Sustainability in Environment
ISSN 2470-637X (Print) ISSN 2470-6388 (Online)
Vol. 8, No. 2, 2023
www.scholink.org/ojs/index.php/se

Original Paper

Verification of Determined Soil Test Based Phosphorous Critical and Requirement Factor for Bread Wheat in Shashemene District

Abay Chala[1], Kasahun Kitila[1] & Mekonnen Workina[1]

[1] Oromia Agricultural Research institute, Adami Tulu Agricultural Research Center, Ethiopia

Received: March 12, 2023 Accepted: April 8, 2023 Online Published: April 27, 2023

doi:10.22158/se.v8n2p40 URL: http://dx.doi.org/10.22158/se.v8n2p40

Abstract

*Verification of P-critical value, P-requirement factor and optimum level of nitrogen fertilizer for bread wheat were conducted in Shashemene district during 2021 growing season. The verification activity was under taken at 10 farmer's fields. It had three treatments that include calibrated phosphorus (critical concentration) with recommended optimum N fertilizer for the area, existing NP fertilizer recommendation (blanket recommendation) and one control plot without NP application. The treatments were applied 10m by 10m plot area that was replicated over the farmers. The yield was harvested and means comparison of grain yield was computed at (α < 0.05). The grain yield response were highly significantly different (P<0.05). Plots treated with soil test based fertilizer recommendation gave the highest grain yield (4312kg/ha) followed by the blanket recommendation that gave 3175kg/ha. The minimum grain yield was obtained from the negative control (1600kg/ha). In addition, maximum total biomass (10500kg/ha) and harvest index (41%) were also obtained from the plots treated with soil test based fertilizer recommendations. The partial budget analysis also indicated that the maximum net benefit of (*103370.*00ETB) and highest MRR (143%) were obtained from application of soil test based recommendation. Therefore, soil test based fertilizer application was recommended and selected for further pre scaling up of demonstration activities.*

Keywords

P-critical, P-requirement factor, Verification

1. Introduction

Wheat (Triticum spp.) is one of the most important cereal crops grown in the world. Ethiopia is the largest wheat producer in Sub-Saharan Africa (SSA), with more than 1.8 million hectares per year

(Abbey et al., 2012). In Ethiopia, wheat currently ranks fourth in production (about 4.5 million tons), contributing 16.6% and 18% of total area and cereal production, respectively (CSA, 2016). Although the nutritional and economic contribution of wheat in Ethiopia is satisfactory, the yield is far below potential due to a number of biophysical and socioeconomic constraints including traditional production. and inadequate technological interventions. Several biophysical and socioeconomic factors have been identified as the main constraints limiting productivity growth in agriculture (Misiko & Ramisch, 2007). Among other factors, the decline in soil fertility is considered to be the main physiological limiting factor to the increase in per capita food production (Beedy et al., 2010).

In Ethiopia, fertilizer use trends focus mainly on the use and fertilization of urea and di-ammonium phosphate (DAP), sources of N and P. Continuous application of nitrogen (N) and phosphorus (P) without careful consideration of other nutrients has resulted in the depletion of other important nutrients such as potassium (K), magnesium (Mg), calcium (Ca), sulfur (S) and other nutrients. micronutrients in soil (Abiye et al., 2004). Unbalanced fertilizer use leads to low fertilizer use efficiency, which leads to lower economic efficiency and greater environmental threat (Abiye et al., 2004).

More recently, soil inventory data show deficiencies in most nutrients such as nitrogen (86%), phosphorus (99%), sulfur (92%), ne (65%) and zinc (53%).) is common in the soil of Ethiopia (Ethio-SIS, 2016). The results of several studies carried out on the status of P in Ethiopian soils (Tekalign & Haque, 1987) indicate that most of the studied soils require the addition of P fertilizers for plant growth to be effective. profit. It is essential that soil test results can be calibrated or correlated with crop response to nutrient applications of the crop in question, as this is the ultimate measure of a fertilizer program. . Proper calibration of soil tests is essential for the success of fertilizer programs and agricultural production (Abaidioo et al., 2000). Although there have been attempts to replace the global guideline with phosphorus guidance based on the response of test crops in soil, very small areas have been addressed. Fertilizer recommendations in Shashamane County are also not based on soil test results. To alleviate this problem, the Adami Tulu Agricultural Research Center conducted a crop-responsive fertilizer calibration process based on site-specific soil tests on wheat and determined optimal nitrogen levels. Priorities apply to this particular area (46 kg/ha), critical P value (21 ppm) and P requirement factors (4.43) Kasahun et al., 2022. However, the study must be further strengthened by conducting soil test crop response verification to wheat in the same district with the following objectives.

2. Objective

1) To verify the phosphorous critical and phosphorus requirement factor identified.

2) To determine the economically optimal rate of chemical fertilizer application for wheat in the study area.

