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Sudan University of Science and Technology

College of Graduate Studies

Department of Agronomy

Forage Yield of Maize as Effected by Maize- Cowpea Mixtures

إنتاجية علف الذرة الشامية تحت تأثير نظام التحميل مع اللوبيا العلفية

A Dissertation Submitted To Sudan University of Science and Technology in Partial Fulfillment for the Degree of M.Sc. in Agriculture

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الآيات

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أَنَّكَ تَرَى الْأَرْضَ خَاشِعَةً فَإِذَا أَنزَلْنَا عَلَيْهَا الْمَاءَ اهْتَزَّتْ وَرَبَتْ إِنَّ الَّذِي أَحْيَاهَا لَمُحْيِي الْمَوْتَى إِنَّهُ عَلَى كُلِّ شَيْءٍ قَدِيرٌ))

فصلت(39)

وَفِي الأَرْضِ قِطَعٌ مُّتَجَاوِرَاتٌ وَجَنَّاتٌ مِّنْ أَعْنَابٍ وَزَرْعٌ وَنَخِيلٌ صِنْوَانٌ وَغَيْرُ صِنْوَانٍ يُسْقَى بِمَاءٍ وَاحِدٍ وَنُفَضِّلُ بَعْضَهَا عَلَى بَعْضٍ فِي الأُكُلِ إِنَّ فِي ذَلِكَ لآيَاتٍ لِّقَوْمٍ يَعْقِلُونَ)) الرعد(4)

صدق الله العظيم

Dedication

To my parents,

To my sister,

And to all my friends.

Acknowledgments

First I do thank ALLAH who supports me with ultimate help, strength and patience to complete this research successfully and peace be upon prophet MOHAMED. I would like to express my sincere appreciation to my supervisor prof. Yassin Mohammed Ibrahim Dagash for his support, and guidance from the first step of this research up to its end. I am greatly indebted to his guidance, supporting, encouragement and continued helping along the study time. My sincere thank are extended to Dr. Ahmed Ali and to all Doctor's in Department of Agronomy Dr. Sami Ali, Dr. Atif Elsadig Dr. Amani Hmed and all the staff in the Department.

Recognition is also due to my colleagues at the Department of crop production, Sudan University of Science and Technology for their interesting comments.

LIST OF CONTENT

ABSTRACT

A Field experiment was conducted at the Experimental Farm, College of Agricultural Studies - Sudan University of Science and Technology - Shambat, in summer 2013, to study the effect of different seed rate of cowpea on forage and growth of maize under mixed cropping system. The experiment was designed in a randomized complete block design (RCBD). The treatments involved different combinations of cowpea-maize mixture viz. A(1:1)one plot divided into parts 50%maize and 50%cowpea.B(1:3) 3cowpea and 1maize.C(3:1)3mize and 1cowpea.D (2:2) 2maize and 2cowpea in one hole, in four replications. Different characters measured were plant height (cm), number of leaves, number of Internodes, stem diameter(cm), fresh weight(g), and dry weight (g).

The statistical analysis showed significant differences for plant height and stem diameter. The results showed that the treatment C 3:1 (3Cowpea and 1Maize) was considered as the best treatment for plant height . The treatment B1:3 (1cowpea and 3maize) gave the best non-significant results for number of leaves, number of internodes and fresh weight .

الخلاصة

أجريت هذه التجربة الحقلية بالمزرعة التجريبية في كلية الدراسات الزراعية – جامعة السودان للعلوم والتكنولوجيا – شمبات. وذلك في صيف2013 بهدف دراسة مدى تأثير اللوبيا الحلو على بعض صفات النمو والإنتاجية للذرة الشامية وصممت التجربة على تصميم القطاعات العشوائية الكاملة RCBDوشملت أربعة معاملات وهي (A)1:1 تعني حوض واحد قسم إلى جزأين 50%ذره شاميه و50% لوبيا حلو (B)3:1 تعني 1لوبياحلو و3 ذره شاميه (C)1:3تعني 3 لوبيا حلو و1ذره شاميه(D) 2:2 تعني2ذره شاميه و2لوبياحلو في الحفرة الواحدة ، في أربعه مكررات ثم تم رصد معايير النمو الخضري والإنتاجية المتمثلة في طول النبات، عدد الأوراق، عدد السلاميات، سمك الساق، الوزن الرطب و الوزن الجاف.

أظهرت نتائج التحليل الإحصائي وجود فروقات معنوية بسيطه لصفة طول النيات وسمك الساق. أما بقية الصفات لم تظهر بها فروقات معنوية واضحة كما أثبتت نتائج التحليل الإحصائي أن المعاملة 1:3 (3 لوبيا حلو 1 ذره شاميه) هي أفضل معاملة لطول النبات أما المعاملة 3:1 (1لوبيا حلو 3 ذره شاميه) أظهرت عدم وجود فروقات معنوية كما أعطت أفضل النتائج في كل من عدد الأوراق، عدد السلاميات والوزن الرطب.

CHAPTER ONE

INTRODUCTION

Improved grasses and legumes have been recommended for intensive farm systems due to their high forage production and nutritive value. Improved grasses are probably one of the cheapest high quality roughages provided that they are grazed or harvested at early stage of maturity.

The shortage of feed particularly during the dry season is one of the major factors limiting livestock productivity in Sudan. Animals is of low resource in Africa usually gain weight during the rainy season, part of which is lost during the harsh period of the dry season. live weight loss during this period for the reason of protein deficit in the diet of rural areas communities. There- fore, the strategies for alleviation protein deficiency are by supplementation with on-farm produced forage legumes and grasses which showed great potential to alleviate this problem (Omer, 2008).

Intercropping is a method of growing tow crops or more in the same area of soil at certain time. Intercropping is used to improve soil properties. Fodder mixtures have many benefits for lands to gain increased efficiency of land use, because the legume crops and grasses with different roots, absorb food from different soil layers , as well as more efficient use of solar energy and can also improve the soil physical and chemical properties.

Forage intercropping is defined as mixed forages contains a species or more of legumes sown with a species or more of grasses with a certain seed rate. These mixtures can be used for pasture, hay, silage and multipurpose(Ibrahim,2005).

