بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Agricultural Studies

Variability and Phenotypic Correlation in some Forage Sorghum (*Sorghum bicolor* L. Moench) Genotypes

A Dissertation Submitted To the Sudan University of Science and Technology in Partial Fulfillment of the Requirements for Degree of B.Sc. in Agriculture (Honors)

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الآية

بسم الله الرحمن الرحيم

قال تعالى:

﴿ سُبْحَانَ الَّذِي خَلَقَ الْأَزْوَاجَ كُلَّهَا مِمَّا تُنْبِتُ الْأَرْضُ وَمِنْ أَنْفُسِهِمْ وَمِمَّا لَا يَعْلَمُونَ (36)﴾

الآية رقم ﴿36﴾ سورة يس

Dedication

To the one and only, my Beloved father

To my mother, who gave me hope and care

To my brothers, my sisters

To my supervisor Dr. Atif Elsadig Idris

Special thanks to Dr. Gafar Farah

To my friends and colleagues

Acknowledgement

Firstly I am thanking Almighty ALLAH giving and patience to complete this study- successfully.

Special thanks to my supervisor **Dr. Atif Elsadig Idris,** for his valuable guidance, and advice throughout this study my thanks extechdel to Department of forage breeding, Shambat Research station staff member for providing me with the experiment data.

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Abstract

A field experiment was conducted at the Demonstrated Farm, Agricultural Research Corporation, Shambat during the season 2015-2016, to investigate the genetic variability and phenotypic correlation between some yield and growth characters in forage sorghum (*Sorghum bicolor* L.) genotype. The experiment was laid in a randomizd complete block design (RCBD) with three replications. Characters studied included: growth attributes (Plant height (cm), stem fresh weight (g), days to 50% flowers and stem dry weight(g). The results showed that hight significant variances all the studied characters. Negative correlation was observed between dry weight and Leaf area, Days to 50% flowers, Leaves weight, Number of leaf. The genotype Abjaro×Abnaffain gave the highest value in dry weight.

ملخص البحث

أجريت تجربة حقلية بالمزرعة التجريبية لهيئة البحوث الزراعية شمبات لموسم 2015-2016م وذلك لبحث التباين الوراثي والارتباط بين الإنتاجية وصفات النمو. صممت التجربة باستخدام تصميم القطاعات العشوائية الكاملة مع ثلاثة مكررات شملت مقاييس النمو الخضري التي تمت دراستها طول النبات، وزن الساق الرطب، عدد أيام النضج، الوزن الجاف للساق. أظهرت النتائج وجود فروقات معنوية لكل الصفات تحت الدراسة كما أظهرت النتائج وجود ارتباط سالبي بين الوزن الجاف ,ومساحة الورقة وعدد أيام 50% إزهار والوزن الرطب للأوراق وعدد الأوراق. وقد أعطى الطراز الوراثي Abjaro×Abnaffain أعلى قيمة في الوزن الجاف.

CHAPTER ONE

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) belongs to the family Poaceae (Gramineae), it is an annual plant, self pollinated and has chromosome number of 2n=20 (Poehlman, 1987). It is used primarily as a grain crop as food for human and as feed for animals. However, in sorghum forage varieties .the stem and foliage are used for green chop, hay and silage,

(Poehlman, 1987) reported that the cultivate. Sorghums originated in east Africa 5000 year ago. It's now grown widely in tropics and sub tropics,..Sorghum is a short day plant, but most of it is forage verities are relatively insensitive to photoperiod, its produced successfully on all types of soils, growth being depended upon the relative soil fertility and moisture supply, it is more tolerant to alkaline or saline soils than most cultivated crops and it is also drought tolerant.

In Sudan the traditional animal production and sector depends on natural ranges, which have been threatened by the Enctoachment of the mechanized crop production shemes seasonal bus fires, excessive use around watering sites, desertification and drought therefore, in this environment of scare and unpredictable rainfall. It is necessary to convert large part of the cultivable land into irrigated forage production. In the last twenty years, forage sorghum genotypes, with it's essential components of yield and quality, has become an important research matter in the tropics and up tropics, (Khair, 1999).

Therefore the objectives of study are to:

1. Study genetic variability in some forage *Sorghum bicolor* L. Moench genotypes for dry yield and growth characters.

2. To Calculate the inter-relationship (Correlation) between dry yield and growth characters in these forage sorghum genotypes.
3. To select the most productive genotype among the studied forage sorghum genotypes.

