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Effect of NPK and blended fertilizer application on Yield, Yield Component and its profitability of Sorghum (*Sorghum bicolor (L.) Moench*) varieties under rainfed condition in north western Tigray, Ethiopia

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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 NPK and blended fertilizers on yield, yield components and economic profitability 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 Agricultural Transformation Agency (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 Phenological parameters, yield and yield components were taken. There was significant interaction effect of fertilizer treatments and sorghum varieties on most of parameters studied. Significantly higher grain yield was recorded in Melkam (5541 kgha^{-1}) treated by NPKSZn. Biomass yield was obtained higher at NPK from Melkam (21087 kgha^{-1}) and Economic analysis indicated that the application of NPKSZn to Melkam variety accrued the highest gross and net return. Application of NPK to Melkam variety accrued the highest benefit: cost ratio. Even though the highest biomass yield and grain yield were recorded in Melkam treated with NPKSZn but the highest % MRR was recorded for Melkam treated by NPK. Thus, farmers can use fertilizer containing NPK to improve sorghum yield at profitability level.

Key words: Blended fertilizer, Dekeba, Melkam, Profitability

INTRODUCTION

Sorghum (*Sorghum bicolor (L.) Moench*) belongs to the family Poaceae which is the fifth most important world cereal, following wheat, maize, rice and barley. 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, is the crop of choice for dry regions and areas with unreliable rainfall (Taye, 2013). It is adapted to wide range of ecological conditions and can be grown under conditions which are unfavorable for most of the cereals (Onyango *et al*., 1998).

In Eastern Africa, more than 70% of sorghum is cultivated in the dry and hot lowlands where serious water deficit is the major production constraint. Most East African sorghum is grown between the altitude of 900 and 1,500 m (Taye, 2013).

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. Fertilizer use in the study area has focused mainly on the application of N and P in the form of urea and di-ammonium 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).

Therefore, improving the nutrient content of the fertilizer that fits to the needs of the crops is required to improve the productivity 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 of NPK and blended fertilizer application on yield, yield component and its profitability of selected sorghum varieties under rain fed conditions in north western Tigray, Ethiopia.

MATERIALS AND METHODS

The experiment was conducted at the experimental station of SMARC at Sheraro sub site during the cropping season of 2016 (July-Nov) which is located at an altitude of 1006 m a.s.l., 14° 24' 00" N latitude, 37° 56' 00" E longitude. The area is characterized hot to warm semi-arid low land plains, with a Monomodal rainfall pattern. The mean total annual rainfall during the growing season was about 675.8 mm. Average annual rainfalls for the last previous 10 years was 683.05 and ranges from 427.7mm to 835.6 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 was clay and other soil properties are listed in Table 1.

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

Table1. Soil Physical and Chemical Properties of the study area

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		Cod of trt
	Blended fertilizer (kg/ha)	Variety use	
Treatment -1	41 N	Melkam	NV1
Treatment -2	46 P	Melkam	PV1
Treatment -3	Blanket recommendation (41N-46P_2O_5)	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-46P_2O_5)	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

Seed rate was 10 kg ha^{-1}. The seed was sown manually by labors with a spacing of 75cm between rows and 15 cm between plants. The growth and yield parameters as well as yield at harvest were recorded as per standard procedures.

The following traits were measured: 50% heading (50%DH), &75% maturity (75%DM),plant height (PH), stem girth(SG), panicle length(PL) and girth(PG), number of green leaf per plant(NGL), total green leaf area per plant(GLA), above ground biomass(BM), grain yield(GY) 1000 seed weight(TSW) and partial budget analysis (economic indices) After data collection, The data were analyzed statistically by using analysis of variance(ANOVA) according for a factorial randomized block design (2 factors) Gen-Stat (15th edition) software and Comparisons among treatment means with significant difference for measured and scored characters were made by using Least Significant Difference (LSD) test at 5% level of significance.

The amount of inputs and outputs per hectare were multiplied with a wage or price of the unit to consolidate all of them in one unit (Birr ha^{-1}) to find out the economic indices *viz*., total cost of production, gross returns, net returns and marginal rate.

