Global Scientific JOURNALS

GSJ: Volume 10, Issue 1, January 2022, Online: ISSN 2320-9186

www.globalscientificjournal.com

Evaluation of different rates of NPSB and copper fertilizers for yield and yield components of teff in Halaba zone, Southern Ethiopia

Shewatsehay Asalf[1*] Mulugeta Habte[2] Atinafu Asefa[3]

Department of Natural Resources Research, Hawassa Agricultural Research Center, Southern Agricultural Research Institute, Hawassa, Ethiopia

shewatsehayasalf@gmail.com,mulerhab2006@yahoo.ca,atinafuasefa2016@gmail.com

Abstract

A trial was conduct to identify the best fertilizers formulae for production of teff in Halaba, Southern Ethiopia since 2018 and 2019. The trial consisted nine treatments: (1) Control, (2) NPSB =23 N,36 P,6.7 S, 0.71 B, (3) NPSB = 46 N,54 P,10 S, 1.07 B, (4) NPSB = 69 N,72 P,13S, 1.4 B, (5) NPSB = 92 N, 90 P, 17 S,1.7 B, (6) NPSB = 23 N,36 P,6.7 S, 0.71 + 0.63 Cu, (7) NPSB = 46 N,54 P,10 S, 1.07 B + 0.63 Cu, (8) NPSB = 69 N,72 P,17 S, 1.4 B + 0.63 Cu and (9) NPSB = 92 N, 90 P, 10 S,1.7 B + 0.63 Cu/ha. The trial was laid out in RCBD with three replications. Parameters were analyzed using SAS (9.4) software. Economic analysis was performed to evaluate the feasibility of fertilizers for teff production. The study revealed that there was significant difference among treatments on plant height, biomass and grain yield. Significantly lower yield was measured from no fertilizer treatments while the highest yield was obtained from 250 kg NPSB +102 kg Urea/ha. However, this treatment was not statistically differing compared to other fertilizer treatments. The economic analysis showed that treatment 2 (NPSB: 23 N, 36 P, 6.7 S, 0.71B kg/ha) and treatment 3 (NPSB = 46 N, 54 P, 10 S, 1.07 B kg/ha) gave the highest benefit with acceptable MRR. Therefore, farmers can use these rates in the area for teff production.

Keywords: *balanced fertilizers, deficiency, economic feasibility, yield*

Background and Justification

Teff is the most important and highly demanded cereal grain in Ethiopia. It has various health benefits and unique nutritional contents. It is high in fiber and rich in iron, calcium, magnesium, protein, and amino acids. But what’s really contributed to its enormous popularity, is that it is gluten free. This means that it demands to athletes, diabetics, coeliacs and others who seek a gluten-free diet (FAO, 2015 and Ayalew A. *et al*, 2011).

Ethiopia, located in eastern Africa, is considered the center of origin of teff (National Research Council, 1996). Currently, the country produces over 90% of the world's teff. But because of its growing popularity, teff production has attracted other countries including; Australia, China, India, South Africa, and the US (Abraham R, 2015).

Teff is an economically superior commodity in Ethiopia. It often commands a market price two to three times higher than maize, the commodity with the largest production volume in the country (Abraham R, 2015), thus making teff an important cash crop for producers (FAO,2015).

More than six million households' life depend on the production of teff covering the largest agricultural area of the country than any other types of grain, but its production and productivity is still very low due to traditional agronomic practices, nutrient deficiencies and susceptibility of the crop to lodging (Teklay T. and G. Girmay, 2016). However, the amount of production is not as much as its production coverage and value (Jeyabalasingh P.M. and D.D. Bayissa, 2018). The low teff crop productivity could also be due to a complex interaction among the environments, lack of appropriate management practices, biotic and a biotic stress. Of these, soil fertility problem is one of the major causes of temporal and spatial yield variability (Dejene, M. and M. Lemlem, 2011). Following soil fertility map made over 150 districts EthioSIS (EthioSIS, 2013) reported that Ethiopian soil lacks about seven nutrients; N, P, K, S, Cu, Zn and B. Although nitrogen and phosphorus nutrients are among the major teff yield limiting soil nutrients, the unbalanced and sub-optimal fertilization of Ethiopian soils by applications of only DAP and Urea (N and P containing fertilizers) for a long period of time has led to severe nutrient mining of the agricultural soils, particularly when the entire crop biomass (grain and stover) are removed from the land (Tekalign M.*et al*, 2016). According to Yonas M, *et al*, 2017, lack of appropriate macro or micro-nutrients in fertilizer blends is one of the national problems which act as the major constraint to crop productivity. Hence, the continuous use of DAP and Urea should be supplemented with the application of additional compound fertilizers containing all the required and deficient in the soil macro and micro-nutrients. Therefore, this study was initiated to provide site and crop specific balanced fertilizer recommendations for better teff production in Halaba district of the Southern Nations, Nationalities and Peoples Regional State (SNNPRS).

