Growth, Development and Yield of Cassava Progeny as Affected by Nutrient Status of Mother Plant 1

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Abstract

Cassava is a very important staple crop in Ghana, contributing significantly to the country's Agricultural GDP. Majority of farmers in eight out of the ten regions in Ghana cultivate the crop due to its ability to grow on marginal lands. The crop has until recently seen little improvement in their husbandry practices. Cassava yields on farmers' fields are low (8-10 t/ha) with potential yields of 30 to 40 t/ha. A major factor contributing to this low yield is the low soil fertility and the poor quality of the planting material. The study investigated the effect of fertilizer application of the mother plant on the growth, development and yield of progenies from these plants. Cassava genotype Dabo was sown in June 2013, at 1 m x I m at CSIR-Crops Research Institute, Kwadaso, Kumasi, Ghana. There were four fertilizer treatments: NPK 30:30:45, 60:30:45, 45:30:45, and Control. The experiment was arranged in a randomised Complete Block Design (RCBD) with three replicates. NPK was applied at one month after planting and Muriate of potash three months after planting. The mother plant was harvested in June, 2014. Cassava yields for all the fertilizer treated plots were significantly higher than the control plot (12.1 t/ha) with yield difference ranging between 68% (20.3 t/ha) and 278 % (33.7 t/ha) in the first year. Cuttings from the mother plants were planted with no fertilizer application in July, 2014. Progeny from the treatment that gave the highest yield in Year 1 (45-30-45, N:P:K) gave the greatest yield (24.0 t/ha) relative to the control (10.3 t/ha) in year two, (233%) higher. Commercial cassava planting material producers should boost the quality of the cassava planting material through fertilizing the mother plant. Farmers can also fertilize a small portion of their cassava farm and use cuttings from the fertilized plot as planting material.

Key words: cassava, fertilizer, planting material, potential yields

Croissance, développement et rendement de la descendance du manioc affectée par le statut nutritif de la plante-mère 1.

Résumé

Le manioc est une culture de base très importante au Ghana, contribuant pour environ 22% du PIB agricole du pays. Environ 90% des agriculteurs de huit des dix régions du Ghana cultivent la culture en raison de sa capacité à pousser sur des terres marginales. La culture a *jusqu'à récemment vu peu d'amélioration dans leurs pratiques d'élevage. Les rendements de manioc dans les champs des agriculteurs sont faibles (8-10 t / ha) avec des rendements potentiels de 30 à 40 t / ha. Un facteur majeur contribuant à ce faible rendement est la faible fertilité du sol et la mauvaise qualité du matériel végétal. L'étude a étudié l'effet de l'application d'engrais de la plante mère sur la croissance, le développement et le rendement des descendances de ces plantes. Le génotype de manioc Dabo a été semé en juin 2013 à 1 mx 1 m au CSIR-Crops Research Institute, a Kwadaso, Kumasi, Ghana. Il y avait quatre traitements d'engrais: NPK 30:30:45, 60:30:45, 45:30:45 et Control. La conception expérimentale était un design de bloc complet randomisé (RCBD) avec trois répétitions. Le NPK a été appliqué un mois après le semis et le Muriate de potasse trois mois après la plantation. La plante mère a été récoltée en juin 2014. Les rendements de manioc pour toutes les parcelles traitées aux engrais étaient significativement plus élevés que la parcelle témoin (12,1 t / ha) avec une différence de rendement comprise entre 68% (20,3 t / ha) et 278% (33,7 t / ha) la première année. Les boutures des plantes mères ont été plantées sans application d'engrais en juillet 2014. La descendance du traitement qui a donné le rendement le plus élevé en année 1 (45-30-45, N: P: K) a donné le rendement le plus élevé (24,0 t / ha) par rapport au témoin (10,3 t / ha), 233% plus élevé. Les producteurs commerciaux de matériel végétal de manioc devraient améliorer la qualité des plants de manioc en fertilisant la plante mère. Les agriculteurs peuvent également fertiliser une petite partie de leur exploitation de manioc et utiliser les boutures de la parcelle fertilisée comme matériel de plantation.*

Mots-clés: manioc, engrais, matériel végétal, rendements potentiels

Introduction:

The importance of cassava as a staple food in Ghana cannot be underestimated. The crop is grown in almost every part of the country. It is estimated that about 90% of farmers in eight out of the ten regions in Ghana cultivate the crop due to the resilience of the crop and its ability to grow on marginal land (IFPRI, 2007). The importance of cassava to the Ghanaian economy can, therefore, not be over-emphasized. However, the crop has been marginalized in food policy debates and burdened with the stigma of being an inferior crop, ill-suited and uncompetitive with the glamour crops such as imported rice and wheat because of several long-standing myths as a poor man's crop full of nothing but carbohydrates. Cock (1985), however, reported that in most developing countries calories are in fact the paramount nutritional shortage. Cassava should therefore be regarded as a cheap energy source with other crops providing the necessary protein, vitamin, mineral and fats required. Cassava yields on farmers' fields are low (8-10 t/ha) with potential yields of 30 to 40 t/ha. A major factor contributing to this low yield is the low soil fertility and the poor quality of the planting material. Keating *et al.*(1982a) reported that in infertile soils, the effects of mineral nutrition are cumulative in that cuttings from plants in these soils emerge more slowly and have a lower yield potential than those from plants grown in more fertile soils.

The objective of the study was to investigate the effect of fertilizer application of the mother plant on the growth, development, and yield of the progeny from these plants. The results of this study will give a good indication for the need or otherwise of those in cassava planting material production to apply a certain level of fertilizer to the plants before cuttings are used to plant.

Materials and Methods:

Experimental design and treatment application

Cassava genotype Dabo was planted in June 2013, at a spacing of 1 m x I m at CSIR- Crops Research Institute, Kwadaso. Four fertilizer treatments including the control were applied as follows: NPK 30:30:45, NPK 60:30:45, NPK 45:30:45, and Control. The experimental design was a Randomized Complete Block Design (RCBD) with three replicates. NPK was applied at one month after sowing and Muriate of potash at three months after planting.

Fertilizer treatments per plant were as follows in the first year:

Treatment 1:
(30:30:45) 20g NPK at One month + 3 g Muriate of Potash (MOP) at three months after planting

Treatment 2:
(60:30:45) 20 g NPK and 13 g of urea at one month + 3 g of Muriate of Potash (MOP) at 3 months after planting.

Treatment 3:
(45:30:45) 20 g NPK and 6.5 g of urea at one month + 3 g of Muriate of Potash at 3 months after planting.

Treatments 4:
Control (No fertilizer)

Field Management: Weeding and other field management practices were undertaken when necessary.

Second year planting (Progeny)

Planting: Planting materials from mother plants harvested from the first year planting (progenies) were planted on the 31st July, 2014. Cuttings were planted at 1 m x 1 m (10,000 plants/ha). Planting distance and all other field practices were the same as previously undertaken for the mother plants.

Fertilizer application: No fertilizer was applied to the plants since performance of the plants were to be determined on the residual nutrient from the mother plant.

Harvesting:
The second year harvesting was done on the 22nd September, 2015

Data analysis:
Data was analysed using the GENSTAT Discovery 4th Edition. Mean separation was done using the SED at $p \leq 0.05$.

Results and Discussions

Table 1 shows the soil physical and chemical properties at the experimental site at Kwadaso. The soil texture for the depths of 0 30 cm was observed to be a sandy loam with PH within the acid range. Soil nitrogen levels at both depts were low.

Plate 1 shows the field development of the fertilized plot of the mother plant (L) and the control plot (R). Plant growth was more vigorous on the fertilized plot than the control plot. The mother plant was harvested in June, 2014.

Plant development of progenies (daughter plants)

Plant development from cuttings (progenies) of the fertilizer treated mother plant was vigorous whereas plant development from cuttings (progenies) of the control (No fertilizer) mother plant was very poor (Plate 2). Weed competition was high on the control plot (Plate 2) as a result of slow establishment and canopy development relative to the progenies from the fertilizer treated plots.

Table 1: Physical and Chemical properties of soils at horizons 0-15 cm and 16 - 30 cm at Kwadaso.

				Bray's Available		Exchangeable Cation m.e. 100^{-1}g								Particle Size Analysis			
Depth	PH	O.C	N	ppm K	pp mP	Ca	Mg	K	Na	TEB	Ex. Acidity	EC EC	% B.S	% Sand	% Silt	% Clay	Texture
0-15cm	5.2	1.8	0.2	100.4	106.8	3.49	0.8	0.12	0.03	4.5	0.45	4.87	90.8	65.8	28	6	Sandy loam
15-30cm	5.4	1.4	0.1	56.6	3.75	2.94	0.8	0.05	0.03	3.9	0.4	4.22	90.5	62.7	28	8	Sandy loam

Plate 1: Development of Cassava from fertilised plot (L) and Control plot (R) 62 DAP at Kwadaso, 2013 (Mother plant)

Plate 2: Year Two Cassava field, progeny from control mother plant (L) and fertilised mother plant (R)