RESULTS AND DISCUSSION

Crop phenology and growth

Days to heading was highly significant ($P < 0.01$) affected by the main effects of variety and fertilizer treatment as well as significantly ($P < 0.05$) affected by the interaction of the two factors (Table 5). Variety Melkam delay to heading and significantly differ from the Dekeba variety on days' to 50% panicle initiation. The maximum number of days to panicle initiation was observed from the plot treated by zero fertilizer, N alone and P alone was applied. The lower number of days to panicle initiation was recorded from the plot treated by NPKSZn (Table 5). Thus, plants or plots that received no fertilizer, only N and P reached panicle initiation about 4.16 days later than those grown under the plot that receive blended fertilizer contain NPKSZn Fertilizer.

Generally, the number of days to panicle initiation (heading) was significantly decreased when macronutrient other than N and P were considered in the fertility management strategy of a field. This is in line with Tanchew, (1995) and Aulakh, (2002). The analysis of variance revealed that the number of days required to reach physiological maturity (75%DM) was significantly affected by variety ($P < 0.001$) and fertilizer ($P < 0.05$) (Table 3 and 4). However, the two factors did not interact to influence significantly this parameter (Table 5). The results showed that Melkam variety required significantly higher number of days than Dekeba variety to reach physiological maturity. This may be attributed to genetic differences (Alam, *et al* 2007). In general, the maturity of sorghum plants was hastened under the plot treated with NPKSZnB and NPKS than under the plot with P only and control.

Number of green leaves and total leaf area per plant

The result indicated that the number of green leaves per plant was significantly (<0.05) and highly significant (<0.001) affected by varieties and fertilizer treatment respectively. The total leaf area per plant was highly significant (<0.001) difference both by varieties and fertilizer treatment (Table 3and 4) Melkam had higher number of leaves (12.127) and leaf area (9366.94 cm^2) than Dekeba (11.753) (8642.44 cm^2) respectively. Due to fertilizer traetments highest number of green leaves (13.37) and total leaf area (11150 cm^2) were recorded with the application of NPK while lowest leaf number (9.67) and leaf area (6378 cm^2) in the control.

Due to the interactive effect of sorghum verities and fertilizer treatment on the number of green leaves and total leaf area per plant were significantly (<0.01) affected (Table 5). Moreover, highest number of leaves (13.93) and total leaf area (11823 cm^2) recorded for Melkam variety treated by NPK and the lowest number of leaves (9.6) and total leaf area per plant (6072 cm^2) was recorded for Dekeba with control. The decrease in leaf area per plant in the treatments may be due to slow availability of nutrient from unblended fertilizer supply during the growth and development of plants. This study was in agreement with the findings by Ayube *et al.* (1999) who reported that application of blended fertilizer significantly increased the leaf area per plant of maize crop.

Plant height

Table 3 and 4 indicated that varieties and fertilizer treatment were induced highly significant ($P<0.001$) effect on plant height. The interaction effects of the two facters had significantly ($P<0.01$) enfluenced height of sorghum (Table 5). Mean comparison of the two Varieties showed significant difference in plant height and variety Dekeba (147.87.cm) had significantly shorter than Malkam(167.49cm) (Table 3) which might be due to the genotypic variation among varieties. This result is in conformity with the findings of Arega *et al.,* (2013).

Table 3. The variation of traits among the two varieties

Variety	50%DH	75%DM	NGL	GLA	SG	PH
V1	75.47	114.70	12.127	9366.94	2.192	167.49
V2	68.03	111.30	11.753	8642.44	2.174	147.87
Sem	0.303	0.220	0.1037	113.036	0.0150	0.912

