International Journal of
Life Sciences
International Peer Reviewed Open Access Refereed Journal

Int. J. of Life Sciences, 2020; 8 (1):51-58
ISSN:2320-7817(p) | 2320-964X(o)

Original Article Open Access

Effect of blended fertilizer application on yield, nutrient and protein content of sorghum (*sorghum bicolor (l.) moench*) varieties under rainfed condition in north western Tigray, Ethiopia

Redai Weldegebriel

Tigray Agricultural Research Institute, Shire-mytsebri Agricultural Research Center P.O.Box 241, Shire, Ethiopia
*Corresponding author E-mail: redai1000@yahoo.com

Manuscript details:

Received: 04.10.2019
Accepted: 09.03.2020
Published: 05.04.2020.

Cite this article as:
Redai Weldegebriel (2020) Effect of blended fertilizer application on yield, nutrient and protein content of sorghum (*sorghum bicolor (l.) moench*) varieties under rainfed condition in north western Tigray, Ethiopia, *Int. J. of. Life Sciences*, Volume 8(1): 51-58.

Available online on
http://www.ijlsci.in
ISSN: 2320-964X (Online)
ISSN: 2320-7817 (Print)

ABSTRACT

Sorghum (sorghum bicolar(L.)Moench) is an important cereal crop, which requires high dose of nutrient for optimum growth and productivity. Even though it is highly adapted to different agro ecology, its yield is constrained by declining soil fertility due to nutrient depletion, low level of fertilizer use and unblended application of fertilizer. An experiment was conducted in Shire-mytsebri Agricultural Research Center; at Sheraro sub site in north western Tigray, Ethiopia, during the main cropping season of 2016 with the aim of to evaluate the effects of blended fertilizers on yield, protein yield and nutrient concentration(%) of (N, P, K) of selected sorghum varieties. The treatments comprised factorial combination of ten levels of fertilizers **(**N, P, Blanket recommendation (NP), NPK, NPS, NPKS, NPKSZn, NPKSZnB, NPKSZnB (ATA) and Control(0)) and two sorghum varieties(Melkam and Dekeba) tested in a Factorial Randomized Block Design(RCBD) with three replication. A data of grain and biomass yield, nutrient concentration (N, P and K) and protein yield were taken. There was significant interaction effect of fertilizer treatments and sorghum varieties on most of parameters of the studied. Significantly higher grain yield (5541kgha^{-1}) was obtained in Melkam treated by NPKSZn. Higher Biomass yield was obtained from Melkam treated by NPK (21087kgha^{-1}). Application of blended fertilizer significantly enhanced Nutrient concentration and protein yield. The highest protein yield (251kg/hr) and nutrient concentration (%) of (N, P, K) (0.7247, 0.5163 and 0.5769kg ha^{-1} respectively) was recorded for Melkam variety treated with NPKSZn. The result showed the application of micronutrient-enriched NPK fertilizers improved the nutritional quality by increasing the quantity of protein and concentration of micronutrients of the harvested grains. Thus, taking the findings of the present study showed that farmers can use a blended fertilizer containing NPKSZn to improve nutritional quality and grain yield of sorghum.

Key words: blended fertilizer, nutrient concentration, protein yield, sorghum, Ethiopia

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.)Moench) belongs to the family Poaceae which is the fifth most important world cerealin production after wheat (*Triticumaestivum*L.), rice (*Oryza sativa* L.), maize (*Zea mays* L.) and barley (*Hordeumvulgare*L.) in the world (Doggett, 1970; FAO, 1985). It is one of the most important cereal crops grown in arid and semi-arid parts of the world, evolved in semi-arid tropical Africa, India and China where it is still used as a major food grain (Taye, 2013). Sorghum, because of its drought resistance and wide range of ecological adaptation, is the crop of choice for dry regions and areas with unreliable rainfall (Taye, 2013) and it is found growing in areas unfavorable for most of the cereals (Onyango et al., 1998).

