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Determining Optimal Nitrogen Level and Soil test-based Phosphorus Calibration study for Bread Wheat (*Triticum aestivum* L.) in Dugda District, East Shewa Zone, Oromia, Ethiopia

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Abstract: Nutrient mining due to sub-optimal fertilizer use on one hand and unbalanced fertilizer use on the other have favored the emergence of multi-nutrient deficiency in Ethiopian soils. Therefore, the study was conducted on twenty-six farmers' fields in Dugda District of East Shewa Zone of Oromia, during the main cropping seasons of 2018-2020. These studies were conducted to determine the economically optimum rate of nitrogen fertilizer in the first year Phosphorus critical (Pc) and phosphorus requirement factor (Pf) in the second year respectively. The treatments consisted of factorial combinations of three levels of TSP (0, 100, and 200) kg ha^{-1} with six levels of nitrogen (0, 23, 46, 69 92, and 115) kg ha^{-1} that gave a total of eighteen treatments. However, in the second two consecutive years, the experiment was conducted to determine phosphorus critical (Pc) and phosphorus requirement factor (Pf), and the treatments consisted of six levels of phosphorus (0, 10, 20, 30, 40, and 50) kg ha^{-1} combined with a single level of nitrogen (69 kg ha^{-1}) that gave a total of seven treatments. The experiments were laid out in randomized complete block design (RCBD) with two replications and the gross plot size was 4 m x 5 m (20 m^2) were used to determine optimum nitrogen in the first year and 4m x 5m (20 m^2) and phosphorus critical (Pc) and also harvested from 4m^2 plot areas. The analysis of variance indicated that Plant height, spike length, number of seeds per spike, biomass yield, and grain yield were highly significantly ($p < 0.01$) influenced by the main effect of nitrogen fertilizer rates. However except for the number of seed per spike, TSP fertilizer significantly ($p<0.05$) affect plant height and the number of seed per spike as well as highly significantly ($p < 0.01$) biomass and grain yield of bread wheat. The highest (68.76 cm) plant height, the highest (41.02) seed per spike, the highest (8867 kg ha^{-1}) biomass, and the highest (3293 kg ha^{-1}) grain yield were recorded by 200 kg TSP ha^{-1}. The highest (71.79 cm) plant height, the highest (9483 kg ha^{-1}) biomass, and the highest (3603 kg ha^{-1}) grain yield were recorded by 69 kg N ha^{-1}. However, the highest (6.867 cm) spike length and the highest (41.79) numbers of seed per spike were recorded by 115 kg N ha^{-1}. Moreover, from all tasted parameters the lowest values were recorded by control plots. The economic analysis revealed that for a treatment to be considered as worthwhile to farmers (100% marginal rate of return) application of 69 kg N ha^{-1}) is profitable which gave the highest (98871 Birr) net return with an acceptable (4607%) marginal rate of return and recommended for farmers in Dugda district. On the other hand, the analysis of variance indicated that Plant height, spike length, number of seeds per spike, biomass yield, and grain yield were highly significantly ($p < 0.01$) influenced by soil test-based phosphorus fertilizer application. The result indicated that the highest (83.9 cm) plant height, the highest (9900 kg ha^{-1}) biomass, and the highest (39980 kg ha^{-1}) grain yield were recorded by 50 kg P ha^{-1}. Moreover, 10ppm phosphorus critical (Pc) and 6.45ppm phosphorus requirement factor (Pf) were identified for bread wheat production for the farmers of Dugda District.

Keywords: Applied phosphorus, bread wheat, Cate and Nelson graph, TSP, Nitrogen, Phosphorous critical (Pc) phosphorus requirement factor (Pf), Soil and Yield.

INTRODUCTION

Wheat is a type of cereal crop cultivated for its grain and used worldwide as a staple food. The many species of wheat together make up the genus Triticum; the most widely grown is common wheat (*Triticum aestivum*) (James, 2014). Ethiopia is also one of the largest wheat producers in Sub-Saharan Africa and

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approximately 80% of the wheat area is planted to bread wheat (Asfaw *et al*., 2013). In Ethiopia wheat is mainly grown in the highlands, which lie between 6 and 16° N latitude and 35 and 42° E longitude, at altitudes ranging from 1500 to 2800 m above sea level and mean minimum temperatures of 6°C to 11°C. In Arsi, Bale, and Shewa Zones, the soil, moisture, and disease conditions within the range of 1900-2300m altitude zone are favorable for the production of early and intermediate maturing varieties of bread wheat. This is estimated to comprise 25% of the total wheat production area, while the remaining 75% falls in the 2300-2700 m altitude zone (MOA, 2016).

