Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.8, No.1, 2018

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

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Abstract
Nutrient management is indispensable for crop production and productivity increments on different soil types. Therefore soil nutrient calibration study is pertinent to increase efficiency use of inorganic fertilizer like DAP and Urea. Based on this understanding site specific soil test based crop response studies for P on bread wheat was made from year 2010-2012 at Lume district. The objective of the experiment was to determine economically optimum N, Phosphorus critical (Pc) and Phosphorus requirement factor. The experimental treatments was developed by factorial combination of four levels of N (0, 46, 92 and 138 Kg ha-1) and P (0, 23, 46 and 92 Kg ha-1) chemical fertilizer that laid out in randomized complete block design with two replications and 40m^2 plot area for each. After 21 days, intensive composite soil samples were collected from each plot for the determination of available P in ppm. Plant height, biomass and grain yield data were collected from 9m^2. The collected data were subjected to two way factorial analysis of variance (ANOVA) using the General Linear Model (GLM) procedures of SAS (SAS, 2001). Comparison of treatment means was performed using Fisher's Least Significant Difference test at $P < 0.05$ probability level. The application of N indicated that significant difference between plant height, biomass and grain yield of bread wheat. However the application of P was not significant on plant height, straw yield and grain yield at Lume whereas the interaction effect of N and P application on grain yield, plant height and straw yield correlation was significant. Furthermore, the study was revealed that phosphorus critical (Pc) point for bread wheat was **19**, and phosphorus requirement factor were also **4.92**. In addition, a partial budget analysis made using the annual average bread wheat grains prices showed **46 kg** N ha^{-1} gave a marginal rate of return of 187%, which is above acceptable minimum rate of return.
Keywords: P- critical, P- requirement factor, partial budget, Acceptable minimum rate of return

INTRODUCTION

The population of Ethiopia is currently growing at a faster rate and demands an increased proportion of agricultural products. On the other hand, growth in food production is not in equal footings with population pressure (Central Statistical Agency, 2015). Strengthening food production capability of the country by wisely exploiting its existing human and natural resources is critical option to avert the existing situation. But, Ethiopia is one of the sub-Saharan African countries where severe soil nutrient depletion restrains agricultural crop production and economic growth. The annual per-hectare net loss of nutrients is estimated to be at least 40 kg N, 6.6 kg P and 33.2 kg K (Scoones and Toulmin, 1999). Continuous cropping, high proportions of cereals in the cropping system, and the application of suboptimal levels of mineral fertilizers aggravate the decline in soil fertility (Tanner *et al*., 1991; Hailu *et al*., 1991; Workneh and Mwangi, 1992). Hence, identification of proper fertilizer mix is beneficial at the macroeconomic level by improving the efficiency of fertilizer procurement and resource allocation.

Therefore, profitable crop production requires adequate levels of phosphorus (P) and other nutrients. For this careful planning is required because of volatile grain and fertilizer prices. So, sound soil test calibration is essential for successful fertilizer program and crop production. It is essential that the results of soil tests could be calibrated or correlated against crop responses from applications of plant nutrients in question as it is the ultimate measure of a fertilization program. An accurate soil test interpretation requires knowledge of the relationship between the amount of a nutrient extracted by a given soil test and the amount of plant nutrients that should be added to achieve optimum yield for each crop (Sonon and Zhang, 2008). Hence, calibration is a vital tool to attain the objective while calibrations are specific for each crop type and they may also differ by soil type, climate, and the crop variety. That means, fertilizer recommendations on soil test basis for economic crop production should be both location and situation specific and can be modified with changes in soil test value as well as input output ratios.

Therefore, this field experiment was done with the basic assumption that fertilizer recommendations typically depend on crop response experiments in which spatial variability has been minimized for every independent variable affecting crop yield except for the nutrient in question, (Kastens et al., 2003).