In Sudan, intercropping of cereals with legumes is a predominant feature in the cropping system which practiced in small scales as a means of maximizing the use of limited farm lands as well as attaining food security to the subsistence farmers. In western Sudan, the usual intercrop system practice is a cereal-legume mixture, where millet and sorghum are widely used as a cereal component of intercropping with crops such as cowpea, groundnut, sesame and roselle. Therefore, this system is considered to help farmers utilizing their limited resources (natural and labor resources) for attaining yield stability, obtaining higher yields per unit area, and having better control of weeds, pests, and diseases. In addition, it provides safe guard against familiar practice of the single crop. The essential features of intercropping systems are that they exhibit intensification in space and time, competition between and among the system components for light, water and nutrients and the proper management of them (Ahmed, et.al, 2013).The present investigation was therefore to determine the growth attributes of component maize crop in a maize cow pea intercropping system under the influence of different crops arrangement and proportion.

The objectives are :-

1- To study the effect of cowpea on maize.

2- To choose the best combination method of intercropping that give high maize yield.

CHAPTER TWO

LITERATURE REVIEW

2-1 Definition

Intercropping is an agricultural practice and cultivation of two crops or more in the same space at the same time as defined by Andrews and kassm, 1976. Sullivan, 2003 added that intercropping promotes the interaction between the different plants. The term intercropping usually coupled with the sustaining agricultural and organic farming. Sustainability of intercropping is referring to the production of food and forage for livestock without depleting the earth resources; it is the application of natures principles (Earless, 2005). Diversity permits better recourses use efficiency in agro-ecosystem, because with higher variation, there is greater microhabitat differentiation allowing the components species and varieties of the system to grow in an environment ideally suited to its special requirements (Mazaheri and Oveysi, 2004).

Intercropping is becoming so important to increase crop productivity and to satisfy food demands of an increasing population. It is a common cropping system in the developing countries (Li *et. al,* 1999). The most important attraction of intercropping is that the yield advantage can usually be achieved simply and cheaply, namely by growing crops together rather than separately. Willey, 1990. Imphasized the importance of forage legumes in maintaining soil quality, productivity and quality of forage mixtures. It is more efficient utilization of low quality cereals through the addition of high protein forages .Intercropping or inter planting as some time called, is the way of controlling insects, in an experiment. In Kenya, in which brassica olerace was intercropped

with beans or onion was significantly reduced the damage and amount of moth larvae (Said and Ityula, 2003).

2-2 Types of intercropping:

There are four common practiced methods of intercropping as identified by (Andrews and Kassam, 1976):

1-Mixed intercropping , in which the two or more crops are grown without row spacing.

2-Row intercropping, is the growing of two or more crops at the same time with at least one crop planted in rows.

3-Strip intercropping, is the cultivation of two or more crops in a strip wide enough to allow crop production and using of machines but close enough to give the chance for crop interaction.

4-Relay intercropping , is the planting of a second crop into the already growing plant at a time when the standing plant is at its reproductive stage but before harvesting.

2-3 Legume-cereal intercropping

Many reviewers and researchers counted the advantages and the benefits of intercropping compared with sole cropping or monoculture .Most of them focused on the productivity .Yadar, (2007) noted that mixed cropping with cereal and legumes not only improve soil fertility but may also provides yield advantage to the cereal crops which may enhance net returns. Go kkus,et. al,1999 acknowledged the symbiotically fixed nitrogen for enhancing grasses quality and quantity and make the intercropping more attractive for the peasant farmers .Several reviews emphasized another role for intercropping rather than

productivity . Hector and Jody,(2002)stated that the intercropping gained an increasing interest in an attempt to substantiate functional agricultural biodiversity production and to reduce pesticide use.

In contrast, intercropping cereal with legumes may cause reduction in cereal grain because of the competition between the two crops. The degree of competition between mixed crops is determined by plant population and crop geometry Shehu, *et .al*,(1999).Interplant competitions usually mediated through competition for soil,water , available nutrient and solar radiation .Thus forage plants typically experience shaded growing conditions resulting from inter and intra species shading since two or more plant type with different growing habits often compete for the same space Red ,*et. al* ,(1999).

Mixed cropping as a method for crop intensification is commonly practised in density populated countries to provide more food. Recent experiments suggested that greater yield are obtained from mixed cropping systems than from growing monoculture crops Ciftci, *et. al,* (2005).They Pointed that intercropping did not affect forage yield compared with a cereal crop when the cereal component seeded at a sole-crop rate. They also stated, that the crude protein (CP) concentration of acereal pea forage was high when barley rather than oat intercropped with pea in the continuous cropping. Forage CP concentration declined as the pea seeding rate increased across the cereal seeding rates. Shehu (1999) studied the effect of intercropping on lablab with sorghum yield and chemical composition and found that the dry matte yield of lablab was greatest when it was the sole crop and least when it was intercropped in bare rows. Also sorghum stalk, leaves and grain were all greater for the sole crop compared with any mixed cropping treatment. They also stated that the crude protein content of the sorghum stem was higher in mix crop than in sole crop and concluded that lablab increased nitrogen availability to the sorghum.

It is possible to produce additional yield of faba bean without any decrease, even with an increase of maize yield at both locations. The system offers a chance of profitable production as the Land Equivalent Ratio (LER) and economic analysis had confirmed it. The intercropping system is more appropriate in terms of sustainability than sole cropping of cereals since the legume component enrich the soil through nitrogen fixation. There was also good ground coverage during intercropping which was important with regard to soil conservation especially at the early stage of maize crop. Tilahun, *et.al,* (2012). Mukhebi and Onim,(1983) observed that the yield potential of mixed cropping systems could be increased substantially through improved management practice. The high cost of labour for hoe weeding owing to the fact that farmers weed up to four times with limited use of herbicide due to lack of sufficient capital and technical knowhow of farmers in Nigeria has made it necessary to focus research efforts into studying compatible crops to be grown in mixture and the best arrangement that can control weeds better.

