CHAPTER ONE

INTRODUCTION

Intercropping is the practice of growing two or more crops in proximity (Thobatsi., 2009). Intercropping is a method of growing two crops or more in the same area of soil at certain time .It is used to improve soil properties . Accordingly, intercropping promotes the interaction between the different plants (Omer.,2008).

In Sudan, intercropping of cereals with legumes is predominant feature in the cropping system which is practiced in small scale as ameans of maximizing the use of limited farm lands, as well as attaining food security to the subsistence farmers . In western Sudan, the usual intercropping system practice is a cereal –legume mixture where millet and sorghum are widely used as cereal components 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(Osman *et al*., 2003).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*., 2012).

In the traditional farming of Sudan, the low productivity of maize was attributed to the low yielding ability of the local open – pollinated cultivars that are normally grown and the greater sensitvity of the crop to water stress (Mukhater.,2006).However ,work in maize improvement in Sudan is limited and only a few cultivars have been released and the work in maize cultural practices is scanty . Maize is nitro positive and needs ample quantity of nitrogen to attain high yield . Nitrogen deficiency is a key factor limiting maize yields. It is , therefore, imperative to use an optimum amount of nitrogen through a suitable and efficient source (Alvarez and Grigere., 2005) .

The main objectives of this study are:

1- To study the impact of phillipsara on maize growth and forage yield.
2- To determine the best intercropping combination that gives the highest forage yield.

CHAPTER TWO

LITERATURE REVIEW

2.1General:

Intercropping is planting of two or more crops, the practice of intercropping over the years has helped to reduced variability in total biomass, seed production and income due to complementary effects among associated crops (Eksandari., 2009) . Intercropping is a dominant cropping system practiced by small holding farmers in developing countries of Africa, Asia and South America to better utilize limited resources, especially land. Most farmers in developing countries have adopted low –input systems mainly for climatic and socioeconomic reasons (Okigbo and Greenland., 1976).

Growing of different crops together and estimating the radiation environment, within this combined cropping system, becomes important. Microclimatic variation affects the performance of crops in a remarkable manner. Radiation environment within a crop canopy has the most important function regulating different Physiological processes. Radiation absorption and interception within the crop canopy and their effect on physiological processes have been delineated in different crops. Intercropping offers the potential for generating more stable yields, due to self – regulation in the crop. This will give the farmer better insurance against crop failure and will safe-guard the farmer‘s earnings, improving product quality such as greater protein content of creals, via planned competition , providing an ecological method via competition and natural regulation mechanisms and planned biodiversity to manage weeds and

Pests. Hence reducing the cost of energy for weed and pest control, and improving the synchrony between microbial immobilization and crop nitrogen demand , due to differences in the quality of the residues and thereby aiding in the conservation of nitrogen in the cropping system (Slingo *et al* .,2005).

legume – cereal intercropping into viable crop rotation as may solve some of the problems .Current farming practices are required to better predict and mange the outcome of competition and thus the symbiotic nitrogen fixation input into the cropping system (Andika., 2011).

The benefit of intercropping is to produce higher yields compared with sole cropping due to better utilization of resources , especially in mixed cultivation of legumes and cereals (Poggio., 2005). Intercropping ensures higher yield stability, higher use efficiency of sunlight, water and soil nourishment elements and reduces labor requirement (Thobatsi.,2009 and Banik *et al*., 2006) , higher competitive ability by weeds, and one of the integrated weed management methods, and higher nitrogen fixation rate by legume sand the yield advantage associated with intercropping as compared to sole cropping is often attributed to mutual complementary effects of component crops and would result into better total use of available soil resources . Although pure stand of legume produces comparable yields to intercropping systems , there is a possibility of nitrogen nutrient transfer from legume to the cereal which could improve the yield of the cereal during the intercropping of cereal with a legume (Hauggaard-Nielsen *et al* 2001) .

Numerous advantages of forage crops intercropping lead researchers in the developing countries to give it great interest . Intercropping has various systems and many advantages.

Other advantages include, conservation and improvement by maintenance of vegetative cover of ground surface and insurance against complete failure of component crops (Iita., 2007). Pal and Shehu(2001), demonstrated that the nodulating legumes intercropped with maize affected the grain yield , stalk yield and N uptake of maize significantly , greater than intercropping with non legumes . Furthermore, residual effect of the legumes significantly affect the grain yield, stalk yield and N uptake of maize . yield and N uptake of maize grown after nodulating legumes were significantly greater than those grown after non – legumes.

