

Original Research Article

Optimum Yaramila (N₂₃P₁₀S₅) blend formulation and its fertilization for growth and yield of wheat in Enderta district, South Eastern Tigray

ABSTRACT

Fertilizer use in Ethiopia has focused mainly on the application of nitrogen and phosphorous fertilizers in the form of di-ammonium phosphate and urea for almost all cultivated crops for the last several years. Such unbalanced application of plant nutrients may aggravate the depletion of other important nutrient elements in soils such as S and micro-nutrients. Present study was conducted in Tigray region Enderta district with the objective of evaluating Yaramila (23-10-5, N: P₂O₅: S) and its rate on yield of wheat crop. In this trial five treatments were included and it was laid out in Randomized Complete Block Design (RCBD) with three replications. The results indicated that biomass, grain, and straw yields of wheat responded to the additional yaramila levels. But, these levels did not beat recommended NP and the maximum grain yield was obtained at the recommended NP. The yaramila@200kg/ha level has almost equal levels of N and P with the recommended NP and additional sulfur levels but the yield and yield components of wheat were not significantly higher than recommended NP even with additional NP adjusted. This implies that either the sulfur or the formulation of blending decreased nitrogen and phosphorus efficiency. Hence, nitrogen and phosphorus are the yield limiting nutrients rather than sulfur for wheat. Moreover, Yaramila blended based on this formulation as source of sulfur is not a suitable fertilizer for wheat growth in the study. So, other alternative sources of sulfur rather than yaramila should be used for wheat production.

Keywords: Yaramila, Blend, Wheat, Fertilization, Enderta

1. INTRODUCTION

“Wheat (*Triticum aestivum* L.) is an important food crop in Ethiopia, next to Maize crop. Ethiopia is the second-largest wheat producer in sub-Saharan Africa, after South Africa” [1]. “Wheat in Ethiopia has become one of the most important cereal crops ranking 4th in total grain production (4.53 10⁶ t) and area (1.69 10⁶ ha) next to teff (*Eragrostis tef*), maize (*Zea mays* L.), and sorghum (*Sorghum bicolor* L. Moench)” [2]. However, wheat's potential output exceeds 5 t·ha⁻¹, creating a potentially problematic yield gap between farmers' expectations and the crop's actual production [3, 4]. According to Central Statistical Authority [5] of Ethiopia the crop accounts for 15.65% of the total cereal output. “However, its productivity is low due to depletion of nutrients and is insufficient to meet the domestic needs of the people in the country” [6]. As a result, for the past several years, farmers in the country had used blanket recommendation of only Urea and DAP (Di Ammonium Phosphate) as an input to improve soil fertility and increase crop production including wheat. On the other hand, reports by [7]

depicted that application of N& P fertilizers alone leads depletion of such as sulfur in soils. Hence, Supply of nutrients at an appropriate amount is always imperative for better growth and development of a crop[8]

"In various parts of the world sulfur deficiency has reported in declining of yield and quality of the crops. Researches pointed out that S deficiency can adversely affect plant growth and grain quality of durum wheat through its effect on protein composition"[9]. Besides, in Ethiopia, application of S with N significantly affects the yield and yield components and grain protein content of rice [10].

"Sulfur deficiency was not reported in Ethiopia for many years. In contrast, in recent years the soil map reports which were developed by Ethiopian Soil Information System (EthioSIS) indicated a sulfur deficiency in various areas of the country including Tigray region"[11]. Inline to this, various efforts were made to include S fertilizer through the introduction of S containing blended fertilizers produced in the country. However, the application rate for various districts in a region is the same and does not consider soil type variability. Moreover, there was no adequate evidence which justifies whether the recommended rates of S containing blend (yaramila [23 N: 10P20S: 5S]) in the blend formula meets the crops nutrient demand or not in. Thus, this study was designed to investigate the optimum level of Yaramila fertilizer for yield increment of wheat in Vertisols of Enderta districts of Tigray region.

