



## Soil Test Crop Response Based P-Calibration Study on Tef (*Eragrostis tef*) in Yabello District of Borana Zone, Southern Oromia, Ethiopia

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### Abstract

This study aimed to determine the optimum nitrogen (N) and phosphorus (P) requirements for Tef (*Eragrostis tef*) production in Yabello District, Southern Oromia, Ethiopia, where soil phosphorus deficiencies often limit crop yields. The experiment was conducted over two phases during the 2022-2024 cropping seasons. In the first phase, 12 factorial treatments combining four nitrogen levels (0, 46, 69, 92 kg/ha) and three phosphorus levels (0, 30, 40 kg/ha) were tested to identify the optimal nitrogen rate. In the second phase, 46 kg N/ha was applied uniformly, and six phosphorus levels (0, 10, 20, 30, 40, 50 kg/ha) were tested to determine the phosphorus critical (Pc) level and phosphorus requirement factor (Pf). The experiment followed a randomized complete block design (RCBD) with three replications. The results showed that grain yield was significantly influenced by the interaction of nitrogen and phosphorus rates. The highest grain yield (1748.23 kg/ha) occurred with 40 kg P/ha and 46 kg N/ha. Economic analysis revealed the highest net benefit (103,603 Birr/ha) and a marginal rate of return of 543% with 46 kg N/ha and 40 kg TSP/ha. The determined phosphorus critical level (Pc) was 14 ppm, and the phosphorus requirement factor (Pf) was 5.79. Based on these findings, the recommended optimal nitrogen rate is 46 kg N/ha, with a Pc of 14 ppm and a Pf of 5.79 for Tef production in Yabello and similar agro-ecological areas. Verification on additional farmland may be necessary before full technology distribution.

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**Keywords:** Fertilizer Rate, Optimum Nitrogen, Phosphorus Critical Point, Phosphorus Requirement Factor, Tef Productivity, Yabello district

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### Introduction

Tef (*Eragrostis tef* (Trotter)), a cereal crop that belongs to the grass family Poaceae, is endemic to Ethiopia and has been widely cultivated in the country for centuries (Teklu and Tefera, 2005). The crop harbors several useful traits both for farmers and consumers. Some of these beneficial traits are; the plant is tolerant to extremely environmental conditions; the seeds are not attacked by storage pests; and the seeds are gluten-free, and hence considered as a healthy food (Kibebew *et al.*, 2011). It is extensively cultivated in Ethiopia with annual coverage of about 2.8 million hectares (Kebebew *et al.*, 2013) <sup>[13]</sup> or it occupies about 25-32% of land under cultivation with cereal crops (Girma *et al.*, 2018) <sup>[10]</sup>. Almost two-thirds of the Ethiopian population relies on tef as their daily staple food. As average incomes rise and urbanization accelerates in Ethiopia, the demand for tef is expected to increase significantly over time (Berhane *et al.*, 2011).

Ethiopia is not only a center of origin for tef but also a region of remarkable diversity and significance for this crop, covering vast areas of land. However, despite its importance, tef production remains relatively low and insufficient to meet the needs of both the population and the market (Anteneh, 2017). Several challenges contribute to this production shortfall, including low soil fertility and suboptimal use of mineral fertilizers. Additionally, factors such as weed competition, a lack of high-yielding cultivars, erratic rainfall patterns in lower altitudes, lodging, waterlogging, and overall low moisture levels further impede tef

cultivation (Desta, 2014)<sup>[9]</sup>

The Blanket fertilizer recommendations currently applied was released several years ago in Ethiopia, does not consider the differences in agro-ecological environments are inappropriate for application to current production systems and for the foreseeable future (Abuye *et al.*, 2021)<sup>[2]</sup>. Farmers have been applying the same P fertilizer rate to their fields regardless of soil fertility variations since the temporal and spatial variations in soil fertility haven't been considered. For this reasons, the blanket recommendation will make inefficient use of these expensive nutrients which contribute to the depletion of scarce financial resources, increased production costs and potential environmental risks (Tarekegne & Tanner, 2001)<sup>[24]</sup>.

