



To evaluate the effect of different organic vs inorganic amendments on the soil health and growth parameters of Sorghum fodder

Dissertation-II

Submitted to the Lovely Professional University

in partial fulfilment of the requirements

for the degree of

MASTER OF SCIENCE

in

AGRONOMY

By

Monika

(11615351)

DEPARTMENT OF AGRONOMY

SCHOOL OF AGRICULTURE

LOVELY PROFESSIONAL UNIVERSITY

PHAGWARA-144401

PUNJAB

INDIA

DISSERTATION-II

Name of Student : Monika
Registration No : 11615351
Section : H1620
Major Subject : Agronomy
Major Advisor : Dr.Geeta Pandey

Certified that topic entitled **“To evaluate the effect of organic vs inorganic amendments on the soil health and growth parameters of sorghum fodder.”** has been decided and formulated by the student herself and is appropriate for her programme.

(Signature of the student)

Monika

Reg No. 1161535

(Signature of the Major advisor)

Dr.Geeta Pandey

UID. 21513

(Signature of co- advisor)

Dr. Arun Kumar K

UID. 18703

Table of contents

S NO.	Topic	Page No
1	Introduction	1-3
2	Review of literature	4-7
3	Materials and methods	8-11
4	References	12-14

INTRODUCTION

Sorghum bicolor (L.) Moench is a genus of flowering plants belongs to family Gramineae. It is an annual plant including both wild and cultivated species (**Mutegi et al., 2010**). Being an important cereal crop, it is also used for fodder purposes and is gaining importance in varied areas of the world (**Bhatti et al., 2008**). Use of sorghum as a forage has been increasing in recent years (**Iptas et al., 1997**). In India, it is grown in 2.6 million hectares in Western U.P, Punjab, Rajasthan and Haryana. It is considered as important fodder in the Punjab particularly in kharif season that covers about 40% of the total fodder acreage. Sorghum fodder meets feed requirement of rainfed areas of Punjab (**Punjab development statistics, 2013**).

Fodder may be defined as the crops that are harvested and used as hay or silage to feed the livestock when availability of green or green fodder is inadequate. History of forage crops can be outlined back to about 1300BC when alfalfa has been found to be cultivated in areas of modern Turkey. Availability of green fodder is about 400 million tonnes which indicates insufficiency of fodder about 63-50% and that of dry fodder is 466 million tonnes against demand of 609 million tonnes (**Anonymous 2014-2015**).

Fodder plays an important role in the agricultural economy of developing countries by supplying low cost source of feed for livestock. In developing countries due to flourishing demand for food, area under cultivation of fodder is less. In Punjab, daily fodder availability is 10-12 kg/animal but the actual requirement is 40-50 kg per animal. Milk production of dairy animals depends upon the timely supply and quality of fodder. Storage of fodder through hay and silage making helps in availability of fodder all around the year. About 5.68 lakh hectare areas is under fodder cultivation constituting about 7% of gross cropped area (**Grover et al., 2013**).

Forage sorghum which grows 6 to 12 ft. tall, outturn increased dry matter in comparison to grain sorghum, and is coarse stemmed and used for silage. Its growth is hasty in nature and has tremendous capacity to generate biomass which helps to overcome adverse conditions (**Zerbini and Thomas, 2003**). As a forage it is better heat and drought tolerant having more water use efficiency (**Marasalis et al., 2010**) and gives high green forage yield (**Yan et al., 2012**). It is also known as crop of little consumption of nitrogen (**Olanite et al., 2010**) and high salt tolerance (**Yan et al., 2012; Saberi, 2013**). It is appropriate for silage and hay making. It is lower in quality due to presence of HCN (**Hingra et al., 1995**) but it is preferred by animals due to luscious nature and palatability. In the initial stages of sorghum, fodder can

have more amount of HCN but as the crop matures concentration decreases. Nitrogen toxicity is not so probable in sorghum fodder. In addition to food and fodder crop, it plays a crucial role in contributing raw material for making of starch, fibre, dextrose, syrup, biofuel, alcohol etc. It contains (70%) carbohydrates, crude fat and nitrogen free extract (**Chaudhry, 1994**).

