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Assessment of Climatic Factors on Growth and Yield of Maize Variety as Influenced by Rates of Sunshine Organic Manure and NPK 20:10:10 Fertilizer

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Abstract— *Maize is one of the most important cereal crops in West Africa. Its production in Nigeria has been hindered by inconsistency in rainfall pattern and low fertility especially in Akure, Ondo State. Two experiments were conducted at the Teaching and Research Farm, Federal University of Technology, Akure (FUTA) in 2016 growing season (wet and dry seasons) to determine the effects of Sunshine Organic Manure and NPK 20:10:10 fertilizer on the growth and yield maize variety, as well in soil fertility improvement. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications per treatment. Suwan^{-1}-SR-Ymaize varietywas used for the experiment and Sunshine Organic manure was applied at the rates of 0, 60, 90, and 120kg N ha^{-1}while NPK 20:10:10 was used as standard at the rate of 70 kg N ha^{-1}. Growth parameters (plant height and number of leaves per plant) were taken at two weeks interval for 12 weeks. At harvest, yield parameters (Seed weight/plant, Weight of 1000 seed (g), Number of seeds/cob, Yield in t ha^{-1}, cob length (cm), cob girth (cm)) were determined. The following weather data were collected; Daily rainfall, maximum & minimum temperature and solar radiation, while the soil data collected were; pH, total N, available phosphorus, potassium, organic carbon, and bulk density. Statistical Package for Social Sciences (SPSS) was used for the data analyses. Mean separation was done using Duncan's Multiple Range Test (DMRT). Results showed an increase in growth and yield parameters recorded with increasing application rates of Sunshine Organic Manure in both growing season.*

***Keywords—* Maize, Fertilizer, climate, Growth, Yield.**

I. INTRODUCTION

Cereal production is a major component of small-scale farming in West Africa. Among cereals, maize is one of the most important as it forms the major staple food for most communities and contributes about 20% of calories to human diet (Braimoh and Vlek, 2006). However, average maize yields per unit of land have fallen over the years, partly due to loss in soil fertility as a result of unsustainable farming activities, especially in the wetter areas where the yield potential is higher (Sanchez, 2002) and partly due to low external inputs (Fosu*et al.*, 2004).

As farmers battle with low soil fertility, climate change presents an additional burden, which for them translates into production risks associated with crop yields, due to the probability of extreme events, the uncertainty of the timing of field operations, and of investments in new technologies. The concern for the present and future climate aberrations, weather trends and their implications for agriculture continue to stimulate researchers as well as public and policy-level interests regarding the analysis of climate change in relation to agricultural productivity (IPCC 2007; Cooper *et al.*, 2006). Reported projections indicate that with the trend in climate change and variability, the impacts on people's livelihoods will be greatest in Africa, where many poor smallholders largely or totally rely on rain-fed agriculture and have few alternatives (IPCC, 2001; Boko*et al.*, 2007), due to high levels of poverty, low levels of human and physical capital, and poor infrastructure (IFPRI, 2009). The specific objective was to determine the effects of organic fertilizer application rates on growth and yield of maize as well as assessing the impacts of climate on crop performance.

II. MATERIALS AND METHODS

The research experiment was carried out during the rainy season (March - July) and dry season (September-December) at the Teaching and Research Farm of the Federal University of Technology, Akure (FUTA) ($7^0$16'N, $5^0$12'E) located in the Rain forest agro-ecological zone of Nigeria in 2016 growing season.

Each trial was laid out in a Randomized Complete Block Design (RCBD) with three replications per treatment.The size of the field was 14 m by 14 m (196 m^2) and each experimental unit was 4 m by 2 m with 1 m alley. There were 15 plots. The allocation of treatments to each experimental unit was done using the Plant Breeding Tools (PBTools) Version: 1.3.