Objectives

- To determine and evaluate P fertilizer requirement for bread wheat based on soil test crop response in Lume district
- To give quantitative guidelines and recommendations of P and N fertilizers for bread wheat in Lume district

MATERIALS AND METHODS

Descriptions of Study Area

The study was conducted at Lume district, East Shewa Zone of Oromia regional state, which capital town located at 73 kilometers far from Finfine (Addis Ababa) to the East. Geographically Lume district located between 8^0 24'300" to 8^0 49'30" North and 39^0 01'00" to 39^0 17'00" East with total area coverage 67514.73 hectares (Figure 1). The Elevation ranges from 1590 to 2512 meters above sea level, whereas the average elevation is 1909 meters above sea level.

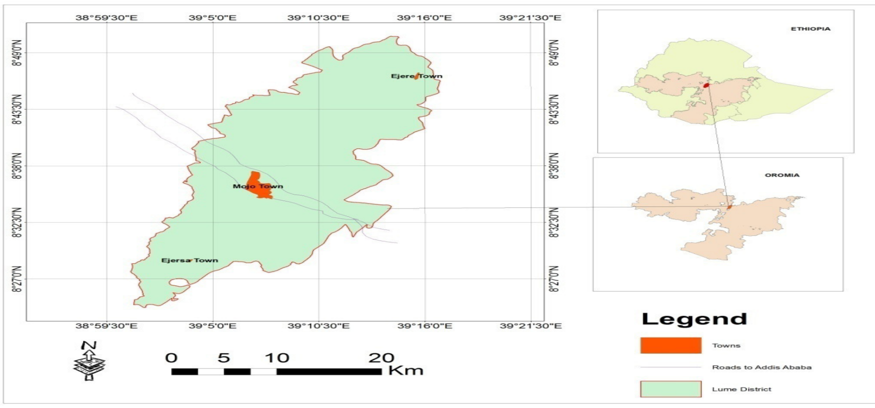

Figure 1: Location map of Lume district

Climate

Climate influences the physical and cultural environments, the types of vegetation, animals reared and crops to be grown, the land use patterns and ultimately the economy. So, Lume area is generally characterized by semi-arid and sub-humid climate based on the moisture index classification of climate (Lemma Gonfa, 1996). The long term average seasonal (June -September) rainfall which influence the rain fed agricultural practices of the year, ranges from 571.86 to 920.44 mm. The minimum monthly average rainfall of 2.70 mm was recorded at Modjo station month of December and maximum monthly average rainfall of 276.07 mm at the same station month of July. The mean monthly rainfall of five stations within and nearest to the study area was calculated from the 10 years of data from 1999 to 2009, which was collected from National Meteorological agency (Figure 2). On other hand, the maximum mean monthly temperature of 32.13 ^oC is recorded at Koka dam station in month of April whereas the lowest minimum mean monthly temperature of 6.86 ^oC was recorded at Chefe-Donsa station in month of December. Hence, crops growth is influenced by total daily mean heat accumulated, which is related to the daily mean temperature (White *et al.,* 2001). Figure 3 shows the monthly minimum and maximum temperature of four stations within and nearest to Lume district.