The expense of production for sorghum silage is low as compared to corn because of reduced seed and irrigation costs. Water demand has been recorded to be (30%) to (50%) lower than for corn, which is an important component in regions that are dependent on irrigation for the production of crop. This crop tolerates lesser soil fertility than corn and even produces equitable yield plus too reciprocate well to fertilization. Forage sorghum can be sown late in the growing period than corn and still gives identical yields.

There are numerous problems which are deal with sorghum fodder producers like supply of poor quality and un-recommended varieties of seeds, scarcity of labour during sowing specifically during harvesting, inadequacy of technical knowledge, low price, lack of market knowledge, late payment by the commission agents. This fodder crop if cultivated commercially has to face competition with the paddy which is the main crop during kharif season. In the states such as Punjab, fodder sorghum is not only grown for marketable purpose however for meeting the demand of fodder for their own animals. Only some farmers are ready to put the area under cultivation for commercial purpose. Marketing of sorghum fodder is also a problem. Only minor marketing channels lie for these type of crops. Fodder preparation as hay or silage is ordinary, apart less than (5 %) of growers pursue specific practices. Even those who aid in these practices are having a view that processed fodder expels smell to the milk (**Grover et al., 2013**). Cultivation of fodder must be continued and various problems related to sorghum fodder should be minimised by adopting improving measures.

Chemical fertilizers are an important constituent in modernized agriculture. These fertilizer helps the crops to grow at accelerated rate and affluent in nutrients and gives instant nourishment through increasing the yield of the crops. Fertilizers are capable to feed the growing population of the country but repeated use of chemical fertilizers leads to land degradation, soil fertility has been declined, and it causes negative effect on soil, animals along with human health. There is distinctness in the cultivation of fodder with organic and inorganic sources (**Yolcu and Tan, 2008**). Need of green forage is booming day-to- day with the establishment of high yielding milch animal. It is essential to promote strategies for high

production potential of fodder. Organic sources apart from providing nutrients to preceding crop, proves to be beneficial for succeeding crop (**Hedge and Dwivedi, 1992**). Organic sources alone can't meet the entire nutrient requirement of the crop in contrast to synthetic fertilizers. Hence, the present study is undertaken to find out the impact of organic sources- FYM, sewage sludge, bio-fertilizers, poultry manure and inorganic sources of fertilizers on the sorghum fodder.

FYM plays a vital role in maintaining soil fertility and productivity by providing balanced nutrition and correcting soil physical, chemical and biological properties (**Kumar *et al.*, 2011**). With the appliance of sewage sludge to the soil, it is reported to increase N, P, and K (**Al-Nahidh, 1991**).

Bio-fertilizers enhances soil organic matter content, enzymatic and microbial activity, more yield on a sustainable basis (**Alizadeh and Ordoorkhani, 2011; Jala –Abadi *et al.*, 2012**). Biofertilizers are important component of integrated nutrient management in soil that helps in maintaining productivity and sustainability of soil (**T. M. Abdel, 2013**). Day by day these fertilizers are substituting chemical fertilizers due to expense efficacy, eco-friendly nature and inexhaustible sources of plant nutrients.

Utility of poultry manure considerably increases organic matter content of soil, N, P, K, Ca, Mg concentration of soil (**Agbede *et al.*, 2008**). Keeping in prospect the current outlines field experiment has been conducted to study the effect of organic and inorganic fertilizer sources on the growth and yield of sorghum with the following objectives:

- To study the effect of organic amendments on the soil health.
- To study the effect of inorganic amendments on the soil health.
- To understand the effect of organic and inorganic amendments on the growth and yield parameters of sorghum fodder.