The biological efficiency of intercropping, measured in terms of Land Equivalent Ratio (*LERs*), at the ratio of 1:1 also showed that intercropping rain fed rice with cowpea has high compatibility factor of 1.84 and a derived intercrop benefit of 0.84 compared with bean intercrops 1.16 whose derived benefits was 0.16. Ogutu, *et. al,* (2012) found that intercropping maize with legume forages with or without fertilizer application generated greater economic returns than pure-stand maize in Kaimosi Cluster, and with fertilizer application in Masumbi Cluster. There was no economic advantage over pure-stand maize at Maseno Research Station, and in Masumbi Cluster without fertilizer application. In Kaimosi Cluster, maize intercropped with leguminous forages yielded greater returns than maize intercropped with Sudan grass when fertilizer was applied, but the results were the same without fertilizer application. For Masumbi Cluster, maize-

followed by maize-Sudan grass were the most promising intercrops only when fertilizer was applied. Otherwise, pure-stand maize was economically superior to the maize intercrops without fertilizer application (Shinggu, *et.al,* 2009). Grain and straw yields of both sorghum and cowpea were higher in sole cropping than in the intercropping mixtures reported by (Oseni 2010). Julius and Kehinde (2013) reported that grain yields of the two crops were higher in sole compared to intercrop across the cropping years, seasons and agroecologies. Soybean intercropped with maize resulted in an area-time equivalency ratio (ATER) higher than 1 for all the treatments confirming the intrinsic advantage of intercropping over sole crops. Among all the treatments, integrated nutrient management (ISFM) resulted in higher yields and monetary advantage index (MAI) values for maize/soybean mixture compared to other treatments. Muyayabantu (2012) reported that the intercrops had yield advantage over the sole crops. Lawson (2013) found that the maize grain yields in sole cropping were significantly higher than in intercropping in both growing seasons. Molatudi and Mariga (2010), Lauk and Lauk (2009) concluded that under growing conditions where cereal sole crops produce rather high yields, intercropping with legumes has no advantages over cereal sole crops. However, when evaluated over a number of years the intercrops are expected to show more stable yields than the specific sole crops. Sole crops produced forage with thicker stems during the growth of the first crop and intercropped plants treated with phosphorus developed thicker stems during the second cut (ratoon) {Abusuwar and omer,2011}.

Growing maize and soybean in alternating single rows decreased Stover and haulm yield much more than growing the two crops in alternating double rows or in one row of maize alternating with two rows of soybean .Undie, *et.al,* (2012) reporded that, farmers would be better off if they adopted double row rice

alternating with single row cowpea arrangement of intercrop. It was evident that NERICA 11 rice variety is compatible with both bean (KK8) and cowpea (Kenya kunde one), Ogutu, *et.al*,(2012). Total nitrogen yield of monocropped and intercropped cowpea and maize, however, was dependent on row spacing and cropping system Kessal and Roskoski ,(1988) Addo-Quaye, (2011) noted that soybean planted in double row arrangement with maize reporded significant higher growth than soybean planted in alternate row arrangement with maize. El Naim, *et.al,* (2013) results indicated that yield had significant differences among the spatial arrangements. 1:1 arrangement obtained the highest values of sorghum panicle weight, sorghum grain yield, sorghum hay weight and combined total hay weight for both sorghum and cowpea. Moreover, the best total LER (2.11) was obtained under 1:1 spatial arrangement. The highest seed yield. Was found with the interactions between cropping system (2:4) and the second distribution of maize planting and both time of planting soybean planted with maize and soybean planted 21 days after maize in first and second season, respectively. The highest values of LER were recorded with intercropping systems (2:2) and (2:4) in both seasons, Abou Elela, et.al, (2012). Ogutu,et.al, 2012. Results showed that, at a ratio of 1:1, single row of rice planted with single row of beans was significantly different from single row rice alternated with single row cow pea, while at a ratio of 1:2, single row rice alternated with double row beans and double cowpea were significantly different. However, double row rice against single rows of beans and single row cowpea were not significantly different.

Tenebe and Petu-Ibikunle (2012) reported that the effects of these cultural interventions were observed on cowpea srtiga count nodulation, net assimilation rate (NAR) and grain yield. NAR were enhanced by the interaction of weeding frequency and spatial arrangement. Weeding × spatial arrangements reduced

striga incidence on cowpea during 2003 and 2004. Weeding thrice × sowing 1:2 and weeding twice × sowing on the same hill gave a statistically similar result. Nodulation was enhanced by the interaction of weeding frequency and spatial arrangement. Weeding frequency × planting arrangement significantly increased cowpeas grain yield during 2004. The highest grain yields (1344 and1347 Kg/ha) were recorded from weeding twice × sowing 1:2 and weeding thrice × sowing on the same hill. Addo-Quaye2011 indicated that Spatial arrangement did not influence these parameters in maize. Interaction between time of planting and spatial arrangement was however significant. LAI and CGR for maize increased with time while NAR declined. For the soybean crop, soybean planted on the same day with maize or planted before maize recorded significant LAI, CGR and NAR values.. Results showed the positive effect of Alfalfa on Rhodes grass characters when they intercropped with each others. The highest yield of intercropping ratios than monocropping and the superior of treatment D (50% Rhodes grass + 50% Alfalfa) over other treatments used in the study were evident, Idris et.al ,(2012). The combinations of 1maize: 1 faba bean planting pattern with the application of $P_2O_5$96-N46 kg / ha was found to be the highest profitable treatment, (Tilahun, *et.al*, 2012).

Imran, *et.al,* (2011) found that all the growth and yield components were significantly affected by the varying planting patterns and intercropping. Maximum value of achene yield (2891 kg ha-1) in case of intercropping treatments was obtained in the alone sowing of sunflower and in case of planting geometries maximum achene yield (3002 kg ha-1) was obtained in the treatment when sunflower was sown at 175/35 cm four rows apart sowing. The interactive effect of different planting patterns and intercropping showed that maximum achene yield (3128 kg ha-1) was obtained in case of P3I2.The maximum net benefit of Rs. 95995 (1130$) was obtained from the plots in which sunflower

was sown at 175/35 cm four rows apart (P3I2). For the minor spacing between rows (0.5 m), the irrigation with saline water caused a reduction of 17% in grain yield and water productivity, while for the larger spacing (0,9 m) this reduction reached almost 40% (Claudivan, *et.al,* 2011). In most cases, LER and yields of the intercrop systems exceeded the groundnut sole crop, indicating that the crop is capable of developing better yield in mixture. Moreover, this intercropping is expected to give a better mixture, and also a better control of soil movement observed in groundnut pure stands Osman and Elamin (2012). Addition of phosphorus significantly increased plant height, number of fruiting branches/plant, fresh weight of leaves and number of branches/plant but not fresh weight of pods/plant of the three crops. In both seasons, fresh forage yield/ha of the three crops increased progressively with increased phosphorus levels applied (Ibrahim, *et.al,* 1995). Intercropping and addition of phosphorus increased plant height of Sudan grass. The leaf area of Clitoria was increased with the addition of phosphorus and intercropping in the first crop, but sole Clitoria scored higher leaf area during the second cut. Lablab leaf area was significantly increased with addition of phosphorus and intercropping in the two seasons. Intercropping of Sudan grass with lablab and Clitoria resulted in large leaf area of Sudan grass. Leaf to stem ratio of Clitoria was mainly increased with the addition of phosphorus. Intercropping lablab with Clitoria significantly increased lablab leaf to stem ratio.