Materials and Methods

Two years field trial was conducted with teff in Halaba special Woreda (district) of SNNPRS in the main cropping season of 2018 and 2019 GC. The experimental site was located between 07.35566 N latitude and 038.05105 E longitudes at an altitude of 1850 m above sea level. The experiment was designed based on the nutrient deficiency of the area which indicated in the soil fertility map of Ethiopia produced by Agricultural Transformation Agency (ATA) (2016). Accordingly, two types of fertilizers (NPSB and NPSBCu) were used in different rates. The experiment consists of nine treatments: (1) no fertilizer (control), (2) NPSB: 23,36,6.7, 0.71 (100 kg NPSB+11 kg urea-top dress/ha), (3) NPSB: 46,54,10, 1.07 (150 kg NPSB+41 kg urea-top dress/ha), (4) NPSB: 69,72,13, 1.4 (200 kg NPSB + 72 kg urea-top dress/ha), (5) NPSB: 92, 90, 17,1.7 (250 kg NPSB + 102 kg urea top dressing), (6) NPSB: 23,36,6.7, 0.71 (100 kg NPSB +11 kg urea-top dress/ha) + Cu foliar application, (7) NPSB: 46,54,10, 1.07 (150 kg NPSB + 41 kg urea-top dress/ha) + Cu foliar application, (8) NPSB: 69,72,17, 1.4 (200 kg NPSB + 72 kg urea-top dress/ha) + Cu Cu foliar application and (9) NPSB: 92, 90, 10,1.7 (250 kg NPSB + 102 kg urea top dressing) + Cu foliar application.

Experimental layout

The experiment was conducted on two farms in each year and laid out in a randomized complete block design using 4 m by 4 m plot size and replicated three times in each farm. To avoid mixing up of treatments the plots were separated by 1 and 1.5 m space between plots and blocks, respectively. All doses of NPSB fertilizers were applied at planting time and urea was top dressed 45 days after planting. For copper foliar application was used. Improved teff variety (Bosep) was planted and other crop management practices were used as recommended for the crop.

Agronomic and economic analysis

Agronomic data for teff, including plant height, tiller number, total biomass and grain yield, were collected. Analysis of variance for all data was done using Proc GLM procedures in the SAS 9.3 program (SAS Institute Inc., Cary, NC USA). The least significant difference (LSD) at 5% probability level was used to establish the significance of differences between the means.

An economic analysis was used to investigate the economic feasibility of the two fertilizer types (NPSB and NPSBCu) for teff production. The partial budget, dominance and marginal rate of return were calculated. For partial budget analysis averages yield that was adjusted downwards by 10% was used, assuming that farmers would get ~10% less yield than is achieved on an experimental site. The average open market price for teff (42 Ethiopian Birr (ETB)/kg) and the official prices for NPSB (10.28 ETB/kg), N as Urea (8.76 ETB/kg) and Cu as copper sulfate (1000 ETB/kg) were used for the analysis. For a treatment to be considered a worthwhile option for farmers, the minimum acceptable marginal rate of return should be over 50% (CIMMYT, 1988). However, Gorfu et al. (1991) suggested a minimum acceptable rate of return should be 100%. Therefore, the minimum acceptable marginal rate of return considered in this study is 100%.