2. MATERIALS AND METHODS

2.1. Study area

The experiment was conducted on Cambisols of Enderta district, south eastern Tigray. Geographically, the district is located between 13°12'55" and 13°38'38" N latitude and 39°16'43" and 39°48'08" E longitudes. The average elevation of the district is about 2200 m above sea level [12]. "The growing season of 2012 had received a relatively lower rainfall compared to the long term average, since the area was among those affected by El-Nino. The mean annual temperature ranges between 11.5 to 24.4 °C" [12].

2.2. Experimental design and procedures

The experiment comprised 5 treatments (T1=control, T2= Rec NP, T3=Yaramila @150Kg/ha

T4= Yaramila @200Kg/ha and T5= Yaramila @200Kg/ha + N P adjusted to recommended rate.

"These treatments were laid out in Randomized Complete Block Design (RCBD) with three replications. The plot size was 3m x 3m with spacing of 1m between blocks and 0.5m between plots based on recommendations set by Mekelle soil research center. The yaramila and phosphorus fertilizers were applied at planting, while the nitrogen fertilizer was applied twice during the crop growth stage that is 1/3 of the full dose at planting and the other 2/3 at the full tillering stage. In the trial, picaflour (Kakaba) bread wheat variety was used as a test crop" [12].

The initial soils of the experimental field were analyzed for texture, pH, organic matter, cation exchange capacity (CEC), total nitrogen, and available phosphorus. The methods used for

soil physical and chemical analysis were Soil pH [13], Organic carbon % [14], soil texture by hydrometer [15], available Phosphorus [16], total nitrogen by Kjeldhal method [17] and Neutral Ammonium acetate method [18] for cation exchange capacity. Data on biomass and grain yield were collected.

2.3. Data analysis

Analysis of variance (ANOVA) was carried out using Statistical Analysis Software (SAS) version 9. Whenever treatment effects were significant, mean separations were made using the least significant difference (LSD) test at the 5% level of probability.

3. RESULTS AND DISCUSSION

3.1. Soil properties before planting

The soil of the study sites are clay and clay loam in texture [10], neutral in pH, low in carbon and total nitrogen [19], low in available P [16], and high in CEC [18].

Table 1: Soil physio- chemical properties of the site before sowing

Parameters	Site1	Site2	Site3
pH _{water} (1:2.5)	7.23	6.95	6.9
Organic Carbon (%)	0.54	0.64	0.72
Total N (%)	0.12	0.06	0.05
PavailableP-Olsen(mg/kg)	3.64	2.88	4.6
CEC (Cmol+/Kg)	32	33	35
% Sand	27	25	19
% Silt	29	35	26
% Clay	44	40	55
Textural class	ClayLoam	Clay Loam	Clay

3.2. Biological yield (total above ground biomass) and grain yield

Results depicted that yield and yield components of wheat increased with increased application level of yaramila (23:10:5 N: P2O5: S) as shown in the figure1 below. Moreover, adjusting the level of NP with yaramila increased biomass, grain, and straw yields of wheat in the study area. However, the highest biomass, grain, and straw yields of wheat were recorded at the recommended NP as compared with all of the treatments. The lowest yield and yield components of wheat were recorded at control treatments.