According to Abdulrahman *et al.* (2021), calibration is the process of determining the relationship between the yield response of adding nutrients to the soil as fertilizer and the test values for the soil. It provides information how much nutrient should be applied at a particular soil test value to optimize crop growth without excessive waste. Calibration research predicts the probability of response from applying a given nutrient which must be determined experimentally in the field (Dahnke and Olsen, 1990)<sup>[8]</sup>. The calibration curve is specific for each crop type, soil type, soil pH, climate; plant species, and crop variety (Agegnehu and Lakew, 2013)<sup>[3]</sup>. Soil test based fertilizer recommendations play a vital role in ensuring balanced nutrition for crops. Therefore, fertilizer application schedules should be based on the magnitude of crop response to applied nutrients at different soil fertility levels (Santhi *et al.*, 2002)<sup>[20]</sup>. That means fertilizer recommendations based on soil test crop responses for

economic crop production should be both soil and situation (agroecology) specific. As in all other regions of the country, a fertilizer recommendation in Yabello district is also not based on soil test results.

### Objectives

- To determine optimum level of N fertilizer for Tef in the Yabello districts
- To determine P-critical value and P-requirement factor for Tef under farmer's conditions.

### Materials and Methods

#### Description of the Study Area

The study was conducted in the Yabello District, Borana Zone of Oromia Regional State, Ethiopia. It is located in the hub of Borana rangeland, 570 km south of Addis Ababa, and both the Ganale-Dawa and Rift-Valley River basins cross through it. Its altitude varies from 1000 to 1800 meters above sea level (masl) at the latitude and longitudes of 4°12'10''–5°16'20'' N and 37°51'40'' – 38°37'30'' E, respectively (Coppock, 1994)<sup>[7]</sup>. Yabello District has bimodal rainfall, with the main rainy season locally known as *Ganna* (60%) is occurring during March to May and the short rainy season locally called *Hagaya* (30%) occurring from October to November. The mean annual rainfall in the Yabello district ranges from 400 mm to 900 mm with high altitudinal variability. The climatic data of Yabello metrological station indicated that the mean annual maximum and minimum temperature are 28.5 °C and 12.3 °C, respectively (Yabello Administrative Office, 2023; NMA, 2023).

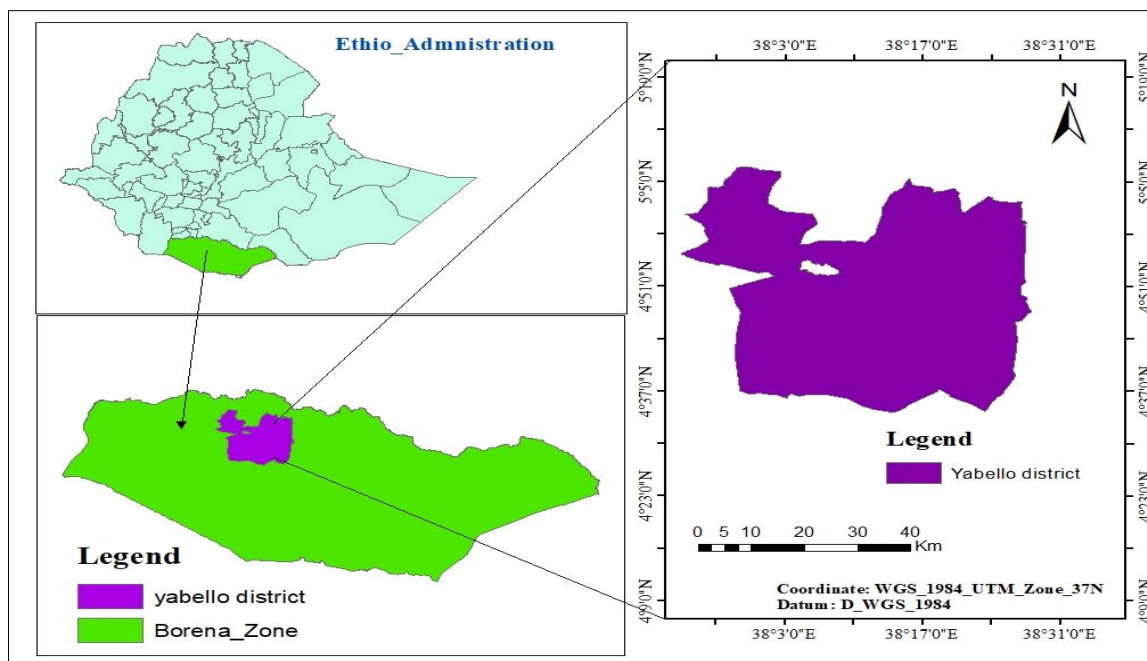


Fig 1: Map of the Study Area

### Soil and Farming Practices

The soil types of the study area are Chromic Cambisol, Eutric Cambisol, Chromic Luvisols, Epileptic Leptosol, and Pellic Vertisol and they comprise texturally five main classes: clay loam, sandy clay loam, loamy sand, clay, and loam (FAO, 2012). Chromic Luvisols were found to be the dominant soil type, which accounts for 79.4% of the total study area (Fenan

*et al.*, 2022). The major crops grown in the study area are maize (*Zea mays*), tef (*Eragrostis tef*), and haricot bean (*Phaseolus vulgaris*) (Desta *et al.*, 2011)<sup>[9]</sup>. Farmers generally cultivate crops using rainfed agriculture as a crop-livestock mixed farming system, and irrigation has also become important in agricultural production activities.

