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EFFECTS OF PERCENTAGE LEAF DEFOLIATION AND NPK 15:15:15 FERTILIZER APPLICATION ON THE GROWTH AND YIELD OF CASSAVA (*Manihot esculenta* (L.) Crantz)

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ABSTRACT

Two field experiments were conducted at the Research Farm of the National Root Crop Research Institute, Umudike, Umuahia, Abia State, on the effects of percentage leaf defoliation and NPK 15:15:15 fertilizer application on the growth and yield parameters of cassava (Manihot esculenta (L.) Crantz), TMS 419 sourced from NRCRI. The experiments were laid out in a factorial scheme, using the randomized complete block design (RCBD). The first experiment was laid out as a 4 by 3 factorial scheme with three (3) replications and twelve (12) treatment combinations, giving a total of thirty-six (36) plots in all while the repeat experiment was laid out as a 2 by 3 factorial scheme with three (3) replications and six (6) treatment combinations, giving a total of eighteen (18) plots. The treatments were 0%, 25%, 50%, 75% and 100% for defoliation and 0kg/ha, 150kg/ha, 200kg/ha, 300kg/ha and 400kg/ha for fertilizer applied. The results showed that significant (5%) defoliation effect was observed on plant height when 50%, 75% and 100% rates of defoliation were carried out. Fertilizer applied was only significant when 400kg/ha of fertilizer was applied. Significant defoliation effect (5%) was observed in the number of leaves and also a significant fertilizer effect (5%) was observed in the number of leaves at 150kg/ha. The interaction between them was also significant. Significant defoliation effect (5%) was observed in the number of branches likewise a significant fertilizer effect (5%) was observed in the number of branches at 300kg/ha. Results showed that NPK fertilizer applied had a significant (5%) effect on the leaf area at 400kh/ha. Although with all levels of defoliation, NPK fertilizer applied and their interaction, none showed any significant effect on the yield parameters, but there were some reasonable percentage yield with 200kg/ha to 400kg/ha fertilizer applied. It therefore showed that farmers can achieve reasonable yield regardless of the degree of defoliation considering the fact that there must be an alternate source of nutrients like the NPK 15:15:15 fertilizer used in the experiment ranging from 200kg/ha to 400kg/ha, and for the farmers with livestock farming inclusive.

Keywords: Defoliation, fertilizer, cassava, vegetative, yield

INTRODUCTION

Cassava, *Manihot esculenta* Crantz belongs to the class Dicotyledoneae, family, Euphorbiaceae and it is known to be perennial woody shrub, grown annually, reaching 2 to 4m in height and the root consisting of the bark and the fleshy starchy parenchyma which is the edible part of

agricultural importance both for human consumption and industrial uses (Lebot, 2009). Cassava known as a root crop is a staple food crop, contributing about 15% of the dietary energy intake of most Nigerians on daily basis, forming essential part of the diet of about 500 million people and provides a suitable means of livelihood for millions of farmers, processors and traders (Donald, Truman, and Robert, 2000). In a bit to increase the yield potential of the cassava crop, the crop had been reported to respond to good soil fertility and adequate fertilizer application (Chaisri *et al*., 2013; Mathias and Kabambe, 2015).

As much as cassava crop has the natural ability to thrive better in an unfavourable condition (Boansi, 2017), excessive amount of rainfall has been reported to effectively affect the lifespan of added fertilizer to the soil, the retention capacity and the availability to the crops and consequently may affect the root formation and quality (Duluora, 2012; FAO, 2013). Nitrogen, Phosphorus and Potassium fertilizer are the three major nutrients that are most important for cassava tuber formation (Odedina *et al*., 2015), while chemical fertilizers usually have 10-20 times higher concentrations of these nutrients (Howeler, 2014).

The importance of cassava cannot be overemphasized; its greatest staple utility rest in Africa (Onwueme, 2002). About 90% of cassava produced is used locally for food (could be processed into over 50 food forms; gari, lafun, bread, flakes, flour etc, Denton *et al.,* 2004), animal feed, and bio fuel, industrial and pharmaceutical uses (El-Sharkawy, 2004).