2.2 Morphology and background of Phillipsara:

Phillipsara (*Vigna trilobata* L Verdc)or synonyms (*Phaseolus trilobus* L Schreb) belongs to the family Fabaceae . It is an annual or perennial legume. Branches are diffuse, stipules peltate , sometimes spurred , ovate ,4 to 15 mm long . Leaves trifoliate, petiole 3.7 to 7.5 cm long , inflorescence a few-flowered raceme , peduncle 8 to 22.5 cm long . Bracteoles 0.3 mm long , corolla yellow , 5 to 6.5 mm long , pods cylindrical , 2.5 to 5 , glabrous to sparingly pubescent , 6 to 12 seeded . It is a medical plant with antimicrobial activity .It is largely found on well drained , alkaline, dark , cracking clay soils , but also on sandy and loamy soils of similar reaction (pH 6.5-9), moderately tolerant of salinity . It doesn't require N- fertilizer, because of its abilities to fix nitrogen, but responds to applications of phosphorus in low (P) soils . The species is native to largely tropical area extending from 24°N in India to 9°S in Indonesia and from near sea level to 700 masl , mostly equating to average annual temperatures around 25-27°C. However, under moisture stress, plants respond with moreden f lowering, far greater seed production and a reduction in vegetative growth (Khair., 1999).

Pillipsara is sown in India, Pakistan and Sudan as a short – term, pasture and green manure crop . During the fallow season, it is allowed to grow for 45- 50 days before it is incorporated into the soil . Sometimes, the green manure is grazed, and allowed to regrow for about a month before being incorporated . It is a summer crop grown in central Sudan (Gezira) from March to October and needs a rainfall of 750 mm . It also Provides human food , the pods being eaten as a vegetable, and seeds,cooked.It is used for green fertilization and forage for animal protein(12%) and total digestible nutrients (TDN) 56%(Abu suwar., 2005).

2.3 Morphology and Background of Maize:

Botanically, maize (*Zea mays* L.) or corn is a member of the Maydeae tribe which belongs to the grass family Poaceae (Gramineae) and is a tall annual plant with an extensive adventitious root system. It is a cross pollinated monoecious plant. The silk develops in the ears, or cobs ,often one on each stalk , each cob has 300 – 1000 kernels in a number of rows . The maize kernel is known botanically as caryopsis (Krivanek*et al* ., 2007).

Maize is the third most important cereal (Lerner and Dona.,2005). The origin of maize remains, uncertain although it is generally agreed that it's evoluation into modern forms took place in Mexico , and it was introduced to Africa as one of the most important staple food crop . Maize is grown at latitudes varying from the equator to slightly north and south to latitudes 50, from sea level to over 300 meter elevation , under heavy rainfall and in semi – arid condition , cool and very hot climates . In Sudan , maize has been known and grown for a long time in small scale areas at different locations under rain, flood and irrigation conditions (FAO, 2005). It is used as forage crop for dairy animals, feed for poultry birds and a variety of industrial purposes . Forage maize contains crude protein in the range of 7.5- 8.2% , while the fat content is usually 1-2.5% . The dry matter is in the range of 32-34 % , ash 7-9% and nitrogen free extract 50% (Iqabal *et al*., 2005).

Maize is generally cultivated in wide spaced rows. Plant density per unit area is one of the important yield determinants of crops. Increase in plant population density often results in higher maize forage yield , but this depends on a number of factors , including climatic conditions of the growing region, plant size and plant maturity. Silage quality may also be affected by population density , as increased plant densities have resulted in reduced maize forage quality (Cox and Cherney., 2001). From the point of global importance , maize represents in all forms of elementary and important feed for farm animals . Feed products from maize are characterized by high energetic nutrients and relatively low content of crude protein with low biological value (Mlynar *et al*., 2004).

2.4 Maize in the Sudan:

Maize (*Zea mays* L) is recently adopted in the Sudan and may have been introduced during the Turkish colonial period in the nineteenth century (Mukhter**,**2006) . Cereal grains are the most important component of Sudanese diet. Understanding of cereals production characteristics in the Sudan is vital for maintenance of efficient and sustainable agriculture and food production (Abdel Rahmaan., 2002).

The popular name of maize in the Sudan "Aishelreef " is consistent with the above notion and as well it was also named in the Northern

State of the Sudan by "Makada" .It provides nutrients for humans and animals and serves as important raw material for the production of starch , oil and protein, alcoholic beverages, food sweeteners and more recently , fuel . The green plant made into silage , has been used with great success in the dairy and beef industries . The straw is good forage for ruminant animals in developing countries . A heavy reliance on maize in the diet, however, can lead to malnutrition and vitamain deficiency disease such as night blindness and kwashiorkor. In the Sudan , maize is considered a minor crop and it is normally grown in Sennar and Blue Nile States , and in small irrigated areas in the Northern States with average productivity of about 0.697 ton / ha (FAO., 2005) .

2.5 Advantages of intercropping:

Most of the advantages associated with intercropping system are more efficient utilization of recourses and biological yield advantage insurance against crop failure is also a motivation for the adoption of intercropping by smallholder farmers. Several reviews emphasized another role for intercropping rather than productivity .