The two-combination intercropping of Sudan grass increased its leaf to stem ratio. Rhizobium inoculation, legume to legume intercropping and addition of phosphorus enhanced nodulation and increased the number and weight of nodules. Phosphorus significantly reduced the amount of HCN in the forage of Sudan grass (Abusuwar and omer 2011). The combinations of 1maize: 1 faba bean planting pattern with the application of 96-46 kg NP_2O_5/ ha was found to be

the highest profitable treatment. It also gave the farmers option of producing both carbohydrate and protein at a time Tilahun, *et.al,* (2012). It is hereby recommended that these plants can be planted with other food crops as they have added food value besides their primary function of suppressing weeds as well as fixing atmospheric nitrogen into the soil (Okonmah, 2011). Application of chemical fertilizer disturbs cowpea biomass but increase millet biomass. Combination of chemical fertilizer and transported manure is important for millet/cowpea production in association and lead to positive nitrogen, phosphorus and carbon economy in the soil {Saidou, *et.al,* (2010)}. Yusuf et.al,(2012) results indicated that the treatment maize planted at 14 days before Planting soyabean gave maize yields of 908.3 and 2,812.5 kg/ha in 2010 and 2011 respectively. These yields were significantly higher than the maize yields obtained at the other intercrop treatments in both years. This treatment also resulted in the highest gross yields of the component crops as indicated by the LER in both years. The highest seed yield/fed was found with the interactions between cropping system (2:4) and the second distribution of maize planting and both time of planting soybean planted with maize and soybean planted 21 days after maize in first and second season, respectively. The highest values of LER was recorded with intercropping systems (2:2) and (2:4) in both seasons{ Abou Elela, *et.al,* (2012)}. Comparing the weed suppression abilities of the legumes - maize yield, cowpea suppressed more weeds in the maize field than groundnut and soybean; and cowpea gave the highest maize yield (2988 kg/ha) which was not significantly different from the sole maize yield (3291 kg/ha) {Lawson et.al,2013}. Based on these field data the frequency of weeding enhanced physical removal of weeds, minimized competetion for growth resources, improved soil conditioning for optimum aeration, increased soil air-water ratio for optimum mycorrhiza and other beneficial soil microbial activities; while intercropping possibly provided canopy coverage for moisture conservation and

pest control (Tenebe, Petu-Ibikunle 2012). This study was conducted with the aim of determining the best time to control weed in maize when grown in mixture with cowpea (Shinggu, *et. al,* 2009). Intercropping tended to increase the concentrations of methionine and threonine in the cereals, and the concentrations in peas were not influenced by intercropping. Hence, legume-cereal intercropping may produce more suitable fodder for monogastric animals than monocultures of cereals mixed with peas.

CHAPTER THREE

MATERIALS AND METHODS

3-1 The site of Experiment

This experiment was conducted at the experimental farm in the College of Agricultural Studies, Shambat. Sudan University of Science and Technology which is located between latitudes15^0 40′ N. ,32^0 32′ E , elevation 380 m. Climate is semi desert with a low per-centage of humidity and average rain-fall with annual rate of 158mm and a mean temperature of (20.3 C° -36.1 C°) and clay soil celtic with semi-desert region (PH7.5-8.7) (Abdelhafeez, 2001).

3-2 Treatments

The treatments consisted of maize and cowpea with different forms of crop proportion viz. one plot divided into two parts one sown with maize and half with cowpea (1:1), one plot sown with 25% cowpea and 75% maize(1:3), one plot sown with 50% maize and 50% cowpea (2:2) and the last plot sown with 75% cowpea and 25% and 25% maize(3:1). All treatments were arranged in a randomized complete block design replicated four times.

3-3 Cultural practices

The experimental site was disc ploughed ,disc harrowed, and leveled ridging up north-south, the spacing between ridges was 70 cm, four Replications were divided into four plots, each plot was 3×3m consisting of three ridges . A soil sample was taken after and before sowing to determine nitrogen in soil laboratory in (SUST). The experiment in 1 July 2013.

The depth of seeds was 2 cm by different rating (maize and cowpea) in one hole. The first irrigation was done eimmediately and then as needed and recommended in the area. Weeding was done two times after three weeks from sowing and after one month from the first weeding.

3-4 Data collection

The following data were obtained from each experimental unit.

3-4.1 Plant height (cm)

It was measured from the surface of the soil to the end of the flay leaf on five different plants and the average was recorded.

3-4.2 Number of leaves per plant

Five plants were collected from each plot and the mean number of leaves per plant was obtained.

3-43 Number of internodes of maize

Five plants of maize were collected from each plot and the average number of internodes plant was recorded.

3-4.4 Stem diameter (cm).

Stem diameter was measured using a string and ruler and from the same five plants used for plant height and the average was obtained.

3-4.5 Fresh weight (g/plant)

Five plants were collected from each plot and weighted, then the average fresh weight per plant was recorded.

3-4.6 Dry weight (g/plant)

Was taken from the same fresh weight of five plants then oven dried a temperature of 80c for 48hours and then weighted and the average dry weight per plant was recorded.