However, in communities where cassava is grown in many African countries, the leaves are harvested for human and livestock consumption. Cows, sheep and goats also routinely eat up the cassava leaves in the farmer's plots. The effects of these leaf removal and distortion of the photosynthetic activities on root formation and yields of the crop have not been assessed in Umudike, Abia State; hence the overall aim of this study was to examine the effects of percentage leaf defoliation on the growth and yield of cassava and NPK fertilizer application. Defoliation is a widespread loss of leaves or stripping of leaves on a plant, it is just all about leaf removal which could be positive or negative; it could be for human or animal feed production. Page *et al*., (1980) found out that experimental defoliation of cassava caused a significant reduction in the root yield, and also a delayed natural leaf regeneration which occurred during the rainy seasons. In recent time, there have been high yield losses in cassava production as a result of the activities of *Zonocerus variegates* (Elegant Grasshoppers) which eat up the cassava leaves and had threatened the livelihood of many poor subsistence farmers (Page *et al*., 1980).

Furthermore, Phengvichith *et al*., (2006), had tested the effects of leaf harvesting at different level of frequencies on storage root yields and thus reported a decrease in storage root yields as the harvesting frequency increases regardless of the variety used. In communities where cassava is grown in many African countries, the leaves are harvested for human and livestock consumption. Cows, sheep and goats also routinely eat up the cassava leaves in the farmer's plots. More so, diseases like cassava mosaic and bacterial blight etc reduce the size of the leaves, thereby reducing the photosynthetic leaf areas. African farmers recognize pests and diseases as important cassava production constraints (Ndunguru *et al*., 2005) and many of these pests and diseases which pose serious damage to the crop, affect the final yield (Mtunda *et al*., 2003). The effects of these leaf removal and distortion of the photosynthetic activities on the tuberisation and yields of the crop have not been assessed; hence the overall aim of this study was to examine the effects of NPK fertilizer application and leaf area manipulation on the growth and yield of cassava. The specific objectives of this study were to:

i. determine the effects of defoliation on the performance (growth and tuber yield) of cassava;
ii. determine the effects of NPK fertilizer application on the crop;
iii. establish if there is any interaction between the NPK fertilizer application and defoliation on the growth and yield of the crop.

METHODOLOGY

The experiments were conducted at Umudike (Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike and the Research Farm of the National Root Crop Research Institute), during the 2012 and 2014 cropping seasons respectively, located at longitude 07° 33'E, latitude 05° 29'N; altitude 122m and an annual rainfall of 2177mm, 72% relative humidity, with monthly temperatures ranging from 17°C-36°C (National Root Crop Research Institute, Umudike, 2011). Umudike is located in the humid tropics and has an annual average temperature of about 26.5°C. The predominant vegetative type is a rain forest (NEST, 1991), while the soil has been classified as a sandy loam ultisol (Agboola, 1979).

Land Preparation

The experimental sites were slashed, cleared, ploughed, harrowed and ridged using a tractor, and were marked out into plots using a measuring tape, pegs and rope with each plot measuring 5m by 4m amounting to 20m² per plot. The total land areas for the first and repeat experiments were 35m by 30m amounting to 1050m² and 35m by 14m amounting to 490m² respectively. Soil samples were collected at random from the experimental sites using a soil auger, bulked together, then air dried, sieved through a 2mm sieve and used to determine the soil Physico-chemical properties of the experimental sites before planting and treatments application.

Source of Materials

The cassava stems used in this study were TMS 419 obtained from National Root Crop Research Institute, Umudike, Umuahia, Abia State.

Experimental Design and Treatments

The experiments were laid out in a factorial scheme, using the randomized complete block design (RCBD). The first experiment was laid out as a 4 by 3 factorial scheme with three (3) replications and twelve (12) treatment combinations, giving a total of thirty-six (36) plots in all while the repeat experiment was laid out as a 2 by 3 factorial scheme with three (3) replications and six (6) treatment combinations, giving a total of eighteen (18) plots.

Two months after planting (2MAP), defoliation and the application of NPK 15:15:15 were carried out simultaneously using the different rates of treatments. The different rates of defoliation for the first and second experiments were 0%, 25%, 50%, 75% and 0%, 100% respectively while the different rates of fertilizer applications for the first and second experiments were 0kg/ha, 150kg/ha, 300kg/ha and 0kg/ha, 200kg/ha, 400kg/ha respectively. (Actually was trying different treatments in order to ascertain the best treatment suitable for optimum cassava production with respect to defoliation and NPK fertilizer application, hence, the inconsistency in the level of treatments in the two years).

