AN EVALUATION OF THE PERFORMANCE OF IMMATURE CASHEW CLONES AT THE KPUWABU CLONAL GARDEN IN GAURA CHIEFDOM, KENEMA DISTRICT EASTERN- SIERRA LEONE

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Abstract: A total of ten (10) immature cashew clones were imported from Ghana by comcashew under Solidaridad project. These clones were received by the Kenema Forestry and Tree Crops Research Centre (KFTCRC) on the 6th June, 2019.

The materials were nursed and later transplanted to the permanent site on 23rd September 2019 at the Kpuwabu Clonal Garden in the Gaura Chiefdom, Kenema District. The aim of the study was to evaluate the performance of the Cashew varieties/clones on the canopy diametre, plant height, stem girth, number of leaves and the maximum leaf area index. Experimental design consisted of the Randomized Complete Block Design (RCBD) with ten different clones as treatments. Three sets of five immature cashew plants were randomly selected and tagged for each variety and formed the sample for three (3) replications used.

Data was collected on the canopy diameter, plant height, stem girth, number of leaves and leaf area index. The data was subjected to statistical analysis. The results obtained indicated significant differences among the clones. Further examination of the means for each variety revealed various levels of the variables; some varieties/clones showed least and highest plant heights, least and highest canopy diameters, least and highest stem girth, least and highest number of leaves and least and highest leaf area index per clone. This confirmed there is variability among the clones.

Finally, the planting of these clones by farmers could improve yields significantly and thereby enhancing the growth and achievement of food security in Sierra Leone.

Keywords: Performance

Introduction

This project forms part of a study evaluating the performance of Cashew clones on the plant height, stem girth, leaf canopy diameter, leaf area index and the number of leaves of ten(10) different cashew clones that were established at the Kpuwabu Clonal garden in the Kenema District. These Cashew clones were received by the Kenema Forestry and Tree Crops Research Centre (KFTCRC) on the 6th June, 2019 from Ghana by ComCashew under Solidaridad Project.

Cashew *(Anacardiumoccidentale L.)*Belongs to Phylum: Spermatophyta, Family: Anacardiaceae, Genus: Anacardium, Species: Anacardium occidentales (Cabi International 2020).

Cashew originated from the north-eastern part of Brazil. The Cashew tree was introduced to India and east coast of Africa (Mozambique) by the Portuguese explorers around the mid to late 1500s.(Red River Foods, Inc. 2012).

In Africa, the tree was introduced along the east coast that is today called; Kenya and Tanzania and was later introduced to the west coast of Africa, in countries such as Senegal, Nigeria (Red River Foods, Inc. 2012). Cashew was later introduced to Ghana, Guinea, Sierra Leone and other African countries. Cashew was first introduced to Africa from India in the1960s (Red River Foods, Inc. 2012).

Cashew can be grown from sea level to an altitude of 1000metres(3000ft), in regions with an average annual rainfall between 500mm(20in.)to 3750mm(150in) (SH Azam-Ali and EC Judge 2001). It is resistant to drought and can best

be cultivated on poor soils, it however prefer deep sandy soil because of its root system which can assist the crop to tolerate different moisture levels and soil types. Research has proven that commercial production is advisable in well drained, sandy loam or red soils (SH Azam-Ali and EC Judge 2001).

In Sierra Leone, cashew production was earlier prominent in the Northern Province and the western area, and recently in the eastern part of the country (Sara Costa, Steffano Bocchi 2017). The soil conditions that favour its production in Sierra Leone are the sandy and good well drained aerated sandy-loam soils or poor soils that is, soils which are low in fertility. (Panda H., 2013).

An average annual rainfall of 1,000–2,000 mm and a temperature of 15–35 °C, with the optimum between 24 and 30 °C is appreciable for a better yield (Sara Costa, Steffano Bocchi 2017). According to Indian Agro Net .com (2016) Priyanka and Amrutha are the high yielding varieties of cashew currently.

The production figure of cashew varies with time and place worldwide. However, the estimated production figures in Metric tons for the main cashew producing countries in Africa and the world at large could be accessed via research. For example; According to n'kalo Service (2018), East Africa was considered the main growing area with a total of 1,795000 Metric tons of raw cashew nut which was to forty- nine percent (49%) of the world's total supply in the year 2018.

Asia happened to be the second main producing area being that India produced six hundred and seventy five thousand metric tons (675,000mt) and Vietnam also produced Four hundred and fifty thousand (450,000mt).

Cashew is a cash crop thus it generates income for its producers. It is used to produce beverage (drinks and wine), flour/starch in industries, animal feed, fodder, forage, used in agro forestry systems, wind breakers, shades, vegetation and erosion control mechanism; the tree of cashew is being used for charcoal production and fuel wood. Another major use is that it can produce essential oils, dye, fibre, gum, pesticides. It is generally used as ornamentals. Moreover, cashew can be used for medicinal purposes (Cab International 2020.)

Research on cashew in Africa

During the mid to late 1500s, the travelers and traders from Portugal introduced the cashew tree to the east coast of Africa in an area that is currently known as Mozambique. This was done in order to practice afforestation and soil conservation respectively (Red River Foods Inc., 2012).The dispersal to the eastern part of Africa (present today, Kenya and Tanzania) must have been because of the elephants' love for fruits (Sara Costa, Steffano Bocchi 2017). Possibly the exciting looks of the fruits, must have urged these elephants to swallow the whole apple together with the nut and meanwhile ,the nut is too hard to digest and the dung must have carried on this dispersal(Sara Costa, Steffano Bocchi 2017).

