Agricultural and Biological Sciences Journal
Vol. 1, No. 4, 2015, pp. 162-166
http://www.aiscience.org/journal/absj

Performance of Some Sorghum (*Sorghum Bicolor* L. Moench) Varieties Under Rain-Fed Condition at Zalingei Area, Sudan (Growth, Yield, Pests and Diseases)

Ali H. Bahar[1], Kamal I. Adam[2], Siddig A. Mohamed Ali[1, *]

[1]Faculty of Agriculture, Department of Agronomy, University of Zalingei, Zalingei, Sudan
[2]Faculty of Agriculture, Department of Crop Protection, University of Zalingei, Zalingei, Sudan

Abstract

A field experiment was conducted at the University of Zalingei demonstration farm (Zalingei, Sudan) during 2013/ 2014 rainy season, to investigate the effect of sowing date and variety on growth, yield, pest and disease performance of some sorghum (*Sorghum bicolor* L. Moench) varieties and local genotypes grown at Zalingei area under rain fed condition. Treatments consisted of three sowing dates (7th July, 10th July and 15th July) and four sorghum varieties and genotypes (Tabat, Wad-Ahmed, Abu-ragaba and Abu-kunjara). Treatments were arranged in split plot design replicated four times with sowing dates in the main plots and varieties in the subplots. Parameters measured were number of leaves/plant, leave area (cm^2) and stem diameter (cm), 1000 grain weight (g) and yield (kg/feddan). Data were statistically analyzed using MSTAT-C software program. Data about pests and diseases were collected by field survey three times during the season at seedling, at vegetative growth stage and at harvest. Primary diagnosis of pest and disease infection was done in the field through visual observation using hand lens. Samples of infected plants were taken to the laboratory for further investigation. Results showed that significant differences ($p \leq 0.05$) were found for number of leaves/plant in the third count and the leave area. Concerning stem diameter results showed no significant differences for different varieties. Results revealed significant differences ($p \leq 0.05$) in number of leaves/plants and leave area during different sowing dates. In case of stem diameter results revealed no significant differences for different sowing dates. Yield results revealed that no significant differences were found. Interaction of sowing date × variety showed significant difference ($p \leq 0.05$) for all parameters measured. Pest and disease results obtained revealed that damping-off of young seedlings was considered to be the most important disease that affect Barbarei at seedling stage, both pre- and post emergence damping-off were observed. Results showed that both sorghum genotypes (Barbarei) - Abu-ragaba and Abu-kunjara- were found to be more affected by disease incidence especially in second sowing date (24.8% and 23% respectively) compared to Tabat and Wad-Ahmed (9.7% and 9.1% respectively). At vegetative growth stage, stem borer was observed equally in all sorghum varieties and Barbarei. With regard to diseases, a bacterial leaf streak was detected.

Keywords

Sorghum, Varieties, Performance, Pests, Diseases, Rain-Fed, Zalingei

Received: April 21, 2015 / Accepted: May 2, 2015 / Published online: June 12, 2015

1. Introduction

Sorghum is the second most important cereal in sub-Saharan Africa. The crop represents a large portion of the total calorie intake in many countries. Five properties make sorghum the staple of choice in addressing nutritional challenges in Africa

* Corresponding author
E-mail address: alibahar9@yahoo.com (K. I. Adam), siddig998@yahoo.com (S. A. M. Ali)