CHAPTER TWO

LITERTURE REVIEW

2.1 Botanical description of sorghum:

Sorghum belongs to family (poaceae), tribe and sub-tribe sorghastrea, this sub-tribe has two genera: cleistachne with four species in southern Africa and India and sorghum, which has wide distribution throughout the warmer regions of the world (poehlman, 1959). Sorghum is often an annual plant with a single stem height from 1-5m it contain nodes and internodes. Tillers come out in some cultivars when they are grown as a ratoon crop. First a single main root is produced from which a large number of much-branched lateral roots are produced. Many adventitious fibrous roots are formed from the lowest nodes of the stem. The stem is usually erect, dry or juicy, insipid or sweet, grooved and nearly oval. The leaves are alternate in two ranks on the stem. The leaf sheaths are 15-55cm long and encircle the stem. The midrib is prominent (Yassin, 2005).

2.2 Economic importance of sorghum bicolor:

Sorghum is world's fifth most important cereal globally and is the dietary staple of more than 500 million people in 30 countries.

It is grown on 40 million ha in 105 countries of Africa, Asia, Oceania and Americas. Africa and India account for the largest share (more than 70%) of global sorghum area while USA, India, Maxico, Nigeria, Sudan and Ethiopia are the major sorghum producers (Kumar *et al.*, 2011). Sorghum is the only viable food grain crop for many of the world's most food insecure people, who live in sub-Saharan Africa. It's importance to food security in Africa is crucial owing to it's uniquely drought tolerance

among cereals and can withstand periods of high temperature. In most of African drought prone countries it was estimated that per capita daily food intake averaged less than 2,000 calories whereas, according to the FAO a daily intake of less than 2,400 calories is indicative of widespread hunger (Taylor, 2003). The importance of sorghum grain as animal feed has been reviewed by many workers (Subramanian and Melta, 2000; Dowliing *et al.*, 2002; Reddy *et al.*, 2000; Kriegshauer *et al.*, 2006). Sorghum grain is significant component of animal feed in the United States, South America, Australia and China and is becoming important in chicken feed in India. In the United States it represents the second most important feed grain following maize.

In Sudan, where the second largest animal wealth in Africa exists, sorghum (forage and residue) constitutes the bulk of the animal feed in the country. Forage sorghum (Abu Sabein) constitutes more than 75% of the area under fodder crops. Livestock in Sudan are traditionally fed on sorghum grain of feterita types produced under rain fed conditions.

Uses of sorghum have been discussed by (Dendy, 1995). Much of the agricultural history of sorghum has been for food, beverage, feed and building materials. It has been used as an industrial crop during the last 100 years.

Mechanization of its cultivation and harvesting has occurred primarily during 1960s. Industrial uses of crop have been for feed, some for starch, the chemical industry and for fuel alcohol. The uses of grain as animal feed have been an important stimulus to global use of sorghum (Dendy, 1995).

2.3 Chemical compositions and nutritive value:

Measured the nutrition value of forage, including content of energy, protein, and when the chemical analysis of forage showed their basic components play an important role in animal nutrition.

(Yassin,2005) In this studies of eight varieties of grasses forage sorghum reported that percentage of protein, minerals and fats decrease with age and increase the proportion of lignin, where the percentage of crude fiber and cellulose for increased a while and change happening in the chemical composition of the advancement of plant age found that the flowing stage. (Idris, 2006). Reported that the nutritive value of leaves and stem decreased when the crops reached grain formation period.

Where also appositive correlation between certain proteins and fats, minerals and cellulose, lignin and crude fiber.

2.4 Forage sorghum varieties:

Forage sorghum varieties can be divided into the following groups:-

a) Sudan grass varieties non-regular juice, many of these items characterized by the high proportion of hydrocyanic acid.
b) Sweet Sudan grass a result of hybridization between sweet durra and sorghum, stem diameter, juice, sweet, low hydrocyanic acid and more palatable.
c) Hybrid variety (first-generation)resulting hybridization between of Sudan grass or Sudan with sorghum such as (SORDAN, SUDAX) is characterized by camel as a harsh market, more yields and more leaves, but some may contain a high proportion of HCN and some are suitable for grazing only.