Result and discussion

The present study revealed that there was statistically significant difference between the treatments. Based on the analysis result all fertilizer treatments significantly ($P < 0.05$) increased teff plant height, biomass and grain yield compared to the control (no fertilizer) one. Statistically higher grain yield was obtained from treatment 5 (NPSB: 69, 72, 13, 1.4 (200 kg NPSB + 72 kg urea /ha)) compared to treatment 6 (NPSB: 23,36,6.7, 0.71 (100 kg NPSB +11 kg) + 0.63Kg Cu/ha) and the control, while the lowest yield was recorded from the control (table 1). Similarly, there was statistically higher above ground total biomass and plant height in treatment 5 compared to control and all fertilizer treatments except treatment 3 and 4 for total biomass. In line with the present study, Jafer (2018) reported that application of NPSB fertilizer for maize significantly increased grain yield. In this study tiller number did not show significance difference among all treatments. Based on the soil fertility map developed by ATA (2016), Cu is one of the nutrients identified as deficient in the soil of Halaba. However, this study revealed that Cu is not affected the grain yield as well as the growth of teff in the area.

Table 1. Yield and yield components of teff influenced by different nutrients at Halaba

Treatments	Plant height (cm)	Tiller No	Biomass yield (t/ha)	Grain yield (kg/ha)
1. Control	78.3d	3.7	3.5c	825.3c
2. NPSB: 23,36,6.7, 0.71 (100 kg NPSB+11 kg urea /ha)	86.9c	4.1	4.4ab	975.2ab
3. NPSB: 46,54,10, 1.07 (150 kg NPSB+41 kg urea /ha)	88.0bc	4.0	4.5ab	1092.1ab
4. NPSB: 69,72,13, 1.4 (200 kg NPSB + 72 kg urea /ha)	93.8a	4.1	4.8a	1128.5a
5. NPSB: 92, 90, 17,1.7 (250 kg NPSB + 102 kg /ha)	90.4b	4.3	4.7b	1176.3ab
6. NPSB: 23,36,6.7, 0.71 (100 kg NPSB +11 kg) + 0.63Kg Cu/ha	88.9bc	3.9	4.1bc	981.0b
7. NPSB: 46,54,10, 1.07 (150 kg NPSB + 41 kg urea-top dress/ha) +0.63Kg Cu/ha	89.0bc	3.9	4.6bc	1069.9ab
8. NPSB: 69,72,17, 1.4 (200 kg NPSB + 72 kg urea) + 0.63 Kg Cu/ha	90.0b	4.0	4.7b	1096.0ab
9. NPSB: 92, 90, 10,1.7 (250 kg NPSB + 102 kg urea) + 0.63 Kg Cu/ha	89.4bc	4.2	4.8bc	1079.8ab
LSD at 0.05	3.0129	NS	0.5881	186.2
CV (%)	6.803186	16.32099	14.77259	18.33416

Note: Values followed by different letters are significantly different at $P < 0.05$.

Economic analysis

The economic analysis indicated that except treatment 2, 3, 4 and 5, other treatments were dominated by the treatments with lower variable cost with higher net benefit (table 2). Treatment 2 gave the lowest total variable costs and higher net benefits than the treatment with the next lowest total variable costs, treatment 6. Treatment 3 gave lower total variable cost with high net benefit compared to treatment 7. Treatment 4 gave lower total variable cost and high net benefit compared to treatment 8. Similarly, treatment 5 had lower total variable cost with high net benefit than treatments 8 and 9. Based on the economic analysis result treatment 2, 3, 4 and 5 were potential options. Therefore, treatments 6, 7, 8 and 9 were eliminated from further economic analysis and treatments 2, 3, 4 and 5 were considered for further partial budget analysis.