Field Layout for the 1st Experimental Site

REP I	REP II	REP III
D0N0	D0N1	D0N2
D1N0	D1N1	D1N2
D2N0	D2N1	D2N2
D3N0	D3N1	D3N2
D0N1	D0N2	D0N0
D1N1	D1N2	D1N0
D2N1	D2N2	D2N0
D3N1	D3N2	D3N0
D0N2	D0N0	D0N1
D1N2	D1N0	D1N1
D2N2	D2N0	D2N1
D3N2	D3N0	D3N1

Key Note: D0 = No (zero) defoliation N0 = No fertilizer applied
D1 = 25% defoliation N1 = 150kg/ha
D2 = 50% defoliation N2 = 300kg/ha
D3 = 75% defoliation

The different Percentages of defoliation were achieved by summing up the number of leaves on the sampled plants and thus multiplied by the required percent

Field Layout for the 2nd Experimental Site

REP I	REP II	REP III
D0N0	D0N1	D0N2
D1N0	D1N1	D1N2
D0N1	D0N2	D0N0
D1N1	D1N2	D1N0
D0N2	D0N0	D0N1
D1N2	D1N0	D1N1

Key Note: D0 = No (zero) defoliation N0 = No fertilizer applied
D1 = 100% defoliation N1 = 200kg/ha
N2 = 400kg/ha

Agronomic Practices

The planting dates of the first and repeat experiment was on the 28th day of May, 2012 and on the 9th day of August, 2014 respectively. (In 2013, I was computing my data and carrying out my analysis before carrying out the next field work, but eventually became sick and could not continue, hence, the 2014.) The cassava stem cuttings were planted one per hole at a spacing of 1m by 1m on a plot of 5m by 4m.

The defoliation process was carried out gradually by carefully and manually detaching the required number of leaves from the cassava stem as proposed while the NPK fertilizer was applied to the base of the cassava stem using the ring method of fertilizer application. Weeding was done manually in a periodic manner, three times before harvest using hoe to avoid competition with the crops for space, light, food, air and other essential needs of the crops and also to avoid pests and diseases infestation. Pesticides (thiamethoxam, 200g/ha)

and herbicides (diuron, 2kg a.i/ ha) application were carried out too in other to control pest and disease and weed infestations respectively.

Data Collection

Four months after planting (4MAP), data were collected on the sampled plants with respect to the following parameters and were repeated on monthly basis for two more consecutive times.

Growth/vegetative traits:

i. Plant height per plant: This was obtained by measuring the tagged plants from the base to the tip of the stem using a meter rule measured in centimeter (cm) and the mean height taken.
ii. Number of leaves per plant: The number of leaves per plant was obtained by counting the leaves on the sampled plants and the mean number taken.
iii. Number of branches per plant: The number of branches per plant was obtained by counting the branches on the sampled plants and the mean number taken.
iv. Leaf area: The leaf area was obtained by a non-destructive and direct method of estimating leaf area called the regression method which was based on measuring the length of the mid-rib of the central lobe of the cassava leaves on sampled plants using $Y = 6.11 \times L$ (Lutaladio, 1986).

Yield and yield components:

i. Number of tubers per plant: The number of roots per plant was obtained by counting the number of roots on the sampled plants as soon as the sample plants were uprooted from the soil and the mean taken.
ii. Weight of tubers per plants: The weight of the roots per plant (in kg) was obtained by weighing the roots per plants as soon as the sampled plants were uprooted from the soil and the mean taken.

Data Analysis

The data collected were subjected to a statistical analysis i.e. Analysis of variance (ANOVA) and in cases where treatments differed significantly, the Fisher's Least Significant Different (F-LSD) was used to determine the degree of significance at 5% significant level (Obi, 2002).

RESULTS AND DISCUSSION

Following the analysis of variance carried out at 5% level of significance. Table 1 showed that a significant (5%) defoliation was observed for plant height in the first experiment with the NPK fertilizer applied and interaction not significant, the plots with the greatest plant height were D0N1, D1N1, D2N1, and D3N1. The first experiment also showed that the difference in the effect of defoliation between D0 and D3, D0 and D2 were highly significant at 5%.

Table 2 which is the repeat experiment showed that the defoliation and the NPK fertilizer applied were significant but there were no interaction for defoliation and NPK. The plots with the greatest plant height were D0N0, and D1N0. According to the results obtained in the repeat experiment only the difference between D1 and D0 that was highly significant at 5% level of significance. The difference between the N1 and N2, and N0 and N1 were highly significant at 5%.