Ethiopia is not self-sufficient in wheat and has a substantial gap primarily due to inefficient transfer of technology and the lack of necessary inputs and blanket type fertilizer application based on soil color characteristics rather than on soil test results and crop requirements. According to the report of the Food and Agriculture Organization of the United Nations (FAOSTAT, 2021) world total, wheat production in 2019 was estimated at 765 million tons from a total of 215 million hectares area harvested; with an average yield of 3547 kg ha^{-1}. However, in Ethiopia, wheat production in 2019 was estimated at 5.3 million tons from 1.7 million ha area harvested with an average yield of 2970 kg ha^{-1}. According to this report despite the large area under wheat in Ethiopia, the average yield of wheat is 19.4 % far below the world's average yield.

Each type of plant is unique and has an optimum nutrient range as well as a minimum required level. Below this minimum level, plants start to show nutrient deficiency symptoms. Excessive nutrient uptake can also cause poor growth because of toxicity. Therefore, the proper amount of application and the placement of nutrients are important (Silva and Uchida, 2000). Moreover, Sonon and Zhang (2014) reported that soil test calibration is specific for each crop type and they may also differ by soil type, climate, and the crop variety and relates soil test measurement in terms of crop response (Rouse, 1965) and essential that the results of soil tests be calibrated against crop responses from applications of the plant nutrients in question as it is the ultimate measure of a fertilization program. The farmers in most parts of the country in general and in the study area, in particular, were applied fertilizers based on blanket recommendation (100 kg ha^{-1} Urea and 100 kg TSP ha^{-1} rather than soil test-based crop response fertilizers application method. Due to this soil test based crop response phosphorus calibration study was conducted for bread wheat with the following objectives:-

- To determine economically optimum N fertilizer for bread wheat in Dugda District.
- To determine Phosphorus critical and phosphorus requirement factor for bread wheat.

MATERIALS AND METHODS

Description of the Experimental Site

The experiment was conducted on a Farmers' field in Dugda District, East Shewa Zone of Oromia Regional State, central Ethiopia, for three consecutive years (2018 -2020). It is located in the Great Rift Valley. Dugda is bordered on the southeast by Lake Zuway, on the south by Adami Tullu Jido Kombolcha, on the west by the Southern Nations, Nationalities and Peoples Region, on the northwest by the Southwest Shewa Zone, on the north by the Bora District. Meki is the town of Dugda district and it has a latitude and longitude of 8°9′N 38°49′E/ 8.150°N 38.817°E with an elevation of 1636 meters above sea level.

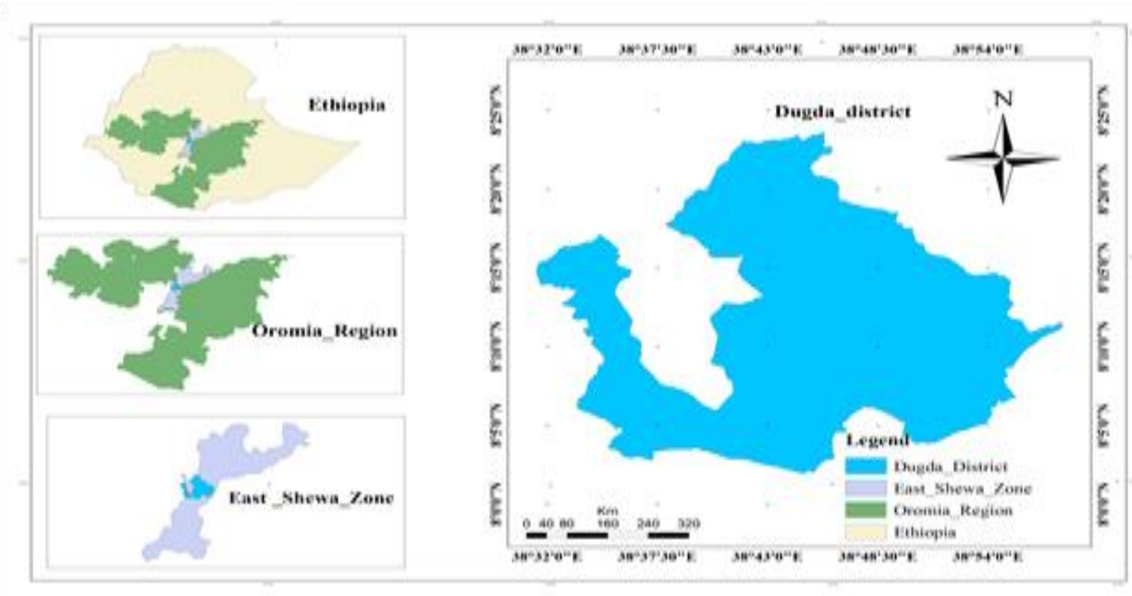

Figure 1: Location Map of Dugda District

Experimental Materials

- ✓ Bread wheat variety (Qaqaba) was used for the study area.
- ✓ TSP (46% P_2O_5),
- ✓ Urea (46% N) were used