Baumann (2004) stated that the intercropping gained an increasing interest in an attempt to substantiate functional agricultural biodiversity production and to reduce pesticide use.

Ibrahim (2005) summarized the benefits and advantages of forage intercropping as following; increase the yield, improve the growth of the forage interfering into intercropping, legumes in intercropping maintain the levels of nitrogen in the soil, the existanse of legumes and grasses in the intercropping system reduces animal bloat, increase palatability, more effective in maintance of the soil from ersion, improve soil texture and structure and give abalanced fodder.

2.6 Types of intercropping:

Numerous types of intercropping , all of which vary , according to the temporal and spatial mixture , to some degree , have been identified. Intercropping is divided into the following four groups (Andrews and Kassam., 1976):

2.6.1 Row intercropping:

Growing two or more crops simultaneously where one or more crops are planted in regular rows, and crop or other crops may be grown simultaneously in a row or randomly with the first crop .

2.6.2 Mixed intercropping:

Growing two or more crops simultaneously with no distinct row arrangement. This type can be suitable for grass – legume intercropping in pastures.

2.6.3 Strip intercropping:

Growing two or more crops simultaneously in different strips wide enough to permit independent cultivation but narrow enough for the crops to interact agronomically.

2.6.4 Relay intercropping:

Growing two or more crops simultaneously during part of the life cycle of each a second crop is planted after the first crop has reached its reproductive stage but before it is ready for harvest.

Further temporal separation is found in relay cropping where the second crop is sown during the growth (often near the onset of reproductive development or fruiting) of the first crop , so that the first crop is harvested to make room for the full development of the second (Tarbal., 2010) .

2.7 Cereal -legume intercropping:

Legume intercropping system play a significant role in the efficient utilization of resourses , mixed cropping with cereal and legumes not only improved soil fertility, but may also provide yield advantage to the cereal crops which may enhance net returns. Cereal – legume intercropping is more productive and profitable cropping system in comparison with solitary cropping (Evans *et al* . 2001).

Carruthers *et al* .,(2000), measured the yield component responses of corn intercropped with soybean and found that corn grain yield , plant height , number of kernels per cob were not different when grown mono cropping or intercropping . While soybean yield components were adversely affected by the presence of the taller corn compound and there was a decrease in yield for intercrop than mono- cropping system.

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.

Forage intercropping is defined as the mixed forages containing 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) . Abusuwar and Omer (2011), noted that sole crops produced forage with thicker stems during the growth of the first crop , while intercropped plants treated with phosphorus developed thicker stems during the second cut . 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. Intercropping cereal and legume crops help to maintain and improve soil fertility. In legume – cereal combination, the legume suffers from competition depression especially when companied with C-4 cereals likes maize under high soil vertical conditions . The legumes play an important role in nitrogen fixation and are important source of nutrition for both humans and livestock (Nandwa *et al* .2011).

In particular forage quality of cereals is usually lower than that required to meet satisfactory production levels for many categories of livestock. Intercropped companion cereals provide structural support for legume growth, improve light interception and facilitate mechanical harvest. Also they gave the farmers option of producing both carbohydrates and protein at a time (Tilahun *et al* ., 2012).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Experimental site:

The study was carried out at the Demonstration farm, Sudan University of Science and Technology , College of Agricultural Studies, Shambat (latitude 15: 40ºN, longitude 32 : 35 ºE, and 380 meters above sea level ; during the summer season from 1/4 to 15/6 /2016 . The climate of the area is semi – desert with a low relative humidity and average rainfall of 158 mm per annum .A mean temperature of 20.3ºC – 36.1ºC. The soil of Shambat is clay soil characterized by deep cracking , moderately alkaline clays and low permeability, low nitrogen content and pH 7.5-8.7 (Abdel Hafeez.,2001).

3.2 Land preparation:

The land was disc ploughed , disc harrowed, ridged and then leveled the ridging was North –south .The spacing between ridges was 70 cm, the size of the plot was 2×3 meter .

3.3 Source of seed:

The seeds used in this study consisted of two fodder crops :

1- Phillipsara, local variety from Agricultural Research Centre (Shambat).

2- Maize, local variety from College of Agricultural Studies, Sudan University of Science Technology (Shambat).

3.4 Treatments layout:

Randomized complete block design (RCBD) with three replications was used to layout the experiment in the field. The experiment comprised of four treatments which were the combination of different cropping systems, control (maize)(A), intercropping using 25%phillipsara with 75% maize (1:3**)** (B) in the same hole, 50% phillipsara with 50% maize (1:1)(C), and75% phillipsara with 25% maize (3:1)(D). Irrigation was applied every 8 days, and harvesting was 75 days after sowing**.**

3.5 Data collection and analysis:

3.5.1 Plant height (cm):

Three plants of maize were randomly selected from each plot and the plant height was measured from soil surface to the tip of the flag leaf using a measuring tape , then the mean height was obtained . The height was measured every 15 days at 30 , 45 , 60 and 75 days .