Table 1: effects of defoliation and NPK fertilizer application on the height (cm) per plant (4map) in the first experiment

	NPK applied (kg/ha)			
Defoliation (%)	**0**	**150**	**300**	**mean**
0	273.00	368.30	263.87	100.57
25	247.47	314.30	263.26	91.67
50	231.63	257.36	245.81	81.64
75	216.17	314.18	247.06	86.38
Mean	80.69	104.51	85.03	
F-LSD (0.05) Defoliation effects	9.5857			
NPK effects	NS			
Defoliation x NPK	NS			

F-LSD = Fisher's Least Significant Different, NS = Not Significant at 5% level of significance

Table 2: effects of defoliation and npk fertilizer application on the height (cm) per plant (4map) in the repeat experiment

	NPK applied (kg/ha)			
Defoliation (%)	**0**	**200**	**400**	**Mean**
0	325.17	414.25	460.16	133.29
100	274.25	398.92	373.42	116.29
Mean	99.90	135.53	138.93	
F-LSD (0.05) Defoliation effects	15.1909			
NPK effects	18.6049			
Defoliation x NPK	NS			

F-LSD = Fisher's Least Significant Different, NS = Not Significant at 5% level of significance

Tables 3 showed a significant (5%) NPK fertilizer applied on the number of branches in the first experiment. The plots with the highest number of branches were D0N0, D1N2, and D2N0. The difference between N0 and N2 was highly significant at 5% level of significance.

Table 4 showed a significant (5%) defoliation effect on the number of branches was observed with NPK fertilizer applied not significant including the interaction between them. The plots with the highest number of branches were DON0, D1N0. The difference between N0 and N1 was highly significant at 5% level of significance. The difference between D0 and D1 was also highly significant at 5%.

Table 3: effects of defoliation and NPK fertilizer application on the number of branches per plant (4map) in first experiment

	NPK applied (kg/ha)			
Defoliation (%)	**0**	**150**	**300**	**Mean**
0	0.84	0.83	0.67	0.26
25	0.17	0.33	0.50	0.11
50	0.64	0.42	0.17	0.14
75	0.00	0.17	0.50	0.07
Mean	0.14	0.15	0.15	
F-LSD (0.05) Defoliation effects	NS			
NPK effects	0.1176			
Defoliation x NPK	NS			

F-LSD = Fisher's Least Significant Different, NS = Not Significant at 5% level of significance

Table 4: effects of defoliation and NPK fertilizer application on the number of branches per plant (4map) in repeat experiment

	NPK applied (kg/ha)			
Defoliation (%)	0	200	400	Mean
0	0.50	1.33	0.00	0.20
100	3.08	2.25	1.92	0.81
Mean	0.51	0.60	0.32	
F-LSD (0.05) Defoliation effects	0.5964			
NPK effects	NS			
Defoliation x NPK	NS			

F-LSD = Fisher's Least Significant Different, NS = Not Significant at 5% level of significance

Results obtained in the first experiment, (table 5) showed that the NPK fertilizer applied, defoliation and interaction were significant, while in the repeat experiment there were no significant effects observed. Nevertheless, the plots with the highest number of leaves were D0N0, D1N1, D2N1, D3N1 and D0N2, D1N2 in the first and repeat experiment respectively. From the results obtained, the difference between N0 and N2 was highly significant at 5%, same with N1 and N2 too. The differences in defoliation between D0 and D3, D0 and D2, and D0 and D1were highly significant at 5%.

Table 5: effects of defoliation and NPK fertilizer application on the number of leaves per plant (4map) in first experiment

	NPK applied (kg/ha)			
Defoliation (%)	**0**	**150**	**300**	**Mean**
0	138.72	143.92	119.05	44.63
25	107.00	122.78	109.74	37.72
50	101.19	126.05	97.45	36.16
75	90.70	128.05	109.23	36.44
Mean	36.47	43.46	36.29	
F-LSD (0.05) Defoliation effects	5.7159			
NPK effects	4.9502			
Defoliation x NPK	9.9002			

F-LSD = Fisher's Least Significant Different, NS = Not Significant at 5% level of significance

Table 6 (repeat experiment) showed that the NPK fertilizer applied was significant for leaf area. The plots with the highest leaf area were D0N1, D1N1, D2N1, D3N1 and D0N2, D1N1 in the first and repeat experiment respectively. None of the differences between them were significant.