Sorghum acts as a principal source of energy, protein, vitamins and minerals for millions of the poorest people living in Africa, Asia and the semi-arid tropics worldwide (Klopfesntein & Hoseney 1995). Most of sorghum cultivars grown in Africa contained only 9 to 11% protein content (Elbashir et al 2008).

In Ethiopia, it is grown all over the country across various agro ecologies (12 of the 18); from high altitude with sufficient amount of rainfall to low lands receiving low rainfall. It is grown as one of the major food cereals in Ethiopia annually 1.8 million ha of land is allotted for sorghum production and 4.3 million ton of grain is produced in the country (CSA 2015). Even though it can grow in different agro-ecological zones, it predominantly cultivated in dry areas that cover nearly 66% of the total area of Ethiopia (Geremew et al. 2004). Nevertheless, crop productivity is estimated at 2300 Kgha-1 (CSA 2015), which is considerably lower than experimental yield that reaches up to 3500 Kgha-1 on farmers' fields in major sorghum growing regions of the country. This still is very low when compared with the yield of 7000Kg to 9000Kgha^{-1} obtained under intensive management (Geremew et al. 2004).

The major problem for low productivity of sorghum is a decline in the soil fertility due to high soil erosion, blanket application of NP fertilizer and lack of blended fertilizer application was one of the major limiting factors to sorghum production in north Ethiopia. The deficiency of essential micronutrients induces abnormal pigmentation, size, and shape of plant tissues, reduces leaf photosynthetic rates, and leads to various detrimental conditions such as yield and grains composition (Masoni et al 1996).

Fertilizer use in the study area has focused mainly on the application of N and P in the form of urea and diammonium phosphate (DAP) for almost all cultivated crops based on the blanket recommendation. Such unblended application of plant nutrients may aggravate the depletion of other important nutrient elements in soils such as K, S and micronutrients (Zn and B).

Today, although the production of energy and protein appears to be adequate to feed the developed world, agriculture systems in many developing countries still do not provide enough nutrients to meet human needs (Welch & Graham 2004). Therefore, improving the nutrient content of the fertilizer that fits to the needs of the crops is required to improve the productivity and nutrient content of sorghum. Blended fertilizers containing both macro and micro elements may possess this characteristic. Thus, the study addressed the challenges of limited knowledge on soil fertility management and associated challenges for increasing crop productivity with increased current fertilizer use. The present study was planned to evaluate the effect blended fertilizer application on grain yield, Nuitrent(N, P and K) and protein content of selected sorghum varieties under rain fed conditions in north western Tigray, Ethiopia.

MATERIALS AND METHODS

The Study Area

The experiment was conducted at the experimental station of Shire-Mytsebri Agricultural Research Center (SMARC) at Sheraro sub-site, which is located in north western Tigray, northern Ethiopia (Fig 1). The research was conducted during the cropping season of 2016 (July-Nov). The experimental site is situated at an altitude of 1006 m a.s.l., 14^{0}24'00" N, 37^{0}56'00" E. The area is characterized by hot to warm semi-arid low land plains, with a Mono-modal rainfall pattern between May and September. The mean annual rainfall for the growing season was about 676 mm. Average annual rainfalls for the last previous 2007-2016 years was 683 mm and ranges from 428 mm to 836 mm. The mean maximum and minimum air temperature of the site was 40.5^{0}C and 13.3^{0}C respectively. The soil at the test site is clay and the system of farming in the area is crop and livestock mixed farming system. Though, sorghum is the dominant crop in the area, it is cultivated together with sesame, finger millet, pearl millet, and legumes like chickpea by rotation in the main season

The Study Method

The soil type at the test site is clay and the physical and chemical properties of the soil used for the experiment are listed below (table 1).

Twenty treatment combinations *viz*., two sorghum test verities [Melkam (MSV387) and Dekeba (ICSR24004)] (Table 2) and ten fertilizer levels including the control were laid out in a factorial randomized block design with three replications (Table 2).

Plant Materials

The sorghum varieties used in the study are Melkam (MSV387), and Dekeba (ICSR24004). They are selected because they are well adapted to the agro-ecology of the study area (lowlands of northern Ethiopia). Seed rate was 10 kg ha^{-1} and sown manually with a spacing of 75cm between rows and 15cm between plants (Wilson and Myers, 1954; Adugnaet al., 2005).

