PRODUCTIVITY OF MILLET (P*ennisetum glaucum* (L) R. BR.) AS INFLUENCED BY INTRA-ROW SPACING, LOW LEVELS OF COMBINED ORGANIC AND IN-ORGANIC FERTILIZERS AND VARIETY IN SOKOTO, SUDAN SAVANNAH, NIGERIA.

Abstract

Pearl millet [(*Pennisetum glaucum* (L.) R. Br.], is an important dietary food for one-third of the world population. When the plant density exceeds an optimum level, competition among plants results to poor plant growth and grain yield. In Nigeria, Farmers cultivates local varieties without considering proper population density resulting to low yield. Inorganic fertilizers are costly and also results to soil pollution. Millet productions can be enhanced through appropriate cultural practices. Field experiment was conducted at Usmanu Danfodiyo University Teaching and Research Dry land Farm, Sokoto, during the 2022 Rainy season to determine effect of intra-row spacing, appropriate combination of organic and inorganic fertilize and variety for optimum yield of millet. The treatments comprises factorial combination of three intra-row spacings (40,50 and 50 cm), three fertilizer treatments: the control with no organic or inorganic fertilizer, 25 kg P205 and 25 kg N ha-^{1}, FYM at 5 t ha-^{1} , 12.5 kg P205 plus 12.5 kg N, plus FYM at 2.5 t ha-^{1} and two verities (Super SOSSAT and Zango), laid out in split plot design, Intra-row spacing and fertilizer was allocated to the main plot, while varieties to the sub plots. Data was collected on growth and yield parameters and subjected to analysis of variance (ANOVA), Duncan New Multiple Range Test (DNMRT) was used to separate the means. The results indicated that 40 cm intra-row spacing produced higher Leaf Area Index (LAI), Panicle length (cm) and total biomass, while 25 kg P205 and 25 kg N ha-^{1}, FYM at 5 t ha-^{1} , 12.5 kg P205 plus 12.5 kg N produced taller plants, higher LAI, panicle weight, 1000 grain weight, grain yield, and total biomass. Super SOSSAT produced higher LAI, Panicle length (cm), panicle weight, 1000 grain weight, grain yield and total biomass, while Zango produced taller plant and longer panicle length. 40cm intra-row spacing, application of combined organic and inorganic fertilizer at the rate of 25 kg N, P and 5 tonne^{-1} FYM and Super Sossat was better to achieve optimum yield.

INTRODUCTION

Pearl millet [(*Pennisetum glaucum* (L.) R. Br.] is a multipurpose cereals crop belonging to family *poaceae*, subfamily *panicoideae*, tribe *paniceae* and genus *pennisetum*; cultivated in semi-arid and dry lands of Africa and Asia (Baltensperger, 2002, ICRISAT, 2006). Millets are significant dietary food for one-third of the world population (Baker, 2003). It is a major source of diet for the poorest people in the poorest countries in the world's (Consultative Group on International Agricultural Research (CGIAR, 2006). Millet is cultivated as a rain fed crop in the tropics and it is the most important cereal crop in the Sahel zone and South of Sahara in Africa (Gibbon and Pain, 1985). Pearl millet is tolerant to drought, high temperature and can be cultivated virtually on any soils (Govindaraj *et al*., 2019), Salama and Zeid (2016) reported that the high tillering and deep root system help the crop to withstand adverse conditions that could cause yield reductions or crop failure in other crops. Ali *et al*. (2010) observed that pearl millet requires low plant nutrients to produce reasonable amount of yield. It is mostly grown on poor marginal soils and low rainfall (<350 mm) where other crops such as wheat, rice and maize cannot be cultivated. It is considered as main component of food security of rural poor people in hot and dry areas of the world (Vadez *et al*. 2012). In northern Nigeria, millet flour is used in making fried cake known as *masa*. Roasted young ears are popular food for children (AFRICANCROPS.NET, 2006). Nutritionally millets are superior to most cereals; they are rich in methionine, cystine, and other vital amino acids for human health. They are also unique sources of pro-vitamin A (yellow pearl millets) and micronutrients (Zn, Fe and Cu). Africa and Asia produced and consumed about 97% of global millets. (Sood *et al*. (2019). India with 37.5% of the total world production is the largest producer of millets, followed by Sudan and Nigeria. Of the 93 millet producing countries of the world, only 7 countries (India, Niger, Sudan, Nigeria, Mali, Burkina Faso, and Chad) have more than one Million hectares of harvested area, while around 25 countries have more than 0.1 Million hectare of harvested area. The major seven millet production countries of the world are India ranked first with 15.29 M ha harvested area, followed by Niger (7.03 M ha), Sudan (3.75 M ha), Nigeria (2.7 M ha), Mali (2.15 M ha), Burkina Faso (1.39 M ha), and Chad (1.22 M ha). (FAOSTAT, 2018). In Nigeria, the annual pearl millet production between 2014 and 2016 ranged from 1.15 to 1.55 million tons, this represent about 5% of total global production with the average yield of 903 kg ha^{-1}, this amount ranked Nigeria as the third world's largest producer after Niger and India (Ajeigbe *et al*., 2019; FAOSTAT, 2018). The Global Market Insights Inc, a United States-based research organization observed that global millet market value is projected to exceed $12 billion by 2025 (The Nation, 2021).

Plant population is one of the most important agronomic practices affecting growth, yield and yield components of pearl millet due to its influence on the inter- and intra-plant competition for nutrients, space and moisture (Ahmed *et al*., 2021). Plant population above optimum level results to competition for light, space, moisture and nutrients, resulting to poor plant growth and decrease in grain yield (Bayala *et al*., 2002). Similarly, very low plant density may result to poor crop yield due to poor interception of solar radiation and net assimilation (Hay & Walker, 1989). Hakeem *et al.* (2020) recommended inter-row spacing of 75 cm and intra-row spacing of 50 cm for millet. The authors further observed that appropriate fertilizer application; seed rate and spacing are among the major agronomic practices for optimum yield of millet. Miko and Manga (2008) reported increased in sorghum height at closer intra-row spacing. Kumari *et al*. (2017) reported significantly linear correlation between the yield and yield components of pearl millet in relation to increasing plant densities, while, Talasila *et al*. (2019), reported non-significant effect of plant densities on yield and yield components of millet. Sanjay e*t al*. (2021) reported increased in plant height with increase in plant density. Number of tillers and panicles significantly decreased with increase in plant density for all tested genotypes (Ahmed *et al*., 2021). Maobe *et al.* (2014) reported increased in tiller and panicle numbers per m^2 as plant population increased in Kenya.