Treatments and Experimental Design

In the first year, the experiment was conducted to determine optimum nitrogen rate and the treatments consisted of factorial combinations of three levels of TSP (0, 100, and 200) kg ha^{-1} with six levels of nitrogen (0, 23, 46, 69 92 and 115) kg ha^{-1} that gave a total of eighteen treatments. However, by using the determined optimum Nitrogen (69 kg ha^{-1}) at the first year; phosphorus critical (Pc) and phosphorus requirement factor (Pf) were determined in the second two consecutive years. So the treatments consisted of six levels of phosphorus (0, 10, 20, 30, 40, and 50) kg ha^{-1} combined with a single level of nitrogen (69 kg ha^{-1}) that gave a total of seven treatments. The experiments were laid out in randomized complete block design (RCBD) with two replications and the gross plot size was 4 m x 5 m (20 m^2) were used and also harvested from 4 m^2 plot areas.

Management of the Experiment

The experimental fields were prepared following the conventional tillage practice which includes three times plowing before sowing of the crop. As per the specification of the design, a field layout was prepared; the land was leveled and made suitable for crop establishment. Sowing was done in mid-July of 2018, 2019, and 2020 using a seed rate of 150 kg ha^{-1}. A full dose of Triple supper phosphate and TSP as per the treatment and one-third of N alone was applied at sowing time. The remaining two-thirds of N alone were top-dressed at the mid-tillering crop stage. during experimenting, other necessary agronomic management practices such as fungicide (Natura) sprayed for yellow rust and herbicide (Palas) sprayed to control both grass leaf and broadleaf were carried out uniformly for all treatments.

Data Collection and Measurement

Yield Components and Yield Parameters

Plant height (cm) Plant height was measured from the soil surface to the tip of a spike (awns excluded) from 10 randomly tagged plants from the net plot area at physiological maturity.

Number of seed per spike: The mean number of seeds per spike was recorded as an average of 10 randomly taken spikes from the net plot area.

Thousand kernel weight:

Thousand kernels weight was determined based on the weight of 1000 kernels sampled from the grain yield of each net plot by counting using an electronic seed counter and weighed with electronic sensitive balance. Then the weight was adjusted to 12.5% moisture content.

Spike length (cm):- was measured from 10 randomly selected wheat heads per plot at harvesting time.

Above ground dry biomass yield: The aboveground dry biomass yield was determined from plants harvested from the net plot area after sun drying to a constant weight and expressed in kg ha^{-1}.

Grain yield: The grain yield was taken by harvesting and threshing the grain yield from net plot area. The yield was adjusted to 12.5% moisture content and expressed as yield in kg ha^{-1}.

Harvest index (HI): The harvest index was calculated as ratio of grain yield per plot to total above ground dry biomass yield per plot expressed as percent.

Soil Sample collection and analysis: - After 21 day's composite soil samples were collected from each plots by using soil auger from a depth of 0-20cm and analyzed for phosphorus.

Determination of critical P concentrations

Critical phosphorus concentration 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. 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).

$$\text{Relative grain Yield \%} = \frac{\text{Yield}}{\text{Maximum Yield}} * 100$$

Determination of Phosphorus requirement factor

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.

$$\mathbf{Pf} = \frac{\mathbf{Kg\ P\ applied}}{\mathbf{\Delta\ Soil\ P}}$$

Statistical Analysis

The data subjected to analysis of variance (ANOVA) as per the experimental design using GenStat (15^{th} edition) software (GenStat, 2012). The Least Significance Difference (LSD) at 5% level of probability was used to determine differences between treatment means.