The maize variety (Suwan^{-1}-SR-Y) was obtained from the Institute of Agricultural Research and Training, Moor Plantation, Ibadan in Nigeria. It was an improved maize variety fortified with protein. Maize seeds were sown two seeds per hole with a spacing of 75 cm by 25 cm but were later thinned to one plant stands 2weeks after planting. Weeding was carried out manually (hoeing and hand-pulling). Growth parameters (plant height and number of leaves per plant) were taken at two weeks interval for 12 weeks. At 8 weeks after planting, fresh leaves and stem weights, oven dried leaves and stem weight were determined while the leaf area was determined using the Leaf area meter. Plant height was measured using a tape in centimeters and average leaf number was determined by counting the total number of leaves of two plant stands in each plot. At harvest, yield parameters (Seed weight/plant, Weight of 1000 seed (g), Number of seeds/cob, Yields in t ha^{-1}, Cob length (cm) and Cob girth (cm)) were determined.

The Sunshine Organic Manure (S.O.M) was applied at varying rates of 0, 60, 90, 120 kgN $ha^{-1}$and NPK 20:10:10 at 70kgN ha^{-1}as recommended rate.

The weather data required include; daily rainfall, maximum & minimum temperature and solar radiation and were collected from the West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) weather observatory, Federal University of Technology, Akure.

Soil Analysis

Core samples were used for determination of soil physical properties. The auger samples were air- dried, grinded and passed through 2 mm sieve and used to determine chemical properties. The methods that were applied were: hydrometer method for soil texture (Jacob and Clark, 2002), Kjeldahl method for total nitrogen (Bremner and Mulvaney, 1982), and the modified Walkley- Black wet oxidation procedure for organic carbon content. Multiplication of the soil organic carbon by 1.72 resulted in soil organic matter (Nelson and Sommers, 1982). Titration method with EDTA solution were used for measuring calcium and magnesium (Lanyon and Heald, 1982), sampling cylinder method for Bulk density (Jacob and Clark, 2002) and the soil pH was carried out using 1:2.5 soil/water ratio and the values were read off using Beckman zeromatric pH meter (Peech, 1965). The amount of phosphorus in soil extracts of soil were determined by Spectrophotometer (Olsen and Sommers, 1982). Exchangeable K and Na after extraction were extracted using 1 N ammonium acetate (pH= 7) and read with flame photometer (Knudsen *et al.*,1982). Statistical Package for Social Sciences (SPSS) and Decision Support Systems for Agro-Technology Transfer (DSSAT) were used for data analyses. Mean separation was done using Duncan’s Multiple Range Test (DMRT).

III. RESULTS

Initial Soil Physicochemical Analysis for both growing seasons

Table 1 shows the monthly means weather data (Rainfall, minimum and maximum temperature and solar radiation) for 2016 at the experimental site. The results of initial chemical and physical analyses of the soil at the experimental site in 2016 for the two growing seasons (wet and dry) are presented in Tables 2 and 3. Both experiments were carried out on the same field. The soil pH was noted to be slightly acidic across the 3 soil depths (0-15, 15-30 and 30-45 cm). The soil pH decrease down the depth (6.31, 6.18, 6.21). The total N value in the top 15 cm layer was moderately available during the first growing season, but was low in the second season (0.34 in the first growing season and 0.19 in the second season). The percentage organic matter (OM) was 0.86, 0.55 and 0.43 in top 15, 30 and 45 cm soil layer, respectively. The available phosphorus was low across the 3 layers 0-15 (10.95 mg kg^{-1}), 15-30 (6.54 mg kg^{-1}) and 30-45cm (3.43 mg kg^{-1}), exchangeable K was moderately available at 0-15 soil depth (0.33) but was low in the top 30 and 45cm layer (0.29 and 0.24 cmol kg^{-1}, respectively). The textural class of the soil is Sandy clay loam. The soil textural class increased down the soil horizon whiles % sand decreased with increasing soil depth. The bulk density (g cm^{-3}) in each layer (0-15, 15-30 and 30-45cm) were 1.52, 1.54, 1.55 respectively.

Soil available P can be rated as low and K as moderate according to Page et al. (1982). Similarly, the percent

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organic carbon (0.5 and 0.55) is rated very low according to Landon (1996).