3.5.2 Number of leaves per plant:

Three plants of maize were randomly selected from each plot and the average number of leaves per plant was counted, every 15 days at 30 , 45 , 60 and 75 days.

3.5.3 Stem diameter (cm):

Three plants of maize were randomly selected from each plot and the stem diameter in the middle of the plant was measured using a measuring tape and ruler and then the mean stem diameter per plant was estimated, every 15 days at 30 , 45 , 60 and 75 days.

3.5.4 Forage fresh weight per plant (g):

At harvest three plants from each plot were taken and weighed. And the mean weight per plant was calculated.

3.5.5 Forage dry weight per plant (g):

The previous three plants were dried in an oven at (80ºC) for 48 hours and then weighed to get the average dry weight per plant.

3.5.6 Statistical analysis:

The data were analyzed according to the standard statistical procedure for a randomized complete block design, using MSTAT-C,computer program. Means were separated by Least Significant Difference (L.S.D),Gomez and Gomez (1984).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 RESULTS:-

4.1.1 Plant height (cm):

The analysis of variance revealed significant differences among the four treatments on plant height (Table1) and Appendix I (A) . There was no difference between the control and 25% phillipsara which are significantly higher than the 50% and 75% philipsara (Table 2). The maximum plant height (148.20cm) was recorded by the treatment 25% phillipsara with 75% maize (B) , and the minimum height (134cm), was found in treatment 75% phillipsara with 25% Maize (D).

4.1.2 Number of leaves per plant:

Significant differences were found among the four treatments on number of leaves (Table 1) and Appendix I (B) .The maximum number of leaves per plant (13.33) was recorded by the treatment 50% phillipsara with 50% maize(C) , and the minimum number of leaves per plant (12.43), was found in the control treatment(A)(Table 2).

4.1.3 Stem diameter (cm):

The analysis of variance revealed significant differences among the four treatments on stem diameter (Table 1) and Appendix I (C). There was no significant difference between control and 25% phillipsara , which were significantly higher than 75% phillipsara (Table 2). The maximum stem diameter (8.05 cm) was recorded by the control treatment(A), and the minimum stem diameter (5.71) was found in treatment 75% phillipsara with 25% maize(D) .

4.1.4 Forage fresh weight per plant (g):

The analysis is of variance revealed no significant differences in fresh weight among the four treatments (Table 1) and Appendix I (D). The highest fresh weight of (305.40g) was recorded by 25%phillipsara with 75% maize(B), and the least fresh weight (238.90g) was recorded by the control (A) as shown in Table (2) .

4.1.5 Forage dry weight per plant (g):

The analysis is of variance revealed no significant differences in dry weight among the four treatments (Table 1) and Appendix I (E).The highest dry weight of (108.90g)was recorded by 25%phillipsara with 75% maize (B) and the lowest fresh weight (73.33g)was recorded by the control (A) as shown in Table(2).

Table -1: The mean squares of some growth characters of maize as affected by intercropping with Phillipsara

Source of variation	Degree of freedom	F.values				
		Plant height(cm)	Number of leaves / plant	Stem diameter (cm)	Fresh weight (g)	Dry weight (g)
Replication	2	4.02	0.74	0.53	3.72	1.91
Treatment	3	0.08*	0.35*	0.19*	0.09 NS	0.23 NS
Experimental Error	6	-	-	-	-	-
Total	11	-	-	-	-	-
Error Mean square	-	376.27	1.28	1.54	4881.14	1275.64
C.V%	-	8.60	8.72	17.94	25.66	39.55
LSD(0.05)	-	8.75	2.26	2.48	13.96	71.36
SE±	-	1.20	0.65	0.72	4.03	2.06

NS = non significant * = significant ($P \leq 0.05$) ** = high significant ($P \leq 0.01$)

Table-2: Means of maize as affected by different phillipsara combinations

Treatments	Plant height(cm)	Number of leaves	Stem diameter(cm)	Fresh
Control,Maize (A)	141.00 a	12.43 a	8.05 a	2
25%Phillipsara with 75% Maize (B)	148.20 a	13.00 a	7.51 a	3
50%Phillipsara with 50%Maize (C)	136.60 b	13.33 a	6.40 a	2
75%Phillipsara with 25%Maize (D)	134.00 b	13.11 a	5.71 b	2
C.V%	8.60%	8.72%	17.94%	2
LSD(0.05)	8.75	2.26	2.48	
SE±	1.20	0.65	0.72	

Means followed by the same letter for each treatment are not significantly different at 5% leve

4.1.6 Relative Growth Rate (RGR):

Relative growth rate(exponential growth rate) is the growth relative to the size of the population. In plant physiology (RGR) is measured to quantify the speed of plant growth. It is measured as the mass increase above ground biomass per day.