Partial Budget Analysis

The dominance analysis procedure as described in CIMMYT (1988) was used to select potentially profitable treatments from the range that was tested. The discarded and selected treatments using this technique were referred to as dominated and un dominated treatments, respectively. For each pair of ranked treatments, % marginal rate of return (MRR) was calculated using the formula:-

$$\textbf{MRR (\%)} = \frac{\text{Change in NB (NBb}-\text{NBa)}}{\text{Change in TCV (TCVb}-\text{TCVa)}} \times 100$$

Where,

NB_a = NB with the immediate lower TCV,
NB_b = NB with the next higher TCV,
TCV_a = the immediate lower TCV and
TCV_b = the next highest TCV.

RESULT AND DISCUSSION

Thousand kernels weight and harvest index

The analysis of variance indicated that different rates of TSP and nitrogen fertilizers did not significantly ($p < 0.05$) influence thousand kernels weight and harvest index of bread wheat crop at the study area (Table 1).

Table 1: Plant height, Spike length, number of seed per spike, Biomass and grain Yield of bread wheat as influenced by main effect of TSP and nitrogen fertilizers rates

Treatment	PH(cm) (cm)	SPL(cm)	NSPS	BM (kg ha^{-1})	GY(kg ha^{-1})
TSP (kg ha^{-1})					
0	65.55^{b}	6.547	38.54^{b}	7042^{b}	2612 ^{b}
100	68.12^{a}	6.684	39.99^{ab}	8325^{a}	3077^{a}
200	68.76^{a}	6.736	41.02^{a}	8867^{a}	3293^{a}
LSD (0.05)	2.388	NS	1.952	890.4	287.5
N (kg ha^{-1})					
0	60.28^{c}	6.333^{c}	37.18^{b}	5417^{d}	1864 ^{d}
23	68.40^{b}	6.386^{c}	39.84^{ab}	7417^{c}	2668 ^{c}
46	68.19^{b}	6.539^{bc}	39.47^{ab}	7900^{bc}	3003 ^{bc}
69	71.79^{a}	6.822^{ab}	39.54^{ab}	9483^{a}	3603^{a}
92	68.86^{ab}	6.867^{a}	41.27^{a}	9000^{ab}	3376^{bc}
115	67.33 ^{b}	6.867^{a}	41.79^{a}	9250 ^{a}	3449 ^{a}
LSD (0.05)	3.377	0.2974	2.760	1259.3	406.6
CV (%)	4.1	3.7	5.7	12.8	11.7

Means followed by the same letter with in the same column of the respective treatment are not significantly different ($P \leq 0.05$) according to fishier Test, PH= plant height, SPL= spike length, SPS= seed per spike, BM= biomass, GY= grain yield, CV = Coefficient of variation, LSD = Least Significant differences, NS = not significant

Plant Height

The analysis of variance indicated that plant height was not affected by the interaction effect of TSP and nitrogen. However, it significantly ($p < 0.05$) and highly significantly ($p < 0.01$) influenced by the main effect of TSP and nitrogen respectively (Table 1).

Increasing the amount of both TSP and N rates increased significantly plant height. The maximum application rate of TSP (200 kg ha^{-1}) resulted in the highest plant height (68.76 cm). Similarly, the highest plant height (71.79 cm) was recorded in the highest (69 kg ha^{-1}) N rate while no fertilizer application recorded the shortest plant height (Table 1). In agreement with this result Diriba *et al.*, (2019) reported the highest (95.5 cm) plant height by application of 300 kg ha^{-1} blended TSPB and 100kg urea fertilization.

Spike Length

The analysis of variance indicated that different rates of nitrogen fertilizer was highly significantly ($p < 0.01$) influenced spike length of Bread wheat crop. However, this parameter was not influenced by both the main effect of TSP and the interaction effect of TSP and nitrogen (Table 1).

The maximum application rate of 115 kg N ha^{-1} resulted in the highest (6.867 cm) spike length. While no fertilizer application has recorded the shortest spike length (6.333 cm) (Table 1). This result is consistent with (Tilahun *et al*., 2021 who reported the highest (7.367 cm) spike length by application of 150 kg N ha^{-1} for bread wheat. This result is also in line with (Lemi and Negash, 2020) who recorded the highest (8.73cm) spike length for Ogolcho variety at 100/100 kg ha^{-1} NPSZnB/Urea application.

Number of Seed per Spike

The analysis of variance indicated number of seed per spike was not affected by interaction effect of TSP and nitrogen. However it was significantly ($p < 0.05$) influenced by the main effect of each TSP and nitrogen (Table 1).