Later on, in the second phase of the sixteen century it was introduced to west coast of Africa, where it is now grown from Senegal to Nigeria (Red River Foods Inc., 2012).

Research on Cashew in Sierra Leone

Cashew production began in Sierra Leone around late 1980s, at that time 600 ha cashew farm was established in Kambia District by the Magbema Cashew Farmers Association, and other trees were planted by one hundred plus by other farmers. At around January 2005, about 3,600 ha of cashew trees were in existence, mostly in the northern and western parts of the country. Of these, about 1,200ha were producing fruits. (Sara Costa, Steffano Bocchi 2017).

Since cashew trees start fruits bearing at 4 to 5 years, it is possible that two thirds of the acreage under cashew was established recently. The 1,200 ha of fruit bearing cashew trees could potentially produce about 940 tons of raw cashew nuts though production roughly estimated to merely about 500 tons. (Sara Costa, Steffano Bocchi 2017).

Research on the importance of cashew as a food crop

Cashew is used to produce beverage (drinks and wine), flour/starch in industries, animal feed (Cab International 2020). Shoo (1997) and WB (2000) explained that cashew is used as various food products such as salted and roasted nuts, ice creams, cakes, chocolates, appetizers to cocktail drinks.

The consumption of cashews on a regular basis and limited manner may help in avoiding blood diseases. Cashew nuts are rich in copper, which plays an important role in the elimination of free radicals from the body. Copper deficiency can lead to iron deficiencies such as anemia. Hence our diet should contain recommended quantity of copper and cashew nuts are a good source.

Derived from the cashew seeds, "cashew oil does wonders for your skin," says Gargi Sharma, Manager Weight Management, Aayna. Cashew nut oil is rich in selenium, zinc, magnesium, and iron and phosphorous. Also, they are great sources of phytochemicals, proteins and antioxidants. The high percentage of selenium in cashews is not only good for your skin but "helps prevent cancer as well," says nutritionist Anju Sood.

According to studies, cashew nuts have a great percentage of dietary fibers. The two essential dietary fibres required by our body are, oleic acid and palmitic acid. "These fibers are not produced by our body hence they need to be consumed externally," says nutritionist Anju Sood. Cashew nuts are good sources of these fibers. Dietary fibers help digest food better, however excessive consumption may cause bloating and significant intestinal gas production. Consumption of nuts like cashews has been related to decreased incidences of several digestive diseases.

Experts say that the consumption of cashews as well as the application of cashew oil on your scalp ensures healthy hair. "Copper present in cashew nut oil helps in the production of skin and hair pigment called melanin," says nutritionist Gargi Sharma. It also enhances hair colour and can provide a silky-smooth texture due to the presence of linoleic and oleic acids.

Research on the nutritional value of Cashew

Cashew nuts contain minerals such as calcium, phosphorus and iron (Nayar1998). Cashew contain low content of carbohydrate which is as low as one percent soluble sugar therefore helps to control diabetes (Shija 2010).Cashew apples and nuts are reliable sources of nutrition in that they contain five times more vitamin C than an orange, and more calcium Vitamin B_1 and iron than other fruits for example, citrus avocados and bananas (Danida 2003).

In the urban environment matched with its excessive pollution, our eyes often suffer from various infections. Cashews contain a powerful antioxidant pigment called Zea Xanthin. This pigment is readily and directly absorbed by our retina, says nutritionist Anju Sood. This then forms a protective layer over our retina which prevents the harmful UV rays. Dr Anshul Jaibahrat Bhatnagar says small quantities of Zea Xanthin helps prevent age related macular degeneration in elderly and hence helps maintain eye health.

Research on the Growth Parameters of Cashew

The common cashew tree can spread wider and grow taller, with a varying height between 8 to 15 m and a diameter that can reach 20 m (Paiva et al., 2003). It is characterized with lighter green leaves, stem girth; earlier branch almost the ground (Barros, 1988). Studies have also shown that Cashew can reach a height mean of 2.11m and mean of 4.52 canopy in the sixth year of the plant's age. (Australian Journal Crop Science 2018).

Large-diameter shade trees in our communities provide more than just shade. Their leaf surface area and transpiration rates cool the air temperatures and help reduce the effects of the urban heat island, as well as reducing heating and cooling costs.

Williams (1946) proposed the term, Leaf Area Index (LAI). It is the ratio of the leaf of the crop to the ground area over a period of interval of time. The value of LAI should be optimum at the maximum ground cover area at which crop canopy receives maximum solar radiation.