3-5 Statistical analysis

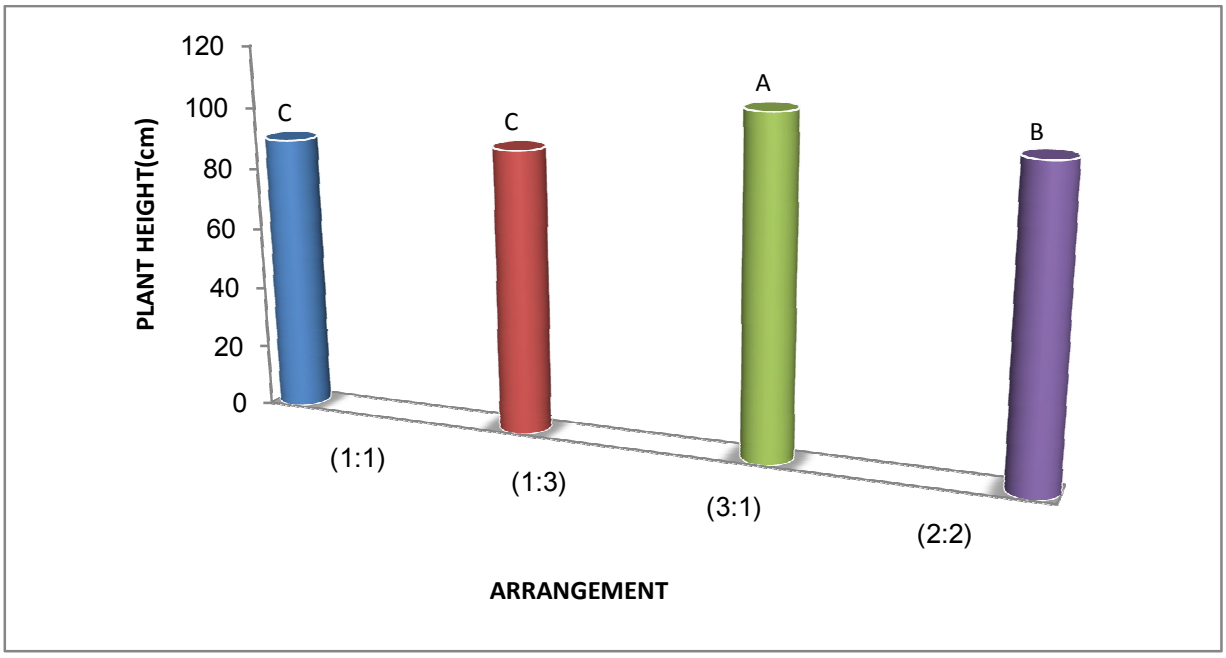
The analysis of variance was carried out according to standard statistical procedures described by Gomes and Gomes (1984), using A Randomized Complete Block Design. L.S.D test was used for mean separation. Both parameters were analyzed using the computer package MSTAT-C.

CHAPTER FOUR

RESULTS

4-1Plant height (cm):

The analysis of variance (Table1) showed that there was a significant difference between treatments for maize. The tallest plant was108.9cm recorded by the combination 3:1 with an increase of 19% from the lowest 89.7cm plant height which obtained by the combination 1:1. It was clear that the combination 2:2 recorded 100.2cm plant height as shown in figure (1-4).



C.V=9.81%

Fig (1-4): Plant height (cm) of maize as intercropped with cowpea.

Means followed by the same letters are not significant at 5% level according to LSD .

Table (1): F- values of arrangement of Maize with as a component crop Cowpea:

Source	Degree of Freedom d. f	F. values					
		Number of leaves	Number of internodes	Plant height	Stem diameter	Fresh weight	Dry weight
Replication	3	2.44	2.07	3.34	3.00	0.07	0.30
Arrangement	3	0.35Ns	0.69Ns	0.75*	3.70*	0.14Ns	0.05Ns
Experiment error	9	–	–	–	–	–	–
Total	15	–	–	–	–	–	–
Error Mean Squares E M S	–	1.11	4.16	91.88	0. 47	0.04	0.00
Coefficient of variation C.V %	–	8.59%	20.59%	9.81%	14.86%	26.85%	28.52%
Stander Error +_	_	0.52	1.07	4.79	0.34	0.10	0.04

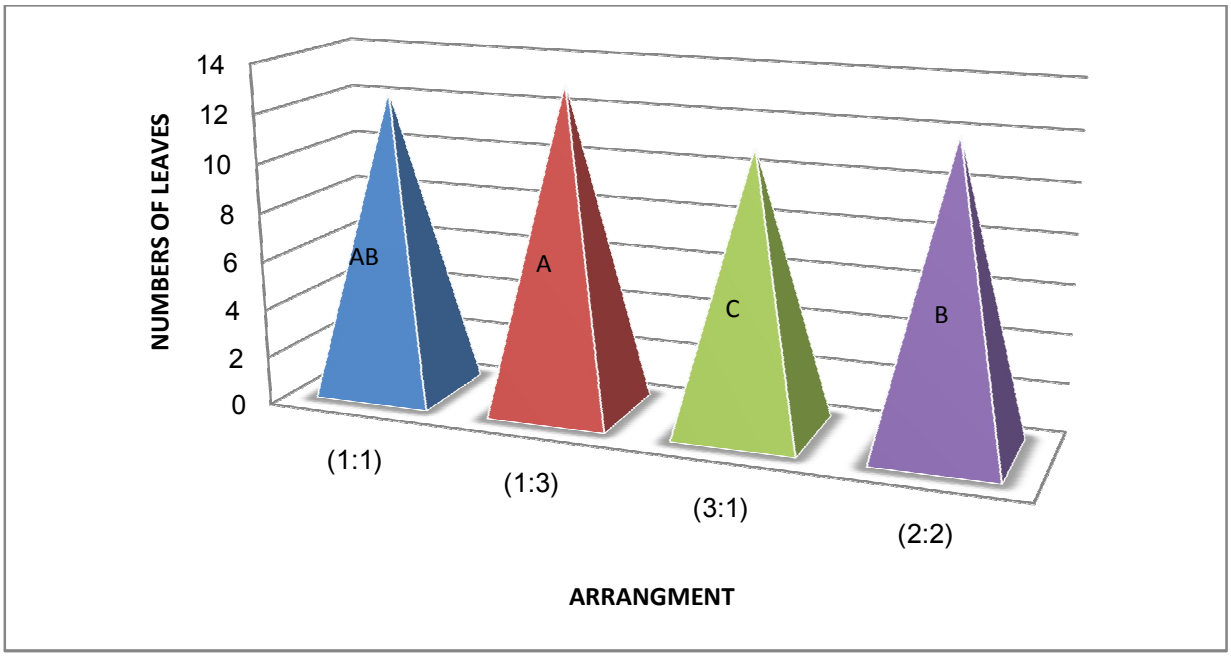
NS = non significant

* = significant at P ≥ 5%

** = significant at P ≥ 1 %

4-2Number of leaves: -

The analysis of variance (Table1) showed that there was no significant difference between treatments for maize. The highest number of leaves per plant 13.25 was recorded by the combination (1:3) by an increase of 2% from the lowest 11.25number of leaves per plant which obtained by the combination(3:1), and mean for leaves number was 12.50, 12.25 in the treatments (1:1, 2:2) respectively as shown in figure (2-4).