Data collection and Analysis

Grain and biomass yield data were collected and subjected to statistical analysis. The analysis of variance (ANOVA) was carried out using Gen State version14 computer software Gomez and Gomez (1984). Mean separation was carried out using least significance difference (LSD) test at 5% probability level

Table 1. Soil physical and chemical properties of the experimental site.

pH	Total N (%)	Pav (ppm)	K Ex (ppm)	CEC (meq/100g)	OM (%)	Particle size distribution			
						Sand (%)	Silt (%)	Clay (%)	Textural class
7.16	0.120	27.295	618.4	21.9	1.136	14	21	65	Clay

Table 2.List of all combination treatment for the experiment

Treatments	Treatment name, composition of the fertilizer &combination		Code of treatment
	Blended fertilizer (Kg/ha)	Variety use	
Treatment -1	41 N	Melkam	NV1
Treatment -2	46 P	Melkam	PV1
Treatment -3	Blanket recommendation (41N-46P2O5)	Melkam	NPV1
Treatment -4	41N-46P-13.7K	Melkam	NPKV1
Treatment -5	41N-46P-0K-8.47S	Melkam	NPSV1
Treatment -6	41N-46P -13.7K-8.47S	Melkam	NPKSV1
Treatment -7	41N-46P-13.7K-9.25S-1.72Zn	Melkam	NPKSZnV1
Treatment -8	41N-46P-13.7K-9.25S-1.72Zn -0.3B	Melkam	NPKSZnBV1
Treatment -9	36N-26.6P-13.7K-5.68S-1.72Zn -0.3B	Melkam	NPKSZnBV1(ATA)
Treatment -10	Control	Melkam	ControlV1
Treatment -11	41 N	Dekeba	NV2
Treatment -12	46 P	Dekeba	PV2
Treatment -13	Blanket recommendation(41N-46P2O5)	Dekeba	NPV2
Treatment -14	41N-46P-13.7K	Dekeba	NPKV2
Treatment -15	41N-46P-0K-8.47S	Dekeba	NPSV2
Treatment -16	41N-46P -13.7K-8.47S	Dekeba	NPKSV2
Treatment -17	41N-46P-13.7K-9.25S-1.72Zn	Dekeba	NPKSZnV2
Treatment -18	41N-46P-13.7K-9.25S-1.72Zn -0.3B	Dekeba	NPKSZnBV2
Treatment -19	36N-26.6P-13.7K-5.68S-1.72Zn -0.3B	Dekeba	NPKSZnBV2(ATA)
Treatment -20	Control	Dekeba	ControlV2

Crop samples of grain were taken per each treatment from each replication during harvesting time and analyzed for nutrient concentrations mainly for total nitrogen, P and K from each plot separately. Nitrogen was determined by the modified Kjeldahl method as described by Jackson (1958) and the concentration of P was measured using spectrophotometer after its extraction by the Olsen method (Olsen et al, 1982). The analyses were carried out at Mekelle Soil Research Center laboratory service.

Quality characteristics of grain (Protein):
Protein content in grain obtained by multiplying the nitrogen content of seed by 6.25 and

Protein yield calculated: Protein yield (kg ha^{-1}) = Protein content (%) X Seed yield Kg ha^{-1}/100 as described by AOAC (1975).

RESULTS AND DISCUSSION

Effects of blended fertilizers on grain and biomass yield of Sorghum varieties

Effect of blended fertilizers on grain yield
The study showed that grain yield was highly significant (P < 0.001) influenced by varieties as well as fertilizer treatment (Table 3 and 4) and the interaction of the two factors (Table 6). Melkam variety gave higher yield (4371.18 $Kgha^{-1}$) than Dekeba (4139.4 $Kgha^{-1}$). Due to the fertilizer treatment highest grain yield (5423 $Kgha^{-1}$) was obtained from the plots treated by NPKSZn and the lowest (2293 Kgha-1) recorded from control (Table 4).