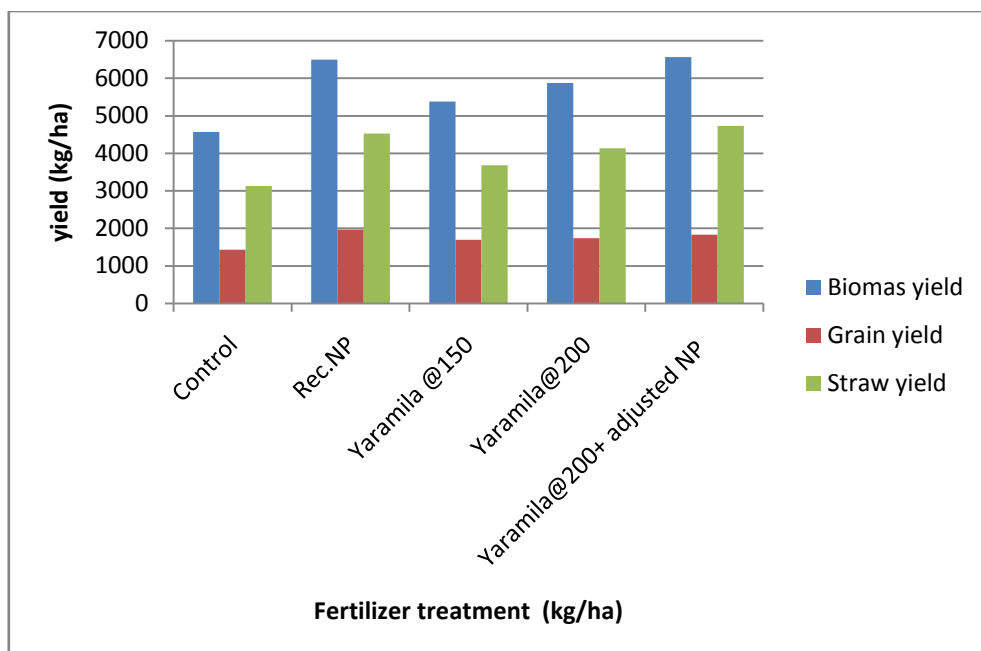


Figure1. Biomass, grain and straw yield of wheat as influenced by fertilizer application

Application of yaramila @ 200kg/ha with adjusted NP significantly ($P= 0.05$) increased biomass, grain and straw yield of wheat in the study area even though it is not significantly different with recommended NP (Table2). On the other hand, the highest grain yield of wheat was recorded at the recommended NP. These results indicated that even if yaramila increased yield and yield components of wheat it could not beat the recommended NP in all yield parameters of wheat in the study area. Yaramila@200kg/ha level has almost equal level N and P with the recommended NP and additional sulfur levels but the yield and yield components of wheat were higher in the recommended NP. This showed that either the formulation of this blending or the level of sulfur decreased the nitrogen and phosphorus efficiency.

Table 2. Effect of yaramila level on biomass and grain yields of wheat

Treatment) (kg/ha-1)	Biomass yield (kg/ha ⁻¹)	Grain yield (kg/ha ⁻¹)	Straw yield (kg/ha ⁻¹)
Control	4567.9c	1436.4b	3131.5c
Rec.NP	6493.8a	1969.8a	4524.1a
Yaramila @150	5382.7bc	1700ba	3682.7bc
Yaramila @200	5876.5ba	1737.7ba	4138.9ba
Yaramila @200+ adjusted NP	6567.9a	1832.7a	4735.2a
Mean	5777.78	1735.31	4042.469
CV	18.15	22.52	18.89
Pvalue	0.00	0.005	0.003

Means followed by the same letter along columns are not significantly different.
RecNP: Recommended nitrogen and phosphorus fertilizer CV: coefficient of variance.

4. CONCLUSIONS

The study was aimed at optimum rates of yaramila fertilization for wheat yield in Cambisols of Enderta district. The results indicated that biomass, grain, and straw yields of wheat responded to the additional yaramila levels. But, these levels did not beat recommended NP and the maximum grain yield was obtained at the recommended NP. The yaramila@200kg/ha level has almost equal level N and P with the recommended NP and additional sulfur levels but the yield and yield components of wheat were not significantly higher than recommended NP even with additional NP adjusted. This implies that either the sulfur or the formulation of blending decreased nitrogen and phosphorus efficiency in the study area. Hence, further detail researches should be done on the nitrogen and phosphorus levels with their interaction and method of application. These NP are the wheat yield limiting nutrients rather than sulfur in the study area.