3. Description of the Study Area

The operation was carried out in Shashemene districts of Western Arsi zone, Oromia. The Shashemene district lies at an average elevation of 2002 m.a.s.l. The district's rainfall pattern is characterized by a two-mode distribution with a small rainy season (March to June) and a large Meher rainy season (July to November). Total annual precipitation is 1520 mm and means an average annual temperature of 19.7. In terms of soil type, the dominant soil unit of Shashemene district is the Andosol. Textually, the soil of the area is classified as sandy loam. Wheat, barley, potatoes, corn and tef are the major crops produced in the district

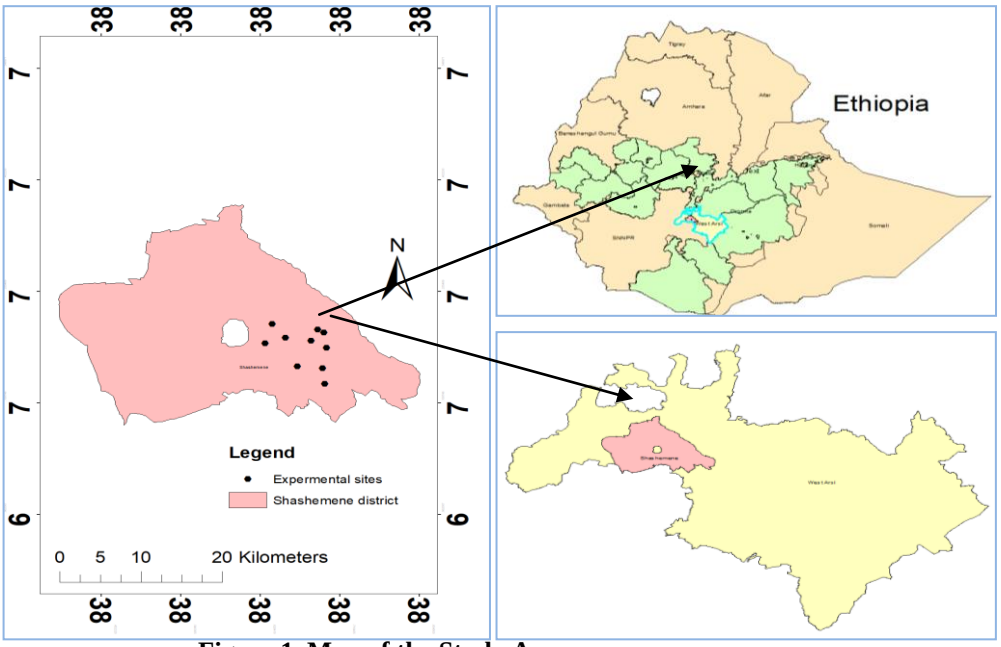

Figure 1. Map of the Study Area

4. Materials and Methods

The verification trial was conducted at 10 purposively selected sites based on their interest and contribution for the first phase trial on determination of pc and pf. Then representative composite soil samples were taken at the soil depth of (0-20 cm) in zigzag method from all sites to identify initial available phosphorous level and soil pH. Bread wheat variety called ‘king bird’ was used as test crop. Urea and TSP fertilizers were used as source of N and P fertilizers, respectively.

5. Treatments

Phosphorus recommendation was calculated and applied according to the formula, P (kg ha-1) = (Pc – P0)* P requirement factor (whereas Pc= 21 ppm, and Pf= 4.43) with determined optimum N (46 kg) and average initial available p (pi) was 15ppm. The treatments were:

1. Soil test based recommendation
2. Blanket recommendation

3. Control (No fertilizer)

Blanket recommendation was 100kg NPS and100 kg Urea and control was plot without fertilizer). The experimental fields were prepared by using oxen plow in accordance with conventional farming practices. The experimental design was simple plot replicated per farmers. The gross plot size was 10 m x 10 m. Full dose of phosphorous as per the treatment and one-half of N was applied at sowing. The remaining one-half of N was top dressed after three weeks of planting. All recommended agronomic management practices including disease and insect pest control were done. Farmers' field visit were conducted to give awareness on importance of soil test based fertilizer recommendations

6. Data Collection and Analysis

Yield data was collected from 2m x 2m from all treatment plots and the result was converted to actual plot size and hectare. In addition, economic analysis was performed to investigate the economic feasibility of the treatments. Partial budget, dominance, marginal and sensitivity analyses were done using (CIMMYT, 1988). Finally, the collected data was subjected to the analysis of variance using the SAS computer package version 9.0 (SAS Institute, 2002) statistical software.

7. Result and Discussions

7.1 Effect of Treatments on Grain Yield

The grain yield response of the treatments were highly significantly different ($P<0.05$). Plots treated with soil test based fertilizer recommendation gave the highest grain yield (4312kg/ha) followed by the blanket recommendation that gave 3175kg/ha. The minimum grain yield was obtained from the negative control (1600kg/ha). Both total biomass and harvest index were found to be highly significantly different among the treatments (table1). In addition, maximum total biomass (10500kg/ha) and harvest index (41%) were also obtained from the plots treated with soil test based fertilizer recommendations followed by the blanket fertilizer recommendation (8538kg/ha) and harvest index (37%). Yield advantage of Soil test based fertilizer recommendation over the blanket and control treatment were computed (table1). Accordingly, treatment applied using Pc has 169% and 36% yield advantage over the control and blanket recommendations respectively. Similarly, previous research output reported by Dejene et al (2009), Gidena (2016), Kefyalew et al. (2016) and Mengistu et al. (2022) also supports this experimental result. According to Mengistu et al. (2022), experiment made in Southeastern Ethiopia, higher grain yield was observed at soil tests based fertilizer recommendation than the blanket type of fertilizer application.