REVIEW OF LITERATURE:

Shashoug *et al.*, (2011) have established that the usage of sewage sludge proved to be valuable for enhancement of soil properties, increase in straw dry matter and thereupon increase in yield of sorghum fodder.

Agbede *et al.*, (2008) conducted an experiment in the Nigeria in which response of poultry manure (PM) was studied on sorghum. Manure was applied @ 7.5 t/ha. The study revealed that the manure considerably improved soil organic matter, soil N, P, K, Ca and Mg concentration. Plant height, leaf area, stem girth and weight of roots, shoot and grain yield significantly increased. The PM had additive effect on soil properties, growth and yield parameters.

Reddy *et al.*, (2007) carried a study in Banglore in which FYM , sewage sludge was used to assess its effect on growth and yield of sorghum. Sewage sludge @5.3 t/ha, FYM @14.7t/ha were used singly and in combination of both and other amendments. Results of the study indicates that the plant height was increased with the application of sewage sludge while FYM gave no appreciable results.

Ghosh *et al.*, (2003) did an analysis in Bhopal with the aim to determine the effect of FYM, poultry manure and inorganic fertilizers for rainfed sorghum. FYM applied was 5 t/ha+75% NPK+1.5t/ha poultry manure. The outcomes revealed that with the increase in NPK content there is increase in root as well as dry matter of shoot after 60 DAS (Days after sowing). All organic fertilizer in combination with inorganic were preferable to exclusive organic for water use efficiency (WUE), grain and straw yield, harvest index (HI). On the whole, application of 75% NPK, 1.5t/ha poultry manure recorded highest WUE, grain and straw yield; yield attributes (ear length, ear weight/plant).

Ahmad *et al.*, (2007) investigated the effect of organic and inorganic fertilizers on yield of sorghum fodder. The results of the study implied that adopting the practice of recommended dose of inorganic sources of fertilizers verified to be best than all other treatments. The consolidation of both organic and inorganic fertilizer -50% NP +50% poultry manures kg /ha can be applied for improving the yield potential of sorghum. Imitated use of FYM with inorganic fertilizers not only increases the availability of nutrients though improves soil fertility and finally improves fodder production.

Jat et al., (2013) showed the effect of integrated nutrient management on yield and nutrient uptake in sorghum by conducting an experiment in Udaipur. They concluded that application of 10 tonnes FYM/ha incomparably increased grain yield (upto 27.7%-28.3%), Stover yield (11.3%-12.9%), nutrient content NPK and their uptake as compared to control treatment. Significant improvement in the grain yield (26.8%-28.5%) and stover yield (11.9%-13.0%) were recognised with the application of Azotobacter +PSB over no inoculation.

Elamin and Madhavi, (2015) showed that in sorghum fodder plant height, leaf area index (LAI), dry matter, grain yield significantly increased with the application of FYM and inorganic fertilizers. The highest LAI was recorded at boot stage (60 DAS) during 2012 and 2013 with the use of organic and inorganic nutrients.

Gawai and Pawal, (2006) performed a field experiment for two years in Maharashtra to study integrated nutrient management in sorghum- chickpea and found that utilization of 75% recommended dose of fertilizer + farmyard manure + biofertilizer [Azospirillum and phosphate-solubilizing bacteria (PSB)] gave significantly more plant height, dry mater, yield attributes and grain and fodder yield of sorghum. Application of 5 tonnes FYM/ha to preceding sorghum gave outcomes with higher growth, yield attributes and yield chickpea with (100%) RDF to chickpea.

Dwivedi et al., (2010) in Gwalior evaluated the contribution of organic manure and biofertilizer in relation to inorganic fertilizer on sustainable basis in sorghum fodder. The fodder yield increased with increasing fertility levels from (50%) to (150%) RDF either inorganic or in combination with FYM and/or biofertilizers. 100 % RDF+ FYM+ Azo.s PSB followed by 100%RDF+FYM proves higher fodder yield (222q ha⁻¹) nitrogen, potassium, phosphorus and sulphur content.