Their leafy canopies intercept the rainfall and reduce storm water runoff. Rainfall is better able to penetrate the soil and percolate into the ground water. As trees grow, they accumulate biomass by sequestering the carbon from the atmosphere and storing it as wood. Trees are carbon sinks; they help reduce global warming. A study at UPenn found that six large-diameter London plane trees (greater than 30" diameter breast height [DBH]) stored 14,291 pounds of carbon and sequestered 470 pounds of carbon annually. It would take approximately 1,300 small-diameter trees to perform the same function. (Source: Bassett, Height is a crucial component of a plant species' ecological strategy. It is central to a species' carbon gain strategy, because height is a major determinant of a plant's ability to compete for light, and because of correlations between plant height and traits such as leaf mass fraction, leaf area ratio, leaf nitrogen per area, leaf mass per area and canopy area (Falster & Westoby 2003). Plant height is also an important part of a coordinated suite of life-history traits including seed mass, time to reproduction, longevity and the number of seeds a plant can produce per year (Moles & Leishman 2008). These traits are central in determining how a species lives, grows and reproduces. Plant size is also correlated with metabolic rate and with maximum population density (Enquist *et al.* 1998). In addition to having a central role in plant ecological strategy, plant height affects important ecosystem variables such as carbon sequestration capacity (through its relationship with plant biomass) and animal diversity (for example, bird and mammal species diversity are tightly correlated with foliage height diversity, Macarthur & Macarthur 1961; MacArthur 1964; Recher 1969; August 1983).

Research on the Production of Cashew in the Traditional Farming System

Cashew production in the traditional farming system may be influenced by factors such as high quality seeds, fertilizer, pests, and diseases. These are the general factors that determine the successfulness of cashew cultivation. Moreover, soil suitability is also a limiting factor that influences cashew productivity (.B. O. Nuga and G.E. Akinbola, 2015).

Cashew could be grown in the arid regions with an average annual rainfall of about 1000 mm which is quite satisfactory for the plant's growth and development.(NurulJadid et el.2017).

The red sandy loam soil is considered suitable for cashew cultivation. The type of soil required could be characterized by slightly acidic pH and water holding capacity at about 80 mm in the rhizosphere zone. (NurulJadid et el.2017).

Research on the yield of Cashew nuts

Cashew is popular to be among the most important species that are highly cultivated in the tropics. It occupies an estimated area of 3.39million hectares area of land in the whole world (Oliveira, 2008.) The global Cashew nut production is estimated to be 3.7 million tons with Vietnam, India, Nigeria, Ivory Coast and Brazil as the main producing areas (Australian journal Crop Science2018).

The yield records of cashew nut may not be same globally due to the differences in climate, soil varieties and a lot of other conditions. For instance; Nigeria's production yield is estimated to 386,500Mt on366,000 ha with an average yield of 2,286kg/ha (Adeigbe O.O et el 2015).

In Sierra Leone, 1,200 ha of cashew trees were able to produce 9040 tons of raw cashew nuts though it was roughly estimated to 500Mt (Sara Costa, Steffano Bocchi 2017).Cashew tree yield of 1.5 to 4kg of nuts per tree is reported to be in Africa (ACA2011)

Research on Cashew industry in Africa

The African Cashew Alliance (ACA) was formed in the year 2006 to promote Cashew production, processing and marketing globally. There are approximately 130 member companies of the ACA. Above 2.5 million African Cashew crop growers now grow nearly 57% of the world's cashews. During the last ten (10) years, the African cashew sector has been highly popular for its immense contribution. The African small scale farmers have produced more Cashew Raw nuts. With a yield over1.6 million tons of Raw Cashew Nut (RCN) in 2015, thus Africa is now the world's largest producer of RCN**.** However processing in Africa is still minimal which is gradually growing from 35,000 MT in 2006 to 105,700 in 2015. It is projected that there has been a 25% increase in RCN (African Cashew Alliance2017).

Statement of the problem

Cashew nut production as a crop has for long be neglected in favor of cocoa production which has left Sierra Leone, Ghana and other West African countries aback in the race for global cashew trade worth billions of US dollars(Ghana Cashew Association, BrongAhafo chapter, 2008 and Peter Kwasi Sarpong 2011).

Some of the constraints faced by farmers in cultivation of cashew include: Inadequate and unavailability of land which attracts small hold farming. The unavailability of labour as well as the high cost of production is considered to be other factors in the production of cashew nut. This is climaxed by lack of capital or money. (Uwagboe E. O. et el 2010).

Constraints of viable planting materials (seed) which is proposed to be caused by damage inflected by pests like; mealy bugs and diseases (powdery mildew) and the absence of cultivation and post-harvest technologies. These undermine the yield quality of cashew products (Uwagboe E. O. et el 2010) .Other factors influencing the production and harvest of Cashew include old parent trees, low yield varieties, dominance of small holdings, wild varieties, land acquisition, high cost of input, climatic conditions, diseases, pests and fire outbreaks, Post-harvest loses, infrastructural constraints, quality, market price of the products and competition amongst the local buying agents (CRIN, 2001) (GEORGE 2015).

Furthermore, evaluating such variation relate to difference in the plant height, stem girth, leaf canopy diameter, leaf area and the number of leaves of each cashew clones can be used to produce high yielding cashew clones.

Aim and Objectives

The aim of this work was to evaluate the performance of cashew clones in the Kpuwabu Clonal Garden.

Specific objectives

- To assess the leaf canopy diameter of the cashew clones
- To assess the plant height of the cashew clones
- To determine the stem girth of the cashew clones.
- To determine the number of leaves present of the cashew clones
- To determine the leaf area index of the various cashew clones

Significance of the Study

This study is evaluating the performance of Cashew clones on height, stem girth, leaf canopy diameter, leaf index area and number of leaves is necessary for several reasons.