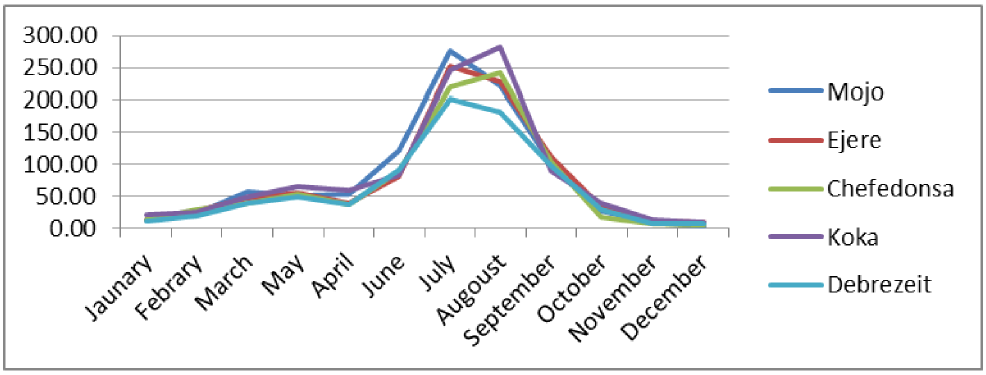

Figure 3. Monthly rain fall of five stations with in and nearest the district

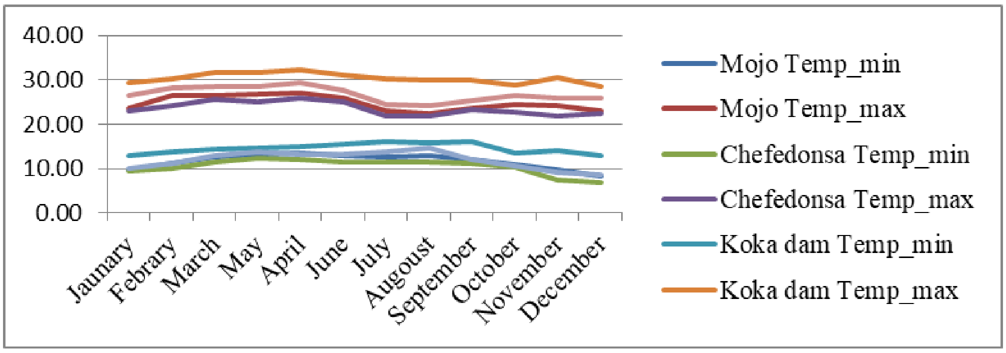

Figure 3. Monthly minimum and maximum temperature

Soil

Soil is defined (Davidson, 1980) as a natural body consisting of layers or horizons of mineral and / or organic constituents of variable thickness, which differ from the parent material in their morphological, physical, and chemical properties and their biological characteristics. According to FAO (1984a) soil classification the soil of Lume district grouped into seven soil type, which is mainly dominated by Eutric Vertisol (44.84%), mollic andosols (21.69) and Luvic Phaeozems (14.76).

Land Use Land Cover

The farming system of the study area is sedentary mixed agriculture and crop rotation is also one of the systems of soil fertility management in advancement. Chemical fertilizer application is another system to increase crop production per unit area. The major crop types in the area are teff, chickpea and wheat. These crops are scaled up by development agents and farmers on the basis of their economic benefits. This indicates that no crop type mainly dominate the area for a long year as the past historical farming systems with less inputs and market assessment and prediction. Generally, major land use of the project area is grouped into four that includes Agricultural land (93.13%), Plantation forest (2.76%), settlements (2.34%) and flower farms (1.77%)

Methodology

The study was conducted on farmers' fields across the district. First composite soil sample was made in zigzag method from **24 f**armers land and analyzed for soil texture, soil pH, OC, total N, available P, available K, CEC in order to identify the level of the required parameters in the soil to select farm land for actual experiment. Based on the level of P content a total of 10 farm lands were selected. The experiment was laid out in randomized complete block design with two replications. The treatment considered for both crops were four levels of P_2O_5 (0, 23, 46, and 96)s and four levels of N (0, 46, 92 and 138) in a factorial combination plus two levels of potassium as satellite treatments to investigate the response of potassium (Table. 1). Replications were folded to minimize soil heterogeneity within each replication.

Table 1. Description of treatments

Treatment # (T1-T6) *($N:P_2O_5:K_2O$ kg ha^{-1})*	Treatment # (T7-T12) *($N:P_2O_5:K_2O$ kg ha^{-1})*	Treatment # (T13-T18) *($N:P_2O_5:K_2O$ kg ha^{-1})*
T1 *(0:0:0)*	T7 *(46:46:0)*	T13 *(138:0:0)*
T2 *(0:23:0)*	T8 *(46:92:0)*	T14 *(138:23:0)*
T3 *(0:46:0)*	T9 *(92:0:0)*	T15 *(138:46:0)*
T4 *(0:92:0)*	T10 *(92:23:0)*	T16 *(138:92:0)*
T5 *(46:0:0)*	T11 *(92:46:0)*	
T6 *(46:23:0)*	T12 *(92:92:0)*	