Plant height, girth, stake weight and root yield of mother plant

Table 2 shows plant height and girth at 10 months after planting for the mother plants. Plant height and girth were significantly lower ($p<0.05$) with the control treatment relative to the fertilizer treated plots. Similarly, stake weight and root yield were significantly lower compared with the fertilizer treated plots. Keating *et al.* (1988) observed that the use of thin stakes from the upper part of the mother plant reduced yield slightly as compared to heavy thick stakes. Oka *et al.* (1987) also reported that stakes with high volume density (weight per unit volume) taken from the lower or middle part of the mother plant gave better sprouting (germination) and a higher survival rate under both dry and wet conditions. Results from this study indicated that the control plot produced cuttings with smaller girth and lower stake weight which when used in planting resulted in lower root yield. Cassava root yields for all the fertilizer treated mother plots were significantly ($p\leq0.05$) greater than the control plot (12.1 t/ha) with yield difference ranging between 68% (20.3 t/ha) and 278 % (33.7 t/ha) in the first year of the experiment (2013) (Table 2).

Root yield of progenies

In the second year of the trial cuttings from the mother plant was used for planting with no fertilizer application. Cuttings from the treatment that gave the highest yield in Year 1 (45-30-45, N:P:K) gave the greatest yield (24.0 t/ha) relative to the control (10.3 t/ha) giving 233% higher root yield than the control (Table 3). Molina and El Sharkawy (1995) reported that the nutritional content of cassava stems as influenced by soil fertility status affected the regenerative ability of collected stakes which in turn affected yields of subsequent crops irrespective of the fertility status. Results from this study agreed with this findings and justified the need for commercial cassava planting material producers to boost the quality of the cassava planting material through fertilizing the mother plant. Farmers in cassava production can also fertilize a small portion of their cassava farm and use cuttings from the fertilized plot as planting material. Plates 3 and 4 show roots harvested from two cuttings

Table 2: Plant height, girth, stake weight at harvest and root yield of cassava genotype Debo (Mother plant)

Treatment	Plant height at 10 months after planting (cm)	Girth at 10 months after planting (cm)	Stake weight/ plot at harvest (kg)	Root yield kg/ha
NPK: 30:30:45	271	14.1	14.1	20300
NPK:60:30:45	260	12.3	12.3	27169
NPK:45:30:45	302	13.6	13.6	33667
Control	269	10.3	10.3	12068
CV%	9.5	4.8	34	16.1
SED (0.05)	10.7	0.05	1.8	1541.5
Mean	275	2.80	12.6	23300

Table 3: Root yield, root length and above ground biomass of mother plants and progenies (daughter plants) of cassava genotype Dabo as affected by fertilizer application.

	Root yield t/ha		Root length (cm)		Above ground biomass t/ha
Treatment	Year One Mother plant (2014)	Year Two daughter plant (2015)	Year One Mother plant (2014)	Year Two daughter plant (2015)	Year Two daughter plant (2015)
NPK 45-30-45	33.7	24.0	34.3	33.7	12.7
NPK 60-30-45	27.2	14.4	25.4	37.5	10.1
NPK 30-30-45	20.3	10.6	26.8	28.6	9.7
Control	12.1	10.3	36.2	33.5	7.6
CV %	16.1	15.7	11.5	23.4	24.5
SED	3.8	5.5	2.8	6.3	2.6
Mean	23.3	14.8	30.6	33.3	10.2

Plate 3 : Cassava root yield of two plants from progeny of control (Non -fertilized) mother plant

Plate 4 : Cassava root yield of two plants from progeny of fertilizer treated mother plant

of progenies (daughter plants) for the control plot and the fertilizer treated plots, respectively.

Conclusions and recommendation:

Cassava is a staple root and tuber crop consumed in different processed forms in Ghana. The crop serves as a food security crop in the country. There is however, competition for the storage root by industry which process the root into cassava flour for industrial use such as root beer, starch and other forms. Farmers in Ghana do not apply fertilizer on their cassava farms thus affecting the productivity of the crop considering the low fertility of most marginal soils where the crop is sown. Several factors have contributed to low productivity of cassava varieties on farmers' fields relative to the potential yields. A major factor is the quality of the cassava planting material. The results of this study showed that cuttings from mother plants grown on a nutrient rich soil develop faster and produce greater root yield compared to that which is grown in a nutrient poor soil. It is recommended that cassava planting material producers apply a certain amount of fertilizer on the plants before cuttings are harvested for sale to farmers. It is also recommended that farmers reserve a small portion of their cassava fields and apply fertilizer on the plants so that they can be used as planting materials in subsequent planting. It is however, recommended that the trial is repeated to confirm results of this study.

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