which include the following: Sorghum is a physiological marvel. It can grow in both temperate and tropical zones. It has one of the highest dry matter accumulation rates, is one of the quickest maturing food plants and has the highest production of food energy per unit of energy expended. Sorghum thrives on many marginal sites.It withstands high rainfall and even water logging.Most importantly, it can endure hot, dry and arid conditions. Sorghum can be grown in innumerable ways. Most is produced under rain-fed conditions, some is irrigated, some is transplanted and it can be allowed to re-sprout from the roots, it is ideal for subsistence and commercial farmers. It has a remarkable array of untapped variability in grain type, plant type, adaptability and productive capacity.Sorghum probably has more undeveloped and underutilized genetic potential than any other major food crop (Onwueme and Sinha, 1999, Rohweder et al., 1965, Eurek, 2010, U.SGrains Council, 2010, Wikipedia contributors, 2006, Harlan De Wet ,1972 and Oelke, 1971). Pasturing cattle or sheep on sorghum stubble, after the grain has been harvested, is a common practice. Both roughage and dropped heads are utilized. Before the 1940s, most grain sorghums were 5-7 feet tall, which created harvesting problems. Today, sorghums have either two or three dwarfing genes in them, and are 2-4 feet tall. While there are several grain sorghum groups, most current grain sorghum hybrids have been developed by crossing Milo with Kafir. Other groups include Hegari, Feterita, Durra, Shallu, and Kaoliang. Grain yields decrease as planting is delayed after early June. Most sorghum plants take 90-120 days to mature, therefore late-planting as an emergency crop is not recommended. (Robinson et al., 1977; Oplinger, 1973; Oelke, 1971; Vanderlip, 1972; Taylor, 1988 and Cooperative Extension Service, 1987). For diseases there are numerous diseases of sorghum. Leaf diseases are the most troublesome for forage producers. These are anthracnose caused by *Colletotrichumgraminicola* (which can be overcome by using resistant varieties) and leaf blight caused by *Helminthosporiumturcicum*. Charcoal rot (*Macrophominaphaseoli*) causes plants to lodge badly. Grain may be affected by covered smut (*Sphacelothecasorghi*) in which the seed is replaced by a sac of spores; fungicidal seed dressing before planting corrects this malady. The parasitic weed *Strigahermonthica* occurs in Africa. Concerning the pests, grasshoppers would appear to be the worst pest for forage sorghum. Grain pests include the sorghum midge, *Contariniasorghicola*, whose larvae feed on the developing seeds. Bird damage is also important and in Africa the weaver bird, *Queleaquelea*, causes major losses. Therefore, there is a need to concentrate on the crop management .This study aimed to investigate the effect of sorghum varieties, sowing date and their interactionon growth and yield of sorghum.The Study also aimed to investigate pest and disease performance of sorghum grown under rain-fed conditions in Zalingei area, Sudan.

2. Materials and Methods

A field experiment was conducted at the University of Zalingei demonstration farm. (Central Darfur State, Zalingei) Latitude 120 54´N; longitude 230 29´ E and altitude 900 m above mean sea level, during 2013/ 2014 rainy season, the objectives of this study is to investigate growth, yield, pest and disease performance of some sorghum (*Sorghum bicolour* L. Moench) varieties and local genotypes under rain fed condition. Treatments consisted of three sowing dates (7th July, 10th July and 15th July). Four sorghum varieties (Abu-ragaba and Abu-kunjara) genotype locally named (Barbarei) obtained from South Darfur local farmers, Tabat and Wad-Ahmed which are locally improved varieties from ministry of agriculture Central Darfur State. Treatments were arranged in split plot design replicated four times with sowing dates in the main plots and varieties in the subplots. The size of the main plots and subplots were 12×3 and 3×3 m respectively. The two sorghum genotypes (Abu-ragaba& Abu-kunjara) named Barbarei grown by direct seeding (Barbarei was usually grown by transplanting in South and West Darfur) beside two other sorghum varieties (Wad-Ahmed and Tabat) in order to evaluate the agronomic performance and resistance to pests and diseases. Measurements of vegetative growth attributes were carried on plant samples from the three central rows of each plot. Five plants were selected randomly from each plot and tagged for vegetative growth attributes. The number of leaves / plant and leaf area measured after 60 days from sowing when plants showed good vegetative growth. Leaf area was obtained on basis of Marshal Formula (Marshall, 1968). The stem diameter (cm) was measured by using Vernia Clipper instrument when plants reached full maturity. Study about pests and diseases were carried out from the same experimental units.Data about pests and diseases was collected by field survey three times during the season: at seedling, at vegetative growth stage and at harvest. Primary diagnosis of pest and disease infection was done in the field through visual observation using hand lens. Samples of infected plants were taken to the laboratory for further investigation. Materials used include microscope, hand lens, Petri dishes, slides, PDA, Alcohol, pigments. For damping-off disease, incidence was calculated using the following formula:

Disease incidence = No. of diseased (seed & seedlings)÷ Total No. of sown seeds (%).Plants were left in the field for 25-30 days after maturity; this was meant to allow for complete maturity and minimum grain moisture content to

prevent rotting later on. The crop was manually harvested by using traditional implement and stored in paper bags at room temperature for a month to complete drying. Thereafter, Heads harvested from each plot were threshed and the weight of grain was determined, this was used in calculation of grain yield per feddan. A random sample of 1000- grains was taken from each plot and then weighed to obtain 1000-grain weight. Data collected were statistically analyzed. Analysis of variance and test of significance were done according to standard procedure of split plot design (Gomez and Gomez, 1984) using MSTAT-C software program.

3. Results and Discussion

As illustrated in Fig.1 results revealed that first sowing date plants (7th July) gave the highest number of leaves/plants for both three counts, followed by second sowing date plants (10th July) then the third sowing date plants (15th July). This could be attributed to higher rates of rain fall at the start of rainy season beside of good distribution of rain amounts which makes suitable conditions of intensive germination and vegetative growth.

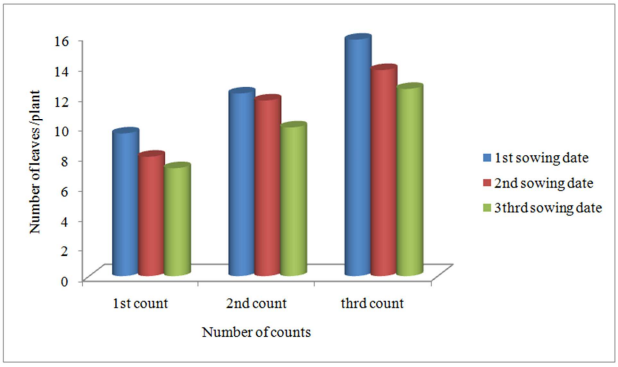

Fig. 1. Effect of sowing date on number of leaves/plant.

Results in Table1 revealed that number of leaves/plants for the third count showed significant differences ($p \leq 0.05$) between the local sorghum varieties (Tabat, Wad-Ahmed) and local sorghum genotypes, known as Barbarei (Abu-ragaba, Abu-kunjara).Results showed that Wad-Ahmed gave the highest number of leaves/plant (15.25) followed by Abu-ragaba and Abu-kunjara (14.82, 13.38) respectively then followed by Tabat as lowest number of leaves/plant (12.52). This could be due genetic factors rather than environmental conditions which similarly affected in the field.For leave area results in Table2showed significant differences ($p \leq 0.05$) between the local sorghum varieties (Tabat, Wad-Ahmed) and local sorghum genotypesBarbarei (Abu-ragaba, Abu-kunjara).Wad-Ahmed and Abu-ragaba showed the highest leave area (671.8cm^2; 616.1 cm^2) respectively followed by Tabat (524.4 cm^2) then finally Abu-kunjara (451.5 cm^2).Concerning stem diameter results showed no significant differences for different varieties.

Table (1). Effect of variety on plant growth parameters.

Varieties	Number of leaves/ plant	Leave area(cm^2)	Stem diameter(cm)
Tabat	12.52b	524.4b	1.95 a
Wad-Ahmed	15.25a	671.8a	1.94 a
Abu-ragaba	14.82ab	616.1a	1.98 a
Abu-kunjara	13.38ab	451.5c	1.98 a
LSD	2.28*	66.28*	0.20 ns
S.E	0.71	20.72	0.06

Note: *significant at 0.05 levels. Ns=not significant.