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT, 2006) developed many pearl millet genotypes with variability in growth and yield and yield components. Chelpuri *et al*. (2019) observed that productivity of pearl millet varied among the different varieties. Baghel and Maloo (2002) reported varietal variation in proso millet. The cultivation of local varieties, rainfall duration, amount and distribution are some of the limiting factors for millet production in Sudan savanna. The local varieties are low yielding and many farmers are skeptical in using new varieties resulting to underutilization of land resources. Yadav *et al*. (2003) observed variation in response to different climatic and production conditions from different genotypes. Growth and yield of millet can be increased by the identification of higher yielding varieties and proper planting time (Arif *et. al*., 2001; Khan *et al*. 2009).

Soils in the semi-arid tropics where millet is cultivated are deficient in plant nutrients, mainly due to continuous cropping, inadequate or no fertilizer, poor recycling of crop residues, and inadequate organic matter application resulting to poor crop yield (Prakasha *et al*., 2018).

Application of combination of organic and inorganic fertilizers increased the productivity of millet (Ramamurthy *et al*., 2004). Melle Talan *et al*. (2015) reported better growth, yield, sustainable production of millet cultivated under integrated nutrient management. Getachew Agegnehu *et al*. (2014) reported deterioration of soil due to continuous applications of inorganic fertilizers, Dejene Kasahun and Lemlem Semungus (2012) observed that application of organic fertilizer improve crop growth. Integrated use of organic and inorganic fertilizers is one of the important means of increasing soil fertility and sustainable increase in crop yields (Gete Zeleke *et al*., 2010; Getachew Agegnehu and Tilahun Amede, 2017). Organic matter provides critical plant nutrients at little cost while application of chemical fertilizers is costly and may exacerbate environmental problems (Nambiar, 1991). Combination of organic manures and chemical fertilizers provides better stability in soil fertility and crop production. Therefore, it is very important to determine appropriate quantities or ratios of organic manures and inorganic fertilizers for better growth and development of crop (Moe *et al*., 2017). Gruhn *et al*. (2000) observed low yield as a result of inappropriate application of plants nutrients in sub-Saharan Africa.

Despite the importance of millet in the world and in Nigerian diet in particular, the yield obtained by the farmers in Nigeria is very low (1.55 t ha^{-1}) compared to the global yield (3.2 t ha^{-1}) (Railey, 2006). The optimum plant densities exerts pressure to explore maximum environmental resources resulting to higher yield, farmers finds its very difficult to maintained optimum plant population resulting to under population resulting to weeds infestation, poor solar radiation and low yield), or dense population which results to lodging, poor light penetration in the canopy, reduce photosynthesis due to shading of lower leaves and drastically reduce the yield (Pradhan and Mishra, 1994). According to the Sangoi (2001) there is no specific optimum population density for all the weather conditions due to variation in environmental conditions. There is a need to determine the optimum population density by adjusting inter and intra – row spacing in relation to other agronomic factors for maximum yields. Poor soil fertility and inappropriate fertilizer application are some of the limiting factors for millet production in Sudan savanna of Nigeria. N, P and K content of soil are the limiting factor for cereal production in the tropics and N is the most limiting (Roe, 2006). The scarcity and the high cost of the inorganic fertilizer affects balance and timely application of plants nutrients. Unavailability of improved seeds make farmers cultivation of local cultivars and this results to low yield (Rakshit and Wang 2016). Therefore it is necessary to determine agronomic practices resulting to increase in the yield of millet in Nigeria. Millet is a very important food crop in Sokoto and Nigeria. Millet production can be enhanced through appropriate cultural practices and by the use of improved varieties (Raemaekers, 2001). Literature reported significant increase in millet yield as a result of cultivation of improve varieties and increase optimum population. Millet important roles as a source of feed and forage (Andrew and Kumar, 1992).

The objectives of the study was to determine effect of intra-row spacing on growth and yield of millet, determine the appropriate combination of organic and inorganic fertilize for optimum yield of millet in Sokoto, Sudan savanna zone of Nigeria and select suitable millet cultivar for increased millet production in Sokoto.

Methodology/Materials and Methods

The study was conducted during the 2022 rainy season at the Dry land Teaching and Research Farm, Usmanu Danfodiyo University Sokoto , Dundaye, Sokoto State, Nigeria. Sokoto lies on latitude 13^0 01'N, longitude 5^0 15'E and 350 m above sea level in the Sudan Savanna agro-ecological zone (Sokoto State Government Diary, 2003). The relative humidity is between 14-28% and 70-75% during dry and rainy seasons, respectively. The area has a long dry season that is characterized by cool dry air during harmattan from November to February and hot dry air during hot season from March to May during the coolest and hottest season of the year, respectively, Minimum and maximum temperature ranges between 23-38 Degrees respectively (Nigerian Meteorological Agency (NIMET), 2022). The soil is hydromorphic that is seasonally flooded during rainy season. The soil type of the area is predominantly sandy in nature and classified as entisols which is characterized by low fertility and poor water holding capacity (Noma and Yakubu, 2002). Prior to planting, soil samples from a depth of 0-15cm using an auger was collected at random from the entire field. The samples were air dried, sieved to pass through 2mm sieve before subjecting it for physic-chemical analysis described by Page *et al*. (1982).

The treatments comprised of factorial combination of three intra-row spacings (40, 50 and 60 cm), combination of three organic and inorganic fertilizer treatments which consist of:- the control with no organic or inorganic fertilizer, 25 kg P205 and 25 kg N ha-^{1} , FYM at 5 t ha-^{1} , 12.5 kg P205 plus 12.5 kg N plus FYM at 2.5 t ha-^{1} and two verities of millet (Super SOSSAT and Zango) laid out on split plot design with 3 replications. Intra-row spacing and fertilizer was allocated to the main plot, while varieties to the sub plots.

The experimental area was ploughed and harrowed at the onset of the rainy season, the gross plot measuring 6m*3.75m (22.5m^2) consisted of three double rows, each with intra-row spacing of 50 cm (6 rows), six (6) meter long and double rows inter-row spacing of 75cm, while plant to plant spacing was as per treatment (40 cm, 50 cm and 60 cm). Dressed seeds (Apron star 42Ws (200 g kg^{-1}, Thiamethoxam, 200 g kg^{-1} Metalaxyl – M and 20 g kg^{-1} (Difenoconazole) at the rate of one sachet (10g) per 4 kg of millet seeds was planted at the rate of 5 kg/ha on 18/06/2022. Plants were grown rain-fed without any supplemental irrigation. Fertilizer application was as prescribed by the treatments. Weeds was controlled manually using a hand-hoe at 2 and 6 WAS. Pest and disease was control as when necessary. Harvesting was manually done by cutting the stems of four middle plants in each plot, with a sickle directly above ground level. The crop was harvested at 88 days after sowing when grains harden and/or appearance of dark pigmentation at the blossom end of the panicle. The crop was cut at ground level and allowed for curing before the ears (heads) were cut and threshed.

Stand count was taken from four rows at three weeks after planting (3 WAP) and extrapolated to stand count per hectare. At 3, 6, 9, 12 and 15 WAS nine tagged sample plants from each plot were used to determine plant height, which was measured from base of the stem at ground level to the tip of the main shoot, number of tillers per plant was counted from sample plant, leaf area was taken directly by multiplying length x width and multiplied by a factor

(0.751) as proposed by Sestak *et al*., 1971), Egharevba (1978). LAI was determined using the following formula.