The research can help to create awareness of the growth parameters used to assess the growth performance of different cashew clones. Cashew nut is among the major cash crops that have the greatest potential for providing foreign exchange and employment opportunities.(Ghana Cashew Association, Brong Ahafo chapter, 2008 and Peter Kwasi Sarpong 2011).

This investigation will help and alert growers and non-growers of cashew nut on the nutritious, financial, medicinal and other significance of cashew production in the research area and beyond (Cab International 2020).
Also, this research will hopefully attract the intervention of the Government through policy makers and other concerned organizations in order to make the production of cashew interesting to cash crop farmers in the research area and the country at large.

The cashew clones would be used by farmers for poverty alleviation and food security promotion in Sierra Leone. Also, the information of this research shall identify clones that would be useful for breeding programmes.

The study would also reveal how cashew growers help to strengthen the capacity of local communities especially cashew farmers in order to improve on their livelihoods through sustainable use of natural resources and application of best agricultural practices.

The research work shall be of great importance to the government through the MAFFS in terms of planning, and the recommendations from this work shall gear towards their improved socio-economic status and livelihoods.

The study of this nature is significant because it improves the skills and productivity of out grower farmers that focuses on organising and training as well as improving their access to high-quality farm services such as harvesting, pruning and transport.

It also gives an opportunity to work hand in hand with the private sector to build the livelihoods of small rural farmers to enhance food security in Sierra Leone.

Finally, the research shall be useful to students for related topics and shall serve as a reference material to students in Sierra Leone and the sub-regions who may want to do similar research work.

METHODOLOGY

Study Area: The research area is located in the Kpuwabu clonal garden, Gaura chiefdom, Kenema District Eastern-Sierra Leone. Kpuwabu .It is situated at $8^{0}17'33$ North latitude and $10^{0}51'50$West longitude in the South-eastern part of the country along the Sierra Leone- Liberia boarder. The research area is approximately 22 Miles away from Kenema.

The study area is characterized by two tropical seasons. The wet season starts from May to November with an annual rainfall of about 255mm. The dry season which lasts between December to April can supply an annual rainfall of 30mm.(M.A Dukulay,2016). The study area also exhibits an unstable temperature ranging from 24^{0}-37^{0}C. (Sierra Leone Weather Forecast, 2020).

The research area is characterized by weathered and leached lateritic soil type. This exhibits reddish to yellowish brown colours. The soil has productivity potential due to nutrients provided by the vegetation.(M.A Dukulay,2016).

Description of the Cashew Clones groups

The immature cashew plants were planted in plots with a clone occupying a plot; clone one (SG 266) having 35 plants, clone two (SG 276) 35 plants, clone three (BE 107) 40 plants, clone four (SG 265) 40 plants, clone five (BE 079) 25 plants, clone six(TAN 393) 25 plants, clone seven (SG 261) 30 plants, clone eight(SG 278) 20 plants, clone nine (SG 273)50 plants and clone ten (SG185) 20 plants. This form a total of three hundred and twenty (320) immature cashew plants. Each plot measures 210m x 50m and the total land area of the entire cashew is 1.05ha

Treatment and Experimental Design

The number of immature cashew plants forms the population. Each clone was planted in an identified plot. A set of five (5) immature cashew plants were randomly selected from each variety and tagged with white cards that formed a sample for the treatment in replication one. Another set of five (5) immature cashew plants were randomly selected from each variety and tagged with red cards that formed a sample for the treatment in replication two. Third set of five (5) immature cashew plants were randomly selected from each variety and tagged with yellow cards that formed a sample for the treatment in replication three.

These immature cashew plants were then subjected to measurement for plant height, number of leaves per plant, leaf area index, and stem girth and leaf canopy diameter.

This shows that the research was carried out in a Randomized Complete Block (RCB) Design.

Population and Sample Size

The immature cashew plants were assigned into plots. Each plot contains a clone of immature cashew plants ranging from 20 to 50 plants/plot which forms the population. The five (5) randomly chosen oil palm trees form the experimental plot. Each clone forms a treatment unit. The ten (10) clones therefore means; there are ten (10) treatments.

Data Collection

Data were collected on the following:

Measuring the leaf canopy diameter, plant height, stem girth, number of leaves and leaf area index of the immature cashew clones planted at the Kpuwabu Clonal Garden.

The following instruments were used in the data collection process;data collection sheet for recording raw data, foot rule for measuring the leaf area, metre rule for measuring plant height, Pen for recording data in the data sheet and String for measuring the stem girth of the stems.

Statistical Analysis

The research was done in Randomised Complete Block design (RCB) with ten (10) clones as the treatments.

Subjected to measurements for leaf canopy diameter, plant height, stem girth, number of leaves and leaf area index. This depicts that the research was carried out in a Randomised Complete Block (RCB) Design.

RESULTS AND DISCUSSION

The results reported here were obtained during the dry season in February 2020 whilst the immature Cashew plants were in the field. The results obtained in this research will be presented in line with the objectives of the research; Canopy diametre, Plant height, Stem girth, Number of leaves and Leaf area index of immature Cashew plants.

