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Determination of Soil P for Optimum Durum Wheat Production in Ada'a, Akaki and Chefe Donsa of The East Shewa, Oromiya Regional State In Central Ethiopia

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Abstract

To respond to the ever escalating prices of chemical fertilizers and getting optimum crop production per unit usage of fertilizers for the continually increasing population, an on-farm soil test based phosphorous determination research experiment was carried out at three locations of East Showa during 2005-07 cropping seasons. Thirty six farmers field were selected for this study. Six levels of phosphorous including the blanket recommendation (0, 11.50, 22.99, 34.49, 45.98 and 57.50 kg P_2O_5) were applied as a treatment, replicated four times and each treatment were laid out in RCBD experimental design. All experimental plots received recommended level of nitrogen (60 kg N) uniformly from urea. The analytical results of both agronomic as well as soil data have showed that application of 34.49 kg P_2O_5 ha^{-1} and 22.99 kg P_2O_5 ha^{-1}at Ude and Akaki provided the maximum mean grain yields of 3.75 and 2.44 t ha^{-1}, respectively in 2005. In the 2006 cropping seasons, however, the absence of any application of external phosphorous gave the highest (3.38 t ha^{-1}) at Chefe Donsa and the least mean grain yield (1.74 t ha^{-1}) was recorded in Ude by 34.49 kg P_2O_5 . In the final year of this study, the results revealed that the two treatments from Chefe Donsa and Akaki gave the maximum comparable mean grain yields 4.89 and 4.49 t ha^{-1} by the application of 57.50 and 22.99 kg P_2O_5 but and the least yield was obtained through the application of soil P only (1.88t) in Ude. This study showed that all the thirty six farms do vary in terms of phosphorous contents and hence blanket recommendation by no means governs wheat yields. Therefore, a total of thirty six regression equations, one for each farmers field, were developed and out of which eighteen were selected in order to map the soil P that remained after phosphorous application in each plot, farm and mineralization of soil reserve (ppm) versus different levels of phosphorous addition resulted in biomass yield of wheat. Accordingly, an average of 97.0, 96.5 and 96.5 (2005), 86.0, 93.0, and 89.5 (2006) and 92.0, 91.5, and 92.5% (2007)remained in the soil for every application of external phosphorous at Akaki, Chefe Donsa and Ude, respectively. In most years, an average of over 85% of the applied phosphorous remained in the soil. In some locations, non-significant differences among the mean grain as well as straw yields of wheat were obtained due to this. It seems that these soils are being saturated by the application of phosphorous all years around with blanket recommendation and probably the crop might get its demand from other means or forms in the soil system rather than from the applied source. Therefore, any phosphorus recommendation for optimum durum wheat production should be on the basis of its soil P value. This experiment also proved that even if the soil phosphorous continuously increases through the application of external phosphorous, it didn't reflect in the increment rather forced to decline mean grain yield. Further research work has to be conducted to find out the mechanisms of how plant use phosphorous from the soil and even the extraction methods along with soil types, environment and in its interaction.

Keywords: Equation, extractions, on-farm, P-values, soil test, regression

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1. Introduction

The biggest challenges facing modern agriculture with respect to phosphorous nutrition is the establishment and maintenance of appropriate balance between providing sufficient phosphorous inputs to sustain production, and minimizing diffuse phosphorous transfer and its associated impacts on environmental quality (Schjonning, *et.al*., 2004).

Accordingly, soil test based fertilizer doses especially those of macronutrients are accepted as being more rational, balanced, efficient and profitable as compared to blanket recommendation. Ethiopia imported between 200 000 and 380 000 MT of DAP and Urea annually (CSA, 2000) since 1966 following the recommendation of Murphy's survey's results indicating that nitrogen and phosphorous were limiting crop production (Murphy, 1963). Since then, however, blanket application of 100 kg DAP and 100 kg Urea was used all over the country irrespective of the climate, soil type, crop species or variety, altitude, precipitation, water availability, and evapo-transpiration. This costs the country huge amount of money in hard currency every year and disrupt the balance between providing sufficient phosphorous and its associated impact on soil quality.