2.5 Cultural practices:

The cultural practices of forage sorghum has been expressed by (Mohammed 2004) as the following.

2.5.1 Land preparation:

Sudan grass needed good land preparation free of mass. It used deep plough with disk plough the beginning of the process of the texture modification. Then used disc harrow to modify the soil particle size, leveling and the final practices ridging.

2.5.2 Sowing method:

Grown either in prose, covering the seed or plant spray or grown with planter and the distance between the lines, 25-40 cm tall at the cut of hay or green forage 80-100 cm tall at the cultivation of silage. The seeds are placed at a depth of 2.5-5cm depending on soil type.

2.5.3 Seed Rate:

15-75kg per hectare and increase the rate depending on soil fertility and availability of irrigation and the more significant was the legs lift and more palatable.

2.5.4 Fertilization:

You need to fertilize the rich to give rich harvest add fertilizer before planting a full NPK and add nitrogen two weeks after germination, as well as after each inhospitable and vary the appropriate amounts of fertilizer by soil type.

2.5.5 Irrigation:

Troy Ray Mahayap after three weeks of agriculture and irrigated every two weeks and shorten the periods of irrigation the land.

2.5.6 Harvesting:

Forage sorghum varieties it can be harvesting in high of plant 155cm.

2.7 Correlation between different characters in sorghum:

Correlations among characters are of interest to the breeders because they might help in identification of easily measured characters that could be used as indicators for more important, but more complex, characters. They are also useful in planting out the possibilities and limitations of simultaneous improvement of desirable characters (Abdalla, 1991). Correlation among traits could be utilized to enhance the rate of selection respnse in the primary traits (Moll and Stuber, 1974) and yield components (Grafius, 1969). Yassin (1973) attributed the association among characters to pleiotropy or linkage. Adam (1967) reported that, negative associations between different traits might be due to the competition of two developing structures of plant for limited resources like nutrients and water supply.

There is strong evidence in the literature showing significant and positive correlation between grain yield and number of grains per ponical (Kambal and Wetster, 1966; Beil and Atkins, 1967; Liang *et al*., 1968; Dabholkar *et al*., 1970; Kambal and Abu- El gasim, 1976; Orozcomeza and Mendoza Onfre, 1983 and others).

Significant positive correlation between grain yield and kernel weight was reported by Malm, (1968); Sindagi *et al*., (1970); (Abifarin and Pickett 1976); However, Kirby and Atking (1968); Pasha and Munshi (1979) found no correlation between the two characters. Monommed, (1988) found that the grain yield per plant was significantly and positively correlated with number of grains per panicle, panicle diameter, stem diameter, threshing percentage, leaf width and leaf area per plant, were and insignificantly correlated with plant height, 1000- grain weight,

panicle length and days 10 50% flowering. Grain yield had positive and significant association with plant height and leaves per plant (Arunkumar *et al*., 2009) and also with panicle weight, harvest index, 100 seed weight and panicle length (Kumar *et al*., 2012).

CHAPTER THREE

MATERIAL AND METHODS

3.1 Experimented site:

The experimental was conducted in field correlation (ARC) Shambat (Lat 15-39^{o} N, Long 32-31^{o} E). The Agricultural Research during season 2015-2016. The soil is clay- silty non saline, non- sodic with pH 7.8

3.2 Plant materials:

The plant material used in this study consisted from seven genotypes of forage sorghum obtained by crossing between different male and females of forage sorghum. The female was the traditional cultivar Abjaro as shown in table 3.1.

3.3 The experiments design and description :

The design of the experiment was a randomized complete block design (RCBD) with three replications.

The land of the experiment was disc ploughed, disck harrowed and leveled by scraper to obtain fine seed bed. Plot size was 3×4 meter and it contains four ridges, 70 cm apant. The sowing date was at 21 October 2015. The plots were watered before sowing to ensure fine seed bed. Nitrogen fertilizer, Urea was added at the seconds irrigation at the rate of 85 kg t/ha irrigation was hand weeding.

3.4 Data Collection:

After the plants at each plot reached 50% flowering, five different plants were selected and from them the following growth and yield characters were measeared as the following.

3.4.1 Leaf area (cm):

Five leaves taken from fourth internod and measured the leaf area by the plant as the following formula:

Leaf area= maximum lengih × maximum width ×0.75

3.4.2 Dry wight (kg/F):

Measuted by parlance taken as 500 gm from each plot and draied by oven (48 hours) then wight in kg/F.