Results shown in Table 2 revealed significant differences ($p \leq 0.05$) in number of leaves/plants during different sowing dates. Highest number of leaves/plant was obtained in first sowing date (15.74), followed by second sowing date (13.74), then at last the third sowing date (12.50). For leave area results revealed significant differences ($p \leq 0.05$) during different sowing dates. The second and third sowing dates performed better in leave area (670.4 cm^2, 603.2 cm^2) while the first sowing date showed the lowest leave area (424.2 cm^2). In case of stem diameter results revealed no significant differences for different sowing dates.

Table (2). Effect of sowing date on plant growth parameters.

Sowing dates	Number of leaves/ plant	Leave area(cm^2)	Stem diameter cm
7th of July	15.74a	424.2b	1.96 a
10th of July	13.74ab	603.2a	2.02 a
15th of July	12.50b	670.4a	1.90 a
LSD	2.63*	76.54*	0.23ns
S.E	0.82	23.92	0.07

Note: *significant at 0.05 levels. Ns=not significant.

As shown in Table 3 results revealed that no significant differences on yield components between varieties and genotypes.1000 grain weight varied from 29.25 g for Wad-Ahmed as highest weight to 22.17 g for Abu-ragaba as lowest weight. The highest yield was obtained by Abu-Kunjara (226.2 kg/feddan), while Wad-Ahmed produced the lowest yield (47.6 kg/feddan). Results showed that sowing dateshad insignificant effect on yield (kg/feddan) and 1000 grain weight (g) (Table 3).These results are in line with results obtained by manyresearchers (Bandiougou,2012) reported that Grain yield and yieldcomponents were influenced by planting date, the effects ofplanting dates on growth, development, and yield of grainsorghum hybrids were found to be variable among hybridmaturity groups and locations, whereas (Ismail and Ali,1996)found thatplanting dates had significant effects on plant height, headweight and final grain yield.

Interaction of variety × sowing dateresults presented in Table 4 showed significant differences ($p \leq 0.05$) for number of

leaves/plant in the third count. Interactions Wad Ahmed×7thJuly and Abu-ragaba×7th July showed the highest number of leaves/plant (16.75, 16.35) respectively, whereas. Tabat× 15th July gave the lowest number of leaves/plant (10.70). For the leave area results revealed also significant differences($p \leq 0.05$).Wad Ahmed× 15th July interaction showed the highest leave area (764.8 cm^2), followed byAbu-ragaba× 15th July interaction registered 732.7(cm^2), while. Abu-kunjara×7th Julyinteraction resulted in the lowest leave area (323.7 cm^2). Results revealed that the biggest 1000 grain weight (g) was found in Abu-kunjara ×10th Julyinteraction(32.00 g) followed byAbu-ragaba× 10th July interaction (30.25 g, 29.50g)respectively, whileTabat×10th July showed the smallest 1000 grain weight(18.50 g).For yield results revealed that no significant differences were found through all interactions. Yield for all interactions varied from 667.1 kg/feddanto 362.5 kg/feddan.Significant variety-by-planting date existed for plant height, head weight, and final grain yield was reported by (Bandiougou, 2012). The vegetative growth attributes and yield components for the sorghum crop studied in this experiment were significantly affected by genetic potentials of different varieties and local genotypes as well as the influence of sowing dates which refer to the effect of environmental conditions. This confirms results reported by Baharetal., 2013.

Table (3). Effect of variety and sowing date on yield components.

Varieties	1000 grain weight(g)	Yield kg/feddan	Sowing dates	1000 grain weight(g)	Yield kg/feddan
Abu-ragaba	22.17a	201.3a	7th of July	27.82a	201.3a
Abu-kujara	23.67a	226.2a	10th of July	25.44a	226.2a
Tabat	27.33a	208.9a	15th of July	23.56a	208.9a
Wad-Ahmed	29.25a	47.6a	LSD	18.63ns	304.7ns
LSD	16.13 ns	263.8 ns	S.E	5.82	95.2
S.E	5.04	82.5			

Note: ns=not significant.