$Leaf\ Area\ Index\ (LAI) = \frac{Leaf\ area\ per\ plant}{Land\ area\ plant\ occupies}$ ……….. (Harfer, 1999)

Yield parameters like panicle length was measured from the base of the panicle to tip of the panicle and expressed as panicle length in centimeters (cm). The 1000-grain weight (g) was determined as an average of three random grain samples taken from each plot. The total biomass was determined by harvesting of two central rows of 3m long (Net plot area of 15 m^2) of the millet crop at ground level, bundled together, dried and weighted. The figure obtained was extrapolated to hectare basis.

The grain yield and straw yield was obtained from net plot extrapolated to Kg and $tonne^{-1}$ hectare respectively, harvest index was determined by dividing the total grain yield by the total biological yield and expressed as % following Donald (1962).

$Harvest\ Index\ (HI) = \frac{Economic\ Yield}{Biological\ Yield} \times 100$ (Donald, 1962)

Threshing percentage was obtained by threshing and winnowing the air dried panicles from the net plot and expressing it as the ratio of grain yield (kg) per panicle weight (kg) expressed in percentage.

$$Threshing\ Percentage\ (TP) = \frac{Grain\ Yield}{Panicle\ Weight} \times 100$$

Data was collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) software. Where `F' test showed significant differences between the treatments, Duncan New Multiple Range Test (DNMRT) was used to separate the treatment means.

Results and Discussion

The soil of the experimental site was sandy, neutral, low in organic carbon, total nitrogen, exchangeable cations and available phosphorous, while the organic matter had medium organic carbon, total nitrogen, exchangeable cations and available phosphorous (Table 1).

Establishment count ha^{-1} and Number of tillers $plant^{-1}$.

The effect of spacing, combined application of organic and inorganic manure and variety on establishment count ha^{-1} and number of tiller $plant^{-1}$ is presented on Figures 1, 2, 3, 4, 5 and 6. The result revealed that, the effect of spacing, combined application of organic and inorganic manure and variety is not significant ($p>0.05$) on establishment count and number of tillers $plant^{-1}$ at 3, 6, 9, 12, 15 Weeks After Sowing (WAS). This could be as results of the low nutrients status of the soil of experimental site (Table 1) and early drought (Appendix I).

Plant height: The effect of spacing, combined application of organic and inorganic manure and variety on plant height is presented on Figures 7, 8 and 9. The result revealed that, the effect of spacing on plant height is not significant ($p>0.05$) at 3, 6, 9, 12, 15 Weeks After Sowing (WAS). At 3 WAS combined application of organic and inorganic manure have no ($p>0.05$) significant effect on plant height, however at 6, 9, 12, 15 WAS the combined application of organic and inorganic manure have significant ($p<0.05$) effect on plant height. The application of 25 kg N, P and 5 $tonne^{-1}$ of Farm Yard Manure (FYM) and 12.5 kg N, P and 2.5 $tonne^{-1}$ of Farm Yard Manure (FYM) were statistically similar with the tallest plants and the control produced the shortest plants. Prakasha *et al.* (2018) observed that application of organic manure along with inorganic fertilizers resulted in availability of nutrients, moisture and utilization of nutrients, therefore the increased in plant height observed with application of fertilizer resulted to increased supply and utilization of plants nutrients resulting in better plant growth. These results is similar to the findings of Chittapur *et al.,* (1994), Muthukrishnan and Subramanian (1980) and Hanumantha Rao *et al.* (1982) who reported increased in plant height of millet as a result of application of fertilizer. The effect of variety of plant height of millet is not significant at 3 WAS, how ever there was significant ($p<0.05$) effect of variety on plant height at 6, 9, 12, 15 WAS. At 6 and 9 WAS Super Sossat differed significantly with tallest plant and the shortest plant was from Zango. At 12 and 15 WAS Zango (local) variety differed significantly with tallest plant and the shortest was from the Super Sossat. The differences in growth with respect to plant height observed among the two varieties may be attributed to differences in genetic characteristics of the varieties, Zango a local variety is a taller variety while Super sossat an improved variety is a semi-dwarf variety. This result is similar to that of Ibrahim *et al.* (2000) who reported the differences in growth parameters of crops to genetic constitution.

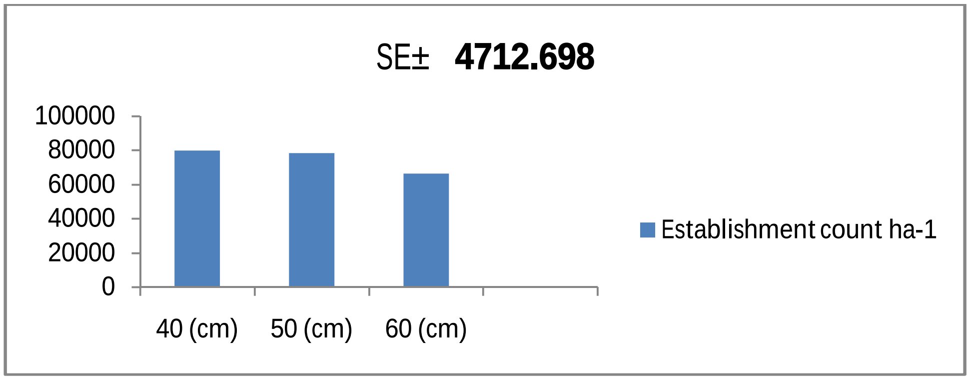

Figure 1: Establishment count of millet as influenced by spacing during the 2022 Rainy season at Sokoto

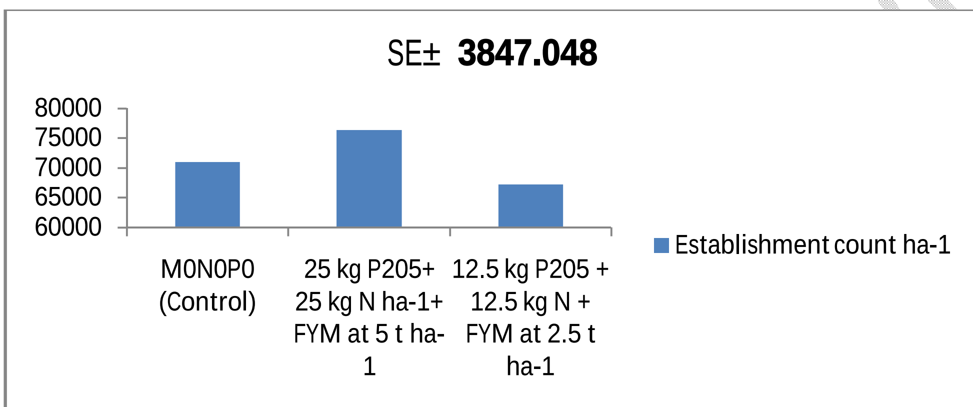

Figure 2: Establishment count of millet as influenced by combined application of organic and inorganic fertilizer during the 2022 Rainy season at Sokoto