3.4.3 Day to 50% flowering:

Taken when 50% of the plant in each plot were at butting stage and the date of 50% butting was record.

3.4.4 Leaf weight (g):

Measured an dry basis leaf were detached from stem and were separately airelries.

4.3.5 Number of leaves:

The number of leaves per plant was counted plant of each plot.

3.5 Statistical Analysis:

The collected data were subjected to statistical analysis using randomized completely block design (RCBD) analysis of variance according to (Gomez and Gomez, (1984).

3.5.1 Coefficient of According to the Following Formula:

$$\text{Cv:}\sqrt{ERROR\ MAEN\ SQURE}\ \frac{}{GRAND}\ MEAN$$

3.5.2 Phenotypic correlation:

The collected data it was used to estimate phenotypic covariance between different yield and growth characters. They were used further for computation of phenotypic correlation between different characters, using the formula suggested by Miller et al. (1958).

Phenotypic correlation coefficient (r ph)= σ^2phxy/ $\sqrt{}$ (σ^2 ph x)(σ^2phy)

Where:

σ^2ph x y = phenotypic covariance between two traits (x,y)

σ^2phx =phenotypic variance for trait x, σ^2phy =phenotypic variance for trait y.

Table 3.1: Forage Sorghum Genotypes Used in the Study

Genotypes	Marks
Abjaro × S. 3 Ab 70 I	Abjaro is the female and the other lines are males (pollinators)
Abjaro × S. 3 Ab 70 II	
Abjaro × S. 3 Ab 70 III	
Abjaro × S. 3 Ab 70 IV	
Abjro × Abnaffain I	
Abjaro × S.G51	
Abjro × Abnaffain I	

CHAPTER FOUR

RESULTS

4.1 Phenotypes Variability:

4.1.1 Leaf Area cm^2:

The analysis of variance showed that there were significant difference $p \leq 0.05$ between the genotypes in leaf area. The genotype (Abjaro × S.3 Ab 70 IV) scored the highets value of (597) and the genotype (Abjaro × S. 3 Ab 70.I) (503.1). the C.V was (4.87). Similer results were reported by (Mohammed, 2004)

4.1.2 Dry weight

From the analysis of variance it was clear that there were significant difference between the dry weight genotypes (Abjaro × Abnaffain I) (205.9) was significantly than (Abjaro × Ab 70. II) (179.7) and (Abjaro × SG 51) (177.0). Similer results were reported by (Idris, 2006)

4.1.3 Day to 50% flowers:

From the analysis of variance it was clear that there was clear thet there were significant difference between the day to butting, genotypes (Abjaro × 3 Ab 70 II) (51.00), (Abjaro × SG. 51) (47.00) (Abjaro × S.3 Ab 70II) (45.00). Similer results were reported by (Yasin, 1973)

4.1.4 Leaf Weight:

From the analysis of variance it was clear that therewere significant difference between the leaf weight genotypes (Abjaro × S.3 Ab 70)

(177.6) was a significantly than genotypes (Abjaro × S.3 Ab 70) (77.4I). Similer results were reported by (Idris, 2006)

4.1.5 Number of leaf:

From the analysis of variance it was clear that there were significant difference between the number of leaf genotypes (Abjaro × S.3 Ab 70 III) (10.30), (Abjaro S.3 Ab 70 IV) (10.30), (Abjaro × S.G 51) (10.20) and (Abjaro × S.3 Ab 70 II) (10.00). Similer results were reported by (Mohammed, 2004)

4.2 Phenotypic Correlation:

The results of phenotypic correlation between different characters was shown in table 4.3. These results showed that there was negative and non significant correlations between dry weight and Leaf area, Day to 50% flowers, Leaf weight, Number of leaves.

These results agreed with the results obtained by Idris, 2006, and Mohammed 2004 in their studies in forage sorghum.