### Site selection and Soil sampling

For deciding representative experimental locations, six sites/farmers/ fields were selected depending on its accessibility for providing good management system and composite soil samples were collected from the district and optimum nitrogen rate that the crop requires were recommended in the first year (2022) in the case of Tef production. In second and third year (2023–2024) randomly twenty sites were selected for determination of phosphorus critical (Pc) and requirement factors. Composite soil samples were collected from all sites by using Auger from the depth of (0-20cm) air dried, grounded and passed through 2mm sieve and analyzed at Yabello Pastoral and Dry Land Agriculture Research Center Soil laboratory keeping its standards/procedures.

### Treatments, experimental design and procedures

In the case of the first year, the experiment was consisted of three levels of P (0, 30, 40 kg/ha) and four levels of Nitrogen (0, 46, 69 and 92 kg/ha) fertilizers were combined as treatments. The treatments were arranged in factorial combination with RCBD replicated three times over six farmers. In second and third years for determination of Pc and Pf treatments consists of six levels of P (0, 10, 20, 30, 40, 50 kg/ha) and 46 kg/ha N were arranged in single factor in RCBD with three replications.

### Determination of critical P concentration (Pc)

Determination of Critical P Concentrations is below which there were a response while above phosphorus was not respond. Intensive composite soil samples were collected after 21 days of planting. At this time the applied phosphorus was ready to be utilized by crop. Critical P value (mg/kg) has been determined following the Cate-Nelson graphical method where soil P values were put on the X-axis and the relative grain yield values on the Y-axis.

$$\text{Relative Yield} = \frac{\text{yield} \times 100}{\text{maximum yield}}$$

The Cate-Nelson graphical method was dividing the Y axis and X axis scatter diagram into four quadrants and maximizing the number of points in the positive quadrants while minimizing the number of points in the negative quadrants (Nelson and Anderson, 1977) [19].

### Determination of Phosphorus Requirement Factor (Pf)

Phosphorus requirement factor (Pf) is the amount of Phosphorus in kg needed to raise the soil P by 1ppm. Average of Olsen P-ppm after 21 days of each applied P-treatment and Phosphorus increase over the control were calculated. Finally, Pf (phosphorus requirement factor) was determined by the following formula.

$$\text{Pf} = \frac{\text{kg P applied}}{\text{change in soil P}}$$

### Statistical Analysis

Yield and soil available data from all sites were managed on Excel software. The collected data were subjected to analysis variance (ANOVA) using the General Linear Model (GLM) procedures of SAS software (SAS, 2002) [21]. Mean comparison of treatments were performed using Fisher's least significant difference test at  $p < 0.05$  probability level.

### Economic Analysis

To identify the economic significance of the treatments, partial budget analysis was employed and calculates the marginal rate of return (MRR) (CIMMYT, 1988) [5]. Since the treatments are significance, economic analysis was done for nitrogen and phosphorus fertilizers. The grain yield was adjusted by 10% to reduce the exaggeration of small plot management. The cost of fertilizer at local market on April, 2022 (Urea and NPS/TSP 30 ETB  $\text{Kg}^{-1}$  and 35 ETB  $\text{Kg}^{-1}$ , respectively). Transport, broad casting, harvesting and bagging cost was estimated 15 Birr  $\text{Kg}^{-1}$  for study area. To use the marginal rate of return (MRR) as a basis for fertilizer recommendation, the minimum acceptable rate of return (MARR) was set to 100% (CIMMYT, 1988) [5].