Table (4). Effect of interaction of variety and sowing date on growth and yield parameters.

variety × sowing date	Number of leaves/plan	Leave area (cm^2)	Stem diameter(cm)	1000 grain weight (g)	Yield (kg/feddan.)
Tabat×7th July	14.05cd	369.9f	2.05 abc	25.50abc	230.9a
Tabat×10th July	12.80de	568.2d	2.08 ab	18.50c	201.3ab
Tabat× 15th July	10.70f	634.9c	1.73 e	22.50abc	226.2a
Wad Ahmed×7th July	16.75a	533.5d	1.73 e	28.00abc	208.9ab
Wad Ahmed× 10th July	14.85bc	717.2b	2.18 a	21.00bc	47.6bc
Wad Ahmed× 15th July	14.15cd	764.8a	1.93 cd	22.00abc	263.5a
Abu-ragaba×7th July	16.35a	469.7e	1.93 cd	28.25abc	231.7a
Abu-ragaba× 10th July	14.50bc	646.0c	1.95 bcd	30.25ab	181.3abc
Abu-ragaba× 15th July	13.60cd	732.7ab	2.05 abc	23.50abc	47.6bc
Abu-kunjara×7th July	15.80ab	323.7g	2.15 a	29.50ab	200.2ab
Abu-kunjara ×10th July	12.80de	481.5e	1.88 d	32.00a	192.1abc
Abu-kunjara ×15th July	11.55ef	549.2d	1.90 d	26.25abc	27.4c
LSD	1.31*	38.27*	0. 12*	9.31*	152.3*
S.E	0.41	11.96	0.04	2.91	47.6

Photo 1. Birds (*Queleaquelea)* as one of the major pest of sorghum in Zalingei area.

Reference to the pest and diseases, results obtained revealed that birds (*Queleaquelea)* is one of the major pest of sorghum in Zalingei area(photo.1) and the damping-off of young seedlings was considered to be the most important disease that affect Barbarei at seedling stage, both pre- and post emergence damping-off were observed.Regarding toTable (5) results showed that both sorghum genotypes (Barbarei) - Abu-ragabaand Abu-kunjara- were found to be more affected by disease incidence especially in second sowing date (24.8% and 23% respectively) compared to Tabat and Wad-Ahmed (9.7% and 9.1% respectively). Although Bahar, et al. (2013) reported that Barbarei was found to be more resistant to pests and diseases in comparison with other sorghum varieties, so the above mentioned results could be due to the fact that Barbarei was normally grown by transplanting and not by direct seeding, in addition to this Barbarei was grown in this

experiment off its normal season (grown in rainy season), also the availability of high soil-moisture and relatively high temperature during the rainy season encourages favourable conditions for soil-born fungi to causes damping-off of young seedlings(Bahar et al. 2013; Agrios, 1985, Giha, 1996). At vegetative growth stage, stem borer was observed equally in all sorghum varieties and Barbarei, but its effect is small. With regard to diseases,a bacterial leaf streak was detected.

Table (5). Incidence (%) of Damping-off diseases among different sorghum varieties in different sowing dates.