Effects of Cultivars and Organic Fertilizer Rates on Growth and Yield of Maize in the wet and dry season of 2016

Table 4 shows the effects of fertilizer application on plant height of selected maize varieties during the 2016 wet and dry season. In the wet season, significant differences ($P > 0.05$) were not observed at 4 and 10 weeks after planting (WAP) while significant differences were recorded in the other weeks. However, maize varieties planted in the control (No fertilizer) plot had the shortest plants across the weeks of the experiments while the plots treated with NPK 20:10:10 had the tallest plants. The sunshine organic manure that was applied at 120 kg N ha^{-1} performed better compared to the other rates of application (60 and 90 kg N ha^{-1}). Statistically, there was no significant difference ($P > 0.05$) in the heights of maizetreated with 60, 90 and 120 kg N ha^{-1} of Sunshine Organic Manure at 4, 6, 8 and 10WAP. In the dry season planting, significant differences ($P > 0.05$) were observed across the weeks of the experiment (4 – 12WAP). However, maize varieties planted in the control plot (No fertilizer) had the shortest plant across the other weeks of the experiments while the plot treated with NPK 20:10:10 had the tallest plant. Also from the table, sunshine organic manure that was applied at 120kg N ha^{-1} performs better compared to the other rates of application (60 and 90kg N ha^{-1}), although there were no significant differences between plant of maize treated with SOM 90 and 120kg N ha^{-1} at 6, 10 and 12WAP. Among the Sunshine Organic manure rates, the application at 60kg N ha^{-1} had the shortest plant.

The results on the effects of Sunshine Organic manure and NPK fertilizers on number of leaves and leaf area (cm^2) of selected maize varieties in the wet and dry season of 2016 were presented in (Table 5). In the wet season, significant differences were not recorded in the number of leaves across the weeks of the experiment except at 4WAP when the control was not significantly different from the others. However, maize treated with NPK 20:10:10 and sunshine organic manure applied at 90 kg N ha^{-1} had the highest number of leaves. Statistically, no significant differences were observed in the *Zea mays* number of leaves in all the Organic fertilizer plots across the weeks of the experiment. Regarding the leaf area, there were significant differences ($P > 0.05$) among the fertilizer rates, the NPK 20:10:10 fertilizer produced maizewith the largest leaf area while the control experiment had the least. Comparing the performance of different organic fertilizer rates, the Sunshine organic manure applied at the rate of 120 kg N ha^{-1} had the largest leaf area while SOM applied at 60 kg N ha^{-1}produced the smallest leaf area

In the dry season experiment, significant differences were recorded in the number of leaf across the weeks of the experiment. However, maize treated with NPK 20:10:10 and sunshine organic manure applied at 120kg N ha^{-1} had the highest number of leaf. Statistically, there were no significant differences between the number of leaf of maize treated with SOM at the rate of 90 and 120kg N ha^{-1}. Regarding the leaf area, there were significant differences ($P > 0.05$) among all the fertilizer rates, the NPK 20:10:10 fertilizer produced maize with the largest leaf area while the control experiment had the least. Comparing the performance of different organic fertilizer rates, the Sunshine organic manure applied at the rate of 120kg N ha^{-1} had the largest leaf area while SOM applied at 60kg N ha^{-1} produced maize with the smallest leaf area. All SOM rates were significantly different from one another.

Table 6 shows the effects of fertilizers on yield parameters (Seed weight/plant, Weight of 1000seed, No of seed/cob, Yield in tha^{-1}, Cob length and Cob girth) of selected maize varieties during the wet and dry season of 2016. In the wet season, significant differences were recorded in the across the aforementioned yield parameters. The NPK 20:10:10 produced the highest yield while the control experiment had the least. However, examining the performances of the maize varieties with sunshine organic manures at varying rates of application shows that the SOM 120 kg N ha^{-1} rate performed best compared to other organic manure rates. Although there was no significant difference among the organic manures rates in the following yield parameters; seed weight/plant and weight of 1000seed. The statistical analysis of the yield parameter also indicated that the control experiment had a better yield because there were no significant differences in the following yield parameters (cob girth, cob length and weight of 1000seed) when compared to the other organic fertilizer rates.

In the second growing season (dry season),significant differences were recorded in the seed weight/plant, Weight of 1000seed, No of seed/cob, Yield in tha^{-1}, Cob length and Cob girth. The NPK 20:10:10 fertilizer produced the highest yield while the control experiment had the least. However, regarding the influence of varying Sunshine Organic Manure rate on the maize varieties shows that the SOM applied at the rate of 120kg N ha^{-1} performed best compare to other organic manure rates. Although there was no significant difference between the application of SOM at 90 and 120kg N ha^{-1} in the following yield parameters; weight of 1000seed, yield in tha^{-1}, cob length and cob girth of selected maize varieties. The statistical analysis of the

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yield parameter also indicated that the control experiment was significantly different from the other treatment and also had the lowest yield.