Ali and Jaloud (1999) determined the effect of sewage sludge on germination, growth and biomass yield of sorghum. There was no considerable reduction in germination due to sewage sludge application. The plant height and the biomass yield increased with an increase in sewage application. There was an increasing pattern in plant height and total biomass yield in heavy textured soil than other soils. Outcomes concluded that there exists an excellent

potential for the use of sewage not only as organic matter but an assuring source of plant nutrition for increasing the productivity of sandy calcareous soils.

Amujoyegbe *et al.*, (2007) studied the effect of Organic and inorganic amendments on the yield and chlorophyll content of maize and sorghum. Grain yield was more in sorghum (3.55 kg/ha) inorganic fertilizer and poultry manure followed by IF inorganic fertilizer treatment for maize and poultry manure for sorghum ((3.37 kg/ha). Sorghum and maize had the highest dry matter under IFPM. Sorghum also had the highest leaf area (2752.9 cm²/plant) under PM while maize on the other hand had the highest LA (1969.5 cm²/plant) under IFPM.

Yadav and Singh *et al.*, (2016) conducted a field experiment in Udaipur to study the effect of integrated nutrient management on sorghum productivity during kharif season (2009). Outcomes showed that recommended dose of fertilizer gives higher NPK uptake and content in grain of sorghum. Results showed that high protein content, grain yield, stover, biological yield and harvest index was obtained under recommended dose of fertilizers.

Barik and Nag (2001) performed an experiment in West Bengal and found that seed inoculation with biofertilizer-Azospirillum and Azotobacter increased the grain yield of sorghum by (8.73%) and (11.91%) as compared to that of no inoculation. Yield attributes and grain yield were increased as increasing levels of nitrogen was applied up to (90) kg ha⁻¹, where grain yield of (1514) kg ha⁻¹ was achieved.

Bhandeet *et al.*, (2002) found that application of 100% RDF + *Azospirillum*+ PSB and 100% RDF significantly increased the grain yield.

Kumar *et al.*, (2002) conducted a field experiment at Agricultural Research Station, Durgapura, (Rajasthan) to study the effect of different levels of FYM (0, 10 and 20 t ha⁻¹), nitrogen (0, 40, 80 and 120 kg N ha⁻¹) and *Azospirillum* culture on yield and quality of fodder sorghum. They concluded that increase in green and dry fodder yield due to *Azospirillum* inoculation varied from 7.8 to 11.3 per cent but its inoculation had no effect on crude protein and crude fibre. Green fodder yield, dry fodder yield content of crude protein and crude fibre either increased significantly or tended to increase with an increase in the dose of FYM and nitrogen application.

Dhonde *et al.*, (2004) conducted a field trial at Mahatma PhuleKrishi Vidyapeeth, Maharashtra, during kharif season (1999) and (2000), to evaluate the effect of integrated nutrient management on the growth and yield of *S. bicolour* (cv. CSH-9). The application of (100%) Recommended Fertilizer Rate gave more dry matter accumulation per plant , but the ear head length (29.30 and 30.0 cm), grain yield (54.25 and 49.03 q ha⁻¹) and fodder yield (102.32 q ha⁻¹) were maximum under 50% RFR + 50% N through FYM during both the trails.

Ghodpage *et al.*, (2005) studied the effects of inorganic and organic fertilizers on the performance of sorghum in Akola, Maharashtra and found that the application of 60:30:30 kg NPK ha⁻¹ + 5 tonnes FYM ha⁻¹ + Azospirillum (seed inoculation) + phosphate solubilizing bacteria, alongwith N fertilizer applied @ 20 kg ha⁻¹, increased total uptake (grain and fodder) of N (124.4 kg ha⁻¹), P (33.0 kg ha⁻¹) and K (130.0 kg ha⁻¹)

Ghosh *et al.*, (2003) found that, integrated use of organic and inorganic - (75%) inorganic NPK + poultry manure @ 1.5 t/ha or (75%) inorganic NPK + FYM @ 5 t/ha was found best leading to quick growth of root and shoot and higher dry matter of sorghum as compared to (100%) inorganic NPK .