Table2. Economic (partial budget and dominance) analysis of fertilizers on teff at Halaba

Treat	NPSB (kg/ha)	N (kg/ha)	Cu (kg/ha)	Av. yield	Adj. yield	TVC (EB/ha)	GB (EB/ha)	NB (EB/ha)	MRR (%)
1	0	0	0	825.3	742.8	0.0	31196.3	31196.3	
2	100	11	0	975.2	877.7	1836.1	36862.6	35026.5	
6	100	11	0.63	981.0	882.9	2655.1	37081.8	34426.7	D
3	150	41	0	1092.1	982.9	3121.9	41281.4	38159.5	
7	150	41	0.63	1069.9	962.9	3940.9	40442.2	36501.3	D
4	200	72	0	1128.5	1015.7	4422.7	42657.3	38234.6	
8	200	72	0.63	1096.0	986.4	5241.7	41428.8	36187.1	D
5	250	102	0	1176.3	1058.7	5708.5	44464.1	38755.6	
9	250	102	0.63	1079.8	971.8	6527.5	40816.4	34288.9	D

Yield adjustment =10%, field price of teff = 42 ETB/kg, official price for urea-N = 8.75 ETB/kg, NPSB fertilizer = 10. 3 ETB/kg, Copper Sulfate-Cu = 1000 ETB/kg, AV. Yield = Average yield, Adj.yield = adjusted yield TVC = total variable costs, GB = gross benefit, NB = net benefit, D indicates dominated treatments that are rejected, MRR = marginal rate of return.

Based on the partial budget analysis (table 3), higher net benefit was obtained from treatment 5 (38755.6 ETB/ha) compared to treatment 2, 3 and 4. However, the marginal rates of return in treatments 2 and 3 were 208.5992% and 243.6631% respectively. This means that the producer can get more than 100% benefit for each 1 ETB investment. The minimum acceptable rate of return assumed in this experiment was 100%. Therefore treatment 2 and 3 also gave an acceptable marginal rate of return for extra investment.

Table 3. Economic (partial budget and marginal rate of return) analysis of fertilizers on teff at Halaba

Treat	NPSB (kg/ha)	N (kg/ha)	Cu (kg/ha)	Av. yield	Adj. yield	TVC (EB/ha)	GB (EB/ha)	NB (EB/ha)	MRR (%)
1	0	0	0	825.3	742.77	0	31196.34	31196.34	
2	100	11	0	975.2	877.68	1836.11	36862.56	35026.45	208.5992
3	150	41	0	1092.1	982.89	3121.91	41281.38	38159.47	243.6631
4	200	72	0	1128.5	1015.65	4422.72	42657.3	38234.58	5.774095
5	250	102	0	1176.3	1058.67	5708.52	44464.14	38755.62	40.52263

Yield adjustment =10%, field price of teff = 42 ETB/kg, official price for urea-N = 8.75 ETB/kg, NPSB fertilizer = 10. 3 ETB/kg, Copper Sulfate-Cu = 1000 ETB/kg, AV. Yield = Average yield, Adj.yield = adjusted yield TVC = total variable costs, GB = gross benefit, NB = net benefit, D indicates dominated treatments that are rejected, MRR = marginal rate of return.

Sensitivity analysis

It would be important to calculate again the partial budget based on expected changes in the market price of inputs in the future. This would help to identify treatments which can remain stable and sustain acceptable returns for producers, regardless of future input price fluctuations. In this study, it was assumed that the official price of NPSB, copper (Cu) and urea fertilizers will increase by 20%. The assumption of price increment in these fertilizers emanated mainly from the change in the exchange rate and cost of transportation.

The sensitivity analysis indicated that (table 4), both treatments 2 (NPSB: 23,36,6.7, 0.71 (100 kg NPSB+11 kg urea) and treatment 3 (NPSB: 46, 54, 10, 1.07 (150 kg NPSB+41 kg urea) gave an acceptable rate of return and would give an economic yield response. Therefore, these treatments could be worthwhile for producers.

Table 4. Partial budget analysis at projected future prices of NPSB, Cu and urea fertilizers for teff production in Halaba woreda

Treat	NPSB	N	Cu_fertl	AY	Adj.Y	TVC	GB	NB	MRR

1	0	0	0	825.3	742.77	0	31196.34	31196.34	
2	100	11	0	975.2	877.68	2203.332	36862.56	34659.23	157.166
3	150	41	0	1092.1	982.89	3746.292	41281.38	37535.09	186.3859

Yield adjustment =10%, field price of teff = 42 ETB/kg, official price for urea-N = 8.75 ETB/kg, NPSB fertilizer = 10. 3 ETB/kg, Copper Sulfate-Cu = 1000 ETB/kg, AV. Yield = Average yield, Adj.yield = adjusted yield TVC = total variable costs, GB = gross benefit, NB = net benefit, D indicates dominated treatments that are rejected, MRR = marginal rate of return.