4.1.6.1 Plant height (cm):

The exponential growth was clear in all growth stages 30,45,60 and 75 days for plant height (Figure-1).The maximum plant height of (75.13cm) in 30 days was recorded by 25% phillipsara with 75%maize(B) and the minimum height (59.71cm) was recorded by 50% phillipsara with 50% maize(C). In 45 days the maximum plant height of (103.40cm) was recorded by 25% phillipsara with 75% maize(B) the minimum height (73.18cm) was recorded by 75% phillipsara with 25 % maize (D). In 60 days the maximum plant height (131.73cm) was recorded by 25 % phillipsara with 75% maize(B) , and the minimum height (119.83cm) was recorded by 75% phillipsara with 25% maize(D) . In 75 days the maximum plant height (148.20cm) was recorded by 25% phillipsara with 75%maize(B) and the minimum height (134cm) was recorded by 75% phillipsara with 25%maize(D).

4.1.6.2 Number of leaves per plant:

The exponential growth was not consistent for all growth stages inspite of the higher growth at 75 days for number of leaves (Figure-2). The maximum number of leaves per plant (8.03) in 30 days was recorded by 50%phillipsara with 50% maize(C) and the minimum number of leaves per plant (6.62) was recorded by the control(A) . In 45 days, the maximum number of leaves per plant (10.91) was recorded by 50%

phillipsara with 50%maize (C) , the minimum number of leaves per plant (10.15) was recorded by control(A) . In 60 , days the maximum number of leaves per plant (12.41) was recorded by 50% phillipsara with 50%maize (B), while the minimum number of leaves per plant (11.89) was recorded by the control(A) . In 75 days, the maximum number of leaves per plants (13.33) was recorded by 50%phillipsara with 50% maize (C) and the minimum number of leaves per plant (12.43) was recorded by the control (A).

4.1.6.3 Stem diameter (cm):

The growth rate was increasing with the plant age for stem diameter (Figure-3) . The maximum stem diameter (2.94 cm) in 30 days was recorded by 50 % phillipsara with 50%maize(C) and the minimum stem diameter (2.06 cm) was recorded by 75%phillipsara with 25% maize(D) . In 45 days, the maximum stem diameter (4.81cm) was recorded by 50% phillipsara with 50% maize(C), the minimum stem diameter (3.01cm) was recorded by 75%phillipsara with 25% maize(D) .In 60 days, the maximum stem diameter (6.03 cm) was recorded by 50%phillipsara with 50%maize(C) and the minimum stem diameter (4.36) was recorded by 75%phillipsara with 25% maize(D) . In 75 days ,the maximum stem diameter (8.05cm) was recorded by 50%phillipsara with 50% maize(C) while the minimum stem diameter (5.71cm) was recorded by 75% phillipsara with 25% maize(D).