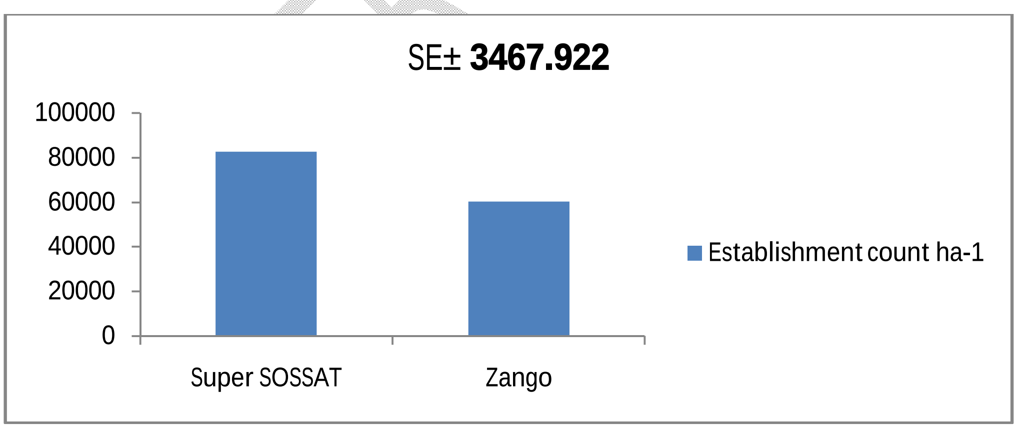

Figure 3: Establishment count of millet as influenced by variety during the 2022 Rainy season at Sokoto

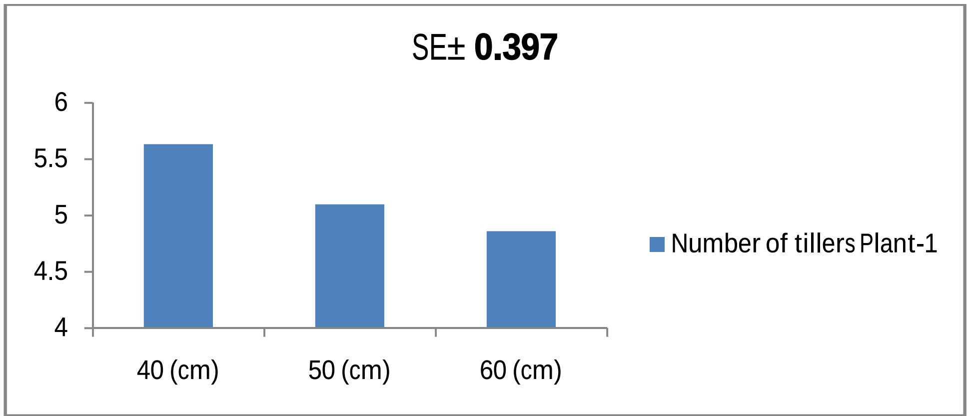

Figure 4: Number of millet tiller plant^{-1} as influenced by spacing during the 2022 Rainy season at Sokoto

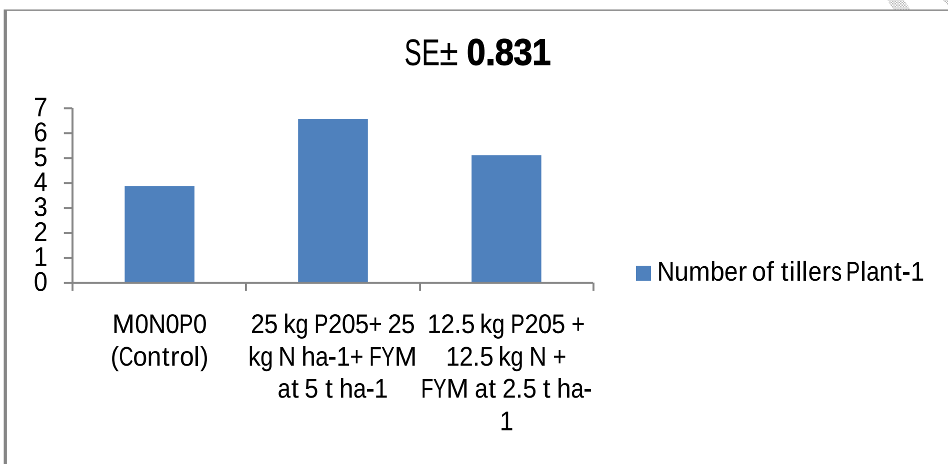

Figure 5: Number of millet tiller plant^{-1} as influenced by combined application of organic and inorganic fertilizer during the 2022 Rainy season at Sokoto

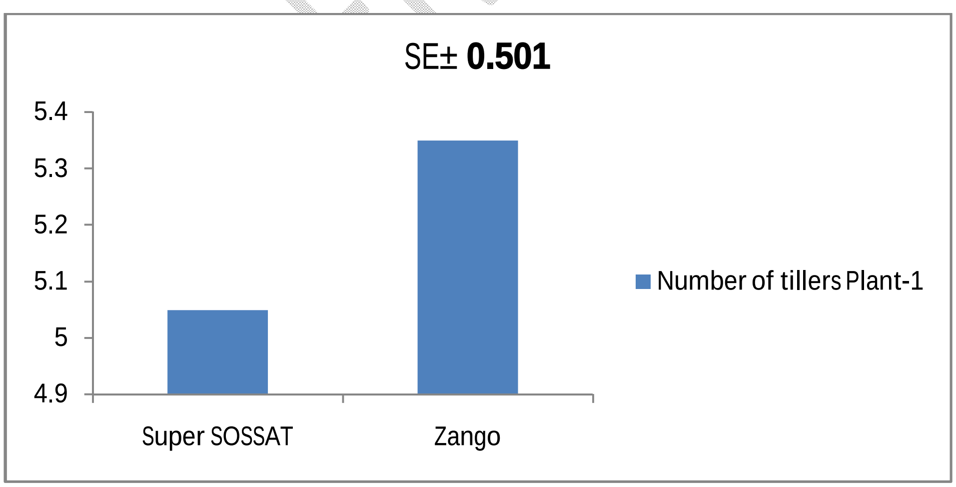

Figure 6: Number of millet tiller plant^{-1} as influenced by variety during the 2022 Rainy season at Sokoto

