Chapter one

Introduction

Grain sorghum (sorghum bicolor L.) is the fifth most important cereal crop grown in the world. Probably because of its versatility and diversity .It is mainly grown in the arid and semi-arid lands of Africa and Asia for rural food society .The future sorghum enterprise is link to the contribution of poverty .This is more relevant and developed nations.

In Sudan sorghum is a traditional crop which is grown in in many parts of the country .It is the main food crop in most is grown mainly as a rain fed, but also as an irrigated crop. Sorghum , like other cereals , is a fertilizer demanding crop. Most of the agriculture experiences go to addition of different types of fertilizers. land degradation affect more than half of Africa ,leading to less an estimated $42 billion and 5 million hectares of productive land each year the majority of farmland produced poor yields due to poor farming (technique nutrient deficiency and irregular watering)(IRISAT2009).The micro dose technology is the application of small mineral fertilizer does in the seed hole when growing or next to the seeding after emergence (10days after growing). The advantages of this technology in Burkina Faso ,2010.

The main objective of this work is to use the micro dose technology to help in reducing the cost and to determine the proper micro dose level under Shambat conditions.

Agriculture Technology:

1. To locate the fertilizer near the roots, thus obtaining a high concentration area which make assimilation of nutrients easier.
2. To limit phosphorus fixation phenomena by the soil.
3. To reduce less of the potassium (K) and nitrogen (N) through teaching .
4. To achieve and early start of plant growth.
5. To increase the efficiency of fertilizer use.
6. To minimize production costs.
7. To improve small producer income.
8. To increase the number of mineral fertilizer user.

However ,BRISAT (2009)mention same difficulties as:

1. The technology is time consuming laborites and difficult to ensure each plant gets the right dose .

2. Access to fertilizer , access to credit , insufficient of information and training to the farmers in appropriate policies.
3. The adoption of technology requires supportive and complementary institute of innovation as well as input and output market linkages.

As mentioned by many researchers the technology uses only about one-tenth of the amount typically used in wheat and one-twentieth of the amount used on common WSA. Yet the African crops are so starved of nutrient such as phosphorus, Potassium and nitrogen that even that micro amount often double crop yield (Bationo et al,2015 and Bielders ,2015).

Chapter two

Literature review

Traditional dry- land farming is the major production system in Sudan and it is the main source of live hood for more than 75% of population .The major food crops grown are millet and sorghum ,while ground nut and sesame are the major cash crops. Other crops grown are watermelon , Roselle ,cowpea, maize, cotton and okra .The productivity of these crops is very low due to poor crop establishment and low soil fertility .The main soil types of the region are the Goz sands that are very low in nitrogen ,phosphorus and organic matter (Ibrahim and Madibo 1989).the maintenance of soil fertility is becoming one of the most important intervention needed to increase crop productivity in the dry area of the west Sudan ,where no recommendation has yet been made to apply inorganic fertilizers in this sector. This can be explained by priority being given to fertilizer distribution in the irrigated sector, low or no response to fertilizer in the rain fed agriculture , (Osman 1983-1988), unavailability of fertilizer and low purchasing power of the smallholders .Application of small amount of mineral fertilizer in the planting hole is a more efficient way to apply mineral fertilizer as compare to broadcasting .This method increases yield at a low cost effective, to apply fertilizer (Hayashi et al .2008;Klaiji et al,2007, Aune and Batino2008).Seed priming, process of soaking seed in water for specific time prior to swing is another low cost approach to increase yields under marginal dry-land conditions(Harris et al.2001, Harris et al.2005,Harris2006and Aune and Batino,2008)

Grain sorghum (sorghum bicolor(L.) Moench) originated in Africa and India, and has historically been one of five major world cereal crops(along with rice(Oryza sativa L.)maize (Zea mays L.) , wheat (triticum aestveum L.) and pearl millet (Pennistum Glaucum (L.) R.Br.).Used as human food . Grain sorghum , along with pearl millet, constitutes the staple cereal of millions people living in very hot , drought-prone tropical regions in west Africa and India (Maunder,2002).In addition to its use as food, grain sorghum is used as feed for animals and feedstock for ethanol, mainly in the western hemisphere. the primary quality criterion of selection of sorghum verities for traditional beer is their potential to produce malt with high alpha – and beata- amylase activities (Taylor and Dewar,2001).Red sorghum grain generally has higher amylase activities than white grain which likely explains the preference of red grain sorghums *dolo* .