The interaction of the two factors showed that the highest grain yield (5541 $Kgha^{-1}$) was recorded for Melkam under NPKSZn treatment and the lowest grain yield (2102 $Kgha^{-1}$) was recorded for Dekeba with control (Table 6). Similar finding was reported by (Sage and Pearcy 1987) and (Al-Abdulsalam, 1997) that indicated a blended supply of inorganic fertilizer results in higher net assimilation rate and increased grain yield. Blankenau et al. (2002) also stated that proper rate and blended fertilizer application are critical for meeting crop needs, and considerable opportunities exist for yield improvement.

Application of blended fertilizers other than using no fertilize, N, P alone and NP (blanket recommended) increased the yield of sorghum. Application of NPKSZn increased sorghum grain yield by 136.5% over the control. This implies that the grain yield was low without application of either of the soil fertility amendments. Similarly, Shrotriya (1998) reported that blended application of fertilizer caused up to 122% increase in sorghum yield in India and Bumb. Likewise Regessa (2005) also found that increased plant growth with optimal nutrient application provides good vegetative cover which resulted in high grain yield of sorghum plant. Moreover and Mesfin and Zemach (2015) reported similar findings.

Effect of blended fertilizers on Biomass yield (kg/hr)
Results of the study showed that biological yield (BY) among the varieties were not significantly difference (Table 3). However, the effect of fertilizer (Table 4) and the interaction effect (Table 6) showed significant effect (P < 0.001) on biomass yield. Due to fertilizer treatment the highest biomass yield (20041 kg ha^{-1}) was obtained from the plots treated by NPK while the lowest biomass yield (14539 $Kgha^{-1}$) was obtained from control.
The interaction of the two factor showed the highest biomass yield (21087 $Kgha^{-1}$) was recorded for Melkam treated by NPK fertilizer and the lowest biomass yield (14468 $Kgha^{-1}$) was obtained from Melkam with control.

Effect of varieties, balanced fertilizer and their interaction on N, P and K content (%), grain, biomass and protein yield of sorghum

Table 3: Effects of varieties on N, P and K content (%), grain, biomass and protein yield of sorghum

Treatment	BY(k.g/hr)	GY(k.g/hr)	Nutrient content (%)			Protein YD(kg/hr)
			Nitrogen	Phosphorus	Potassium	
Melkam	17653.39	4371.18	0.5916	0.3811	0.4642	166.86
Dekeba	17341.49	4139.40	0.5747	0.3662	0.4376	153.75
Sem	238.887	32.274	0.00758	0.00634	0.00833	2.989
LSd	NS	92.399***	ns	ns	0.02384*	6.051***

Table 4: The effect of fertilizer treatments on N, P and K content (%), grain, biomass and protein yield of sorghum

Treatment	BY(k.g/hr)	GY(k.g/hr)	Nutrient content (%)			Protein YD(kg/hr)
			Nitrogen	Phosphorus	Potassium	
41 N	15843 df	2951 d	0.5140 c	0.2982 c	0.3813cd	94.6 e
46 P	15315 f	2989 d	0.4500 d	0.3556 b	0.4005cd	83.6 e
Blanket recommendation (41N-46P2O5)	17450 cd	4599 c	0.5967 b	0.3584 b	0.4631 b	171.4 d
41N-46P-13.7K	20041 a	5107 b	0.6800 a	0.4531 a	0.5372 a	217.3 b
41N-46P-0K-8.47S	18253 bc	4655 c	0.6117 b	0.3855 b	0.4277bc	178.2 d
41N-46P -13.7K-8.47S	18511 abc	4675 c	0.6267 b	0.3845 b	0.4638 b	183.1 cd
41N-46P-13.7K-9.25S-1.72Zn	19321 ab	5423 a	0.7107 a	0.4891 a	0.5308 a	241 a
41N-46P-13.7K-9.25S-1.72Zn -0.3B	18313 bc	5120 b	0.6033 b	0.3717 b	0.4697 b	193 c
36N-26.6P-13.7K-5.68S-1.72Zn -0.3B	17387 cde	4741 c	0.5967 b	0.3783 b	0.4730 b	177.2 d
Control	14539 f	2293 e	0.4417 d	0.2621 c	0.3617 d	63.5 f
Sem	534.167	72.168	0.01694	0.01419	0.01862	6.683
Lsd	1529.280***	206.611***	0.0485***	0.04062***	0.0533***	13.53***

Table 5: The effect of interaction of varieties and fertilizer treatments on N, P and K content (%), grain, biomass and protein yield of sorghum.