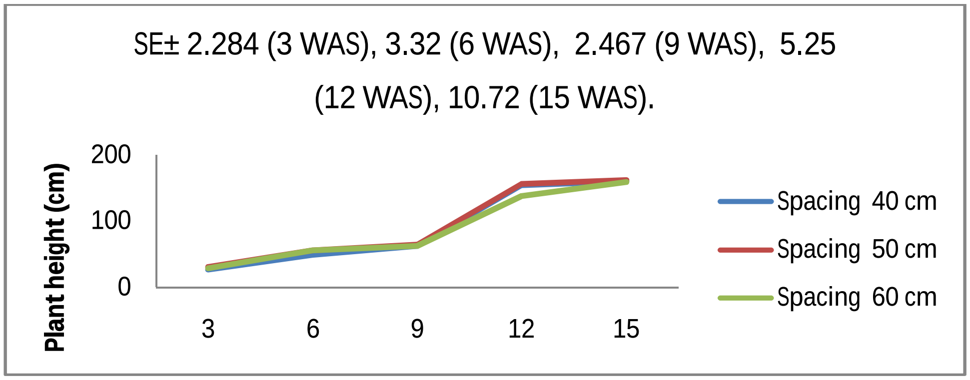

Figure 7: Plant height of millet as influenced by spacing during the 2022 Rainy season at Sokoto

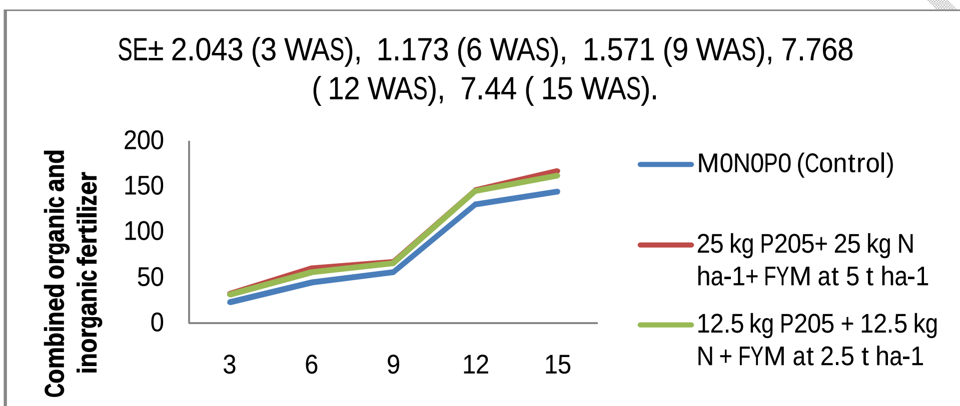

Figure 8: Plant height of millet as influenced by combined application of organic and inorganic fertilizer during the 2022 Rainy season at Sokoto

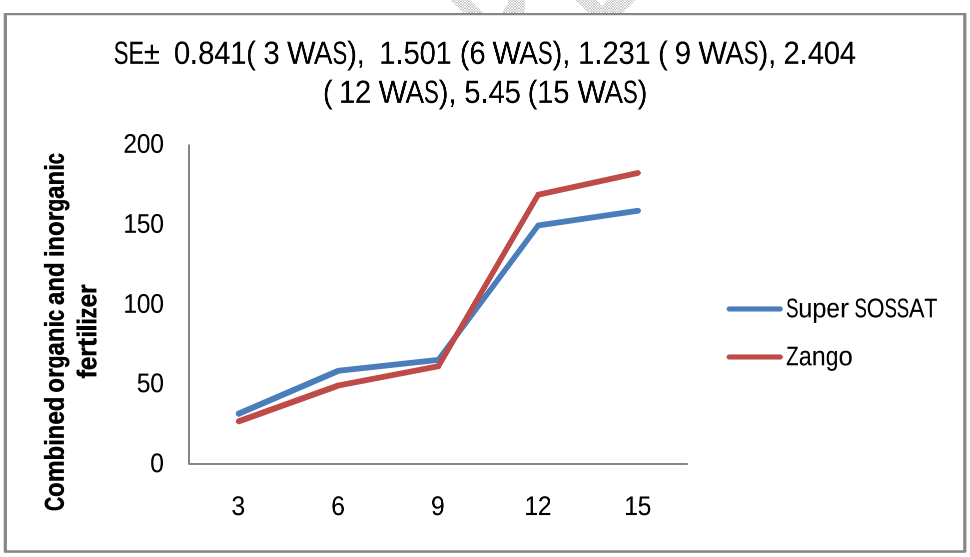

Figure 9: Plant height of millet as influenced by variety during the 2022 Rainy season at Sokoto

Leaf Area Index (LAI)

The effect of spacing, combined application of organic and inorganic manure and variety on LAI is presented on Figures 10, 11 and 12. The result revealed no significant ($p>005$) effect of spacing on LAI at 3 and 6 WAS, however, however there was significant ($p<0.05$) effect of spacing on LAI at 9, 12 and 15 WAS. The closes spacing (40cm) is statistically similar with 50 cm with the highest LAI and the lowest LAI was from the widest intra-row (60cm) spacing. LAI significantly increased with closer intra-row space (40 cm). Danish *et al.* (2020) concluded that higher LAI at closer intra-row spacing could be due to more number of plants per unit area which results to increase in photosynthesis and the volume of roots in the soil, facilitating the utilization of environmental resources, while Hulihalli and Shantveerayya, (2018) stated that optimum planting density differ with climate, soil type, location, sowing time and varieties. At 3 WAS combined application of organic and inorganic manure have no significant ($p>0.05$) effect on LAI. Leaf area index is an important parameter of maize. Increasing plant density resulted to increase in leaf area index as a result of more area occupied by plants per unit area. Similarly increasing leaf area index is one of the ways of increasing solar radiation capture within the canopy and accumulation of dry matter. Similar result was observed by Winter and Ohlrogge (1973) who reported that LAI in maize increases with increase in plant density. The increasing of LAI was attributed to the rise in total leaf area/plant (Alam *et al*., 2007). The application of 25 kg N, P and 5 tonne^{-1} of Farm Yard Manure (FYM) and 12.5 kg N, P and 2.5 tonne^{-1} of Farm Yard Manure (FYM) were statistically similar with the highest LAI and the lowest LAI was from control at 6, 9, 12 WAS and at maturity. The LAI significantly increased with combined application of organic and inorganic fertilizer. This could be due to availability and utilization of plants nutrients. Ramamurthy *et al.* (2004) observed that the productivity of finger millet can be increased by application of organic and inorganic fertilizers. There was significant ($p<0.05$) effect of variety on LAI at 3, 6, 9, 12, 15 WAS, Super Sossat differed significantly with height LAI and the lowest LAI was from Zango. This could be as results of improved genotype from the improved cultivar. In maize the differences observed in leaf area index of the two varieties could be attributed to the differences in the photosynthetic activities of leaves, differences in chlorophyll content and activity of photosynthetic enzymes. This research finding is similar to that of Gwizdek (1989) who attributed the differences between the leaf area and other growth characters of maize genotypes to differences in photosynthetic activity of leaves, chlorophyll content, stomata conductance value and activity of photosynthetic enzymes.