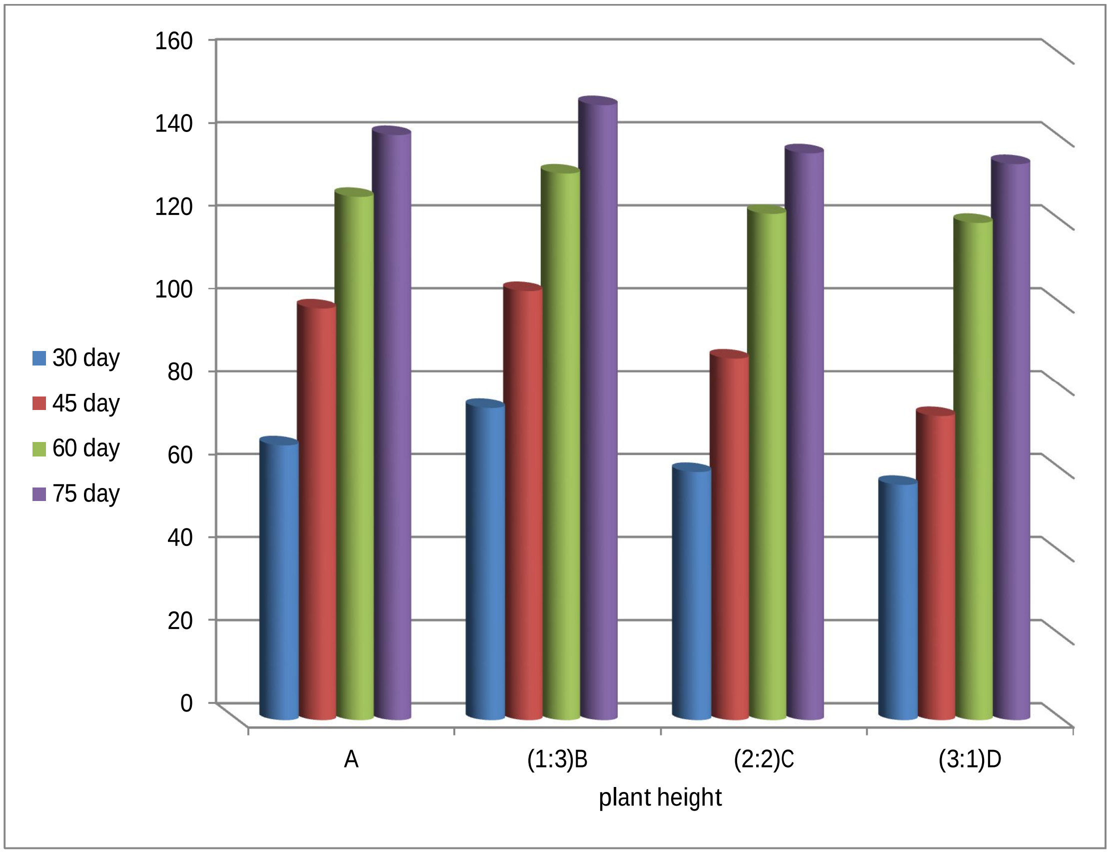

Figure (1): Mean plant height (cm) of maize intercropped with phillipsara along the growing season.

Treatments:-

(A) 100% maize.

(B) 25% phillipsara with 75% maize(1:3).

(C) 50% phillipsara with 50% maize(2:2).

(D) 75% phillipsara with 25% maize(3:1).

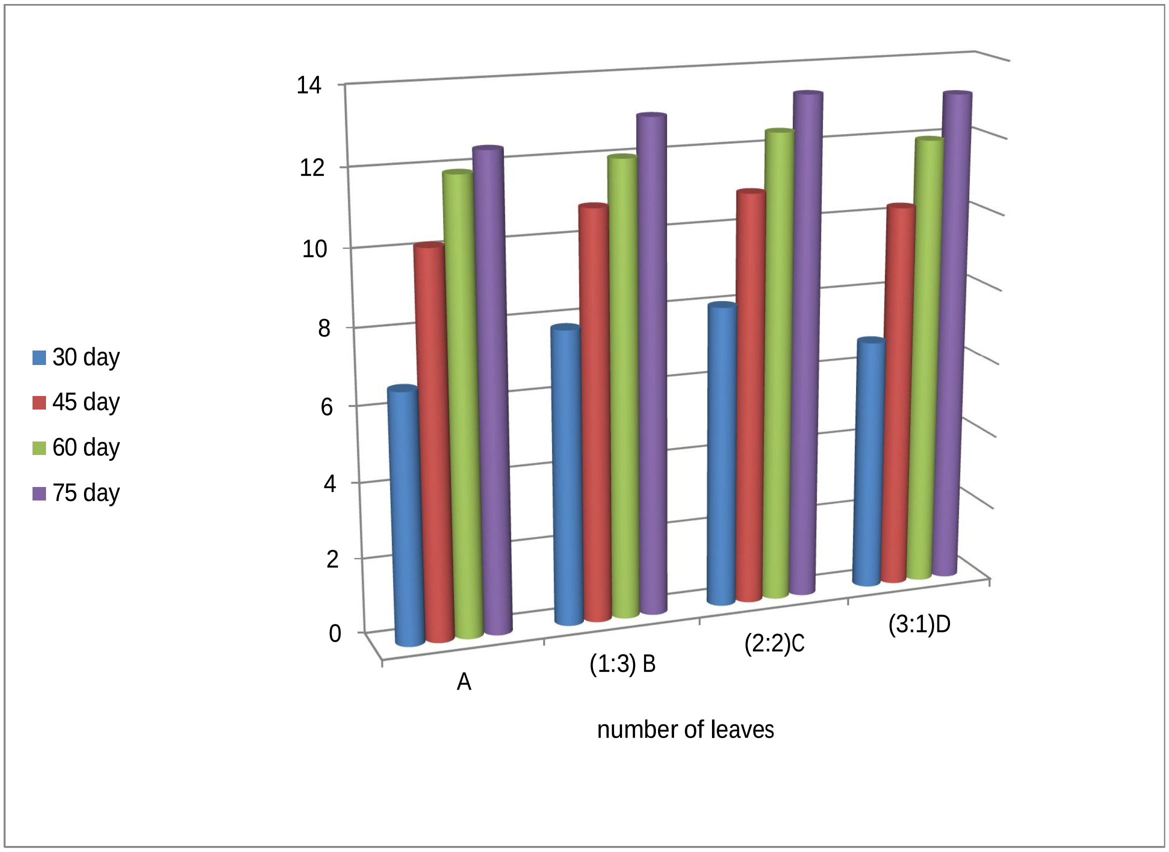

Figure (2): Mean number of leaves per plant of maize intercropped with phillipsara along the growing season.