IV. DISCUSSION

This study clearly demonstrates the effects of Sunshine Organic Manure (SOM) at different rates on the growth and yield of *Zea mays*. A general assessment of the effects of SOM on growth and yield parameters recorded across the two growing seasons showed that the organic fertilizer positively influenced the performance of the crop with increasing rates of application. However, this trend was clearly observed during the dry season experiment (second growing season) compared to the wet season (first growing season). In the first growing season, the SOM applied at 0, 60, 90 and 120kg N ha^{-1}were not significantly different from one another for some parameters, such as number of leaves, plant height at 6WAP and 10WAP, weight of 1000seeds,Cob length, Cob girth and seed weight/plant. The control experiment (No fertilizer) had the lowest yield in both trials when compared to the fertilized plots. During the first growing season, significant differences were not observed between the control (no fertilizer) and some application rates of the SOM (60, 90 and 120kg N ha^{-1}) for some parameters e.g. plant height at 8WAP, cob length, cob girth and no of seeds/cob. The reason for these results may be attributed to the influence of the existing soil nutrients. From the initial soil analysis, the results revealed that the soil nutrients tested for N, P, K, Ca, Ma, OM and %OC were moderately available in the soil, according to the soil analysis guidelines for interpretation (Thiagalingam, 2000). This clearly explains the reason why maize normally planted without fertilizer application by local farmers gives a better yield.

It was also observed from the study that NPK proved to be efficacious as a good source of inorganic fertilizer that supported good vegetative growth and yield performance of maize. The NPK 20:10:10 fertilizer performance was better compared to the SOM at different rates (60, 90 and 120kg N ha^{-1}). However, this may be attributed to the percentage concentrations of Nitrogen, Phosphorus and Potassium present in the SOM (3% N: 1.5% P: 1%K). The percentage of N present in the SOM is about 6 times lower as compared to that of N content of the NPK fertilizer (20%N). The initial soil analysis that was carried out at the commencement of the second experiment revealed that the nitrogen content of the soil was low. The low amount of total soil N may be attributed to low soil organic matter because Nitrogen is one of the most essential components of organic matter. The decomposition of organic matter leads to the release of some nutrients including N.

The second experiment commenced two weeks after harvesting the first trial. Ploughing was carried out a week after harvesting and a week before planting the second trial. Therefore, the low soil organic matter may be attributed to high C: N ratio of undecomposed maize residues (straw). A study conducted by Kpongor (2007), stated that crop residues and farmyard manure increases Soil Organic Content.

Effects of environmental factors

The following environmental factors might have affected the maize performances during the two growing seasons; temperature, moisture availability, solar radiation, soil structure, and soil nutrients.

The first planting commenced on 14 May, 2016; the mean monthly weather data for the Solar Radiation, Maximum Temperature, Minimum Temperature and Rainfall were 18.0, 30.5, 22.9 and 54.8 respectively. Despite the low mean monthly rainfall recorded at the time of establishing the first trial (time of sowing), over 85% germination was recorded 6 days after sowing (visual observation). This result may be attributed to the influence of the soil physical properties on seed germination. The % Sand, Silt and Clay of the soil were 60.3%, 21.6% and 18.1% respectively. The small percentage of clay content present in the soil might have been responsible for soil water retention ability. Also, the bulk density and % soil moisture content were 1.57gcm^{-3} and 22.60% and rainfall was continuous and sufficient.

According to Walter (1967), for sowing it is important to know whether the rains are continuous and sufficient to ensure enough soil moisture during planting, and whether this level will be maintained or even increased during the growing period in order to avoid total crop failure. This is because water is essential for all plant growth and development and it is an integral part of living systems.

However, reduction in maize growth and yield parameters recorded during the 2^{nd} growing season could not be easily linked to soil water availability because the mean average rainfall for both growing season (197mm and 139.3mm) were enough for optimum yield production. According to Oldeman and Suardi (1977), maize needs an average monthly precipitation of 100 to 140 mm. They basically takes 3 to 3.5 months for optimum growth and will need an average of 300-500 mm of precipitation during this period.