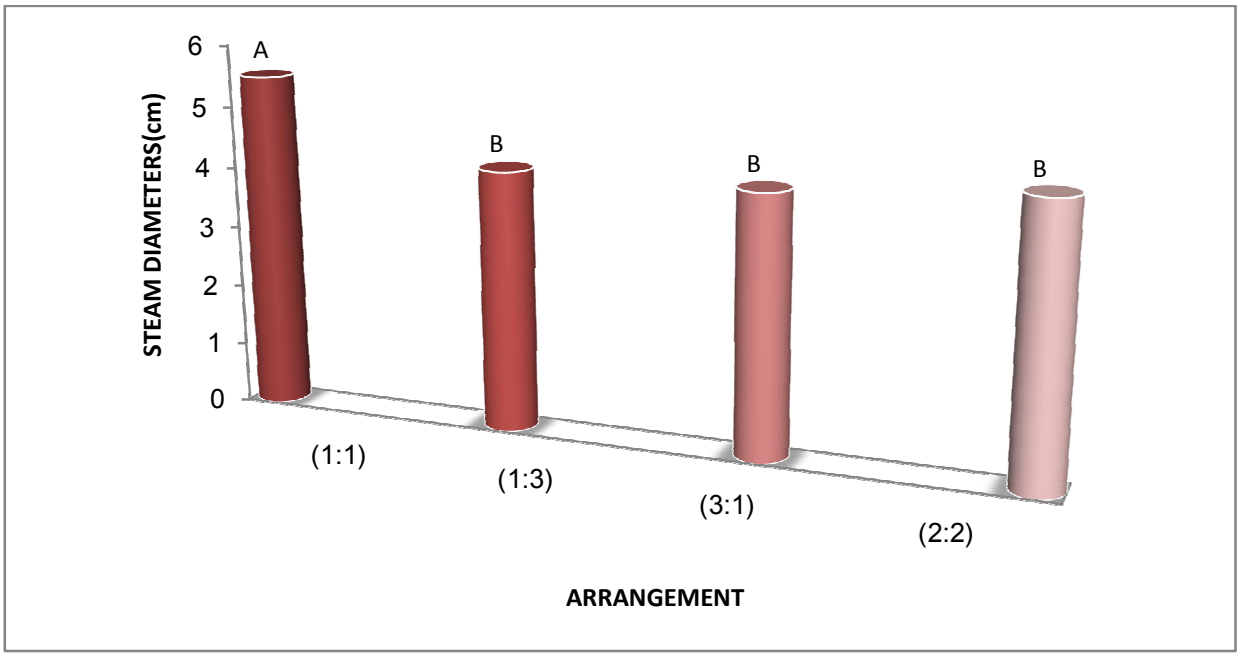
C.V =8.59%

Fig(2-4): Number of leaves per plant of maize as intercropped with cowpea.

Means followed by the same letters are not significant at 5% level according to LSD .

4-3 Stem diameter (cm):

The analysis of variance (Table 1) showed that there was a significant difference between treatments for stem diameter of maize. The highest stem diameter (5.500cm) was recorded by the combination1:1 by an increase of 1.25% from the lowest 4.250cm stem diameter which obtained by the combination 1:3. It was clear that the combination 2:2 recorded 4.500cm thickness of stem as shown in figure (4-3).



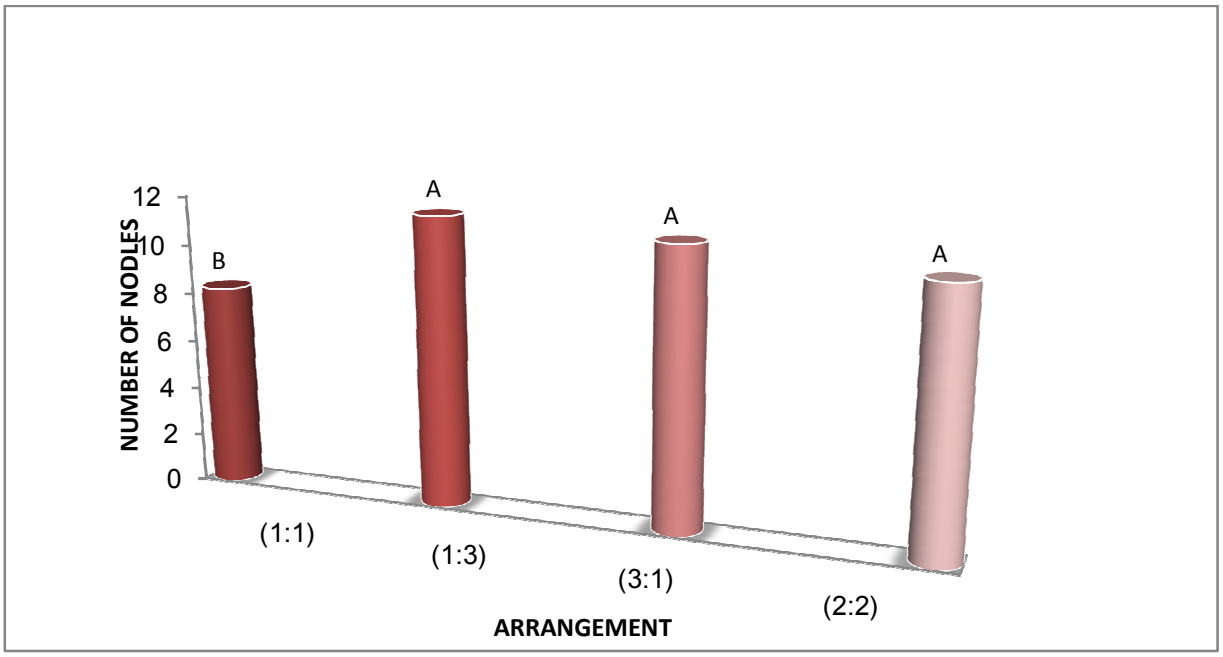
C.V= 14.86%

Fig (4-3) : Stem diameter(cm) of maize as intercropped with cowpea.

Means followed by the same letters are not significant at 5% level according to LSD .

4-4 Number of internodes:

The analysis of variance (Table1) showed that there was no significant difference between treatments for number of internodes of maize. The highest number of internodes 11.75was recorded by the combination1:3 by an increase of 3.5% from the lowest 8.25number of nodules which obtained by the combination1:1. It was clear that the combination3:1 recorded11.25 and the combination 2:2 recorded 10.50 as shown in figure (4-4).