To increase output , and attempt to combat declining soil fertility, farmers in west Africa apply in organic fertilizer . Fertilizer recommendations tend to be generic guidelines based upon.

Limited crop response trials and are a poor guide to maximize the benefits to farmers operating in variable environments (Vanlauwe & Giller,2006).In addition , farmers are constrained in accessing fertilizer in sufficient quantities at the appreciate time due to poorly functioning input markets (Morris et al ;2007).Aside from addressing the under lying institutional factors that contribute to these shortcomings, there is a need in the short term for a technique tailored to the need of the resource – constrained farmer operating under challenging environmental and market conditions.

With these considerations in mind, researchers at ICRISAT(international crops research institute for the semi-Arid tropics)developed a technique called fertilizer micro dosing

,which is precision (or point source)application of small (less than the recommended dosage)quantities of inorganic fertilizer formulation among other factors. Initial research on micro dosing advised application of fertilizer at sowing . The amount of fertilizer used under micro dosing and the timing of of application vary depending upon the target crop, region , planting density ,and fertilizer formulation among other factors. Initial research of micro dosing advised application of fertilizer at sowing time and set the micro dosing rate at 60 kg ha-1 of NPK (Buerkert & Hiernaux,1998;Burekert et al.,2001;Tabo et al.,2006).Emerging literature continues to inform the practice of micro dosing as researchers study how arrange of fertilizer quantities and application date affect organic efficiency and profitability . For example Sime & Aune (2014)investigated the effect of three separate micro dosing rate of 27,50 and 80kg ha -1of NPK on maze in Ethiopia .Hayashi et al,2008invesigated effect of delayed application of micro dose quantities upon millet production .However , based upon studies thus far micro dosing at its varies rates and timing has in general shown to be an effective technique in SSA for enhancing crop production and profitability while also advising limited access to fertilizer

(Camera et al,2013;Hayashi et al,2008; Tabo et al 2011;Twomlo et al,2010).According to these same slide micro dosing. Can economically advantageous technique as compared to alternative fertilizer application techniques, such as broadcasting, or no fertilizer in application. While micro dosing was introduced in Niger, Mali, and Burkina Faso as early as 1998)‹ Tabo et al., 2011), the technique was only introduced into Benin in 2011. Despite the economic potential of fertilizer micro dosing as demonstrated through the aforementioned studies, reports indicate that fertilizer micro dosing has not seen widespread adoption in the region. Thus, an examination of the factors that enable or constrain the adoption of fertilizer micro dosing is of particular importance as researchers begin to promote fertilizer micro dosing in Benin. Additiotially, while researchers in Niger, Mali and Burkina Faso are contrasting micro dosing against agronomic ally inefficient fertilizer application methods such as broadcasting, researchers

in Benin are comparing the technique to a more efficient precision application of fertilizer that the government has successfully promulgated throughout the country. This context changes the relative value of micro dosing.

Chapter three

Materials and methods

3.1Experimental Site:

A field Experiment was conducted the Demonstration Farm the College of Agricultural Studies University of Science and Technology, Shambat Sudan.(l5.40 N.,32,32E., elevation 380 m). The climate is semi-desert with a low relative humidity and annual rainfall rate of 150 mm and a mean temperature of (20.3 C° - 36 .IC°) and clay soil Celtic, pH 7.5-8.7 AbdulllafeeZ (2001).

3.2 Treatments:

The treatments consisted of five treatments which were:

- Control without fertilizer
- 1gm compound fertilizer micro dosing.
- 2gm compound fertilizer micro dosing
- 3gm compound fertilizer micro dosing
- 4gm compound fertilizer micro dosing

3.3 Source of Seed:

(local variety, were obtained from College of Agricultural Studies, Sudan university of Science Technology, " Shambat. ”

3.4 Land Preparation:

The experimental site was disc ploughed ,disc harrowed, and then followed by harrowing and leveling and ridging up north-south. The spacing between ridges was30cm. four plots each plot was3 x3 m, consisting of three rows .Soil sample was taken before sowing, and after harvesting to determine the amount of nitrogen. Crop was sown at first December 2015 the depth of seeds was 2 cm seeds were planted as per the treatment weeding was done two times after three weeks from sowing and after one month from the first hand weeding .Soil sample were taken before planting and after harvesting .