### Results and Discussions

#### Selected soils physicochemical properties before planting

The results of particle size distribution, pH, OM, TN and Av. P of the soil were summarized and presented in Table 1. Accordingly, the percentages of sand, clay, and silt content were represented by soil particle size distributions with values ranging from 29 - 81%, 10 - 48%, and 9 - 43% for percent sand, clay and silt content, respectively. As the rating suggested by Hazelton, P. and Murphy, B. (2007) [11], moderate to very high level of sand, low to high level of clay and very low to high level of silt contents. The pH ( $\text{H}_2\text{O}$ ) values of the soil samples collected before sowing were ranged from 5.99-7.09 (Table1) consequently the soils of the study site lie in general from moderately acid to neutral soil reaction (Murphy (1968 and Jones J., 2003) [18, 12]

The range values for soil organic matter (OM) was 0.79 to 2.69%. As per the ratings of (Tekalign, 1991) [25], OM contents for soils of the experimental sites rated into very low to moderate class. The values of total nitrogen (TN) content varied from 0.11 to 0.23% rated as low to moderate as ratings suggested by (Landon, 1991) [17]. The values of available phosphorus (Av. P) ranged from 5.5 to 9.1 mg/kg which rated low to moderate based on the critical values for determined by the Olsen method established by (Clements and McGowen (1994)) [6]. Cation exchange capacity (CEC) values were ranged from 14.8 to 20.7  $\text{cmol}^+/\text{kg}$  according to (Hazelton and Murphy, 2007) [11], rated into low to medium (Table 1). This classification indicates that the soil has a moderate capacity to hold cations, which can affect nutrient availability for plants. Soils with low to medium CEC may require more frequent fertilization to ensure that plants receive adequate nutrients. The reasons for the extremely low to low categories of these important soil plant nutrients might include leaching, continuous mono-cropping based on cereals (primarily tef), low or restricted inputs of fertilizers from organic and inorganic sources, nutrient fixation, or loss from soil erosion.

**Table 1:** Selected soils physicochemical properties status for the experimental sites of Yabello District (2022-2024).

Farmer's name	pH	EC	%sand	%clay	%silty	Textural class	%OC	%OM	Av P	Tot. N	CEC
Jatani	7.09	2.12	35	22	43	Loam	2.69	4.64	5.5	0.11	15.6
Jarso	6.70	2.68	67	20	13	sandy clay loam	1.90	3.27	9.0	0.16	18.2
Abduba	6.35	1.61	81	10	9	loamy sand	0.79	1.37	8.9	0.20	14.8
Beko	6.35	1.53	25	47	28	Clay	1.08	1.87	9.1	0.17	17.3
Bute	6.22	0.85	59	22	19	sandy clay loam	1.00	1.72	9.0	0.23	20.7
Guracha	5.99	1.78	29	48	23	Clay	2.54	4.38	8.2	0.22	16.8
Mean	6.45	5.79					1.26	2.17	9.0	0.18	17.2

### Determination of Optimum Nitrogen Fertilizer

The analysis of variance indicated that the interaction effect of P and N fertilizer rates had a significant ( $p < 0.05$ ) impact on the yield of tef. The highest tef yield (1748.23 kg ha<sup>-1</sup>) was obtained from the application of 40 kg P with 46 kg N ha<sup>-1</sup> followed by 1679.3 kg and 1644.4 kg of tef yield which were obtained from the application of 30 kg of P with 46 kg N (ha<sup>-1</sup>), and 40 kg of P with 69 kg N (ha<sup>-1</sup>), respectively (Table 2). This result shows the existence of a positive interaction of P, and N fertilizers for the production of tef crops, and the responsiveness to the application of high-level fertilizer

phosphorus. While the lowest yield (872.30 kg ha<sup>-1</sup>) was recorded from control (unfertilized plot). In agreement with this results Amante *et al.* (2023)<sup>[4]</sup> found that the main and interaction effects of both P and N fertilizer rates shows highly significant difference ( $P < 0.05$ ) for tef grain yield in Bora district. The lowest (1,017 kg/ha) mean grain yield of the crop was obtained from the control (without fertilizers application) and the highest (1,592 kg/ha) mean grain yield was recorded from the application of 200 kg P/ha with 115 kg N/ha.

**Table 2:** Interaction effect of N and P fertilizers on Tef (DZ\_CR-385) grain yield at Yabello District in 2022 cropping season.