The establishment of phosphorous management thresholds in the high and low intensity farming systems will require determination of the appropriate amounts and forms of phosphorous inputs, together with continued development of strategies for efficient phosphorous cycling, designed to maintain economically viable levels of production with minimum phosphorous transfer (Condron, 2004). In this line, research results of 21 experiments showed that the response rates to fertilizer (kg grain kg^{-1} of nutrients) was 12.6 when fertilizer rates were based on soil test in contrast to 7.8 by adopting the blanket recommendations (Randhawa and Velayuthan, 1982). This figure shows that the advantage of soil test based recommendation; increment of about 5 kg of grain per kg of nutrients.

For long, it was believed that phosphorus, next to nitrogen, is one of the major plant nutrients and satisfactory level of both grain and forage production on Vertisols totally depends on its adequate supply (Mesfin, 1980). According to Asnakew and Tekalign (1991) soil fertility trials carried out at Holleta on red and black soils, both nitrogen and phosphorous significantly affected wheat grain yields. The highest mean grain yields were obtained with the application of 60 kg N and 60 kg P_2O_5 per ha. This is an indication of equivalent need of nitrogen and phosphorous for optimum crop production. Phosphorous fertilizer rates considerably vary depending on crop and soil factors as well as differences in fertilization recommendation philosophies. In general, the fertilizer recommendation at high soil test levels is regarded as an insurance measure with the intention that the recommender wishes to be sure that fertilizer does not become a limiting factor and that crop production is at optimum level. Researcher should, therefore, recommend basing phosphorous fertilizer rate on soil test and other soil factors and maintaining fertilization according to crop removal for effective and efficient use of fertilizers.

Earlier attempt in Ethiopia was made by Desta in 1978 to study fertilizer response and crop performance under acidic soil at Indibir. The study showed that there was fertilizer response on selected crops. Later on Tekalign and Haque employed eight chemical methods for estimating the available phosphorous in 32 Ethiopian soils using Phasey beans as a test crop grown on small pots in greenhouse and soil test values then correlated with plant characteristics (Tekalign and Haque, 1991). Olsen method gave the highest correlation with the percentage yield and phosphorous uptake in all three cuts and also was giving 97 percentage correct predictions. Research studies by Desta (1978) at Indibir showed that the effects of phosphate fertilizer on the grain yield of maize and on soil phosphate. It includes practical recommendations for nitrogen and phosphate fertilization in the cultivation of maize, triticale, tef and potato. Detailed studies on prescribing soil and nutrient needs of a crop were made by Whitney *et al.* (1985) and suggest that to focus on soil testing and plant analysis. Research results of Akande *et al.* (2010) showed that phosphate application significantly enhanced dry matter yield of maize and cowpea. Residual and applied phosphorous changes the performance of sorghum (Manzoor *et al.*, 2010). Englistad (1985) wrote in detailed how fertilizer technology goes up and its impact on its uses. Similarly, authors like Beatan (1973), Brown (1987) and Westrnmann (1990) all suggested that soil testing is vital for fertilizer recommendation.

Basing fertilizers, especially the macronutrient (those needed in large quantity by the plant), dose on soil testing has never been more important to Ethiopia than it is today in view of large escalation in fertilizer prices. 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. Ethiopian farmers practicing unbalanced fertilizer use or those using blanket doses for long time will gain most from soil test based fertilizer applications. However, Beatan (1973), Brown (1987) and Westermann (1990) all suggested that any fertilizer recommendation philosophies should take soil test values as baseline information while Manzoor *et al.* (2010) finds it residual and applied phosphorous are pertinent and Akande *et al.* (2010) relies on the presence of phosphate rock and its recovery should be the bases of any recommendations. Therefore, the objective of this experiment was to investigate a soil test value of phosphorous recommendation for optimum durum wheat production in Ada’a, Chefe Donsa and Ude Wereda’s of East Showa.

2. Materials and Methods

2.1 Site description

Akaki is found 30 km North of Debre Zeit and its geographic location is at 08^{0}53$'$39” North latitude and 38^{0}49$'$13” East longitude. It has a soil dominated by heavy clay and Eutric Vertisols. It has an altitude 2400m a.s.l and hot to warm sub-humid climate (NMA, 2007). Chefe Donsa is located 35 km east of Debre Zeit and its geographic location is at 08^{0}57$'$15” North latitude and 39^{0}06$'$04” East longitude. Its textural class is Heavy Clay and Soil Types was Eutric Vertisol, Altitude 2450m a.s.l, and is hot to warm sub-humid climate (NMA, 2007). Ude is located 60 km East of Addis Ababa and its geographical extent ranges from 08^{0}45$'$15$''$ to 08^{0}46$'$45$''$ North latitude and from 38^{0}46$'$45$''$ to 39^{0}01$'$00$''$ East longitude. The soil textural class was Loam and having the haplic Andosols, Vitric Andosols and Vertisols. The mean annual rainfall, mean maximum and monthly temperatures ranges between is 801.3mm, 25.5 ^{0}C, 23.7 in July & 27.7^{0}C in may, respectively. The mean annual minimum temperature is 10.5^{0}C, monthly values ranges between 7.4 in December and 12.1^{0}C in July and August. It has an altitude 1850m a.s.l and hot to warm sub-humid climate (NMA, 2007).