Table 6: effects of defoliation and npk fertilizer application on the leaf area (cm^2) per plant (4map) in repeat experiment

	NPK applied (kg/ha)			
Defoliation (%)	0	200	400	Mean
0	1,190.25	1,361.05	1,407.95	439.92
100	1,125.98	1,371.61	1,336.98	426.06
Mean	386.04	455.44	457.49	
F-LSD (0.05) Defoliation effects	NS			
NPK effects	58.4618			
Defoliation x NPK	NS			

F-LSD = Fisher's Least Significant Different, NS = Not Significant at 5% level ofsignificance

Results showed no significant effect was observed for defoliation, NPK fertilizer applied and the interaction between the defoliation and NPK fertilizer applied were not significant in both experiments. The plots with the highest number of roots include D0N2, D1N2, D2N1, D3N1 and D0N2, D1N2 in the first and repeat experiment respectively. No significant effect was observed for defoliation, NPK fertilizer applied, and the interaction between the defoliation and NPK fertilizer applied were not significant in both experiments. Although no significant effects were observed in the treatments and interaction, the root weights, were observed to be higher in the following plots D0N2, D1N1, D2N1, D3N2 and D0N2, D1N2 in the first and repeat experiment respectively as compared with the control and the plots with zero level of the fertilizer applied.

From the data collected and the statistical analysis of variance (ANOVA) carried out, differences existed in some of the parameters upon which data were collected. Defoliation had a significant effect on the plant height at 5% level of significance with defoliation at 75% and 100% being highly significant (This implies that defoliation had a significant effect on plant height at 5% level of significance but defoliation effect was highly significant when defoliation was carried out at 75% and 100% rate of defoliation). However, with the NPK fertilizer applied, the effect of defoliation was reduced; this is in line with the findings of Munyahali *et al*., (2017), who stressed that harvesting of young leaves resulted in small or negligible effects on cassava growth and yields compared to the mineral fertilizers which increase both cassava growth and yields. The NPK fertilizer application increased growth parameters and this is in line with the findings of Omotoso and Shittu, (2007), who explained that the NPK fertilizer significantly increased growth parameters (plant height, leaf area, root length, number of leaves). Defoliation at 25% and 50% had no significant effect on the crop especially at 25% level of defoliation, this suggests that some kind of compensation must have taken place, following the fact that most crop plants were found to compensate for partial defoliation such as damage from the herbivores and this agreed with the findings of Strauss and Agrawel, (1999). A significant defoliation effect was observed for plant height in the first experiment conducted, others (fertilizer and interaction) showed no significant effect and this

is in line with the findings of Nwaoguala *et al*., (2015) while in the repeat experiment conducted, the defoliation and NPK fertilizer applied were significant but the interaction was not. Results showed that defoliation had a significant effect on the plant height at 50%, 75% and 100% defoliation, with 75% and 100% being highly significant and the NPK fertilizer applied at 200kg/ha and 400kg/ha was very effective in reducing the effect of the defoliation on cassava growth and yield, this is in line with finding of Nwaoguala *et al*., (2015),which stated that the NPK fertilizer application promoted vegetative growth to cushion the adverse effects of defoliation, but at 100% defoliation the plant had its tallest height of 398.92cm upon 200kg/ha of NPK fertilizer applied.

The increase in plant height was as a result of the NPK fertilizer applied, which implies that plants showed responses to growth and yield with respect to fertilizer application (FAO, 2004). This could be because the fertilizer added extra and sufficient nutrients to the soil which aided the nutrient availability and was made use by the cassava to douse the effect of defoliation and this agreed with the findings of Howeler, (1996). Nwaoguala *et al*., (2015) indicated that to increase the yield potential of cassava, the crop is expected to show good responses to good soil fertility and adequate fertilizer. Defoliation at 50%, 75% and 100% with the application of 200kg/ha and 400kg/ha were significant but the application of 400kg/ha was highly significant than 200kg/ha (It implies that when defoliation were carried out at the rate of 50%, 75% and 100%, the application of 200kg/ha and 400kg/ha were significant (in reducing the effects of the defoliation), but the application of 400kg/ha was highly significant (400kg/ha was more effective). Branching was most observed as showed by the results obtained, defoliation and NPK fertilizer applied had effect on the branching of the cassava plant. The application of 300kg/ha of NPK fertilizer was highly significant and 100% defoliation was very detrimental to the branching of the crop. Defoliation, fertilizer applied and interaction were very much significant with respect to the number of leaves of the crop in the first experiment conducted.