Elgala *et al.*, (1990) reported that when poultry manure is applied to sorghum gives significantly higher dry matter yield. **Elawad (2004)** found that the poultry manure is an excellent source of nutrient and can be integrated into most of the fertilizer programs.

Materials and methods:

Technical programme

A.Name of experiment: Effect of organic vs. inorganic amendments on the soil health and growth parameters of Sorghum (fodder).

B.Location: The experiment has been conducted on Agricultural research farm, LPU, phagwara.

C) Experimentals details

1. Year of experimentation : 2017
2. Recommended dose of fertilizers : 20: 8 kg N: P ha⁻¹
3. No. of treatments : 7
4. No. of replications : 3
5. No. of plots : 21
6. Plot size : 5 x 4 m
7. Date of sowing : 2nd fortnight of June
8. Experimental design : Complete Randomized block design
(RCBD)
9. Crop and variety : Sorghum, SX-17
10. Row Spacing : 22 cm
11. Estimated area needed : 500 m²

D) Treatment details:

T1	:	Control
T2	:	100% RDF
T3	:	70% RDF+10% Poultry manure(PM)+20% sewage sludge (S.S)
T4	:	50% RDF+ 25% FYM+25% Biofertilizer(B.F)
T5	:	30% RDF+35% FYM+35% S.S
T6	:	20% RDF+30% FYM+30% S.S+20% B.F
T7	:	20% PM+30% B.F+25% FYM+25% S.S

E) Layout:

R1	IRRIGATION CHANNEL	R2	IRRIGATION CHANNEL	R3
T1		T2		T3
T2		T3		T4
T3		T4		T5
T4		T5		T6
T5		T6		T7
T6		T7		T1
T7		T1		T2

F) Collection of samples:

Soil samples has been taken for analysis to check the soil status (pH, N, P, K, EC and organic carbon) of experimental field before conducting the experiment.

Methods to be followed during analysis are as under:

SL.NO	TEST PARAMETER	METHOD	REFERENCES
-------	-------------------	--------	------------

1	pH	Glass Electrode	Sparks (1996)
2	EC	Conductivity Meter	Sparks (1996)
3	Organic Carbon	Wet Digestion	Walkley and Black (1934)
4	Available Nitrogen	Alkanline Potassium Permanganate Method	Subbiah and Asija(1956)
5	Available Phosphorus	Olsen's Method	Olsen et al (1954)
6	Available Potassium	Flame Photometer	Jackson (1973)

G) Observations to be recorded:

1. SOIL HEALTH:

- pH
- EC
- Soil available Nitrogen
- Available phosphorous

- Available potassium
- Dehydrogenase activity

2. GROWTH PARAMETERS:

- Plant Population
- Plant height (cm)
- Stem Grith
- HCN content
- No of leaves per plant
- Fresh Weight
- Dry Matter Production

3. YIELD ATTRIBUTES:

- Forage yield (kg/ha)

4. Statistical analyses will be conducted after the crop harvesting using SPSS 16 software

H) Work to be done:

Parameters	Schedule
Sowing	1st fortnight of June
Irrigation	About 5 irrigations
Harvesting	1 st cutting is ready in 55-65 days after sowing and then after an interval of about 35-40days

References

- AbdelmuniemYousif Elamin and K. Madhavi. 2015. Influence of Integrated Nutrient Management on Growth and Yield parameters of kharif Sorghum (*Sorghum bicolor* L. Moench), *American Journal of Scientific and Industrial Research*, ISSN: 2153-649X, doi: 10.5251.
- Agbede, T. M., Ojениyi, S.O. and Adeyemo A.J. 2008. Effect of Poultry Manure on Soil Physical and Chemical Properties, Growth and Grain Yield of Sorghum

in Southwest, Nigeria, *American-Eurasian Journal of Sustainable Agriculture*, 2(1): 72-77.