Varieties & genotypes	First sowing date(7^{th} July)	Second sowing date(10^{th} July)	Third sowing date(15^{th} July)
Tabat	7.3	9.7	6.3
Abu-ragaba	15.1	24.8	12.7
Abu-kunjara	16.3	23.0	11.0
Wad-Ahmed	6.9	9.1	6.1

4. Conclusion

Sorghum bicolor species locally named (barbarei) includeswide diversity of phenotypes (Abu- ragaba and Abu-kunjara) both with different seeds color. It is widely grown by transplanting in South and West DarfurStates whereas, Wad-Ahmed and Tabatare locally improved varieties grown in many parts of the Sudan, under irrigation and rain-fed conditions by direct seeding .Sorghum plays important role (economic and nutrition). The babarei phenotypesseems to have different behaviour in comparison with othercultivated species or varieties of sorghum in Darfur that plants produces flowers and grain only when weather getscooler (October-November), although the plant headscontinue to form normally. It could be concluded that thevegetative growth parameters of sorghum are mostly determined by genetic factors rather thanbe influenced by environmental factors. On the other hand, interaction of variety ×sowing dates showed significantdifferences both for vegetative parameters and yield components.Therefore, further studies are recommended.

References

[1] Ali H. Bahar, Kamal I. Adam, Adam A. Mohamed, Abdulmutalab M. Khatir, Siddig A. Mohamed Ali. 2013. Assessment of Botanical Features and Crop Field Potentialities of Sorghum bicolor (L.) Moench Specific Phenotype (Barbarei) in South Darfur State: ARPN Journal of Agricultural and Biological Science. Vol. 8 No. 8. www.arpnjournals.com

[2] Agrios, N.G. 1985.General Plant Pathology. Second edition: Translated by Mohammed Musa Abu Argub.

[3] Bandiougou D. 2012. Effect of planting date on growth, development, and yield of grain sorghum hybrids. Thesis submitted in partial fulfilment of the requirements for the degree Master of Science. Department of Agronomy College of Agriculture Kansas State University Manhattan, Kansas.

[4] Eurek, A. 2010. Sequencing of sorghum genome completed, January 28, 2010, Retrieved August 30, 2010.

[5] Gao, L. S. 1794. Flora of China Vol. 22 Page 600 Sorghum Moench, Methodus. 207.

[6] Giha, O.H. 1996. Introduction to Plant Pathology. [6] Harlan J.R and De Wet J.M.J. 1972. A Simplified Classification of Cultivated Sorghum. Crop science. Vol. 12. Pp172-176.

[7] Ismail A.M.A. and A.H. Ali .1996. Planting Date Effect on Growth Characters and Yield of Sorghum under a dry Farming-system in an Arabian Gulf Environment Qatar Univ. Sci. J. 16(1): 81-88.

[8] Marshall, J.K. 1968. Methods for Leaf Area measurements of Large and Small Leaf Samples. Photosynthetica 2 (1):41-47.

[9] Oelke, E.A. 1971. Grain Sorghum in Minnesota. Crop News No. 12, Agronomy and Plant Genetics, Univ. of Minn.

[10] Onwueme,I.C. and Sinha, T.D. 1999. Field Crop Production in TropicalAfrica. Published by: CTA, Wageningen, Netherland, pp. 176-179.

[11] Oplinger, E.S. 1973. Grain Sorghum Production in Wisconsin. Field Crops 24A. Univ. of Wis. Agronomy mimeo. 8p.

[12] Robinson, R.G., W.W. Nelson, J.H. Ford, and D.P. Warnes. 1977. Drought and Grain Sorghum. Misc. Report 147, Minnesota Agr. Exp. Station.

[13] Rohweder, D.A., J.M. Scholl, P.N. Drolsom and M.D.Groskopp. 1965. Sorghums for Forage in Wisconsin. Circular 638, University of Wisconsin-Extension.

[14] Taylor, R. W. (ed). 1988. Grain Sorghum. A Manual for Production and marketing. Extension Bulletin 148, Delaware Cooperative Extension.

[15] U.S. Grains Council Sorghum.

[16] Vanderlip, R.L. 1972. How a Sorghum Plant Develops. Kansas State Univ. Coop. Ext. Serv. Pub. C447.

[17] Wikipedia contributors .2006. Sorghum. Wikipedia, the Free Encyclopaedia. Retrieved May 18, 2006 from http://en.wikipedia.org/wiki/Sorghum.