Table 4. 1:: Performance of seven crossing sorghum genotypes of the forage yield related rats and yield

Genotypes	Leaf area	Dry weight	Dry to 50% flowers	Leaf weight	Number of leaf
Abjaro × S. 3 Ab 70 I	503.1 c	190.3 ab	45.76 b	77.4 d	8.60 b
Abjaro × S. 3 Ab 70 II	515.9 c	179.7 b	52.00 a	177.6 a	10.00 a
Abjaro × S. 3 Ab 70 III	565.4 ab	192.5 ab	51.00 a	12.4 b	10.30 a
Abjaro × S. 3 Ab 70 IV	597.4 a	198.6 ab	51.00 a	86.00 cd	10.30 a
Abjro × Abnaffain I	574.9 ab	205.9 a	47.00 b	101.00 b	9.1 b
Abjaro × S.G51	532.10 bc	177.00 b	47.00 b	95.03 bc	10.20 a
Abjro × Abnaffain II	529.4 bc	188.00 ab	47.00 b	100.10 b	9.00 b
C.V %	4.87	6.51	1.55	6.88	3.95

Means of the some letter are not signicant at ($P \leq 0.05$) level

Table 4. 2: Mean square from single ANOVA for forage yield and yield related rats of seven crossing Forage sorghum genotypes

Source	Df	Leaf area	Dry weight	Dry to buting	Leaf weight	Number of leaf
Replication	2	4501.47	12.92	2.90	24.254	0.24143
Genotypes	6	3468.50*	17.53**	19.67**	494.375**	1.5485**
Error	12	707.17	3.0067	0.5714	44.603	0.1444
C. V. %		4.87	6.51	1.55	6.88	3.95

Table 4. 3: Phenotypic Correlation between some yield and growth character in seven forage sorghum genotypes

	Leaf area	**Dry weight**	**Day to bott**	**Leav weight**
Dry weight	0.3389 n-s			
Day to bott	0.3074 n-s	-0.0335*		
Leav weight	0.0352 *	-0.2893 n-s	0.3888n-s	
Number of Leaf	0.2176 n-s	-0.3688 n-s	0.6401n-s	0.2942 n-s

n-s, * and ** non significant, significant at 0.05 and significant at 0.01, respectively

CHAPTER FIVE

CONCLUSIONS

Based on the result obtained from this study, it could be concluded that:

1. High variability obtained between forage sorghum genotypes used in this study could be of a great benefit in any forage sorghum breeding program.
2. The results of phenotypic correlation obtained between different characters could be useful in forage sorghum breeding program.
3. The genotypes Abjaro ×Abnaffain was the highest of the dry weight, therefore it could be used by forage sorghum farmers in the Sudan.
4. This work should be repeated another season to confirm the results.

References

1- **Abdalla, H.A.** (1991). Evaluation of exotic and local parental lines of sorghum (sorghum biclor L. Moench.). and their F1 hybrids at different environments, M.Sc., thesis, faculty of agriculture Khartoum university, Sudan .

2- **Abifarin, A.O**. and Picket, R.C (1970) combining ability and hetrosis for yield. Protein, lysine and certain plant characters in 18 diverse inbreds and 65 hybrids in (sorghum. Biclor L. Moench). African soils 15-399-416.

3- **Adams, M.W.** (1967) . basics of yield compensation in crop plants with special reference to the field bean, (*pahseolhus vulgaris* L). crop Sci., 7:505-510.

4- **Arunkumar, B; Biradar, B.D. and salimath, P.M** (2009). Genetic variability and character association studies in Rabi sorghum. Khamataka. J. Agric. Sci, 17:471-475.

5- **Beil, G. M. and Atkins, R. E.** (1967). Estimates of general and specific combining ability in FI hybrid for grain yield and its components in grain sorghum . (Sorghum, Vulgare Pers). J. . crop Sci, 7:225-28.

6- **Dabholkar, A. R; Telang, S. W**. and Patal, K.C. (1970) correlations in sorghum hybrid. J. Sci, cult. Pp 36: 466.

7- **Dagash, Y. M. (2005).** Qatar University pp112-117.

8- **Dendy, D.A.V** (1995) sorghum and the millet: production and importance evolution 4: 787-802.

9- **Dowling, L**. F. Amdt, C. and Hamaker, B. R. (2002). Economic viability of high digestibility sorghum as feed for market broilers J. Agron, 94:1050-1058.

10- **Gomez, K. A. and A. A. Gomez** 1984.Statistical Procedures for Agricultural Research 2nd .Ed. Johon Wiley And Sons, Inc. Newyork. Grain Yield Response Aust .J. Agric. Res 29: 897-912.