Assess the Canopy diameter for ten immature cashew clones planted at the Kpuwabu Clonal Garden.

Figure 1 illustrates the percentage distribution of cashew varieties measured in the field.

Three Categories of Canopy diametre measurements were observed; the least canopy diametre, moderate canopy diametre and highest canopy diametre. The least canopy diametre category had mean scores ranging from 16-20. The moderate canopy diametre had mean scores ranging from 21-25.The highest canopy diametre had mean scores ranging from 26-30.

Rating of the ten (10) immature of cashew plants on percentage basis, the least canopy diametre category which emerged as the lowest had 40% which include; clone 1(BE 107), clone 4 (SG 185), clone 7(SG 266) and clone 8(SG 276).The moderate canopy diameter category had 40% which include; clone 2 (TAN 393), clone 5(BE O79),clone 6(SG 265) and clone (SG 261). Whilst the highest canopy diametre category had 20% which include; clone 3(SG 273) and clone 10(SG 278).

The analysis of variance for canopy diametre showed significant variation among the treatments at 5% level.

The results showed that there were significant differences among the clones as far as measurement was concerned. Clone 10(SG 278) with a mean score of 28.0 displayed the highest mean score of canopy diametre. At the same time, clone 7(SG 266) displayed the lowest canopy diametre with a mean score of 16.0.

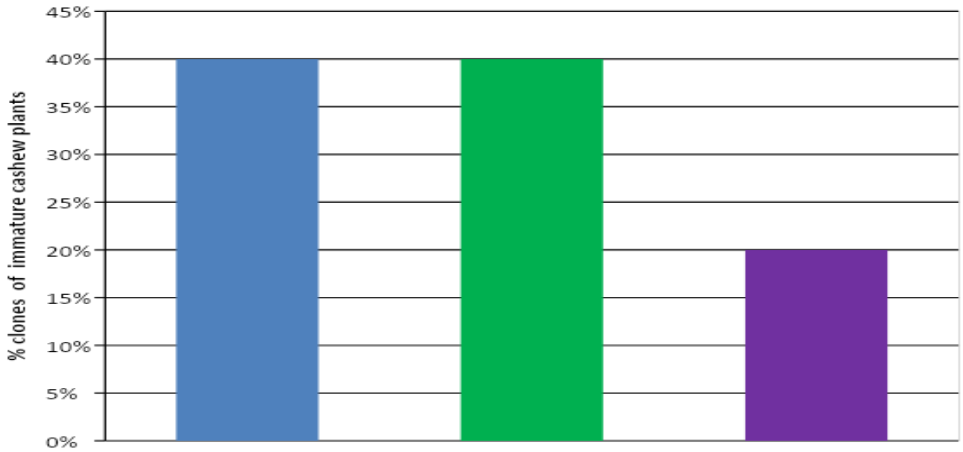


Figure1: Percentage distribution of cashew clones measured in the field

Assess the plant height for ten immature cashew clones planted at the Kpuwabu Clonal Garden.

Figure II illustrates the percentage distribution of cashew varieties measured in the field.

The means of plants were categorized into three; the least plant height, moderate plant height and highest plant height. The least plant height category had mean scores ranging from 30-36. The moderate plant height had mean scores ranging from 37-43. The highest plant height had mean scores ranging from 44-50.

Rating of the ten (10) immature clones of cashew plants on percentage basis, the least plant height category had a percentage of 50 % and which includes; clone 1(BE 107), clone4 (SG 185), clone5 (BE 079), clone 7(SG 266) and clone8 (SG 276). The moderate plant height category had 30% which includes; clone 2 (TAN 393), clone 6 (SG 265) and clone 9 (SG 261). The highest plant height category had 20% which include; clone 3 (SG273), clone 10 (SG278).

The analysis of variance of plant heights showed significant difference among the clones at 5% level. The highest mean score was recorded for clone 10(SG 278) with a mean score of 45.0 and the lowest plant height recorded had a mean score of 28.0 which include clone5 (BE 079).

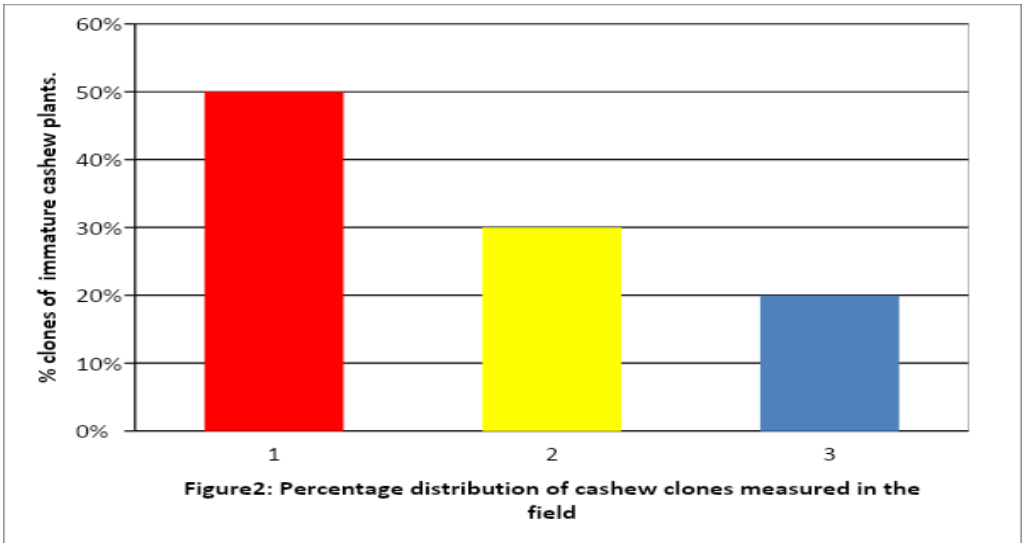


Figure2: Percentage distribution of cashew clones measured in the field

Determine the stem girth for ten immature cashew clones planted at the Kpuwabu Clonal Garden.