Gross plot size: 5m x 8m Harvested area: 3m x 3m

Land preparation was done using the local ox plow. Then, amount of seed and fertilizer per plot were weighed, bread wheat seeds and fertilizers (total DAP and half urea) were sown by scatter method. After 21 days of plantation, composite soil samples were taken at 0-15 cm depth using auger for each treatment and replications separately, and the samples were subjected to laboratory analysis using Olsen method. Intensive sampling after 21 days of planting was with the assumption that fertilizer P might be available to plant in the given days interval. With continuous field management, all field agronomic data and post harvest data were collected including, date of emergency, date of flowering, number of tiller, maturity date, height, yield and biomass. Based on soil available P laboratory analysis result of pre-planting and post planting soil composite samples (available P values in samples collected from unfertilized and fertilized plots) data, p requirement factor was calculated that enables one to determine the quantity of P required per hectare to raise the soil test by 1 mg kg^{-1} (1 part per million), and to determine the amount of fertilizer required per hectare to bring the level of available P above the critical level. Hence:

Pr = kg P applied/change in soil P

For the determination of critical values of P, the Cate-Nelson diagram method (Nelson and Anderson, 1977) was used, where soil P values were put on the X-axis and relative yield values on the Y-axis, and scatter points were divided into two populations. Hence soil and yield data from 10 sites of all treatments with their replications were used for such analysis**.** This was achieved by overlay of a clear plastic sheet having a pair of perpendicular lines drawn on it to produce four quadrants, roughly of the same relative size. The overlay was then positioned on the graph in such a way that the maximum number of points fell in the positive quadrants while the lowest number fell in the negative quadrants. The vertical line defines the responsive and non-responsive ranges whereas; the optimum is indicated by the point where the vertical line crosses the x-axis.

On the other hand, economic analysis was performed to investigate the economic feasibility of the treatments. Partial budget, dominance, marginal and sensitivity analyses were used. The average yield was adjusted downwards to reflect the difference between the experimental plot yield and the yield farmers will expect from the same treatment. The average grain yield also adjusted by reducing 10% to minimize the over estimation of yield when yield of small plot converted to hectare basis. The average open market price (Birr kg^{-1}) of bread wheat, urea (N) and DAP (P) fertilizers were used for analysis. For a treatment to be considered a worthwhile option to farmers, the minimum acceptable rate of return (MARR) should be 100% (CIMMYT, 1988), which is suggested to be realistic. This enables to make farmer recommendations from marginal analysis.
Finally, using Phosphorus requirement factor, Phosphorus critical level and initial P values (soil P value from composite soil sample before fertilization) rate of P fertilizer to be applied was calculated as follows:

Rate of P fertilizer to be applied = (Critical P conc.- initial P values) × P requirement factor.

Data Management and Analysis

All agronomic and soil data which were collected across locations was properly managed using the EXCEL computer software. The collected data was subjected to the analysis of variance using the SAS computer package version 9.0 (SAS Institute, 2002) statistical software.

RESULTS AND DISCUSSION

A field experiment was designed and studied to identify bread wheat response to the applied P at Lume district from 2010-2012 on 10 farm lands, which include determination of soil P critical, P requirement factor and N optimum. Accordingly, Bread wheat experimental data analysis result indicated that, most of the treatments significantly produce mean grain yield as compared to the control. That means, except treatment 2, 3 and 4 (those treatments with zero level of nitrogen fertilizer), all the rest produce significant mean grain yield as compared to the control (Table 2). Accordingly, the mean grain yield ranged from 1945.28 kg/ha (Control) to 4217.67 kg/ha (92 P_2O_5 level/treatment 16/). This result signifies that the existence of positive interaction of P and N fertilizers for the production of bread wheat, and the responsiveness to the application of high level fertilizer phosphorus. Similarly, previous research output reported by Desta (1978), Mesfin (1980) and Asnake and Tekalign (1991), also supports this experimental result. According to Mesfin Kebede, and Tekalign Tadesse (2012), experiment made in 2005 at Chefe Donsa, Ude and Akaki on durum wheat, highest yield was observed at soil tests P raised to 6.91, 7.39 and 7.40 ppm, respectively.