Table 1. Effect of Treatments on Grain Yield and Yield Components

Treatments	Mean GY in Kg/ha	Total BM (kg)	HI (%)	Yield adv. (%) over	
				Over Control	Over blanket application
STBFR	4312[a]	10500[a]	41.06[a]	169	36
Blanket Recommendation	3175[b]	8538[b]	37.18[b]	98	-
Control	1600[c]	4005[c]	39.99[ab]		
CV (%)	14.17	12.99	9.44		
LSD(0.05)	678.34	1252.4	2.60		
Significance	**	**	**		

** Highly significant, STBFR=soil test based fertilizer recommendation.

Figure 2. Experimental Sites in Shashemene District

7.2 Partial Budget Analysis

The partial budget analysis indicated the maximum net benefit of (103370.00ETB) and highest MRR (1736%) were obtained from application of recommended fertilizer P-critical and optimum N (46kg /ha). The lowest net benefit was obtained from the control treatment (Table 7).

Table 7. Partial Budget (ETB) Analysis Using CIMMT, 1988

Treatments	Mean Gy kg/ha	Unit price	NPS in kg/ha	Unit cost	UREA in kg/ha	Unit cost	TVC/ha	Gross income/ha	Net income	MRR (%)
Control	1600.0	25.00	0.00	0.00	0.00	0.00	0.00	40000.0	40000.00	0
Blanket	3175.0	25.00	100.00	18.50	59.00	17.50	2882.5	79375.0	76492.50	1266.00
STBFR	4312.0	25.00	160.00	18.50	84.00	17.50	4430.0	107800.0	103370.00	1736.83

STBFR: soil test based fertilizer recommendation.

8. Conclusion and Recommendation

It was identified that application of soil test based fertilizer application gave maximum grain yield with highest yield advantage over the blanket recommendation. Therefore, it was highly recommended for the farmers and other beneficieries to use the recommended fertilizer rate instead of the blanket ones. NPS rate determination and wider demonstration of the technologies are the remaining activities in the study area.

Acknowledgements

I acknowledge Oromia Agricultural Research Institute (OARI) and Adami Tullu Agricultural Research Center for granting the research fund and facilitation of the resources respectively.

References

Abeyo, B., Braun, H., Singh, R., Ammar, K., & Payne, T. (2012). The performance of CIMMYT wheat germplasm in East Africa with special emphasis on Ethiopia. In Quilligan E, et al. (Ed.), *Book Abstracts of Wheat for Food security in Africa* (p. 22), conference AA, Ethiopia.

Abiye, A., Mamo, T., Peden, D., & Diedhiou, M. M. (2004). Participatory on Farm Conservation Tillage Trial in the Ethiopian highland Vertisols: The Impact of Potassium Application on Crop Yields. *Experimental Agriculture*, *40*(3), 369-379. https://doi.org/10.1017/S0014479704002029

Beedy, T. L., Snapp, S. S., Akinnifesi, F. K., & Sileshi, G. W. (2010). Impact of gliricidia sepium intercropping on soil organic matter fractions in a maize-based cropping system, Agriculture, *Ecosystems & Environment*, *138*, 139-146. https://doi.org/10.1016/j.agee.2010.04.008

Central Statistical Agency (CSA) [Ethiopia] and ICF. (2016). *Ethiopia Demographic and Health Survey*.

Ethio-SIS (Ethiopia Soil Fertility Status). (2016). *Fertilizer Recommendation Atlas of the Southern Nations, Nationalities and Peoples' Regional State, Ethiopia* (p. 81).

Gidena, T. (2016). Verification and Demonstration of Soil Test Based Phosphorus Fertilizer Recommendation Rate on Yield of Teff (Eragrostis Tef (Zucc) Trotter) in Vertisols of Northern Ethiopia. *Journal of Natural Sciences Research*.

Kefyalew, A., Tilahun, F., & Tadesse, H. (2016). Verification and Demonstration Pc and Pf Determined Through Soil Test Based Crop Response Study for P on Bread Wheat at Lume Area of Oromia Region, Ethiopia. *International Journal of Research and Innovations in Earth Science*, *3*(6).

Mengistu, C., Kasu, T., Gobena, N., Anbessie, D., & Almaz, A. (2022). Verification an Demonstration of Soil Test Based Phosphorous Calibration for Wheat Crop under Nitisols of Southeastern Ethiopia. *J Ecol & Nat Resour*, *6*(1), 000269. https://doi.org/10.23880/jenr-16000269

Misiko, M., Tittonell, P. A., Ramisch, J. J., Richards, P., & Giller, K. E. (2008). Integrating new soyabean varietes for soil fertility management in smallholder systems through participatory research: Lessons from western Kenya. *Agricultural Systems*, *97*(1-2), 1-12.

https://doi.org/10.1016/j.agsy.2007.10.002