Treatment	GY(k.g/hr)	BY(k.g/hr)	Nutrient content (%)			Protein yield (k.g/hr)
			Nitrogen	Phosphorus	Potassium	
V1F1	3219 f	16780 c-f	0.5146 ef	0.2982 fg	0.3883 efg	103.1 h
V1F2	3180 f	14718 ef	0.4100 g	0.3992 cd	0.4485 cdef	81.5 i
V1F3	4678 e	17942 bcd	0.5833 cde	0.3798 cd	0.4500 cdef	170.8 fg
V1F4	5168 b	21087 a	0.7033 a	0.4712 ab	0.5430 ab	227.2 b
V1F5	4713 e	17701 bcd	0.6200 cd	0.3798 cd	0.4402 def	182.9 defg
V1F6	4773 de	19033 abc	0.6533 abc	0.3733 cde	0.4780 bcd	194.6 cde
V1F7	5541 a	19203 abc	0.7247 a	0.5163 a	0.5769 a	251 a
V1F8	5118 bc	17813bcd	0.6100 cd	0.3624 de	0.4718 bcde	195.2 cd
V1F9	4838 cde	17788bcd	0.6266 bcd	0.3701 cde	0.4939 bcd	189.7 cdef
V1F10	2484 h	14468 f	0.4700 fg	0.2612 g	0.3513 g	72.5 ij
V2F1	2683 gh	14907 ef	0.5133 ef	0.2982 fg	0.3743 fg	86.1 hi
V2F2	2797 g	15912def	0.4900 f	0.3121 efg	0.3526 g	85.6 hi
V2F3	4520 e	16958b-e	0.6100 cd	0.3369 def	0.4761 bcde	172 fg
V2F4	5047 bcd	18995 abc	0.6567 abc	0.4351 bc	0.5314 abc	207.5 c
V2F5	4597 e	18805 abc	0.6033 cd	0.3912 cd	0.4152 defg	173.5 efg
V2F6	4577 e	17988 bcd	0.6000 cd	0.3957 cd	0.4496 cdef	171.7 fg
V2F7	5305 ab	19440 ab	0.6967 ab	0.4620 ab	0.4846 bcd	231.1 b
V2F8	5122 bc	18813abc	0.5967 cd	0.3811 cd	0.4676 bcde	190.9 cdef
V2F9	4644 e	16986 b-e	0.5667 de	0.3866 cd	0.4522 cdef	164.7 g
V2F10	2102 i	14611 ef	0.4133 g	0.2629 g	0.3720 fg	54.5 j
MEAN	4255.29	17497.44	0.5831	0.3737	0.4509	160.30
SEM	102.061	755.426	0.02396	0.02006	0.02633	9.452
CV	4.2	7.5	7.1	9.3	10.1	7.2
LSD	292.192**	2162.73**	0.06859***	0.05744**	0.07538*	19.134***

Means in a column followed by the same letter are not significantly different at P≤0.05.
Where; GY($Kgha^{-1}$); yield per hectare in Kg, BM ($Kgha^{-1}$); biomass yield per hectare in kg.

Increasing in biological yield may be due to the application of blended fertilizer in combination with the genetic potential of the variety that increased the growth rate of sorghum, which ultimately produced more biological yield. Biomass yield increased consistently with application of blended inorganic fertilizers from 14539 $kgha^{-1}$ (control) to 20041 $kgha^{-1}$ in the plot treated by NPK fertilizer. The lower biomass yields recorded on the control revealed that neither sole application nor lower rates are sufficient to improve crop production significantly and to maintain soil fertility status at a high level. The results of the present study substantiates that lack of adequate nutrient supply and poor soil structure are the principal constraints to crop production under low input agriculture systems (Azrag, and Dagash, 2015). The findings in this study were in lined with the report by (Regessa, 2005) who ascertained the increasing application of fertilizer nutrients such as N P and K increases the grain yield and biomass weight of sorghum significantly.