REFERENCES

- [1] Demeke M, Di Marcantonio F. Analysis of incentives and disincentives for wheat in Ethiopia. *Gates Open Res.* 2019 Feb 15;3(419):419.
- [2] CSA C. Agricultural sample survey report on area and production of major crops. Private peasant holdings, Meher season 2016/2017 (2009 EC). 2017 Feb 2.
- [3] Mideksa T, Letta T, Bayisa T, Abinasa M, Tilahun A, Hundie B, Alemu W, Abera M. Bread wheat varietal development and release in Southeastern Highlands of Ethiopia. *American Journal of Biological and Environmental Statistics.* 2018;4(1):15-9.
- [4] Mann ML, Warner JM. Ethiopian wheat yield and yield gap estimation: A spatially explicit small area integrated data approach. *Field Crops Research.* 2017 Feb 1;201:60-74.
- [5] CSA (Central Statistical Authority of Ethiopia). Agricultural sample survey 2014/2015. Report on area and production for major crops. 2015.vol.1. Addis Ababa, Ethiopia.
- [6] CSA (Central Statistical Agency). Agricultural sample survey 2009/10. Report on area production of crops (private peasant holdings, Meher Season). The FDRE statistical bulletin. 2010.Vol. 391, Addis Ababa, Ethiopia.
- [7] Bereket H, Stomph TJ, Hoffland E. Teff (*Eragrostis tef*) production constraints on Vertisols in Ethiopia: farmers' perceptions and evaluation of low soil zinc as yield-limiting factor. *Soil Science and Plant Nutrition.* 2011;57(4):587-96.
- [8] Ali N, Anjum MM. Effect of different nitrogen rates on growth, yield and quality of maize. *Middle East J. Agric. Res.* 2017;6(1):107-12.

- [9] Ercoli L, Arduini I, Mariotti M, Lulli L, Masoni A. Management of sulphurfertiliser to improve durum wheat production and minimise S leaching. *European Journal of Agronomy*. 2012 Apr 1;38:74-82.
- [10] Habtegebrial K, Mersha S, Habtu S. Nitrogen and sulphur fertilizers effects on yield, nitrogen uptake and nitrogen use efficiency of upland rice variety on irrigated Fulvisols of the Afar region, Ethiopia. *Journal of Soil Science and Environmental Management*. 2013 Jun;4(3):62-70.
- [11] EthioSIS (Ethiopia Soil Information System). Soil Fertility Status and Fertilizer Recommendation Atlas for Tigray Regional State. 2014: p76.
- [12] Gebre T, Kibru T, Tesfaye S, Taye G. Analysis of watershed attributes for water resources management using GIS: The case of Chelekot micro-watershed, Tigray, Ethiopia. *Journal of Geographic Information System*. 2015 Mar 3;7(02):177.
- [13] Rhoades JD. Soluble Salts pp. 199-224 in AL Page, RH Miller and DR Keeney.(ed.) *Methods of Soil Analysis Part 2 Chemical and Microbiological Properties*. American Society of Agronomy, Madison, Wisconsin. 1982.
- [14] Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science*. 1934 Jan 1;37(1):29-38.
- [15] Bouyoucos GJ. Hydrometer method improved for making particle size analyses of soils 1. *Agronomy Journal*. 1962 Sep;54(5):464-5.
- [16] Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. US Department of Agriculture; 1954.
- [17] JM B. Total nitrogen. *Methods of soil analysis*. 1982:595-624.
- [18] Landon, J. R. Booker tropical soil manual: A handbook for soil survey and agricultural land evaluation in the tropics and sub-tropics Essex, NY: Longman Scientific and Technical. 1991:p. 474.
- [19] Tadesse T, Haque I, Aduayi EA. Soil, plant, water, fertilizer, animal manure and compost analysis manual. ILCA PSD Working Document. 1991.