On the other hand, the experimental result also indicated that, consistently increment and significantly difference of all required bread wheat agronomic parameter (plant height, straw yield and grain yield) as compared to zero as well as between levels, with the increment level of fertilizer N applications. This significant difference on agronomic parameter with required N fertilizer levels signifies very low soil capacity to supply crop with N nutrient. Conversely, the increment of the level of fertilizer P did not indicated the significant difference between all levels for all agronomic parameter (Table 3 and 4,). This was might be because of initial (unfertilized soil) P level of the soil. But the Correlation coefficient between agronomic parameter (Plant height, straw yield and Grain yield) on bread wheat was statistically significant at 0.05 probability level (Table 5).

Table 2. Response of bread wheat grain yield to NP fertilizers application on Eutric Vertisol soil

Fertilizer		P			
	Trt	0	23	46	92
N	0	1945.28 ^{f}	1946.32^{f}	1957.15^{f}	2009.44^{f}
	46	2962.86 ^{d}	3188.2 ^{dc}	3163.627^{d}	3181.87^{d}
	92	3657.58 ^{bc}	3885.98^{ba}	3766.98^{ba}	4024.49^{ab}
	138	4045.17 ^{ab}	4087.67^{ab}	4217.67^{a}	4205.39^{a}
LSD (0.05)		466.94			
C.V %		23.1			

N = nitrogen ; P= phosphorus; LSD= Least Significance Difference ; CV = coefficient of variation.

Table 3: Effect of P (kg/ha) applied on plant height, straw yield and grain yield on bread wheat crop at Lume District.

	Agronomic parameter		
P (kg/ha)applied	pt Ht(cm)	Syld(kg/ha)	Gyld(kg/ha)
0	75.74a	6330.78a	3151.72a
23	75.70a	6812.86a	3283.81a
46	75.95a	7251.93a	3276.35a
92	77.00a	6885.00a	3349.25a
LSD < 0.05	NS	NS	NS

*Pt Ht = (plant height cm); Syld = Straw yield(kg/ha); Gyld = Grain yield(kg/ha); LSD = Least Significance Difference

Table 4: Effect of N (kg/ha) applied on plant height, straw yield and grain yield on bread wheat crop at Lume District.

	Agronomic parameter		
N kg/ha)applied	pt ht(cm)	Syld(kg/ha)	Gyld(kg/ha)
0	65.02d	4684.0c	1964.6d
46	76.09c	6209.1b	3124.1c
92	80.56b	7902.8a	3833.8b
138	82.81a	8394.6a	4139.0a
LSD < 0.05	1.71	1055.4	23.1

*Pt Ht = (plant height cm); Syld = Straw yield(kg/ha); Gyld = Grain yield(kg/ha); LSD = Least Significance Difference

Table 5: Correlation coefficient between Plant height, straw yield and Grain yield on bread wheat crop at Lume District.

	Correlation coefficient		
	pt ht (cm)	Syld (kg/ha)	Gyld (kg/ha)
plant height ht(cm)	1.00	0.245(<.0001)	0.746(<.0001)
Straw yield (kg/ha)	0.245(< .0001)	1.00	0.278(<.0001)
Grain yield (kg/ha)	0.746(<.0001)	0.278(<.0001)	1.00

*Pt Ht = (plant height cm); Syld = Straw yield (kg/ha); Gyld = Grain yield (kg/ha)