Effects of blended fertilizers application on nutrient content

Nitrogen concentration in grain (%)

Table 3 showed that N concentration of grain showed difference among varieties. Even though it was not statically significant, grain N concentration in Melkam (0.59) was higher than Dekeba (0.57%). The different fertilizer treatment combinations had significantly influenced the N concentration on the grain of Sorghum (Table 4). The N concentration in grain varied from 0.4417 to 0.7107% (Table4). The highest grain N concentration was observed in the plot treated by NPKSZn (0.7107%) followed by the plot treated NPK (0.68%) and significantly higher than the rest of the treatments. The lowest grain N concentration was obtained from the control.

Table 5 showed that the mean N concentration in grain due to the interaction of the two factors was 0.5831 %. Treatments showed a wide variation in N concentration and ranges from 0.4100 to 0.7247 %. The highest N concentration (0.7247 %) was obtained in treatments with Melkam treated by NPKSZn followed by Melkam treated by NPK (0.7033%) and the lowest N concentration was found in Melkam treated by P alone (0.41%). Similarly finding in Indian by Tandone, and Kimo, (1993) in pearl millet was reported as the concentrations of N on the plant was high in plot treated by NPKSZn in rain fed condition. In addition to that similar findings were reported by Fageria *et al.,* (2009) that stated grain N-concentration increased significantly with nutrient availability. Adequate and blended form of fertilizer absolutely enhances the total nutrient concentration of N in the plant at the same time productivity of that crop, which means a treatment that accumulates maximum nutrient gave the highest yield.

Phosphorus concentration in grain (%)

Table 3 and 4 indicated that the P concentration in the grain was significantly influenced by varieties and fertilizer treatments. Table 4 showed phosphorus content in grain varied from 0.2621 to 0.4891%. The highest P concentration was found in plot treated by NPKSZn (0.4891%) followed by NPK (0.4531%) and the lowest P concentration in grain was found in control (0.2621%). Due to the interaction of the two factors the highest (0.5163%) P concentration in was recorded for Melkam treated with NPKSZn and the lowest P concentration by grain recorded for Melkam in control (0.0.2612%).

Potassium concentration in grain (%)

The result showed that different treatment combinations of inorganic fertilizers significantly influenced the K concentration in the grain. The K concentration in grain varied from 0.3617 to 0.5372% (Table 4). The highest K concentration in grain (0.5372%) was recorded in the plot treated by NPK, which was statistically identical NPKSZn which may be due to presence of S and the interaction between the nutrients is positive interaction. The lowest K concentration in grain (0.3617%) was recorded from the control.

Due to the interaction of the two factor the highest (0.5769%) K concentration in grain was obtained in treatment Melkam treated by NPKSZn followed by Melkam *NPK (0.3450%), the same finding to this study by Khan *et al*., (2005) studied that the effects of different combinations of N, P and K fertilizers on sugarcane and found that high concentration of N, P, K with best yield of crop was obtained by combined application of NPK. In addition to the above study, Tanchev (1995) also shows that combination of NPK fertilizers showed high N, P and K concentration with better results on the growth, height, tillering, panicle weight and thousand grain weight of sorghum. The lowest K concentration in grain was recorded for Melkam with control (0.3513%).

Effects of blended fertilizers on protein yield (kg/hr) of Sorghum

The results presented in tables 3 and 4 indicates significant ($P<0.001$) difference in protein yield in sorghum grain both by varieties and fertilizer treatments. Among the sorghum varieties, higher protein yield is recorded from Melkam than that of Dekeba. Due to fertilizer treatment the highest protein yield (241 kg ha^{-1}) was obtained in plot treated by NPKSZn (Table 4) while the lowest protein yields (63.5 kg ha^{-1}) was recorded in control. Due to the interaction of the two factors (Table 5), highest protein yield (251 kg ha-1) was recorded for Melkam treated by NPKSZn, which recorded the highest yield (5541kg/ha^{-1}) and the lowest protein yield (54.5 kg ha^{-1}) was recorded for Dekeba with control.