Treatments:-

(A) 100% maize.

(B) 25% phillipsara with 75% maize(1:3).

(C) 50% phillipsara with 50% maize(2:2).

(D) 75% phillipsara with 25% maize(3:1).

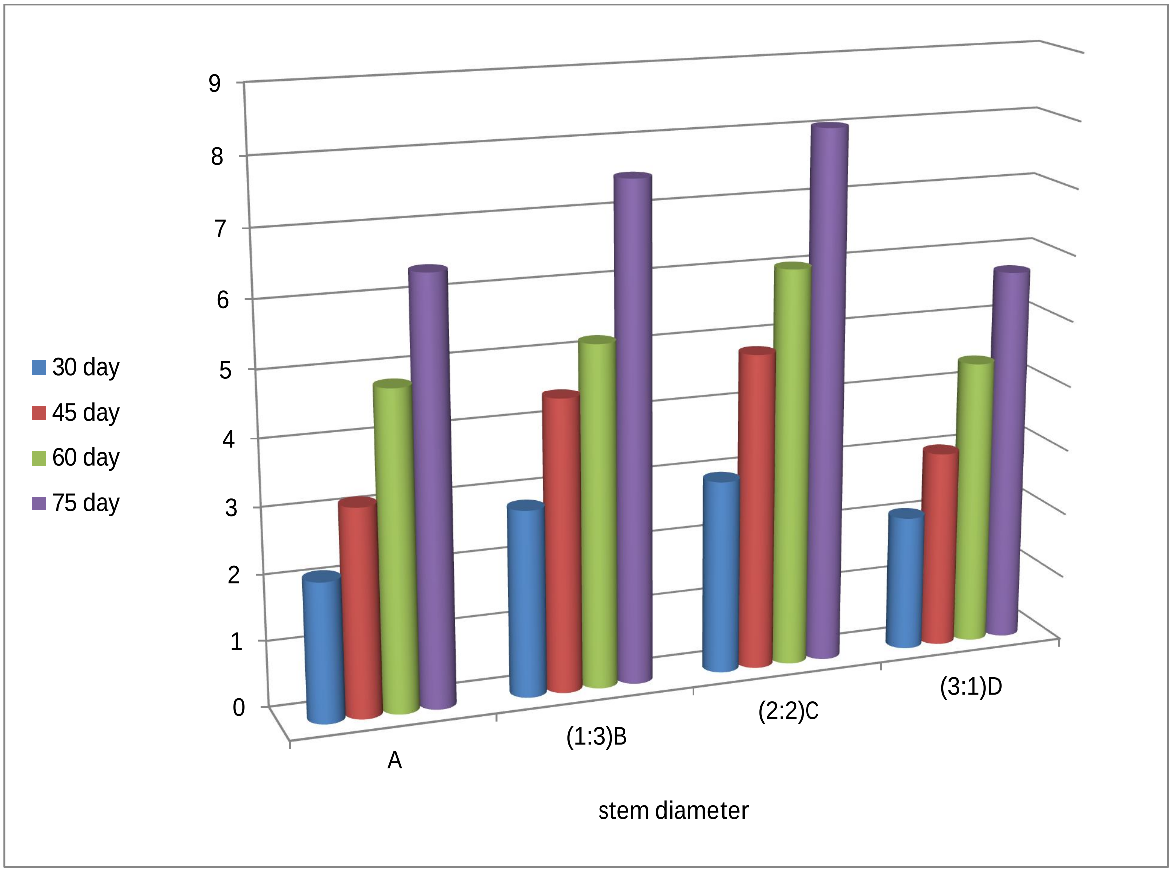

Figure (3): Mean of stem diameter (cm) of maize intercropped with phillipsara along the growing season.

Treatments:-

(A) 100% maize,

(B)25% phillipsara with 75% maize(1:3).

(C) 50% phillipsara with 50% maize(2:2),

(D) 75% phillipsara with 25% maize(3:1).

4.2 DISCUSSION

The significant increase in plant height may be due to response to nitrogen, as it was indicated that nitrogen enhanced and significantly increased plant height. Similar results were reported by Gokmen *et al* ., (2001) and Moraditochaee *et al* ., (2012). These results were different from Woomer *e tal* .,(2004) who reported that maize height was reduced by 23% when intercropped with cowpea.

Number of leaves per plant was significant different among the four treatments. This may be due to the fact that maize fully utilized the nitrogen fixed by phillipsara . Similar results were observed by Ayube *et al* ., (2003) and Nadeem *et al*., (2009)who found that the increase in number of leaves per plant could be ascribed to the fact that nitrogen often increases plant growth and plant height and production of leaves.

The results of analysis of data collection from the experiment showed that there were significant differences in the character of stem diameter between the four treatments . This may be due to the fact that maize utilized the nitrogen fixed by phillipsara. Similar results were reported by Bakht *et al* ., (2006) and Cheema *et al*., (2010), who found that nitrogen significantly increased stem diameter.