Figure III illustrates the percentage distribution of cashew clones measured in the field.

The analysis of variance for stem girth showed less or insignificant difference among the varieties at 5% level. The scores showed interesting findings among the clones in terms of stem girth. Unfortunately, no specific clone showed the highest stem girth. Clones 3(SG 273),9(SG 261) and 10(SG 278) recorded a mean score of 4.0 each, which showed the highest mean score.Whist the lowest mean score was 2.0 which was recorded for clone 8(SG278).

The sizes of stem girth were categorized into three; the least stem girth, moderate stem girth and highest stem girth. The least stem girth category had mean scores ranging from 1-2. The moderate stem girth had mean scores ranging from 3-4. The highest stem girth had mean scores ranging from 5-6 and no clone fall within this category.

Rating of the (10) immature clones of cashew plants on percentage basis, the least stem category had a percentage of 10 % which includes clone 8(SG 276). The moderate stem girth category had 90% which include clone 1(BE 107), Variety 2 (TAN 393),clone 3(SG273),clone 4(SG 185),clone 5(BE 079), clone 6(SG 265), clone 7(SG266),clone 9(SG 261) and clone 10(SG 278). There was no clone recorded for the highest mean score for the stem girth.

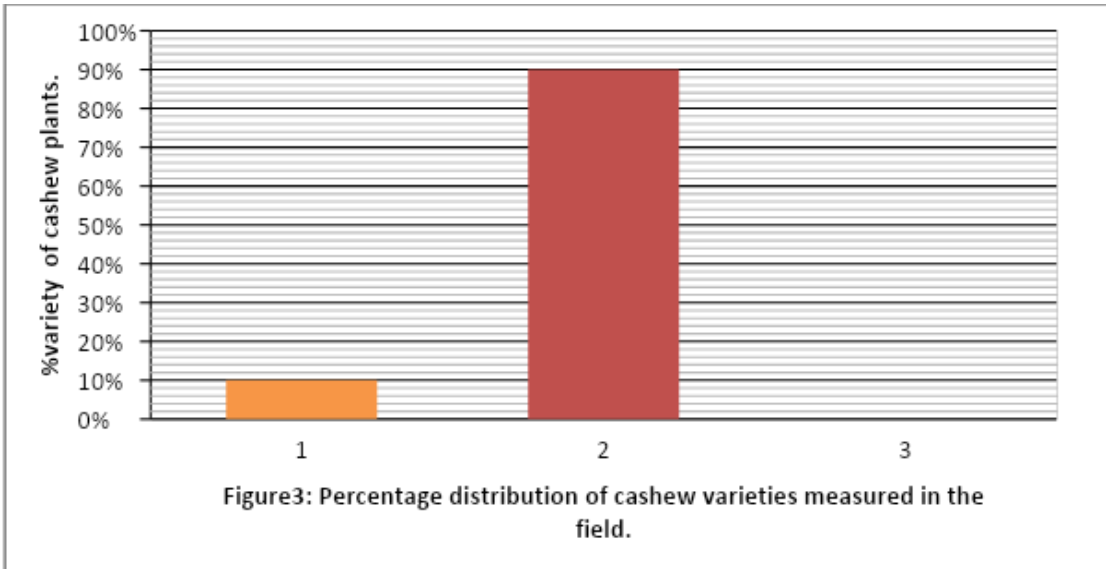


Figure3: Percentage distribution of cashew varieties measured in the field.

Determine the Number of leaves for ten immature cashew clones planted at the Kpuwabu Clonal Garden.

Figure IV illustrates the percentage distribution of cashew clones measured in the field.

The analysis of variance for number of leaves showed a highly significant difference among the treatments at 5% level. The highest mean score was recorded for clone 2 (TAN393) with a mean score of 28.0. Clone 2 (BE 107) recorded the lowest number of leaves with a mean score of 10.0.

The number of leaves was categorized into three; the least number of leaves, moderate number of leaves and highest number of leaves. The least number of leaves per plant category had mean scores ranging from 10-18. The moderate number of leaves had mean scores ranging from 19-27. The highest number of leaves had mean scores ranging from 28-36.

Rating of the ten (10) immature cashew clones on percentage basis, the least number of leaves and moderate categories had a the same percentage of 40 each and these include clone 1(BE 107), clone 5(BE 079), clone 7(SG 266), clone 8(SG 276) and clone 9(SG 261), clone 3 (SG273), clone 4(SG185), clone 6(SG 265) and clone 10(SG 278). The highest number of leaves category had 20% and these include clone 2 (TAN 393) and clone 10(SG 278).