Where V1; Melkam and V2; Dekaba

Table 4: The effect of fertilizer treatments on the measured traits

Fertilizer treatment	50%DH	75%DM	NGL	GLA(cm^2)	SG(cm)	PH(cm)
N	73.67 c	112.7 abc	11.03 de	7609 c	1.940 d	153.5 def
P	73.83 c	113.8 c	10.90 e	7373 c	2.003 d	152.5 ef
NP	70.50 ab	113.0 abc	11.67 cd	7985 c	2.150 c	156.5 cde
NPK	72.00 bc	113.2 bc	13.37 a	11150 a	2.427 a	163.1 ab
NPS	70.83 ab	112.2 ab	12.50 b	9627 b	2.137 c	159.5 a-d
NPKS	72.50 bc	113.3 bc	12.40 b	9693 b	2.290 b	156.4 cde
NPKSZn	69.83 a	113.3 bc	13.17 a	11073 a	2.413 a	165.2 a
NPKSZnB	69.67 a	111.5 a	12.47 b	9818 b	2.367 ab	162.3 abc
NPKSZnB(ATA)	71.00 ab	113.0 abc	12.23 bc	9341 b	2.287 b	158.6 b-e
Control	73.67 c	114.0 c	9.67 f	6378 d	1.817 e	149.2 f
Sem	0.679	0.492	0.2319	252.756	0.0335	2.039
LSD	1.943***	1.410*	0.6638***	723.622***	0.0959***	5.839***

Table 5: The effect of interaction of varieties and fertilizer treatments on the measured traits

Treatments	50% DH	75%DM	NGL	GLA(cm^2)	SG(cm)	PH(cm)
NV1	76.33 f	114.3 de	11.07 ghi	7922 de	1.920 gh	162.1c-f
PV1	75.67 f	115.0 e	11.13 f-i	7943 de	2.000 fgh	160.9d-g
NPV1	75 ef	114.7 de	11.73d-h	8170 de	2.193 de	167.4 bcd
NPKV1	76.33 f	115.3 e	13.93 a	11857 a	2.420 a	173.1 ab
NPSV1	74.33ef	114.3 de	12.47 b-e	9615 bc	2.047 fg	170.8 abc
NPKSV1	76.67 f	114.7 de	12.53 b-e	9890 bc	2.340a-d	166.6 bcd
NPKSZnV1	74.67ef	115.7 e	13.47 ab	11823 a	2.427 a	176.9 a
NPKSZnBV1	74 ef	112.7 bcd	12.8 bcd	10036bc	2.387 abc	174.5 ab
NPKSZnBV1(ATA)	75.33 f	115.0 e	12.4 b-e	9729 bc	2.313a-d	165.2 cde
ControlV1	76.33 f	115.3 e	9.73 jk	6684 gh	1.873 hi	157.4e-h
NV2	71.0 cd	111 abc	11.0 hi	7297 efg	1.960 fgh	144.9 ij
PV2	72 de	112.7 cd	10.67 ij	6802 fgh	2.007 fgh	144.1 ij
NPV2	66 ab	111.3 abc	11.6 e-i	7801 ef	2.107 ef	145.7 ij
NPKV2	67.67ab	111 abc	12.8 bcd	10443 b	2.433 a	153.1f-i
NPSV2	67.33ab	110 a	12.53 b-e	9640 bc	2.227 de	148.3 hij
NPKSV2	68.33bc	112 abc	12.27 cde	9496 bc	2.24 cde	146.1 ij
NPKSZnV2	65.00 a	111.0 abc	12.87 bc	10323 b	2.40 ab	153.5f-i
NPKSZnBV2	65.33ab	110.3 ab	12.13 c-f	9599 bc	2.347abcd	150.1 hij
NPKSZnBV2(ATA)	66.67ab	111.0 abc	12.07 c-g	8952 cd	2.260 bcd	151.9 ghi
ControlV2	71 cd	112.7 cd	9.60 k	6072 h	1.760 i	141.0 j
MEAN	71.75	113.00	11.940	9004.69	2.183	157.68
SEM	0.960	0.696	0.3279	357.451	0.0474	2.884
CV	2.3	1.1	4.8	6.9	3.8	3.2
LSD	2.747*	1.994*	0.9388**	1023.4**	0.1356*	8.257**

-Means in a column followed by the same letter are not significantly different at P≤0.05.