The result indicated that there was constant rate of increments on the number of seed per spike, as the rate of each TSP and N enhanced from the lowest rate to the highest rate of fertilizer application. The result showed that, highest (41.02) and (41.79) number of seed per spike were recorded by the maximum application rate of 200 kg TSP ha^{-1} and 115 kg N ha^{-1} respectively While nil fertilizer application was recorded the smallest number of seed per spike (Table 1). This result is consistent with the finding of (Tilahun *et al*., 2021) who reported the highest (39.94) number of seed per spike by application of 200 kg NPS ha^{-1} for bread wheat. This result is also in parallel with the finding of Dinkinesh *et al*., (2020) who reported the highest (42.7) number of seed per spike by application of 183 kg ha^{-1} blended NPSB for durum wheat.

Biomass Yield

The analysis of variance indicated Biomass was not affected by the interaction effect of TSP and nitrogen fertilizer rates. However, it was highly significantly (p <0.01) influenced by the main effect of each TSP and nitrogen fertilizers (Table 1).

Biomass Yield has been increasing as the rate of TSP and N increased from the lowest rate to the highest application rates. The result showed that the highest (890.4 kg ha^{-1}) and (9483 kg ha^{-1}) biomass yields were recorded by the maximum application rate of 200 kg TSP ha^{-1} and 69 kg N ha^{-1} respectively. While nil fertilizer application was recorded the smallest biomass yield per all plots (Table 1). The result is in parallel with Dinkinesh *et al*., (2020) who reported the highest (11772 kg ha^{-1}) biomass yield by application of the highest (183 kg ha^{-1}) NPSB for durum wheat varieties. Similarly, (Eyasu *et al*., 2020) reported that application of 200 kg NPSZnB resulted in the highest 16.9 tone ha^{-1} biomass yield of wheat.

Grain Yield

Grain yield, biomass yield, seed per spike, spike length, plant height of bread wheat significantly responded (p<0.001) to P fertilizer application rate. Grain yield significantly (p<0.001) affected by P rate. Thus the application of 50 kg P ha^{-1} gave a significantly higher grain yield. Moreover, the determination of Pc defined by the Cate Nelson method for the study area was 10 ppm with a mean relative yield response of about 66%. The soil available phosphorus vs phosphorus fertilizer of the district was ranges 6.39 and 12.26 ppm for 0 and 50 kg P ha^{-1} respectively. The P requirement factor (Pf), is computed from the difference between available soil test P values from plots that received 0-50 kg P ha^{-1}. Where the available p vs. p fertilizer applied were ranges 6.39 to 12.26 ppm for 0 and 50 kg P ha^{-1} respectively. Where the Pf of the district were ranged from 3.98 to 8.40 and the overall average Pf of all treatments was 6.45 for the study area.

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 (100% marginal rate of return (MRR)) was considered as the minimum acceptable rate of return (CIMMYT, 1988).

Table 2: Partial budget and marginal analysis for TSP and N rate of bread wheat

urea (kg ha^{-1})	TSP (kg ha^{-1})	Adjusted yield down wards by 10% (kg ha^{-1})	Gross Benefit (Birr ha^{-1})	Total variable cost (Birr ha^{-1})	Net return (Birr ha^{-1})	MRR %
0	0	1,450	43,506	-	43,506	-
0	100	1,508	45,248	2,000	43,248	D
0	200	2,075	62,253	3,600	58,653	D
50	0	1,824	54,734	1,100	53,634	921
50	100	2,575	77,252	2,700	74,552	D
50	200	2,804	84,110	4,300	79,810	D
100	0	2,259	67,784	1,800	65,984	1,764
100	100	2,808	84,245	3,400	80,845	3,959
100	200	3,041	91,224	5,000	86,224	D
150	0	2,975	89,258	2,500	86,758	8,702
150	100	3,268	98,028	4,100	93,928	3,023
150	200	3,486	104,571	5,700	98,871	4,607
200	0	2,538	76,127	3,200	72,927	D
200	100	3,285	98,550	4,800	93,750	2,788
200	200	3,294	98,816	6,400	92,416	D
250	0	3,059	91,782	3,900	87,882	9,743

Where, TSP cost = 16 Birr kg^{-1}, UREA cost = 14 Birr kg^{-1}of N, TSP, bread wheat grain per ha = 30 Birr kg^{-1}, TSP and Urea application cost = 400 Birr ha^{-1}, MRR (%) = Marginal rate of return, D= Dominated treatment.

As indicated in Table 2, the partial budget and dominance analysis showed that the highest net benefit 98,871 Birr ha^{-1} was obtained in the treatment that was treated with 150 kg ha^{-1} urea and 200 kg TSP ha^{-1} while the lowest net benefit 43,506 Birr ha^{-1} was obtained in the control treatment.