3.5 Data Collection:

When sorghum plant was 50% flowering , the following data were recorded .

3.5.1 Plant Height(cm):

Five plants of sorghum were randomly selected from each plot and the plant height was measured from soil surface to the tip of the flag leaf using measuring tape .Then the mean height was obtained.

3.5.2 Number of Leaves per Plant:

Five plants from each plot were taken and the average number of leaves per plant was contained .

3.5.3 Length of Inter Node:

Five plants from each plot were taken and the average length of inter nodes per plant was measured.

3.5.4 Stem Diameter (cm):

Five plants from each plot were taken and the diameter in the middle of the plant was measured using a strip and a ruler and then the mean stem diameter per plant was estimated.

3.5.5 Forage Fresh Yield per Plant(g):

At harvest five plants from each plot were taken and weighted .And the mean weight per plant was taken.

3.5.6 Forage DryYield/ Plant (g):

The five plant from each plot used for fresh weight were dried at the oven (80c°) for 48 hours and then weighed and the average dry weigh per plant was recorded.

3.5.7 Statistical Analysis:

The data were analyzed according to the standard statistical procedure for a randomized complete block design as described by Gomez and Gomez (1984) using MSTAT. C computer package.

Chapter Four

Results

The results of the study for all tested parameters are indicated in (Table 1) and separate detailed figures from (1-6).

According to (Table 1), the results revealed that, there is significant difference among the treatments for the plant height, number of leaves and node length; while there was no significant difference among the treatments for stem thickness, shoot fresh and dry weights.

The coefficient of variation for all tested parameters ranged between 8.50 – 27.79%.

The plant height was higher for the 2g microdose treatment (163.88cm) and the lowest value was for the control (128.97cm) (Table 1/ Figure 1).

The best number of leaves was obtained from the 2g microdose treatment (8.38) and the lowest was recorded for the 4g microdose treatment (6.48) (Table 1/ Figure 2).

The 4g microdose treatment resulted in the best stem thickness (4.48cm) without significant differences from the other microdose treatments including their control (Table1/ Figure 3).

The highest node length was recorded for 4g microdose (19.45cm) while the control resulted in the lowest value (15.9 cm) (Table 1/ Figure 4).

The highest values of shoot fresh weight was recorded from 2g microdose treatment (80.83g) while the lowest value was obtained from the 4g microdose treatment (58.45g). However, the effect was statistically equaled among all microdose treatments (Table 1/ Figure 5).

The shoot dry weight was also revealed no significant differences among the treatments and the performance was statistically similar to each other (Table 1/ Figure 6). In conclusion; the results of the study showed that, the microdosing was very effective for Sorghum growth. However, there is consistency between different levels. Therefore the experiment should be repeated for another year to confirm the results.

Table 1: The average means of *Sorghum bicolor* on micro dose experiment.

NPK levels (g)	**Plant height** (cm)	**Number of leaves**	**Stem thickness** (cm)	**Node length** (cm)	**Shoot fresh weight** (g)	**Shoot dry weight** (g)
Control	128.97 b	7.73ab	3.18a	15.90c	62.30a	18.53a
1.0	153.02 ab	7.45abc	3.35a	19.18b	78.58a	18.93a
2.0	163.88 a	8.38a	3.43a	17.35ab c	80.83a	18.98a
3.0	157.30 a	6.98bc	3.38a	16.95bc	70.60a	20.88a
4.0	154.02 ab	6.48c	3.48a	19.45a	58.45a	18.13a
Lsd. Value	28.04	1.10	0.84	2.33	30.04	6.77
c.v.	12.01	9.69	16.25	8.50	27.79	23.30

* Means followed with the same letter (s) within the column are not significantly different.

Table 2: Summary of ANOVA (F. value) of *Sorghum bicolor* on micro dose experiment.