N Rate kg ha <sup>-1</sup>	P <sub>2</sub> O <sub>5</sub> Rate kg ha <sup>-1</sup>		
	0	30	40
0	872.30 <sup>i</sup>	1276.80 <sup>f</sup>	1067.10 <sup>h</sup>
46	1131.60 <sup>g</sup>	1679.3 <sup>b</sup>	1748.23 <sup>a</sup>
69	1345.40 <sup>e</sup>	1611.76 <sup>c</sup>	1644.4 <sup>bc</sup>
92	1330.20 <sup>e</sup>	1490.50 <sup>d</sup>	1602.0 <sup>c</sup>
LSD(0.05)	1.79		
CV (%)	21.33		

### Partial Budget Analysis

To identify treatments with the optimum return to the farmer's investment, marginal analysis was performed on non-dominated treatments. For a treatment to be considered worthwhile to farmers (a 100% marginal rate of return (MRR)) was considered as the minimum acceptable rate of return (CIMMYT, 1988)<sup>[5]</sup>. As indicated in Table 3, the

partial budget and dominance analysis showed that the highest net benefit 103603.1 Birr ha<sup>-1</sup> was obtained in the treatment that was treated with 46 kg ha<sup>-1</sup> of N and 40 kg P ha<sup>-1</sup>, while the lowest net benefit 54578.6 Birr ha<sup>-1</sup> was obtained in the control treatment. Hence, 46 kg N ha<sup>-1</sup> is economically optimal for tef production in Yabello District.

**Table 3:** Partial budget and marginal analysis for TSP and N rates of Tef

N	P <sub>2</sub> O <sub>5</sub>	GY (Kg/ha)	Adj. GY(Kg/ha)	TVC (ETB)	GNB(ETB)	NB(ETB)	MRR (%)
0	0	872.3	778.9	3836.6	58415.3	54578.6	
46	0	1131.6	1010.3	7531.0	75775.5	68244.5	369.9
0	30	1276.8	1140.0	9420.1	85502.3	76082.2	414.9
69	0	1345.4	1201.3	10353.8	90094.5	79740.7	391.8
0	40	1067.1	952.8	11358.3	71457.8	60099.4	-D
92	0	1330.2	1187.7	11063.2	89079.0	78015.8	D
46	40	1782.7	1591.7	15775.1	119378.3	103603.	543.0
46	30	1679.3	1499.4	14248.1	112453.5	98205.4	353.5
69	40	1644.4	1468.2	17404.7	110116.5	92711.8	D
69	30	1578.0	1408.9	15476.7	105666.8	90190.1	130.8
92	40	1602.0	1430.3	18791.0	107275.5	88484.5	D
92	30	1490.5	1330.8	16742.5	99813.0	83070.5	264.3

TSP cost = 3500 Birr ku<sup>-1</sup>, UREA cost = 3000 Birr ku<sup>-1</sup>, tef grain = 75 Birr kg<sup>-1</sup>, TVC = Total variable cost (Birr ha<sup>-1</sup>) AGY = Adjusted grain yield downwards by 12.5% (kg ha<sup>-1</sup>), GNB = Gross Net Benefit, NR = Net return (Birr ha<sup>-1</sup>), MRR (%) = Marginal rate of return, Control = unfertilized.

### Yield and Yield Components Responses to Phosphorus Fertilizer Rates

The responses of yield and yield components of tef to phosphorus fertilizer were presented in Table 4. Phosphorus fertilizer among the treatments had a substantial impact on grain yield as well as the yield components of tef, according to the mean analysis of variance across all experimental locations. The results showed that the maximum phosphorus

application rate (50 kg/ha) produced the largest biomass (4.20 tonne ha<sup>-1</sup>), spike length (35.71 cm), plant height (88.48 cm), and tiler number (3.56), while the control produced the lowest yield. Accordingly; the highest grain yield (1498.29 kg/ha) obtained at 46 N kg/ha and 40 kg/ha P while the lowest (978.68 kg/ha) obtained from the control plot. This might be due to NP fertilizer induced vigorous vegetative growth, which in turn, resulted in increased biological yield.

These results are in agreement with the results reported by Legesse, 2017 which showed, the application of phosphorus fertilizer rates of 10, 20, 30, 40, and 50 kg ha<sup>-1</sup> increased grain yields of tef by 48, 58, 64, 65 and 70 %, respectively, compared to the control (without P fertilizer). Besides, this result supported with the finding of Khan *et al* (2010)<sup>[16]</sup> and Shazma *et al* (2016)<sup>[23]</sup> who stated applications of optimum NP fertilizer enhanced grain yield. Additionally; Shazma *et al* (2016)<sup>[23]</sup> also obtained the decline grain yield and yield

components due to application NP fertilizer beyond optimum rate. The findings of this study demonstrate the positive impact of phosphorus application on tef yield and growth parameters. The significant differences among treatments suggest that higher phosphorus rates contribute to improved growth metrics, leading to increased biomass and grain yield. The results support the hypothesis that phosphorus is a limiting nutrient for tef production.