The 2^{nd} growing season began September 1^{st}, 2016, and ended December 8th, 2016. Comparing the performances of the maize cultivar in both growing seasons, it was observed that the yield was higher in the first growing season than the second season. Despite the fact that the same treatment

(Fertilizer types and maize varieties) and management practices were applied, there was a reduction in maize yield. In addition, the experiment was also conducted on the same site (Teaching and Research Farm of the Federal University of Technology, Akure). Also, grains harvested from the first trial were not used as seeds for the second experiment because of the likelihood of segregation, so new similar maize varieties were obtained from the Institute of Agricultural Research and Training, Moor Plantation, Ibadan in Nigeria.

After assessing all the likelihood reasons that may be responsible for low yield recorded during the second experiment, the following factors were suspected to have led to decease in yield of the selected maize cultivars; High temperature and low soil fertility.

Month	Solar Radiation	TMax	TMin	Rain
September	15.7	27.5	21.7	363.2
October	18.7	29.0	21.8	168.6
November	20.0	30.8	22.2	25.4
December	18.7	31.4	21.4	0.0

The table above is an extract from the aforementioned mean monthly weather data for 2016 (January to December). From the table above, it was observed that the solar radiation, Maximum and Minimum Temperature increases from September to December while rainfall decreases. The maize for the second trial was sown on September 1st, 2016. The mid-October marked the end of vegetative growth stage and the initiation of the tasseling, silking and milking stage. However, the implication of this on the yield of maize is that increase in temperature will accelerate physiological development i.e. hastening maturation thereby reduces yield. In addition, the soil moisture stress is critical at this development stage (grain filling) of the plant, which can have a serious effect on grain size and weight and hence on yields.

As earlier suggested by Boote and Sinclair (2006) high temperature reduces yield by accelerating physiological development (hastening maturation), not allowing the crop to progress slowly through the season so as to maximize time for the capture of resources and for assimilate partitioning to reproductive structures.

V. CONCLUSIONS

Maize grain yield was positively influenced by the rates of the organic fertilizers applied, although the inorganic fertilizer (NPK 20:10:10) had the best yields. The inorganic fertilizer led to decrease in soil pH while the sunshine organic manure helped maintain the soil pH within the optimum range. In line with the objective of this study, which was to acquire a better understanding of the yield potentiality of maize variety using the organic fertilizer rates, it shows the efficacious and productivity of the inorganic fertilizer used (NPK 20:10:10) over different organic fertilizer rates (Sunshine Organic Manure at 60, 90 and 120kgha^{-1}).

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TABLES

Table.1: Monthly Means Weather data for 2016 at the experimental site

Month	Solar Radiation (W/m^2)	Maximum Air Temperature (°C)	Minimum Air Temperature (°C)	Rainfall (mm)
January	18.8	33.8	19.6	9.4
February	19.0	35.4	22.0	0.0
March	17.1	33.1	24.0	149.8
April	19.4	32.1	23.7	15.6
May	18.0	30.5	22.9	54.8
June	15.6	28.2	21.9	321.6
July	14.4	27.4	21.6	148.4
August	13.5	27.4	21.4	263.2
September	15.7	27.5	21.7	363.2
October	18.7	29.0	21.8	168.6
November	20.0	30.8	22.2	25.4
December	18.7	31.4	21.4	0.0

Source: West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) weather station

Table.2: Initial Soil Physicochemical Analysis for the first growing season

	0-15	15-30	30-45
		Depth (bottom), cm	
Particle size analysis (%)			
Clay	21.6	22	26.5
Silt	18.1	18.6	18.9
Sand	60.3	59.4	54.6
Bulk density g/cm^3	1.52	1.54	1.55
Soil pH	6.31	6.18	6.21
Nitrogen (%)	0.34	0.31	0.29
Phosphorus (mg kg^{-1})	10.95	6.54	3.43

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Organic Matter	0.86	0.55	0.431
Exchangeable cation (cmol kg^{-1})			
Potassium	0.33	0.29	0.24
Calcium	3.10	4.01	3.20
Magnesium	2.00	1.80	1.60
ECEC	17.86	19.41	15.30