NS = nonsignificant; * = significant at P ≤ 0.05; **= significant at P ≤0.01; *** = significant at P≤0.001

Where; 50% DH; days to 50% heading, 75% DM; days to 75% physical maturity, NGL; average leaf no per plant, GLA; average total leaf area per plant, SG; stalk girth, PH; plant height, NH/P; no of heads per plot and SCH; stand count at harvest.

The tallest plants with large girth (165.2 and 2.413cm) were obtained from the plots treated with NPKSZn applications and the shortest height with small girth (149.2 and 1.817cm) treated with no fertilizer. Due to the interaction effect of varieties and fertilizer result showed that the tallest (176.9 cm) plant height was recorded for Melkam treated with NPKSZn and large girth recorded for Dekeba treated by NPK and the shortest with small girth (141 and 1.760 cm) was recorded from Dekeba in control (Table 5). Yousif (1993) found that the application of blended nutrients gave the tallest plant height farther more Elasha (2007) reported that applying no nitrogen and phosphorus resulted in significantly shorter plants compared to fertilize. It can be suggested the application of optimum fertilizer nutrients increased the plant growth and biomass and the increased amounts of nutrient increases the production of sorghum (Bayu et al., 2006).

Yield attributes

Crops with higher panicle length, panicle girth and panicle seed weight could have higher grain yield. Panicle length and panicle seed weight was highly significant (P< 0.001) influenced by varieties and fertilizer treatment (Table 6 and 7). The interaction of the two factors was significantly affected (<0.01) panicle length, panicle girth and panicle seed weight (Table 8). Tallest panicle length (28.52cm), girth (19.11cm) and panicle seed weight (65.57g) was recorded for Melkam than Dekeba. The tallest Panicle length (30.17 cm), girth (22.63 cm) and seed weight (81.34 g) was recorded from the plot treated by NPKSZn and the shortest panicle length (24.93 cm), small panicle girth (16.67 cm) and lowest panicle seed weight (34.4 g) was recorded from the control. The interaction effect of the two factors showed a tallest and shortest Panicle length (30.93 and 23.4 cm), large and small panicle girth (22.80

Table 6: The variation of traits among the two varieties

Variety	PL(cm)	PG(cm)	PY(g)	GY(Kgha-1)	BM (Kgha-1)	HI%	TSW(g)
V1	28.52	19.11	65.57	4371.18	17653.39	24.58	32.64
V2	27.20	19.04	62.09	4139.40	17341.49	23.55	32.09
Sem	0.206	0.143	0.484	32.274	238.887	0.321	0.250
LSD	0.590***	NS	1.386***	92.399***	NS	0.918*	NS

Table 7 : The effect of fertilizer treatments on the measured trait

Fertilizer treatment	PL(cm)	PG (cm).	PY(g)	GY(Kgha-1)	BM (Kgha-1)	HI%	TSW(g)
N	26.27 d	17.47 de	44.26 d	2951 d	15843 df	18.70 c	29.56 b
P	26.90 cd	17.47 de	44.83 d	2989 d	15315 f	19.62 c	30.69 b
NP	27.17 cd	18.30 cd	68.98 c	4599 c	17450 cd	26.44 ab	33.12 a
NPK	29.90 a	23.10 a	76.61 b	5107 b	20041 a	25.64 b	33.27 a
NPS	27.60 cd	18.30 cd	69.82 c	4655 c	18253 bc	25.55 b	34.16 a
NPKS	28.33 bc	18.60 c	70.13 c	4675 c	18511 abc	25.28 b	32.79 a
NPKSZn	30.17 a	22.63 a	81.34 a	5423 a	19321 ab	28.17 a	33.32 a
NPKSZnB	29.40 ab	19.73 b	76.80 b	5120 b	18313 bc	28.02 a	33.36 a
NPKSZnB (ATA)	27.93 c	18.50 c	71.12 c	4741 c	17387 cde	27.30 ab	33.21 a
Control	27.93 c	18.50	34.40 e	2293 e	14539 f	15.93 d	30.17 b
Sem	24.93 e	16.67	1.083	72.168	534.167	0.717	0.558
Lsd	0.461***	0.320***	3.099***	206.611***	1529.280***	2.052***	1.598***

Table 8: The effect of interaction of varieties and fertilizer treatments on the measured traits