Determination of Phosphorus critical concentration and P-requirement factor

The Cate_Nelson graphical method was employed to determine the phosphorus critical point for bread wheat in a Dugda district. Accordingly, the phosphorus critical concentration above which the responses of the crop become minimal was 10ppm for bread wheat production (Fig 1).

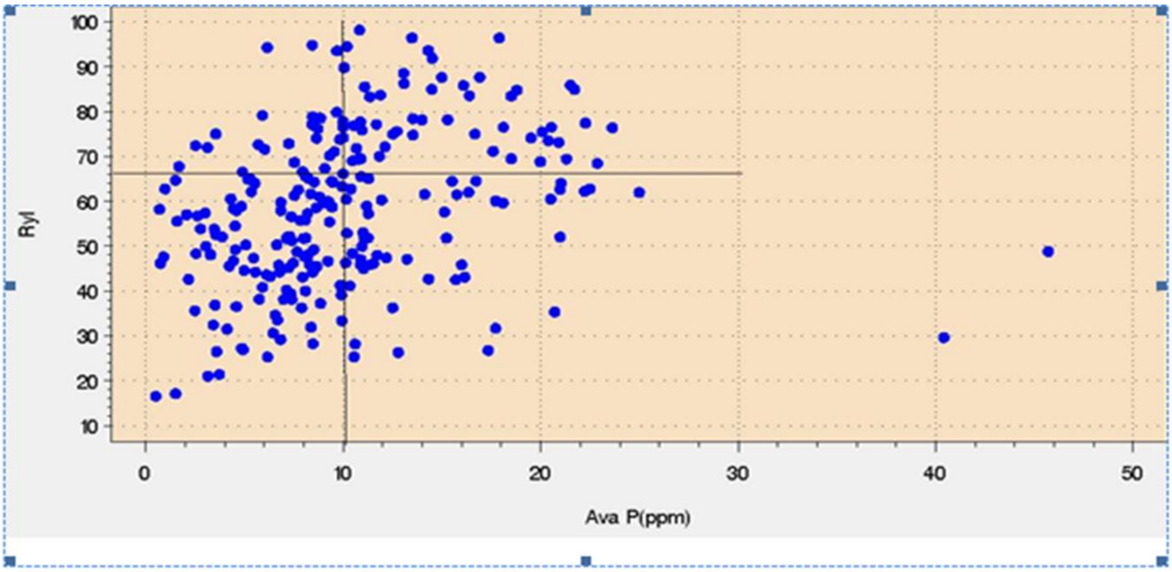

Fig : Phosphorus critical concentration for Bread wheat at Dugda District, 2021.

Table 3: Determination P-requirement factor in Dugda District

treatments kg P ha^{-1}	Olsen - P (ppm)		P increase Over control	P requirements factor kg P^{-1} (ppm)/ Δ P
	Range	Average		
0	0.92-10.06	6.39	-	-
10	1.60-22.24	8.90	2.51	3.98
20	1.52-23.64	10.21	3.82	5.23
30	3.88-21.72	10.98	4.59	6.54
40	1.70-22.88	11.15	4.76	8.40
50	1.00-25.00	12.56	6.17	8.10
Mean				6.45

Phosphorus requirement factor (Pf) is the amount of phosphorus in kg needed to raise the soil phosphorus by 1ppm for bread wheat crop at Dugda district was 6.45 (Table 3).

Table 4: Mean grain yield and yield components as influenced Phosphorus fertilizer application

P-applied Kg ha^{-1}	N Kg ha^{-1}	Plant height(cm)	Spike length(cm)	Seed/ spike	BM Ton ha-^{1}	GY Qt. ha-^{1}
0	0	69.89c	6.24c	35.13b	6.20c	20.69b
10	69	80.67b	7.07b	40.99a	8.93b	35.61a
20	69	82.77a	7.16a	41.85a	9.48ba	38.48a
30	69	83.26a	7.16a	41.79a	9.56ba	39.08a
40	69	83.82a	7.23a	41.79a	9.88a	39.97a
50	69	83.91a	7.00ba	42.47a	9.90a	39.98a
LSD(0.05)		2.30	0.24	2.23	1.01	4.24
CV (%)		5.88	7.84	12.43	25.65	27.02