The results showed for protein yield of sorghum grains indicated that micronutrients fertilization is an effective method in improving storage protein in sorghum grain. It has been reported that micronutrients fertilization at low pH enhanced protein synthesis in cereal crops (Fageria et al 2002). In addition, the application of micronutrient-enriched NPK fertilizers improved the nutritional quality by increasing the quantity of protein of the harvested grains, since micronutrient enriched NPK fertilizers also increase the concentration of micronutrients in grain (Malakouti 2008).

CONCLUSION

Fertilizer use in the study area has focused mainly on the application of N and P in the form of urea and diammonium phosphate (DAP) for almost all cultivated crops based on the blanket recommendation. Such unblended application of plant nutrients may aggravated the depletion of other important nutrient elements in soils such as K, S and micronutrients (Zn and B). This study found that inorganic blended fertilizers can improve yield and nutritional quality of sorghum significantly. Moreover, a result of this experiment has substantiated the importance of micronutrients (Zn and B) combination with macronutrients (NPKS) fertilizers enhancing yield and nutritional quality of Sorghum. The Yield and nutritional quality were better in treatments that receive NPKSZn fertilizer compared to other treatments practiced in the area.

The maximum grain yield and protein yield was recorded from Melkam treated with NPKSZn whereas the lowest grain yield and biomass were recorded for Dekeba in control. Generally, use of blended fertilizer contains NPKSZn significantly influenced most yield and nutritional quality of sorghum as compared to the control and treatments with single fertilizers (N and P). Thus, Melkam variety treated with NPKSZn was found the highest grain and biomass yield with better nutritional quality at the most profitable level than another treatment. There for it can be concluded that NPKSZn is suitable to apply to improve the productivity and nutritional quality of sorghum in Sheraro area.

Acknowledgment

The authors really acknowledge to Tigray Agricultural Research Institute (TARI) and Shire-Maytsebri Agricultural Research Center (SMARC) for awarding the study. I am also highly thankful to the member of Shire-Maytsebri Agricultural Research Center in general and in particular to the members of crop core process researchers, who facilitated the supply of seed and fertilizer and help on field layout and helping me in every aspect.

Conflict of Interest

The author declares that there is no conflict of interest.

REFERENCES

Adugna, A., Tefera, T & Deresa, A. 2005. Sorghum production guideline: Production and research experience (Simachew Manaye, Ed.). EARO, pp1-31.

Al-Abdul Salam, M. A. 1997. Influence of nitrogen fertilization rates and residual effect of organic manure rates on the growth and yield of wheat. Arab Gulf Journal of Science Research 15: 647-660

Azrag, A. A. D, and Dagash, Y, M .I. 2015. Effect of Sowing Date and Nitrogen Rate on Growth, Yield Components of Sorghum (Sorghum Bicolor L.) and Nitrogen Use Efficiency, Journal of Progressive Research in Biology (*JPRB ISSN 2454-1672*).

Blankenau, K., Olfs, H.W. and Kuhlmann, H. 2002. Strategies to improve the use efficiency of mineral fertilizer nitrogen applied to winter wheat. *Journal Agronomy and Crop. Sci., 188:146-154.*

CSA. 2015. Report on area and production of crops . Statistical Bulletin 578. Addis Ababa: Central Statistic Authority.

Doggett, H. 1970. Sorghum. Longman, Green and Co. Ltd. London, UK, pp1- 403.

Elbashir H Z, Mustafa A I, El Tinay A H & Babiker E E (2008). Biochemical characteristics of sorghum (Sorghum bicolor L. Moench) flour supplemented with cluster bean (Cyamopsis tetragonolaba L.): Influence of fermentation and/or cooking. Journal of Biological Science 8: 722-729.