Table.3: Initial Soil Physicochemical Analysis for the second growing season

	0-15	**15-30**	**30-45**
		Depth (bottom), cm	
Particle size analysis (%)			
Clay	22.0	23.1	28.2
Silt	19.7	21.5	19.5
Sand	58.3	55.4	52.3
Bulk density g/cm^3	1.53	1.51	1.52
Soil pH	6.22	6.17	6.19
Nitrogen (%)	0.19	0.16	0.15
Phosphorus (mg/kg)	6.92	4.45	3.21
Organic Matter	0.95	0.86	0.73
Exchangeable cation (cmol kg^{-1})			
Potassium (cmol/kg)	0.25	0.23	0.20
Calcium (cmol/kg)	2.73	3.23	3.13
Magnesium (cmol/kg)	1.17	1.15	1.14
ECEC	20.12	17.54	15.26

Table.4: Effects of fertilizer treatments on plant height of maize at successive growth periods in the wet and dry season of 2016

Fertilizer	Weeks after planting			
Treatment (Kg N/ha)	4	6	8	10
		Wet season		
0	49.30a	84.87a	144.07a	190.89a
SOM 60	51.74a	91.88ab	144.67a	198.89a
SOM 90	54.60a	91.07ab	155.29a	204.11a
SOM 120	57.62a	96.20ab	158.71ab	213.67a
NPK 70	58.61a	115.06b	184.96b	218.33a
		Dry season		
0	42.44a	59.25a	95.38a	135.53a
SOM 60	46.64ab	71.11b	108.07ab	158.36b
SOM 90	50.98b	83.38c	114.67ab	163.44b
SOM 120	60.50c	88.04c	131.09b	167.64b
NPK 70	70.34d	103.40d	157.91c	191.47c

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Means in the same columns not followed by same letters are significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

Table.5: Effects of fertilizer treatments on number of leaves and leaf area of Maizeat successive growth periods in the wet and dry season of 2016

Fertilizer Treatment (Kg N/ha)	Weeks after planting 4	6	8	10	Leaf Area at 8WAP (cm^2)
Wet season					
0	7.57ab	10.09a	10.90a	9.44a	754.22a
SOM 60	6.66a	9.97a	10.73a	9.44a	867.43ab
SOM 90	8.12b	10.59a	10.92a	10.06a	979.37bc
SOM 120	8.02b	10.38a	11.43a	9.50a	1025.74cd
NPK 70	8.40b	10.83a	11.41a	10.28a	1133.12d
Dry season					
0	6.70a	6.40a	7.91a	8.93a	747.72a
SOM 60	7.43ab	7.49ab	8.91ab	9.58ab	860.93ab
SOM 90	7.83bc	8.51bc	9.71bc	10.04bc	972.87bc
SOM 120	8.40bc	9.31bc	10.42bc	10.56bc	1019.24cd
NPK 70	9.33c	10.27c	11.04c	11.33c	1126.62d

Means in the same columns not followed by same letters are significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

Table.6: Effects of fertilizers on yield parameters of selected maize varietiesduring the wet and dry season of 2016

Fertilizer Treatment (Kg N/ha)	Seed weight/plant	Weight of 1000seed (g)	No of seed/cob	Yield in T ha^{-1}	Cob length (cm)	Cob girth (cm)
Wet season						
0	171.67a	333.33a	273.56a	1147.67a	12.79a	8.28a
SOM 60	203.78ab	345.56a	328.39ab	1265.78ab	15.36ab	9.96ab
SOM 90	215.01ab	365.56a	322.94a	1392.00ab	15.08a	9.79a
SOM 120	229.00ab	360.00a	347.61ab	1511.56b	16.22ab	10.53ab
NPK 70	297.89b	377.78b	427.72b	1721.67c	19.98b	12.97b
Dry season						
0	89.67a	237.78a	206.00a	569.44a	9.78a	6.34a
SOM 60	131.22b	277.78b	302.33bc	820.56b	14.06ab	9.10ab
SOM 90	163.11c	307.78bc	345.78bc	1007.78c	16.36bc	10.60bc
SOM 120	194.56d	330.00bc	398.89c	1199.44c	18.08bc	11.74bc
NPK 70	256.22e	363.33d	458.44d	1619.44d	21.16c	13.73c

Means in the same columns not followed by same letters are significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).