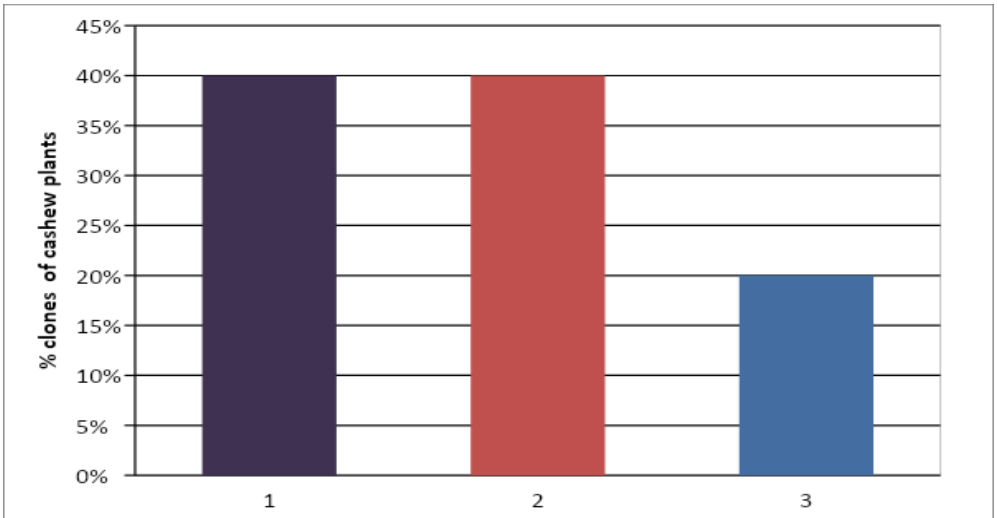


Figure 4: Percentage distribution of cashew clones measured in the field.

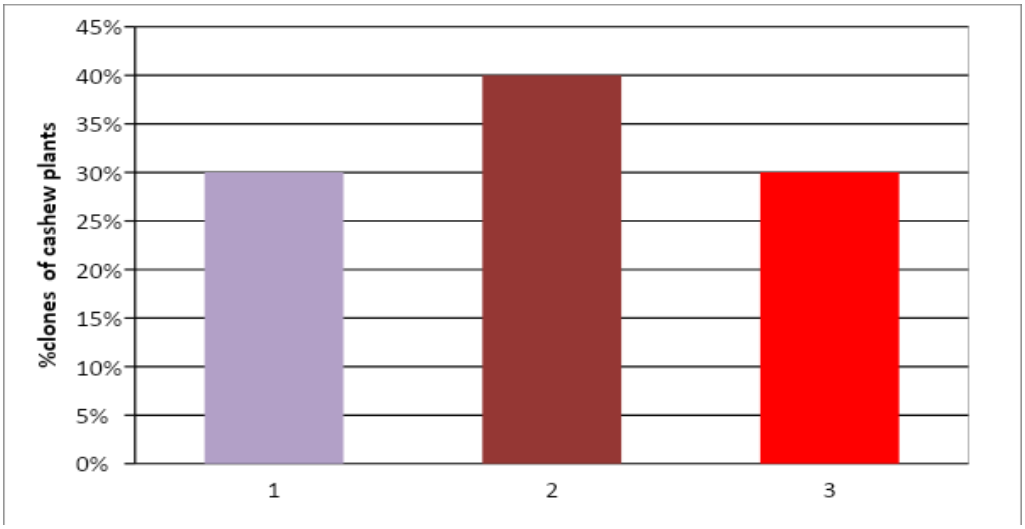
Determine the leaf area index for ten immature cashew clones planted at the Kpuwabu Clonal Garden.

Figure V illustrates the percentage distribution of cashew clones measured in the field.

The analysis of variance for leaf area index showed significant difference among the treatments at 5% level.
The scores showed less significant differences among the varieties in terms of leaf area index. Clone 3 (SG 273) recorded the highest leaf area index with a mean score of 64.0. On the contrary, clone 7 (SG 266) recorded the lowest leaf area with a mean score of 26.0.

The leaf area indices were categorized into three; the least leaf area index, moderate leaf area index and highest leaf area index. The least leaf area index category had mean scores ranging from 26-40. The moderate leaf area index had mean scores ranging from 41-55.Whilst the highest leaf area index had mean scores ranging from 56-70.

Rating of the ten (10) immature clones of cashew plants on percentage basis, the least leaf area index category had a percentage of 30 % which include; clone 7(SG 266), clone 8(SG 276) and clone 10 (SG 278). The moderate leaf area index category had 40% which included clone 2 (TAN 393), clone 4 (SG 185), clone 6(SG 265) and clone 9(SG 261). The highest leaf area index category had 30% which include clone1 (BE 107), clone 3(SG 273) and clone 5 (BE 079).



SUMMARY, CONCLUSION AND RECOMMENDATIONS

In this chapter, findings are summarized, conclusions drawn and recommendations made according to the objectives of the research.

Summary

The study revealed a number of key findings on the evaluation of the performance of cashew clones planted at the Kpuwabu clonal garden.

Canopy diametre

The analysis of variance for the canopy diameter showed significant variations among the treatments at 5% level. The highest and lowest mean scores for the canopy diameter were 28.0 and 16.0 respectively.