Fageria N K, Baligar V C & Clark R B (2002). Micronutrients in crop production. Advance Agronomy 77: 185-268

Fageria N., Dos santos K., Cutrim A., and dos A., 2009. Nitrogen uptake and its association with grain yield in lowland rice genotypes. *Journal of Plant Nutrition, 32:11,1965 — 1974.*

Food Agriculture organization of the United Nations (FAO) (1985). FAO statistical data: www.faostat.fao.org.

Geremew G, Asfaw A, Taye T, Tesfaye T, Ketema B and Hilemichael H. 2004. Development of sorghum varieties and hybrids for dryland areas of Ethiopia. Uganda Journal of Agricultural Science 9:594–605.

Gomez, K.A & Gomez, A. A. 1984. Statistical procedures for agricultural research. 2nd edition, John Wiley and Sons Inc., ISBN-10: 0471870927, 680p.

Jackson M., 1958. Soil chemical analysis prentice-Hall. Inc. Sixth printing department of soil science, university of wiconsin, madison, Wis. p496.

Klopfesntein C F & Hoseney R C (1995). Nutritional properties of sorghum and millets. In: Sorghum and Millets: Chemistry, Technology (edited by D.A.V. Dendy) St Paul, MN: Am. Assoc. Cereal Chemists, pp. 125-168.

Malakouti M J (2008). The effect of micronutrients in ensuring efficient use of macronutrients. Turkish Journal of Agriculture & Forestry 32: 215–220.

Malakouti, M. J. 2008. The effect of micronutrients in ensuring efficient use of macronutrients. Turk J. Agric., 32:215-220.

Masoni A, Ercoli L & Mariotti M (1996). Special properties of leaves deficient in iron, sulfur, magnesium, and manganese. Agronomy Journal 88: 937–943.

Mesfin Kassa, Zemach Sorsa. Effect of Nitrogen and Phosphorus Fertilizer Rates on Yield and Yield Components of Barley (Hordeum Vugarae L.) Varieties at Damot Gale District, Wolaita Zone, Ethiopia. American Journal of Agriculture and Forestry. Vol. 3, No. 6, 2015, pp. 271-275. doi: 10.11648/j.ajaf.20150306.15.

Olsen R. and Sommer L.,1982. Phosphorus. In: A. L., R. H, Miller and D. R. Keeneys (eds.). Method of Soil Analysis Chemical and Biological Properties; American Society of Agronomy, 9: 403-430.

Onyango, R.M., T.K. Mwangi, W.W. Kiya and M.K. Kamidi, 1998. Maintaining soil productivity by combining organic and inorganic fertilizers in smallholder farms within the Kitale Region in Kenya. Proceedings of the 6 the Eastern and southern Africa

Regessa Kumssa. 2005. Effects of Integrated Use of Decomposed Coffee Husk and Inorganic N and P Fertilizers on Yield and Yield Related Parameters of Sorghum on Nitisols of Jimma Area, Ethiopia, MSc thesis.

Sage, RF. and Pearcy, R.W. 1987. The nitrogen use efficiency of C3 and C4 plants. Plant Physiol. 84: 954-958.

Shrotriya, G.C. 1998. Blended fertilization–Indian experience. Proc. Symp. Plant Nutrition Management for Sustainable Agriculture Growth. NFDC, Islamabad.

Tanchev, D. 1995. Effect of fertilizer application on the development of seed yield of sorghum. *J.Agri.***,** *32***(***3): 35-37.*

Tandon, H.L.S and Kimo, I.J. 1993. Blended Fertilizer Use – its practical importance and guidelines for agriculture in the Asia & Pacific Region (FADINAP).

Taye T., 2013 Sorghum production technologies training manual Ethiopian Agricultural Research Organization (EARO), Melkassa Research Center Nazret, Ethiopia.

Welch R M & Graham R D (2004). Breeding for micronutrients in staple food crops from a human nutrition perspective. Journal of Experimental Botany 55: 353–364.

Wilson HK & Myer WM (1954) Field crop production: Agronomic principles and practices. Lippincott Company, USA, 674p.