**Table 4:** Responses of biomass, SL, TN, PH and grain yield to combined application of optimum N and P levels for tef production at Yabello District

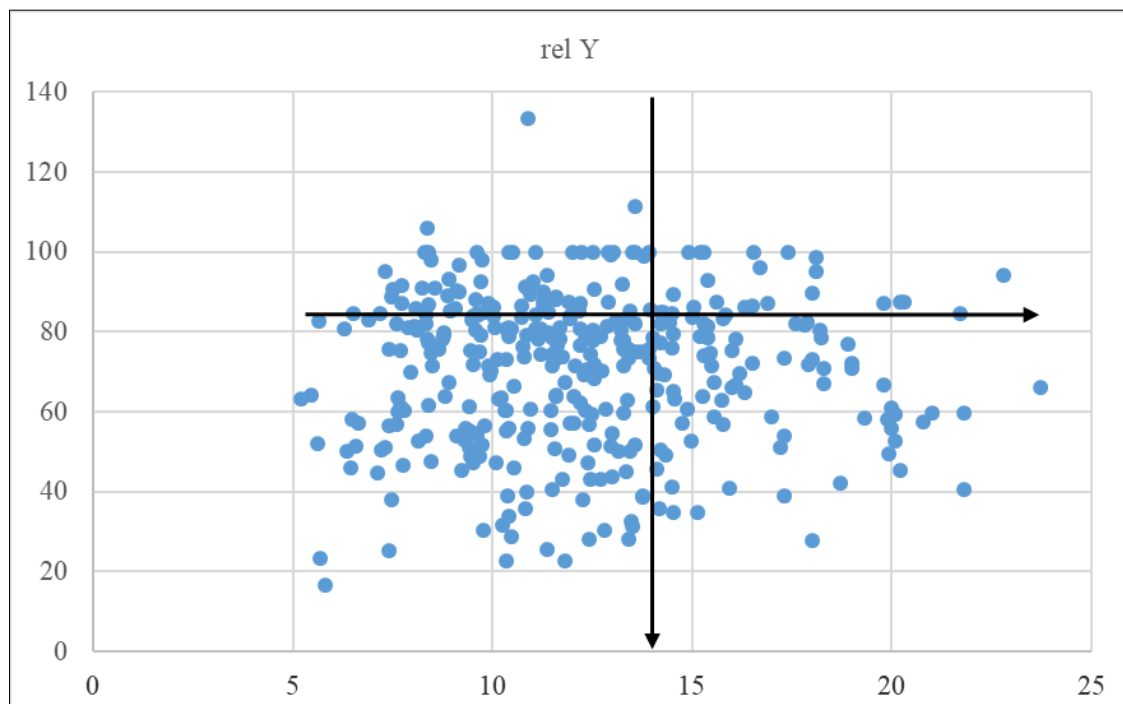
Phosphorus rate (kg/ha)	SL(cm)	PH(cm)	TN	Biomass (ton/ha)	Grain Yield (kg/ha)
50	35.71 <sup>a</sup>	88.48	3.56 <sup>ab</sup>	4.20	1457.29 <sup>a</sup>
40	29.71 <sup>c</sup>	81.73	3.21 <sup>abc</sup>	4.17	1498.67 <sup>a</sup>
30	32.63 <sup>b</sup>	91.41	3.71 <sup>a</sup>	3.96	1341.9 <sup>ab</sup>
20	30.16 <sup>c</sup>	91.78	2.98 <sup>bc</sup>	3.93	1261.89 <sup>bc</sup>
10	29.2 <sup>c</sup>	76.98	2.81 <sup>c</sup>	3.87	1119 <sup>cd</sup>
0	25.89 <sup>d</sup>	82.74	1.81 <sup>d</sup>	3.74	978.68 <sup>d</sup>
Mean	30.6	85.5	3.0	3.98	184.6
CV	6.4	22.6	22.8	7.8	7.95
LSD	1.8	ns	0.6	ns	1276.24

Means with the same factor and column followed by the same letter are not significantly different at a  $\alpha < 0.05$

#### Determination of Phosphorus Critical Concentration (Pc)

The critical phosphorus concentration (Pc) was calculated using the scatter diagram derived from the relative grain yields of tef and the subsequent soil test phosphorus values for all levels (0-50 kg P ha<sup>-1</sup>). The Cate-Nelson graphical method was used to identify the critical points of phosphorus; scatter points were divided into two populations, and the two perpendicular lines were moved vertically and horizontally

until the maximum number of points in the two positive quadrants (or, conversely, the minimum number of points in the negative quadrants). Finally, the point where the vertical line crosses the x-axis was defined as critical soil test levels. Accordingly, the phosphorus critical concentration above which the responses of the crop become minimal was 14 ppm for tef crop production in Yabello District.