The least canopy diametre category was 40% of the clones, whilst the highest canopy diametre was 20%.

Plant height

The analysis of variance for the plant height showed significant variations among the treatments at 5% level.

The highest and lowest mean scores for the plant heights were 45.0 and 28.0 respectively. The least plant height category recorded 50% of the clones, the moderate plant height category was 30% and the highest plant height category was 20%.

Stem girth

The analysis of variance for the stem girth showed insignificant variations among the treatments at 5%.
The highest and lowest mean scores for the stem girth were 4.0 and 2.0.
The least stem girth category recorded 10% of the clones, the moderate stem girth category was 90% and the highest stem girth category had 0%.

Number of leaves

The analysis of variance for the number of leaves showed a highly significant variation among the treatments at 5% level.

The highest and lowest mean scores for the number of leaves were 28.0 and 10.0 respectively. Both the least and moderate number of leaves category recorded 40% of the clones, whilst the highest number of leaves category recorded 20% of the clones.

Leaf area index

The analysis of variance for the leaf area indices showed significant variations among the treatments at 5% level.
The highest mean score for the leaf area index recorded 64.0 and the lowest mean score recorded 26.0. Both the least and moderate leaf area indices categories recorded the same percentage of 30 each and the moderate leaf area index category recorded 40% of the clones.

CONCLUSION

Based on the summary of the research, the following conclusions were drawn.

Canopy diameter

The study reveals that the canopy diametre had a mean score of 28.0. This means that the treatments produced low canopy size. Since the canopy area is small, more weeds will prevail. The cashew trees may not produce many branches and fruits and hence low yield.

Plant height

The results also showed the highest mean score of the plants height was 45.0. The length of plant height may be suitable for easy transportation of dissolved minerals in the soil to the leaves and transportation of manufactured food to the various parts of the crop where it is needed and may also enhance harvesting.

Stem girth

From the results analysis, the highest mean score of the stem girth was 4.0 and the lowest mean score was 2.0. The result indicates that the stem girth for the plants were very small and so less amount of food substances will be stored and transported to the various parts of the plant. Also the plant will produce few nodes, branches and leaves.

Number of Leaves

Leaves are central to a plant's function and survival. Fundamental to all ecosystems, they act as a plant's food source, enabling it to absorb sunlight, make sugars, and carry water and nutrients through their veins.

The highest mean score for the number of leaves per plant was 28.0. This result reveals that the treatments produced less number of leaves. The few leaves will attract less sunlight during photosynthesis and this may lower the rate of manufacture of food.

Furthermore, the rate of respiration is affected since all of these occur in the leaves.
However, the rate of transpiration may be low which helps the crop to withstand draught and ever green.

Leaf area index

Finally, the research showed that the highest mean score of the maximum leaf area was 64.0.The findings indicate that the leaves have large surface areas. This will enable the crop to survive in an environment with less sunlight and can accelerate the photosynthetic process and carbon balance. The leaves will also aid the rate of respiration and smoother weeds that may compete with the crop for food, sunlight, water and air.

RECOMMENDATIONS

Considering the conclusion of this research, the following recommendations were made on immature cashew plants.

Canopy diametre

- Apply nitrogenous fertilizers such as urea, SSP, MOP for the first three years of cashew production for a wider crown.
- Grow large quantity of Variety2 (TAN 393),Variety3 (SG 273) Variety5(BE O79), Variety6(SG 265) and Variety9(SG 261)and Variety10(SG 278) for their wider canopy potentials.
- Intercrop with other crops such as legumes and cereals in order to suppress the growth of weeds and thereby increase its yield potential.

Plant height

- The mean height for the cashew varieties was appreciable and it seems suitable for easy transportation of food and water.
- The varieties with the greater plant height such as Variety2 (TAN 393),Variety3 (SG273 Variety6 (SG 265) and Variety9 (SG 261)), Variety10(SG278) should be maintained for breeding programmes.

Stem girth

- Apply cultural practices such as earthening up, mulching, fertilizer such as Zinc and Potassium should be applied on cashew for larger stem girth size.
- Variety1(BE 107), Variety2(TAN 393),Variety3(SG273),Variety4(SG 185),Variety5(BE 079),Variety6(SG 265), variety7(SG266),Variety9(SG 261) andVariety10(SG 278) seem to possess desirable stem girth potential and therefore need to be maintained for cashew improvement in sierra Leone.

Number of leaves

- Apply nitrogenous fertilizers on the immature cashew plants that produced fewer number of leaves
- Control leaf attacking pests such as grass hoppers etc. to increase leaf production.
- Maintain Variety3 (SG 273), Variety4 (SG 185), Variety 6 (SG 265) and Variety10(SG 278). Variety2 (TAN 393) and Variety 10 (SG 278) for their high leaf production potential.

Leaf area index

- Variety1 (BE 107),) Variety2(TAN 393), Variety3(SG 273)Variety4(SG 185),andVariety5(BE 079Variety6(SG 265) and Variety9(SG 261) are to be maintained for their broader leaf areas and will also enhance high degree of photosynthesis and transpiration processes.

Lastly, this research should be conducted at another site for further investigation for canopy diametre, plant height, stem girth, number of leaves and leaf area on immature cashew plants.

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