Determination of Optimum Nitrogen Fertilizer Application for Bread Wheat

Optimum yield can be gained in the presence of all available essential nutrients at balanced and optimum level where phosphorus and nitrogen are the most deficient essential nutrient in the country. Therefore, determination of optimum nitrogen fertilization level during P fertilizer calibration is the most important procedure. Hence, determination of optimum nitrogen fertilization level was done by partial economic analysis procedure, which is **46 kg N/ha** for bread wheat on eutric vertisols soil for Lume area

Determination of P Critical for Bread Wheat

For the determination of critical values of P, the Cate-Nelson diagram method (Nelson and Anderson, 1977) was used, where soil P values were put on the X-axis and relative yield values on the Y-axis, and scatter points were divided into two populations. Then, by moving the two perpendicular lines vertically and horizontally, until the number of points showing through the overlay in the two positive quadrants is at a maximum (or conversely, the number of points in the negative quadrants is at a minimum). Finally, the point where the vertical line crosses the X-axis was defined (taken) as 'critical soil test levels. Hence, P critical values for bread wheat at Lume area on vertisols soil were **19 ppm** (Figure 3).

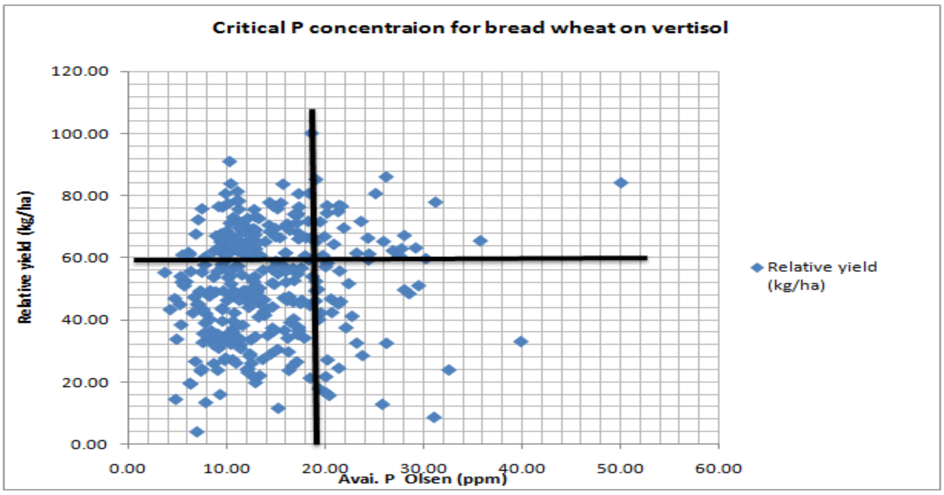

Figure 3. Relative yield Vs P Olsen plot chart for P critical determination

Determination of Phosphorus Correction Factor (Pf)

Calculated phosphorus requirement factor (Pr), which is the amount of P in kg needed to raise the soil test P by 1ppm for bread wheat production at Lume area was **4.92**. These Phosphorus requirement factor enables to determine the quantity of P required per hectare to raise the soil test by 1 ppm, and to determine the amount of fertilizer required per hectare to bring the level of available P above the critical level (Table 4).

Table 4. Determination of P requirement factor (Pf) for bread wheat, Lume

Fertilizer treatment kg P ha^{-1}	Olsen - P (ppm)		P increase Over control	*P requirements factor= kg P P^{-1} (ppm)
	Range	Average		
0	3.83-23.25	10.93		
10	5.36-39.88	13.64	2.71	3.69
20	4.84-31.08	14.62	3.69	5.42
40	6.45-50	18	7.07	5.66
Mean olsen				**4.92**

CONCLUSION AND RECOMMENDATIONS

- Phosphorus calibration study has been conducted on bread wheat for two years (2011-2012 growing season) at Lume district.
- Accordingly, Optimum nitrogen rate (46 kg N/ha), critical P (Pc) concentrations (19 ppm) and P (Pf) requirement factors (4.92) for bread wheat have been determined, at Lume bread wheat growing area on Eutric vertisols soil.
- Farther verification of the result on farm land could be a pre request before disseminating the technology to the user.