Grain yield, biomass yield, seed per spike, spike length, plant height of bread wheat significantly responded ($p<0.001$) to P fertilizer application rate. Grain yield significantly ($p<0.001$) affected by P rate. Thus application of 50 kg P ha^{-1} gave significantly higher grain yield. Moreover, the determination of Pc defined by the Cate Nelson method for the study area was 10 ppm with mean relative yield response of about 66%. The soil available phosphorus vs. phosphorus fertilizer of the district was ranges 6.39 and 12.26 ppm for 0 and 50 kg P ha^{-1} respectively. The P requirement factor (Pf), computed from the difference between available soil test P values from plots that received 0-50 kg P ha^{-1}. Where the available p vs. p fertilizer applied were ranges 6.39 to 12.26 ppm for 0 and 50 kg P ha^{-1} respectively. Where, the Pf of the district were ranges 3.98 to 8.40 and the overall average Pf of all treatments was 6.45 for the study area.

CONCLUSION AND RECOMMENDATION

Ethiopia is also one of the largest wheat producers in Sub-Saharan Africa and approximately 80% of the wheat area is planted to bread wheat (Asfaw *et al*. 2013). However, according to the report (FAOSTAT, 2019), its productivity has been 19.38 % far below the world's average yield. This is might be due to the blanket way of fertilizer application in type (only DAP and Urea) and amount without considering agro-ecology and crop types. Such practice leads to inefficient use of fertilizers by wheat since the amount to be applied can be more or less than the crop requires. Therefore, soil test-based crop response and site-specific P fertilizer application with newly introduced fertilizers such as TSP are very important for fertilizer recommendations to improve the trend and increase crop yield. Therefore, this study was conducted to determine the economically optimum rate of nitrogen fertilizer in the first year and the treatments have consisted of factorial combinations of three levels of TSP (0, 100, and 200) kg ha^{-1} with six levels of nitrogen (0, 23, 46, 69 92 and 115) kg ha^{-1} that gave a total of eighteen treatments. However, in the second two consecutive years the experiment was conducted to determine phosphorus critical (Pc) and phosphorus requirement factor (Pf and the treatments consisted of six levels of phosphorus (0, 10, 20, 30, 40, and 50) kg ha^{-1} combined with a single level of nitrogen (69 kg ha^{-1}) that gave a total of seven treatments. The experiments were laid out in randomized complete block design (RCBD) with two replications and the gross plot size was 4 m x 5 m (20 m^2) were used to determine optimum nitrogen in the first year and 4m x 5m (20 m^2) and phosphorus critical (Pc) and also harvested from $4m^2$ plot areas. The analysis of variance indicated that Plant height, spike length, number of seeds per spike, biomass yield, and grain yield were highly significantly ($p < 0.01$) influenced by the main effect of nitrogen fertilizer rates. However except for the number of seed per spike, TSP fertilizer significantly ($p<0.05$) affect plant height and the number of seed per spike as well as highly significantly ($p < 0.01$) biomass and grain yield of bread wheat. The highest (68.76 cm) plant height, the highest (41.02) seed per spike, the highest (8867 kg ha^{-1}) biomass, and the highest (3293 kg ha^{-1}) grain yield were recorded by 200 kg TSP ha^{-1}. The highest (71.79 cm) plant height, the highest (9483 kg ha^{-1}) biomass, and the highest (3603 kg ha^{-1}) grain yield were recorded by 69 kg N ha^{-1}. However, the highest (6.867 cm) spike length and the highest (41.79) numbers of seed per spike were recorded by 115 kg N ha^{-1}. Moreover, from all tasted parameters the lowest values were recorded by control plots. The economic analysis revealed that for a treatment to be considered as worthwhile to farmers (100% marginal rate of return) application of 69 kg N ha^{-1}) is profitable which gave the highest (98871 Birr) net return with an acceptable (4607%) marginal rate of return and recommended for farmers in Dugda district. On the other hand, the analysis of variance indicated that Plant height, spike length, number of seeds per spike, biomass yield, and grain yield were highly significantly ($p < 0.01$) influenced by soil test-based phosphorus fertilizer application. The result indicated that the highest (83.9 cm) plant height, the highest (9900 kg ha^{-1}) biomass, and the highest (39980 kg ha^{-1}) grain yield were recorded by 50 kg P ha^{-1}. Moreover, 10ppm phosphorus critical (Pc) and 6.45 ppm phosphorus requirement factor (Pf) were identified for bread wheat production for the farmers of Dugda District.