Apart from 0%, all other levels of defoliation had same level of significances and were highly significant. The plants with the highest number of leaves were seen in plots on which 150kg/ha of fertilizer were applied, but both 150kg/ha and 300kg/ha of fertilizer applied were highly significant and the interaction was not. Defoliation, fertilizer applied and interaction showed no significant effect on leaf area in the first experiment, while fertilizer applied showed a significant effect on the leaf area obtained in the repeat experiment result, and this agreed with the findings of Omotoso and Shittu, (2007), which indicated that the NPK fertilizer significantly increased growth parameters (plant height, leaf area, number of leaves), but none were highly significant.

From the tables of mean effects of defoliation and NPK fertilizer application on final harvest, results showed that the highest ton (weight of fresh roots) was in 0% defoliation, followed by 25% and then the other levels of defoliation, this is in line with the findings of (Geetha, 2018), which expressed that in groundnut, the lowest pod mass per plant was recorded in severe (100%) defoliation. Results also showed that at 0% defoliation with 300kg/ha of fertilizer applied, the crop had 85.00 numbers of tubers and it had 76.00 at 75% defoliation with 300kg/ha of fertilizer applied while in the repeat experiment the crop had 107.2 number of tubers at 100% defoliation with 400kg/ha of fertilizer applied and this is in line with the findings of Suzanne *et al*., (1996), while at 0% defoliation with 400kg/ha of fertilizer applied the crop had 111.1 number of tubers. The roots had the highest weight of 16.70kg at 0%

defoliation with 300kg/ha NPK fertilizer applied followed by 12.50kg at 75% defoliation with 300kg/ha of NPK fertilizer applied while in the repeat experiment the crop had 25.3kg of roots at 0% defoliation with 400kg/ha of fertilizer applied and 24.5kg at 100% defoliation with 400kg/ha of fertilizer applied. It implies that the repeat experiment had more weights with respect to root weights than the initial experiment, though none has a significant effect on the final yield parameters, this is probably because adequate fertilizer application has the capacity to reduce the effects of leaves defoliation on the crop productivity, and plants showed responses to growth and yield with respect to fertilizer application (FAO, 2004), which stated that plants showed responses to growth and yield with respect to fertilizer application, and the cassava crop has the ability to adjust and is resilient under unfavorable conditions (Jarvis *et al*., 2012).

CONCLUSION

With respect to the results obtained from this research, it was observed that besides the control plots, defoliation affected virtually all parameters especially the vegetative traits. The plots with zero fertilizer had the lowest performance at the different levels of the defoliation, while those with 150kg/ha to 400kg/ha fertilizer applied performed better especially 150kg/ha, 200kg/ha and 400kg/ha for the vegetative traits and 200kg/ha, 300kg/ha and 400kg/ha for the yield parameters. Defoliation at 50% and above affected plant height, number of leaves, while it affected the number of branches at 100% level of defoliation. The number of branches were affected positively when 150kg/ha and 300kg/ha of fertilizer were applied, number of leaves when 150kg/ha was applied, plant height when 200kg/ha to 400kg/ha of fertilizer were applied, and the leaf area at all levels. Defoliation equally affected the yield which was attributed to the reduction in the photosynthetic activities of the crop, but yielded reasonably as a result of the fertilizer applied which added and supplied the needed nutrients for the growth and development of the crop roots and the cassava crop has the ability of recovering after passing through difficult times like undergoing defoliation even at 100% level of defoliation. The plots with zero level of fertilizer applied performed poorly at the different levels of defoliation as compared to those with certain level of fertilizer applied but yielded better especially with the 200kg/ha, 300kg/ha and 400kg/ha.

RECOMMENDATIONS

It is therefore recommended that farmers be less worrisome because they can still achieve reasonable yield regardless of the degree of defoliation, be it by drought, pest and diseases, deliberately for animal feed production, and or especially by grazing animals, considering the possibility of making available an alternate source of nutrients such as NPK 15:15:15 fertilizer in the range of 200kg/ha to 400kg/ha for maximum yield production, to supplement for the nutrient deficiency as a result of the distortion of the photosynthetic activities of the defoliated leaves and for the farmers with livestock farming inclusive, this is of great importance to them, owing to the fact that they can defoliate at 25% and 50% level of defoliation for their animal's feed production but at least from 2 months after planting (2MAP) and yet have reasonable yield available for consumption etc.

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