11- **Grafius. J. E. (1969).** Stress: A necessary ingredient of genotype by environment interaction. Pp 346-355 in 2nd int. Barely Genetics Symp.

12- **Idris, A. E.** (2006) evaluation of some lince of forage sorghum (*Sorghum bicolor* L. moench) for hybrids production in the Sudan. Ph.D. this, faculty of agriculture , university of Khartoum.

13- **Kambal, A. E. and Abu El-Gasim, E. H.** (1976). Manifestations of heterosis in grain sorghum and relations among components of yield, Weight per bushel and height. J. Crop Sci., 6:513-515.

14- **Kambal, A. E.** and Webster, O. J (1966). Manifestation of hybrid vigor in rain sorghum and the relations among the components of yield, weight per bushel and hight. J. grop Sci, 6: 513-515.

15- **Kirby, J.S and R.E** Atkins (1968). Hetrosis response for vegetative and mature plant characters in grain sorghum, (*Sorghum bicolor* L Moench) J . Grop Sci, 8:335-339.

16- **Kriegshauser, T. D.; Tuinstra, M. R. and Hancock, J. D.(2006).** Variation in nutritional value of sorghum hybrids with contrasting seed weight characteristics and comparisons with maize in broiler chicks] J. Crop Sci., 46: 69-695.

17- **Kumar, A; Reddy**, B.V.S: Ramahiah, B. and Sharma. R (2011). Heterosis in white – grained grain mold resistant sorghum hybrids. J. of SAT. Agric. Research 9:1-6.

18- **Kumar, N.V; Reddy**, C.V.C and Reddy, P.V.R (2012) study on character association in Rabi sorghum plant archives 12: 1049-1051.

19- **Liang, G. H. L; Heyne**, E.G; Change , J.H. and Koh, Y.O. (1968). The analysis of heritable variation for three agronomic traits in ab-variety

20- **Malam, N.R. (1968).** Exotic gemplasm use in grain sorghum improvement J. Crop Sci, 8:295-298

21- **Mohammed M. I. (2004)**. Breeding for forage sorghum (sorghum bicolor l.moench) in the Sudan using stocks as males and introudeced stocks as females. Ph.D there faculty of agriculture university of Khartoum.

22- **Mohammed, Maarouf, I**. (1988). Agronomic performance and genetic variability or some Venezuelan sorghum mutants and some local sorghum cultivars. (sorghum bicolor L. Moench). M.Sc thesis faculty of agriculture U. of K.

23- **Moll , R. H. and Stuber,** C.W (1974) quantitative genetics. Empirical results relevant to plant breeding. Adv. Agron. 26:313-317 .

24- **Orazco Meza, F.D.E.J** and Mendoza Onofre, L.E (1983). Comparison of sorghum hybrids, (*sorghum bicolor*, L Moench) and some of their progenitors. Agrociencia. Sorghum and millet Abstr. 9: (10) Abstr. No-754.

25- **Pasha, M. A. M. and Munshi, Z. A. (1979).** Correlation studies in sorghum (Sorghum bicolor L. Moench). Agriculture Pakistan. 24: 245-259.

26- **Poehlman, H.M. (1959)** breeding filed crops Holt, Rinenant and Winston, inc new York pp279-304.

27- **Poehlman, J. M. (1959).** Breeding field ccrops 3rd Ed- An avi Book. Published by Van Nostw and Rejnhold. New York. Pp.508-555.

28- **Sindagi, S.S; Swarup, V. and singh** , D (1970) variation and heritability of some qualitative characters in F2 progenies of intervarietal crosses of sorghum. Indian. J. gent. Plant Breed . 30:

29- **Subramanium, V. and Metta V. C. (2000).** Sorghum grain for poultry feed. In: Technical and institutional options for sorghum grain mold management (eds.) Chandrashekar, A., Bandyopadhyay R., and Hall, A. J. Proceedings of an international consultation, 18-19 May 2000, ICRISAT India pp 242-247.

30- **Taylor, (2003)**. overview importance of sorghum in Africa available from: www.afripro.org.uk/papers/paper01taylor.pdf.

31- **Yasnin, T.E. (1973)**. Genotypic and phenotypic variances and correlations in faba bean (*Vicia Faba* L) J. agric. Sci. (camb) 81:445-448.