The results showed that there were no significant differences in the character of fresh weight between the four treatments. This may be due to the fact that maize utilized the little nitrogen fixed by phillipsara . This result was similar to that observed by Mohta and De., (1980) for maize / soybean intercropping, who found that the yields of the creals were not affected by intercropping with soybean. This result was similar to Ahmed ., (2012) who indicated that mixing cowpea with maize does not affect much the status of maize fresh weight .

The results showed that there were no statistical differences in the character of the dry weight per plant between the four treatments . This may be due to the fact that nodulation is very poor at the heavy cracking soils of Shambat as stated by Ahmed,(2012) . These results were supported by Carrthers *et al* ., (2000) who found that sole cropping performed better than intercropping . These results were similar to that observed by Adelek., (2011) who indicated that mixing cowpea with maize doesn't affect maize dry weight .

The results along times showed that the trend followed the exponential relative growth rate (RGR) as the growth was increasing with time for all measured characters . These results were in line with (Chave *et al*., 2003; Muller-Landau *et al*., 2006 and Sillett *e t al*., 2010) who found that canopy plant may be considerd to grow asymptotic in terms of height , even as their growth and biomass may increase without limit.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

5-1 Summary:

The effect of phillipsara as a forage legume crop on maize as a grass forage crop is necessary for establishment of intercropping method aimed at giving high forage yield and good quality forage .

Significant differences among the four intercropping treatments for growth were observed . The maximum plant height and fresh weight and dry weight recorded were at 25% phillipsara with 75% maize(B) and the maximum number of leaves per plant recorded was at 50% phillipsara with 50% maize(C), the minimum number of leaves per plant was recorded by the control(A) , the maximum stem diameter was recorded by the control(A) and the minimum stem diameter was recorded by 75% phillipsara with 25% maize(D). Characters of maize on forage fresh weight per plant, forage dry weight per plant showed no significant differences while plant height, number of leaves per plant and stem diameter were significant (0.05).

5.2 Conclusions:

1- The intercropping system is more appropriate in terms of sustainability than sole cropping of creals since the legume component will enrich the soil through nitrogen fixation .

2- There was also good ground coverage during intercropping which was important with regard to soil conservation ,especially at the early stages of the maize crop.

3- This study concluded that the higher mixture percentage of the cereal was better than the legume , as 25% phillipsara is far better than 75% phillipsara in plant height , fresh and dry weights.

4- The experiment is recommended to be repeated for another year to confirm the results .

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APPENDIX-I

ANALYSIS OF VARIANACE TABLES

A- Plant height(cm):-

Source	Degree of freedom	Sum of squares	Mean of square	F-value
Replication	2	3025.696	1512.84	4.02
Treatment	3	348.350	116.11	0.08*
Error	6	2257.629	376.27	
Total	11	5631.59		

C.V % = 8.60% $LSD_{0.05}$ =8.75

NS= Non significant

* = Significant (P≤0.05)

** = Highly significant (P≤0.01)

B- Number of leaves per plant:-

Source	Degree of square	Sum of squares	Mean of square	F- value
Replication	2	1.88	0.94	0.74
Treatment	3	1.32	0.44	0.35*
Erorr	6	7.67	1.28	
Total	11	10.87		

C.V % = 8.72% $LSD_{0.05}$=2.26

NS= Non significant

* = Significant (P≤0.05)

** = Highly significant (P≤0.01)

C- Stem diameter(cm) :-

Sourace	Degree of freedom	Sum of squares	Mean of square	F- value
Replication	2	1.64	0.82	0.53
Treatment	3	10.10	3.37	0.19*
Error	6	9.24	1.54	
Total	11	20.98		

C.V % = 17.94% $LSD_{0.05}$=2.48

NS= Non significant

* = Significant (P≤0.05)

** = Highly significant (P≤0.01)

D- Fresh weight (G) :-

Sourace	Degree of freedom	Sum of squares	Mean of square	F-value
Replication	2	36298.04	18149.02	3.72
Treatment	3	7425.50	2475.17	0.09NS
Erorr	6	29286.86	4881.14	
ToTal	11	73010.40		

C.V % = 25.66% $LSD_{0.05}$=13.96

NS= Non significant

* = Significant (P≤0.05)

** = Highly significant (P≤0.01)

E- Dry weight (g) :-

Sourace	Degree of freedom	Sum of squares	Mean square	F- value
Replication	2	4884.71	2442.36	1.91
Treatment	3	2428.15	809.39	0.23NS
Erorr	6	7653.87	1275.64	
Total	11	14966.73		

C.V % = 39.55% $LSD_{0.05}$=71.36

NS= Non significant

* = Significant (P≤0.05)

** = Highly significant (P≤0.01)