V*F	PL	PG	PY(g)	GY(kgha-1)	BM(kgha-1)	HI%	TSW(g)
NV1	27.73 c-f	18.07 cde	48.29 f	3219 f	16780 c-f	19.36 ef	31.14b-e
PV1	26.73 efg	17.33 def	47.70 f	3180 f	14718 ef	21.66 de	31.00 cde
NPV1	27.13 def	18.60 bcd	70.16 e	4678 e	17942 bcd	26.1 abc	33.75 ab
NPKV1	30.20 ab	22.93 a	77.52 b	5168 b	21087 a	24.67 cd	34.47 a
NPSV1	28.13 b-f	18.33 b-e	70.69 e	4713 e	17701 bcd	26.6abc	33.70 ab
NPKSV1	29.00 a-d	18.07 cde	71.59 de	4773 de	19033 abc	25.09 c	32.4a-e
NPKSZnV1	30.93 a	22.80 a	83.11 a	5541 a	19203 abc	28.92 a	33.57 abc
NPKSZnBV1	30.13 ab	19.73 b	76.78 bc	5118 bc	17813 bcd	28.75 ab	32.8 a-d
NPKSZnBV1 (ATA)	28.73 b-e	18.40 bcd	72.6 cde	4838 cde	17788 bcd	27.2abc	33.54 abc
ControlV1	26.47 fg	16.87 ef	37.26 h	2484 h	14468 f	17.37 fg	29.99 ef
NV2	24.80 gh	16.87 ef	40.24 gh	2683 gh	14907 ef	18.04 f	27.99 f
PV2	27.07 def	17.60 def	41.96 g	2797 g	15912 def	17.59 f	30.39 def
NPV2	27.20 def	18.00 cde	67.80 e	4520 e	16958 b-e	26.8 abc	32.5 a-e
NPKV2	29.60 abc	23.27 a	75.7 bcd	5047bcd	18995 abc	26.6 abc	32.1 a-e
NPSV2	27.07 def	18.27 b-e	68.95 e	4597 e	18805 abc	24.45 cd	34.61 a
NPKSV2	27.67 c-f	19.13 bc	68.66 e	4577 e	17988 bcd	25.48 bc	33.20 abc
NPKSZnV2	29.40 abc	22.47 a	79.58 ab	5305 ab	19440 ab	27.4 abc	33.06 abc
NPKSZnBV2	28.67 b-e	19.73 b	76.82 bc	5122 bc	18813 abc	27.3 abc	33.88 a
NPKSZnBV2 (ATA)	27.13 def	18.60 bcd	69.66 e	4644 e	16986 b-e	27.4abc	32.9 a-d
ControlV2	23.40 h	16.47 f	31.53 i	2102 i	14611 ef	14.49 g	30.35 def
MEAN	27.86	19.08	63.83	4255.29	17497.44	24.06	32.36
SEM	0.652	0.452	1.531	102.061	755.426	1.014	0.789
CV	4.1	4.1	4.2	4.2	7.5	7.3	4.2
LSD	1.866**	1.295**	4.383**	292.19**	2162.728**	2.902**	2.260*

Means in a column followed by the same letter are not significantly different at $P\leq0.05$.

Where; PL(cm); panicle length, PG(cm); panicle girth, PY(g); yield per one plant in gram, GY($Kgha^{-1}$); yield per hectare in Kg , BM ($Kgha^{-1}$); biomass yield per hectare in kg, HI%; Harvest Index, YSW(g); thousand seed weight and 16.47cm) and highest and lowest panicle seed weight (83.11 and 31.53 g) respectively was recorded under Melkam treated with NPKSZn and Dekeba treated with no fertilizer respectively. Tanchew, (1995) also reported that a better result on panicle seed weight and head weight was obtained from plot treated with combination NPKSZn fertilizer on sorghum.

Grain yield

The study showed that grain yield was highly significant ($P < 0.001$) influenced by varieties as well as fertilizer treatment (Table 6 and 7) and the interaction of the two factors (Table 8). 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 7).

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 8). 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.