Acknowledgements

First of all, we thank our God who enables us, in all circumstance, to perform our research activity properly. Secondly, the authors would like to thank Oromia Agricultural Research Institute and Zeway Soil Research Center for funding the research and providing all the necessary facilities required for the research, respectively. At last but not at least, our special thank also forwarded to all staff members, especially to Laboratory analysis team for their support and unreserved effort to provide reliable samples analysis data on time.

REFERENCES

Asgelil Dibabe, Taye Bekele and Yesuf Assen. 2007. The Status of micro-nutrients in Nitosols, Vertisols, Cambisols and Fluvisols in major maize, wheat, teff and citrus growing areas of Ethiopia. pp 77-96. *In*: Proceedings of Agricultural Research Fund Research Projects Completion Workshop Held on 1-2 February 2007 at Ethiopian Institute of Agricultural Research.

Asnakew Wolde-ab, Tekalign Mamo, Mengesha Bekele and Tefera Ajema. 1991. Soil Fertility Management of wheat in Ethiopia. pp. 112-144. In: Hailu Gebre Mariam, Tanner, D.G and Mengestu Hulluka (ed). Wheat Research in Ethiopia historical perspective. IAR/CIMMYT, Addis Ababa

Beyene, D. 1978. Fertilizer Response of Crops at Indibir. IAR Soil Science Bulletin, Institute of Agricultural Research, Addis Ababa, Ethiopia.

L.M. Condron. 2004. Phosphorus-Surplus and Deficiency. Danish Institute of Agricultural Science, Research Center Foulum, Tjele, Denmark.

Central Statistical Agency, 2015. Agricultural sample survey report on crop and livestock product utilization 2014/2015 (2007 E.C.). Bulletin 578, Volume VII.
Centeral Statistical Authority (CSA), 2000. Agricultural sample survey: Report on area and production for major crops (private peasant holdings) of 1999/2000. Statistical Bulletin (1) 193, Addis Ababa, Ethiopia.
CIMMYT. 1988. From Agronomic Data to Farmer Recommendations: An Economics Training Manual. Completely revised edition. Mexico, D.F. ISBN 968-6127-18-6
FAO 1984a. Assistance to Land-Use Planning, Ethiopia: Geomorphological and Soil. Field Document AG DP/ETH/78/003. The United Nations Development Programme and Food and Agriculture Organization. FAO, Rome.
FAO, 1984. Physical and chemical methods of soil, plant analysis. FAO soil Bulletin No. 10, FAO of the United Nations, Rome, 1984.
Getachew Sime * and Jens B. Aune, 2014. Maize Response to Fertilizer Dosing at Three Sites in the Central Rift Valley of Ethiopia. agronomy: ISSN 2073-4395. www.mdpi.com/journal/agronomy.
Hesse, R.L., 1971.A text book of soil chemical analysis. William clowes and Sons Ltd., London.
Kastens TL, Schmidt J, Dhoyvetter KC, 2003. Yield models implied by traditional fertilizer recommendations and a framework for including non-traditional information. Soil Science Society of America Journal.;2003, 67:351–364
Lema Gonfa 1996. Climate classifications of Ethiopia. National Meteorological Service**s** Agency, Addis Abeba, Ethiopia.
Mamo, T. Haque I. 1991. Phosphorus Status of some Ethiopian soils. III Evaluation of soil test methods for available Phosphorus. Tropical Agriculture, Trinidad.
Mesfin Abebe. 1980. State of Soil Science Development for Agriculture in Ethiopia. Ethiopian journal of Agricultural Science 2 (2): 139-15.
Mesfin Kebede, and Tekalign Tadesse[1], 2011 **.** Indexing soil P to recommend for durum wheat in East Shewa, Oromiya Region. Report and Opinion 2011;3(1):134-140]. (ISSN: 1553-9873). http://www.sciencepub.net
Mesfin Kebede, 2012. Journal of Environment and Earth Science www.iiste.org. ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online) Vol 2, No.1, 2012.Indexing soil P to recommend for durum wheat in East Shewa, Oromiya Region.
Nelson. L.A. and Anderson. R.L. (1977): Partitioning of soil test crop response probability. *In* M. Stelly (ed.), Soil Testing, Correlating and Interpreting the Analytical results. ASA Special publication 29, Madison, Wisconsin: 19-38.
Olsen, S.R. Cole, Watanable, F.S. and Dean, L.A. (1954) Estimation of available phosphorus in soils by extraction with sodium bicarbonate. Circ. U.S. Dep. Agric. 939.
P. Schjonning, S.Elmholt, and B.T. Chritsensen. 2004. Manageing Soil Quality; Challenges in Modern Agriculture. Danish Institute of Agricultural Science, Research Center Foulum, Tjele, Denmark
SAS. 2002. User's Guide: Statistics Version 9.00. SAS Institute, Inc., Cary, North Carolina.USA.
USDA Soil Survey Staff, 1982. Soil Survey Laboratory method and procedures for collecting soil samples. Soil survey investigation report No. 1, soil conservation services, Washington: 63p
Walkley, A.J. and Black, I.A. (1934) Estimation of soil organic carbon by the chromic acid titration method. Soil Sci. 37: 29-38.