**Fig 2:** Relative grain yield Vs P Olsen plot chart for P critical level determination

#### Determination of Phosphorus Requirement Factor (Pf)

The phosphorus requirement factor, which is the amount of phosphorus in kg needed to raise the soil phosphorus by 1 ppm enables us to determine the amount of fertilizer required

per hectare to bring the level of available phosphorus above the critical level. The average Olsen phosphorus (ppm) after 21 days of each applied phosphorus treatment and the phosphorus increase over the control were calculated.

The phosphorus requirement factor was also determined from the difference between available soil test phosphorus values and from plots that received 0-50 kg P ha<sup>-1</sup>. As a result, the

district's Pf ranged from 3.45 to 8.06 (Table 5), and the study area's overall average Pf of all treatments was 5.79.

**Table 5:** Phosphorus requirement factor for tef in Yabello district

Phosphorous rate (kg/ha)	Av P (ppm) /Olsen method/		P increase over control	P requirement factor (Pf)
	Range	Average		
0	2.6-13.4	8.6		
10	3.2-15.6	11.5	2.9	3.45
20	4.6-18.4	12.6	4.0	4.38
30	5.4-26.4	13.2	4.6	6.52
40	6.1-27.6	14.7	6.1	6.56
50	7.3-30.4	14.8	6.2	8.06
Average				5.79

### Conclusions and Recommendations

Calibration provides information how much nutrient should be applied at a particular soil test value to optimize crop growth without excessive waste. However, the present study, soil test based crop response phosphorus calibration study for tef production in Yabello District was conducted for three consecutive years (2022- 2024). The results revealed that agronomic parameters of Tef were found to be significantly influenced by both the N and combined NP fertilizer rates. The economic analysis showed that the highest net benefit of 103603 Birr ha<sup>-1</sup> with a 543% marginal rate of return was obtained in the treatment that was treated with 46 kg N ha<sup>-1</sup> of urea and 40 TSP kg ha<sup>-1</sup>. Therefore, uses of 46 N kg/ha fertilizer for Tef production at the district and areas having similar soil conditions and agro-ecology is advisable. In this soil test-based crop response phosphorus calibration study, the phosphorus critical (Pc) concentration (14 ppm) and the phosphorus requirement factor (pf), with a value of 5.79, were determined for tef production. Since both are the nutrients that most limit yield in the study area, it can be concluded that soil test crop response-based fertilizer application, in particular a combined application of optimum nitrogen and phosphorus calibration study, significantly improves yield and yield component of tef production in Yabello District. Therefore, additional field testing may be necessary to verify the results before distributing the technology to end users.

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### Conflict of Interest

The authors declare no conflict of interest

### References

1. Abdurahman Husien, Tilahun Firomsa, Tilahun Abera. Soil test crop response based phosphorus calibration study for bread wheat in Kofele District, West Arsi Zone Oromia, Ethiopia. *J Sci Agric.* 2021;5:20-25.
2. Abuye F, Haile M, Haile W. Soil fertility status, fertilizer application and nutrient balance in SNNPR, southern Ethiopia in contrasting agro-ecological zones of Ethiopia. *Afr J Agric Res.* 2021;17(11):1433-1452.
3. Agegnehu G, Lakew B. Soil test phosphorus calibration for malting barley (*Hordeum vulgare* L.) production on Nitisols of Ethiopian highlands. *Trop Agric.* 2013;90:177-187.
4. Amante Lemma Ayela, Tilahun Firomsa Erenso, Tilahun Abera Eshete, Abdurahman Husien Bedaso. Soil test crop response based phosphorus calibration studies for teff [*Eragrostis tef* (Zucc.) Trotter] in Bora District, East Shewa Zone of Oromia, Ethiopia. 2023.
5. CIMMYT. From agronomic data to farmer recommendations: an economics training manual. Completely revised ed. Mexico, DF: CIMMYT; 1988.
6. Clements B, McGowen I. Strategic fertilizer uses on pastures. NSW Agriculture Agnote Reg 4/57. Orange (NSW): NSW Agriculture; 1994.
7. Coppock DL. The Borana Plateau of southern Ethiopia: synthesis of pastoral research, development and changes in 1980–1990. Addis Ababa: International Livestock Centre for Africa; 1994;5:374.
8. Dahnke WC, Olsen RA. Soil test correlation, calibration and recommendation. In: Westerman RL, editor. Soil testing and plant analysis. 3rd ed. Madison (WI): Soil Science Society of America; 1990.
9. Desta BG. Assessment of factors affecting farmers' adoption level of row planting technology and yield improvement on the production of *Eragrostis teff* [Zucc.]. The case of Minjar Shenkora Woreda, Amhara Region, Ethiopia. 2014.
10. Girma TM, Tana T, Assefa KP. Responses of tef [*Eragrostis tef* (Zucc.) Trotter] varieties to blended NPSB fertilizer rates at Gelan, Central Ethiopia. Doctoral dissertation, Haramaya University; 2018.
11. Hazelton P, Murphy B. Interpreting soil test results: what do all the numbers mean? 2nd ed. Collingwood (Australia): CSIRO Publishing; 2007.
12. Jones JB. Agronomic handbook: management of crops, soils and their fertility. Boca Raton (FL): CRC Press; 2003.
13. Kebebew Assefa, Solomon Chanyalew, Zerihun Tadele, eds. Achievements and prospects of tef improvement;