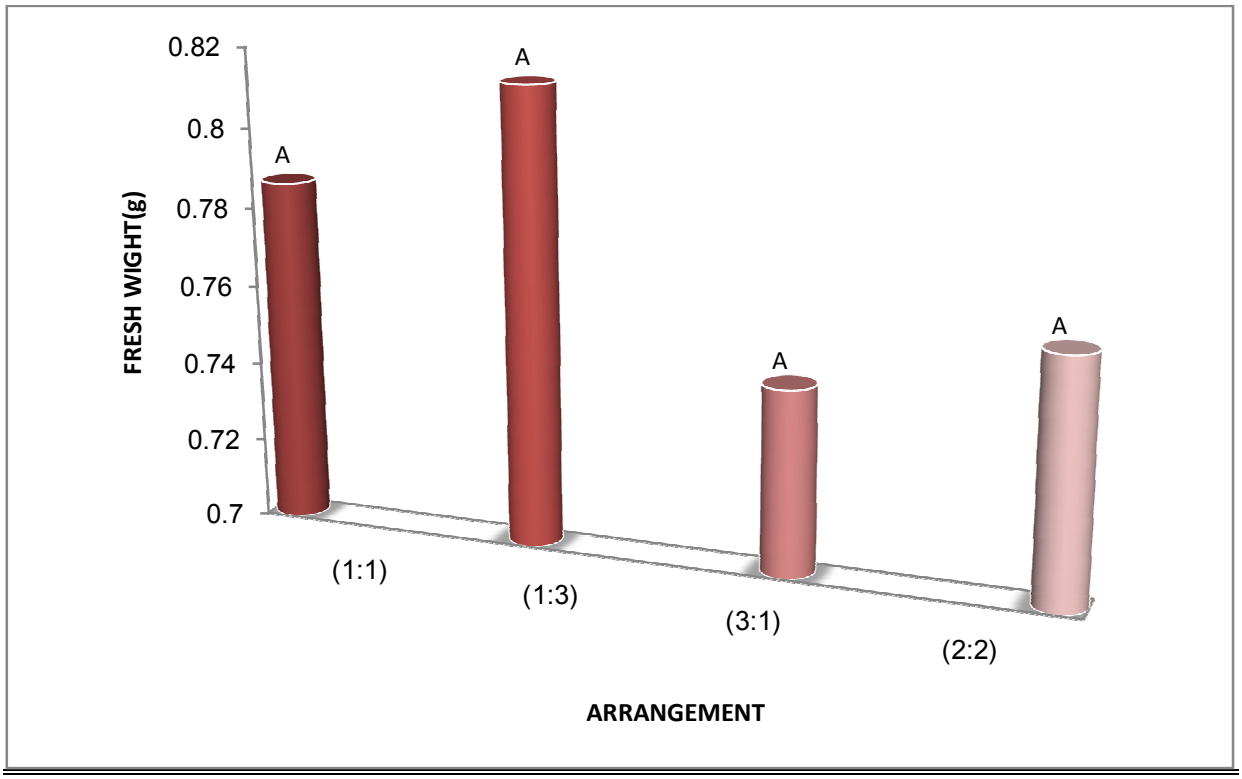
C.V=20.59%

Fig(4-4): Number of internodes of maize as intercropped with cowpea.

Means followed by the same letters are not significant at 5% level according to LSD .

4-5fresh weight (g) per plant:

The analysis of variance (Table1) showed that there was no significant difference between treatments for fresh weight per plant of maize. The highest fresh weight 0.8145(g) was recorded by the combination1:3 by an increase of 0.06 % from the lowest 0.7467(g) fresh weight which obtained by the combination 3:1. It was clear that the combination2:2 recorded 0.7615 (g) and the combination1:1 recorded 0.7865(g) as shown in figure (4-5).



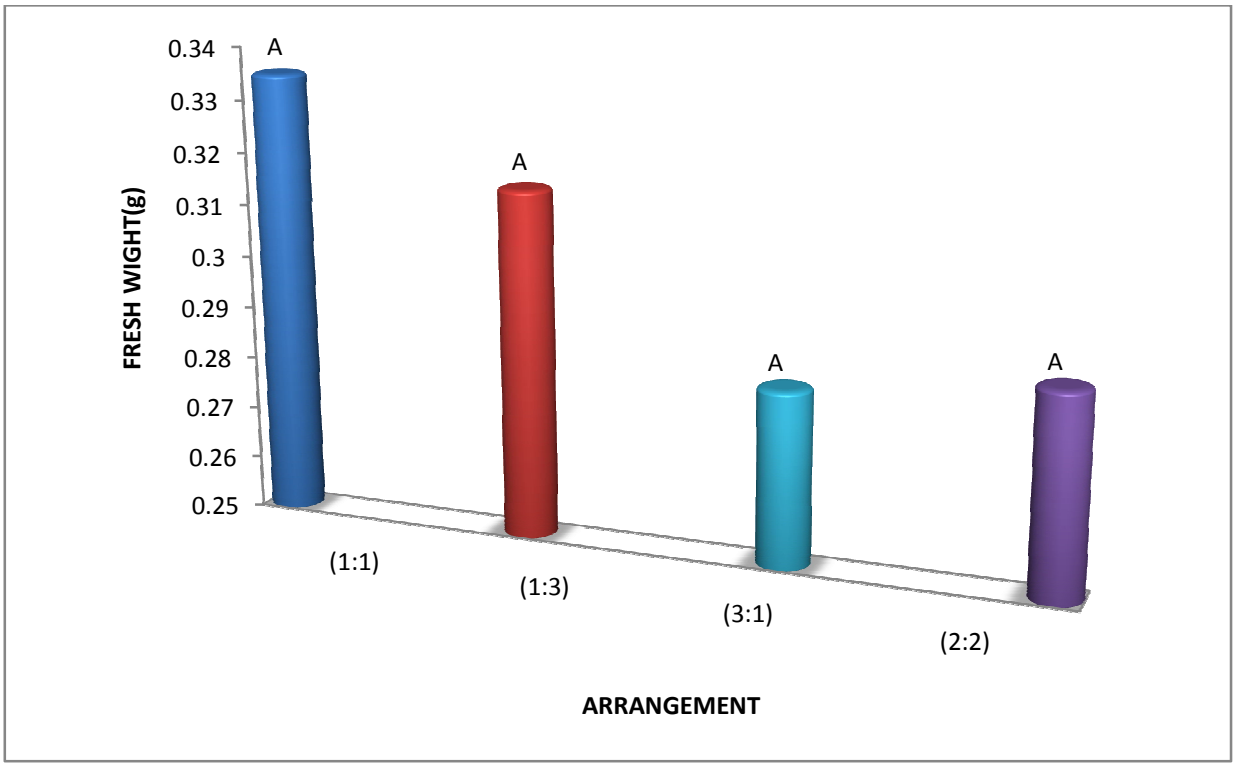
C.V=26.85%

Fig (4-5): Fresh weight per plant (g) of maize as intercropped with cowpea.