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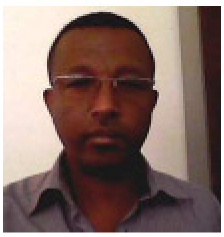

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1. Characterization and classification of irrigated soils and irrigation waters of major water supply sources in Meki Ogolcha area in East Shewa Zone of Oromia. The Ethiopian Journal of Sciences and Sustainable Development, Journal of Adama University. Volume Number 2, may 2001, Adama, Ethiopia.
2. Problem factors' characterization and classification of water logging site of Likime area North Shewa Zone of Oromia Region, Ethiopia. International Journal of Research and Inovations in Earth Science (IJRIES). Volume-3, Issue-3, Sept-2016.
3. Soil fertility assessment and mapping at Shashamane district, West Arsi Zone, Oromia, Ethiopia.

International Journal of Research and Inovations in Earth Science (IJRIES). Volu www.ijries.org

4. Phosphorous Requirement Mapping for Maize at district, West Arsi Zone, Oromia, Ethiopia. Research and Innovations in Earth Science (Online), September, 2016: 2394-1375. International Journal of Research and Innovations in Earth Science ISSN (Online) : 2394-1375
5. 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 Inovations in Earth Science (IJRIES). Volume-3, Issue-6, Nov-2016. www.ijries.org, ISSN: 2394-1375.
6. Evaluation of the Effect of Salt Affected Soil on Selected Hydraulic Properties of Soils in Meki Ogolcha Area in East Showa Zone of Oromia Region, Ethiopia. Journal of Biology, Agriculture and Healthcare www.iiste.org ISSN 2224-3208 (Paper) ISSN 2225-093X (Online) Vol.6, No.21, 2016.
7. Assessement of Physicochemical Properties of Soils as Influenced by Different Land Uses in Bedele Area in Ilubabor Zone, Southwestern Ethiopia. **International Journal of Agriculture Innovations and Research Volume 5, Issue 4, ISSN (Online) 2319-1473.**
8. Characterization of Physicochemical Properties of Soils as Influenced by Different Land Uses in Bedele Area inIlubabor Zone, Southwestern Ethiopia. Journal of Natural Sciences Research. www.iiste.org, ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online), Vol.7, No.5, 2017.
9. Phosphorus Critical Level and Optimum Nitrogen Rate Determination on Teff for Sustainable Soil Fertility Management and Economical Teff Production at Lume Area of Oromia Region, Ethiopia. Journal of Biology, Agriculture and Healthcare. www.iiste.org. ISSN 2224-3208 (Paper) ISSN 2225-093X (Online). Vol.7, No.19, 2017.

In addition there are five published papers on proceeding and also Editor of two published proceedings.