- proceedings of the Second International Workshop, November 7–9, 2011, Debre Zeit, Ethiopia. Addis Ababa: Ethiopian Institute of Agricultural Research; Bern: University of Bern; 2013. ISBN: 978-3-033-03818-9.
14. Kebebew Assefa, Yu JK, Zeid M, Getachew Belay, Hailu Tefera, Sorrells MF. Breeding tef [*Eragrostis tef* (Zucc.) Trotter]: conventional and molecular approaches (review). *Plant Breed.* 2011;130:1-9.
  15. Kefyalew Assefa Gejea, Tilahun Firomsa Erenso. Phosphorus critical level and optimum nitrogen rate determination on bread wheat for sustainable soil fertility management and economical production at Lume area of Oromia region, Ethiopia. *J Biol Agric Healthc.* 2018;8(1):26-33.
  16. Khan MB, Lone MI, Ullah R, Kaleem S, Ahmed M. Effect of different phosphatic fertilizers on growth attributes of wheat (*Triticum aestivum* L.). *J Am Sci.* 2010;6(12):1256-1262.
  17. Landon JR. Booker tropical soil manual: a handbook for soil survey and agricultural land evaluation in the tropics and subtropics. Essex (UK): Longman Scientific and Technical; 1991.
  18. Murphy HF. A report on the fertility status and other data on some soils of Ethiopia. *Experiment Station Bulletin No. 44.* Dire Dawa (Ethiopia): College of Agriculture; 1968.
  19. Nelson LA, Anderson RL. Partitioning soil test-crop response probability. In: Peck TR, editor. *Soil testing: correlating and interpreting the analytical results.* Madison (WI): American Society of Agronomy; 1977.
  20. Santhi R, Natesan R, Seh'akumari G. Soil test based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu. Tamil Nadu Agricultural University, Coimbatore, India; 2002.
  21. SAS Institute Inc. *SAS/STAT User's Guide.* Version 9.0. Cary (NC): SAS Institute Inc.; 2002.
  22. USDA Soil Survey Staff. *Soil survey laboratory methods and procedures for collecting soil samples.* Soil Survey Investigations Report No. 1. Washington (DC): Soil Conservation Service; 1982.
  23. Shazma Anwar, Israeel, Babar Iqbal, Shehryar Khan, Muhammad Faraz, Nawab Ali, Saddam Hussain, Muhammad Mehran Anjum. Nitrogen and phosphorus fertilization of improved varieties for enhancing yield and yield components of wheat. *Pure Appl Biol.* 2016;5(4):727-737.
  24. Tarekegne A, Tanner D. Effects of fertilizer application on N and P uptake, recovery and use efficiency of bread wheat grown on two soil types in central Ethiopia. *Ethiop J Nat Resour.* 2001;3:219-244.
  25. Tekalign Tadese. *Soil, plant, water, fertilizer, animal manure and compost analysis.* Working Document No. 13. Addis Ababa (Ethiopia): International Livestock Research Center for Africa; 1991.
  26. Temesgen Godebo, Fanuel Laekemariam, Gobeze Loha. Nutrient uptake, use efficiency and productivity of bread wheat (*Triticum aestivum* L.) as affected by nitrogen and potassium fertilizer in Keddida Gamela Woreda, Southern Ethiopia. *Environ Syst Res.* 2021;10(1):1-16.

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