Conclusion and Recommendation

The study revealed that applying the deficient soil nutrients, nitrogen, phosphorus, sulphur and boron, indicated in the soil fertility map of the area (Halaba) was improved teff yield. Treatment 5 (NPSB: 92, 90, 17, 1.7 (250 kg NPSB + 102 kg /ha)) gave significantly higher teff yield compared to treatments 2 and the control.

The economic analysis showed that the highest net benefit was obtained from treatment 3 with acceptable marginal rate of return. However, treatment 2 also resulted in more than the required return. The sensitivity analysis also showed both treatments could give acceptable marginal rate of return under 20% fertilizers price increment. Therefore, NPSB: 69 kg N + 23.5 kg P + 10 kg S + 1.07 kg B/ha and NPSB: 92 kg N + 31 kg P + 13 kg S +1.4 kg B/ha could be recommended for teff production in Halaba area.

References

Abraham R. Achieving food security in ethiopia by promoting productivity of future world food tef: A review. Adv Plants Agric Res 2015; 2(2): 00045.

ATA (Agricultural Transformation Agency), 2016. Soil Fertility Status and Fertilizer Recommendation Atlas of the Southern Nations Nationalities and Peoples' Regional State, Ethiopia, by Ministry of Agriculture and Natural Resources and Agricultural Transformation Agency, Addis Ababa, Ethiopia.

Ayalew A, Kena K, Dejene T. Application of NP Fertilizers for better production of Teff (Eragrostis tef (Zucc.) Trotter) on different types of soils in southern Ethiopia. J Nat Sci Res 2011; 1(1): 6-15.

Dejene, M. and M. Lemlem, 2011. Integrated agronomic crop managements to improve teff productivity under terminal drought. Water stress. Vienna: InTech, pp: 235-254.

EthioSIS, 2013. Towards improved fertilizer recommendations in Ethiopia-Nutrient indices for categorization of fertilizer blends from EthioSIS woreda soil inventory data. Adiss ababa, Ethiopia.

FAO. Analysis of price incentives for Teff in Ethiopia Technical notes series, MAFAP, by Assefa B. Demeke M., Lanos B, 2015 Rome.

Gorfu, A., Taa A., Tanner D.G., and M. wangi W., (1991) On-farm research to derive fertilizer recommendations for small-scale bread wheat production: methodological issues and technical results. Report No. 14. IAR, Addis Ababa, Ethiopia.

Jafer, D., 2018. Validation of blended fertilizer for maize production under limed condition of acid soil. Journal of Natural Sciences Research 8 (23):52-58.

Jeyabalasingh, P.M. and D.D. Bayissa, 2018. Knowledge on Improved Practices of Teff by Smallholder Farmers in Ethiopia. Journal of Extension Education, 29(4): 22-39.

National Research Council. Lost crops of Africa volume I grains. Washington, D.C.: National Academy Press. 1996

Tekalign, M., G. Tilahun, D.G. Tanner and G. Getinet, 2016. Response of rain fed bread and durum wheat to source, level and timing of nitrogen fertilizer at two Vertisols sites in Ethiopia. In: Preceding the Ninth Regional Wheat Workshop for Eastern, Central and Southern Africa. Addis Ababa, Ethiopia, CIMMYT, pp: 127-147.

Teklay, T. and G. Girmay, 2016. Agronomic and economic evaluations of compound fertilizer applications under different planting methods and seed rates of teff [Eragrostis tef (Zucc.) Trotter] in Northern Ethiopia. Journal of the Dry Lands, 6(1): 409-422.

Yonas, M., V.R. Cherukuri and A. Habtamu, 2017. Production Potential of Teff [Eragrostis tef (Zucc.) Trotter] Genotypes in Relation to Integrated Nutrient Management on Vertisols of Mid High lands of Oromia Region of Ethiopia, East Africa. Advances in Crop Science and Technology, 04(06): 21-34.