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REFERENCES

- Alem, A. T., & Legese, H. (2018). Effects of fertilizer rate (blended) and sowing methods on yield of bread wheat (Triticum aestivum) and its economic profitability in Western Ethiopia. *International Journal of Comprehensive Research in Biological Sciences*, *5*(7), 1-14.
- Silva, J. A., & Uchida, R. (2000). Plant Nutrient Management in Hawaii's Soils, Approaches for Tropical and Subtropical Agriculture, eds. College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa.
- FAOSTAT (Food and Agriculture Organization of the United Nations). (2018). (Online) Available at http://www.fao.org/faostat/en/#data. Accessed on August 22, 2021.
- Rouse, R. D. (1967). Organizing data for soil test interpretation. p. 115-123. In Hardy, G. W. (ed.) Soil testing and plant analysis. Part 1. SSSA. Spec. Publ. 2. SSSA, Madison, WI.
- Sonon, L. S., & Zhang, H. (2014). Soil test calibration work in southern USA. University of Texas A and M University, USA.
- Negassa, A., Shiferaw, B., Koo, J., Sonder, K., Smale, M., Braun, H. J., ... & Geleta, A. B. (2013). The potential for wheat production in Africa: Analysis of biophysical suitability and economic profitability. Mexico, D.F.: CIMMYT.
- CIMMYT (International Maize and Wheat Improvement Center). (1988). From Agronomic Data to Farmer Recommendations: An Economics Training Manual. Completely revised edition. Mexico, DF. 79p.
- Dinkinesh, A., Tamado T., & Tadesse, D. (2020). Effects of Blended TSPB Fertilizer Rates on Yield and Grain Quality of Durum Wheat (*Triticum turgidum* L.) Varieties in Minijar Shenkora District, Central Ethiopia: Ethiop. *J Agric Sci*, *30*(3), 57-76.

- Elias, E., Teklu, B., & Tefera, T. (2020). Effect of blended fertiliser application on bread wheat yield, agronomic efficiency and profitability on Nitisols of Southern Ethiopia. *South African Journal of Plant and Soil*, *37*(4), 292-299.
- Food and Agriculture Organization of the United Nations (2019).FAOSTAT (Online). Available at: http://www.fao.org/faostat/en/#data/QC.
- GenStat. (2012). GenStat Executable Release 15.2. Lawes Agricultural 425 Trust, Rothamstead Experimental Station, Harpenden, Clarendon 426 Press, London.
- Hailu, H., Mamo, T., Keskinen, R., Karltun, E., Gebrekidan, H., & Bekele, T. (2015). Soil fertility status and wheat nutrient content in Vertisol cropping systems of central highlands of Ethiopia. *Agriculture & Food Security*, *4*(19), 1-10.
- James, D. M. (2014). Botany. Jones & Bartlett Publishers. p. 223. ISBN 978-1-4496-4884-8. Perhaps the simplest of fruits are those of grasses (all cereals such as corn and wheat)...These fruits are caryopses.
- Gejea, K. A., Erenso, T. F., & Banja, T. 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).
- Lemi, A., & Negash, G. (2020). Effects of Variety and Fertilizer Rate on Yield of Bread Wheat (Triticum aestivum, L) Varieties in East Wollega Zone, Western Ethiopia: *Agricultural and Biological Sciences Journal*, *6*(2), 60-71.
- Duressa, L. A., & Ayana, N. G. (2020). Effects of variety and fertilizer rate on yield of Bread Wheat (Triticum aestivum L.) Varieties in East Wollega Zone, Western Ethiopia. *J. Agric. Biol. Sci*, *6*(2), 60-71.
- MoA (Ministry of Agriculture). (2016). Ministry of Agriculture, Animal and Plant Health Regulatory Directorate. Crop variety register, Issue No. 19. Addis Ababa, Ethiopia.
- Tagesse, A., Ketema, B., & Tamado, T. (2018). Effect of Blended TSP Fertilizer Supplemented with Nitrogen on Yield Components and Yield of Bread Wheat (Triticum aestivum L.). *Journal of Natural Sciences Research*, *8*(11). ISSN 2224-3186.
- Abera, T., Lemma, A., Hundesa, C., Husen, A., & Firomsa, T. (2021). Response of Yield Components and Yield of Bread Wheat (Triticum aestivum L.) to Blended NPS and N fertilizers Levels at Liban Chukala District, East Shewa Zone, Oromia, Ethiopia. *International journal of research and innovation in earth science*, *8*(1), 2394-1375.
- Ishete, T. A., & Tana, T. (2019). Growth, yield component and yield response of durum wheat (Triticum turgidum L. var. Durum) to blended NPS fertilizer supplemented with N rates at Arsi Negelle, Central Ethiopia. *African Journal of Plant Science*, *13*(1), 9-20.