	F. Value						
Source of variation	**Degree of freedom**	**Plant height (cm)**	**Number of leaves**	**Stem thickness (cm)**	**Node length (cm)**	**Shoot fresh weight (g)**	**Shoot dry weight (g)**
Replication	3	8.83	2.92	2.42	3.89	20.36	2.33
Fertilizer	4	2.13*	4.07*	0.17Ns	3.99*	1.01 Ns	0.23 Ns
Error	12	-		-	-	-	-
Total	19	-		-	-	-	-
C.V.	-	28.04	1.10	0.84	2.33	30.04	6.77
Lsd. Value	-	12.01	9.69	16.25	8.50	27.79	23.30

Ns= not significant, * Significant (5%), ** highly significant (1%),

Chapter Five

Discussion

Response of Sorghum Characters to Fertilizer Micro dosing:

Regardless of different adverse conditions prevailed in the study site during the experimentation, all of the fertilizer rates (micro dosing) increased parameters of plant height, number of leaves and node length compared to the control. This shows that there is a need for applying fertilizer in Sorghum production at most soils of our country. A fertilizer application method that is efficient with a smaller amount of fertilizer is to be the most important for marginal farmers in the central Sudan. Such a method will have high potential to increase farmers' interest, economic viability and sustainability with respect to applying fertilizer in Sorghum. In this respect, results of this study showed that the micro dosing method of fertilizer application was found to improve Sorghum yields with smaller quantities of fertilizer. The results of the study are strongly agreed with those obtained by Mahman,S.(,2015.). D.,Mamado *et al*. (2015).

Previous studies on the response of Sorghum and pearl millet reported by Palé *et al*. (2009); Vitale and Sanders (2005), had also shown similar effects that lower fertilizer rates increased crop yields more than the higher rates in micro dosing in sub-Saharan countries. Inasmuch as, the results of the study concerning the adoption of micro dose technology reported by Agricultural Technologies in Burkina Faso (2010) showed that, the lowest fertilizer rate in micro dosing was able to improve sorghum yield more than that of broadcasting in sub-Saharan countries. Similar results were also reported by Bationo *et al*. (1998); Bagayoko *et al*. (1992) as they concluded that, the cereals in general revealed lower yield response to the highest fertilizer rate in micro dosing and this can be owed that, there is a limit to the dose of fertilizer that can be applied through micro dosing. They also noticed that, the high levels of fertilizer found to depress pocket seed germination and lower plant population at harvest and these negative effects on maize performances might be attributed to the burning effects of high doses of fertilizer in the micro dosing method of application. Such remarks were also reported by Druilhe and Jesús (2012); FAOSTAT (2011); Coulibaly *et al*. (2000).

Therefore, if the farmers are practicing micro dosing, they can obtain a good yield at a low rate of fertilizer application. Yet, further study based on long-term data is required to rectifying optimum fertilizer rates for the different sites of sub- Sahelian countries depending on soil quality and other governing agro-ecological conditions.

As a result, the micro dosing method of fertilizer application becomes more efficient in increasing the yield of cereals than the banding and broadcasting method of fertilizer application. This might be due to the fact that placing fertilizer close to the seed in soils increases fertilizer uptake by crops as reported by (FAOSTAT 2000).

This indicates that under a better soil management system and favorable seasonal rainfall conditions, farmers can still get reasonable yields from crops through the application of microdose technology. Although the labor demand in microdosing (4.8 man-days ha−1) is nearly twice that in banding (2.3 days ha−1) for the application of fertilizers, the microdosing method still appears attractive and viable.

Conclusions and Recommendations:

1/ Micro dosing in Sorghum is an interesting option for farmers, because it gives a high yield, as well as favorable gross margins.

2/ Both fertilizer micro dosing and banding improves yields.

3/ The lowest fertilizer rates improve yields as much as higher rates under both micro dosing and banding.

4/ Micro dosing shows that it is more efficient than banding, which may increase farmers' interest in applying fertilizer with the micro dosing method.

In conclusion, lower fertilizer rates under micro dosing are more productive and profitable than higher rates under micro dosing or banding methods.

References:

Abera ,T, wegary, D and Debele, T. (2016).Varsetis and Nitrogen vates of Grain ylild and Nitrogen use efficiency ofHighland Maize in lokeKutaye western Ethiopia. Amoricon S. of ExpeinartolAgricaltve. 12(1):1-16

Agricultural Technolog in Bvrkinafaso. (2010). Managemnt of natural Resouece in Bukinafaso .WA-SAF GRAD. Borkirefaso.