2.2 Soil characteristics

The soil textural classes in the experimental areas were found to range from silty loam to heavy clay and having the soil types Haplic Andosols, Vitric Andosols and Eutric Vertisols. Before planting composite soil samples and after harvest, from plots that receive different levels of phosphorous were sampled and analyzed. Accordingly, a total of 252 soil samples, 36 composite soil samples before planting and 216 soil samples after harvest from each plot (one sample is made of a composite of 15 augur sub-samples from a given experimental plot) were collected, prepared and analyzed for its phosphorous. Olsen method was used for the determination of available phosphorous (Olsen *et al.*, 1954).

2.3 Treatments

The experiment was carried out on 36 farmers’ field at three locations (Ude, Akaki and Chefe Donsa) of East Showa under their own management conditions. Four farmers were selected from a single location for a year, each farmer serve as a replication and a total of thirty six farmers were involved for three years in this study. The test crop was durum wheat, *klinto* variety with the recommended seed rate (150kg ha^{-1}). The plot size was 10m by 10m with a total effective plot area of 600 m^2 (20m by 30m) and the design for this experiment was RCBD. There was 1.5 and 1m spacing between block and experimental plot, respectively. Triple Super Phosphate (TSP) with six different levels (0, 11.50, 22.99, 34.49, 45.98 and 57.50 kg P_2O_5) was used as a treatment. All experimental plots received recommended level of nitrogen (60 kg N) from urea. Statistical software packages such as Microsoft Excel were used to compile and summarize while SAS used to make statistical analysis and development of regression equations.

3. Results and Discussion

3.1 Agronomic Result

On the contrary of the previous research reports by Desta (1978), Mesfin (1980) and Asnake and Tekalign (1991) most of the treatments failed to significantly produce mean grain yield as compared to the control. For instance, at Akaki, except in the 2005 cropping season, the treatments did not show any significance differences for the mean grain yields of wheat. Accordingly, the highest (2.66 t ha^{-1}) and the lowest mean grain yield (1.79 t ha^{-1}) were obtained by the application of the blanket recommendation and the highest rate of phosphorus, respectively. During 2006, however, although not significant, two treatments, the absence of any application of phosphorous and with 34.49 kg, gave the highest mean grain yield of 2.91 t each. The treatments have shown a significant difference in the mean straw yield but not in grain yield for the last cropping season (2007). The control group even performs better than with few P-fertilizer levels both in the mean grain yield at 11.50 and 45.98 kg P_2O_5. Significant differences for the straw yield would result the maximum and minimum yields of 5.60 and 4.82 t of straw by 57.50 and the control, respectively (**Error! Reference source not found.**). Even though at Chefe Donsa significant differences were observed in the mean grain yield of durum wheat for every application of the phosphorous but the blanket recommendation failed to beat the lower levels of applied phosphorous in terms of mean grain yield. Accordingly, the highest (2.77 t) and the lowest (2.09 and 2.19 t) was recorded by 11.50, 57.50 and 0 kg P_2O_5 (2005). Also similar trends were followed in 2006. The highest and the least mean grain yield of 3.38 and 2.34 t was obtained with the absence of any application of phosphorous and by the treatment with the additional 34.49 kg of P_2O_5 over the soil. In 2007, 57.50 kg P_2O_5 gave the highest mean grain (4.89 t) and followed by 34.49, 45.98, 11.50, 22.99, and control, respectively with 4.07, 3.94, 3.80, 3.58 and 3.50 t, respectively. Even though a non-significant difference was observed for the straw yields, the maximum Straw yield (6.53t ha^{-1}) was obtained with heavy application of phosphorous and the lowest (4.96 t) for without any application of it. And the soil in this location indicates its responsiveness to phosphorous fertilization to some extent (**Error! Reference source not found.**). Significant differences were observed in the mean grain yield for all the three years and straw, too, except the last two years at Ude for straw yield. Accordingly, the highest (3.75 t) and the least mean grain yield (2.64 t) were observed by the following treatments (34.49 and 0 kg P_2O_5). In 2006, however, the maximum mean grain yield of 2.66 tone was obtained the application of only 11.50 kg of P_2O_5, followed in diminishing order by phosphorous application rates of control (2.54 t), 57.50 (2.27t) and 22.99 (2.22t). Furthermore, the lowest grain yield of 1.74 t was obtained with the application 34.49 kg of phosphorous. However, the trend is different when we look into the straw yield. The highest mean straw yields of 4.97 t, of the lowest grain yield, and 4.57 t were obtained with the 34.49 and 22.99 kg P_2O_5 applications, respectively. In 2007, the highest mean grain yield (3.53 t) was obtained with the application of 57.50 kg P_2O_5 and followed by 22.99 and then back to 45.98 kg having the yield of 3.29 and 3.11 kg ha^{-1}, respectively (Table **Error! Reference source not found.**). The least grain yield was obtained by the soil phosphorous only. This showed that the soil in Ude is responsive to any P fertilizations regarding the mean grain yield. Contrarily to the grain yield, the mean straw yield showed non-significant differences. Results of the works of Akande *et al.* (2010) showed that the yield of maize significantly increases with increasing levels of phosphorous and its recovery by cow pea. Comparison of the residual and applied phosphorous on the yield and quality of fodder sorghum showed that residual phosphorous contribute to the yield and quality of sorghum (Manzoor *et al.*, 2010). Non-significant difference among the treatments on yield of wheat can be due to the residual effects having received from blanket recommendations for years in these farms. Besides, the residual and applied phosphorous, crop and soil type along with climate would be the possible reasons for having different results than reported earlier.