Biomass yield

Results of the study showed that biological yield (BY) among the varieties were not significantly difference (Table 6). However, the effect of fertilizer (Table 7) and the interaction effect (Table 8) showed significant effect (<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 inteaction 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 whith control. 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.

Harvest index (HI %)

The result showed that the harvest index was significantly (<0.05) affected by sorghum varieties (Table 6) and highly significant (<0.001) influenced by fertilizer treatment and the interaction of the two factor (Table 7 and 7). There was significant variation among the varieties with the higher HI% recorded in Melkam (24.58%) while the lower (23.6%) recorded in Dekeba (Table 6). The variation found for HI dynamics could be largely explained by difference in assimilation during grain filling and remobilization of pre–heading assimilates this variation may be due to genetic variation for this trait has been reported by (Kumudini *et al*., 2002). The present study showed that among fertilizer treatment the highest mean values of harvest index (28.17%, 28.02%) were recorded from the plot treated by NPKSZn and NPKSZnB respectively as compare the other treatments.

Thousand Seed weight (TSW)

The analysis of variance showed that thousand seed weight was not significantly affected by varieties but significantly affected by fertilizer treatment and the interaction of the two factors. Among the fertilizer treatments, the highest thousand seed weight (34.16g) was recorded from plots treated by NPS applications and the lowest (29.56g) was from the plots treated with N only. Due to the inteaction of variety and fertilizer the highest 1000 seed weight (34.61g) was recorded in Dekeba treated by NPS followed by Melkam treated NPKSZn (34.47g) and the lowest 1000 seed weight (27.99g) was recorded for Dekeba treated by N

Partial budget analysis (economic analysis)

The most important step in performing partial budget analysis is the proper identification of data on the costs and benefits associated with the alternative technologies. It is known that farmers apply fertilizer so as to get profit. Achieving the goal of yield increment depends not only on the kind and amount of fertilizer but also on the cost of the fertilizer and price of the yields (Black, 1992). Now days the demand and market price of sorghum grain and stalk is high as compare to the previous time, that's why growers need to use fertilizer and increase both grain and stalk as a result their income increases.

The maximum relative net return (28084.53 ETBha^{-1}) was found in Melkam treated by NPK interaction. Due to the genotypic difference in nutrient uptake partitioning and general performance of sorghum, the application of NPK fertilizer was economically suggested. In all plots treated with NPK was found with highest net benefits. This was done based on price rate of the cost of fertilizer and labor (for application) and price of the output (adjusted grain yield and stalk yield).

The result shows the highest MRR have highest net benefit per ha. The highest %MMR (1879.86) with corresponding values of 28084.53 ETB ha^{-1} thus, Present study revealed that the combined use of N, P and K fertilizer is better in economic terms for growing sorghum under rain fed conditions this result is the same Khaliq, Abbasi and Hussain., (2006) who have the same opinion after analyzing the financial data of fertilizer use in cotton

CONCLUSION

Fertilizer use in the study area has focused mainly on the application of N and P in the form of urea and di-ammonium 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 sorghum yield and yield components signifycantly. Moreover, a result of this experiment has substantiated the importance of micronutrients (Zn and B) combination with macronutrients (NPKS) fertilizers enhancing yield and yield components of Sorghum and its profitability. Yield and yield components were better in treatments that receive NPKSZn fertilizer compared to other treatments practiced in the area.

The maximum grain yield (5541 Kgha^{-1}) and total biomass yield (19203 Kgha^{-1}) was recorded from Melkam treated with NPKSZn whereas the lowest grain yield (2102 Kgha^{-1}) and biomass (14468 Kgha^{-1}) were recorded for Dekeba in control. Generally, use of blended fertilizer contains NPKSZn and NPK significantly influenced most yield and yield components of sorghum as compared to the control and treatments with single fertilizers (N and P). However a fertilizer containing NPK improved sorghum yield at profitability level, while applying micronutrients was not profitable. Thus, Melkam variety treated with NPK was found the highest grain and biomass yield at the most profitable level than another treatment. There for it can be concluded that NPK is economically suitable to apply to improve the productivity of sorghum in Sheraro area

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