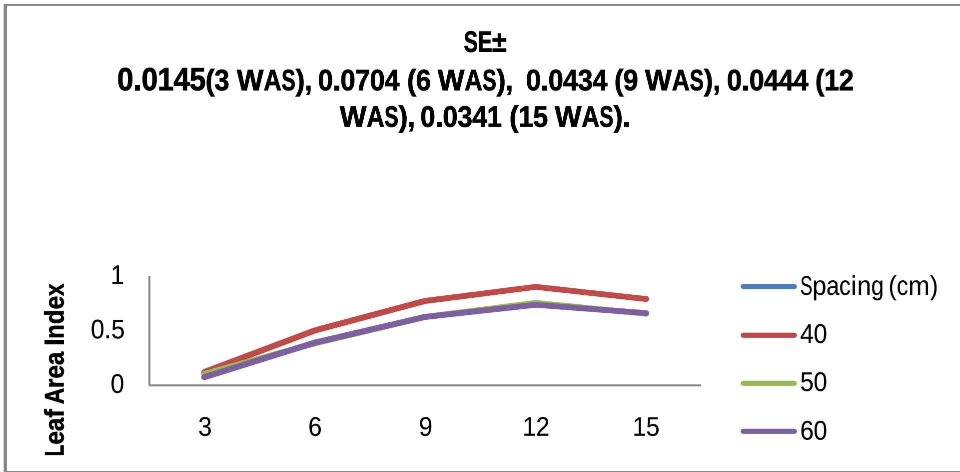

Figure 10: Leaf Area Index of millet as influenced by spacing during the 2022 Rainy season at Sokoto

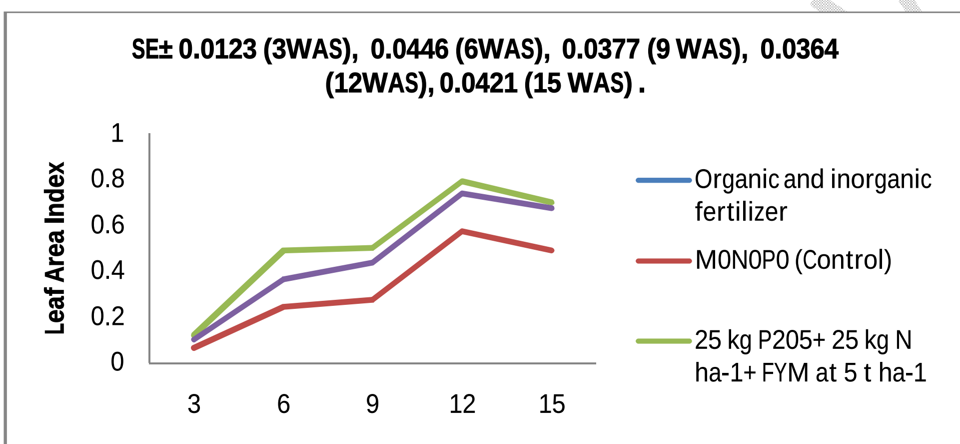

Figure 11: Leaf Area Index of millet as influenced by combined application of organic and inorganic fertilizer during the 2022 Rainy season at Sokoto

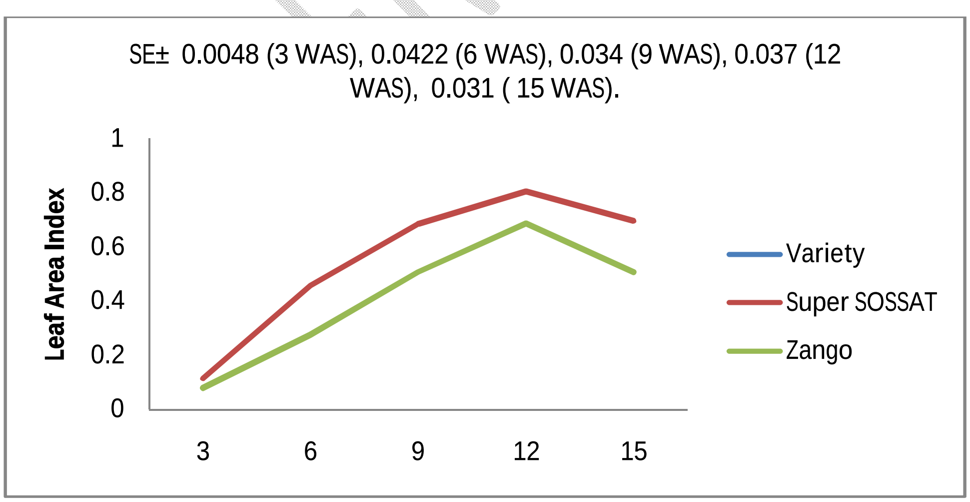

Figure 12: Leaf Area Index of millet as influenced by variety during the 2022 Rainy season at Sokoto

Yield and yield Components

The effect of spacing, combined application of organic and inorganic manure and variety on panicle length (cm), panicle weight, 1000 grain weight (g), grain yield (Kg ha^{-1}), Harvest index (HI), Threshing percentage (%) and total biomass (t ha^{-1}) is presented on Table 2. The results indicated significant ($p<0.05$) effect of spacing, combined application of organic and inorganic manure and variety on panicle length and total biomass t ha^{-1}. the closest spacing (40 cm), differed significantly with the longest panicle while the wider spacing 50 cm and 60 cm did not differ significantly with the shortest panicle. The 50 cm intra-row spacing produced the highest total biomass and the lowest biomass was from the widest spacing (60 cm). Intra-row spacing have no significant effect on panicle weight, 1000 grain weight (g), grain yield (Kg ha^{-1}), Harvest index (HI) and Threshing percentage (%). The increased in the panicle length and total biomass as a result of close spacing could be due to increased competition for space, sunlight and available nutrients. This is similar to the findings of Dalley *et al.* (2006) and Ashraf *et al.* (2014), who reported increase in biological yield due to narrow spacing was also reported by. The dry matter production is the result of complementary effect of leaf area index resulting to higher total dry matter production, which influenced improve plant growth resulting to higher dry matter accumulation in leaves and stem.

The combined application of organic and inorganic manure have no significant ($p>0.05$) effect on panicle length (cm), Harvest index (HI) and Threshing percentage (%), however, the combined application of organic and inorganic manure have significant ($p<0.05$) effect on panicle weight, 1000 grain weight (g), grain yield (tha^{-1}) and total biomass (t ha^{-1}). The application of 25 kg N, P and 5 tonne^{-1} FYM produced the highest panicle weight, 1000 grain weight (g), grain yield (tha^{-1}) and total biomass (t ha^{-1}) and the lowest panicle weight, 1000 grain weight (g), grain yield (tha^{-1}) and total biomass (t ha^{-1}) was from control (Table 2).