In most of the years and location, the blanket recommendation failed in short of producing its positive influence in mean grain yield of wheat. According to recommendation of Condron (2004) and Schjoning *et al.* (2004), to maintain economically viable levels of wheat production with minimum phosphorous transfer and keeping the balance between providing sufficient phosphorous inputs to sustain production, and minimizing diffuse phosphorous transfer and its associated impacts on environmental quality should be taken in to account for recommendations along with the soil P value.

3.2 Soil Result

By taking the two variables (*Y*, residual soil phosphorous after harvesting (ppm), *dependant*, and *X*, the externally applied phosphorous as a treatment (kg ha^{-1}), *independent variable*) a regression equations were developed by using SAS. All the discussions took into account the mean grain yield of wheat in relation to the amount of applied as treatment and the remaining phosphorous in the soil after every harvest. Accordingly, thirty six regression equations were developed but only eighteen were selected for making an index for optimum durum wheat production. Thus, equations 1-6, 6-12 and 12-18 represent the regressions equations for 2005, 2006 and 2007 years, respectively. In all these regression equations, cd, u and a are referring to Chefe Donsa, Ude and Akaki, respectively.

$Ycd = 0.102X+4.27$,	$R^2=0.96$	Equation 1
$Ycd = 0.112X+5.46$,	$R^2=0.97$	Equation 2
$Yu = 0.250X+5.83$,	$R^2=0.91$	Equation 3
$Yu = 0.110X+4.38$,	$R^2=0.87$	Equation 4
$Ya= 0.1702X+2.29$,	$R^2=0.97$	Equation 5
$Ya= 0.1002X+4.33$,	R2=0.97	Equation 6

The highest mean grain yields were obtained as a result of the application of only 11.50 kg P_2O_5 (6.75 ppm), 34.49 kg P_2O_5 (8.17 ppm), and 45.98 kg P_2O_5 (8.91 ppm) at Chefe Donsa, Ude and Akaki, respectively (2005).