- Ali A. Al-Jaloud. 1999. Effect of Sewage Sludge on Germination, Growth and Biomass Yield of Sorghum in Calcareous Soils, *Pakistan Journal of Biological Sciences*, Volume 2, 494-497.
- Alizadeh O, Ordoorkhani, K. 2011. Use of N₂ fixing bacteria, Azotobacter, Azospirillum in optimizing of using N in sustainable wheat cropping. *ADV. Environment. Biology*. 5(7): 1572-1574
- Al-Nahidh, S.I., 1991. Effect of frequency of irrigation on sewage sludge amended soil and corn nutrition. *J. Arid Soil Res. Rehabil.*, 5: 137-146.
- Arvind Yadav and P. Singh. 2016. Effect of Integrated Nutrient Management on yield, Protein content, Nutrient content and uptake of sorghum (*Sorghum bicolor* (L.) Moench), *Innovative Farming*, 1(2): 30-34.
- Azraf-ul-Haq Ahmad, Imran Qadir and Naeem Mahmood. 2007. Effect of Integrated Use of Organic and Inorganic Fertilizers on Fodder Yield of (*Sorghum bicolor*.), *Pak.J. Agri. Sci.*, Vol. 44(3).
- B. J. Amujoyegbe, J. T. Opabode and A Olayinka. 2007. Effect of organic and inorganic fertilizer on yield and chlorophyll content of maize (*Zea mays* L.) and *Sorghum bicolor* (L.) Moench), *African Journal of Biotechnology* Vol. 6 (16), pp. 1869-1873.
- Barik, A. K. and Nag, P. 2001. Effect of biofertilizers with nitrogen levels on grain yield of sorghum fodder. *Forage research*. 27 (3):199-202.
- Bhande, N. D.; Naphade, P. S.; Hadole, S. S.; Kubde, K. J. and Dangore, S. T. 2002. Yield and uptake of nutrients by kharif sorghum as influenced by integrated nutrient management. *PKV Research journal*. 26 (1/2):1-4.
- Bhatti, I.H., R. Ahmad, A. Jabbar, M.S. Nazir and T. Mahmood. 2008. Competitive behaviour of component 1 crops in different sesame legume intercropping systems, *Int. J. Agric. Biol.*, 8: 165-167.
- Chaudhry, A. R, Nazir, S., E. Bashir, and R. Bantle. 1994. Fodder crop. In: *Crop Production, Nation Book foundation*, Islamabad. pp. 400-401.
- D.K. Grover and Sanjay Kumar. 2013. Sorghum (Fodder) Cultivation in Punjab -An Economic Analysis, *Agricultural Economics Research Review*.