The higher panicle weight, 1000 grain weight and grain yield recorded with the combined application of organic and inorganic fertilizer could be due to combined application of organic and inorganic fertilizers which helps to improve the soil fertility and productivity of finger millet (Ramamurthy *et al.*, 2004). Nitrogen is deficient in soils of the tropics and there is direct effect and response of crops to nitrogenous fertilizer (Aflakpui *et al*., 1997). This is because adequate supply of plants nutrients is essential for optimum growth and development crops and primary nutrients such as nitrogen and phosphorus are important for plant growth and yield, Nitrogen is vital for leaf growth and good green color, while Phosphorous is important in formation of new roots, seeds, fruit and flowers (Marschner, 1997). Prakasha *et al.* (2018) observed that application of organic manure along with inorganic fertilizers resulted in availability of nutrients and moisture which influence improved plant growth and development. These results is similar to the findings of Chittapur *et al.* (1994), Muthukrishnan and Subramanian (1980) and Hanumantha Rao *et al.* (1982) who reported increased in plant height of millet as a result of application of fertilizer. Several researchers observed that the production and translocation of synthesized photosynthates is a function of mineral nutrition supplied. These results are similar to that of Reddy (1974), Puttaswamy and Krishnamurthy (1975) and Pandushastry (1977), who observed optimum plant growth and development as a results of application of plants nutrients.

The effect of variety on panicle length (cm), panicle weight, 1000 grain weight (g), grain yield (tha^{-1}) and total biomass (t ha^{-1}) is significant ($p<0.05$), Zango (The local variety) differed significantly ($p<0.05$) from the super Sossat with the longest panicle, however super Sossat

differed significantly ($p<0.05$) from the Zango with the highest panicle weight, 1000 grain weight (g), grain yield (Kg ha^{-1}) and total biomass (t ha^{-1}) . The effect of variety on harvest index (HI) and threshing percentage (%) is not significant ($p<0.05$) (Table 2). This could be as results of improved genotype from the improved cultivar. The differences observed in growth of the two varieties of maize could be attributed to the differences in the photosynthetic activities of leaves. This research finding is similar to that of Gwizdek (1989) who attributed the differences in growth characters of maize genotypes to differences in photosynthetic activity of leaves, chlorophyll content, stomata conductance value and activity of photosynthetic enzymes.
The relatively lower yield of millet observed from this research could be as results of the low nutrients status of the soil of experimental site (Table 1) and early drought and terminal drought (Appendix I). There was drought immediately after sowing and rainfall terminated in September in 2022.

Conclusions

The results of the research indicate that intra-row spacing, combined application of organic and inorganic fertilizer and variety had significant influences on most of the growth parameters, yield and yield components of millet, 40cm intra-row spacing, application of combined organic and inorganic fertilizer at the rate of 25 kg N, P and 5 $tonne^{-1}$ FYM and Super Sossat was better to achieve optimum yield, further research is recommended to confirm the findings.

Table 2: The effect of spacing, combined application of organic and inorganic manure and variety on panicle length (cm), panicle weight, 1000 grain weight (g), grain yield (Kg ha^{-1}), Harvest index (HI), Threshing percentage (%) and total biomass (t ha^{-1}).

Treatment	Panicle Length (cm)	Panicle weight (g)	1000 grain weight (g)	Grain yield (kg ha^{-1})	HI (%)	Threshing (%)	Total Biomass t ha^{-1}
Sowing date (cm)							
40	49.93^{b}	275.92	8.97	940	26.15	66.90	3.87^{ab}
50	40.05^{b}	283.33	8.58	930	25.90	59.72	4.20^{a}
60	37.61^{b}	259.26	7.56	790	26.12	71.44	3.00^{b}
SE±	2.189	17.388	0.626	0.143	2.199	4.880	0.387

Significant	*	NS	NS	NS	NS	NS	*
Organic and inorganic fertilizer (F)							
M0N0P0 (Control)	41.67	231.47^{b}	7.50^{b}	560^{b}	19.81	59.01	2.41^{b}
25N:25P:5FYM (N and P are in kg and FYM in t/ha)	43.83	312.96^{a}	9.64^{a}	1380^{a}	35.83	75.01	5.30^{a}
12.5N:12.5P + 12.5 kg N + 2.5 FYM (N and P are in kg and FYM in t/ha)	42.09	274.07^{ab}	8.65^{b}	720^{b}	22.53	64.05	3.36^{ab}
SE±	2.904	10.691	0.410	0.157	4.659	13.025	0.488
Significance	NS	*	*	*	NS	NS	*
Variety							
Super SOSSAT	33.26^{b}	340.93^{a}	9.17^{a}	1.14^{a}	26.90	66.76	4.12^{a}
Zango	51.79^{a}	240.73^{b}	8.57^{b}	0.63^{b}	25.21	65.28	3.26^{b}
SE±	2.161	9.838	0.392	0.101	2.543	3.250	0.235
Significance	*	*	*	*	NS	NS	*
Interaction							
S X F	NS	NS	NS	NS	NS	NS	NS
S X V	NS	NS	NS	NS	NS	NS	NS
F X V	NS	NS	NS	NS	NS	NS	NS
S X F X V	NS	NS	NS	NS	NS	NS	NS

Means with the same letter (s) is not significantly different (P < 0.05) according to Duncan New Multiple Range Test. NS=not significant

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Appendix I: Meteorological Data of Experimental area during the 2022 Rainy Season

MONTHS	DAYS	MAXIMUM (Degree celcius)	MINIMUM (Degree celcius)	RELATIVE HUMIDTY (%)	WINDSPEED (Knot)	WIND DIRECTION (Degree)	RAINFALL (mm)
June	1	40.7	26.2	43	13	210	0
June	2	40.2	27.0	51	8	220	0
June	3	37.2	27.2	47	10	140	0
June	4	39.6	27.5	47	11	230	0
June	5	37.4	27.5	57	15	250	4
June	6	35.6	24.6	67	10	200	8.5
June	7	35.0	24.0	66	11	160	0
June	8	39.3	27.0	48	14	210	0
June	9	41.0	27.5	48	8	230	0
June	10	39.5	26.5	56	8	220	7.5
June	11	33.6	22.3	74	12	230	3.5
June	12	34.5	23.6	74	9	250	1.6
June	13	39.3	26.3	55	11	250	0
June	14	36.5	25.0	47	8	240	27.5
June	15	34.0	23.5	75	8	240	43.7
June	16	31.2	22.2	80	10	230	0
June	17	29.5	24.5	78	16	240	13.5
June	18	32.3	21.8	62	11	200	0
June	19	36.1	24.6	58	10	230	0
June	20	37.0	25.8	57	17	190	0
June	21	35.5	26.9	67	8	210	0
June	22	35.2	23.3	62	11	190	1.5
June	23	36.8	25.6	60	9	240	0