$Ycd = 0.11x+4.07$,	$R^2=0.89$	Equation 7
$Ycd = 0.04x+4.16$,	$R^2=0.97$	*Equation 8*
$Yu = 0.2497x+5.83$,	$R^2=0.92$	Equation 9
$Yu = 0.108x+4.38$,	$R^2=0.87$	*Equation 10*
$Ya = 0.13x+4.93$,	$R^2=0.99$	Equation 11
$Ya = 0.093x+6.02$,	$R^2=0.73$	*Equation 12*

In 2006, the soils P in all the three locations have the correlations values ranges from 86.6 to 99.5% with the average values of 92.8, 90.2 and 96.2% for Chefe Donsa, Ude and Akaki, respectively. Ude is found to behave a bit less than that of Chefe Donsa and Akaki by 2.8 and 6.2% respectively. The reason for this would be the weathering frequency of the soil due to environmental factors especially the fluctuation in temperature and soil types. At Akaki and Chefe Donsa, the highest ranges were observed and hence the average as well. Accordingly, the P values and levels are found to be in increasing order from Ude, Chefe Donsa and Akaki. This means that of the applied treatments 92.8 for Chefe Donsa, 90.2 for Ude and 96.2% for Akaki remain in the soil system after the plant uptake and loss. Thus, it is a good indication for recommending the amount of phosphorous. Even though the correlation values between applied phosphorous and that remained in the soil after harvest were a bit lower than that of Tekalign and Haque

(1991), the trends would predict the same.

In order to obtain the maximum mean grain yield at Akaki (2.91 t), we need to have 6.60 ppm (Equations 11), at Chefe Donsa, the soil phosphorous was sufficient to produce the highest yield (Equation 7 and 8) and in Ude 2.66 t would be a results of 5.62 ppm (Equations 10).

Ycd = 0.1068x+4.36,	R^2=0.86	Equation 13
Ycd = 0.0857X+7.74,	R^2=0.97	Equation 14
Yu= 0.1302x+6.42,	R^2=0.97	Equation 15
Yu= 0.1106x+5.60,	R^2=0.88	Equation 16
Ya= 0.0965x+5.25,	R^2=0.87	Equation 17
Ya= 0.192x+7.86,	R^2=0.97	Equation 18

2007 showed a bit different observations. 94.8, 91.2 and 85.5% correlations were found between the treatments and soil P for Chefe Donsa, Ude and Akaki, respectively having the ranges from 74.32 to 96.53 in Akaki. Except in Akaki, increasing correlations were observed for the rest two locations; Chefe Donsa and Ude. Comparably the highest mean grain yields were obtained with the application of 22.99 kg P_2O_5 (4.66 t) and the highest rates (4.64 t) for Akaki and the Chefe Donsa(4.89 t) but at 11.50 kg P_2O_5 all yields by having 10.80, 7.47 and 8.23 ppm (Equations 13-18). In Ude, increasing levels of P_2O_5 by one step (11.50) from the control (0) yields positives effect and continuously decrease and rise. Application of 11.50 and 22.99 kg P_2O_5 yields 7.92 and 9.42 ppm, and thus the highest grain yield was obtained with this level and decreases with increasing application at 92 %. At Akaki, the soil P is already 7.86 ppm for the first and second respectively and didn't respond to phosphorous application at 85.4% (74-97%). According to the suggestions made by Beatan (1973), Brown (1987) and Westermann (1990) on soil test values, Manzoor *et al.* (2010) on residual and applied phosphorous, and Akande *et al.* (2010) on the presence of phosphate rock and its recovery should be the bases of any recommendations.

Table 1 Mean grain and straw yields of durum wheat as affected by the application of P-fertilizer at Akaki

Treatment	2005		2006		2007	
(P_2O_5)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)
0.00	2.13ab	2.98	2.91	3.23	4.49	4.82c
11.50	2.17ab	2.92	2.85	3.28	4.45	4.65bc
22.99	2.44a	3.18	2.89	3.24	4.66	5.03ab
34.49	2.22ab	2.92	2.91	3.23	4.61	4.14c
45.98	2.66a	3.69	2.89	3.24	4.32	4.48bc
57.50	1.79b	2.87	2.86	3.27	4.64	5.60a
CV (%)	14.89	17.16	8.18	8.22	14.91	10.97
Mean	2.24	3.09	2.88	3.25	4.53	4.79
LSD 5%)	0.61	NS	NS	NS	NS	0.918

Means within a column followed by different letters are significantly different as judged by LSD at $P \leq 0.05$.

Table 2 Mean grain and straw yields of durum wheat as affected by the application of P-fertilizer at Chefe Donsa

Treatment	2005		2006		2007	
(P_2O_5)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)
0.00	2.19c	4.64	3.38a	4.22	3.50b	4.96
11.50	2.77a	5.87	3.05a	3.97	3.80b	5.13
22.99	2.57abc	4.44	3.08a	4.12	3.58b	5.01
34.49	2.24bc	5.74	2.34b	3.26	4.07b	6.11
45.98	2.75ab	5.42	3.10a	3.69	3.94b	5.40
57.50	2.09c	4.83	3.09a	3.70	4.89a	6.53
CV (%)	11.70	19.10	11.56	16.69	10.92	17.63
Mean	2.44	5.16	3.01	3.83	3.96	5.52
LSD 5%)	0.61	NS	NS	NS	NS	0.918

Means within a column followed by different letters are significantly different as judged by LSD at $P \leq 0.05$.