Means followed by the same letters are not significant at 5% level according to LSD .

4-6 Dry weight (g)per plant:

The analysis of variance (Table1) showed that there was no significant difference between treatments for the dry weigh per plant . The highest dry weight 0.335(g) was recorded by the combination1:1 by an increase of 19% from the lowest 0.283(g) dry weight which obtained by the combination3:1. It was clear that the combination1:3 recorded 0.316 (g) dry weight as shown in figure (4-6).



C.V=28.52%

Fig (4-6): Dry weight per plant (g) of maize as intercropped with cowpea

Means followed by the same letters are not significant at 5% level according to LSD .

CHAPTER FIVE

DISCUSSION

The significant differences obtained in the plant height, stem diameter and non-significant differences in the other characters in this study indicates that cowpea has non-negative effected on the growth of maize. These results could indicate the availability of using any of these ratios in any further intercropping systems between maize and cowpea. On the other hand, this study open the way to select the most suitable ratio of intercropping that produce high yield. Similar findings were reported by Omer (2008). in a study of intercropping between some forage grasses and legumes.

The results of the analysis of nitrogen in the soil was 3% before planting and 2% after harvest and this is an indicator that maize crop is a nitrogen demanding crop.

There were a significant difference between treatment in plant height and the highest value in plant height was in treatment (3:1) which reached 108 cm. This increase in plant height with (3:1) might be due to the height amount of nitrogen fixed by cowpea and utilized by maize. This result was similar to that observed by Adeleke, (2011).

Number of leaves per plant was not statistically different although there was an increase in the treatment of 75% maize and 25% cowpea. This may be due to the fact that maize utilized the nitrogen fixed by cowpea.

The results of analysis of data collected from that experience showed that there was significant differences in the character of the thickness of the stem (stem

diameter) between the four treatments as maize utilized the nitrogen fixed by cowpea. These was similar to that observed by Ahmed, (2013).

Number of internodes . per plant was not statistically different and there was a constancy in the treatment of 75% cowpea and 25% maize, 25% cowpea and 75% maize. This may be due to the fact that maize utilized the nitrogen fixed by cowpea .This was similar to that observed by Ahmed, (2011).

The results of analysis of data collected from that experiment showed that there was no obvious differences in the character of the fresh weight per plant between the four treatments. These results were different from Ahmed, (2011) who indicated that mixing cowpea with Maize does not affect much the status of Maize fresh weight.

The results of analysis of data collected from that experiment showed that there was no obvious differences in the character of the dry weight per plant between the four treatments. These results were different from Adeleke, (2011) who indicated that mixing cowpea with maize does not affect maize dry weight.

In conclusion, maize-cowpea mictures 3:1 (75% cowpea and 25% maize) obtained the highest values of plant height and stem diameter of maize.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

Significant differences were observed for plant height and stem diameter. Based on the results we can conclude that :-

1) The treatment C 3:1 (25%Maize and 75%Cowpea) produced the highest ss

2) Intercropping increased protein percentage by using different ratios of intercropping which will give a balance feed to animals.

3) Intercropping increased the amount of nitrogen in the soil as indicated by soil analysis and maize utilized that nitrogen for its growth.

4) The experiment should be repeated for another year to confirm the results.

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APPENDIX

Appendix(1): Soil analysis from soil labortary

Soil sample before the sowing

pH paste	ECe paste	P ppm	N
7.3	0.68	7	0.03

Soil sample after the sowing

pH paste	ECe paste	P ppm	N
7.7	0.78	6.4	0.02

Appendix(2) : Analysis of Variance Table .

a) Plant height (cm)

Source of Variance	Degree of Freedom	Sum of squares	Mean square	F- Value
Replication	3	922.871	307.624	3.3479
Arrangement	3	207.963	69.321	0.7544*
Error	9	826.968	91.885	
Total	15	957. 803		

C.V %= 9.81 s/y= 4.7928 $LSD_{0.05}$=7.224

Ns= not significant

* = significant at 5%

**=highly significant (1%)

b) Number of leaves

Source of Variance	Degree of Freedom	Sum of squares	Mean square	F- Value
Replication	3	3.188	2.729	2.4410
Arrangement	3	1.188	0.396	0.3540^{NS}
Error	9	10.063	1.118	
Total	15	19.438		

C.V %= 8.59 s/y=0.5287 $LSD_{0.05}$=0.7968

Ns= not significant

* = significant at 5%

**=highly significant (1%)

c)Number of inter nodes

Source of Variance	Degree of Freedom	Sum of squares	Mean square	F- Value
Replication	3	28.688	9.563	2.0707
Arrangement	3	9.688	3.229	0. 6992^{NS}
Error	9	41.563	4.618	
Total	15	79.938		

C.V %= 20.59 s/y=1.0745 $LSD_{0.05}$=1.619

Ns= not significant

* = significant at 5%

**=highly significant (1%)

d) Stem diameter (cm)

Source of Variance	Degree of Freedom	Sum of squares	Mean square	F- Value
Replication	3	4.250	1.417	3.0000
Arrangement	3	5.250	1.750	3.7059*
Error	9	4.250	0.472	
Total	15	13.750		

C.V%= 14.86 s/y=0.3436 $LSD_{0.05}$=0.5177

Ns= not significant

* = significant at 5%

**=highly significant (1%)

e) Fresh weight (g/p)

Source of Variance	Degree of Freedom	Sum of squares	Mean square	F- Value
Replication	3	0.010	0.003	0.0714
Arrangement	3	0.019	0.006	0. 1457^{NS}
Error	9	0.400	0.044	
Total	15	0.429		

C.V%= 26.85% s/y=0.1054 $LSD_{0.05}$=0.1581

Ns= not significant

* = significant at 5%

**=highlysignificant (1%)

f) Dry weight (g/p)

Source of Variance	Degree of Freedom	Sum of squares	Mean square	F- Value
Replication	3	0.007	0.002	0.3036
Arrangement	3	0.001	0.000	0.0581^{NS}
Error	9	0.069	0.008	
Total	15	0.077		

C.V %= 28.52 s/y=0.0436 $LSD_{0.05}$=0.06740

Ns= not significant

* = significant at 5%

**=highly significant (1%)