Akinrinde EA, Okeleye KA.(2005) Short and long term effects of sparingly soluble phosphates on crop production in two contrasting Alfisol. West Afr. J. of Appl. Ecol. ;8:141-149.

Anetor MO, Akinrinde EA.(2006) Response of asoybean [*Glycine max* (L.)Merrill] to lime and phosphorus fertilizer treatments on an acidic alfisol of Nigeria.Pakistan J. of Nutr. ;5(3):286-293.

Awodun, M.A., S.O. Ojeniyi, A. Adeboye and S.A. Odedina,(2007). Effect of oil palm bunch refuse ash on soil and plant nutrient compositionand yield of maize . American-Eurasian Journal of Sustainable Agriculture, 1(1): 50-54.

Bagayoko ,M.,Maman ,N.,pale,s ,sirifi,S, Taonda S J.B., TravreS.andMason,S.C(2011).Microdose and NandPfertilizer application rates ferpearlmillet in West Africa .AfriceJ.of Agricultural Research 6(S):1141-1150.

Bationo, A, Sogodogo D.,Mamado G.,Taonda,J.S.and Mahaman,S(,2015.) The fertilizer microdoseTechnology .Borkina Faso

Beatty PH, Anbessa Y, Juskiw P, Carroll RT, Wang J, Good AG.(2010) Nitrogen use efficiencies of spring barley grown under varying nitrogen conditions in the field and growth chamber. Ann. Bot. ;105: 1171-1182.

Bielderr C.L. and Gerad ,B. (2015.).Millet response to microdose fertilizeration in soth –western Niger .Effect of antecedent fertility management and environmental factor . field crops reseach (171) (1):165-175.

Bielders C.(2015). Microdosefertilization :a step on the ladder towords crop intensificafon in the sahel .Earth and Life Institute.

Chukwuko K.S.;Ajala ,S.;Nwosw; p.candOmotayo , O.E.(2015).Effect of NPK single fertilizers or Relative growth performance of two cycles of Maize grown in aDegradedsal of south west Nigeria .J. of Agronomy .14(4);(203-211).

Dai, J., T. Becquer, J. Rouiller, H. Reversat, G. Bernhard and F. Lavelle, (2004.) Influence of heavy metals on C and N mineralization andmicrobial biomass in Zn-, Pb-, Cu-, and Cdcontaminated soils. Applied Soil Ecology, 25: 99-109.

Dawit S, Fritzsche F, Tekalign M, Lehmann J, Zech W.(2002) Soil organic matter composition in the sub humid Ethiopian highlands as influenced by deforestation and agricultural management. Soil Sci. Soc. of Am. J. ;66:68-82.

FAO(200). Use of phosphate rocks for sustainable Agriculture In: Fertilizer and plant Nutrition Bulletin, 13. FAO Land and water Development Division and International Atomic Energy Agency; .

Galloway JN, Bekunda M, Cai Z, Erisman JW, Freney J, Howarth RW, Martinelli LA, Scholes MC, Seitzinger SP.(2004) A preliminary assessment of changes in the global nitrogen cycle as a result of anthropogenic influences, third international nitrogen conference, October 12-16, 2004. Nanjing, China. ;35.

Glass, A.D.M., (1989). Plant Nutrition: An Introduction to Current Concepts. Jones and Bartlett Publishers, Boston, MA, USA, pp: 234.

International Crops Research Institute for the semi- Arid Tropics (TCRISAT) (2009). Fertilizer Micr odosing Boosting prodnction in Un prodnctive lands. India.

Norwood CA. Water use and yield of limited-irrigated and dry land corn. Soil Sci. Soc. Am. J.(2000);64:365–370. 15. of the increasing demand for food and l costs and severe environmental contamination [3,19].

Nyamangara J.(2001) Enhancing soil fertility in the smallholder farming areas of Zimbabwe: constraints and opportunities. Beyond nutrient balances: The impact of research on processes of change in African agriculture. Addis Ababa, Ethiopia;.

Quiñones MA, Borlaug NE, Dowswell CR.(1997) A fertilizer based green revolution for Africa. In: Buresh RJ, Sanchez PA, Calhoun F. (Eds.). Replenishing Soil Fertility in Africa.Special.Publ No. 51,SSSA, Madison, WI. ;81-109.