- Dwivedi AK, Sharma G, Tomar PS and Sutaliya R. 2010. Response of fodder sorghum (*Sorghum bicolor*) to Integrated Nutrient Management for Sustainable Agricultural Production.
- El Awad, G.E. 2004. Effect of chicken manure and urea fertilizer on growth and yield of teff grass (*Eragrostis tef* Zucc.). M.Sc. Thesis. University of Khartoum, Sudan.
- Elgala, A.M. Ali, O.M. and Sikhry, E.M. 1990. Effect of certain Fe, Mn, Zn and Cu, to sorghum plants grown in sandy soil. *Egyptian J. of Soil Sci.* 30(12): 315-312.
- Gawai P.P, Pawar V.S, 2006. Integrated nutrient management in sorghum (*Sorghum bicolor*)–chickpea (*Cicer arietinum*) cropping sequence under irrigated conditions.
- Ghodpage, R. M. and Datke, S. B. 2005. Efficient use of inorganic and biofertilizers on productivity, nutritive value and nutrient uptake of rainfed sorghum (*Sorghum bicolor* L. Moench) in a Vertisol. *Agricultural Science Digest*. 25 (4): 257-259.
- Ghosh P.K., Bandyopadhyay K.K., Tripathi A.K., Hati K.M., Mandal K.G., Misra A. K. 2003. Effect of integrated management of farmyard manure, phosphocompost, poultry manure and inorganic fertilizers for rainfed sorghum (*Sorghum bicolor*) in Vertisols of central India, *Indian Journal of Agronomy*, Volume : 48, Issue: 1
- Hingra, S.H., B. Davis and M.J.A. Akhtar. 1995. Fodder Production. Food and Agricultural Organization of the United Nations. pp. 8.
- Iptas, S., M. Yilmaz, A. Oz, and R. Avcioglu. 1997. Possibilities of utilizing silage corn forage sorghum and sorghum-sudangrass hybrids under the ecological conditions in Tokat. In: Proc. 1st Turkey Silage Conference, Bursa, Istanbul, Turkey, Hasad Press (Eds.). pp. 97-104.
- Jala-Abadi AL, Siadat SA, Bakhsandesh AM, Fatil G, Alemi Saied KH. 2012. Effect of organic and inorganic fertilizer on yield and yield components in wheat (*T. aestivum* and *T. durum*) genotypes. *Adv. Environ. Biol* 6(2): 756-762.
- Kumar, A. and Prasad, N.K. 2002. Nutrient harvest and soil fertility as influenced by nutrient management in rice (*Oryza sativa*) forage crop sequences. *Indian J. Agron.*, 47(2) : 158-162.

- M. K. Jat, H. S. Purohit, Bahadur Singh, Mukesh Choudhary. 2013. Effect of integrated nutrient management on yield and nutrient uptake in sorghum (*Sorghum bicolor*), *Indian Journal of Agronomy* 58(4): 543-547.
- Marsalis, M. A., Angadi, S. V., Contreras- Govea, F. E. 2010. Dry matter yield and nutritive value of corn, forage sorghum, and BMR forage sorghum at different plant populations and nitrogen rates. *Field Crops Res.*, 116(1): 52 57.
- Mubarak Abdelrahman Abdalla, Nazar Omer Salih, Ali Ahmed Hassabo and Ahmed Gofoon Mahala. 2007. Effect of application of organic amendments on quality of forage sorghum (*Sorghum bicolor* L.) in the semi-arid tropics, *Archives of agronomy and soil science*, Volume 53 , Issue 5.
- Olanite, J. A., Anele, U. Y., Arigbede, O.M., Jolaosho, A. O., Onifade, O. S. 2010. Effect of plant spacing and nitrogen fertilizer levels on the growth, dry-matter yield and nutritive quality of Columbus grass (*Sorghum almum stapf*) in southwest Nigeria. *Grass Forage Sci.*, 65(4): 369 375.
- Reddy, S. R.; Reddy, V. C.; Parama, V. R. R.; Pampa Samanta. 2007. Effect of FYM, Sewage sludge and urban compost on growth and yield of sorghum (*Sorghum bicolor* (L.) Moench), *Journal of Soils and Crops* Vol.17 No.2 pp.211-216 ref.4.Vol. 26(No.1) pp 55-62.
- Yan, K., Chen, P., Shao, H., Zhao, S., Zhang, L., Xu, G., Sun, J. 2012. Responses of photosynthesis and photosystem II to higher temperature and salt stress in Sorghum. *J. Agron. And Crop Sci.*, 198(3): 218 225.
- Yolcu, H., M. Tan. 2008. Organic Forage Crops Cultivation. Ataturk University *Journal of Agriculture Faculty*, 39: 145-150.
- Zerbini, E. and D. Thomas. 2003. Opportunities for improvement of nutritive value in sorghum and pearl millet residues in south Asia through genetic enhancement. *Field Crop Res.*, 84: 10-15.