
400	0.36	0.49	0.37	0.40
600	0.39	0.38	0.41	0.40
Mean	0.41	0.44	0.38	

	2017/2018	**2018/2019**
LSD (0.05) for fertilizer sources (f) means =	NS	NS
LSD (0.05) for NPK rates (R) means =	NS	NS
LSD (0.05) for f x R means =	NS	NS

Table 7: Effect of NPK fertilizer Sources and rates on storage root yield (t/ha) for two cropping seasons.

NPK rates (kg/ha)	Fertilizer Sources NPK 12:12:17:2	NPK 15:15:15	NPK 20:10:10	Mean
		2017/2018		
0	30.80	30.20	34.60	31.80
200	24.90	25.40	37.20	29.10
400	34.00	28.90	31.90	31.60
600	20.90	26.30	24.10	23.80
Mean	27.65	27.70	34.45	
		2018/2019		
0	18.5	23.90	19.20	20.50
200	23.70	16.10	39.00	26.30
400	29.60	32.70	25.00	29.10
600	21.10	20.60	23.00	21.60
Mean	23.20	23.30	26.60	

	2017/2018	2018/2019
LSD (0.05) for fertilizer sources (f) means =	NS	NS
LSD (0.05) for NPK rates (R) means =	NS	NS
LSD (0.05) for f x R means =	NS	NS

Table 8: Effect of NPK fertilizer Sources and rates on dry matter content (%) and moisture **content (%) for 2017/2018 cropping seasons.**

NPK rates (kg/ha)	**Fertilizer Sources NPK 12:12:17:2**	**NPK 15:15:15**	**NPK 20:10:10**	**Mean**
		Dry Matter Content (%)		
0	38.17	39.66	37.88	38.57
200	35.62	34.75	33.80	34.72
400	33.62	37.36	35.76	35.58
600	31.89	34.95	32.95	33.26
Mean	34.83	36.61	35.10	
		Moisture Content (%)		
0	61.84	60.35	62.13	61.44
200	64.38	65.26	66.21	65.28
400	66.39	62.64	64.25	64.42
600	68.12	65.05	67.05	66.74
Mean	65.18	63.33	64.91	

	Dry matter content	**Moisture content**
LSD (0.05) for fertilizer sources (f) means =	0.02	0.02
LSD (0.05) for NPK rates (R) means =	0.03	0.03
LSD (0.05) for f x R means =	0.05	0.05

Table 9: Effect of NPK fertilizer Sources and rates on starch content (%) for 2017/2018 cropping seasons.

NPK rates (kg/ha)	Fertilizer Sources NPK 12:12:17:2	NPK 15:15:15	NPK 20:10:10	Mean
0	34.24	31.35	30.33	31.97
200	34.04	29.43	30.72	31.40
400	27.57	30.93	29.65	29.38
600	27.03	29.75	27.14	27.97
Mean	30.72	30.37	29.46	
LSD (0.05) for fertilizer sources (f) means =		0.15		
LSD (0.05) for NPK rates (R) means =		0.21		
LSD (0.05) for f x R means =		0.36		

DISCUSSION

Except for the taller plants obtained from the application of the lower fertilizer rate of 200kg/ha and zero application at 9 and 12MAP, NPK fertilizer sources and rates did not differ in their effects on cassava growth and storage root yield. This result could be partly due to the fairly high nutrient status of the experimental sites (2.20 – 3.34% organic matter, 0.10 – 0.15% N and 0.15 – 0.22 Cmol/kg K) and partly due to the late planting of the crop (late September 2017 and early October 2018). The organic matter and nitrogen contents of the soil in 2017/2018 and 2018/2019 and potassium content in 2018/2019 were above critical values of 2.0% organic matter, 0.15% nitrogen and 0.2 Cmol/kg potassium reported by Fairhurst (2012). Along with the application of fertilizer at the onset of the dry season in November following late planting, the efficiency of applied fertilizer was greatly reduced. With a low monthly rainfall of 31.0mm and 44.3mm in November 2017 and 2018 respectively and no rainfall in December, the dissolution of the NPK fertilizers would have been seriously hampered. Working in a relatively fertile soil, Kang *et al*, (1981) found linear root yield depression with increasing nitrogen rates from zero to 120kg/ha while Oikeh *et al*. (2009) also reported that yields of rice cultivars were higher at zero nitrogen than at other nitrogen levels due to moisture stress.

However, dry matter, moisture and starch contents were considerably influenced by both factors and their interactions.Ezedinma *et al*. (1981) had observed that fresh storage yields did not differ significantly but dry matter yield did vary with dates. Lower moisture and higher dry matter contents were obtained from the application of NPK (15:15:15) fertilizer as against the higher moisture and lower dry matter contents from other fertilizer formulations (NPK 20:10:10 and NPKMg 12:12:17:2). This is probably due to the balanced nutrition or moderate levels of nitrogen and potassium in the former, as both elements are critical for cassava or root and tuber crops production (Howeler and Spain, 1978; Okpara *et al*., 2014; Njoku *et al*., 2001).

Starch yield was higher with application of NPK (15:15:15) and NPKMg (12:12:17:2) than with NPK (20:10:10) compound fertilizer. This suggest that the higher potassium levels in NPK (15:15:15) and NPKMg (12:12:17:2) increased starch yield while the lower potassium content in NPK (20:10:10) caused a drop in starch yield. Howeler *et al*. (2006) had reported that compound fertilizers that are high in nitrogen and potassium but low in phosphorus are the most suitable for cassava. Boateng and Boadi (2010) reported that starch formation and translocation of sugars to all parts of plants require potassium. The effect of potassium in increasing starch content of the root is attributed to its role as a factor for a number of enzyme reactions in carbohydrate metabolism, particularly the polymerization of glucose to starch (Obigbesan, 1983). Akinsanmi (1999) and Brady and Weil, (1999) noted that potassium is useful for root formation and therefore tuber crop production and also helps in the uptake of nitrates from the soil. The presence of magnesium in NPKMg (12:12:17:2) fertilizer may also have contributed to the higher starch yield of the fertilizer formulation, as the element is important in phloem loading and transport of photoassimilates into sink and organs and subsequent storage as starch (Cakmak *et al*.,1994; Cakmak and Yazici, 2010; Hermans *et al*., 2005 and Liu *et al*., 2016).

Zero application regardless of compound fertilizer sources reduced the moisture and increased dry matter contents of the root tubers, whereas the reverse was true with all cases of applied fertilizer for those parameters.Starch yield was generally greatest with NPKMg (12:12:17:2) fertilizer application at the lower rate of 200kg/ha or the control (zero application), followed by application of NPK (15:15:15) irrespective of rates. This implies that under a droughty situation in a relatively fertile soil, as was the case in this investigation, NPKMg (12:12:17:2) fertilizer should be applied at the low rate of 200kg/ha or fertilizer application should be discouraged to increase starch yield and avoid detrimental effects on cassava tuber, including rot or deterioration of roots due to high moisture contents (Dandago and Gungula, 2011; Law-Ogbomo and Remison, 2007).

CONCLUSION

Except at 200kg/ha, the use of NPK (15:15:15) fertilizer resulted in lower moisture and higher dry matter contents of the cassava root tubers at all fertilizer rates compared to the other NPK fertilizer sources and rates, while starch yield was higher with the application of NPKMg 12:12:17:2 at 200kg/ha or zero application, indicating that these fertilizer formulations (NPK 15:15:15 or NPKMg 12:12:17:2) are better compound fertilizer sources for cassava production and are hereby recommended.

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