Rehman MA, Sarker MAZ, Amin MF, Jahan AHS, Akhter MM. (2011)Yield response and nitrogen use efficiency of wheat under different doses and split application of nitrogen fertilizer. Bangladesh J. Agric. Res. ;36:231-240.

Sanchez PA, Shepherd KD, Soule MJ, Place FM, Buresh RJ, Izac AMN, Mokwunye AU, Kwesiga FR, Ndiritu CG, Woomer PL.(1997) Soil fertility replenishment in Africa: an investment in natural resource capital. In: Buresh RJ, Sanchez PA, Calhoun F. (Eds.). Replenishing fertility in Africa.Soil Science Society of America, Special publication number 51, Madison, WI, USA. ;1–46.

Sanchez PA. Soil fertility and hunger in Africa. Sci. (2002);295:2019–2020.

Sheldrick WF, Lingard J.(2004) The use of nutrient audits to determine nutrient balances in Africa.Food Policy. ;29: 61-98.

Slime,G.andAune,J.B(.2014). Maize response to fertilizer Dosing at three Sites in the central |Rift valley of Ethiopia. Agronomg J.4:436-451.

Sogodogo ,D.,Cobaly,B., Coulibaly ,B.Y. and Sacko K. (2016). Impavt mineral Fertilizer Microdosing on The Yiekd of Sorghum in Adoption fields of Women Trained in farmers Field School in Niako in south Sudan Arca of Mali .Int-J-of corrcntMiarobiology and Applied Science r S(4):698-704.

Wakene N, Huluf G(2003). Influence of land use and management on some soils of Bako, Western Ethiopia. Agropedology.;13:1-9.

Wua, B., S.C. Caob, Z.H. Lib, Z.G. Cheunga and K.C. Wonga, (2005).Effects of biofertilizer containing N-fixer, P and K solubilizer and AMfungi on maize growth.Geoderma, 125: 155-162.

Appendices:

Appendix (1): A N OVA Table for Plant height

K Value	Source	D.F.	Sum of Squares	Mean Square	F. Value	Prob.
1	Replication	3	8775.5	2925.17	8.83	0.0023
2	Factor A	4	2823.10	705.77	2.13	0.1394
-3	Error	12	3973.5	331.13		
	Total	19	15572.1			
- Coefficient of Variation: 12.01%						

Appendix (2): A N OVA Table for Number of leaves

K Value	Source	D.F.	Sum of Squares	Mean Square	F. Value	Prob.
1	Replication	3	4.5080	1.50267	2.92	0.0774
2	Factor A	4	8.38	2.095	4.07	0.0259
-3	Error	12	6.1720	0.51433		
	Total	19	19.0600			
Coefficient of Variation: 9.69%						

Appendix (3): A N OVA Table for (Stem thickness)

K Value	Source	D.F.	Sum of Squares	Mean Square	F. Value	Prob.
1	Replication	3	2.164	0.72133	2.42	0.1167
2	Factor A	4	0.20800	0.05200	0.17	0.9473
-3	Error	12	3.57600	0.29800		
	Total	19	5.94800			
Coefficient of Variation: 16.25%						

Appendix (4): A N OVA Table for (Node length)

K Value	Source	D.F.	Sum of Squares	Mean Square	F. Value	Prob.
- 1	Replication	3	26.634	8.87800	3.89	0.0373
2	Factor A	4	36.4070	9.10175	3.99	0.0276
-3	Error	12	27.3610	2.28008		
-	Total	19	90.4020			
Coefficient of Variation: 8.50%						

Appendix (5): A N OVA Table for shoot fresh weight

K Value	Source	D.F.	Sum of Squares	Mean Square	F. Value	Prob.
1	Replication	3	23212.1	7737.38	20.36	0.0001
2	Factor A	4	1534.60	383.65	1.01	0.4405
-3	Error	12	4560.5	380.04		
	Total	19	29307.3			
Coefficient of Variation: 27.79%						

Appendix (6): A N OVA Table for shoot dry weight

K Value	Source	D.F.	Sum of Squares	Mean Square	F. Value	Prob.
1	Replication	3	134.885	44.9618	2.33	0.1263
2	Factor A	4	17.908	4.4770	0.23	0.9152
-3	Error	12	231.832	19.3193		
	Total	19	384.625			
Coefficient of Variation: 23.03%						