June	24	37.5	28.0	60	5	240	0
June	25	36.0	26.2	60	15	130	0
June	26	31.3	27.3	75	11	220	0
June	27	34.0	23.0	74	16	220	9.2
June	28	36.0	26.0	65	8	240	0
June	29	29.4	26.4	76	16	210	1.6
June	30	24.2	23.5	70	13	210	70.2
July	1	29.8	22.0	80	11	210	0
July	2	32.6	23.0	76	14	160	0
July	3	34.2	24.8	68	17	190	48.7
July	4	26.8	21.3	82	10	210	22.3
July	5	32.0	22.8	75	17	240	0
July	6	34.0	23.8	68	13	220	1
July	7	35.0	23.6	62	10	220	0
July	8	36.0	26.8	67	13	220	0.8
July	9	34.1	25.6	67	9	230	173
July	10	30.2	22.0	80	13	220	0
July	11	33.0	24.3	85	10	200	0
July	12	34.5	25.0	83	13	230	19.4
July	13	32.5	22.3	82	8	210	0
July	14	32.7	24.8	84	12	240	0
July	15	33.2	24.8	80	8	140	0
July	16	27.7	22.2	98	11	230	52.5
July	17	30.0	23.6	96	12	250	6.8
July	18	27.5	23.3	98	6	210	38.7
July	19	29.6	23.0	90	13	190	3.5
July	20	31.8	23.5	92	12	240	21
July	21	31.8	21.1	82	9	170	21
July	22	30.2	24.2	82	13	190	0
July	23	33.0	20.5	88	12	170	66
July	24	29.5	23.5	78	8	120	0
July	25	31.5	24.2	76	12	200	0
July	26	34.1	23.6	77	13	230	0
July	27	32.5	24.6	73	16	210	0
July	28	30.5	25.2	89	12	230	0
July	29	23.5	21.5	85	13	210	50
July	30	31.6	23.6	84	15	260	0
July	31	32.0	21.8	96	9	200	55
Aug	1	29.5	21.2	86	8	230	0
Aug	2	29.5	23.0	84	14	220	0
Aug	3	29.5	23.7	88	5	200	0
Aug	4	31.0	22.0	100	11	250	8
Aug	5	26.0	22.0	84	5	220	124

Aug	6	30.2	23.0	79	8	200	0
Aug	7	30.2	23.0	76	8	180	0
Aug	8	32.7	24.5	76	13	150	0
Aug	9	29.3	22.1	91	2	190	0
Aug	10	30.5	23.5	83	7	220	0
Aug	11	24.6	23.2	95	9	170	10.6
Aug	12	29.2	23.4	88	6	230	0
Aug	13	32.4	22.1	83	11	170	0
Aug	14	31.5	23.7	85	5	250	14.5
Aug	15	29.0	23.3	91	6	230	28.8
Aug	16	22.7	21.5	95	8	220	34.1
Aug	17	29.2	21.2	88	11	130	0
Aug	18	31.8	23.3	83	8	240	0
Aug	19	30.6	21.5	88	9	200	58.5
Aug	20	30.0	21.5	87	8	250	0
Aug	21	30.6	23.8	81	3	200	0
Aug	22	31.0	23.6	87	8	230	50
Aug	23	29.2	21.8	87	4	210	0
Aug	24	30.2	22.0	85	8	180	10.6
Aug	25	27.8	23.5	90	7	230	6.9
Aug	26	33.2	23.5	86	3	190	0
Aug	27	39.0	26.5	77	6	190	30.4
Aug	28	29.0	23.4	87	7	190	0
Aug	29	31.5	24.3	85	11	260	35.6
Aug	30	31.6	21.4	82	9	210	0
Aug	31	33.5	22.5	79	9	190	0
Sep	1	29.7	21.5	85	11	210	1.2
Sep	2	30.2	24.0	87	9	190	28.9
Sep	3	30.8	21.0	96	9	210	38.2
Sep	4	31.6	21.9	77	9	170	0
Sep	5	32.5	24.1	83	10	260	17.8
Sep	6	31.5	21.4	88	10	220	3
Sep	7	29.6	21.3	88	8	180	0
Sep	8	32.2	23.5	88	7	210	53
Sep	9	30.7	21.2	91	6	160	0
Sep	10	29.5	24.0	89	9	260	12.4
Sep	11	30.3	21.0	93	8	190	0
Sep	12	33.0	23.0	84	7	230	0
Sep	13	32.1	23.8	85	6	220	0
Sep	14	33.5	23.0	78	11	240	0
Sep	15	32.6	25.3	78	5	200	1.7
Sep	16	31.0	22.7	79	4	230	50.6
Sep	17	28.1	20.5	80	6	270	0

Sep	18	32.4	23.5	84	9	230	36.5
Sep	19	30.5	21.5	88	9	220	8.5
Sep	20	30.5	22.5	80	9	190	0
Sep	21	32.5	21.0	84	7	260	0
Sep	22	34.5	24.5	82	7	240	0
Sep	23	35.2	23.2	86	7	230	0
Sep	24	34.6	21.0	76	7	230	0
Sep	25	36.3	21.6	62	6	200	0
Sep	26	36.4	20.6	73	7	240	12.4
Sep	27	32.6	19.5	77	6	220	0
Sep	28	32.7	19.8	79	6	250	0
Sep	29	33.6	20.4	78	8	290	0
Sep	30	31.2	18.7	87	5	210	0
Oct	1	33.0	19.5	74	3	220	0
Oct	2	32.0	20.0	67	8	220	0
Oct	3	34.2	20.0	73	9	180	0
Oct	4	35.0	21.3	70	12	180	0
Oct	5	30.6	19.5	82	9	240	0
Oct	6	29.9	21.4	73	9	210	0
Oct	7	33.4	20.2	92	8	230	19
Oct	8	34.0	19.6	70	10	270	0
Oct	9	36.2	22.2	80	7	210	0
Oct	10	35.5	21.5	74	4	160	0
Oct	11	36.0	20.8	65	6	220	0
Oct	12	37.5	19.5	57	7	240	0
Oct	13	37.6	20.7	48	6	170	0
Oct	14	35.0	21.5	68	9	170	0
Oct	15	35.4	21.3	80	7	140	0
Oct	16	37.0	19.2	69	6	160	0
Oct	17	37.6	16.8	44	8	230	0
Oct	18	37.6	17.3	35	10	190	0
Oct	19	37.4	17.9	36	4	200	0
Oct	20	37.0	17.4	46	7	120	0
Oct	21	37.7	20.8	36	13	170	0
Oct	22	37.5	19.5	34	5	120	0
Oct	23	37.5	20.7	34	4	140	0
Oct	24	38.4	21.5	34	11	70	0
Oct	25	37.8	21.3	34	11	100	0
Oct	26	37.2	19.2	33	8	170	0
Oct	27	36.5	16.8	32	8	90	0
Oct	28	37.7	17.3	34	6	70	0
Oct	29	36.0	17.9	35	11	90	0
Oct	30	36.7	17.4	33	5	60	0

Oct	31	36.1	17.5	34	11	90	0

Source: Nigerian Meteorological Agency (NIMET) , 2022