Table 3 Mean grain and straw yields of durum wheat as affected by the application of P-fertilizer at Ude

Treatment	2005		2006		2007	
(P_2O_5)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)	Grain Yield ($t\ ha^{-1}$)	Straw Yield ($t\ ha^{-1}$)
0.00	2.64b	3.82c	2.54ab	4.35	1.88b	4.41
11.50	3.33ab	5.01a	2.66a	4.31	2.45b	4.11
22.99	3.36ab	4.75ab	2.22abc	4.57	3.29a	5.25
34.49	3.75a	4.52abc	1.74c	4.97	2.43b	4.78
45.98	3.31ab	4.64abc	2.02bc	4.54	3.11a	5.53
57.50	2.73b	4.00bc	2.27abc	4.00	3.53a	5.67
CV (%)	16.40	10.52	14.62	12.5	12.41	17.59
Mean	3.19	4.46	2.24	4.46	2.78	4.96
LSD 5%)	0.61	NS	NS	NS	NS	0.918

Means within a column followed by different letters are significantly different as judged by LSD at $P \leq 0.05$.

4. Summary and Conclusion

The highest mean grain yield was obtained as a result of the application of only 11.50 kg P_2O_5 (6.75 ppm), 34.49 kg P_2O_5 (8.17 ppm), and in 45.98 kg P_2O_5 (8.91ppm) at Chefe Donsa, Ude and Akaki, respectively (2005). In 2006, the soils P in all the three locations have the correlations values ranges from 86.6 to 99.5% with the average values of 92.8, 90.2 and 96.2% for Chefe Donsa, Ude and Akaki, respectively. Ude is found to have the values a bit less than that of Chefe Donsa and Akaki by 2.8 and 6.2% respectively. In order to obtain the maximum mean grain yield at Akaki (2.91 t) we need to have 6.02 ppm. Similarly, at

Chefe Donsa, the soil P was sufficient to produce the highest yields. 2.66 t would be a result of 5.83 ppm from 11.50 kg P_2O_5. 2007, a bit different observations were found. 94.8, 91.2 and 85.5% correlations were found between the treatments and soil P for Chefe Donsa, Ude and Akaki, respectively having the ranges from 74.32 to 96.53 in Akaki. Except in Akaki, increasing correlations were observed for the rest two locations; Chefe Donsa and Ude. Comparably the highest mean grain yields were obtained with the 22.99 kg P_2O_5 (4.66 t) for Akaki and the Chefe Donsa (4.89 t) for 57.50 kg P_2O_5 yields by having 7.47, and 8.23 ppm, respectively. The possible reasons for having different phosphorous amount in the different farmers field would be the fertilizer usage philosophies, weathering frequency of the soil due to environmental and soil factors, and cropping patterns. Thus, determination of soil P can serve as a good indication for recommending the amount of phosphorous to be added on the field for optimum crop production.

From this we can see that the soils of experimental sites do differ in their ability for supplying soil nutrients especially phosphorous, even in the same location among farmers fields. Besides, from the result of this study we can notice that the residual effect of the previously and continuously applied blanket phosphorous in the soil do have an impact on the performance of the wheat, a test crop. Generally, in almost every regression equations, the amount of soil P values after applying different levels of phosphorous as a treatment showed correlation that ranged from 74.32-96.53% at Akaki and from 86.6 in Ude to 99.5% Akaki. This means that from the applied of every phosphorous rate an average of at least 74% remained in the soil. Thus, it is better to test the soil for its phosphorous prior to planting and further application of additional phosphorous sources. If soil P-value in these locations is about 7.39, 7.86 and 7.92 ppm or more, the soil will not respond in terms of yield increments rather the speeded up its accumulation at Chefe Donsa, Akaki and Ude, respectively. If the soil P is less than these ppms, we need to supplement an equivalent phosphorous till reaches 7.38, 7.89 and 7.92 ppm at Chefe Donsa, Akaki and Ude, respectively.

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